Bonfiglioli
Vectron

ACTIVE CUBE

Application Manual
Positioning
Frequency inverter 230 V / 400 V

Bonfiglioli

TABLE OF CONTENTS

1 General Information about the Documentation

1.1 Instruction manuals

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

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 frequency inverter by the software.

Operating Instructions

The Operating Instructions document 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.

Application manual

The application manual supplements the documentation for purposeful 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.

If you need a copy of the documentation or additional information, contact your local representative of BONFIGLIOLI.

The following instructions are available for the *ACTIVE CUBE* series:

ACTIVE CUBE Operating Instructions	Function of frequency inverter.
Quick Start Guide *ACTIVE CUBE*	Installation and commissioning Supplied with the device.
Manuals Communication interfaces	CM-CAN: CANopen manual CM-PDP-V1: Profibus DP-V1 manual CM-232/CM-485: VABus manual (serial protocol) CM-232/CM-485 Modbus: Modus ASCII and RTU manual CM-VABus/TCP: Ethernet Module CM-VABus/TCP CM-ModbusTCP: Ethernet Module CM-Modbus/TCP CM-EtherCAT®: Ethernet Module CM-EtherCAT® CM-ProfiNet: Ethernet Module CM-ProfiNet CM-EtherNet-I/P: Ethernet Module CM-EtherNet-I/P (i.V.)
Manuals Extension modules	EM-ABS-01: Absolute encoder module EM-ENC-01: Speed sensor (encoder) module EM-ENC-02: Speed sensor (encoder) module EM-ENC-03: Speed sensor (encoder) module EM-ENC-04: Speed sensor (encoder) module EM-ENC-05: Speed sensor (encoder) module EM-IO-01: Extension module for digital inputs/outputs EM-IO-02: Extension module for digital inputs/outputs EM-IO-03: Extension module for digital inputs/outputs EM-IO-04: Extension module for digital inputs/outputs EM-RES-01: Resolver module EM-RES-02: Resolver module EM-RES-03: Resolver module EM-SYS: System Bus module
Safe Torque Off (STO) manual	Safety function STO
Liquid Cooling - Complement to Operating Instructions	Properties specific to liquid cooled frequency inverters
Application manual "Parallel connection"	Parallel connection of Size 8 frequency inverters
PLC application manual	Logic linking of digital signals. Functions for analog signals such as comparisons and mathematical functions. Graphical support for programming with function blocks.
Application manual "Positioning"	Positioning functions of Configurations x40.
Application manual "Electronic gear"	Linking of at least 2 drives as electronic gear with Slave drive in Configuration x15 or x16.
Application manual "Hoist unit drives"	Advanced brake control for hoist unit drives.

The products for CANopen® communication comply with the specifications of the user organization CiA® (CAN in Automation).

The products for EtherCAT® communication comply with the specifications of the user organization ETG (EtherCAT Technology Group).

The present documentation was prepared with great care and it was subjected to extensive and repeated reviews. For reasons of clarity, it was not possible to include all details of all types of the product in the documentation. Neither was it possible to consider all conceivable installation, operation or maintenance situations. If you require further information or if you face specific problems insufficiently addressed in the documentation, contact your local BONFIGLIOLI agent.
The present document was created in German. Other language versions are translations.

1.2 This document

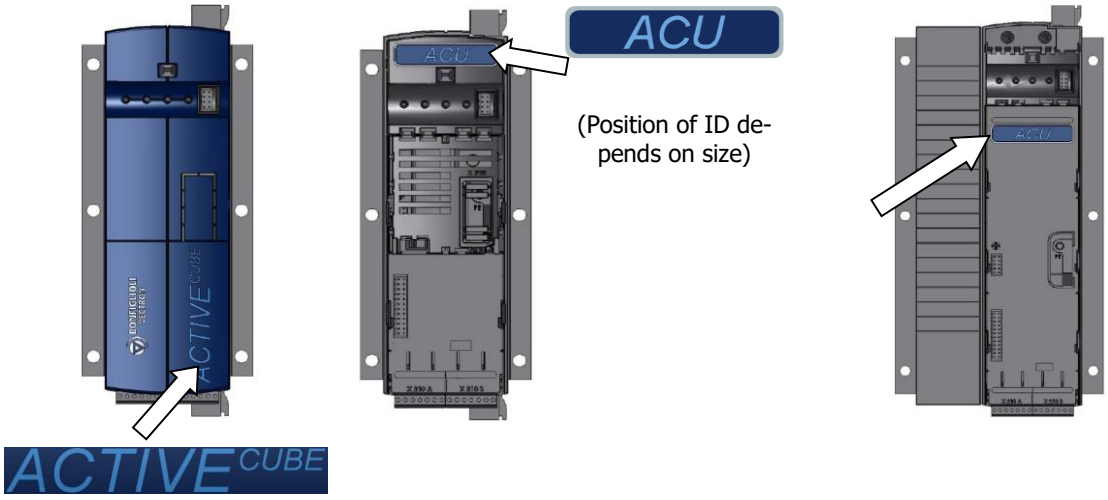
This document describes the positioning application functions for frequency inverters of the *ACTIVE Cube* series. The modular hardware and software structure enables customer-specific adaptation of the frequency inverters. Applications with high functionality and dynamism requirements can be realized easily.
The Operating Instructions contain important information on the installation and the use of the product in its specified application range. Compliance with this user manual contributes to avoiding risks, minimizing repair cost and downtimes and increasing the reliability and service live of the frequency inverter.
For this reason, make sure you read the Operating Instructions carefully.
IMPORTANT:
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.

For safe commissioning and operation of the ACU (ACTIVE Cube) series, the following documentation must be complied with:
- The Operating Instructions Document
- Application manual “Safe Torque Off ACU”

This document applies to the following frequency inverter series:
- ACTIVE Cube 210 / 201
- ACTIVE Cube 410/ 401
- ACTIVE Cube 510
- ACTIVE Cube 610

The ACTIVE Cube series can be recognized by its type plate on the case and the identification below the top cover.



1.3 Warranty and liability

BONFIGLIOLI Vectron GmbH (hereinafter referred to as "manufacturer") notes that the contents of this Operating Instructions document do not form part of any previous or existing agreement, assurance or legal relationship between the manufacturer and the user of these Operating Instructions (hereinafter referred to as the "User"). Neither are they intended to supplement or replace such agreements, assurances or legal relationships. Any obligations of the manufacturer shall solely be based on the relevant purchase agreement which also includes the complete and solely valid warranty stipulations. These contractual warranty provisions are neither extended nor limited by the specifications contained in this documentation.
The manufacturer reserves the right to correct or amend the specifications, product information and omissions in these operating instructions without prior notice. The manufacturer assumes no responsibility to update these Operating Instructions. The manufacturer shall not be liable for any damage, injuries or costs which may be caused by the aforementioned reasons.
In addition, the manufacturer excludes any warranty and disclaims all liability, including without limitation direct, indirect, special, punitive, incidental, exemplary or consequential damages arising out of or in connection with one or more of the following causes:

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

1.4 Obligation

These Operating Instructions must be read before commissioning and complied with. Anybody entrusted with tasks in connection with the

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

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

1.5 Copyright

In accordance with applicable law any copyrights relating to this document shall remain with

BONFIGLIOLI Vectron GmbH
Europark Fichtenhain B6
47807 Krefeld
Germany

1.6 Storage

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

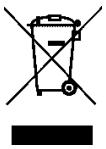
1.7 Final decommissioning

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

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

Disposal requirements under European Union WEEE regulations

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



2 General safety instructions and information on use

This chapter 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 who has special technical know-how and experience with electrical installations. In addition, Qualified Electricians must be familiar with the applicable standards and regulations, they must be able to assess the assigned tasks properly and identify and eliminate potential hazards.

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

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

2.2 Designated use

The frequency inverter is designed according to the state of the art and recognized safety regulations.
The frequency inverters are electrical drive components intended for installation in industrial plants or machines. Commissioning and start of operation is not allowed until it has been verified that the machine meets the requirements of the EC Machinery Directive 2006/42/EC and DIN EN 60204-1.
The frequency inverters meet the requirements of the low voltage directive 2014/35/EU and DIN EN 61800-5-1. CE-labelling is based on these standards. Responsibility for compliance

with the EMC Directive 2014/30/EU lies with the operator. Frequency inverters are only available at specialized dealers and are exclusively intended for commercial use as per EN 61000-3-2.
No capacitive loads may be connected to the frequency inverter.
The technical data, connection specifications and information on ambient conditions are indicated on the rating plate and in the documentation and must be complied with in any case.

2.3 Misuse

Any use other than that described in "Designated use" shall not be permissible and shall be considered as misuse.
For, example, the machine/plant must not be operated

- by uninstructed staff,
- while it is not in perfect condition,
- without protection enclosure (e.g. covers),
- without safety equipment or with safety equipment deactivated,
- when general requirements, such as operating conditions and technical data, are not met.

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

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

2.4 Residual risks

Residual risks are special hazards involved in handling of the frequency inverter which cannot be eliminated despite the safety-compliant design of the device. Residual risks are not obviously identifiable and can be a potential source of injury or a health hazard.
Typical residual hazards include:

- Electrical hazard
- Danger of contact with energized components due to a defect, opened covers or enclosures or improper working on electrical equipment.
- Danger of contact with energized components in frequency inverter if no external disconnection device was installed by the operator.

During operation, all covers must be installed correctly, and all electrical cabinet doors must be closed to minimize electrical hazards.
When LEDs and other indicating elements on the frequency inverter go out, this does not necessarily mean that the device is deenergized. Before carrying out any Work at the device where contact with energized parts might be possible, it must be checked in any case, i.e. irrespective of the status of any indicating elements that may be installed, if the device is deenergized.

Charged capacitors in DC link
Sizes 1 through 7 (up to 160 kW): The DC-link may have dangerous voltage levels even up to 3 minutes after shutdown.
Size 7 and 8 (as from 160 kW): The DC-link may have dangerous voltage levels even up to 10 (in some configurations up to 25) minutes after shutdown. The valid waiting period is indicated on the device housing.

Electrostatic charging
Touching electronic components entails the risk of electrostatic discharges.

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

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

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

2.5 Safety and warning signs on 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 Operating Instructions

2.6.1 Hazard classes

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

DANGER

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

WARNING

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

CAUTION

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

NOTICE

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

2.6.2 Hazard symbols

Symbol	Meaning	Symbol	Meaning
	General hazard		Suspended load
	Electrical voltage		Hot surfaces
	Danger of crushing		

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

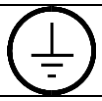
Symbol	Meaning
	Wear body protection

	Wear ear protectors

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 Sensitive Devices, i.e. components and assemblies sensitive to electrostatic energy

2.6.8 Information signs

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

2.6.9 Font style in documentation

Example	Font style	Use
1234	bold	Representation of parameter numbers
Parameter	inclined, font: Times New Roman	Representation of parameter names
P.1234	bold	Representation of parameter numbers without name, e.g. in formulas
Q.1234	bold	Representation of source numbers

2.7 Directives and guidelines to be adhered to by the operator

The operator must follow the following directives and regulations:

- Ensure that the applicable workplace-related accident prevention regulations as well as other applicable national regulation are accessible to the staff.
- An authorized person must ensure, before using the frequency inverter, that the device is used in compliance with its designated use and that all safety requirements are met.
- Additionally, comply with the applicable laws, regulations and directives of the country in which the frequency inverter is used.
- For liquid cooled frequency inverters, comply with the cooling water guideline VGB-R 455 P.
- 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 Operating Instructions, the operator should issue separate internal user manuals for the frequency inverter. The Operating Instructions of the frequency inverter must be included in the Operating Instructions 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 skilled personnel. The staff must not be under the influence of any drugs. Note the minimum age required by law. Define the staff's responsibility pertaining to 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 Operating Instructions 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 Operating Instructions, 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.

2.9.3 Ear protectors

The frequency inverter produces noise. Due to noise development, frequency inverters should only be installed in normally unstaffed areas.
Noise emission in operation is < 85 dB(A) in the case of sizes 1 through 7.
Noise emission in operation is approx. 86 dB(A) in the case of size 8. Ear protectors must be used when staying near the frequency inverter.

2.10 Organizational measures

- 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.

2.10.1 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 so at your own risk.

2.10.2 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 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.

2.10.3 Electrical connections

The five safety rules must be complied with.
Never touch live terminals. In sizes 1 through 7, the DC-link may have dangerous voltage levels up to 3 minutes after shutdown. In size 8, the DC-link may have dangerous voltage levels up to 10 (in some configurations up to 25) minutes after shutdown. The valid waiting period is indicated on the device housing.
When performing any work on/with the frequency inverter, always comply with the applicable national and international regulations/laws on work on electrical equipment/plants of the country in which the frequency inverter is used.
The cables connected to the frequency inverters may not be subjected to high-voltage insulation tests unless appropriate circuitry measures are taken before.
Only connect the frequency inverter to suitable supply mains. The frequency inverter may be operated in TN, TT and IT grid types. Precautions must be taken for operation in IT grids, see Chapter 7 "Electrical installation". Operation in a corner-grounded TN grid shall not be permissible.

The five safety rules

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

- Disconnect
- Secure to prevent restarting
- check for absence of voltage,
- carry out earthing and short-circuiting
- cover or shield neighboring live parts

2.10.4 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, all covers must be installed correctly, and all electrical cabinet doors must be closed. During operation, never open the machine/plant.
No connection work shall be carried out while power supply is on.
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 braking 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. After shutdown, 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 skilled personnel 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 the frequency inverter and children must not have access to the device.
Do not bypass nor decommission any protective devices.
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 AutoStart function is activated.
If staff are endangered, a restart of the motor must be prevented by means of external circuitry.
Before commissioning and the start of the operation, make sure to fix all covers and check the terminals. Check the additional monitoring and protective devices according to EN 60204 and applicable the safety directives (e.g. Working Machines Act or Accident Prevention Directives).

2.10.5 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. Any repair work may only be carried out by the manufacturer or persons approved/licensed by the manufacturer. Any repair work must be carried out by qualified electricians. 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.

2.10.6 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.

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

2.11 Safety Instructions on Function "Safe Torque Off" (STO)

The function „Safe Torque Off" (STO) is a functional safety feature, i.e. it protects staff from damage, provided that projecting, installation and operation are performed properly. This function does not disconnect the plant from power supply.
In order to disconnect the plant from power supply (e.g. for maintenance work), an "Emergency Stop" provision as per EN 60204 must be installed.

WARNING

Uncontrolled Starting

Improper installation of the safety circuitry may result in uncontrolled starting of the drive. This may cause death, serious injuries and significant material damage.
Safety functions may only be installed and commissioned by skilled personnel.
The STO function is not suitable for emergency stop as per EN 60204. An emergency stop can be realized by installing a mains contactor.
An emergency stop according to EN 60204 must be functioning in all operation modes of the frequency inverter. Resetting of an emergency stop must not result in uncontrolled starting of the drive.
The drive is started again when the function STO is no longer required. In order to comply with EN 60204, it must be ensured by taking external measures that the drive does not start without prior confirmation.
Without a mechanical brake, the drive will not stop immediately but coast to a standstill. If this may result in personal or material damage, additional safety measures must be taken.

- If persons may be endangered after disconnection of the motor power supply by STO, access to the hazard areas must be prevented until the drive has stopped.
- Check the safety function at regular intervals according to the results of your risk analysis. Bonfiglioli Vectron GmbH recommends that the check be performed after one year, at the latest.

The STO function is fail-safe for one fault. However, on rare occasions, the occurrence of component defects may cause jerking of the motor shaft (max. 180°/pole pair, e. g. jerk by 90° with 4-pole motor, 180°/2).

- Check if this causes a dangerous movement of the machine.
- If the STO function is used, the special safety, installation and instructions on use instructions shall be complied with.

WARNING

Dangerous voltage!

The safety function “Safe Torque Off” may only be used if mechanical work is to be performed on the driven machines, not for work on live components.

After disconnection of an external DC 24 V power supply, the DC link of the frequency inverter is still connected to mains supply.

Even if power supply to the motor is disconnected, and the motor is coasting to a standstill or has already stopped, high voltages may still be present on the motor terminals.

Before working (e. g. maintenance) on live parts, the plant must always be disconnected from mains supply (main switch). This must be documented on the plant.

When the function “Safe Torque Off” is triggered, the motor is not isolated from the DC link of the frequency inverter. High voltage levels may be present at the motor.

Do not touch live terminals.

The application manual "Safe Torque Off STO" must be complied with, particularly if the safety function described there is used.

3 System description

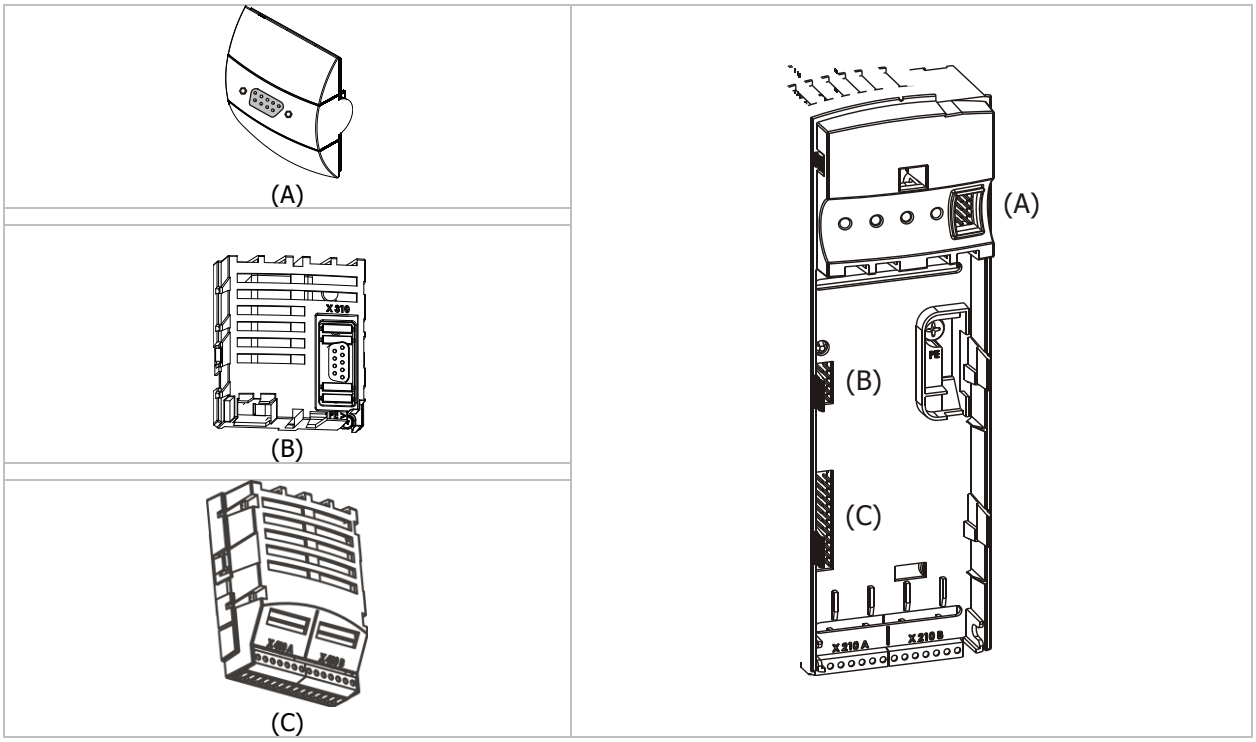
Positioning via motion blocks enables movement by a certain distance or to a target position. For each motion block, a separate motion profile can be set, including speed, acceleration and deceleration ramp. When motion blocks are processed automatically, the drive will react according to the parameterized behavior when it reaches the target position.

3.1 Scope of functions

- Positioning of linear and round axes
- Optimized round axes positioning (shortest way)
- Absolute and relative positioning
- Touch probe positioning for evaluation of sensors, e.g. motion as from this point
- Specification of values and parameter configuration can be done via user-defined scale (user units)
- 32 motion blocks for different target positions and motion profiles
- Automatic motion block sequence, event or time controlled
- Repetition of motion blocks
- Teach-in function for taking over the actual position value as the target position in the motion block
- JOG mode for manual operation via digital inputs
- Combination of positioning with electronic gear
- Different homing modes for determining the reference point for positioning
- Flying homing
- Control via digital inputs or communication module
- Motion Control Interface (MCI) for field bus independent standardized Positioning control
- Monitoring: Position monitoring via target window, contouring error monitoring, hardware and software limit switches
- Parameter configuration via commissioning and diagnosis software VPlus

Components required

- Frequency inverter ACU (ACTIVE Cube),
- Incremental encoder or resolver,
- Suitable extension module,
- Interface adapter KP232 for port (**A**),
- Commissioning and diagnosis software VPlus, version 4 or higher



Optional Components

Communication modules (1 option possible),

Port (**B**):

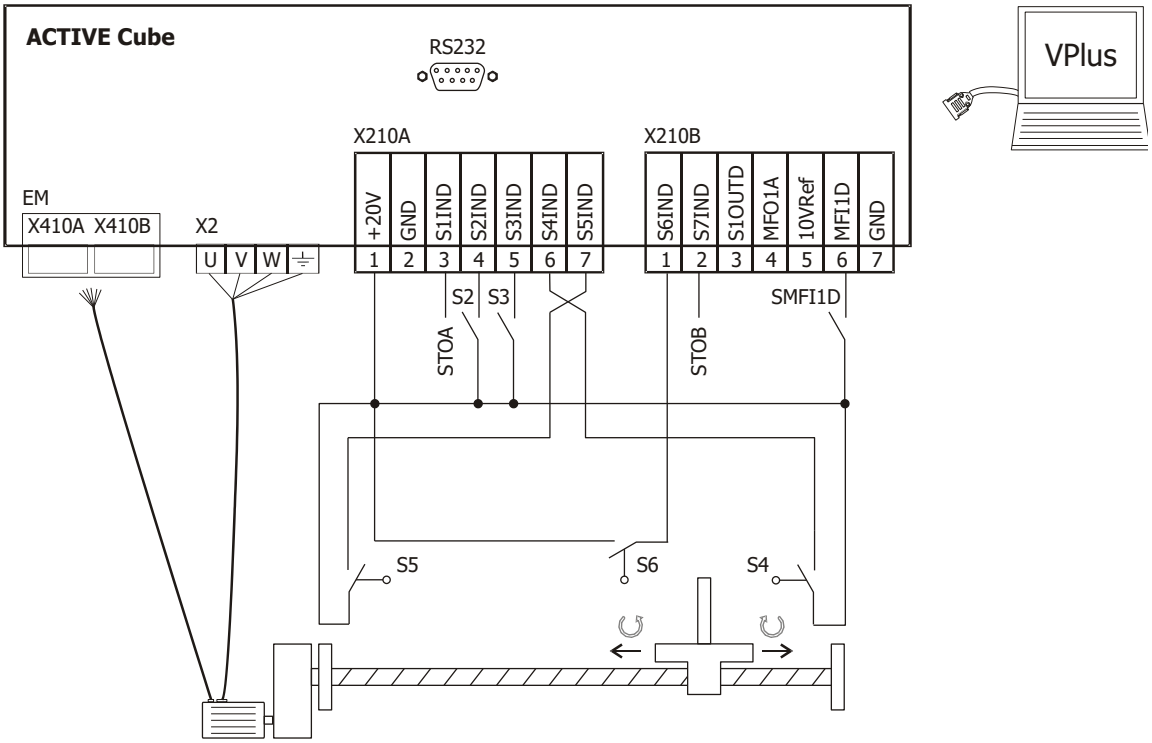
- CM-232 with RS232 interface,
- CM-485 with RS485 interface,
- CM-PDP-V1 with Profibus–DP-V1 interface,
- CM-CAN with CANopen interface

Epansion modules (1 option possible), port (C):

- EM-ENC for detailed evaluation of incremental encoder (TTL to RS-422A/RS-485 or HTL, DC 5 to 30 V),
- EM-IO for additional analog and digital outputs; depending on module, system bus interface available, too,
- EM-RES for resolver evaluation; depending on module, system bus interface available, too,
- EM-SYS for communication via system bus

3.2 Terminal diagram ACTIVE Cube (ACU) series

The terminal diagram shows an example of a linear axis, with standard parameter configuration of digital inputs. The sensor is evaluated using an EM extension module.



Terminal diagram ACTIVE Cube (ACU) series

↻: clockwise; ↺: Anticlockwise

Switch	Function
STOA	Wire input S1IND as shut-down path STOA of safety function STO [1)]
STOB	Wire input S1IND as shut-down path STOB of safety function STO [1)]
S2	Start positioning or clockwise operation in JOG mode
S3	Stop positioning or anticlockwise operation in JOG mode
S4	Limit switch for limitation of motion range in positive direction [2)]
S5	Limit switch for limitation of motion range in negative direction [2)]
S6	Home switch for homing, point of reference for absolute positioning
SMFI1D	Change-over between positioning mode and JOG mode (JOG mode in manual mode)

[1)] Safety function STO (Safe Torque Off) is wired through two channels via inputs STOA and STOB. This safety function is described in user manual "Safe Torque Off". The "Safe Torque Off" user manual must be complied with when using the "Safe Torque Off" function.

[2)] Different from the factory setting. Assign S4IND and S5IND to the parameters for HW limit switches. Set Parameter *Operation mode* **490** of speed sensor 1 to „0 - Off".

4 Commissioning of the Frequency Inverter

⚠	**WARNING!**	• Carry out the electrical and mechanical installation according to the operating instructions or the "Quick Start Guide" of the frequency inverter. Comply with the safety instructions provided there.

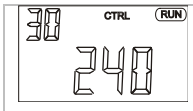
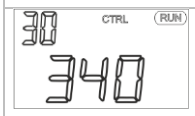
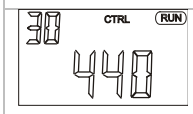
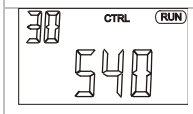
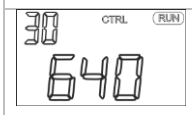
Frequency inverters of the ACU series feature the "Safe Torque Off" function. In any case comply with the application manual "Safe Torque Off" when using this safety function.

4.1 Commissioning of the motor

⚠	**CAUTION!**	• During the guided commissioning, comply with the safety instructions in chapter "General Safety Instructions and Information on Use" and in the Operating Instructions or the "Quick Start Guide" of the frequency inverter.

Carry out the guided commissioning procedure of the frequency inverter for one of the configurations listed below. These configurations contain the motion block positioning functions.

NOTE:	The guided commissioning contains the function for parameter identification. The parameters are determined by way of measurement and set accordingly. In the case of higher requirements as regards the accuracy of the speed/torque control, carry out the guided commissioning procedure once again **under operating conditions** because part of the machine data depends on the operating temperature.

	**Configuration 240, field-oriented control with positioning** Configuration 240 extends the field-oriented control of an asynchronous machine by the positioning functions. The motor controller and the position controller can use the same encoder (motor encoder) or different encoders (motor encoder and position encoder).
	**Configuration 340, sensorless and sensorbased field-oriented control of SynRM with positioning** Configuration 340 extends the control of a synchronous reluctance machine by the positioning functions. The synchronous reluctance machines can be operated in open or closed loop.
	**Configuration 440, sensorless field-oriented control with positioning** Configuration 440 extends the sensorless field-oriented control of an asynchronous machine by the positioning functions. The motor is controlled without sensors. The positioning controller can be used via any encoder input.
	**Configuration 540, field-oriented control of synchronous machine with positioning** Configuration 540 extends the field-oriented control of a synchronous machine by the positioning functions. Extension module EM-RES with resolver interface are required for this. The motor controller and the position controller can use the same encoder (motor encoder) or different encoders (motor encoder and position encoder).
	**Configuration 640, DMR PMSM with positioning** Configuration 640 extends the functionality of the sensorless field-oriented control of Configuration 610 by positioning functions. The motor is controlled without resolver feedback.

⚠	**CAUTION!**	To enable control of a synchronous machine in configuration 540, parameter *Offset* **382** must be set before the guided commissioning. To do this, proceed according to the operating instructions for the extension module EM-RES installed. Otherwise, personal or machine damage may occur.

NOTE:	For first commissioning, the drive can be controlled manually, using the JOG function, via the "FUN" key or the digital inputs. The processing speed of automatic motion block sequence can be reduced for commissioning. To do this, use the speed override function.

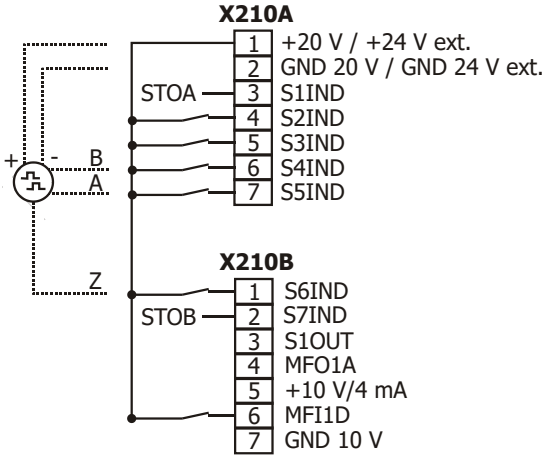
NOTE:	The motor encoder should only be used for motor and position control in slip-free systems (e.g. linear spindle). In systems where slip may occur (e.g. wheel/rail systems) always use a position encoder to obtain optimal results.

4.2 Control Inputs and Outputs

The modular structure of the frequency inverters enables a wide spectrum of applications on the basis of the available hardware and software functionality. The functionality of the control inputs and outputs described in the "Quick Start Guide" and operating instructions is extended in the described configurations.

	**CAUTION!**	Switch off power supply before connecting or disconnecting the control inputs and outputs. Verify that the keyed control inputs and outputs are deenergized before connecting or disconnecting them. Otherwise, components may be damaged. The unit may only be connected with the power supply switched off. Make sure that the frequency inverter is discharged.

4.2.1 ACU frequency inverters of ACTIVE Cube series



Control terminal X210A	
X210A.1	+20 V voltage output (I_{max}=180 mA) or input for external power supply 24 V
X210A.2	GND 20 V/ GND 24 V (ext.)
X210A.3	Safety function, digital input STOA
X210A.4	Start Positioning JOG Clockwise Store actual position value (latching)
X210A.5	Stop Positioning JOG Anticlockwise Touch probe
X210A.6	Encoder 1 Track B [1] or freely programmable [2]
X210A.7	Encoder 1 Track A [1] or freely programmable [2]

Control terminal X210B	
X210B.1	Home switch [3] or Encoder 1 Zero Track Z [4]
X210B.2	Safety function, digital input STOB
X210B.3	Operating message
X210B.4	Analog signal of actual frequency
X210B.5	Supply voltage +10V
X210B.6	Change-over position control/JOG mode (JOG mode active) Teach-In-Signal
X210B.7	Ground 10 V

[1] Factory setting in configuration 240

[2] If no speed sensor is connected to S4IND/S5IND the digital inputs can be used freely programmable (e.g. for hardware limit switches).

[3] Factory setting in configurations 240, 440 and 540

[4] For evaluation of an encoder zero track an *Operation Mode* **490** for speed sensor 1 higher than 1000 must be selected. Linking of other functions to this input are not active.

The connection diagram describes the default assignment of control terminals and functions in the different configurations positioning control. According to the requirements of the application, the other functions can be assigned to the control terminals.

NOTE:	In order to fully use the positioning functions, an optional extension module is required. This module enables, for example, encoder evaluation, motion-block change-over or reference percentage change-over.

4.2.2 Factory settings of the digital inputs

Control input functions			
Digital Input	**Control terminal**	**Control positioning**	**JOG mode / Teach-in**
Digital inputs of frequency inverter:			
S1IND	X210A.3	Digital input STOA for safety function	
S2IND	X210A.4	Start Positioning / Store actual position value [3]	JOG Clockwise
S3IND	X210A.5	Stop Positioning, Touch probe [1]	JOG Anticlock-wise
S4IND	X210A.6	Freely programmable or Encoder 1 Track B	[2]
S5IND	X210A.7	Freely programmable or Encoder 1 Track A	[2]
S6IND	X210B.1	Home switch or Encoder 1 Zero Track Z	[2]
	X210B.2	Digital input STOB for safety function	
MFI1D	X210B.6	Change-over position control/JOG mode (JOG mode active)	Teach-in signal in teach-in mode
Digital inputs extension module:			
EM-S1IND	depending on module	Motion Block Change-Over 1 Alternative: - Encoder 2 Zero Track Z - Fixed frequency change-over 1 - Fixed percentage value change-over 1	
EM-S2IND		Motion Block Change-Over 2 Alternative: - Encoder 2 Track A - Fixed frequency change-over 2 - Fixed percentage value change-over 2	
EM-S3IND		Motion Block Change-Over 3 Alternative: - Encoder 2 Track B	

[1] Comply with the notes in section 5.5.1.3.
[2] Depending on the settings of parameters *Configuration* **30** and *Operation Mode* **490**. See chapter 4.4.1.4.
[3] Switch on the function via parameter *Operation Mode* **1280**. Comply with the notes in section 5.14.

Control terminal/ Identification	Description
X210A.4	
Start Positioning	The input is assigned to parameter *Start Positioning* **1222**. When activated, the *Starting-Record Number* **1228** or another motion block selected by the motion block change-over function is started. The motion blocks can be switched via digital inputs EM-S1IND, EM-S2IND and EM-S3IND of an extension module.
JOG Clockwise	In JOG mode, the drive is moved in positive direction (clockwise) at an adjustable fixed speed. JOG mode is activated via terminal **X210B.6**. In teach-in operation modes (*Operation Mode* **1221**), the JOG function is activated automatically.
Store actual position value	The function can be switched on via parameter *Operation Mode* **1280**. With signal edge the actual position value is stored in the EEPROM and displayed via *Latched Position* **1281**.

Control terminal/		Description
X210A.5		
	Stop Positioning	The drive stops at the current position at deceleration ramp set in *Deceleration* **1206**.
	JOG Anticlockwise	In JOG mode, the drive is moved in negative direction (anticlockwise) at an adjustable fixed speed. JOG mode is activated via terminal **X210B.6**. In teach-in operation modes (*Operation Mode* **1221**), the JOG function is activated automatically.
	Touch probe	Input for momentary contact switch or sensor for setting the reference position. Effective in *Motion Mode* **1208** with touch-probe. Rising or falling edge (depending on setting of *Motion Mode* **1208**) on input sets the point of reference at the current position. As soon as the signal is received, the drive moves by the relative distance of parameter *Target Position/Distance* **1202**. Parameter configuration for digital signal "Stop Positioning" should be changed when touch probe mode is used.
X210A.6		
	Encoder 1	Input Encoder 1 Track B, HTL, DC 12 … 30 V
	or freely programmable	Evaluation of parameterized functions if the terminal is not used as encoder input.
	Possible function: **Pos. HW Limit Switch**	Input for positive hardware limit switch. Limitation of travel range in positive direction. The drive reacts according to parameter *Fault Reaction* **1143** when the switch is reached. Positive direction (clockwise direction) is disabled. Set parameter *Pos. HW Limit Switch* **1138** = "540 - S4IND inverted (Hardware)". Set Parameter *Operation Mode* **490** of speed sensor 1 = "0 - Off". If X210A.6 is used as encoder input the HW limit switch function is not evaluated as this input.
X210A.7		
	Encoder 1	Input Encoder 1 Track A, HTL, DC 12 … 30 V
	or freely programmable	Evaluation of parameterized functions if the terminal is not used as encoder input.
	Possible function: **Neg. HW Limit Switch**	Input for negative hardware limit switch. Limitation of travel range in negative direction. The drive reacts according to parameter *Fault Reaction* **1143** when the switch is reached. Negative direction (anticlockwise direction) is disabled. Set parameter *Neg. HW Limit Switch* **1137** = "541 - S5IND inverted (Hardware)". Set Parameter *Operation Mode* **490** of speed sensor 1 = "0 - Off". If X210A.7 is used as encoder input the HW limit switch function is not evaluated as this input.
X210B.1		
	Home switch	Input for reference cams. Marks the point of reference for absolute positioning. Via parameter *Home Switch* **1139**, the logic status of the switch is evaluated.
	or Encoder 1	Input Encoder 1 Zero Track Z, HTL, DC 12 … 30 V. Select one of the settings 1001 … 1132 (with reference pulse) for parameter *Operation Mode* **490**.

Control terminal/		Description
X210B.6		
	JOG-Mode Active	Activates JOG mode. JOG clockwise via terminal **X210A.4** or JOG anti-clockwise via terminal **X210A.5** is executed. In teach-in operation modes (*Operation Mode* **1221**), the JOG function is activated automatically.
	Teach-In	When a rising signal edge is received, the current position in the selected motion block is saved as the target position. The motion block is selected by parameter *Starting-Record Number* **1228** or the motion block change-over function (parameters **1224** to **1227** and **1254**). The function is activated via *Operation Mode* **1221**. Parameter *Teach-In-Signal* **1239** must be assigned the digital input signal or the logic signal which is to trigger saving of the actual position.

4.3 Digital inputs for speed sensor inputs or for other functions

The setting of parameter *Operation Mode* **490** of speed sensor 1 affects the processing of functions which are linked to the digital inputs S4IND, S5IND and S6IND:

- In the settings 1 … 132 for *Operation Mode* **490** the digital inputs S4IND and S5IND are prepared for speed sensor inputs.
- In the settings 1001 … 1132 for *Operation Mode* **490** the digital inputs S4IND, S5IND **and** S6IND are prepared for speed sensor inputs.

The setting of the digital inputs as speed sensor inputs (1 … 1132 for *Operation Mode* **490**) has higher priority than the control of other functions via these inputs. Other functions will not be evaluated.
Set *Operation Mode* **490** to "0 - Off" if S4IND, S5IND and S6IND shall not be used as speed sensor inputs but for control of other functions via these inputs.

Selection for *Operation Mode* 490	S4IND, S5IND and S6IND as speed sensor inputs or for other functions
0	Functions which are assigned to the digital inputs S4IND, S5IND and S6IND will be evaluated. The digital inputs S4IND, S5IND and S6IND are **not** prepared as speed sensor inputs.
1 … 132	The digital inputs S4IND and S5IND are prepared as speed sensor inputs. Other functions which are assigned to the inputs S4IND and S5IND will **not** be evaluated.
1001 … 1132	The digital inputs S4IND, S5IND and S6IND are prepared as speed sensor inputs. Other functions which are assigned to the inputs S4IND, S5IND and S6IND will **not** be evaluated.

For the settings of speed sensor inputs also refer to section 4.4.1.

For more details on frequency inverter settings ☞ Operating instructions document VEC170, Chapter Operating behavior.

4.4 Positioning - commissioning procedure

Terminal assignment:

- S1IND (STOA) and S7IND (STOB): LOW signal
- S2IND (Start positioning): LOW signal
- S3IND (Stop positioning): LOW signal
- S4IND and S5IND: encoder track B and track A or for parameterized function
- S6IND: home switch or encoder zero track Z
- MFI1D (JOG mode): LOW signal

Commissioning of frequency inverter:

- Comply with chapter "Commissioning of Frequency Inverter",
- set up configuration 240, 340, 440, 540 or 640,
- switch on power supply,
- start commissioning and diagnosis program VPlus (if not yet done for commissioning),
- Set up reference system (motion distance per rotation of drive and gear factor),
- Select suitable homing mode,
- Select encoder source for positioning

For manual mode (JOG mode):

- Set up parameters for JOG mode or use factory settings,
- Release with HIGH signal on S1IND (STOA) and S7IND (STOB),
- Activate JOG mode with HIGH signal at MFI1D, clockwise via S2IND, anticlockwise via S3IND, perform function test

Entering motion profile:

In VPlus, set up the parameters of the motion blocks, then switch on speed override in order to position at reduced speed during commissioning.

Start positioning:

Check readiness for operation: when green LED is flashing: ready for operation; if green and red LED are flashing: ready for operation and warning message is present, repair fault,
Release with HIGH signal on S1IND (STOA) and S7IND (STOB) and start of positioning with HIGH signal on S2IND
For communication via field bus or system bus: Set up other parameters according to operating instructions of the corresponding extension or communication module.

Motion blocks

The motion profile is defined in motion blocks, indicating the target position, speed and acceleration. A positioning operation may comprise a maximum of 32 motion blocks.
Discrete selection: Each of the 32 motion blocks can be selected both via logic signals and parameters (also for transfer via field bus or system bus).
Cycle: The motion blocks can be repeated or processed in a freely programmable order.
In the motion blocks, the motion block to be processed next can be identified.
The next motion block can be activated:

- - by events, e.g. via digital inputs or logic signals
- - after a definable delay

In the motion block, the motion mode is selected: absolute (referred to a fixed reference position), relative (to moving distance, referred to last position approached) or "Touch Probe" (to moving distance, referred to a sensor signal on digital input S3IND).

Digital signals for status indication

Digital signals can be influenced depending on the status of a motion order. For example, a digital signal can be parameterized such that it signals reaching of the target position or the end of the motion block.

JOG mode

The drive is operated manually via two digital inputs at a parameterizable, fixed speed. This enables for example functional tests for commissioning and approaching of positions for teach-in mode.

Teach-In

With this function, any position approached can be entered directly in a motion block as a target position. The required position can be approached in JOG mode. The current position

value is saved as the target position when an increasing edge is present on the teach-in terminal.

Homing

To determine the drive speed and position, the frequency inverter captures the signals from position sensors such as incremental encoders or resolvers. When the frequency inverter is switched on, there is no relation between the position sensor and the mechanical position of the axis. In order to determine an absolute point of reference (reference position) for the positioning operation, a homing operation must be performed. All absolute position data is referred to this reference position. By selecting a certain homing mode, you can define in which direction the reference position is to be found and which type of switch (limit switch, home switch) is used. In the homing operation, the drive moves to the reference position and stops there.

Before an absolute positioning operation can be started, the point of reference of the positioning operation must be determined in a homing operation. Otherwise, error message "F1570 – No Homing Done" will be displayed if you try to start an absolute positioning operation.

Relative positioning and velocity operations are possible without homing.

Flying Homing

If the homing should be done during a positioning procedure, the flying homing process can be used. While the motion is active, the flying homing can be used to update the reference position. In example this is useful in applications, where gear boxes with infinite gear ratios are used. Using the flying homing can compensate small deviations for the actual position.

The current motion is finished without changing the target position. Only after the motion was finished the next motion will take into account the changed reference point.

Monitoring

To limit the motion range and protect the machine, limit switches are connected to the digital input terminals of the frequency inverter. The behavior of the drive when reaching the limit switches is parameterizable (e.g. error switch-off, shut down).

Software limit switches enable monitoring of the permissible motion range. Positioning commands will be executed only within the range defined by parameters. The software limit switches are active only after a successful homing operation.

The adjustable target window monitors the current position after performance of a positioning operation. Reaching of the required position is signaled only if the current position is within the target window.

The contouring error monitoring function monitors the maximum permissible deviation of the current position and the required position. This monitoring function determines how accurately the positioning operation must be performed.

4.4.1 Getting started

In order to use the positioning function, you must start the frequency inverter to Configuration `240`, `340`, `440`, `540` or `640`. If required, perform a motor measurement. Several functions will be readjusted as soon as you set up the configuration of the positioning operation. This includes the functions of the digital inputs.

WARNING!	• Ensure that your parameterization corresponds to the connected terminals.

For commissioning, you must select different configurations for the following cases:

Case	Description	Possible *Configuration* 30
1	Motor encoder is position encoder at the same time	240, 340, 540
2	Two different encoders for motor and positioning	240, 340, 540
3	No motor encoder, external encoder for positioning	340, 440, 640

Actual Speed Source **766** and *Actual Position Source* **1141** have to be set according to the configuration and application.

Parameter		Settings		
No.	**Description**	**Min.**	**Max.**	**Fact. sett.**
766	Actual Speed Source	Selection		
1141	Actual Position Source	Selection		

4.4.1.1 Motor encoder is position encoder at the same time

In slip-free systems, the motor encoder can be used as position encoder at the same time. By using one encoder for both functions, the overall costs can be reduced.

Configuration **30 = 240 | 340 | 540, motor encoder = position encoder**		
Encoder 1	**Encoder 2**	**Motor controller**
Operation Mode **490**	*Operation Mode* **493**	*Actual Speed Source* **766**
Division Marks **491**	*Division Marks* **494**	*Actual Position Source* **1141** = "0 - As **P.766** Actual Speed Source"
	Level **495**	

In the corresponding parameters, set up the properties of the encoders according to the wiring of Encoder 1 or Encoder 2. The parameters of Encoder 2 are available only if the corresponding extension module is connected.

- Adjust parameter *Actual Speed Source* **766** to connected encoder.
- Adjust parameter *Actual Position Source* **1141** to "0 - As **P.766** Actual Speed Source" (corresponds to factory settings).

4.4.1.2 Two different encoders for motor and positioning

In systems where slip may occur, the motor encoder cannot be used as position encoder at the same time. Due to the slip (e.g. slipping in the case of a wheel/rail system), the motor encoder cannot approach the actual target with sufficient accuracy. By using a position encoder connected to the positioning system, precise positioning is possible even in the case of a system where slip may occur. The corresponding configurations are described in the following tables. In any case, you will need a suitable extension module for evaluation of Encoder 2.

NOTE:	If both a motor and a position encoder are used, the function "Electronic Gear" cannot be used.

Encoder 1 is motor encoder
Encoder 2 is position encoder

Configuration **30 = 240 | 340 | 540, motor encoder, position encoder**			
Encoder 1	**Encoder 2**	**Motor controller**	**Position controller**
Operation mode **490**	*Operation mode* **493**	*Actual Speed Source* **766** = "1 – Speed Sensor 1"	*Actual Position Source* **1141** = "2 – Speed Sensor 2"
Division Marks **491**	*Division Marks* **494**		
	Level **495**		

Encoder 1 is position encoder
Encoder 2 is motor encoder

Configuration **30 = 240 | 340 | 540, position encoder, motor encoder**			
Encoder 1	**Encoder 2**	**Motor controller**	**Position controller**
Operation mode **490**	*Operation mode* **493**	*Actual Speed Source* **766** = "2 – Speed Sensor 2"	*Actual Position Source* **1141** = "1 – Speed Sensor 1"
Division Marks **491**	*Division Marks* **494**		
	Level **495**		

In the corresponding parameters, set up the encoders parameters according to the properties of Encoder 1 or Encoder 2. The parameters of Encoder 2 are available only if the corresponding extension module is connected.
Adjust parameter *Actual Speed Source* **766** to connected motor encoder. The external encoder is evaluated via parameter *Actual Position Source* **1141**.

4.4.1.3 No motor encoder, external encoder for positioning

In some applications the speed control accuracy and the dynamic behaviour of a sensorless motor control are sufficient. Positioning is possible in non-slip and in slip-containing systems via an external encoder.

Configuration **30 = 340, 440 or 640, only position encoder**			
Encoder 1	**Encoder 2**	**Motorregler**	**Position controller**
Operation mode **490**	*Operation mode* **493**	*Actual Speed Source* **766** = 3 - Machine Model	*Actual Position Source* **1141** = "1 - Speed Sensor 1" or "2 - Speed Sensor 2", depending on the application
Division Marks **491**	*Division Marks* **494**		
	Level **495**		

Set the encoder behavior in the correlsponding parameters for speed sensor 1 and speed sensor 2. The speed sensor 1 parameters are only available if an expansion module with speed sensor input is installed.

4.4.1.4 Consider the operation mode settings for speed sensor input

The digital input signals S4IND, S5IND and S6IND can set as signal sources in all configurations (parameter *Configuration* **30**).

- In parameter settings *Operation Mode* **490** > 0 the inputs S4IND and S5IND are evaluated only as speed sensor inputs. Other functions at these inputs are not evaluated.
- In parameter settings *Operation Mode* **490** > 1000 additional the input S6IND is evaluated as speed sensor track. Other functions at this input are not evaluated.

Digital inputs	*Operation Mode* **490 =**		
	1001 ... 1132	**1 ... 1000**	**0**
S4IND	Speed sensor 1 track B		Freely programmable
S5IND	Speed sensor 1 track A		Freely programmable
S6IND	Speed sensor 1 track Z	Home switch	

4.4.2 Reference system

The reference system provides the link between the electrical system and the mechanical system. In parameter *Feed Constant* **1115**, the user units (u) per revolution (U) are entered. By choosing a suitable parameter configuration, the feed constant can consider both the mechanical motion distance and the accuracy (resolution) (see example).
Via *Gear Box: Driving shaft revolutions* **1116** and *Gear Box: Motor shaft revolutions* **1117**, it is possible to consider the transmission ratio of a gearbox.
The terms *Gear Box: Driving shaft revolutions* **1116** and *Gear Box: Motor shaft revolutions* **1117** are used in compliance with CANopen Standard CiA402 *Device Profile Drives and Motion Control.*

Parameter		**Settings**		
No.	**Description**	**Min.**	**Max.**	**Fact. sett.**
1115	Feed constant	1 u/U	2^{31}-1 u/U	65536 u/U
1116	Gear Box: Driving shaft revolutions	1	65 535	1
1117	Gear Box: Motor shaft revolutions	1	65 535	1

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

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

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

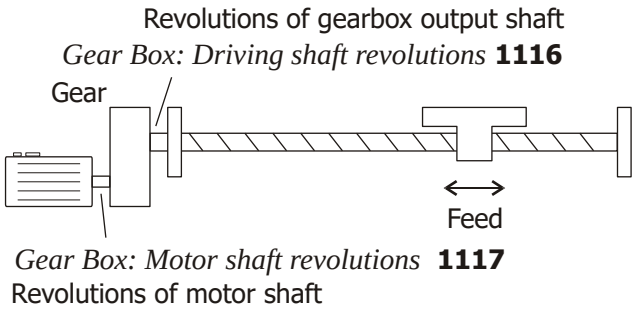
Note: The same formulas can be used for the conversion from acceleration a [Hz/s] to a [u/s²] and vice versa. Replace in the formulas the velocities f[Hz] and v [u/s] with a [Hz/s] and a [Hz/s²].

Maximum motion distance

The internal representation of position values is limited to $\pm 2^{31}$-1 increments, referred to a resolution of 2^{16} increments/revolution. The maximum motion distance s_{max} depends on the settings of parameters *Feed Constant* **1115**, *Gear Box: Driving shaft revolutions* **1116** and *Gear Box: Motor shaft revolutions* **1117**. At a higher accuracy of the feed constant and gear factor, the maximum motion distance is reduced.

$$s_{max}[u] = \frac{\pm\left(2^{31}-1\right)\text{Ink} \cdot \textit{Feed Constant}\ \textbf{1115}\ \frac{[u]}{U} \cdot \textit{Gear Box : Driving shaft revolutions}\ \textbf{1116}}{2^{16}\ \frac{\text{Ink}}{U} \cdot \textit{Gear Box : Motor shaft revolutions}\ \textbf{1117}}$$

Example: Linear axis, drive via gearbox



- Feed rate of linear axis: 25 mm per revolution of the output shaft
- Required positioning accuracy: ±1/100 mm
- Gear factor: 1/19.75

$$\text{Feed Constant} = \frac{\text{Feed rate}}{\text{Accuracy}} = \frac{25\,\text{mm}}{1/100\,\text{mm}} = 2500$$

$$1\,\text{unit} = 0.01\,\text{mm}$$

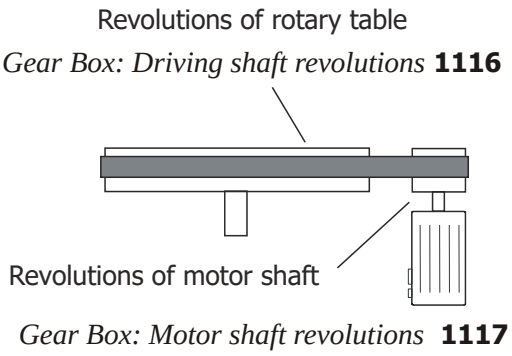
- Set *Feed Constant* **1115** to 2500 u/U.

$$\text{Gear factor} = \frac{19.75}{1} = \frac{\textit{Gear Box : Motor revolutions}\ \textbf{1117}}{\textit{Gear Box : Shaft revolutions}\ \textbf{1116}} = \frac{1975}{100}$$

- Set *Gear Box: Driving shaft revolutions* **1116** to 100.
- Set *Gear Box: Motor shaft revolutions* **1117** to 1975.

$$s_{max}[u] = \frac{\pm\left(2^{31}-1\right)\text{Inc} \cdot 2500\ \frac{[u]}{U} \cdot 100}{2^{16}\ \frac{\text{Inc}}{U} \cdot 1975} = \pm 4147848\,\text{units} \approx \pm 41478\,\text{mm} \approx \pm 41.5\,\text{m}$$

Example: Rotary table



- Turning angle (feed) of rotary table: 360°
- Required positioning accuracy: ±1/10 °

– Wheel diameters (Driving shaft / motor): 2.45 m/0.18 m

$$Gear\ factor = \frac{Gear\ Box : Motor\ revolutions\ \mathbf{1117}}{Gear\ Box : Shaft\ revolutions\ \mathbf{1116}} = \frac{\text{Diamaeter shaft}}{\text{Diameter motor}} = \frac{245}{18}$$

$$\text{Feed Constant} = \frac{\text{Feed rate}}{\text{Accuracy}} = \frac{360°}{1/10\,°} = 3600$$

- Set *Feed Constant* **1115** to 3600 u/U.
- Set *Gear Box: Driving shaft revolutions* **1116** to 245.
- Set *Gear Box: Motor shaft revolutions* **1117** to 18.

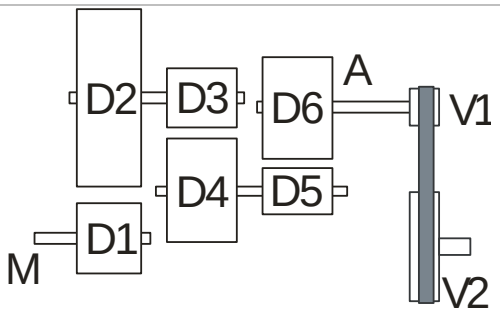
$$s_{max}[u] = \frac{\pm\left(2^{31}-1\right)\text{Ink} \cdot 3600\,\frac{[u]}{U} \cdot 245}{2^{16}\,\frac{\text{Ink}}{U} \cdot 18} = \pm 1\,605\,631999 \text{ units} \approx \pm 160563\,200° \approx \pm 446009\,U$$

NOTE:	Gear transmission factors are rounded in many cases and may result in a "drift" in the application, i.e. due to the rounded values, the deviation between the actual position and the required position increases with each revolution. This particularly affects rotary table applications which turn in one direction continuously because their position change continues to increase all the time. Use exact gear transmission factors in order to eliminate this drift. The exact gear transmission factor can be calculated from the number of teeth of the individual gearwheels.

Example: Calculation of gear factors

Example: Three-stage gearbox
(i = 12.2 rounded) at reduction gearing of 3:1.
Number of teeth:

D1 = 13	D2 = 25
D3 = 12	D4 = 27
D5 = 11	D6 = 31
V1 = 1	V2 = 3



M: motor side, A: output side, V: reduction gearing

Gear Box: Driving shaft revolutions **1116**	= D1 x D3 x D5 x V1 = 13 x 12 x 11 x 1 = 1716
Gear Box: Motor shaft revolutions **1117**	= D2 x D4 x D6 x V2 = 25 x 27 x 31 x 3 = 62775

4.4.2.1 Empirical Determination of the Feed constant

The feed constant is typically described in the data sheet of a linear system or known by the mechanical construction.
If the system is unknown, the feed constant must be determined empirically.
Perfom the following steps to determine the feed constant:

- Parameterize
  - *Gear Box: Driving shaft revolutions* **1116** and
  - *Gear Box: Motor shaft revolutions* **1117**
  - *Feed Constant* **1115 1115** = 100000 u

  The *Feed Constant* **1115** is set to a high value first to enhance the accuracy and to minimize the danger of damaging the machine. The higher the Feed Constant is set, the lower is the output frequency with other parameters unchanged like the Jog frequency in example.

- When using an application encoder, parameterize additionally:
  - EC2 Gear Factor Numerator **513**
  - EC2 Gear Factor Denominiator **514**

  Please comply for the parameterization with the notes in the EM manual.
- Move the application into middle position (in example via Jog mode).
- Note the *Act. Position* **1108** (in example 12450 u)
- Move the application a short distance (in example via Jog mode), that you can measure accurately (in example 10 cm).
- Measure the traveled distance (in example with measuring tape).
- Note the new *Act. Position* **1108** (in example 132450 u)
- Calculate the difference [u] with both noted position values.

  The new feed constante calculates as follows:

$$\text{Feed constant [u]} = \frac{\text{Difference [u]}}{\text{travel [m]}} \times \text{required accuray [m]}$$

Example: Required is the solution 0,1 mm:

$$\text{Feed constant} = \frac{1324550\text{ u} - 124540\text{ u}}{10\text{ cm}} \times 0{,}1\text{ mm} = 1200010\text{ u} \times 0{,}001 = 1200\text{ u}$$

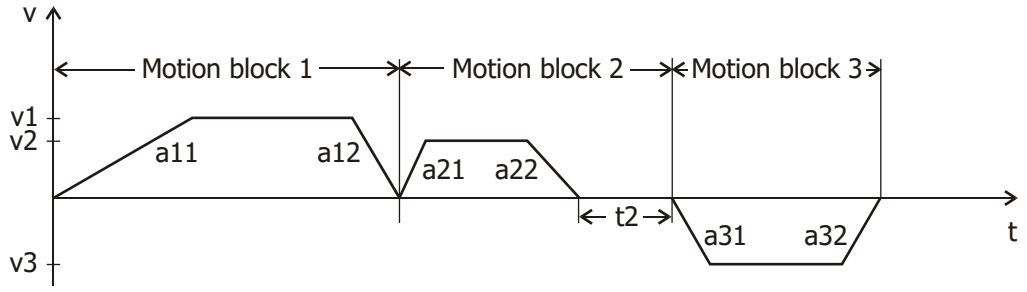
- Check the accuracy of the Positioning.
  - If traveled to far, increase the feed constant minimal.
  - If traveled not far enough, decrease the feed constant minimal.
- Repeat the check until the accuracy is sufficient.
- If the travel distance is big enough a multiplier of a revolution of the driving shaft can be used to enhance the accuracy for travelling to determine and check the feed constant.
- Parameterize
  - all Parameters, that reference to the feed constant (speeds, target positions, accelerations, decelerations, etc) corresponding to that conditions are suitable to each other and to avoid excessive speed or excessive accelerations.
- Move one driving shaft revolution (or less if a complete revolution is not possible). Enter as target position one driving shaft revolution:

$$\text{Target position [u]} = \frac{\text{Gear Box : Driving Shaft revolutions 1117}}{\text{Gear Box : Motor Shaft revolutions 1116}} \times \text{Feed constant 1115}$$

4.4.3 Setting up a motion profile

For complex motion profiles, e.g. profiles requiring different speeds and accelerations, different motion blocks must be created.

Example:



Motion block 1		Motion block 2		Motion block 3	
Approach target pos. 1		Approach target pos. 2		Return	
a11	Acceleration	a21	Acceleration	a31	Acceleration
v1	Speed	v2	Speed	v3	Speed
a12	Deceleration	a22	Deceleration	a32	Deceleration

	t2	Delay until next motion block, e.g. for workpiece machining

Motion block parameters	In example above:
Target Position / Distance **1202**	s1, s2, s3
Speed **1203**	v1, v2, v3
Acceleration **1204**	a11, a21, a31
Deceleration **1206**	a12, a22, a32
Delay **1212**	t2
Delay: Next Motion Block **1213**	3 (motion block 2)
Event 1 **1214**	6 – On (motion block 1)
Event 1: Next Motion Block **1215**	2 (motion block 1); 0 (motion block 3);

The motion profile shown in the example requires parameterization of 3 motion blocks.

4.4.4 Control via software

All parameters of the frequency inverter can be set up via the PC software VPlus. In *Configuration* **30**, set up an operation mode x40 which is suitable for positioning. Now, when data are read from the inverter, all parameters are read and are available for parameterization.
With the PC software VPlus, 32 motion blocks with different motion profiles are available. The program VTable which is included in VPlus enables comfortable parameterization of the motion blocks. The program can be started via menu entry "Start Positioning" or the "Positioning Function" icon. VTable represents the 32 motion blocks arranged in columns, which provides better clarity. Via index 0, values can be changed for all motion blocks at the same time. This can be used, for example, to change the speed in all motion blocks quickly and comfortably.

VTable

Motion Blocks	Index 0	Index 1	Index 2
1202 Target Position / Distance		0 units	4096 units
1203 Speed		10000 u/s	20000 u/s
1204 Accelereation		100000 u/s^2	100000 u/s^2
1205 Ramp Rise Time		500 ms	500 ms
1206 Deceleration		100000 u/s^2	327680 u/s^2
1207 Ramp Fall Time		500 ms	500 ms
1208 Motion Mode		0 - absolute	0 - absolute
1209 Touch-Probe-Window		65536 units	65536 units
1210 Touch-Probe-Error: Next M...		-2	-2
1211 No. of Repetitions		0	0
1212 Delay		0 ms	0 ms
1213 Delay: Next Motion Block		0	0
1214 Event 1		75 - S6IND	275 - S6IND inverted
1215 Event 1: Next Motion Block		2	3
1216 Event 2		7 - Off	7 - Off
1217 Event 2: Next Motion Block		0	0
1218 Digital Signal 1		12 - Start: off Ref.reached: on End: ---	0 - Start: --- Ref.reached: --- End: ---
1219 Digital Signal 2		0 - Start: --- Ref.reached: --- End: ---	0 - Start: --- Ref.reached: --- End: ---
1247 Digital Signal 3		0 - Start: --- Ref.reached: --- End: ---	0 - Start: --- Ref.reached: --- End: ---
1248 Digital Signal 4		0 - Start: --- Ref.reached: --- End: ---	0 - Start: --- Ref.reached: --- End: ---
1260 Interrupt-Event 1		7 - Off	7 - Off
1261 Int.-Event 1: Eval.-Mode		1 - Level-Controlled	1 - Level-Controlled
1262 Int.-Event 1: Next Motion Bl...		0	0
1263 Interrupt-Event 2		7 - Off	7 - Off
1264 Int.-Event 2: Eval.-Mode		1 - Level-Controlled	1 - Level-Controlled
1265 Int.-Event 2: Next Motion Bl...		0	0

4.4.5 Write index and read index for the motion blocks table

Via the write and read indices, the index of the motion block table the parameters of which are to be read or written is specified. VTable uses the parameters automatically for writing and reading. The write and read parameters are required for parameterization via keypad or for parameterization via a bus system (e.g. PROFIBUS).

Parameterize and read motion blocks with write index and read index via software VPlus

The motion blocks can be parameterized in the user interface VPlus or in the motion block table VTable. In the user interface VPlus, an index of the motion block table can be set via parameter *Motion Block Sel. (Writing)* **1200**. The chosen index corresponds to a column in the motion block table. The settings of parameters **1202** to **1219**, **1247** and **1248** are taken over in the selected index of the motion block table. Via parameter *Motion Block sel. (Reading)* **1201**, the values of a selected index can be read from the motion block table.

Parameter		Settings		
No.	**Description**	**Min.**	**Max.**	**Fact. sett.**
1200	Motion Block Sel. (Writing)	0	65 [1)]	1
1201	Motion Block Sel. (Reading)	0	65 [1)]	1

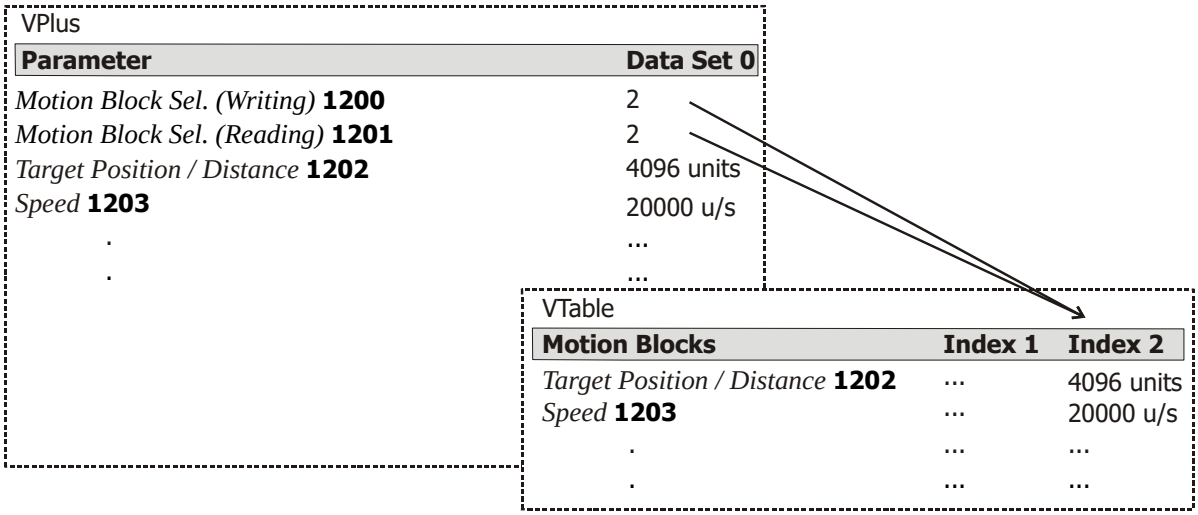
[1)] Setting defines the place where motion blocks are saved.

Settings for fixed parameterization (non-volatile):	Settings only required for parameterization via communication interface (volatile):
0: all motion blocks in EEPROM	33: all motion blocks in RAM
1 … 32: individual motion blocks in EEPROM	34 … 65: individual motion blocks in RAM

NOTE:	The settings"0" and "33" for *Motion Block Sel. (Writing)* **1200** change all motion blocks in EEPROM and RAM.

In the case of non-volatile storage (0…32), the changed values are still available when power supply is switched on again.
In the case of volatile storage (33…65), the data is only stored in RAM. If the unit is switched off, this data is lost and the data required are loaded from EEPROM after restart.

Definition:
Motion block RAM = Motion block EEPROM +33
Write index/*Motion Block Sel. (Writing)* **1200,**
Read index/*Motion Block Sel. (Reading)* **1201**



5 Operation Modes of the Positioning

5.1 General Information about Operation Modes

The following operation modes are available for positioning. Operation modes:

- **Positioning mode**. Automatic operation for sequence-controlled and repeatable approach to different targets in an application. The target can be selected via an overriding controller (parameter channel of field bus or digital inputs).
- **Homing**. A homing operation is performed in order to define a new point of reference in the system. After a homing operation, the identified point of reference is used as the basis of all positioning operations.
- **Flying Homing**. The flying homing can be operated at all times. The reference position is changed immediately, but an ongoing movement is not influenced. Only the movements starting after the flying homing was executed will use the updated reference position.
- **JOG mode**. This operation mode enables free moving via digital inputs. This mode is often used for setup or service purposes.
- **Teach-in mode**. Teach-in mode is normally used only during first commissioning of a plant or after the plant has been retrofitted. In this mode, a current position can be saved for a motion block in the frequency inverter.

"Positioning Mode" and "Teach-In Mode" are selected via parameter *Operation Mode* **1221**. "Homing Mode" is activated either automatically or manually. "Flying Homing Mode" is activated manually. "JOG Mode" is activated via a digital input which deactivates "Positioning Mode".

5.1.1 Assignment of digital inputs

In the individual operation modes of the positioning, the digital inputs have different inputs. The following table provides an overview of the functions and assigns them to the terminals, as parameterized in the factory settings for the functions. Assignment of terminals S4IND/S5IND depends on *Configuration* **30**.

	Function			
	Positioning	**JOG mode**	**Homing**	**Teach-In**
Operation mode **1221** =	1xx, 2xx	1xx, 2xx	1xx, 2xx	30x
Terminal				
S2IND	*Start Positioning* **1222**	*Jog Clockwise* **1232**	*Start Positioning* **1222**	*Jog Clockwise* **1232**
S3IND	*Stop Positioning* **1223** Touch probe [1)]	*Jog Anticlockwise* **1233**	"0"	*Jog Anticlockwise* **1233**
S4IND		**30** = 440, 540	Freely programmable, e.g. for *Positive HW Limit Switch* **1138** [2)]	
		30 = 240	Encoder track A	
S5IND		**30** = 440, 540	Freely programmable, e.g. for *Negative HW Limit Switch* **1137** [2)]	
		30 = 240	Encoder track B	
S6IND			*Home Switch* **1139**	
MFI1D	"0"	"1"		*Teach-In Signal* **1239**

[1)] Deactivate function "Stop Positioning" at S3IND if "Touch Probe" mode is used in the motion sequence. For parameter *Stop Positioning* **1223**, you can also select any other digital input.

[2)] Assign S4IND and S5IND to the inputs for HW limit switches. Parameterized functions will be evaluated only if the inputs are not used as encoder inputs.

For evaluation as break contacts, you can assign inverted inputs to the parameters for the HW limit switches, e.g. *Positive HW Limit Switch* **1138** = "540 - S4IND inverted (Hardware)". This can be used for wire-break monitoring.

NOTE:	For controller release of the power component, wiring of the following digital inputs is required: STOA (terminal X210A.3) and STOB (terminal X210B.2). In safety-oriented systems, the documentation "Safe Torque Off" shall be complied with.

5.1.1.1 Instructions on MFI1D (multifunction input)

Multi-function input MFI1D is processed, depending on the application or function, as an analog input value or a digital input signal. By default, the positioning function uses multi-function input MFI1D as a digital signal for certain functions.
The sampling rate of multi-function input MFI1D is slower than that of digital signals S1IND, S2IND, etc. For this reason, this input should only be used for signals which are not time-critical, e.g. signal for activation of JOG mode.

NOTE:	Do not use multi-function input MFI1D as an input for limit switches or reference cams. For limit switches and reference cams, use digital inputs S2IND ... S6IND or the digital inputs EM-SxIND of an extension module.

5.1.2 Operation modes for controlling the positioning operation

Parameter *Operation mode* **1221** defines:

- Selection of starting record number via parameters or digital inputs
- Automatic sequence of motion orders or individual order
- Start of teach-in mode

5.1.3 Input and output signals

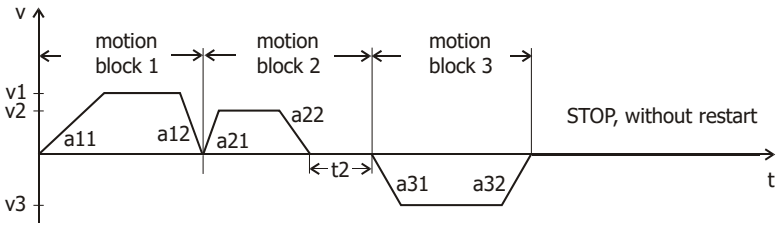
Operation mode **1221**		Function
0 -	Off	No positioning.
101 -	Sequence Mode w/o Restart, 1st Motion Block via Digital Inputs	Signal on *Start Positioning* **1222** starts the positioning operation with the motion block selected with the digital inputs of motion block change-over. When the target position is reached, the settings for delay, event and next motion block are evaluated. If 0 is determined as the next motion block, the sequence is complete. The target position is maintained after the end of the automatic sequence.
102 -	Sequence Mode w/o Restart, 1st Motion Block via P. 1228	Signal on *Start Positioning* **1222** starts the positioning operation with the motion block set in parameter *Starting Record Number* **1228**. When the target position is reached, the settings for delay, event and next motion block are evaluated. If 0 is determined as the next motion block, the sequence is complete. The target position is maintained after the end of the automatic sequence.
111 -	Sequence Mode with Restart, 1st Motion Block via Digital Inputs	Signal on *Start Positioning* **1222** starts the positioning operation with the motion block selected with the digital inputs of motion block change-over. When the target position is reached, the settings for delay, event and next motion block are evaluated. If 0 is determined as the next motion block, the sequence is complete. When the last motion block position is reached, the sequence is started with the 1st motion block automatically.
112 -	Sequence Mode with Restart, 1st Motion Block via P. 1228	Signal on *Start Positioning* **1222** starts the positioning operation with the motion block set in parameter *Starting Record Number* **1228**. When the target position is reached, the settings for delay, event and next motion block are evaluated. If 0 is determined as the next motion block, the sequence is complete. When the last motion block position is reached, the sequence is started with the 1st motion block automatically.
201 -	Single Motion, Motion Block Sel. via Digital Inputs	Signal on *Start Positioning* **1222** starts the positioning operation with the motion block selected with the digital inputs of motion block change-over. After completion of the motion, the target position is maintained.
202 -	Single Motion, Motion Block Sel. via P. 1228	Signal on *Start Positioning* **1222** starts the positioning operation with the motion block set in parameter **1228** *Starting Record Number*. After completion of the motion, the target position is maintained.

Operation mode **1221**		**Function**
301 -	Teach-In, Motion Block Sel. via Digital Inputs	Signal on *Teach-In Signal* **1239** enters the current position in the motion block as the *Target Position / Distance* **1202**. The motion block for entering the position is selected via the motion block change-over digital inputs. The JOG function is activated automatically. Move to position to be saved via digital inputs for parameters *Jog Clockwise* **1232** and *Jog Anticlockwise* **1233** (factory settings S2IND and S3IND).
302 -	Teach-In, Motion Block Sel. via P. 1228	Signal on *Teach-In Signal* **1239** enters the current position in the motion block as the *Target Position / Distance* **1202**. The motion block for entering the position is selected via parameter *Starting Record Number* **1228**. The JOG function is activated automatically. Move to position to be saved via digital inputs for parameters *Jog Clockwise* **1232** and *Jog Anticlockwise* **1233** (factory settings S2IND and S3IND).
1000 -	Control by Function Table	The function (operation mode 5xx) which is selected for parameter *FT-instruction* **1343** in the function table is executed. Also refer to the application manual "Function Table".

Operation mode **1221**

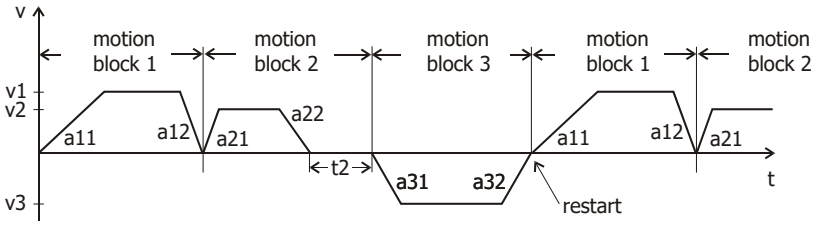
Sequence mode without restart

10x Parameter *Operation mode* **1221** = 101 or 102



Sequence mode with restart

11x Parameter *Operation mode* **1221** = 111 or 112

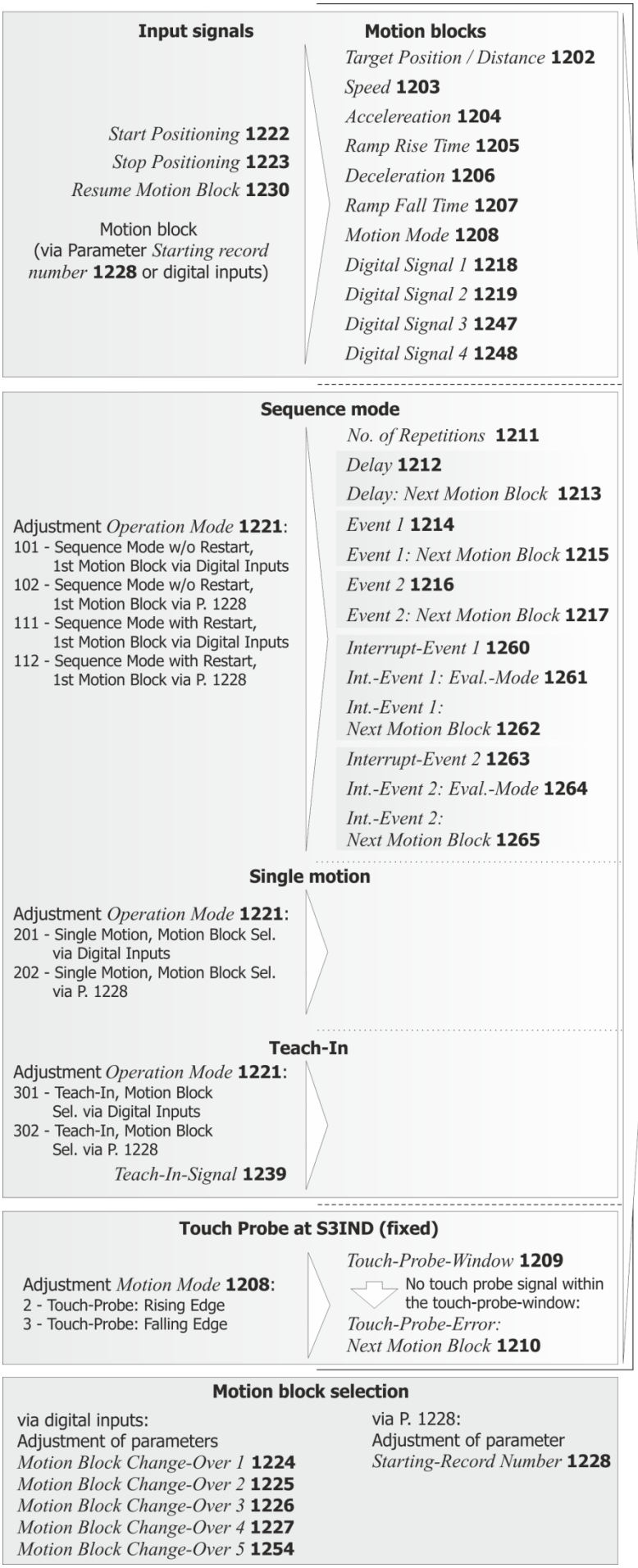


Single motion

20x Parameter *Operation mode* **1221** = 201 or 202

Teach-In

30x Parameter *Operation mode* **1221** = 301 or 302


Input signals
Motion blocks
Start Positioning 1222
Stop Positioning 1223
Resume Motion Block 1230
Motion block (via Parameter Starting record number 1228 or digital inputs)
Target Position / Distance 1202
Speed 1203
Accelereation 1204
Ramp Rise Time 1205
Deceleration 1206
Ramp Fall Time 1207
Motion Mode 1208
Digital Signal 1 1218
Digital Signal 2 1219
Digital Signal 3 1247
Digital Signal 4 1248
Sequence mode
Adjustment Operation Mode 1221:
101 - Sequence Mode w/o Restart, 1st Motion Block via Digital Inputs
102 - Sequence Mode w/o Restart, 1st Motion Block via P. 1228
111 - Sequence Mode with Restart, 1st Motion Block via Digital Inputs
112 - Sequence Mode with Restart, 1st Motion Block via P. 1228
No. of Repetitions 1211
Delay 1212
Delay: Next Motion Block 1213
Event 1 1214
Event 1: Next Motion Block 1215
Event 2 1216
Event 2: Next Motion Block 1217
Interrupt-Event 1 1260
Int.-Event 1: Eval.-Mode 1261
Int.-Event 1: Next Motion Block 1262
Interrupt-Event 2 1263
Int.-Event 2: Eval.-Mode 1264
Int.-Event 2: Next Motion Block 1265
Single motion
Adjustment Operation Mode 1221:
201 - Single Motion, Motion Block Sel. via Digital Inputs
202 - Single Motion, Motion Block Sel. via P. 1228
Teach-In
Adjustment Operation Mode 1221:
301 - Teach-In, Motion Block Sel. via Digital Inputs
302 - Teach-In, Motion Block Sel. via P. 1228
Teach-In-Signal 1239
Touch Probe at S3IND (fixed)
Adjustment Motion Mode 1208:
2 - Touch-Probe: Rising Edge
3 - Touch-Probe: Falling Edge
Touch-Probe-Window 1209
No touch probe signal within the touch-probe-window:
Touch-Probe-Error: Next Motion Block 1210
Motion block selection
via digital inputs:
Adjustment of parameters
Motion Block Change-Over 1 1224
Motion Block Change-Over 2 1225
Motion Block Change-Over 3 1226
Motion Block Change-Over 4 1227
Motion Block Change-Over 5 1254
via P. 1228:
Adjustment of parameter
Starting-Record Number 1228
Output signals
Operation modes for digital outputs:
60 - Target Position Reached
160 - Inv. Arrived at desired Position
62 - Motion-Block Digital Signal 1
63 - Motion-Block Digital Signal 2
64 - Motion-Block Digital Signal 3
65 - Motion-Block Digital Signal 4
162 - Inv. Motion-Block Digital Signal 1
163 - Inv. Motion-Block Digital Signal 2
164 - Inv. Motion-Block Digital Signal 3
165 - Inv. Motion-Block Digital Signal 4
Logic signal sources:
282 - Target Position Reached
891 - Motion-Block Digital Signal 1
892 - Motion-Block Digital Signal 2
893 - Motion-Block Digital Signal 3
894 - Motion-Block Digital Signal 4
895 - Inv. Motion-Block Digital Signal 1
896 - Inv. Motion-Block Digital Signal 2
897 - Inv. Motion-Block Digital Signal 3
898 - Inv. Motion-Block Digital Signal 4

NOTE:	Before an absolute positioning operation can be started, the point of reference of the positioning operation must be determined in a homing operation. Otherwise, error message "F1570 – No Homing Done" will be displayed if you try to start an absolute positioning operation. Relative positioning and velocity operations are possible without homing.

5.2 Homing

When the drive is started, a defined starting position must be specified for absolute positioning modes. In a homing operation, the point of reference of the positioning operation is determined. All positioning data relates to this point of reference. Once the homing operation is started, the drive moves until it reaches a home switch or limit switch and stops there. The limit switches limit the motion path. The direction of movement (search direction) at the start of the homing operation is defined by the homing mode. Additional the reaching of a limit switch will change the direction of the drive (depending on the homing mode). The limit switches can also be used as the point of reference. For a list of homing modes, refer to chapter "List of Homing Modes".
Relative positioning and velocity operations are possible without homing.
Homing can be started:

- via a digital input
- by a control word via system bus or field bus [1)]
- automatically before the start of a motion block positioning operation

[1)] Extension module with system bus or field bus interface required

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

5.2.1 Automatic of manual start of homing

Use parameter *Start Homing (manual)* **1235** to start homing manually via a logic signal, e.g. via a digital input. The signal must be present until completion of the homing operation is signaled by logic signal "59 – Homing Done". If the start signal is reset during a homing operation, the drive will be stopped. Homing is not completed and positioning is not possible.
When a homing is not necessary in the application, the corresponding Operation mode can be selected.
The signal "614 – Homing done" shows the status, if the System has a valid homing.
The homing start condition is defined by parameter *Operation Mode* **1220**.

Operation mode **1220**		Function
1 -	manual	Start of homing via parameter *Start Homing (manual)* **1235**. For manual start of homing, the parameter must be assigned a logic signal or a digital input.
2 -	automatic	**Factory setting.** Automatic start of homing if controller is released and signal is present on *Start Positioning* **1222**. Automatic homing is performed only if the drive has not been referenced yet when the Controller release via digital inputs STOA and STOB is set. The automatic homing is done at the first Start after the mains were switched on.

Operation mode **1220**		**Function**
10 -	No homing necessary	This setting offers the possibility to start an absolute positioning without homing. The actual position remains. The bit "Homing done" in Source 614 "Homing done" and in the Status word is set accordingly. This setting is useful in following applications: – When using an **absolute encoder** connected to the ACU after the successful initial commissioning. – When using a non-absolute encoder the drive cannot be moved mechanically during power off (i.e. blocked with a mechanical brake). **NOTE:** The bit "homing done" is set immediately when changing into this operation or power on (even if the output stage is inhibited). With different inverter data sets different behaviors can be set up. **ATTENTION:** This setting can result in damages in the plant or on persons when used improperly. The invalid moving area must be protected accordingly (in example using limit switches). Furthermore a power off must not result in a possible movement or a movement must not lead to a dangerous state in the plant after power restart.

5.2.2 Input and output signals for homing

Terminal assignment for homing						
Function	**Controller release**	***Start Homing (manual)* 1235** [1]	***Stop Positioning* 1223**	***Home Switch* 1139** [2]	***Neg. HW Limit Switch* 1137**	***Pos. HW Limit Switch* 1138**
		Off*	S3IND*	S6IND* [6]	S5IND [6]	S4IND [6]
Drive disabled	0	X	X	X	0 *(1)*	0 *(1)*
Homing is started	1	1	0	0	0 *(1)*	0 *(1)*
Home position is set	1	1	0	edge [3]	0 *(1)*	0 *(1)*
Homing is interrupted	1	1	1	X	0 *(1)*	0 *(1)*
Error message, limit switch as make contact function *(brake contact function)*						
F1445 [5]	X	X	X	X	1 *(0)*	1 *(0)*
F1447 (F1446) [5]	X	X	X	X	0 *(1)*	1 *(0)* [4]
F1448 (F1446) [5]	X	X	X	X	1 *(0)* [4]	0 *(1)*

0 = Low / 1 = High / X = any / * = factory setting

[1] **Start Homing:** Homing is started automatically if required (drive not yet referenced) in parameter configuration *Operation Mode* **1220** = "2 – automatic". In parameter configuration *Operation Mode* **1220** = "1 – manual", the digital signal *Start Homing (manual)* **1235** must be present.

[2] **Home switch:** The home switch can be a reference cam, a limit switch or the zero pulse of an encoder. Also refer to the descriptions of the individual homing modes (parameter *Homing Mode* **1130**) in section 6.

[3] **Edge:** The rising or falling edge is evaluated depending on the homing mode (parameter *Homing Mode* **1130**).

[4] A hardware limit switch is used for reversing the direction of rotation, depending on the homing mode (parameter *Homing Mode* **1130**). If the direction of rotation is reversed, value 0 is permissible (only in this case) and will not trigger an error.

[5] **Error messages:** Also refer to chapter "Positioning Error Messages"

F1445: Pos. and Neg. HW-Lim Switch Simultaneously

F1446: Limit Switch Incorrect Wired

F1447: Pos. HW Limit Switch

F1448: Neg. HW Limit Switch

[6] Depends on *Operation Mode* **490**. Comply with the instructions in sections 4.3 and 4.4.1.4.

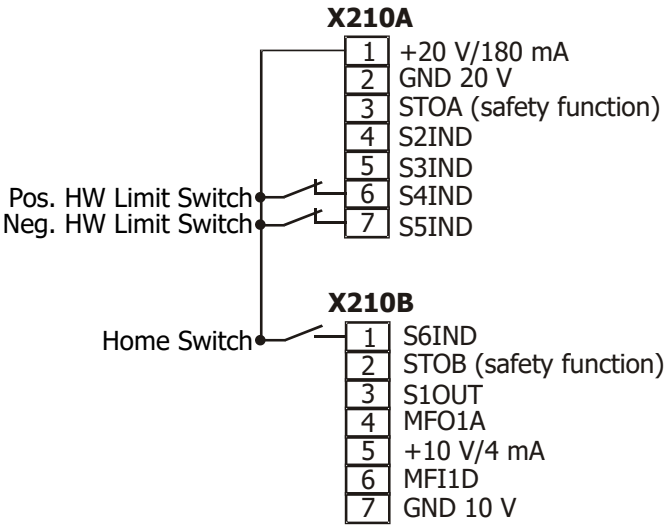
Assign S4IND and S5IND to the parameters for HW limit switches.

Values in parentheses *(0)* and *(1)* apply if the digital inputs for the limit switches are configured as inverted inputs *(brake contact function)*, e.g. *Positive HW Limit Switch* **1138** = "540 - S4IND inverted (Hardware)".
In most homing operations, a home switch (cam) and a hardware limit switch will be required. Mind wiring and parameter configuration accordingly.

Input terminals for homing

Pos. HW Limit Switch **1138** =
"540 - S4IND inverted (Hardware)" → set
Neg. HW Limit Switch **1137** =
"541 - S5IND inverted (Hardware)" → set

Home Switch **1139** =
"75 - S6IND" (factory setting)



Manual start of homing

Operation Mode **1220** = "1 - manual" → set

Controller release:
Connect STOA (X210A.3) and STOB (X210B.2) for the safety function

Start Homing (manual) **1235** → Assign digital signal

Automatic start of homing

Operation Mode **1220** = "2 - automatic" (factory setting)

Controller release:
Connect STOA (X210A.3) and STOB (X210B.2) for the safety function

Start Positioning **1222** = S2IND (X210A.4)

For a description of the homing modes, refer to chapter 6 (List of homing modes).

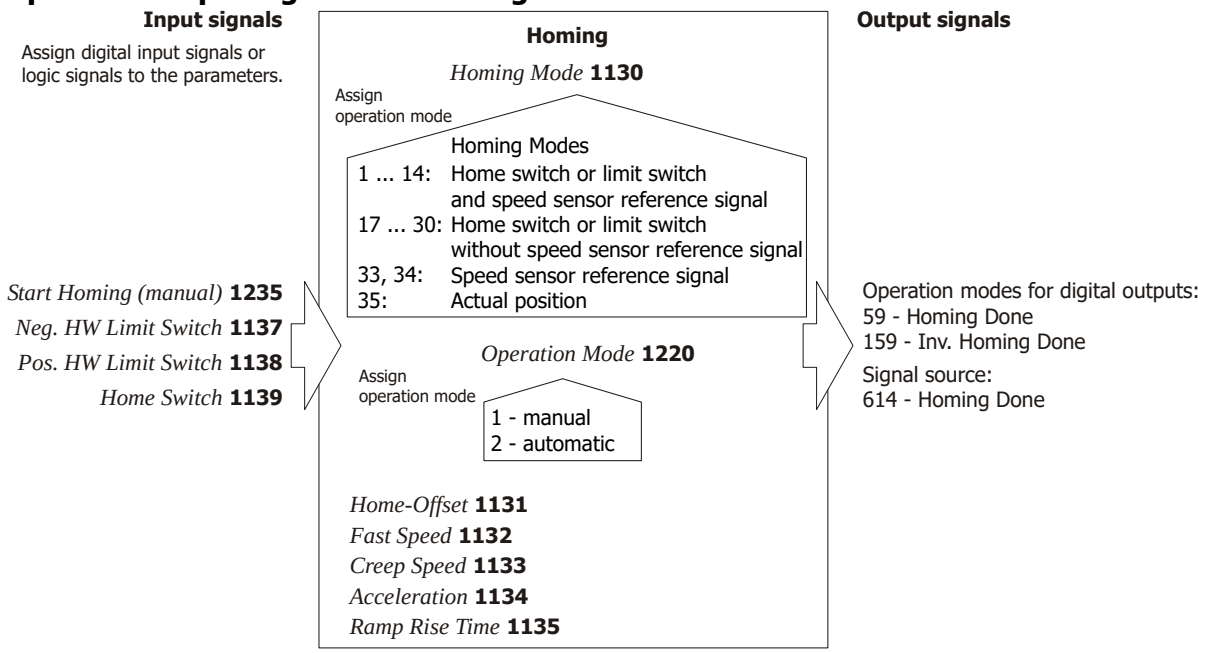
Parameter		Settings		
No.	**Description**	**Min.**	**Max.**	**Fact. sett.**
1130	Homing Mode	0	35	0

Operation mode "59 – Homing Done" can be linked to a digital output or a logic signal.

Digital signal		Function
59 -	Homing Done	Output signal if reference position is set (reference position defined). This is done by homing or by taking over the current position as the reference position.
159 -	Inv. Homing Done	Like operation mode 59, but with inverted output signal.

Signal "614 – Homing Done" is available as an internal signal source for control functions.

Input and output signals for homing



ATTENTION!	During manual homing, do not reset the homing control signal (parameter *Start Homing (manual)* **1235**). The control signal must be present until the "Homing Done" is signaled. Otherwise, homing is stopped. Without successful homing, no absolute positioning operation can be started, i.e. error message "F1570 No Homing Done" will be displayed if you try to start a positioning operation.

NOTE:	Relative positioning and velocity operations are possible without homing.

5.2.3 Homing mode

Via parameter *Homing Mode* **1130**, you can define which signal will set the reference position, the direction in which the search for the point of reference is to be started, as well as the condition for reversing the direction for the reference position.
Possible signals for setting the reference position:

- Negative hardware limit switch (anticlockwise)
- Negative hardware limit switch (clockwise)
- Home switch
- Zero pulse of an encoder

For the homing mode suitable for the relevant application, refer to chapter "List of Homing Modes".

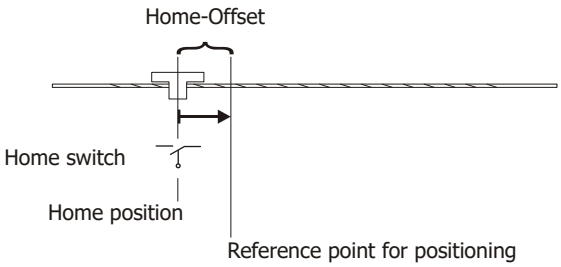
The home switch is necessary in several homing modes and is set up via *Home Switch* **1139**.

Parameter		Settings		
No.	**Description**	**Min.**	**Max.**	**Fact. sett.**
1139	Home Switch	Selection		75-S6IND

5.2.4 Home offset

With parameter *Home Offset* **1131**, the point of reference for positioning can be adjusted to the mechanical system.
The value adjusted for parameter *Home Offset* **1131** is added to the home position.
Negative values will cause a shift of the point of reference in positive direction (clockwise), positive values will cause a shift in negative direction (anticlockwise).
Point of reference for positioning = home position - home offset

In the factory settings, the point of reference for positioning corresponds to the home position.



Parameter		Settings		
No.	**Description**	**Min.**	**Max.**	**Fact. sett.**
1131	Home-Offset	$-(2^{31}-1)$ u	$2^{31}-1$ u	0 u

5.2.5 Speed and acceleration of homing operation

Homing is started at fast speed. As soon as a certain point is reached, operation is continued at creep speed. The point at which the speed is changed depends on the homing mode selected.

The factory setting of parameter *Fast Speed* **1132** corresponds to a rotary frequency of 5 Hz for a four-pole machine with the reference system set to factory settings, *Creep Speed* **1133** corresponds to 1 Hz.

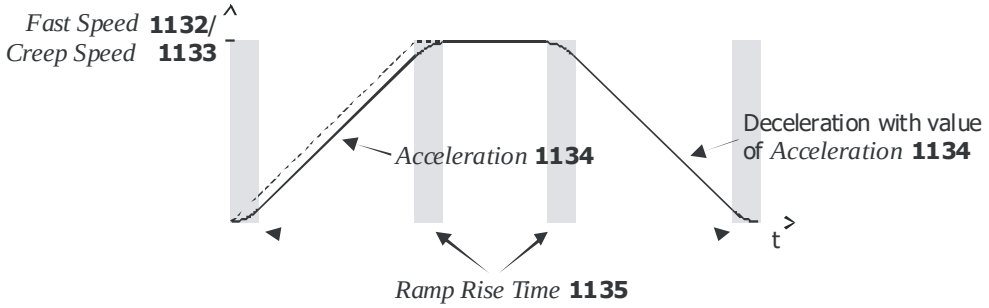
The direction is defined by the homing mode.

Parameter		Settings		
No.	**Description**	**Min.**	**Max.**	**Fact. sett.**
1132	Fast Speed	1 u/s	$2^{31}-1$ u/s	327 680 u/s
1133	Creep Speed	1 u/s	$2^{31}-1$ u/s	163 840 u/s

Via parameter *Acceleration* **1134**, the acceleration and deceleration value to be used for homing is adjusted.

Parameter *Ramp Rise Time* **1135** defines the time in which the frequency is to be brought to the acceleration and deceleration ramp adjusted for homing. In this way, a non-linear acceleration and deceleration (S-curve) can be obtained for homing, and the load during acceleration and deceleration of the drive can be reduced, e.g. in order to limit jerking. The factory setting of 0 ms causes a non-linear acceleration and deceleration ramp. The ramp rise time is added once per acceleration or deceleration operation.

Parameter		Settings		
No.	**Description**	**Min.**	**Max.**	**Fact. sett.**
1134	Acceleration	1 u/s²	$2^{31}-1$ u/s²	327680 u/s²
1135	Ramp Rise Time	0 ms	2000 ms	0 ms



5.3 Flying homing and Position latch

The functionalities "Flying homing" and "Position latch" use some parts of functionnality at the same time, but can be used for different purposes.

5.3.1 Flying homing

The Flying homing can be used to update the reference position during a running motion. This is helpful in example in round table applications with infinite gear box ratio or slip depending applications. The Flying homing is activated via *Start Flying Homing* **1283** and *Operation Mode* **1280**. For the activation *Start Flying Homing* **1283** must be linked with a digital signal. The setting of *Operation Mode* **1280** selects the edge of S2IND, which is used to update the reference point.
When the Flying homing is used during an active motion, the running motion is not changed, the motion is continued until the original target is reached. The *Act. Position* **1108** changes to *Offset Flying homing* **1282** at the time of the detected selected edge of S2IND.

Operation Mode **1280**	Function
0 - Off	Flying homing and Position latch is deactivated. **Factory setting.**
1 - S2IND Rising Edge	While *Start Flying Homing* **1283** is TRUE, a rising edge at S2IND will set a new reference position. *Offset Flying Homing* **1282** adjusts the reference position by the entered value.
2 - S2IND Falling Edge	While *Start Flying Homing* **1283** is TRUE, a falling edge at S2IND will set a new reference position. *Offset Flying Homing* **1282** adjusts the reference position by the entered value.

Parameter		Settings		
No.	**Description**	**Min.**	**Max.**	**Fact. sett.**
1282	Offset Flying homing	$-(2^{31}-1)$ u	$2^{31}-1$ u	0 u

Parameter		Factory setting	
1283	Start Flying Homing	7 -	False

5.3.2 Position latch

The Position latch can be used to store the actual position in actual value *Latched Position* **1281**. This value can then be used for different purposes, like reading out by a PLC or usage for diagnosis.

Operation Mode **1280**	Function
0 - Off	Flying homing and Position latch is deactivated. **Factory setting.**
1 - S2IND Rising Edge	Each rising edge at S2IND writes the actual position into the actual value *Latched Position* **1281**.
2 - S2IND Falling Edge	Each falling edge at S2IND writes the actual position into the actual value *Latched Position* **1281**.

5.4 Positioning Mode

Positioning mode enables precise approaching of a target in a plant. By defining parameters such as speed, acceleration and ramp rise time, different application-specific load points can be considered. The different positioning modes and monitoring methods can be adjusted individually for each motion block. In this way, it is possible to mix absolute and relative positioning operations. The touch-probe evaluation additionally enables the definition of remaining distances via an initiator.

5.4.1 Motion block management

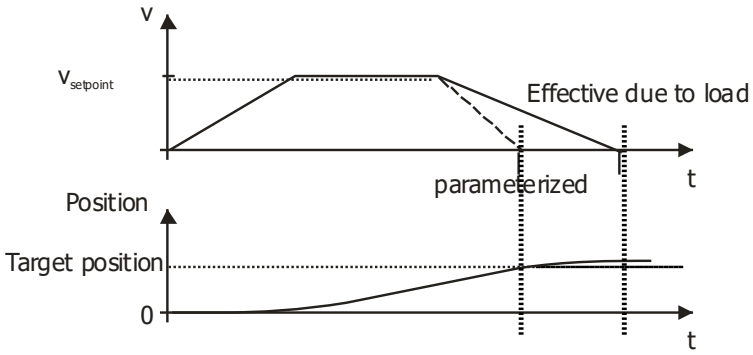
Different motion profiles can be configured in 32 motion blocks. A motion block contains parameter entries on:

- target position / distance
- speed
- acceleration
- deceleration

- Positioning mode (absolute, relative, touch-probe (sensor), speed (endless), combination with electronic gear)
- number of repetitions
- next motion block
- digital signal for logic links and communication interface

ATTENTION!

After changing motion profiles, you should test the automatic sequence of motion blocks at reduced speed. The scaled speed function can be activated via parameter *Speed Override* **1236**. For the test, an emergency stop device must be provided in order to be able to stop the drive immediately in the case of extraordinary movements.
If the load moment is changed while motion blocks are being processed, the target position may not be reached. The deceleration value set in the motion block is too low in this case in order to stop the axis at the target position.



5.4.2 VTable

The control software VPlus enables access to the parameters of the frequency inverter. The additional program VTable which is included in VPlus enables easy and comfortable access to all 32 motion blocks at the same time. Motion blocks 1 to 32 are entered in VTable via index 1 to 32. Index 0 can be used in order to set a value in all motion blocks at the same time.

The parameters in the motion blocks perform one of three functions:

- Target position incl. speed
- Next motion block logic module
- Setting of digital signal

Motion Blocks	Index 0	Index 1
1202 Target Position / Distance	[A]	0 units
1203 Speed		10000 u/s
1204 Accelereation		100000 u/s^2
1205 Ramp Rise Time		500 ms
1206 Deceleration		100000 u/s^2
1207 Ramp Fall Time		500 ms
1208 Motion Mode		0 - absolute
1209 Touch-Probe-Window		65536 units
1210 Touch-Probe-Error: Next M...		-2
1211 No. of Repetitions	[B]	0
1212 Delay		0 ms
1213 Delay: Next Motion Block		0
1214 Event 1		75 - S6IND
1215 Event 1: Next Motion Block		2
1216 Event 2		7 - Off
1217 Event 2: Next Motion Block		0
1218 Digital Signal 1	[C]	12 - Start: off Ref.reached:
1219 Digital Signal 2		0 - Start: --- Ref.reached: ---
1247 Digital Signal 3		0 - Start: --- Ref.reached: ---
1248 Digital Signal 4		0 - Start: --- Ref.reached: ---
1260 Interrupt-Event 1	[B]	7 - Off
1261 Int.-Event 1: Eval.-Mode		1 - Level-Controlled
1262 Int.-Event 1: Next Motion Bl...		0
1263 Interrupt-Event 2		7 - Off
1264 Int.-Event 2: Eval.-Mode		1 - Level-Controlled
1265 Int.-Event 2: Next Motion Bl...		0

Mux/DeMux	Ind [D]	Index 1	Index 2
1252 Mux Input		7 - Off	7 - Off

The parameterized indices for *Mux Input* **1252** are independent from the motion

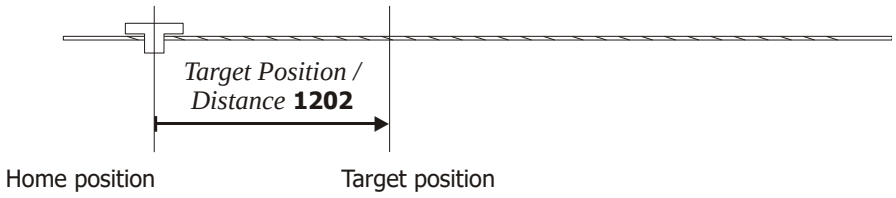
block and can be used by the multiplexer for different digital signals [D].

5.5 Positioning Mode And Motion Block Data

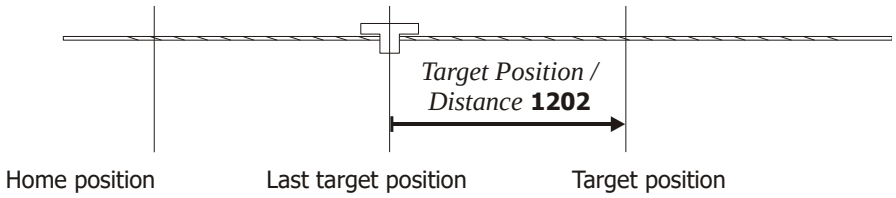
5.5.1 Motion Mode

The positions are defined either in relation to a fixed reference position (absolute motion mode), in relation to other positions or a touch-probe sensor. Parameter *Motion Mode* **1208** enables the selection.

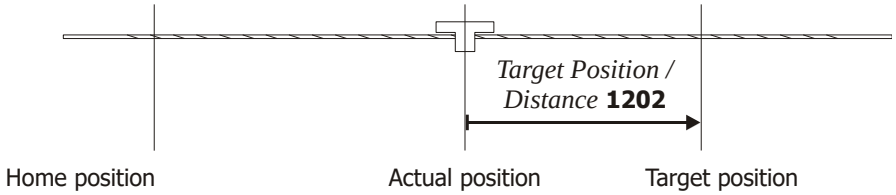
Motion Mode **1208** = 0 - absolute



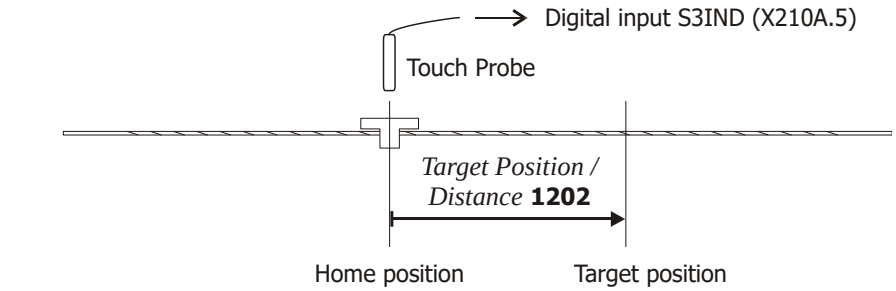
Motion Mode **1208** = 1 - relativ



After JOG-Mode, *Motion Mode* **1208** = 1 - relativ



Motion Mode **1208** = 2 - Touch-Probe: Rising Edge or 3 - Touch-Probe: Falling Edge



Motion Mode **1208** = "0 – absolute": An absolute position is a defined position on the motion path referred to the reference position. The absolute position is approached independent from the current position value.
For an absolute Positioning a homing is required.
Motion Mode **1208** = "1 – relative": A relative position refers to the previous target position or the current position after JOG mode.
Motion Mode **1208** = "2 – touch probe": rising edge" or "3 – touch probe: falling edge": a touch probe positioning operation refers to the reference position defined by a sensor signal.

The operation mode of parameter *Motion Mode* **1208** defines the reference of the target position.
Operation modes 10 to 14 are combined with the function of an electronic gear.

Motion Mode 1208	Function
0 - absolute	Target position relates to the fixed reference position (point of reference for positioning). Factory setting. See chapter "5.5.1.1. For an absolute Positioning a homing is required.
1 - relative	A relative positioning operation relates to a variable position. This may be the last target position or the current position reached in manual JOG mode. See chapter 5.5.1.2.
2 - Touch probe: rising edge	The rising edge of a digital signal on digital input S3IND is used for setting a reference point for a relative positioning operation. See chapter 5.5.1.3.
3 - Touch probe: falling edge	The falling edge of a digital signal on digital input S3IND is used for setting a reference point for a relative positioning operation. See chapter 5.5.1.3.
4 - Velocity	The drive moves at the speed profile parameterized in the selected motion block. The target position is not relevant and is not evaluated. See chapter 5.5.1.4
10 - Gearing, absolute	Absolute motion mode is combined with the electronic gearing function. The drive is synchronized with the master drive when it attains the master speed. See chapter 5.5.1.5.
11 - Gearing, relative	Relative motion mode is combined with the electronic gearing function. The drive is synchronized with the master drive when it attains the master speed. See chapter 5.5.1.5.
12 - Gearing, touch probe: rising edge	Operation mode 2 is combined with the electronic gearing function. The drive is synchronized with the master drive when it attains the master speed. See chapter 5.5.1.5.
13 - Gearing, touch probe: falling edge	Operation mode 3 is combined with the electronic gearing function. The drive is synchronized with the master drive when it attains the master speed. See chapter 5.5.1.5.
14 - Gearing	Like operation mode 4, but the drive moves at the speed profile defined by the electronic gear. The target position is not relevant and is not evaluated. The drive is synchronized with the master drive when it attains the master speed. See chapter 5.5.1.5.
20 - Gearing, direct sync., absolute	Absolute motion mode is combined with the electronic gearing function. The drive is accelerated to the master speed. At the start of a motion block the drive is synchronised with the master drive directly.
21 - Gearing, direct sync., relative	Relative motion mode is combined with the electronic gearing function. The drive is accelerated to the master speed. At the start of a motion block the drive is synchronised with the master drive directly.
22 - Gearing, direct sync., Touch-Probe: Rising Edge	Operation mode 2 is combined with the electronic gearing function. The drive is accelerated to the master speed. At the start of a motion block the drive is synchronised with the master drive directly.
23 - Gearing, direct sync., Touch-Probe: Falling Edge	Operation mode 3 is combined with the electronic gearing function. The drive is accelerated to the master speed. At the start of a motion block the drive is synchronised with the master drive directly.
24 - Gearing, direct synchronisation	Like operation mode 4, but the drive moves at the speed profile defined by the electronic gear. The target position is not relevant and is not evaluated. The drive is accelerated to the master speed. At the start of a motion block the drive is synchronised with the master drive directly.

NOTE:	If both a motor and a position encoder (two different encoders) are used, the function "Electronic Gear" cannot be used. Also refer to section "Two different encoders for motor and positioning", chapter 4.4.1.2.

The motion mode of the actual motion block can be displayed via parameter *Actual Motion Mode* **1255**.

5.5.1.1 Motion mode "absolute"

Parameter *Motion Mode* **1208** = "0 – absolute":
The target position is the position adjusted in the motion block at *Target Position/Distance* **1202**.
Target position relates to the fixed reference position (point of reference for positioning) which is determined by a homing operation. An absolute distance is covered, referred to the reference position.

When the target position is reached, logic signal "282 Target Position Reached" is set. The signal is reset when the next motion block is started or the drive leaves the target window (monitoring of current position at end of positioning).
In operation mode 60 or 160 (inverter), the logic signal "Target Position Reached" can be output via a digital output.
For an absolute Positioning a homing is required.

5.5.1.2 Motion mode "relative"

Parameter *Motion Mode* **1208** = "1 – relative":
A relative positioning operation relates to a position which was reached before. This may be the last target position or the current position reached in manual JOG mode.
If the last position was reached through a motion block positioning operation, *Target Position/Distance* **1202** indicates the value of a position in relation to the last target position, regardless of whether it was reached or not.
New target position = last target position + relative distance
If the last position was reached through a manual JOG operation, the value of parameter *Target Position/Distance* **1202** is a relative position relating to the current position.
New target position = current position + relative distance

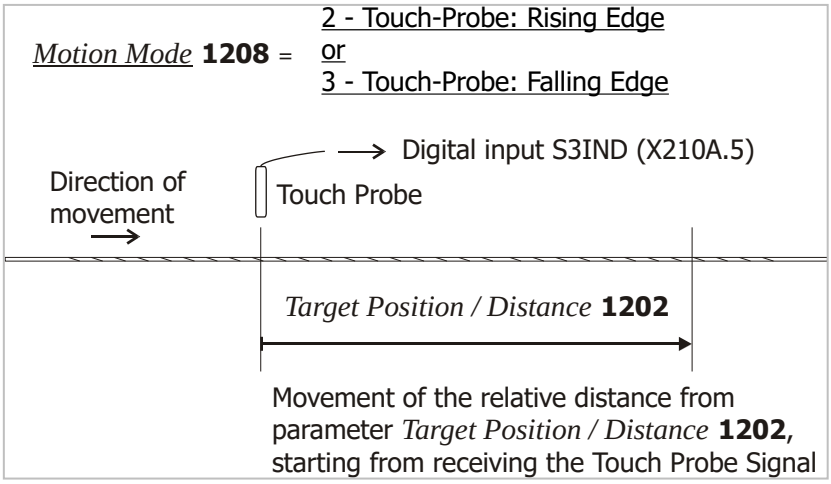
5.5.1.3 Motion mode "touch probe" (sensor)

Activation of motion mode "touch probe":

- Parameter *Motion Mode* **1208** = "2 – touch probe: rising edge" or
- Parameter *Motion Mode* **1208** = "3 – touch probe: falling edge"

The rising or falling edge of a digital signal on digital input S3IND (terminal 210A.5) is used for setting a reference point for a relative positioning operation. As soon as the signal is received, the drive moves by the relative distance of parameter *Target Position/Distance* **1202**. The function is permanently linked to digital input S3IND, parameterization on another digital input is not possible. The touch probe signal must be connected to this input when a touch probe motion mode is selected.
The function can be used in order to position the front edge of workpieces of a different length at the same place, for example. A momentary contact switch can supply the touch-probe signal.
The current position is set as the reference position when the rising edge (operation mode 2) or the falling edge (operation mode) is received on the digital input (touch probe signal).
The touch probe position is the position at which a rising/falling edge is received on digital input S3IND plus the value of parameter *Target Position/Distance* **1202**.

NOTE:	By default, digital input S3IND is assigned the function "Stop Positioning". Change the occupation of parameter *Stop Positioning* **1223** and, if necessary, change wiring if touch probe function is used.



If the value of parameter *Target Position/Distance* **1202** is too low in order to stop at the target position at the deceleration entered in the motion block, the target position is passed, the direction is reversed and the position is approached from the opposite side.
In parameter *Touch-Probe-Window* **1209**, you can enter the range in which the touch probe signal must be received. The starting point of the touch probe window is the last target position or the current position in JOG mode.
The end point of the touch probe window is in the direction of the motion.
If 0 is entered in parameter *Touch-Probe-Window* **1209**, the touch probe window is deactivated.

Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Fact. sett.**
1209	Touch-Probe-Window	0 u	2^{31}-1 u	65 536

If no touch-probe signal is received within the touch probe window, the settings of parameter *Touch-Probe-Error: Next Motion Block* **1210** will become effective.

Touch-Probe-Error: Next Motion Block **1210**		Function
-3 -(negative 3)	Em. stop, error	The drive is stopped via *Emergency Ramp* **1179**, after that, error message "F1573 No touch probe signal detected" is output.
-2 -(negative 2)	Stop, error	**Factory setting.** The drive is stopped at the active deceleration ramp from parameters *Deceleration* **1206** and *Ramp Fall Time* **1207**, after that, error message "F1573 No touch probe signal detected" is output.
-1 -(negative 1)	Error Switch-Off	The drive is stopped, after that, error message "F1573 No touch probe signal detected" is output. Coast-down of the drive.
0 -	deactivated	Positioning operation and processing of next motion blocks is stopped.
1 … 32		The corresponding motion block is executed.

Example: Motion mode touch probe

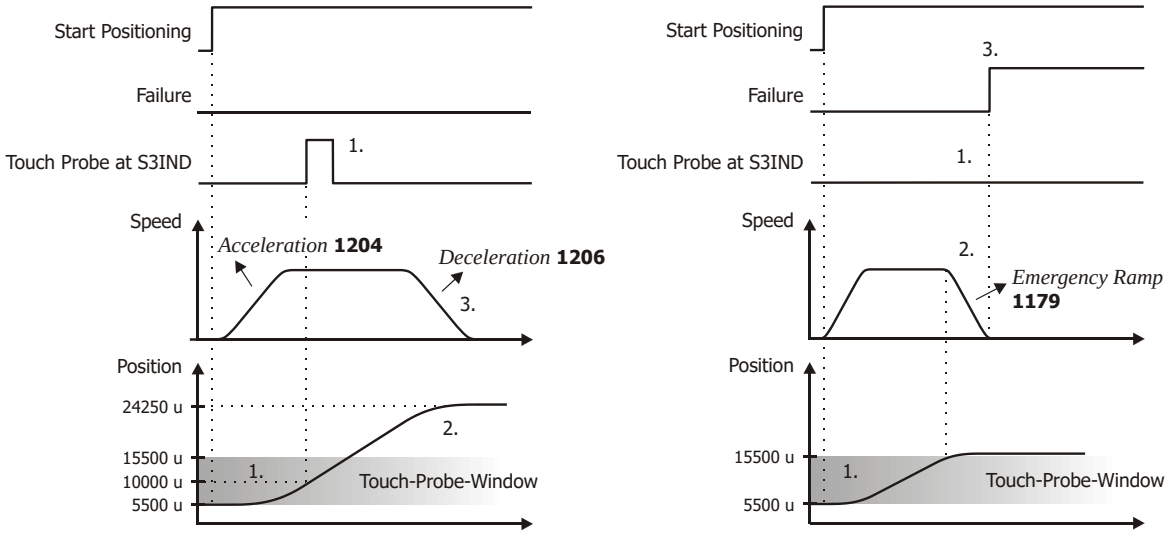
Example: Touch probe	
Target Position / Distance **1202**	14250 u
Motion Mode **1208**	2 – touch probe: rising edge
Touch-Probe-Window **1209**	10000 u
Touch-Probe-Error: Next Motion Block **1210**	-3

Touch probe signal: set reference point and move

1. Touch Probe signal is received within the Touch-Probe-Window. The actual position is saved as home position.
2. Movement of the relative distance from parameter *Target Position / Distance* **1202**
3. Stop at the target position with the value of parameter *Deceleration* **1206**

No signal within touch probe signal

1. No Touch Probe signal is received within the Touch-Probe-Window.
2. Shutdown of the drive with *Touch-Probe-Error: Next Motion Block* **1210** = "-3 - Em. stop, error" (*Emergency Ramp* **1179**)
3. Failure message "F1573 No Touch Probe Signal Detected".



5.5.1.4 Motion mode "velocity"

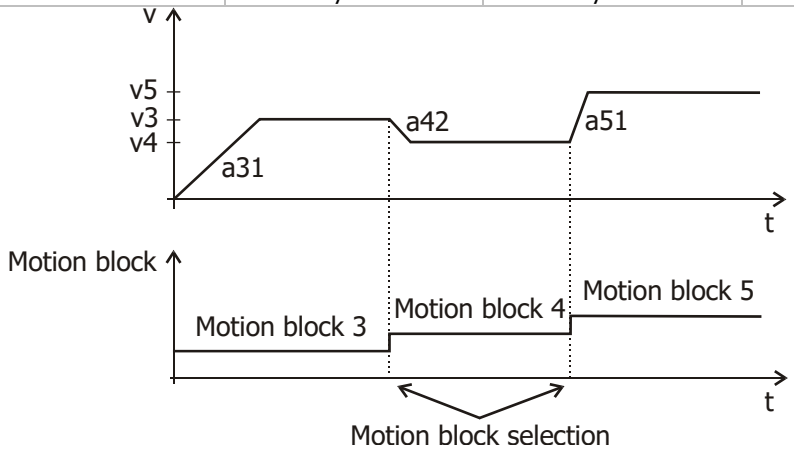
Parameter *Motion Mode* **1208** = "4 – velocity":
The drive is accelerated to *Speed* **1203** at the motion profile set in the motion block. Settings for *Target Position / Distance* **1202** will not be evaluated. The motion block remains active until another motion block is selected. Jumping to motion blocks with other motion modes, e.g. "absolute" or "relative" is possible.

Motion block selection

The motion blocks can be selected via:

- *Delay* **1212**
- *Delay: Next motion block* **1213**
- *Event 1* **1214**
- *Event 1: Next Motion Block* **1215**
- *Event 2* **1216**
- *Event 2: Next Motion Block* **1217**
- *Interrupt-Event 1* **1260**
- *Int.-Event 1: Next Motion Block* **1262**
- *Interrupt-Event 2* **1263**
- *Int.-Event 2: Next Motion Block* **1265**

Example: Motion block sequence in motion mode "velocity"

Motion blocks	Index 3	Index 4	Index 5
Motion Mode **1208**	4 - velocity	4 - velocity	4 - velocity
			
v3: *Speed* **1203** from motion block 3, a31: *Acceleration* **1204** from motion block 3			
v4: *Speed* **1203** from motion block 4, a42: *Delay* **1205** from motion block 4			
v5: *Speed* **1203** from motion block 5, a51: *Acceleration* **1204** from motion block 5			

If the value of *Speed* **1203** is reached, this can be signalized. For one of the parameters *Digital Signal 1* **1218**, *Digital Signal 2* **1119**, *Digital Signal 3* **1247** or *Digital Signal 4* **1248** an operation mode with „Ref.reached: on" must be selected. See chapter 5.5.6.

5.5.1.5 Combination with electronic gear

Positioning operation modes 10 to 14 and 20 to 24 (parameter *Motion Mode* **1208**) are combined with the electronic gearing function.

Operation modes 10 to 14, "Gearing"	Operation modes 20 to 24, "Gearing, direct synchronisation"
Synchronisation at attaining the master speed	Direct synchronization at the start of a motion block

Operation modes 10 to 14, "Gearing"

The drive accelerates the master speed at 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 with the master. In the case of a relative positioning operation, this engaging position is used as the start position.

The acceleration and deceleration for synchronization occurs according to the characteristic of an S-shaped curve.

Logic signal "57 – In Gear" signals synchronous operation and can be output via a digital output. Logic signal "624 – In Gear" can be used for logic functions.

During synchronous operation, the ramps parameterized in the motion block are deactivated. Acceleration and deceleration are defined by the master.

The slave unit calculates the delayed starting point internally from the parameterized target position and the corresponding delay. As soon as this point is reached, the unit disengages from the master and starts the deceleration. Logic signals "57 – In Gear" and "624 – In Gear" are reset.

The drive speed is limited by the value adjusted for parameter *Maximum Frequency* **419**, even if the master drive exceeds this value. Logic signals "57 – In Gear" and "624 – In Gear" are reset in this case.

Operation modes 20 to 24, "Gearing, direct synchronisation"

The drive accelerates the master speed at the ramps parameterized in the motion block. At the start of a motion block the drive is sychronised with the master drive directly. The master speed is processed by the position controller directly.

The acceleration and deceleration for synchronization occurs according to the characteristic of an S-shaped curve.

Logic signal "57 – In Gear" signals synchronous operation and can be output via a digital output. Logic signal "624 – In Gear" can be used for logic functions.

During synchronous operation, the ramps parameterized in the motion block are deactivated. Acceleration and deceleration are defined by the master.

The drive speed is limited by the value adjusted for parameter *Maximum Frequency* **419**, even if the master drive exceeds this value. Logic signals "57 – In Gear" and "624 – In Gear" are reset in this case.

For jerk reduction the output of the position controller can be limited via Parameter *Limitation* **1118**. The value limits the speed for compensation of the position deviation during synchronisation. Refer to chapter 5.13 "Position Controller".

NOTE:	If both a motor and a position encoder (two different encoders) are used, the function "Electronic Gear" can only be used via system bus.

Direction of movement at the start of the positioning

Motion mode		
Gearing, absolute or relative		
	The initial direction depends on the target position	
	Target position is in direction	
	Positive:	Negative:
	Slave-drive is accelerated to the master speed in the same direction	Slave-drive is accelerated to the master speed in the opposite direction
Gearing, Touch-Probe		
	Slave-drive is accelerated to the master speed in the same direction	

Gearing

Slave-drive is accelerated to the master speed in the same direction. The operational behavior corresponds to the electronic gear function in the configurations x15. Refer to the application manual "Electronic Gear".

After drives are in synchronous operation, a reversal of the master-drive results in a reversal of the slave-drive independent of the motion mode.

Signals for synchronization acknowledgement

The synchronous operation of the drive and master drive is indicated by the signal "In Gear".
Logic signal "57 - In Gear" can be output via a digital output.
Logic signal "624 - In Gear" can be used for logic functions.
The signals "In Gear" are set if the relative deviation between master- and slave-position is lower than the value of *"In-Gear"-Threshold* **1168** for at least *„In-Gear"-Time* **1169**.

Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Fact. sett.**
1168	"In-Gear"-Threshold	0 u	2^{31}-1 u	0 u
1169	"In-Gear"-Time	1 ms	65535 ms	10 ms

NOTE:	If parameter *"In-Gear"-Threshold* **1168** is set to the value zero the signals "In Gear" are set when the drive attains the master speed.

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

- The relative deviation between master- and slave-position exceeds the value of *"In-Gear"-Threshold* **1168**.
- The drive is decelerated according to the ramps defined in the motion block and stops at the target position.
- The speed of the master drive exceeds the value of *Maximim Frequency* **419** *.

* The speed of the slave-drive is limited to *Maximim Frequency* **419**.

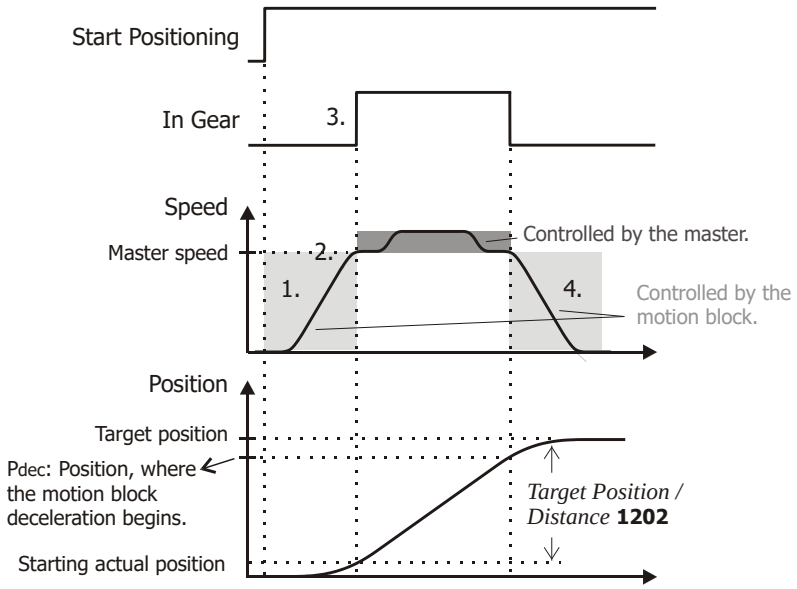
Motion mode "Gearing", synchronisation at master speed

Activation of motion mode "Gearing":

- Parameter *Motion Mode* **1208** = "10 - Gearing, absolute" or
- Parameter *Motion Mode* **1208** = "11 - Gearing, relative" or
- Parameter *Motion Mode* **1208** = "14 - Gearing"

1. Acceleration with ramps from the motion block (*Acceleration* **1204**)
2. Synchronisation of drive and master after attaining the master speed.
3. Synchronisation message via logic signal "In Gear"
4. Movement to the target position with the deceleration value from the motion block (*Deceleration* **1206**).
   Reset of logic signal "In Gear".

The position Pdec where the deceleration begins is calculated from target position, speed and deceleration ramp. When Pdec is reached the slave is uncoupled from the master and moves to the target position.

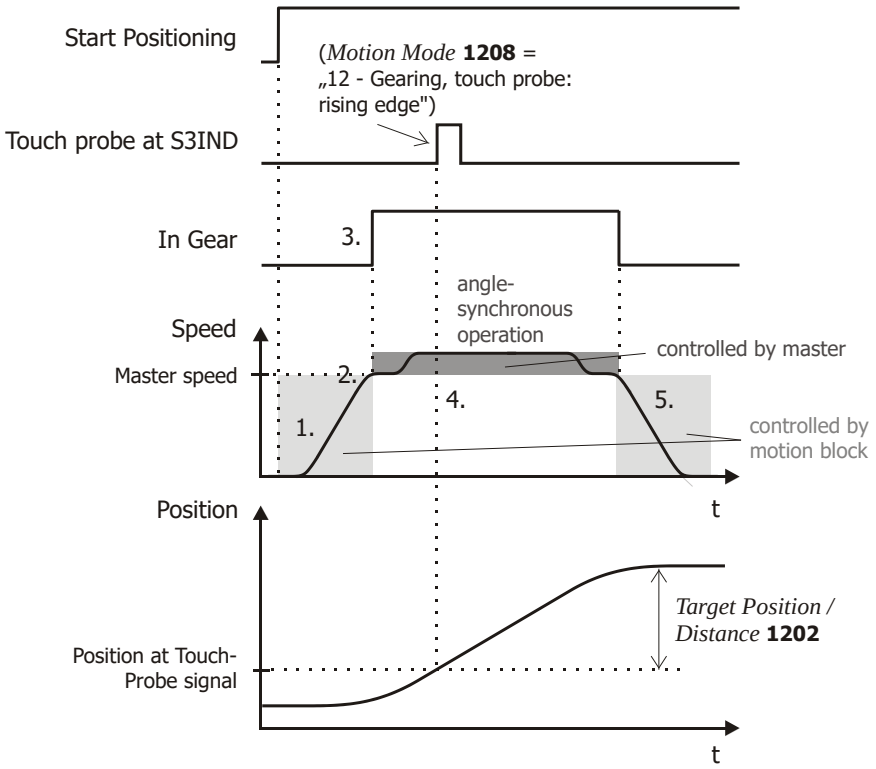


Motion mode "Gearing, touch probe",
synchronisation at master speed
Activation of motion mode "Gearing, touch probe":

- Parameter *Motion Mode* **1208** = "12 - Gearing, touch probe: rising edge" or
- Parameter *Motion Mode* **1208** = "13 - Gearing, touch probe: falling edge"

Motion mode 12 corresponds to motion mode 2 - "Touch probe: rising edge", but contains the additional electronic gearing function. For motion mode 2 refer to chapter 5.5.1.3.
Motion mode 13 corresponds to motion mode 3 - "Touch probe: falling edge", but contains the additional electronic gearing function. For motion mode 2 refer to chapter 5.5.1.3.

1. Acceleration with ramps from the motion block (*Acceleration* **1204**, *Ramp Rise Time* **1205**).
2. Synchronisation of drive and master after attaining the master speed.
3. Synchronisation message via signals 57- and 624- "In Gear".
4. Movement of the relative distance *Target Position/Distance* **1202** (after receiving the touch probe signal).
5. Stopping with *Delereation* **1206** and *Ramp Fall Time* **1207** from motion block.



Positioning mode "Gearing, direct synchronisation"

Activation of motion mode "Gearing, direct synchronisation"

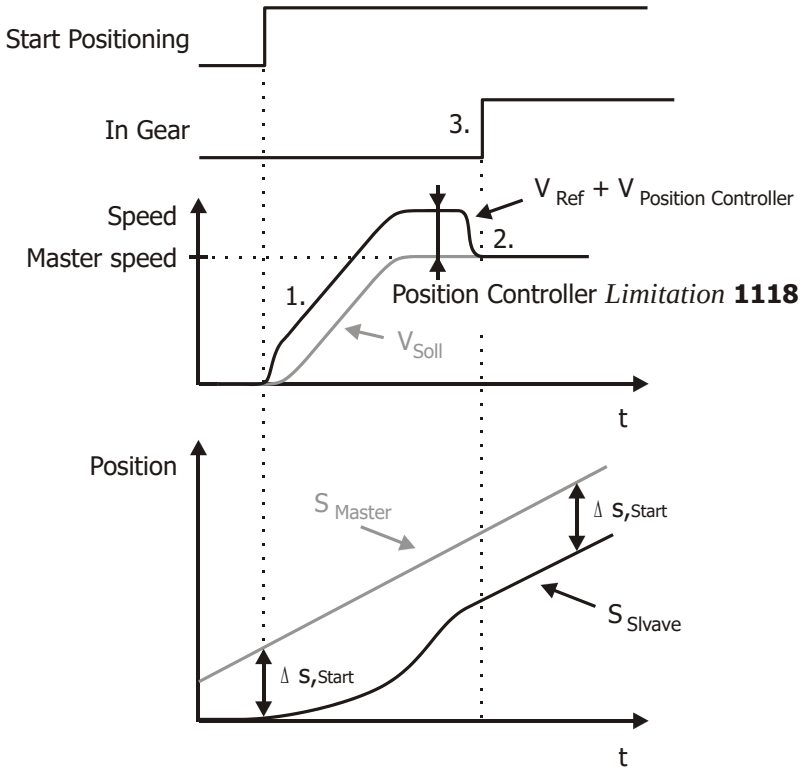
- Parameter *Motion Mode* **1208** = "20 - Gearing, direct sync., absolute" or
- Parameter *Motion Mode* **1208** = "21 - Gearing, direct sync., relative" or
- Parameter *Motion Mode* **1208** = "24 - Gearing direct synchronisation"

With Touch-Probe signal:

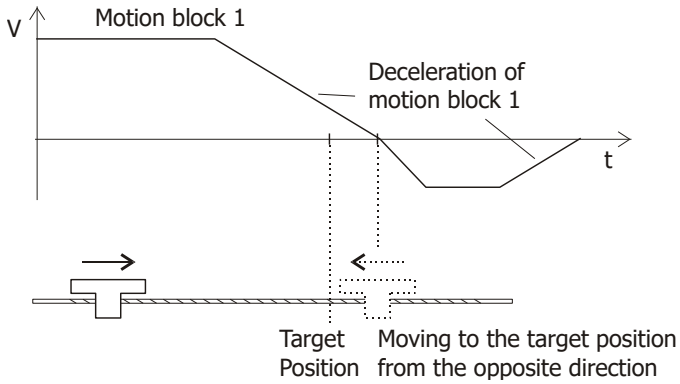
- Parameter *Motion Mode* **1208** = "22 - Gearing, direct sync., Touch-Probe, pos. Edge" or
- Parameter *Motion Mode* **1208** = "23 - Gearing, direct sync., Touch-Probe, neg. edge"

Gearing, direct synchronisation

1. Synchronisation of slave position and position of master drive
2. Acceleration with ramps from the motion block (*Acceleration* **1204**)
3. Synchronisation message via logic signal "In Gear"



ATTENTION!	During the processing of motion blocks and operation modes with electronic gearing for *Motion Mode* **1208**, the direction of motion of the axis may be reversed. The speed defined by the master is too high in order to reach the target position at the deceleration set in the motion block. In this case, the target position is passed with the current deceleration and then approached from the opposite direction.



ATTENTION!	In motion operation modes with electronic gearing the speed override function is deactivated.

Parameter *Master Speed* **1129** indicates the speed of the master on the output of the electronic gear in the operation modes with electronic gear (*Motion Mode* **1208**).

NOTE:	For more information on the function of the electronic gear, refer to the chapter "Electronic Gear" and the application manual "Electronic Gear".

5.5.2 Motion block data

The data of each motion block is saved separately. The motion block data consist of values for:

Target	Logic	Digital signal
Position Speed Acceleration Deceleration Ramp rise times	Next motion block - Event - Interruption Event - Delay	Digital signals for indication of status of motion orders

5.5.2.1 Target position

Parameter *Target Position/Distance* **1202** defines the distance to be covered.
The meaning of the parameter depends on parameter *Motion Mode* **1208**.
In *Motion Mode* **1208** = "0 – absolute", an absolute target position is approached, referred to the reference position.
In *Motion Mode* **1208** = "1 – relative", a distance in relation to the current position or the last target position is covered.
If the last position was reached via the JOG function, the value of the parameter is a relative position relating to the current position (distance). However, if the last position was selected as a result of a motion command, the value indicates a position in relation to the last target position (distance).

Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Fact. sett.**
1202	Target Position / Distance	-2^{31} u	$2^{31}-1$ u	65536 u

NOTE:	The target position / distance must be within the range of the software limit switches in order to be able to start a motion order.

5.5.2.2 Speed

The target position is approached at the value of parameter *Speed* **1203**. The distance to the target position and the parameterized acceleration and deceleration determine if the speed is reached.

Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Fact. sett.**
1203	Speed	$-(2^{31}-1)$ u/s	$2^{31}-1$ u/s	163840 u/s

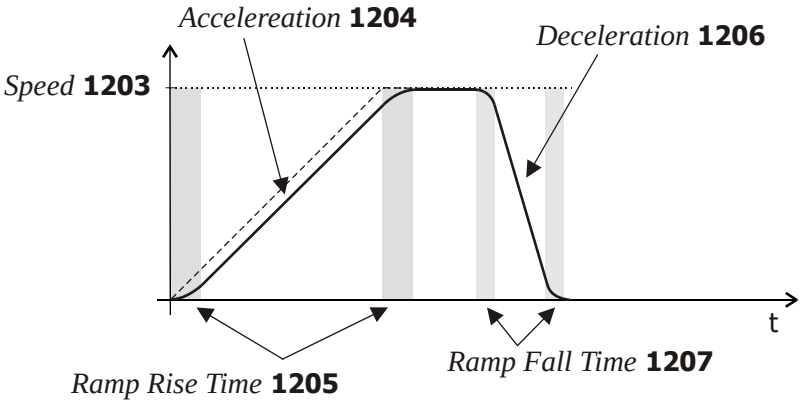
NOTE:	In the operation modes with electronic gear (Parameter *Motion Mode* **1208**), the settings for parameter *Speed* **1203** do not have any effect. The speed is defined by the master.

Parameter *Act. Speed* **1107** indicates the current speed in unit [u/s].

5.5.2.3 Acceleration and Deceleration

For parameters *Acceleration* **1204** and *Deceleration* **1206**, the values for the motion to the target position are adjusted.
Via the ramp rise time, a non-linear acceleration and deceleration (S-curve) can be obtained, and the load during acceleration and deceleration of the drive can be reduced, e.g. in order to limit jerking. The factory setting of 0 ms causes a linear ramp.

Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Fact. sett.**
1204	Acceleration	1 u/s^2	$2^{31}-1$ u/s^2	327680 u/s^2
1205	Ramp Rise Time	0 ms	2000 ms	0 ms
1206	Deceleration	1 u/s^2	$2^{31}-1$ u/s^2	327680 u/s^2
1207	Ramp Fall Time	0 ms	2000 ms	0 ms



5.5.2.4 Automatic sequence of motion blocks (next motion block)

In parameter configuration *Operation Mode* **1221** = 1xx (e.g. 101, 111, "Sequence Mode"), the positioning function enables an automatic sequence of motion blocks, i.e. when the target position is reached, the next target position is selected. The sequence control can be time-based (e.g. after a certain time has elapsed) or event-oriented (e.g. via digital inputs or logic modules).

The next motion block starts:

- After expiry of a delay time:
  After expiry of *Delay* **1212** the motion block from *Delay: Next Motion Block* **1213** starts. If *Delay* **1212** is set to "0", this event is not evaluated.
- After attaining a target position:
  Event 1 **1214** starts the motion block from *Event 1: Next Motion Block* **1215**.
  Event 2 **1216** starts the motion block from *Event 2: Next Motion Block* **1217**.

- After interruption of a running motion block:
  Interrupt-Event 1 **1260** starts the motion block from *Int.-Event 1: Next Motion Block* **1262**.
  Interrupt-Event 2 **1263** starts the motion block from *Int.-Event 2: Next Motion Block* **1265**.

In that way logic-specific branches in the sequences can be parameterized.

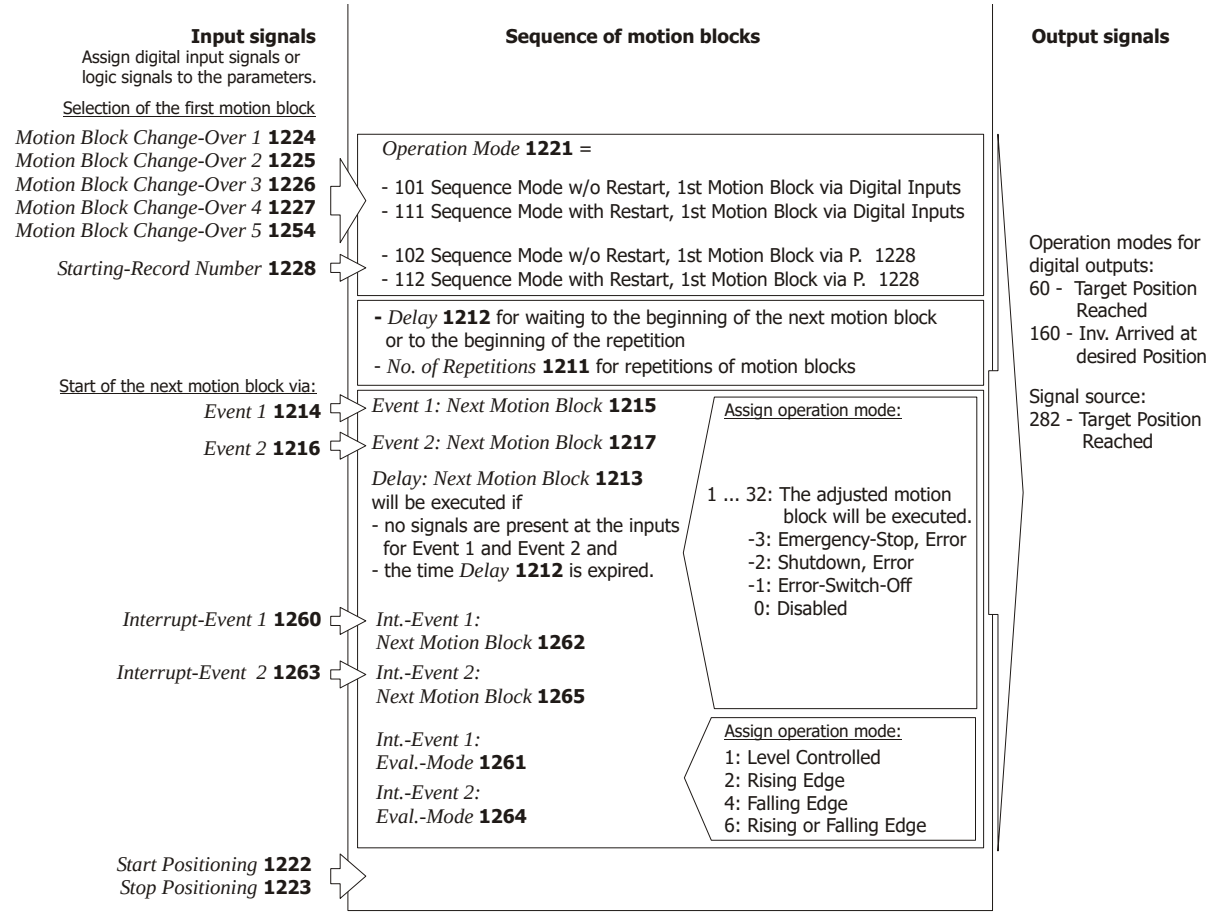
In the case of a relative positioning operation, the motion block can also be repeated via *No. of Repetitions* **1211**.

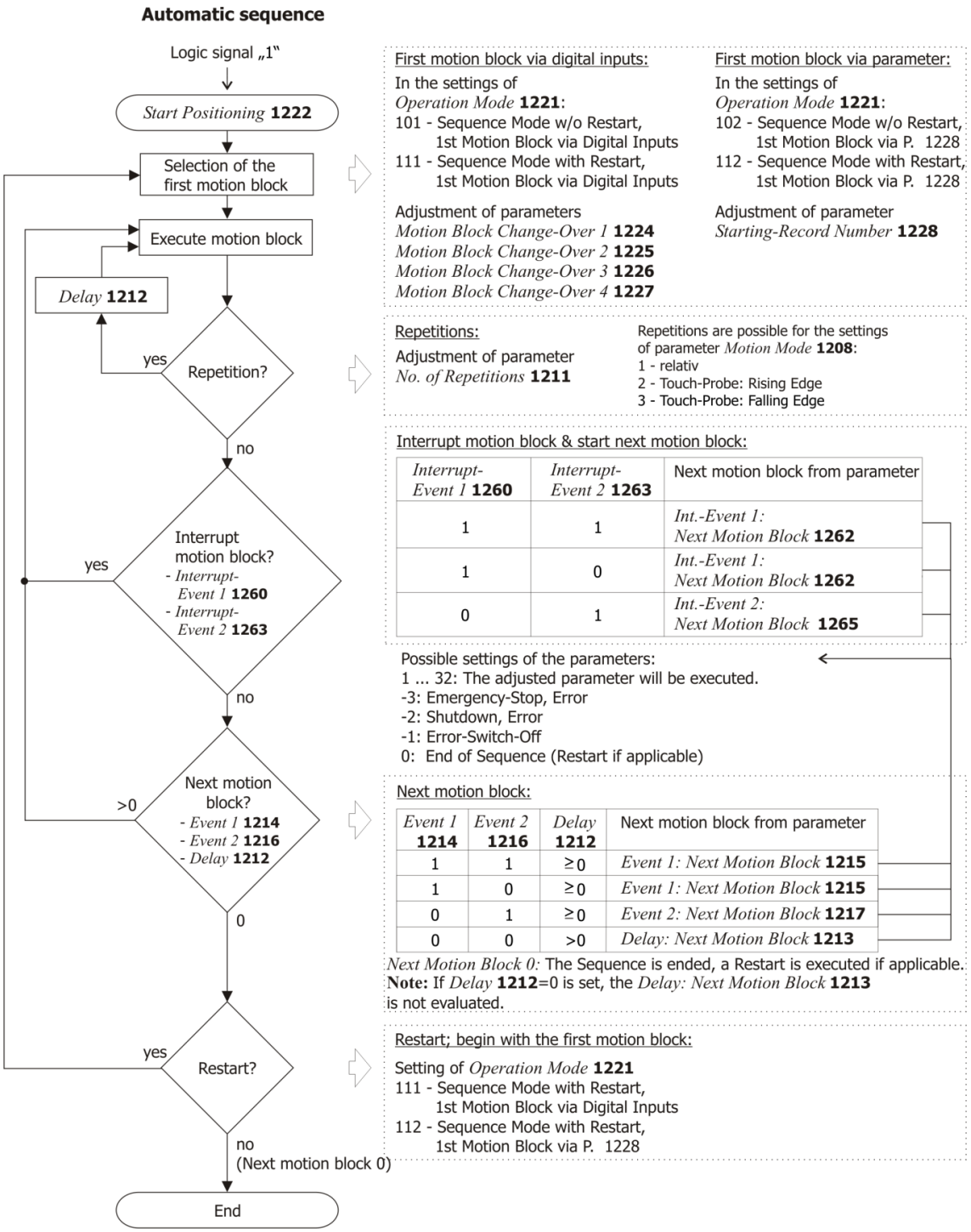
Motion blocks are processed automatically in the following order:

- Motion block is selected
- Motion block is executed with or without repetition
- Interrupt a motion block and jump to the next motion block under configurable conditions according to priority
  a) *Int.-Event 1: Next Motion Block* **1262**
  b) *Int.-Event 2: Next Motion Block* **1265**
- Jump to next motion block under configurable conditions according to priority:
  a) *Event 1: Next Motion Block* **1215**
  b) *Event 2: Next Motion Block* **1217**
  c) *Delay: Next Motion block* **1213**

Valid next motion blocks are individual motion blocks 1 to 32. Value 0 (factory setting) stops the sequence of the positioning operation. If *Operation Mode* **1221** = 11x ("with restart") is selected, the sequence will be restarted as described above. If *Operation Mode* **1221** = 10x ("without restart") is selected, the positioning operation will not start before the next positive edge of the signal assigned to parameter *Start Positioning* **1222** is received.

Input and output signals for automatic motion block sequence





NOTE:	Repetitions are executed for relative or touch-probe motions only. Absolute motions have a fixed target position.

After **completion** of the current motion order, a new motion order can be started automatically.

As soon as the positioning operation is started with the corresponding logic signal for parameter *Start Positioning* **1222**, the operation is started with the first motion block.

When the target position is reached the settings are evaluated for parameters:

- *Delay* **1212**
- *Delay: Next motion block* **1213**
- *Event 1* **1214**
- *Event 1: Next Motion Block* **1215**
- *Event 2* **1216**

– *Event 2: Next Motion Block* **1217**

If parameter *Event 1* **1214** receives a logic signal via the assigned input, the motion block adjusted in parameter *Event 1: Next Motion Block* **1215** is activated.
If a signal is present on *Event 2* **1216**, *Event 2: Next Motion Block* **1217** will be activated.
If logic signals are present on Event 1 and Event 2 at the same time, the motion block from parameter *Event 1: Next Motion Block* **1215** will be activated.
In parameter *Delay* **1212**, you can set the time which is to pass before the next motion block is processed. In this time, Event 1 and Event 2 will be evaluated. The delay time will not elapse completely if Event 1 or Event 2 occurs in this time. If there are no logic signals on Event 1 nor on Event 2 after the delay has elapsed, the motion block set in parameter *Delay: Next Motion Block* **1213** will be processed. With the setting *Delay* **1212** = 0 the evaluation of the Delay Next Motion Block is deactivated and a setting in *Delay: Next Motion Block* **1213** is not processed.
If motion block *No. of Repetitions* **1211** is set, this motion block is repeated. Repetitions are executed for relative or touch-probe motions only. The repetition will not be started before the time set in parameter *Delay* **1212** has elapsed.

Motion Mode **1208**	**Function**
0 – absolute	*No. of Repetitions* **1211** is not evaluated.
1 – relative	Settings of parameter *No. of Repetitions* **1211** are evaluated.
2 – touch probe: rising edge	
3 – touch probe: falling edge	

Parameter		**Setting**		
No.	**Description**	**Min.**	**Max.**	**Fact. sett.**
1211	No. of Repetitions	0	255	0
1212	Delay	0 ms (=deactivated)	65 535 ms	0 ms (=deactivated)
1213	Delay: Next Motion Block	-3	32	0

NOTE:	If repetitions (parameter *No. of Repetitions* **1211**) are set, the delay (parameter *Delay* **1212**) will be evaluated during the repetitions only. The settings for Event 1 and Event 2 will become active only after the last repetition and the delay.

After **interuption** of the current motion order, a new motion order can be started automatically.
During a running motion block the settings are evaluated for parameters:

– *Interrupt-Event 1* **1260**
– *Int.-Event 1: Next Motion Block* **1262**
– *Interrupt-Event 2* **1263**
– *Int.-Event 2: Next Motion Block* **1265**

If parameter *Interrupt-Event 1* **1260** receives a logic signal via the assigned input, the motion block adjusted in parameter *Int.-Event 1: Next Motion Block* **1262** is activated.
If a signal is present on *Interrupt-Event 2* **1263**, *Int.-Event 2: Next Motion Block* **1265** will be activated.

Priority:

If logic signals for interruption are present on Event 1 and Event 2 at the same time, the motion block from parameter *Int.-Event 1: Next Motion Block* **1262** will be activated.

Interruption, level controlled or edge-triggered

The signals for *Interrupt-Event 1* **1260** and *Interrupt-Event 2* **1263** can be evaluated level controlled or edge-triggered. The evaluation can be set via the parameters *Int.-Event 1: Eval.-Mode* **1261** and *Int.-Event 2: Eval.-Mode* **1264**.

Operation modes for parameters 1261 and 1264	Function
1 - Level Controlled	If parameter 1261 is set to this mode: The level of the signal (which is assigned to parameter 1260) interrupts the running motion block and starts the next motion block from parameter 1262. If parameter 1264 is set to this mode: The **level** of the signal (which is assigned to parameter 1263) interrupts the running motion block and starts the next motion block from parameter 1265.
2 - Rising Edge	The same as operation mode 1, but a **rising edge** interrupts the running motion block and starts the next motion block.
4 - Falling Edge	The same as operation mode 1, but a **falling edge** interrupts the running motion block and starts the next motion block.
6 - Rising or Falling Edge	The same as operation mode 1, but a **rising edge or falling edge** interrupts the running motion block and starts the next motion block.

Set the next motion block, stop of the drive or error switch-off for an event:

By entering one of the listed values for parameters

- *Delay: Next Motion Block* **1213**
- *Event 1: Next Motion Block* **1215**
- *Event 2: Next Motion Block* **1217**
- *Int.-Event 1: Next Motion Block* **1262**
- *Int.-Event 2: Next Motion Block* **1265**

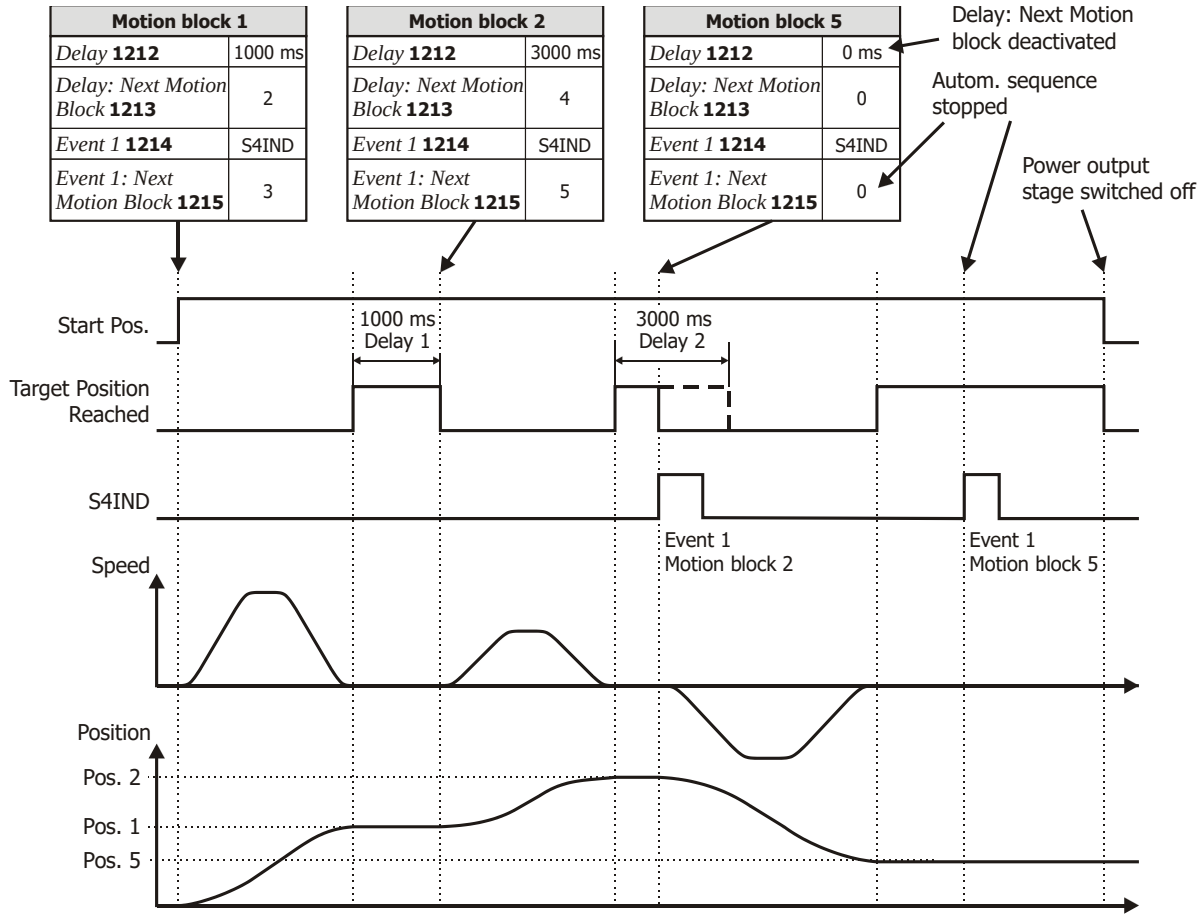
the next motion block or user-defined behavior in the case of events can be selected. Errors in the motion sequence can be identified quickly by emergency stop, stop and the error switch-off function.

Next motion block **1213, 1215, 1217, 1262, 1265**	Function
-3 - (Minus 3) Em. stop, error	The drive is stopped via *Emergency Ramp* **1179**, after that, error message "F15XX User-Defined Error in Motion Block" is output.
-2 - (Minus 2) Stop, error	The drive is stopped at the active deceleration ramp, after that, error message "F15XX User-Defined Error in Motion Block" is output.
-1 - (Minus 1) Error Switch-Off	The drive is switched off, after that, error message "F15XX User-Defined Error in Motion Block" is output.
0 - Disabled	**Factory setting**. Processing of next motion blocks is switched off.
1 ... 32	The corresponding motion block is executed.

Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Fact. sett.**
1214	Event 1	Logic signal or digital input		7 - Off
1215	Event 1: Next Motion Block	-3	32	0 - Disabled
1216	Event 2	Logic signal or digital input		7 - Off
1217	Event 2: Next Motion Block	-3	32	0 - Disabled
1260	Interrupt-Event 1	Logic signal or digital input		7 - Off
1261	Int.-Event 1: Eval.-Mode	1	6	1 - Level Controlled
1262	Int.-Event 1: Next Motion Block	-3	32	0 - Disabled
1263	Interrupt-Event 2	Logic signal or digital input		7 - Off
1264	Int.-Event 2: Eval.-Mode	1	6	1 - Level Controlled
1265	Int.-Event 2: Next Motion Block	-3	32	0 - Disabled

Example:

Start of tne next motion block after delay expiry and by event 1



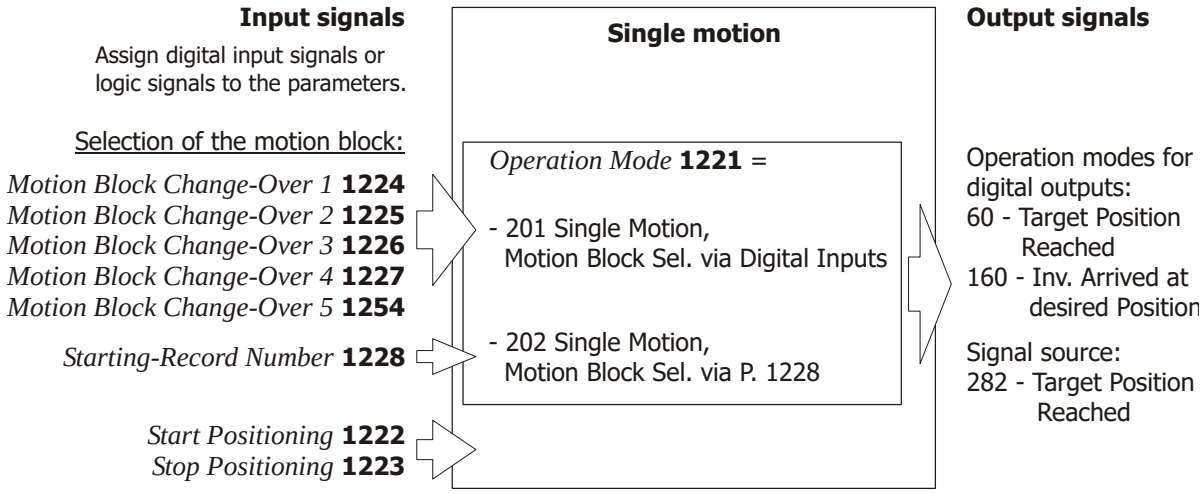
The current motion block can be displayed via parameter *Actual Motion Block* **1246** or read via signal source "879 - Actual Motion Block" using the Scope function in the PC software VPlus.

NOTE:	If event-controlled sequences and the settings for *Operation Mode* **1221** = 11x are used, note the settings in parameters **1212** to **1217** (delay, next motion block, event) in any case. Otherwise, the drive may jump between the first motion block points if the condition Next Motion Block = 0 is fulfilled and a restart of the positioning operation is triggered directly.

5.5.2.5 Single motion

A signal on *Start Positioning* **1222** starts the *Starting Record Number* **1228** (parameter *Operation Mode* **1221** in setting "202- single motion, motion block from p. 1228") or the motion block set via parameters *Motion Block Change-Over 1* **1224** to *Motion Block Change-Over 5* **1254**, (parameter *Operation Mode* **1221** in setting "201-single motion, motion block via digital inputs"). After completion of the motion, the target position is maintained.

If operation mode "Speed" or an operation mode with el. gearing is selected for *Motion Mode* **1208**, the drive will continue to turn until the signal on *Start Positioning* **1222** is reset or interrupted by a signal on *Stop Positioning* **1223**.



5.5.3 Control of motion

5.5.3.1 Selection of motion block

If the motion blocks are selected via digital signals, motion blocks 1 to 32 can be selected via the motion block change-over function.
The motion block selection via digital inputs is active if parameter *Operation Mode* **1221** is set to one of the following modes:

- 101 - Sequence Mode w/o Restart, 1st Motion Block via Digital Inputs
- 111 - Sequence Mode with Restart, 1st Motion Block via Digital Inputs
- 201 - Single Motion, Motion Block Sel. via Digital Inputs
- 301 - Teach-In, Motion Block Sel. via Digital Inputs

In operation modes 101, 111 and 201, the motion starts with the motion block selected via the digital inputs when a signal is present on the input for *Start Positioning* **1222**.

In operation mode 301, the current position is saved as the *Target Position / Distance* **1202** in the motion block selected via the digital inputs when a signal is present on input for *Teach-In-Signal* **1239**.

Parameter		Factory setting	
1224	Motion Block Change-Over 1	320 -	EM-S1IND [1]
1225	Motion Block Change-Over 2	321 -	EM-S2IND [1]
1226	Motion Block Change-Over 3	322 -	EM-S3IND [1]
1227	Motion Block Change-Over 4	7 -	Off
1254	Motion Block Change-Over 5	7 -	Off

[1] Digital inputs of optional extension module

The motion block change-over function depends on the settings of parameter *Operation Mode* **1221**:

Operation Mode 1221		Function
101 -	Sequence Mode w/o Restart, 1st Motion Block via Digital Inputs	Signal on *Start Positioning* **1222** starts the automatic sequence of motion blocks with the motion block selected by the motion block change-over function.
111 -	Sequence Mode with Restart, 1st Motion Block via Digital Inputs	
201 -	Single Motion, Motion Block Sel. via Digital Inputs	Signal on *Start Positioning* **1222** starts the motion block selected by the motion block change-over function.
301 -	Teach-In, Motion Block Sel. via Digital Inputs	Signal on *Teach-In Signal* **1239** enters the current position in the motion block selected by the motion block change-over function as the target position. The target position is saved in parameter *Target Position / Distance* **1202**.
0 -	Off	Sequence Mode/Single Motion/Teach-In is switched off.
102 - 112 - 202 - 302 -		In these settings the 1st motion block (sequence mode) or motion block (single motion/Teach-In) is not selected via the digital inputs for the motion block change-over. The motion blocks are selected via parameter *Starting-Record Number* **1228**.

1000 -	Control by function table.

Input signals for motion block change-over

Input signals

Assign digital input signals to the parameters.

Motion Block selection

Motion Block Change-Over 1 **1224**
Motion Block Change-Over 2 **1225**
Motion Block Change-Over 3 **1226**
Motion Block Change-Over 4 **1227**
Motion Block Change-Over 5 **1254**

Motion Block Change-Over

In the settings of parameter *Operation Mode* **1221** =
101 - Sequence Mode w/o Restart, 1st Motion Block via Digital Inputs
111 - Sequence Mode with Restart, 1st Motion Block via Digital Inputs
201 - Single Motion, Motion Block Sel. via Digital Inputs
301 - Teach-In, Motion Block Sel. via Digital Inputs

Select one of the motion blocks 1 ... 32

Parameters *Motion Block Change-Over* (**1224** to **1227**, **1254**) are binary encoded and are added via the value of the bits. Additionally, "1" is added for calculation of the motion block - motion block exists as an overriding motion block enabling parameter changes across all motion blocks at the same time.

Selection of motion blocks with motion block change-over function

Motion block change-over 1 1224	Motion block change-over 2 1225	Motion block change-over 3 1226	Motion block change-over 4 1227	Motion block change-over 5 1254	Motion block
2^0	2^1	2^2	2^3	2^4	$1+2^0+2^1+...$
0	0	0	0	0	1
1	0	0	0	0	2
0	1	0	0	0	3
1	1	0	0	0	4
0	0	1	0	0	5
1	0	1	0	0	6
0	1	1	0	0	7
1	1	1	0	0	8
0	0	0	1	0	9
1	0	0	1	0	10
0	1	0	1	0	11
1	1	0	1	0	12
0	0	1	1	0	13
1	0	1	1	0	14
0	1	1	1	0	15
1	1	1	1	0	16
0	0	0	0	1	17
1	0	0	0	1	18
0	1	0	0	1	19
1	1	0	0	1	20
0	0	1	0	1	21
1	0	1	0	1	22
0	1	1	0	1	23
1	1	1	0	1	24
0	0	0	1	1	25
1	0	0	1	1	26
0	1	0	1	1	27
1	1	0	1	1	28
0	0	1	1	1	29
1	0	1	1	1	30
0	1	1	1	1	31
1	1	1	1	1	32

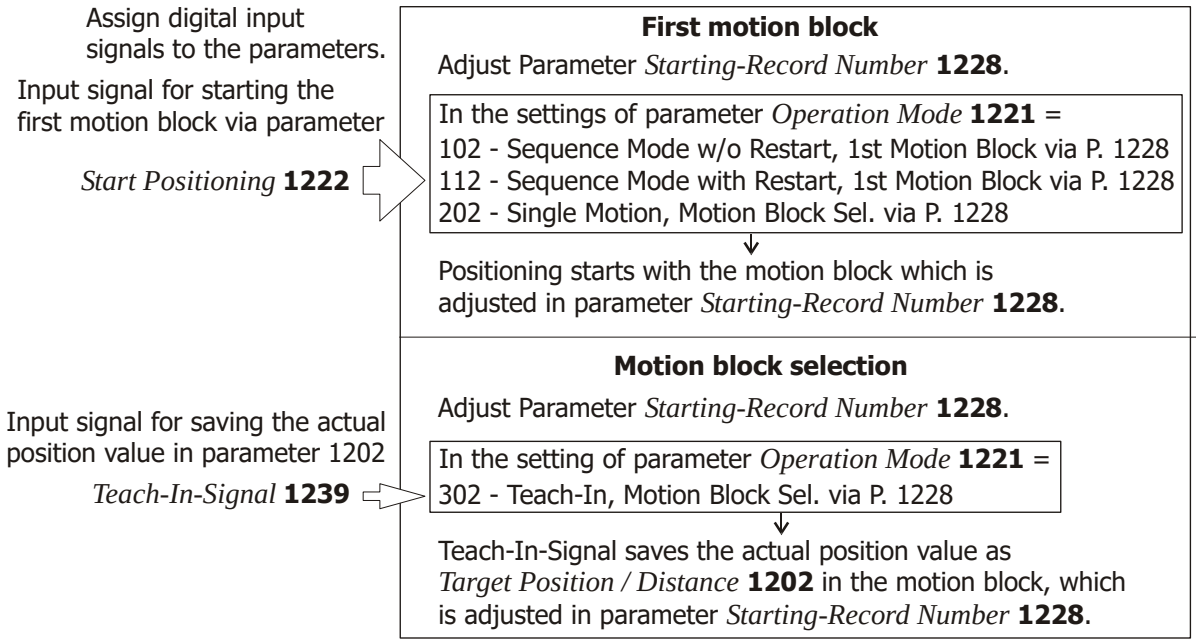
5.5.3.2 Motion block selection via parameter (starting-record number)

Via parameter *Starting-Record Number* **1228**, one of the 32 motion blocks can be selected.
The motion block selection via parameter is active if parameter *Operation Mode* **1221** is set to one of the following modes:

- 102 - Sequence Mode with Restart, 1st Motion Block via **P.1228**
- 112 - Sequence Mode with Restart, 1st Motion Block via **P.1228**
- 202 - Single Motion, Motion Block Sel. via **P.1228**
- 302 - Teach-In, Motion Block Sel. via **P.1228**

In operation modes 102, 112 and 202, the motion starts with the motion block selected in parameter *Starting Record Number* **1228** when a signal is present on the input for *Start Positioning* **1222**.
In operation mode 302, the current position is saved as the *Target Position / Distance* **1202** in the motion block set in parameter *Starting Record Number* **1228** when a signal is present on input for *Teach-In-Signal* **1239**.

Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Fact. sett.**
1228	Starting-record number	1	32	1



The function of the starting record depends on the settings of parameter *Operation Mode* **1221**:

Operation mode 1221		Function
102 -	Sequence Mode without Restart, 1st Motion Block via P. 1228	Signal on *Start Positioning* **1222** starts the automatic sequence of motion blocks set in parameter *Starting Record Number* **1228**.
112 -	Sequence Mode with Restart, 1st Motion Block via P. 1228	
202 -	Single Motion, Motion Block Sel. via P. 1228	Signal on *Start Positioning* **1222** starts the motion block set in parameter *Starting Record Number* **1228**.
302 -	Teach-In, Motion Block Sel. via P. 1228	Signal on *Teach-In Signal* **1239** enters the current position in the motion block selected in Parameter *Starting-Record Number* **1228** as the target position. The target position is saved in parameter *Target Position / Distance* **1202**.

5.5.4 Input and output signals for motion blocks

The controller enables the execution of individual orders, repetition of motion blocks and automatic sequence of motion blocks.
The motion block for the motion order can be selected via digital inputs or parameters. The terminal assignment (without selection of motion block) is shown in the following table.

Terminal assignment for motion mode

Function	Controller release	*Start Positioning* **1222**	*Stop Positioning* **1223**	Touch probe	*Neg. HW Limit Switch* **1137**	*Pos. HW Limit Switch* **1138**
		S2IND*	**S3IND***	**S3IND****	**S5IND** [3]	**S4IND** [3]
Drive disabled	0	X	X	X	0 *(1)*	0 *(1)*
Positioning is started and processed (5.5.5.1)	1	1	0	0	0 *(1)*	0 *(1)*
Touch probe event is processed (5.5.1.3)	1	1	0	edge (parameter **1208**) [1]	0 *(1)*	0 *(1)*
Positioning is stopped (5.5.5.1)	1	1	1	X	0 *(1)*	0 *(1)*
Error message, limit switch as make contact function *(brake contact function)*						
F1445 [2]	X	X	X	X	1 *(0)*	1 *(0)*
F1447 (F1446) [2]	X	X	X	X	0 *(1)*	1 *(0)*
F1448 (F1446) [2]	X	X	X	X	1 *(0)*	0 *(1)*

0 = Low / 1 = High / X = any / * = factory setting

** = When the touch probe input (S3IND fixed) is used, parameterization of *Stop Positioning* **1223** (factory setting S3IND) must be changed.
[1] Setting of *Motion Mode* **1208** = 2, 3, 12 or 13
[2] Also refer to chapter "Positioning Error Messages"
F1445: Pos. and Neg. HW-Lim Switch Simultaneously
F1446: Limit Switch Incorrect Wired
F1447: Pos. HW Limit Switch
F1448: Neg. HW Limit Switch
[3] Depends on *Operation Mode* **490**. Comply with the instructions in sections 4.3 and 4.4.1.4.
Assign S4IND and S5IND to the parameters for HW limit switches.

Values in parentheses *(0)* and *(1)* apply if the digital inputs for the limit switches are configured as inverted inputs *(brake contact function)*, e.g. *Positive HW Limit Switch* **1138** = "540 - S4IND inverted (Hardware)".

NOTE:	For controller release of the power component, wiring of the following digital inputs is required: STOA (terminal X210A.3) and STOB (terminal X210B.2). In safety-oriented systems, the documentation "Safe Torque Off" shall be complied with.

NOTE:	Before an absolute positioning operation can be started, the point of reference of the positioning operation must be determined in a homing operation. Otherwise, error message "F1570 – No Homing Done" will be displayed if you try to start an absolute positioning operation. Relative positioning and velocity operations are possible without homing.

5.5.5 Starting, stopping and resuming

The processing of a parameterized positioning sequence can be started and stopped by 3 digital signals. The following table summarizes the control options. The significant signal is marked bold.

Mode	Start	Stop	Resume	Description
Normal	**1**	0	0	The motion blocks are executed in the parameterized order.
Stop	1	**1**	0	As soon as the stop signal is present the drive will be stopped with *Deceleration* **1206**. If the stop signal is resetted the drive will proceed at the cancelled position.
Cancel	**1→0**	X	0	As soon as the start signal is resetted the positioning sequence will be cancelled and the drive will be stopped with *Deceleration* **1202**. If the start signal is set again the positioning starts with the starting-record number.
Re-sume	1	0	**1**	If a positioning sequence is cancelled the resume function allows the proceeding of the sequence at the last position (instead of the starting-record number). Therefore first set the resume signal and then set the start signal.

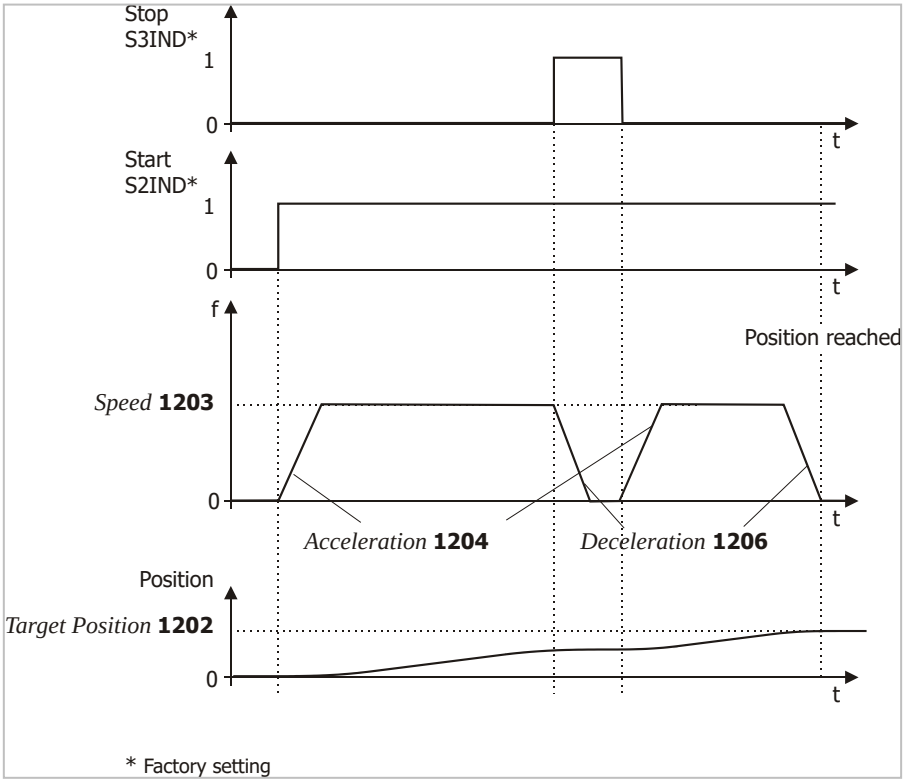
Consult the following chapters for a detailed description.

5.5.5.1 Starting and stopping positioning

The positioning operation is controlled via signals for both parameters *Start Positioning* **1222** and *Stop Positioning* **1223**. The parameters can be assigned logic signals or digital inputs. The positioning operation is started with a positive edge on digital input or a logic signal for parameter *Start Positioning* **1222** (factory setting S2IND). The logic signals for motion block change-over are evaluated only when a signal for parameter *Start Positioning* **1222** is present. Via *Operation Mode* **1221**, it is defined if a single motion or an automatic sequence is started. After completion of an automatic motion block sequence, a restart can be performed. *Operation Mode* **1221** defines the action after start positioning and the motion block selection.
Operation Mode **1221:**

- automatic sequence or single motion
- restart after automatic sequence
- first motion block for automatic sequence via motion block change-over function or via parameter *Starting-Record Number* **1228**
- motion block for single motion via motion block change-over function or via parameter *Starting-Record Number* **1228**

If the signal for *Stop Positioning* **1223** is set during a motion order, the drive will stop at the current position at the *Deceleration* **1206** set in the current motion block. As soon as "Stop Positioning" is reset, the motion block is continued.



If the signal for *Start Positioning* **1222** is reset during a motion order, the drive will stop at the current position at the *Deceleration* **1206** set in the active motion block. If *Start Positioning* **1222** is set again the sequence of motion blocks begins with the 1st motion block. If the time set in parameter *Holding Time* **638** is exceeded, the drive is switched off.

Parameter		Factory setting	
1222	Start Positioning	71 -	S2IND
1223	Stop Positioning	72 -	S3IND

A motion block can be started with "Start Positioning" even if the "Holding Time" is not elapsed.

Input signals for starting and stopping motion block sequences or single motions

Input signals

Assign digital input signals orlogic signals to the parameters.

Start Positioning **1222**
Stop Positioning **1223**

Start and Stop of the positioning:
A positioning sequence or a single motion will be executed or stopped according to the adjusted parameter *Operation Mode* **1221**.

Assign operation mode

Operation Mode **1221**

101 - Sequence Mode w/o Restart, 1st Motion Block via Digital Inputs
102 - Sequence Mode w/o Restart, 1st Motion Block via P. 1228
111 - Sequence Mode with Restart, 1st Motion Block via Digital Inputs
112 - Sequence Mode with Restart, 1st Motion Block via P. 1228
201 - Single Motion, Motion Block Sel. via Digital Inputs
202 - Single Motion, Motion Block Sel. via P. 1228

NOTE:	Before an absolute positioning operation can be started, the point of reference of the positioning operation must be determined in a homing operation. Otherwise, error message "F1570 – No Homing Done" will be displayed if you try to start an absolute positioning operation. Relative positioning and velocity operations are possible without homing.

Example:

In an application, the position in motion block 1 is approached first after activation. Motion block 1 is set in *Starting-Record Number* **1228**. Then, the absolute target positions 2, 3 and 4 are approached continuously according to the parameter configuration. If the start signal is reset and started again, the sequence starts again with motion block 1. If, however, the stop signal is received, the operation is stopped as long as the stop signal is present.

Example: Motion profile	
Starting-Record Number **1228**	1
Next motion block [1)] [index 1]	2
Next motion block [1)] [index 2]	3
Next motion block [1)] [index 3]	4
Next motion block [1)] [index 4]	2

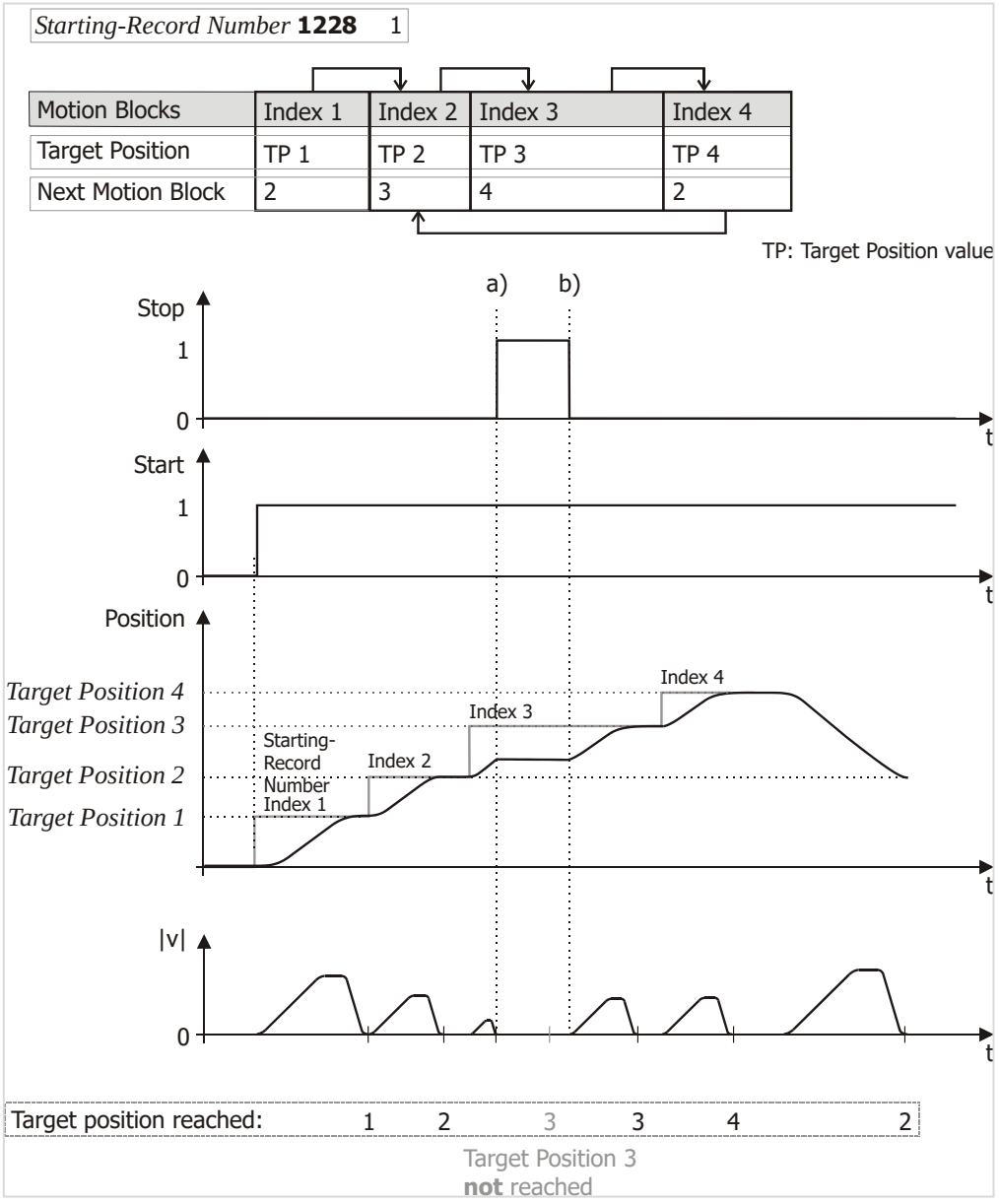
[1)] Possible parameters for setting of next motion block:

Delay: Next Motion Block **1213**,
Event 1: Next Motion Block **1215**,
Event 2: Next Motion Block **1217**,
Int.-Event 1: Next Motion Block **1262**,
Int.-Event 2: Next Motion Block **1265**

According to the example above: Reaction of the drive on set "Stop Positioning" and reset "Start Positioning"

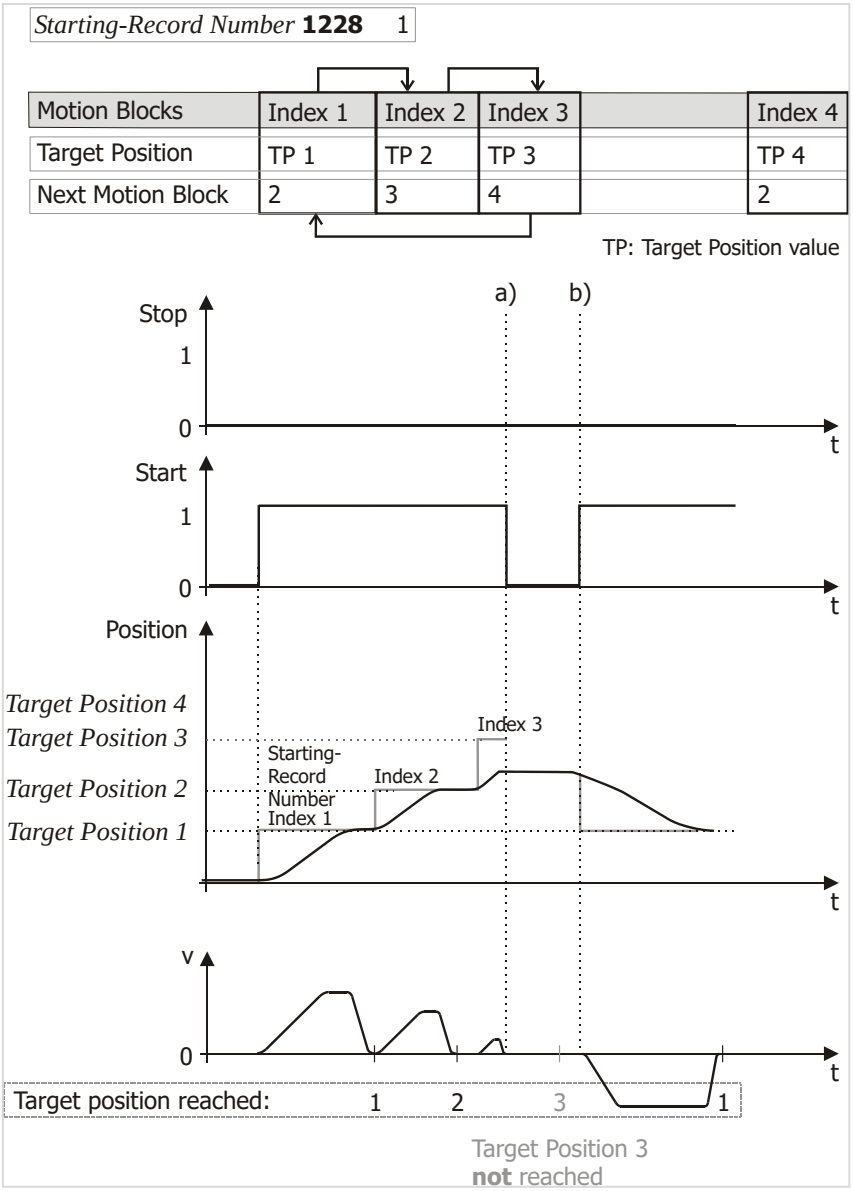
– Reaction on set "Stop Positioning" (example)

Distance-time and velocity-time diagrams



a) Set "Stop positioning":
The drive decelerates and stops immediately with *Deceleration* **1206**.
b) Reset "Stop Positioning":
The current motion block will be continued.

Reaction on reset "Start Positioning" (example)
Distance-time and velocity-time diagrams



a) Reset "Start Positioning":
The drive decelerates and stops immediately with *Deceleration* **1206**.
b) Set "Start Positioning" again:
The drive moves to the target position 1 from *Starting-Record Number* **1228**.

5.5.5.2 Resuming interrupted motion blocks

The resume function enables continuing motion blocks after an interruption by an error or by resetting of the "Start Positioning" signal.
Resumption is effected as follows:

- 1. Set signal on the input assigned to parameter *Resume Motion Block* **1230**.
- 2. Set Signal *Start Positioning* **1222**

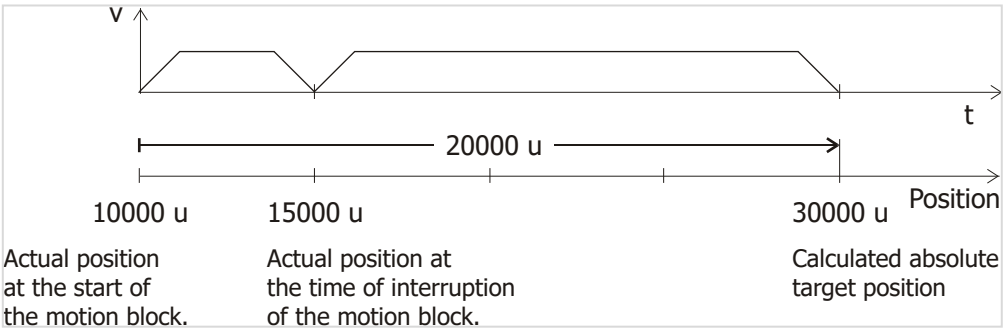
The resumed motion block is indicated by parameter *Motion Block to Resume* **1249**.

NOTE:	The resume is deactivated while the teach-in function is being carried out. In this case, *Motion Block to Resume* **1249** has the value -1.

In the case of an absolute positioning operation, the target position for resumption is taken over from the interrupted motion block directly.
In the case of a relative positioning operation, the target position for resumption is calculated from the target position saved in the motion block and the current position at the time the motion block is started.

Example: Resumption in the case of relative positioning operation

The current position is 10000 u. A distance of 20000 u is to be covered. After the start of the motion block, an error occurs and the drive stops at position 15000. To resume this motion block, the absolute target position of 30000 u is calculated, i.e. 10000 u (actual position at start of motion block) + 20000 u (distance from motion block. Positioning is started in absolute motion mode.



When the power supply is turned off, the last actual position of the drive is saved.
Except for the settings of *Operation Mode* **1220** = "2 - automatic" (automatic start of homing) and additional *Homing Mode* **1130** = "35 - Current Position" (current position is home position).

5.5.6 Digital signals for indication of status of motion orders

For each motion block, there are 4 digital signals which are influenced depending on the status of the motion order and can be used for indicating the status of motion orders:

- *Digital Signal 1* **1218**
- *Digital Signal 2* **1219**
- *Digital Signal 3* **1247**
- *Digital Signal 4* **1248**

To control logic functions or for transmission via the system bus (available if extension module with system bus interface is connected) the following signals can be selected:

- 891 – Motion-Block Digital Signal 1
- 892 – Motion-Block Digital Signal 2
- 893 – Motion-Block Digital Signal 3
- 894 – Motion-Block Digital Signal 4
- 895 – Motion-Block Digital Signal 1 inverted
- 896 – Motion-Block Digital Signal 2 inverted
- 897 – Motion-Block Digital Signal 3 inverted
- 898 – Motion-Block Digital Signal 4 inverted

Operation modes for digital outputs:

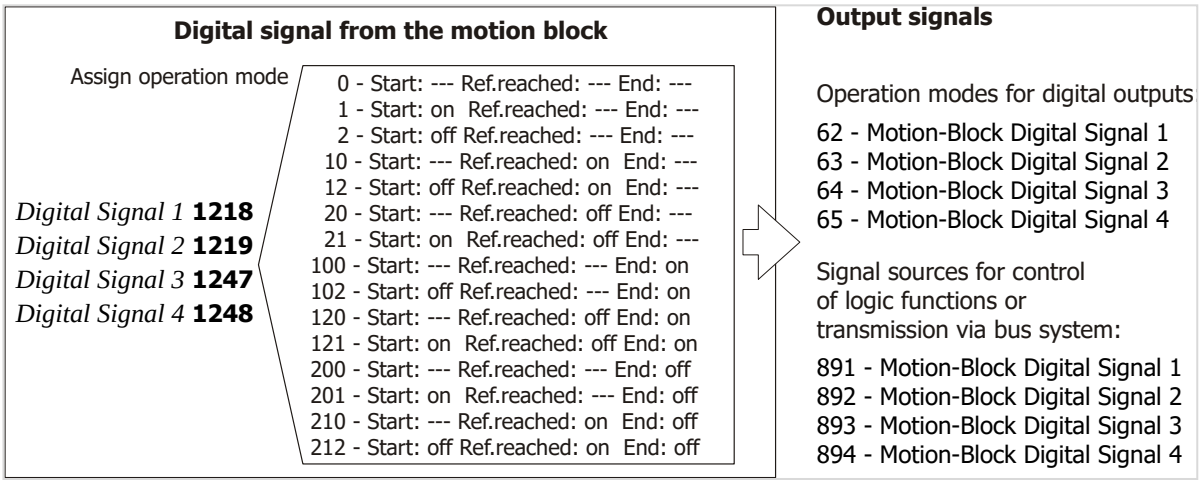
- 62 – Motion-Block Digital Signal 1
- 63 – Motion-Block Digital Signal 2
- 64 – Motion-Block Digital Signal 3
- 65 – Motion-Block Digital Signal 4
- 162 – Motion-Block Digital Signal 1 inverted
- 163 – Motion-Block Digital Signal 2 inverted
- 164 – Motion-Block Digital Signal 3 inverted

– 165 – Motion-Block Digital Signal 4 inverted

The statuses of the digital signals can be influenced (set, reset or leave unchanged) when the following events occur:

– Reference value reached
– Start of motion block
– End of motion block

Digital output signals of motion blocks



The operation mode is the result of the combination of 3 possible input signals and 3 status changes to produce the required output signal. The unit digit defines the evaluation upon the start of the motion block, the tens digit defines the evaluation as soon as the reference value is reached and the hundreds digit defines the evaluation at the end of the motion block.

Signal	Operation mode		
	Start	Reference value reached	End
unchanged	__0	_0_	0__
On	__1	_1_	1__
Off	__2	_2_	2__

NOTE:	The underscore characters "_" are used as wildcards so that it can be seen directly for which place (unit, tens, hundreds digit) the value is used.

Start

"Start" is evaluated when a positioning operation starts.

Reference value reached

The evaluation of "Reference value reached:" depends on the parameter configuration for *Motion Mode* **1208**:

Motion Mode 1208	Evaluation of "Reference value reached":
0 - absolute 1 - relative 2 - Touch probe: rising edge 3 - Touch probe: falling edge 10 - Gearing, absolute 11 - Gearing, relative 12 - Gearing, touch probe: rising edge 13 - Gearing, touch probe: falling edge 20 - Gearing, direct sync., absolute 21 - Gearing, direct sync., relative 22 - Gearing, direct sync., Touch-Probe: Rising Edge	Evaluation of "Reference value reached:" if *Target Position / Distance* **1202** is reached.

23 -	Gearing, direct sync., Touch-Probe: Falling Edge	
4 -	Velocity	Evaluation of "Reference value reached:" if *Speed* **1203** is reached.
14 -	Gearing	Evaluation of "Reference value reached:" when master speed is reached and logic signal "57 – In Gear" is set.
24 -	Gearing, direct synchronisation	

End

The evaluation of "End:" depends on the parameter configuration for *Operation Mode* **1221**:

Operation mode **1221**	**Evaluation of "End":**
Automatic sequence	Evaluation of "End:" after completion of motion block.
Single motion	No evaluation of "End": The digital signal corresponds to the status "Reference value reached:". The status depends on the selected operation mode for the digital signal (parameter 1218, 1219, 1247, 1248). Possible statuses: "off", "on" or "unchanged".

Example 1:

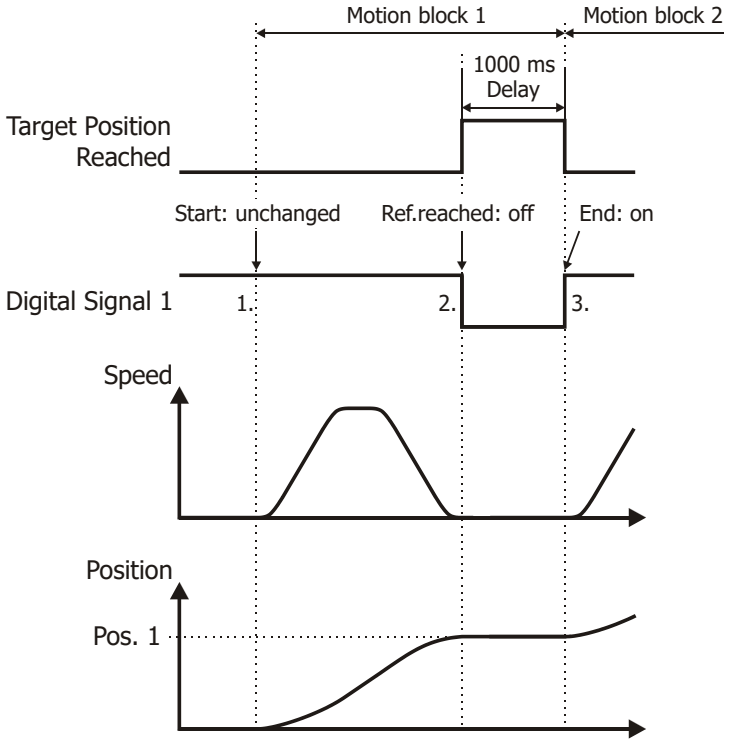
Digital signal 3 is to indicate that the target position was reached. When the position is reached, the output signal is to be "1". When the position is not reached, the output signal is to be "0". As soon as the target position is reached, the output is to be switched on, i.e. tens digit is _1_. When the motion block is started, it is assumed that the target position has not been reached, i.e. unit digit is __2. At the end of the motion block, the target position is unchanged; i.e. hundreds digit 0__. If you combine these digits you get Operation Mode 012.
For this reason parameter *Digital Signal 3* **1247** = 12.

Example 2:

Operation mode 120 for parameter *Digital Signal* 1 **1218**

- Digital signal 1 (signals "62 – Motion Block Digital Output 1" and "891 – Motion Block Digital Output 1") remains unchanged when the motion block starts.
- Digital signal 1 is reset when the target position is reached.
- Digital signal 1 is set at the end of the motion block (incl. delay).

Motion block 1	
Delay **1212**	1000 ms
Delay: Next Motion Block **1213**	2
Digital Signal 1 **1218**	120 - Start: --- Ref.reached: off End: on



5.6 JOG Mode

For commissioning and teach-in mode, the drive can also be controlled manually via digital inputs. JOG mode offers various options:

- The drive is moved clockwise or anticlockwise, via two digital inputs in each direction
- 4 fixed speeds available in each of 4 data sets; selection via reference frequency channel
- Control possible via buttons of control unit
- Separate acceleration and deceleration ramps
- Approaching of positions to be saved as target positions in motion blocks. This function is available in teach-in mode.
- Moving without automatic sequence for commissioning and service

Input signals for JOG mode:

Input signals

Assign digital input signals to the parameters.

Activate JOG-Mode:
Jog-Mode Active **1231**

Move with direction of rotation:
Jog Clockwise **1232**
Jog Anticlockwise **1233**

JOG-Mode

Reference values, Fixed speed values:
Fixed Speed 1 **1170**
Fixed Speed 2 **1171**
Fixed Speed 3 **1172**
Fixed Speed 4 **1173**
Jog-Speed Keypad **1174**

Reference values, Ramps:
Acceleration **1175**
Ramp Rise Time **1176**
Deceleration **1177**
Ramp Fall Time **1178**
Emergency Ramp **1179**

Reference value with selected Fixed speed via *Reference Frequency Source* **475** (FF = Fixed speed)

Selection of the Fixed speed via
Fixed Frequency Change-Over 1 **66**
Fixed Frequency Change-Over 2 **67**

Via *Jog-Mode Active* **1231**, the JOG function is activated. Via signal *Jog Clockwise* **1232** or *Jog Anticlockwise* **1233**, the drive is moved in clockwise/anticlockwise direction at the required speed. The speed is defined via the reference frequency channel with parameter *Reference Frequency Source* **475**. For parameter *Reference Frequency Source* **475**, an operation mode with fixed speed (FF) must be selected. One of the four fixed speeds can be selected via parameters *Fixed Frequency Change-over 1* **66** and parameter *Fixed Frequency Change over 2* **67**.

Parameter		Factory setting	
1231	Jog-Mode Active	76 -	MFI1D
1232	Jog Clockwise	71 -	S2IND
1233	Jog Anticlockwise	72 -	S3IND

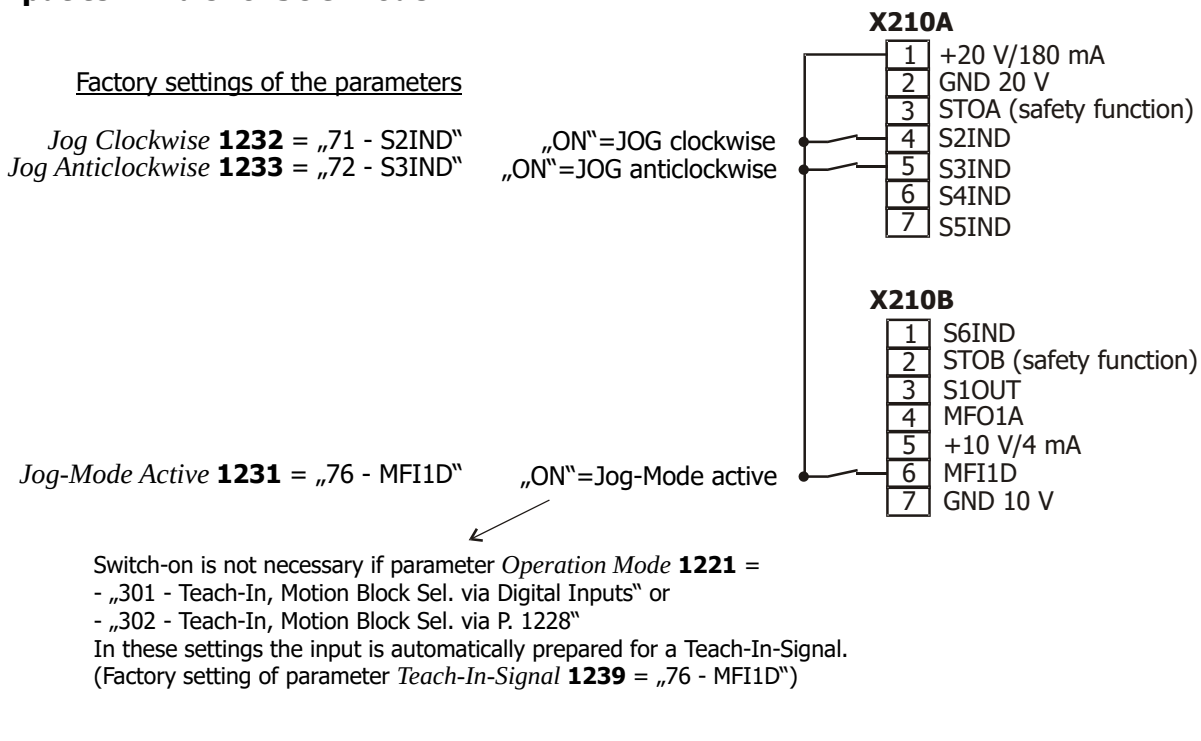
0 = Low / 1 = High / X = any / * = factory setting

[1] Also refer to chapter "Positioning Error Messages"
F1445:Pos. and Neg. HW-Lim Switch Simultaneously
F1446:Limit Switch Incorrect Wired
F1447:Pos. HW Limit Switch
F1448:Neg. HW Limit Switch
[2] Depends on *Operation Mode* **490**. Comply with the instructions in sections 4.3 and 4.4.1.4.
Assign S4IND and S5IND to the parameters for HW limit switches.

Values in parentheses *(0)* and *(1)* apply if the digital inputs for the limit switches are configured as inverted inputs *(brake contact function)*, e.g. *Positive HW Limit Switch* **1138** = "540 - S4IND inverted (Hardware)".

NOTE:	JOG mode can be started without homing. The hardware limit switches are active; the software limit switches relate to the reference position and are active only after a homing operation.

Input terminals for JOG mode:



Switch-on is not necessary if parameter *Operation Mode* **1221** =
- „301 - Teach-In, Motion Block Sel. via Digital Inputs" or
- „302 - Teach-In, Motion Block Sel. via P. 1228"

In these settings the input is automatically prepared for a Teach-In-Signal.
(Factory setting of parameter *Teach-In-Signal* **1239** = „76 - MFI1D")

NOTE:	For release of the power component, wiring of the following digital inputs is required: STOA (terminal X210A.3) and STOB (terminal X210B.2). In safety-oriented systems, the documentation "Safe Torque Off" shall be complied with.

5.6.1 Fixed speed in JOG mode

Four fixed speeds can be used in JOG mode. The fixed speed to be used can be selected via parameter *Reference Frequency Source* **475** of the reference frequency channel. For parameter *Reference Frequency Source* **475**, an operation mode with fixed speed (FF/fixed frequency) must be selected. Via the logic states of the signals assigned to parameters *Fixed Frequency Change-Over 1* **66** and *Fixed Frequency Change-Over 2* **67**, one of the four fixed speeds can be selected. Parameters *Fixed Frequency Change-Over 1* **66** and *Fixed Frequency Change-Over 2* **67** must be assigned digital input signals or logic signals (factory setting: digital inputs EM-S1IND and EM-S2IND of an optional extension module).

Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Fact. sett.**
1170	Fixed Speed 1	$-(2^{31}-1)$ u/s	$2^{31}-1$ u/s	163840 u/s
1171	Fixed Speed 2	$-(2^{31}-1)$ u/s	$2^{31}-1$ u/s	327680 u/s
1172	Fixed Speed 3	$-(2^{31}-1)$ u/s	$2^{31}-1$ u/s	655360 u/s
1173	Fixed Speed 4	$-(2^{31}-1)$ u/s	$2^{31}-1$ u/s	1310720 u/s
1174	Jog-Speed Keypad	$-(2^{31}-1)$ u/s	$2^{31}-1$ u/s	163840 u/s

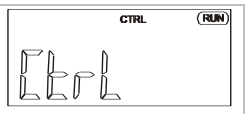
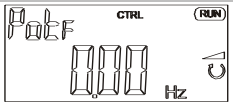
Selection of fixed speed		
***Fixed frequency change-over 1* 66**	***Fixed frequency change-over 2* 67**	**Selected fixed speed (FF)**
0	0	*Fixed Speed 1* **1170**
1	0	*Fixed Speed 2* **1171**
1	1	*Fixed Speed 3* **1172**
0	1	*Fixed Speed 4* **1173**

Selection of fixed speed for JOG mode:

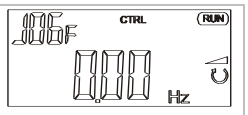
- Set one or several of parameters *Fixed Speed 1* **1170** to *Fixed Speed 4* **1173**.
- Assign digital inputs or logic signals to parameters **66** and *Fixed Frequency Change-Over 2* **67**. Via the logic states of the input signals, select a fixed speed.
- For parameter *Reference Frequency Source* **475**, set an operation mode with fixed speed (FF), e.g. "10 – Abs. Val. Fixed Frequency (FF)".

When a digital signal is present for *Jog Mode Active* **1231** and *Jog Clockwise* **1232** or *Jog Anticlockwise* **1233**, the drive moves at the selected speed.

JOG mode via keypad can be activated:

• Navigate to the CTRL menu. • Actuate the ENT-key. Signal CTRL flashes.	
• Actuate the ENT-key again to reach the local operation mode (stopped).	

- Use the FUN-key to travel with *Jog-Speed Keypad* **1174**. While the key is actuated the drive runs. If the key is not actuated any more the drive will be stopped at the deceleration ramp.
- Use the ENT-key to change the direction of rotation. The direction of rotation is indicated at the display via an arrow and „F" (Forward) or „R" (Reverse). The direction of rotation can be changed at standstill or during travel operations.

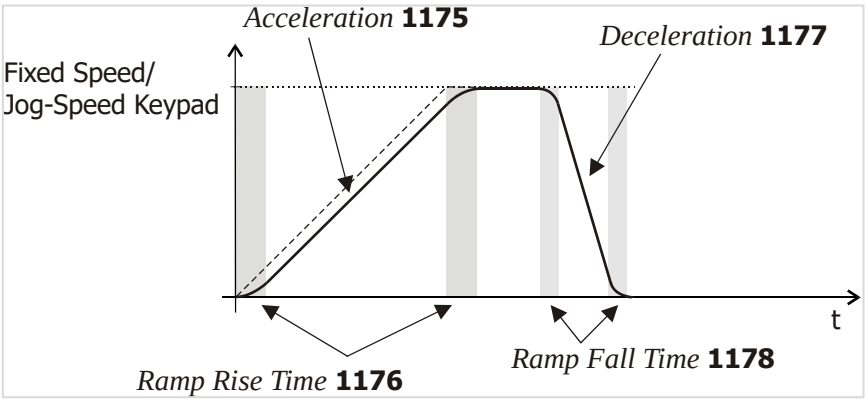


	WARNING!	The RUN-key of the keypad allows manual operation in all configurations. This manual operation uses the fixed speed as the reference value. Direction of rotation and travel speed of both modes can be different. If you use the manual operation pay attention to the parameter settings.

5.6.2 Acceleration and Deceleration in JOG Mode

In JOG mode separate acceleration and deceleration ramps with S curves (ramp times) are used:

Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Fact. sett.**
1175	Acceleration	1 u/s²	232-1 u/s²	327680 u/s²
1176	Ramp Rise Time	0 ms	2000 ms	0 ms
1177	Deceleration	1 u/s²	232-1 u/s²	327680 u/s²
1178	Ramp Fall Time	0 ms	2000 ms	0 ms
1179	Emergency Ramp	1 u/s²	2^{32}-1 u/s²	655360 u/s²



5.7 Teach-In (Saving Actual Position as Target Position)

The "Teach-In" function is used in order to approach the target positions in a plant manually and to save the corresponding position values in the motion blocks. The function works like the JOG function, with the following differences:

- Teach-In is activated via parameter *Operation Mode* **1221**.
- By default, input MFI1D (Terminal X210B.6) is used for the teach-in signal.

How teach-in works:

- Set the motion block to be parameterized via digital inputs or parameter *Starting-Record Number* **1228**.
- Move to required target position in JOG mode.
- Save actual position for the selected motion block via *Teach-In Signal* **1239**.
- Repeat procedure for other positions.
- JOG mode is activated automatically in teach-in mode (parameter *Operation Mode* **1221**).

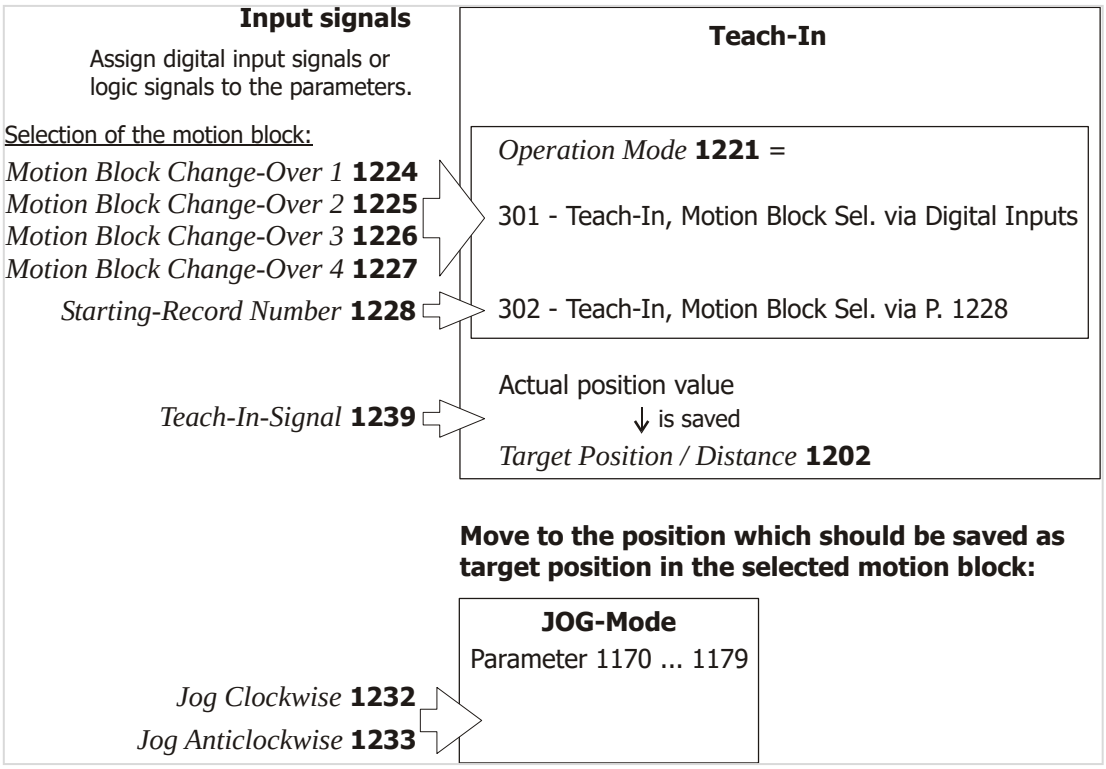
NOTE:	The first two steps of the sequence above can be executed vice versa.

Activate "Teach-In" function:

Set parameter *Operation Mode* **1221** to:

- "301 - Teach-In, Motion Block Sel. via Digital Inputs" or
- "302 - Teach-In, Motion Block Sel. via P. 1228"

Input signals for teach-in



Approached positions can be entered in a motion block directly.
The drive can be moved to the required position using the JOG function.

- clockwise (factory setting: digital input S2IND):
  parameter *Jog Clockwise* **1232**
- anticlockwise (factory setting: digital input S3IND):
  parameter *Jog Anticlockwise* **1233**

Setting of parameter *Jog-Mode Active* **1231** is not required in Teach-In mode.
As soon as parameter *Teach-In-Signal* **1239** receives a positive signal edge via a logic input signal (factory setting MFI1D), the current position is entered in the current motion block as a target position. The current motion block is defined by parameter *Starting-Record Number* **1228** or the motion block change-over function (parameters 1224 to 1227, 1254).

NOTE:	In order to achieve maximum accuracy, move drive to required position, stop drive and set teach-in signal when drive has stopped.

In teach-in operation modes (parameter *Operation Mode* **1221**), the JOG function is activated automatically. In this case, signals on input for *Jog-Mode Active* **1231** will not be processed.

Parameter		Factory setting	
1239	Teach-In-Signal	76 -	MFI1D

Standard Terminal assignment Teach-In

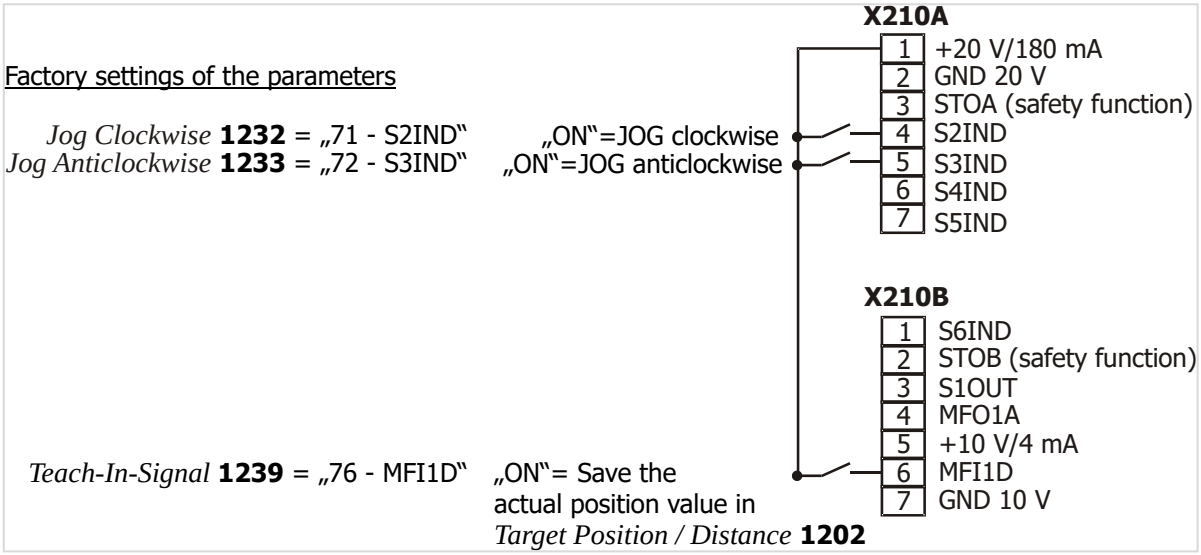
Function	**Con-troll-er re-lease**	*Jog clock-wise* **1232**	*Jog anticlo-ckwise* **1233**	*Teach-In Signal* **1239**	*Neg. HW li-mit switch* **1137**	*Pos. HW li-mit switch* **1138**
		S2IND*	S3IND*	MFI1D*	S5IND [2]	S4IND [2]
Drive disabled	0	X	X	0	0 *(1)*	0 *(1)*
Drive disabled	X	1	1	X	0 *(1)*	0 *(1)*
Jog clockwise	1	1	0	0	0 *(1)*	0 *(1)*
Jog anticlockwise	1	0	1	0	0 *(1)*	0 *(1)*
Position saved	X	X	X	1 (positive flank)	0 *(1)*	0 *(1)*
Error message, limit switch as make contact function *(brake contact function)*						
F1445 [1]	X	X	X	X	1 *(0)*	1 *(0)*
F1447 (F1446) [1]	X	X	X	X	0 *(1)*	1 *(0)*
F1448 (F1446) [1]	X	X	X	X	1 *(0)*	0 *(1)*

0 = Low / 1 = High / X = any / * = factory setting

[1] Also refer to chapter "Positioning Error Messages"
F1445: Pos. and Neg. HW-Lim Switch Simultaneously
F1446: Limit Switch Incorrect Wired
F1447: Pos. HW Limit Switch
F1448: Neg. HW Limit Switch
[2] Depends on *Operation Mode* **490**. Comply with the instructions in sections 4.3 and 4.4.1.4.
Assign S4IND and S5IND to the parameters for HW limit switches.

Values in parentheses *(0)* and *(1)* apply if the digital inputs for the limit switches are configured as inverted inputs *(brake contact function)*, e.g. *Positive HW Limit Switch* **1138** = "540 - S4IND inverted (Hardware)".

Input terminals for teach-in



Selection of motion blocks for teach-in

Selection of motion block where the current position is to be saved as a target position:

Operation mode **1221**	**Selected motion block**
301 - Teach-In, Motion Block Sel. via Digital Inputs	The current position is saved as the *Target Position / Distance* **1202** in the motion block selected by the motion block change-over function. Motion block change-over is effected through digital inputs assigned to the following parameters: – Motion block change-over 1 1224 – Motion block change-over 2 1225 – Motion block change-over 3 1226 – Motion block change-over 4 1227 – Motion block change-over 5 1254

Parameter Motion Block Change-Over					
1224 2^0	**1225 2^1**	**1226 2^2**	**1227 2^3**	**1254 2^4**	**Motion Block $1+2^0+2^1+2^2+2^3+2^4$**
0	0	0	0	0	1
1	0	0	0	0	2
0	1	0	0	0	3
1	1	0	0	0	4
0	0	1	0	0	5
1	0	1	0	0	6
0	1	1	0	0	7
1	1	1	0	0	8
0	0	0	1	0	9
1	0	0	1	0	10
0	1	0	1	0	11
1	1	0	1	0	12
0	0	1	1	0	13
1	0	1	1	0	14
0	1	1	1	0	15
1	1	1	1	0	16
0	0	0	0	1	17
1	0	0	0	1	18
0	1	0	0	1	19
1	1	0	0	1	20
0	0	1	0	1	21
1	0	1	0	1	22
0	1	1	0	1	23
1	1	1	0	1	24
0	0	0	1	1	25
1	0	0	1	1	26
0	1	0	1	1	27
1	1	0	1	1	28
0	0	1	1	1	29
1	0	1	1	1	30
0	1	1	1	1	31
1	1	1	1	1	32

302 - Teach-In, Motion Block Sel. via P. 1228

The current position is saved as the *Target Position / Distance* **1202** in the motion block selected by the parameter *Starting Record Number* **1228**.

NOTE:	Before executing the teach-in function, homing must be completed successfully. Otherwise, error message "F1570 No Homing Done" will be displayed.

The available number of teach-in positions in *Operation Mode* **1221** = 301 depends on the number of digital inputs available for motion block change-over.

Number of digital inputs	Max. number of teach-in positions
1	2
2	4
3	8
4	16
5	32

NOTE:	The teach-in function can be used for saving the target positions. The other values of the motion blocks such as speed, acceleration, etc. are changed via the corresponding parameters.

5.8 Electronic gear

Electronic gears are used in many plants where a synchronous operation, either continuous or for a limited period of time, of several drives is required. The function includes:

- Activation/deactivation of synchronization of several drives at any time during operation.
- Adjustable ratio of different gear factors between master and slave.
- Parameterizable signals for feedback "In Gear".
- Synchronization of slave drive with master drive via system bus or encoder inputs.
- Combination of electronic gear with positioning modes possible

NOTE:	If two encoders (motor encoder and position encoder) are used, the function "Electronic Gear" can only be used via system bus.

Typical applications include:

- Belt conveyors
  Example: Several belt conveyors are connected in series mechanically. The material is transferred from one conveyor to the next which conveys it at the same speed. The different motor gears are compensated in the internal calculation in the slave.
- Hoisting applications
  Example: A material elevator is driven by 2 motors on the left and right side. For safety reasons (redundancy) and in order to save space and reduce costs, two identical small motors are used instead of one large motor. Synchronous operation prevents tilting of the platform.

5.8.1 Master position source

The following operation modes are available for selecting the source of the signal for positioning in combination with the electronic gear function. Via parameter *Master Position Source* **1122**, the operation mode is selected.

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 **doesn't change** if the master makes a homing. "607 – Act. Position (16/16)", mechanical position of master drive. Value **changes** if the master makes a homing. "620 – motion profile gen.: Internal Ref. Position", reference position of master drive; advantage: improved controller properties. Value **doesn't change** if the master makes a homing. "627 – motion profile gen.: Ref. Position", reference position of master drive; advantage: improved controller properties. Value **changes** if the master makes a homing. The settings 607 and 627 are only to be used in exceptional cases. In most applications sources 606 and 620 are more useful.

In setting "11 - RxPDO1.Long1 extrapolated" of parameter *Master Position Source* **1122** the system bus synchronization must be set to 1 or 10 to ensure a reliable function of *Operation Mode* **1180**.

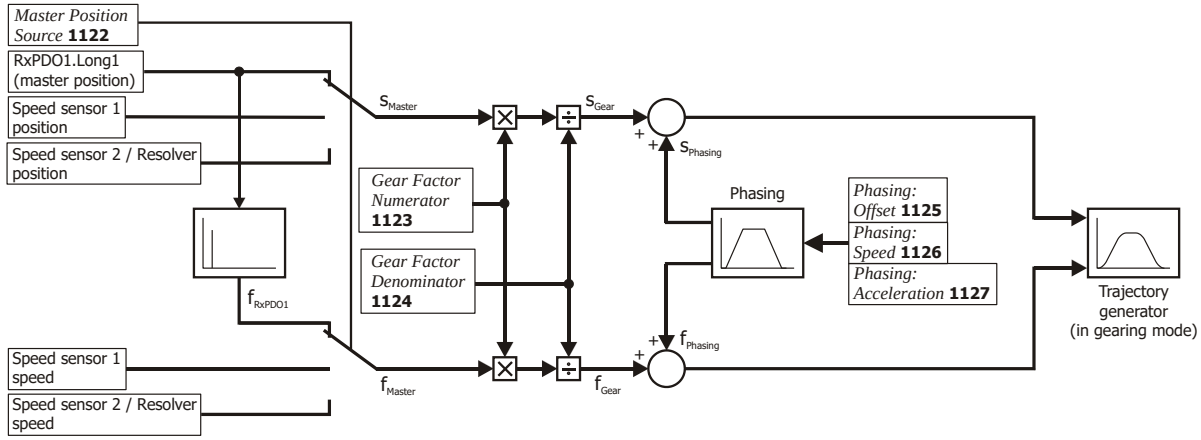
Operation mode **1180**	
0 -	Off [1]
1 -	RxPDO1 [2]
2 -	RxPDO2 [3]
3 -	RxPDO3 [3]
10 -	SYNC

[1] If the error message "F1453 Systembus-Synchronization not activated" is displayed when the slave drive is started, one of the operation modes 1, 2, 3 or 10 must be selected.
[2] Synchronization of processing with data telegram or cyclic sending of SYNC telegram.
[3] Not recommended for el. gear because no extrapolation done.

The synchronization of several drives needs high refresh rates to assure optimum results. Set the corresponding time (i.e. *TxPDO1 Time* **931**) at the transmit side to a low value. For the usage of the sync-function at the system bus set *SYNC-Time* **919** to a low value.
The bus load of the system bus must have sufficient reserves for proper operation.

Note:	The system bus is described in the manuals of the extension modules with system bus interface.

Block diagram: electronic gear and phasing function



5.8.2 Gear factor

Via parameters *Gear Factor Numerator* **1123** and *Gear Factor Denominator* **1124**, the gear factor is set permanently at the frequency inverter of the Slave drive.

$$\text{Gear factor} = \frac{\textit{Gear Factor Numerator}\ \mathbf{1123}}{\textit{Gear Factor Denominator}\ \mathbf{1124}}$$

Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Fact. sett.**
1123	Gear Factor Numerator	-32 767	32 767	1
1124	Gear Factor Denominator	1	65 535	1

5.8.3 Resynchronization

Limitation of acceleration when the gear factor is changed is effected via parameter *Resync. on Change of Gear-Factor* **1142**. The slave is resynchronized with the master when the gear factor has changed. This function avoids sudden speed changes.

Resync. on Change of Gear Factor **1142**	Function
0 - Off	Resynchronization is switched off.
1 - On	The slave is resynchronized with the master frequency when the gear factor has changed. The drive adjusts to the new frequency. The acceleration ramps set in the motion block are considered. If the gear factor changes, signals "57 – In Gear" and "624 – In Gear" are reset. As soon as the new frequency is reached, the signals are set again.

5.8.4 Phasing function

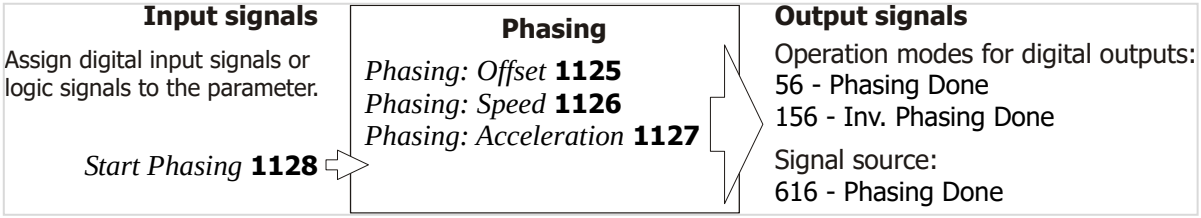
With the phasing function, the slave position is offset from the received position of the master by the value entered in *Phasing: Offset* **1125**.
The function can be executed via a logic signal assigned to parameter *Start Phasing* **1128**. After start, *Phasing: Speed* **1126** and *Phasing: Acceleration* **1127** are used until the slave position is offset from the master position by *Phasing: Offset* **1125**.

Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Fact. sett.**
1125	Phasing: Offset	$-(2^{31}-1)$ u	$2^{31}-1$ u	65 536 u
1126	Phasing: Speed [1)]	1 u/s	$2^{31}-1$ u/s	65 536 u/s
1127	Phasing: Acceleration	1 u/s²	$2^{31}-1$ u/s²	65 536 u/s²

[1)] is added to master speed

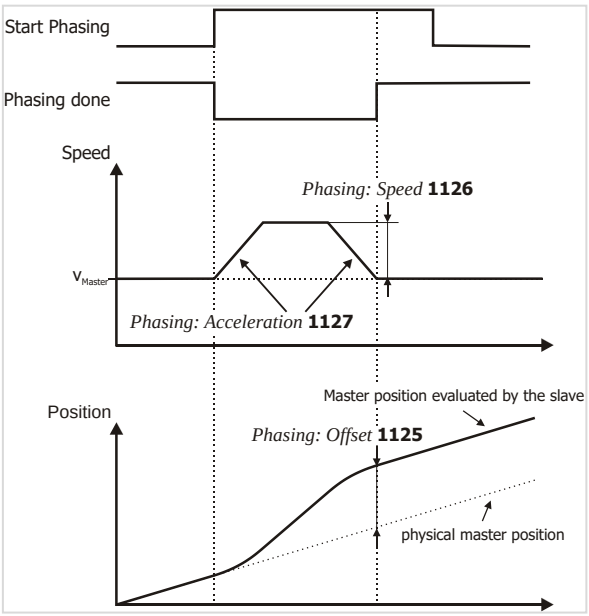
Parameter		Factory setting	
1128	Start Phasing	7 -	Off

Input and output signals of phasing function



Example of phasing function:

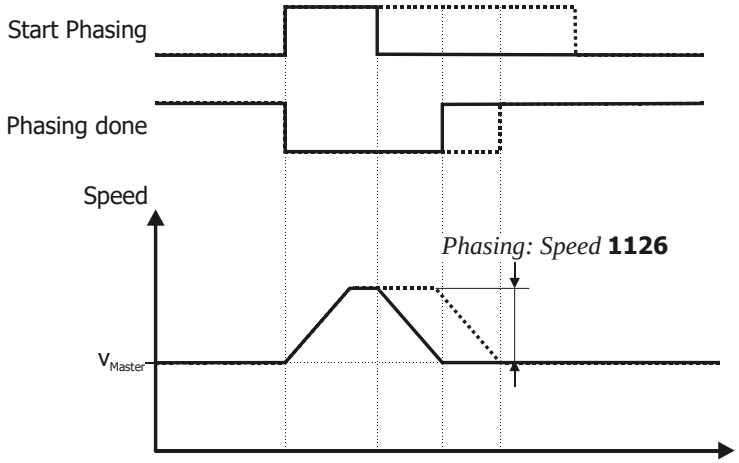
1. Signal "Start Phasing" is set.
2. Acceleration at "Phasing: Acceleration" to "Phasing: Speed".
3. After offset by "Phasing: Offset", the digital signal "616 - Phasing Done" is set. The signal is available as operation mode "56 - Phasing Done" for digital outputs.



The phasing function can be cancelled by resetting the Start Phasing signal. The current speed is reduced at the value of *Phasing: Acceleration* **1127** and signal "56 - Phasing Done" is set.

Example of cancellation of phasing function

1. Signal "Start Phasing" is set
2. Deceleration to master speed
3. Signal "Phasing Done" is set



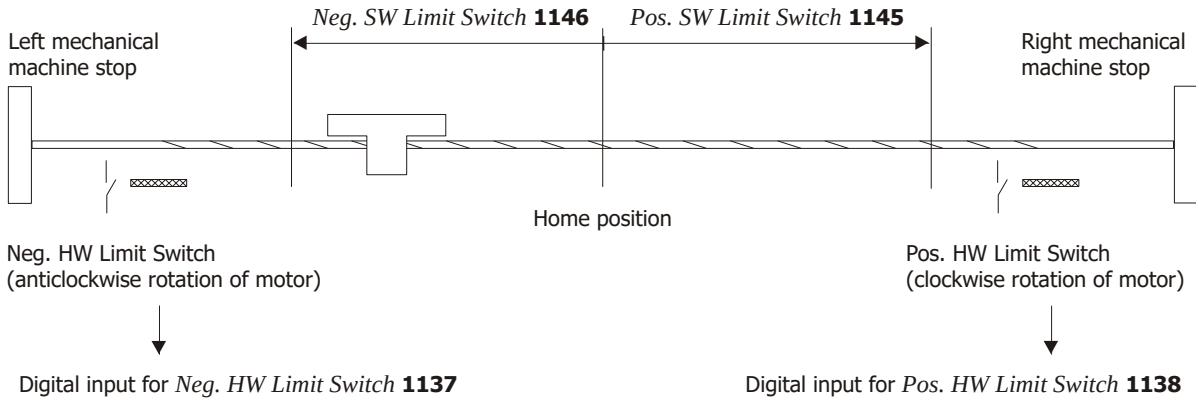
5.9 Monitoring Functions

5.9.1 Travel limits

Bumping into the mechanical stops of a limited travel range can be prevented by:

- Hardware limit switches
- Software limit switches (parameters)

Limit switches can be used in order to protect the machine and to limit the travel range.



NOTE:	The software limit switches are active only after a successful homing operation.

5.9.2 Hardware limit switches

⚠	**WARNING!**	The position axis must be provided with hardware limit switches. They prevent bumping into mechanical stops and damaging of the machine. Hardware limit switches must be arranged mechanically such that, in the case of an error, there is still sufficient distance left for stopping the drive. If the travel range is limited by hardware limit switches only and if they are evaluated by the frequency inverter, the following must be considered: Changing the parameter settings of the hardware limit switches, deactivation of the fault reaction or setting of the fault reaction to "Warning" may result in the drive not stopping when it reaches the hardware limit switches. If high values are adjusted for speed and acceleration, and the system has a high mass moment of inertia, it may overrun the limit switches and bump into the mechanical stops of the plant. Do not set excessively high speed and acceleration values in order to avoid damage. Test hardware limit switches before commissioning: – Disconnect drive from load to avoid damage. – Check evaluation of hardware limit switches. – Check wiring of hardware limit switches: Neg. HW limit switch on negative end of travel range for anticlockwise rotation of motor, pos. HW limit switch on positive end of travel range for clockwise operation of motor.

For each direction of motion, there is one HW limit switch.
The HW limit switches are connected to digital inputs which are assigned to parameters *Neg. HW Limit Switch* **1137** and *Pos. HW Limit Switch* **1138**.

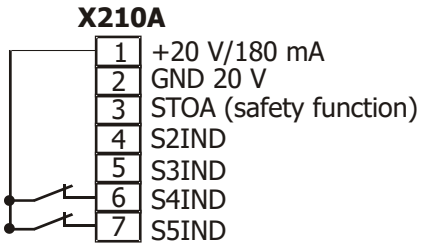
Parameter		Factory setting		Setting, e.g.	
1138	Pos. HW Limit Switch	7 -	Off	540 -	S4IND inverted (Hardware)
1137	Neg. HW Limit Switch	7 -	Off	541 -	S5IND inverted (Hardware)

ATTEN-TION!	For the connection of HW limit switches to the inputs S4IND and S5IND check the setting of parameter *Operation Mode* **490** of speed sensor 1. Set parameter *Operation Mode* **490** = „0 - Off". Also refer to sections 4.3 and 4.4.1.4.

Input terminals for HW limit switches

Factory settings of the parameters
Pos. HW Limit Switch **1138** = "7 - Off"
Neg. HW Limit Switch **1137** = "7 - Off"

Settings
Pos. HW Limit Switch **1138** =
"540 - S4IND inverted (Hardware)"
Neg. HW Limit Switch **1137** =
"541 - S5IND inverted (Hardware)"



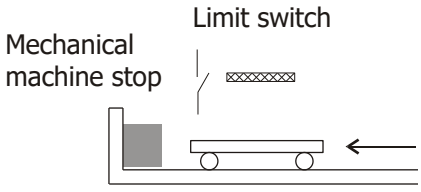
NOTE:	For wire-break monitoring, the inverted signals of the parameters of the HW limit switches can be evaluated, e.g. *Pos. HW Limit Switch* **1138** = "540 - S4IND inverted (Hardware)". In this case, the limit switches must be designed as break contacts.

The limit switches are monitored, considering the direction of rotation. An error is signaled if the position of the limit switches does not correspond to the direction of rotation of the motor, i.e. if limit switches are wired incorrectly. The positive HW limit switch must be in positive direction for Motor Clockwise. The negative HW limit switch must be in negative direction for Motor Anticlockwise.
The limit switch inputs evaluate static signals (no signal edges). Pulse switches are not evaluated as hardware limit switches.

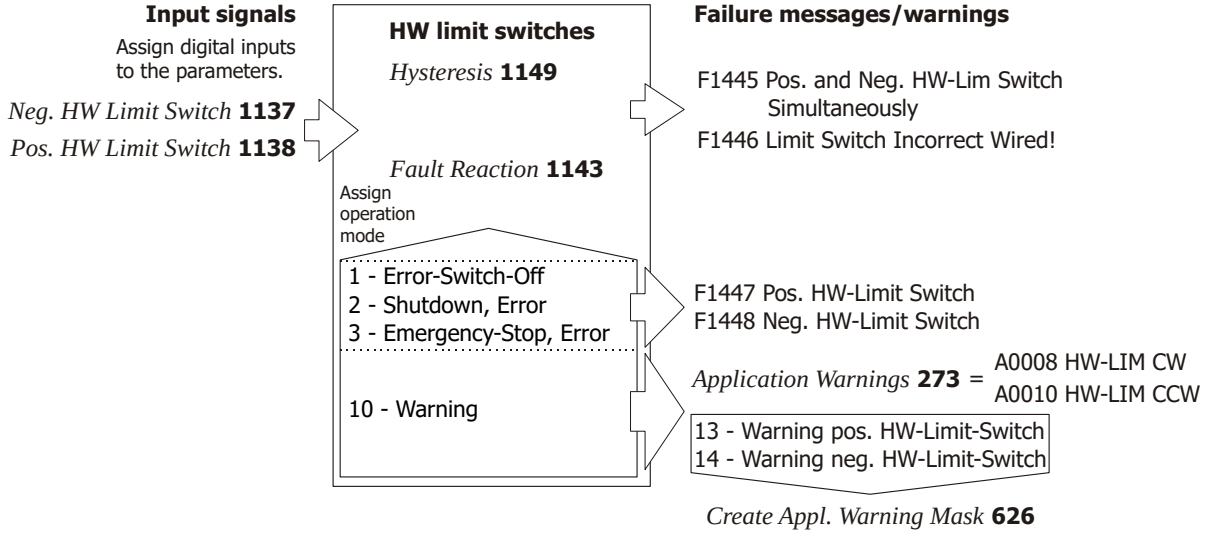
NOTE:	Possibly overrunning of hardware limit switches is not monitored. This can happen if the signal time of the limit switch is too short to be recognized by the frequency inverter.

Example: If the negative limit switch is reached, the limit switch signal triggers the selected fault reaction (parameter 1143). However, if the limit switch is overrun and the limit switch signal is no longer present, the axis continues to move in negative direction if the controller release and start positioning signals are still present.

Limit switch cannot be overrun:



Input signals and error messages /warnings of hardware limit switches:



The following digital inputs and operation modes can be assigned to the parameters *Pos. HW Limit Switch* **1138** and *Neg. HW Limit Switch* **1137**.

Available settings for *Pos. HW Limit Switch* 1138, *Neg. HW Limit Switch* 1137			
6 -	TRUE	532 -	EM-S1IND (Hardware) [1) 2)]
7 -	FALSE	533 -	EM-S2IND (Hardware) [1)]
284 -	STOA inverted	534 -	EM-S3IND (Hardware) [1)]
285 -	STOB inverted	538 -	S2IND inverted (Hardware)
292 -	STOA	539 -	S3IND inverted (Hardware)
293 -	STOB	540 -	S4IND inverted (Hardware)
526 -	S2IND (Hardware)	541 -	S5IND inverted (Hardware)
527 -	S3IND (Hardware)	542 -	S6IND inverted (Hardware)
528 -	S4IND (Hardware)	543 -	MFI1D inverted (Hardware)
529 -	S5IND (Hardware)	544 -	EM-S1IND inverted (Hardware) [1)]
530 -	S6IND (Hardware)	545 -	EM-S2IND inverted (Hardware) [1)]
531 -	MFI1D (Hardware)	546 -	EM-S3IND inverted (Hardware) [1)]

[1)] Requires an expansion module.

[2)] If an expansion module with digital port (switch-selectable digital input/output) is installed *Operation Mode* 558 must be set to "0 - Input".

[3)] If MFI1D is used as hardware limit switch input take into account that the sampling rate of this input is lower than the sampling rate of the other digital inputs.

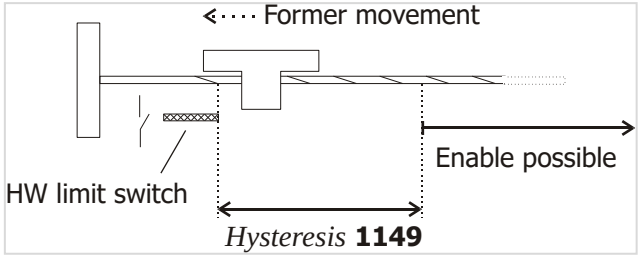
5.9.2.1 Hysteresis for hardware limit switch

Via parameter *Hysteresis* **1149**, the switching hysteresis of a limit switch (e.g. proximity switch) can be considered. In addition, the hysteresis prevents non-defined switching when the axis has stopped at a limit switch position.

The drive can be enabled if the distance between the axis and the hardware limit switch exceeds the value of parameter *Hysteresis* **1149**.

Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Fact. sett.**
1149	Hysteresis	0 u	2^{31}-1 u	182 u

Example:



The HW limit switch is activated. The drive can only be enabled after the axis has been travelled the distance of *Hysteresis* **1149** opposite to the former movement.
JOG-Mode can be used to move away from a HW limit switch. Refer to section 5.6 and 5.9.2.3.

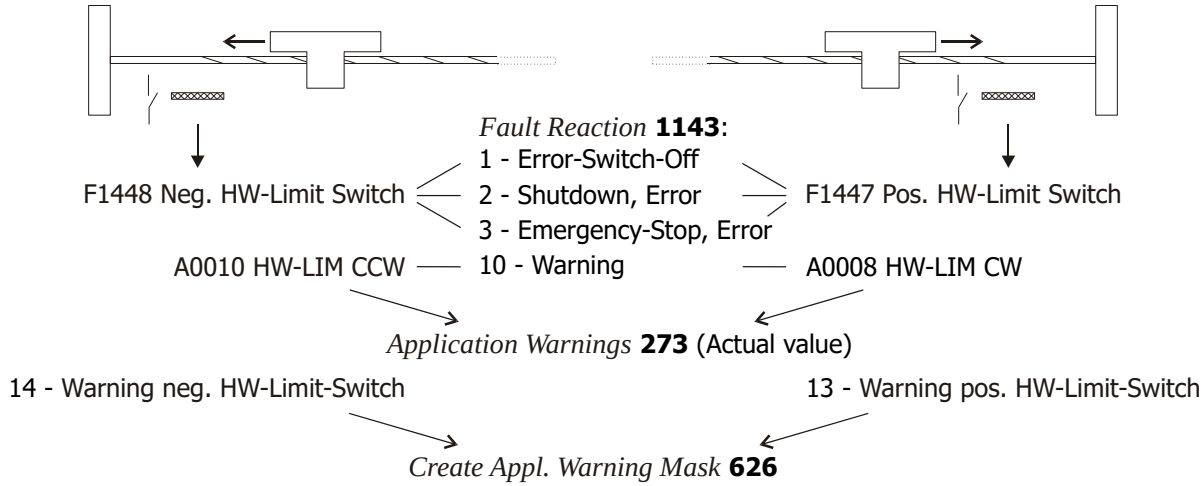
5.9.2.2 Fault reaction

Via parameter *Fault Reaction* **1143**, you can define the behavior of the drive when the hardware limit switch is reached.

Fault Reaction 1143	Function
0 - Disabled	No evaluation of hardware limit switches.
1 - Error-Switch-Off	**Factory setting**. The drive is stopped and error message "F1447 Pos. HW Limit Switch" or "F1448 Neg. HW Limit Switch" is output.
2 - Shutdown, Error	The drive is stopped at the current deceleration ramp[1)] and error message "F1447 Pos. HW Limit Switch" or "F1448 Neg. HW Limit Switch" is output.
3 - Emergency-Stop, Error	The drive is stopped at the current emergency ramp[2)] and error message "F1447 Pos. HW Limit Switch" or "F1448 Neg. HW Limit Switch" is output.
10 - Warning	Via parameter *Application Warnings* **273**, warning message "A 0008 HW-LIM CW" is output when the positive HW limit switch is reached, "A 0010 HW-LIM CCW" is output when the negative HW limit switch is reached. For parameter *Create Appl. Warning Mask* **626**, "13 - Warning pos. HW-Limit-Switch" and "14 - Warning neg. HW-Limit-Switch" are available.

[1)] Deceleration ramp:
In JOG mode, the drive is stopped based on the values for parameters *Deceleration* **1177**, *Ramp Fall Time* **1178**. When motion blocks are processed, the drive is stopped based on the values for *Deceleration* **1206** and *Ramp Fall Time* **1207**.
[2)] Emergency ramp: The drive is stopped based on the value for parameter *Emergency ramp* **1179**.

Warnings and error messages of hardware limit switches



Hardware limit switches can also be used for homing. In this case, the hardware limit switches are not evaluated by parameter *Fault Reaction* **1143** during homing.

Warning! If evaluation of hardware limit switches is off, external control measures must be taken to ensure that in dangerous situations, e.g. hardware limit switch overrun, safety device open, danger of loads falling down, the drive is switched off immediately and a mechanical brake is triggered, if necessary. Evaluation of the hardware limit switches does not perform any safety functions and does not meet the requirements of any standardized safety category.

5.9.2.3 Move away from HW limit switches

If an axis is at a hardware limit switch, the drive is disabled for the direction from where the limit switch was approached. In this case:

– Acknowledge error and move in opposite direction in JOG mode (refer to section 5.6) or

– Acknowledge error and start positioning in opposite direction

If you try to position in the former direction, error message "F1451 Clockwise Operation Locked" or "F1452 Anticlockwise Operation Locked" will be displayed.

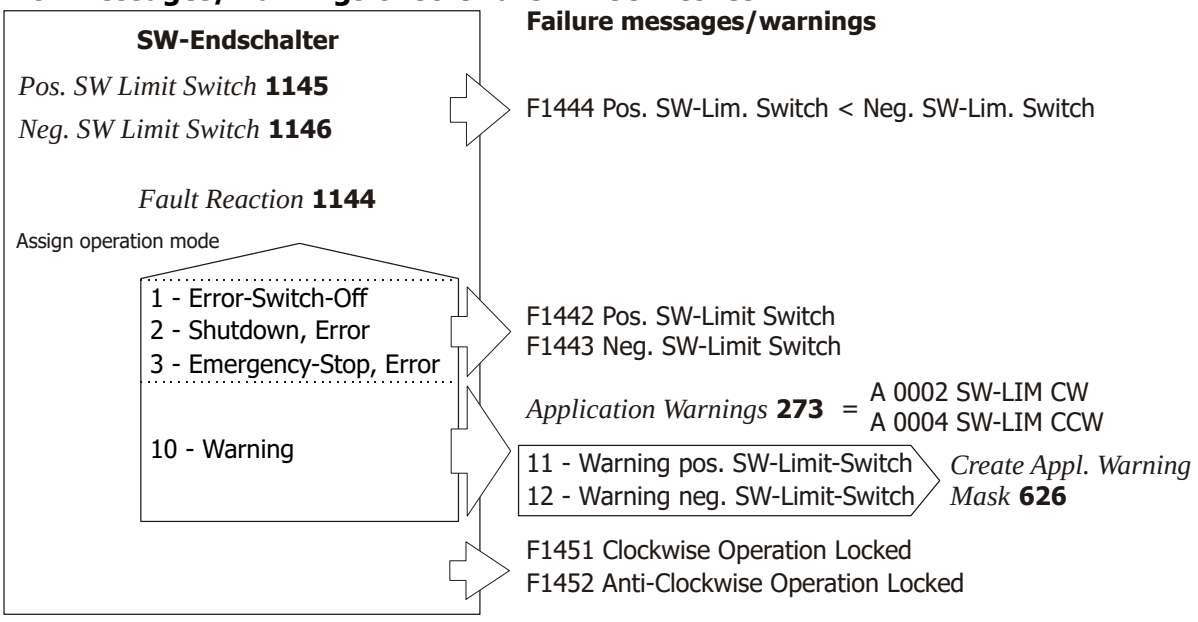
5.9.3 Software limit switches

For limitation of the travel range or protection of the machine, parameters *Positive SW Limit Switch* **1145** and *Negative SW Limit Switch* **1146** can be set. Travel commands will be executed within this travel range only.
The parameters of the SW limit switches should be set such that the HW limit switches and SW limit switches are not reached during operation.
The SW limit switches are related to the point of reference.
The SW limit switches are ready for operation if:

– a homing operation was completed successfully and
– one of the following operation modes is selected for parameter *Fault Reaction* **1144**: "1 – Error Switch-Off", "2 – Shutdown, Error", "3 – Emergency-Stop, Error", "10 – Warning".

Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Fact. sett.**
1145	Pos. SW Limit Switch	$-(2^{31}-1)$ u	$2^{31}-1$ u	65 536 u
1146	Neg. SW Limit Switch	$-(2^{31}-1)$ u	$2^{31}-1$ u	-65 536 u

Error messages/warnings of software limit switches:

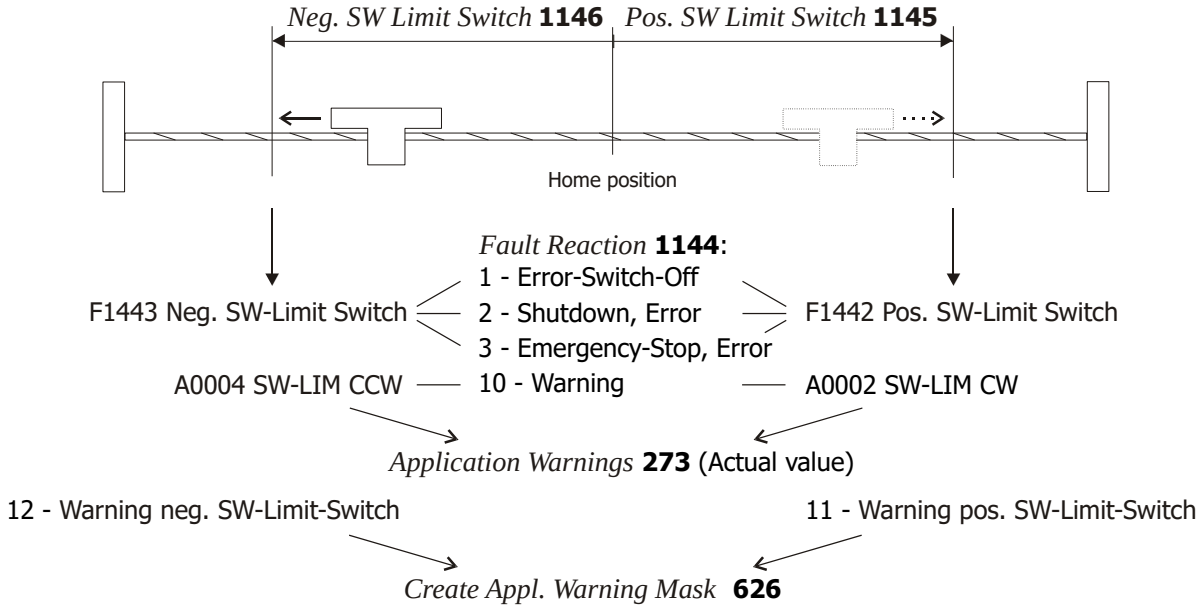


Via parameter *Fault Reaction* **1144**, you can define the behavior of the drive when the software limit switch is reached.

Fault Reaction **1144**	Function
0 - Disabled	**Factory setting**. No evaluation of software limit switches.
1 - Error Switch-Off	The drive is stopped and error message "F1442 Pos. SW Limit Switch" or "F1443 Neg. SW Limit Switch" is output.
2 - Shutdown, error	The drive is stopped at the current deceleration ramp[1)] and error message "F1442 Pos. SW Limit Switch" or "F1443 Neg. SW Limit Switch" is output.
3 - Emergency-Stop, Error	The drive is stopped at the current emergency ramp[2)] and error message "F1442 Pos. SW Limit Switch" or "F1443 Neg. SW Limit Switch" is output.
10 - Warning	Via parameter *Application Warnings* **273**, warning message "A 0002 LW-LIM CW" is output when the positive SW limit switch is reached, "A 0010 SW-LIM CCW" is output when the negative SW limit switch is reached. For parameter *Create Appl. Warning Mask* **626**, "11 - Warning pos. SW-Limit-Switch" and "12 - Warning neg. SW-Limit-Switch" are available.

[1)] Deceleration ramp:
In JOG mode, the drive is stopped based on the values for parameters *Deceleration* **1177**, *Ramp Fall Time* **1178**. When motion blocks are processed, the drive is stopped based on the values for *Deceleration* **1206** and *Ramp Fall Time* **1207**.
[2)] Emergency ramp: The drive is stopped based on the value for parameter *Emergency ramp* **1179**.

Warnings and error messages of software limit switches



NOTE:	Limit switches are assigned as follows: Pos. SW limit switch for clockwise operation, neg. SW limit switch for anticlockwise operation.

When software limit switches are evaluated, the behavior of the drive depends on the *Motion Mode* **1208** and *Fault Reaction* **1144**:

Motion Mode 1208	Behavior
0 - absolute, 1 - relative	If the *Target Position/Distance* **1202** is outside of the travel range defined by parameters *Positive SW Limit Switch* **1145** and *Negative SW Limit Switch* **1146**, the motion block will not be started. The drive reacts as defined in parameter *Fault Reaction* **1144**.
2 - Touch probe 3 -	If the SW limit switches are overrun before the touch-probe signal was received, the drive reacts as defined in parameter *Fault Reaction* **1144**. If the current *Target Position/Distance* **1202** is outside of the defined travel range when the touch-probe signal has been received, the target position will not be approached. The drive reacts as defined in parameter *Fault Reaction* **1144**.
4 - Velocity, 10 … 24 - gearing	The drive moves to the position of a SW limit switch. Then, the drive reacts as defined in parameter *Fault Reaction* **1144**.
JOG function	

5.9.3.1 Move away from SW limit switches

The axis can be moved to the defined travel range again:

- Acknowledge error and move in opposite direction in JOG mode or
- Acknowledge error and start positioning in opposite direction

Error "F1444 Pos. SW-Lim. Switch < Neg. SW-Lim. Switch" is displayed if parameters *Positive SW Limit Switch* **1145** and *Negative SW Limit Switch* **1146** are set such that the positive SW switch is to the left of the negative SW switch. The value of the positive SW switch must be greater than the value of the negative SW switch.
If the axis is at the position of a software limit switch, the corresponding direction of rotation of the drive is disabled. If you try to move in this direction, error message "F1451 Clockwise Operation Locked" or "F1452 Anticlockwise Operation Locked" will be displayed.

5.9.4 Target window

The target window monitors the current position after completion of a positioning operation. A positioning operation is complete as soon as the current position is in the target window. Via parameter *Target Window* **1165**, you can define as from which distance from the target position the signal "60 – Target Position Reached" is set. This setting is valid both for the positive and negative direction.
If the parameter value is set to 0, the operation will be complete as soon as the Position reference value reaches the target position. For the Position reference value an internal value is used, that is calculated anew depending on the profile data for each internal cycle step.
Via parameter *Target Window Time* **1166**, you can define how long the axis must be in the target window before "60 – Target Position Reached" is signaled.

Parameter		Setting		
No.	Description	Min.	Max.	Fact. sett.
1165	Target Window	0 u	2^{20} u	182 u
1166	Target Window Time	1 ms	65 535 ms	1 ms

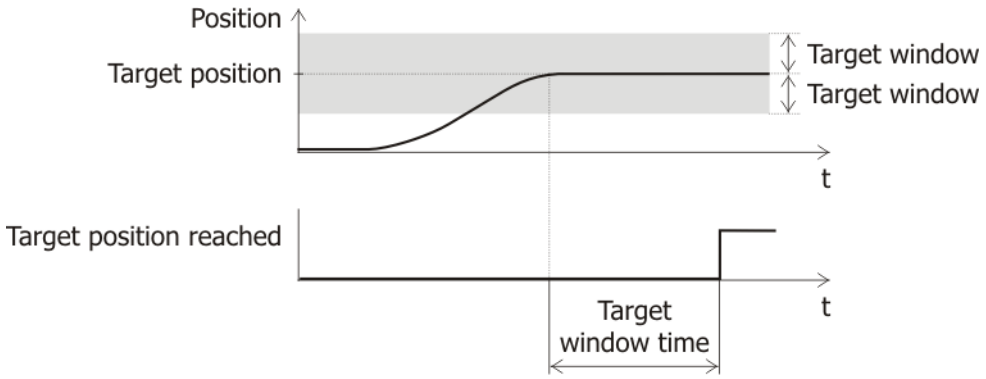
Target window

Target Window **1165**
Target Window Time **1166**

Output signals

Operation modes for digital outputs:
60 - Target Position Reached
160 - Inv. Arrived at desired Position

Signal source:
282 - Target Position Reached



Note: The size of the target window affects the automatic sequence of motion blocks because the positioning operation requires a higher precision in the case of a small target window (small tolerance). The following motion block is started when the target window is reached.

5.9.5 Contouring error supervision

Contouring errors may occur, for example, if the acceleration and deceleration ramps are not adjusted to the moment of inertia of the load and the drive cannot follow the specified reference values. With the contouring error threshold, you can define a maximum deviation between the current position and the required position. If this limit is exceeded for a user-defined time, the drive will respond as defined in parameter *Fault Reaction* **1120**.

Fault Reaction **1120**	Function
0 - Disabled	**Factory setting**. No evaluation of contouring error threshold.
1 - Error-Switch-Off	The drive is switched off and error message "F0404 Control Deviation Position Controller" is output, if the *Error Threshold* **1106** was exceeded by the time defined in *Contouring Error Time* **1119**.
2 - Shutdown, Error	The drive is stopped at the current deceleration ramp [1] and error message "F0404 Control Deviation Position Controller" is output, if the *Error Threshold* **1106** was exceeded by the time defined in *Contouring Error Time* **1119**.
3 - Emergency-Stop, Error	The drive is stopped at the current emergency ramp [2] and error message "F0404 Control Deviation Position Controller" is output, if the *Error Threshold* **1106** was exceeded by the time defined in *Contouring Error Time* **1119**.

[1] Deceleration ramp:
In JOG mode, the drive is stopped based on the values for parameters *Deceleration* **1177**, *Ramp Fall Time* **1178**. When motion blocks are processed, the drive is stopped based on the values for *Deceleration* **1206** and *Ramp Fall Time* **1207**.
[2] Emergency ramp: The drive is stopped based on the value for parameter *Emergency ramp* **1179**.
If the range defined by parameter *Warning Threshold* **1105** is left, the following is performed:

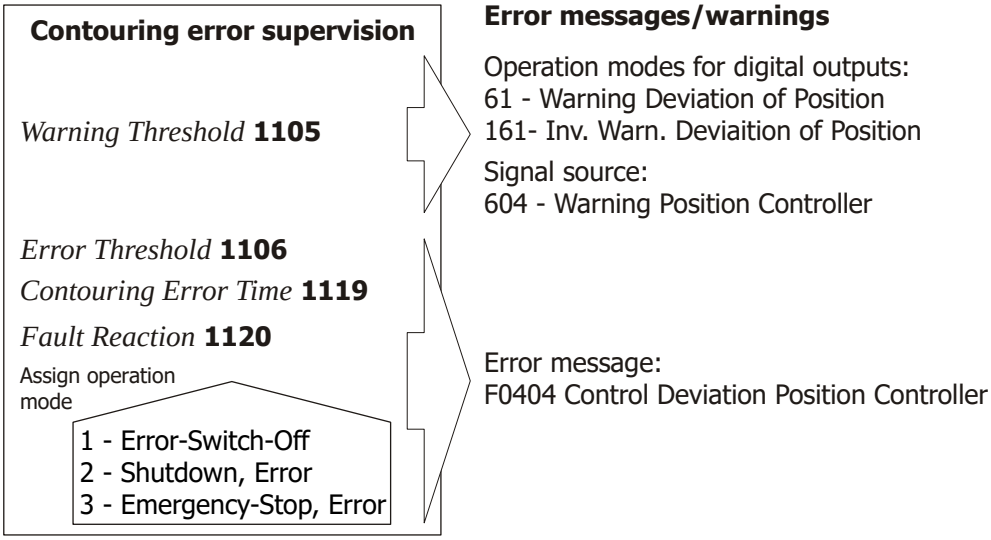
- Signal "604 – Warning Position Controller" is set.
- The warning is available via "61 - Warning Deviation of Position" and "161 - inv. Warning Deviation of Position" for digital outputs.
- Parameter *Application Warnings* **273** reads "A0020 CONT".

If the range defined by parameter *Error Threshold* **1106** is left, the drive responds as defined in *Fault Reaction* **1120**.

Via parameter *Contouring Error Time* **1119**, you can define how long the *Error Threshold* **1106** may be exceeded before the *Fault Reaction* **1120** is triggered.

Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Fact. sett.**
1105	Warning Threshold	0 u	2^{31}-1 u	32 768 u
1106	Error Threshold	0 u	2^{31}-1 u	65 536 u
1119	Contouring Error Time	0 u	65 535 ms	10 ms

Contouring error supervision output signals



Note: The contouring error threshold has no influence on the positioning accuracy but defines how exactly the travel distance must be kept so that no error is signaled. Very low contouring error values may cause frequent error messages.

Parameter *Act. Contouring Error* **1109** contains the current contouring error value.
The peak contouring error value can be monitored via parameter *Peak Value Contouring Error* **1121** in the actual value memory.
With parametersetting *Reset Memory* **237** = "18 - Peak Value Contouring Error", you can reset the saved value on the optional control unit KP500 or via a communication interface.
By reducing the acceleration and deceleration values step by step, triggering of the contouring error can be avoided. The reduction of these values, however, also changes the motion profile so that it may no longer meet the requirements of the application. In this case, the mechanical design and the selected drive power must be checked.

5.9.6 Warning mask Application

The Warning mask signals via a digital signal if an afore configured warning applies. The configuration of the Warning mask is carried out via *Create Appl. Warning Mask* **626**.
As soon as limit switches are reached or contouring error limits are exceeded, a warning can be issued. Depending on the application, any number of warnings can be configured. This enables internal and/or external control using a common output signal. The warning signal refers to the parameter values set in error/warning behavior. The display of *Warning Application* **273** is not affected by the Warning mas

Create warning mask application **626**	**Function**
0 - No change	The configured warning mask is not changed.
2 - Activate all Warnings	The warnings reports stated are linked in the warning mask.
10 - Warning V-Belt	Warning message of V-belt monitoring according to *Operation Mode* **581**.
11 - Warning pos. SW limit switch	Warning message indicating that the positive SW limit switch has been reached.
12 - Warning neg. SW limit switch	Warning message indicating that the negative SW limit switch has been reached.
13 - Warning pos. HW limit switch	Warning message indicating that the positive HW limit switch has been reached.
14 - Warning neg. HW limit switch	Warning message indicating that the negative HW limit switch has been reached.
15 - Warning position controller	Warning message, indicating that the contouring error monitoring range adjusted with parameter *Warning Threshold* **1105** has been left.
102 - Deactivate All Warnings	All warnings are deactivated.
110 - Deactivate Warning V-Belt	No warning message of V-belt monitoring.
111 - Deactivate warning pos. SW limit switch	No warning when positive SW limit switch is reached.
112 - Deactivate warning neg. SW limit switch	No warning when negative SW limit switch is reached.
113 - Deactivate warning pos. HW limit switch	No warning when positive HW limit switch is reached.
114 - Deactivate warning neg. HW limit switch	No warning when negative HW limit switch is reached.
115 - Deactivate warning position controller	No warning message when contouring error monitoring range adjusted with parameter *Warning Threshold* **1105** has been left.

NOTE:

Parameter *Warning Application* **273** shows the Application Warnings independent from the created Warning mask.
In the error environment, *Application Warning Status* **367** shows the current warnings of the positioning functions independent from the created Warning mask.

The current warning mask can be read via parameter *Actual Appl. Warning Mask* **627**. The operation modes of parameter *Create Appl. Warning Mask* **626** are encoded in *Actual Appl. Warning Mask* **627**. If several warnings are combined, the code can be calculated from the hexadecimal addition of the individual warnings and the corresponding code.

Warning code			*Create Warning Mask Application* 626
A	FFFF	-	2 - Activate all Warnings
A	0002	SW-LIM CW	11 - Warning pos. SW limit switch
A	0004	SW-LIM CCW	12 - Warning neg. SW limit switch
A	0008	HW-LIM CW	13 - Warning pos. HW limit switch
A	0010	HW-LIM CCW	14 - Warning neg. HW limit switch
A	0020	CONT	15 - Warning position controller

Example:

Warning codes A0002 SW-LIM CW + A0004 SW-LIM CCW
= Warning code A0006 SW-LIM CW SW-LIM CCW
The individual warning messages and the configured warning mask are available as operation modes for the digital outputs:

Digital signal	Function
26 - Application Warning	All warnings application are deactivated.
27 - Warning Mask, Application	All warnings of Warning Mask, Application are activated.
28 - Warning, gen. + Warning, Application	All warnings and application warnings are deactivated.
29 - Warn. Mask, gen. + Warn. Mask, Appl.	All warnings of warning mask and all warnings of application warning mask are activated.
126 - Inv. Warning Application	Operation mode 26 inverted
127 - Inv. Warning Mask Application	Operation mode 27 inverted
128 - Inv. Warning, gen. + Warning, Application	Operation mode 28 inverted
129 - Inv. Warn. Mask, gen + Warn.	Operation mode 29 inverted

Additionally, logic signals "215 – Application Warning Mask" and "216 – Application Warning" can be used as sources for logic functions.
If an application warning is present, "A8000 Warn2" is displayed additionally via parameter *Warnings* **269**.

5.10 Speed Override

The positioning function uses the parameterized speeds of the individual motion blocks.
Alternatively, the positioning speed can be defined via an external reference value source. For this purpose, the *Speed Override* **1236** function is enabled. The set values can be changed during operation dynamically, e.g. by a potentiometer on an analog input. The speed override function does not affect the ramps set for acceleration and deceleration. The function can be used, for example, for commissioning, maintenance or in setup mode.
The signal source for adjusting the speed (e.g. analog multi-function input or fixed percentage) is done via parameter *Reference Value Source* **476**.

Speed Override 1236	Function
0 - Off	**Factory setting**. Speed override disabled. Motion blocks are processed at parameterized speeds.
1 - On	Speed override enabled. The speeds in the motion blocks are set via the selected signal source.

The function does not change the speed in settings 10 to 24 (gearing) for parameter *Motion Mode* **1208**. The master speed is still applied. The function has to be activated on the master drive.

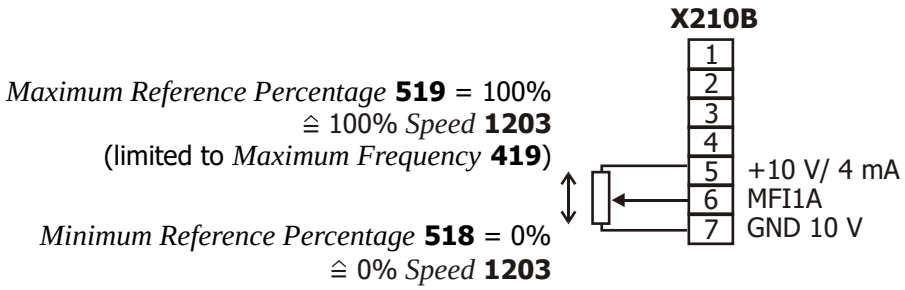
Note: The travel speed is limited by the *Maximum frequency* **419**. The range (limits for change of travel speed) is defined by *Min. Reference Percentage* **518** and *Max. Reference Percentage* **519**.

Note: When Scaling the percentage value, always the absolute value is derived. A change of direction with negative percentage reference values is therefore **not possible**.

Example: The travel speed is controlled from 0 … 100% (0 … 10 V) via a reference value potentiometer on multifunction input MFI1A. The percentages refer to the speed values set in the motion blocks.

- Power supply for reference value potentiometer via terminal X210B.5, ground to terminal X210B.7
- Reference value from potentiometer via multifunction input MFI1A, terminal X210B.6
- Multifunction input 1: Parameter *Operation mode* **452 =** "1 – Voltage Input"
- Reference value via reference value channel: Parameter *Reference Percentage Source* **476** = "1 - Abs. Analog Value MFI1A"
- Parameter *Minimum Reference Percentage* **518** = 0.00% (factory setting)
- Parameter *Maximum Reference Percentage* **519** = 100.00% (factory setting)
- Parameter *Speed Override* **1236** = "1 - On"

Actual value parameter *Reference Percentage* **229** shows the specified travel speed percentage.



5.11 Position Comparator

The position comparator compares the current position and the specified positions. It checks if the actual position is within the specified range (defined by on and off positions). Via the comparator, logic functions can be controlled or activated, depending on the current position value.

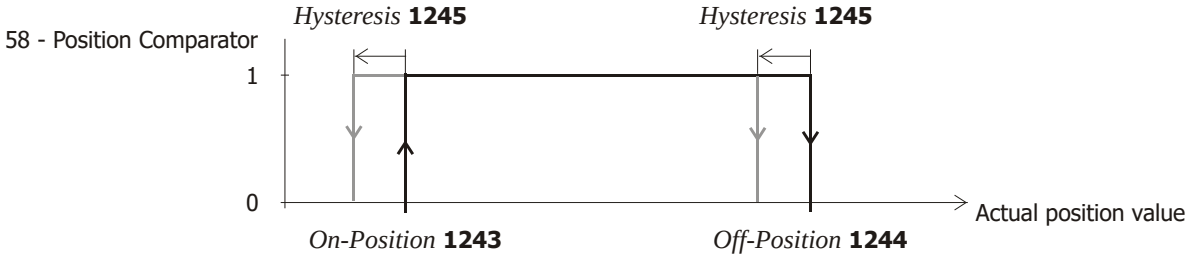
The following signals are set if the current value is in the range between the *On-Position* **1243** and the *Off-Position* **1244**:

- "58 – Position Comparator" and "158 - Inv. Position Comparator" for digital outputs
- "876 – Position Comparator Out" and "877 - Position Comparator Out inverted" for logic functions

Parameter *Hysteresis* **1245** prevents non-defined switching states when the system has stopped exactly at a switching position. In this case, the output is reset if the current position is smaller than the "on position minus hysteresis" or greater than the "off position plus hysteresis".

Actual position				Signal source 58 [1]	Signal source 158 [2]
	Actual position	<	On-position - hysteresis	0	1
On-Position - Hysteresis	<	Actual position	< On-position	last value	
On-Position	<	Actual position	< Off-position	1	0
Off-Position	<	Actual position	< Off-position + hysteresis	last value	
Off-Position + Hysteresis	<	Actual position		0	1

[1] 58 – Position Comparator
[2] 158 – Inv. Position Comparator

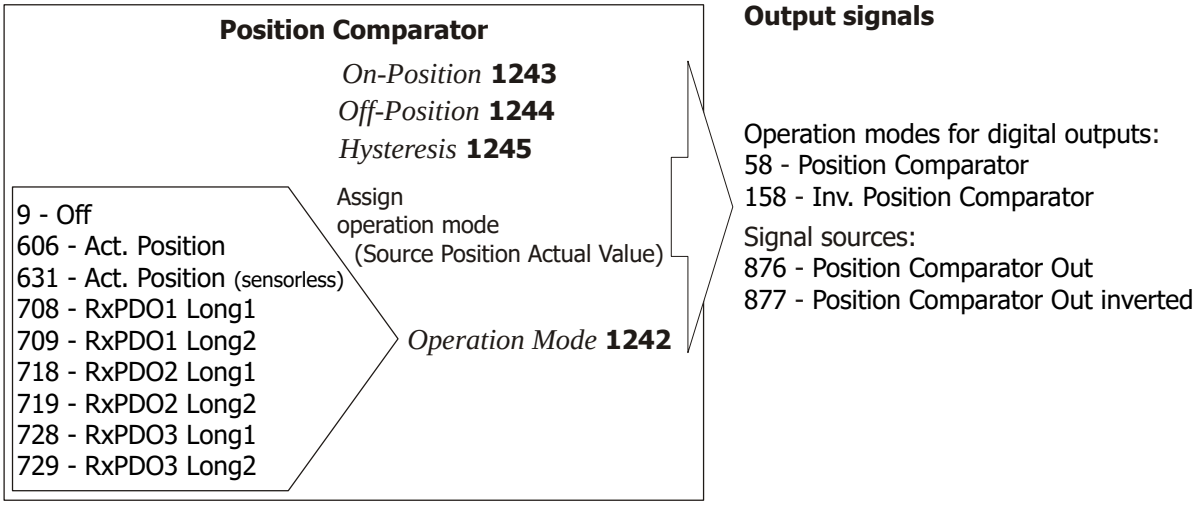


Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Fact. sett.**
1243	On-Position	-2^{31} u	$2^{31}-1$ u	0 u
1244	Off-Position	-2^{31} u	$2^{31}-1$ u	65 536 u
1245	Hysteresis	0 u	$2^{31}-1$ u	182 u

The position comparator is active only if *On-Position* **1243** < *Off-Position* **1244**. If *On-Position* **1243** ≥ *Off-Position* **1244**, the position comparator will continuously signal "0".
Via parameter *Operation Mode* **1242**, you can define the source for the actual position to be processed by the comparator.

Operation mode **1242**		Function
9 -	Off	Comparator is switched off.
606 -	Actual position	Current position value is processed by comparator.
631 -	Sensorless Act. Position	Current position is processed by comparator (for *Configuration* **30** = 340, 440, 640)
708 -	RxPDO1 Long1 [1)]	Actual position received via system bus is processed by comparator.
709 -	RxPDO1 Long2 [1)]	
718 -	RxPDO2 Long1 [1)]	
719 -	RxPDO2 Long2 [1)]	
728 -	RxPDO3 Long1 [1)]	
729 -	RxPDO3 Long2 [1)]	

[1)] Set corresponding TxPDO Long to "606 – Act. Position".



5.12 Rotary Table Application

A rotary table is a round axis with unlimited travel range. No limit switch required.

Unlimited travel ranges.

Via parameter *Operation Mode* **1240**, the type of motion to the target position is defined. The direction of rotation and way optimization (shortest way) can be specified.

Operation mode **1240**		Function
0 -	Off	Round table positioning switched off.
1 -	On	Round table positioning switched on. Direction of rotation depends on parameterized target position. Motion is always performed such that 0° will not be passed. Maximum travel range is always smaller than one rotation.
2 -	On / Optimized (shortest way)	Shortest way to target position is taken. Relative motions are not optimized; motion blocks must be configured accordingly.
3 -	On / Clockwise Rotation	Motion is performed in clockwise (positive) direction (absolute positioning). Negative direction is disabled for absolute positioning.

4 -	On / Anticlock-wise Rotation	Motion is performed in anticlockwise (negative) direction (absolute positioning). Positive direction is disabled for absolute positioning.

NOTE: Settings of parameter *Operation Mode* **1240** only affect the direction of rotation in the case of absolute positioning operations (parameter *Motion Mode* **1208**). Relative positioning operations are not optimized; direction of rotation depends on the settings of parameter *Target Position/Distance* **1202** in the motion blocks.

Parameter *Units per Revolution* **1241** must be set to the units per revolution. This setting represents the distance covered per revolution.

Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Fact. sett.**
1241	Units Per Revolution	1 u	2^{31}-1 u	65 536 u

NOTE: The reference system must be set up via parameters *Feed Constant* **1115**, *Gear Box: Driving shaft revolutions* **1116** and *Gear Box: Motor shaft revolutions* **1117** (Chapter "Reference system").
Use exact gear transmission factors. The exact gear transmission factor can be calculated from the number of teeth of the individual gearwheels. Do not use rounded values, because this may result in a drift (deviation between the actual position and the required position).

Example: Definition of units as degrees (°), setup of reference system (*Feed Constant* **1115**), Feed Constant = 3600 for resolution of 0.1°; revolution distance = 3600 u

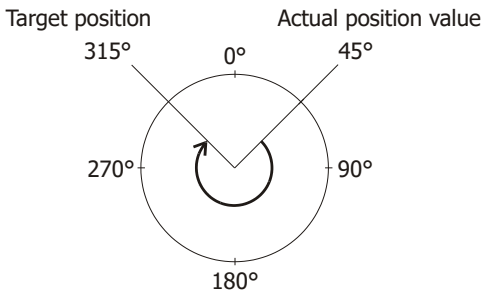
NOTE: In order to limit the travel range of a rotary table, it can be configured as a linear axis. Linear movements can be effected via a round axis, e.g. in the case of a belt conveyor.

Examples for settings of parameter *Operation Mode* 1240:

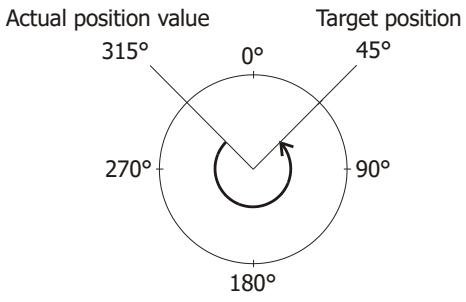
Example: Operation Mode "1 - On", for absolute and relative positioning

	Current position	Target position	Direction of rotation
Example 1	45°	315°	clockwise (positive); target position > act. position
Example 2	315°	45°	anticlockwise (negative); target position < act. position

Example 1



Example 2



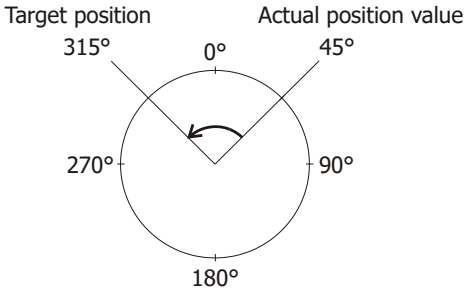
Direction of rotation depends on values for target position in motion blocks.

Angle 0° is not passed.

Example: Operation Mode "2 – On /Optimized (shortest way)" compared to Operation Mode "3 – On /Clockwise Rotation" (not optimized)

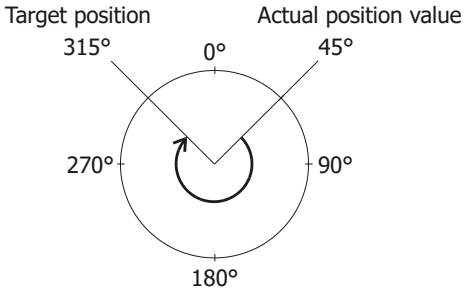
	Current position	Target position	Direction of rotation
Operation mode 2	45°	315°	anticlockwise (negative); optimized
Operation mode 3	45°	315°	clockwise (positive)

Operation mode 2



Direction is optimized.

Operation mode 3

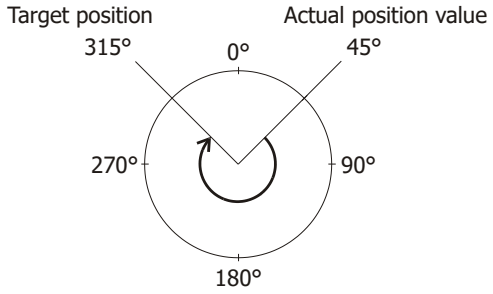


Direction of rotation is defined by operation mode.

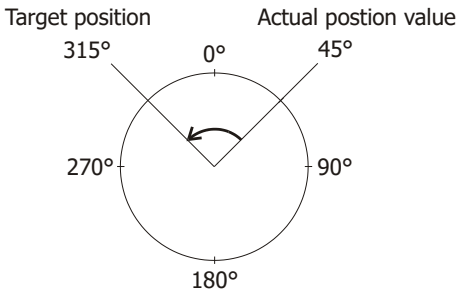
Example: Operation modes "3 – On /Clockwise Rotation" and 4 – "On / Anticlockwise Rotation"

	Current position	Target position	Direction of rotation
Operation mode 3	45°	315°	clockwise (positive)
Operation mode 4	45°	315°	anticlockwise (negative)

Operation mode 3



Operation mode 4



Direction of rotation is defined by operation mode.

5.13 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 parameter *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.

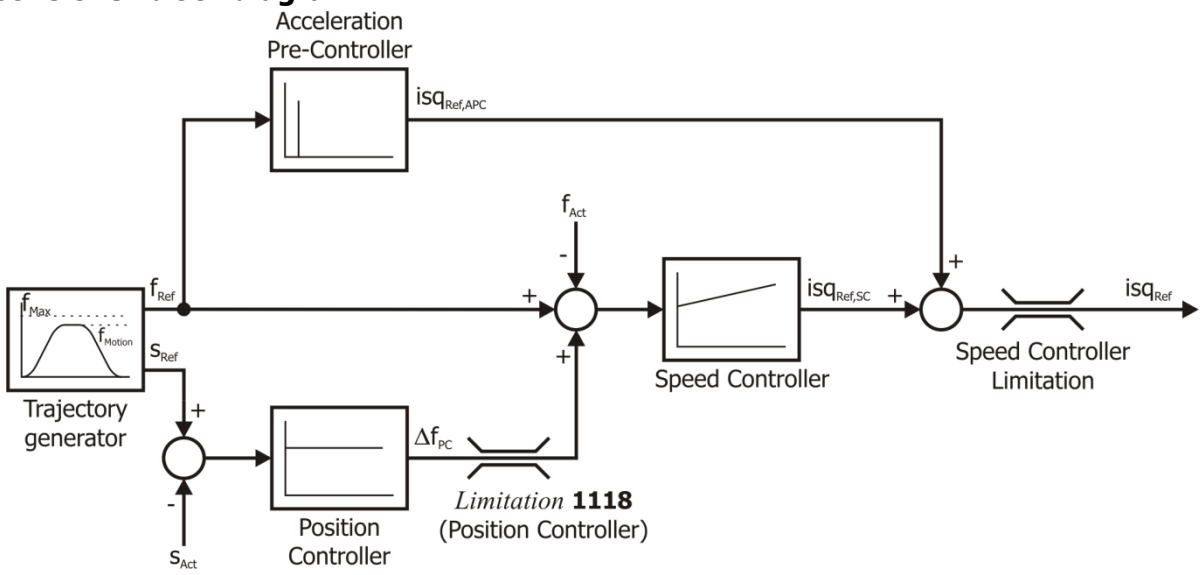
ATTENTION!	The Output of the Position Controller is not limited by *Maximum frequency* **419**. *Maximum frequency* **419** limits the value of the Motion Profile generation. Due to the addition of the Profile generator reference speed and the output of the Position Controller, higher frequencies than *Maximum frequency* **419** can occur. *Maximum frequency* **419** and *Limitation* **1118** must be set to appropriate values during the commissioning. Chapter 10.2 contains conversion formulas between Hz and u/s. Manufacturer recommends: • Set *Maximum frequency* **419** to 90 % of the mechanical rated speed and • the *Limitation* **1118** of the Position Controller to the value corresponding to 10 % of the Maximum frequency.

Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Fact. sett.**
1104	Time Constant	0.00 ms	300.00 ms	10.00 ms [1] 100.00 ms [2]
1118	Limitation	0 u/s	2^{31}-1 u/s	327 680 u/s

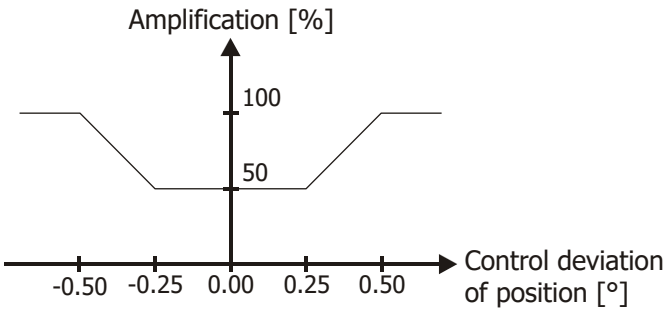
[1] Factory setting for selection *Configuration* **30** = 240 or 540
[2] Factory setting for selection *Configuration* **30** = 340, 440 or 640

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

Controller block diagram



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



The following 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 pilot control, refer to the operating instructions of the frequency inverter.

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

5.14 Store the actual position value (latching function)

With the latching function the actual position value of the drive can be stored. With a rising or falling signal edge at digital input S2IND the actual position value is stored in the EEPROM and displayed via *Latched Position* **1281**.
Parameter *Operation Mode* **1280** allows to set the storing of actual position value to rising or falling signal edge.

Operation Mode **1280**		**Function**
0 -	Off	The Latching function is switched off.
1 -	S2IND Rising Edge	With a rising signal edge at digital input S2IND the actual position value is stored in the EEPROM and displayed via *Latched Position* **1281**.
2 -	S2IND Falling Edge	With a falling signal edge at digital input S2IND the actual position value is stored in the EEPROM and displayed via *Latched Position* **1281**.

The latched position is available as signal source:

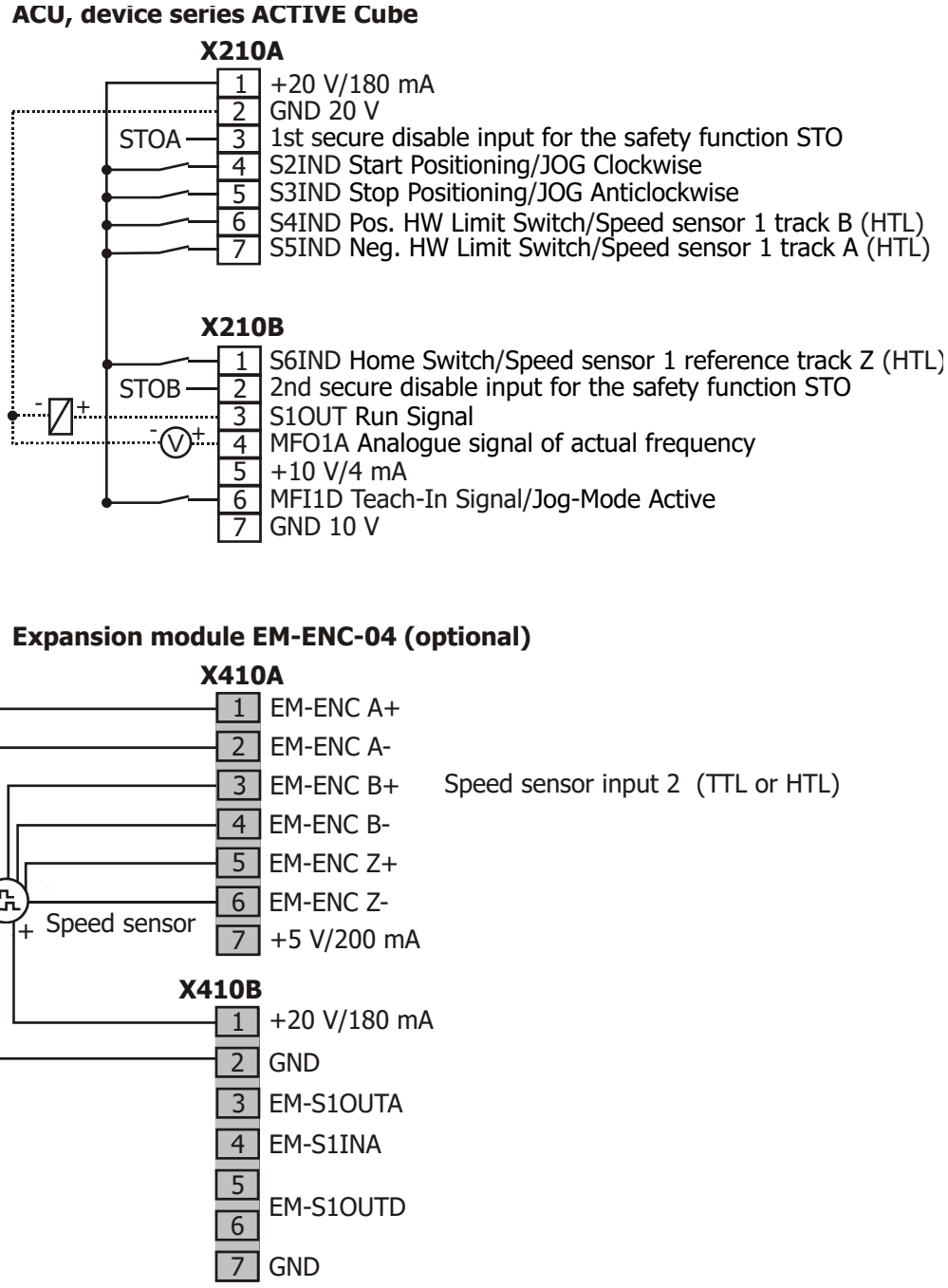
- Source "617 - Latched Position", for example as actual position value for the position comparator
- Source "617 - Latched Position" for transmission via systembus (TxPDO Long) in internal format
- Source "618 - Latched Position (User-Units)" for transmission via systembus (TxPDO Long) in user units
- Source "1028 (in user units) … 1031 (in user units * 1000) for the scope function

The latched position is stored in the internal EEPROM during mains switch-off or mains failure. This enables resuming of interrupted movements.

NOTE:	The function is permanently linked to digital input S2IND, parameterization on another digital input is not possible.

Consider the assignment of the digital input S2IND to other functions (for example to *Start Positioning* **1222**) for the usage of the latching function. If applicable change the parameter assignment and wiring.

5.15 Wiring Example



In configuration 240 S4IND (X210A.6) and S5IND (X210A.7) are parameterized by default as inputs for Encoder 1. Via S6IND (X210B.1), the zero track of a HTL encoder can be evaluated. Alternatively, the inputs of an optional extension module EM-ENC can be used as encoder inputs. In this case, inputs S4IND and S5IND must be parameterized for a changed assignment of functions.

In configuration 540, evaluation of Encoder 1 (parameter *Operation Mode* **490**) is disabled by default, parameter *Act. Speed Source* **766** is not available. Digital inputs S4IND (X210A.6) and S5IND (X210A.7) can be used as inputs for HW limit switches.

Configuration 540 enables evaluation of resolvers and requires an optional expansion module EM-RES.

Parameters for inputs:

Parameter		Setting/Selection		
30	Configuration	240	340, 440, 540, 640	
490	Operation Mode speed sensor 1	1 … 1132	0 - Off	
766	Act. Speed Source	1 - Speed sensor 1 or 2 - Speed sensor 2 [1]	[2]	
1222	Start Positioning	71 - S2IND ❶		
1232	Jog Clockwise	71 - S2IND		
1223	Stop Positionierung	72 - S3IND ❷		
1233	Jog Anticlockwise	72 - S3IND		
			Fact. set.	Setting
1138	Positive HW Limit Switch	7 - Off	7 - Off	e.g. 540
1137	Negative HW Limit Switch	7 - Off	7 - Off	e.g. 541
1139	Home Switch	75 - S6IND		
1239	Teach-In-Signal	76 - MFI1D ❸		
1231	Jog-Mode Active	76 - MFI1D		

[1] Only available in combination with extension module, e.g. EM-ENC/EM-RES.

[2] Configuration 340, 440, 540, 640 requires an extension module EM-RES for evaluation of the resolver on the synchronous motor, is wired to this source internally and cannot be changed. Configuration 340, 440, 640 uses internal operands.

❶ Digital input S2IND has function "JOG Clockwise":

- If HIGH signal is present on MFI1D. MFI1D is assigned to parameter *Jog-Mode Active* **1231** (factory settings).
- Automatically by setting parameter *Operation Mode* **1221** to:
  "301 - Teach-In, Motion Block Sel. via Digital Inputs" or
  "302 - Teach-In, Motion Block Sel. via P. 1228".

❷ Digital input S3IND has function "JOG Anticlockwise":

- If HIGH signal is present on MFI1D. MFI1D is assigned to parameter *Jog-Mode Active* **1231** (factory settings).
- Automatically by setting parameter *Operation Mode* **1221** to:
  "301 - Teach-In, Motion Block Sel. via Digital Inputs" or
  "302 - Teach-In, Motion Block Sel. via P. 1228".

❸ JOG mode is switched on automatically by setting parameter *Operation Mode* **1221** to:

- "301 - Teach-In, Motion Block Sel. via Digital Inputs" or
- "302 - Teach-In, Motion Block Sel. via P. 1228".

Digital input MFI1D is provided for connection of a teach-in signal in these settings (for saving current position as target position in motion block). In these settings, JOG mode does not have to be switched on separately via digital input MFI1D (parameter *Jog-Mode Active* **1231**). For all other settings of parameter *Operation Mode* **1221**, digital input MFI1D is provided for activation of JOG mode.

6 List of homing modes

In the following sections, the homing modes are explained in detail. The sections are organized as follows:

- 6.1 Brief description
- 6.2 Overview table
- 6.3 Graphical overview
- 6.5 Detailed explanations

The graphic overview and overview table are recommended for experienced users who are already familiar with the functions of the different homing types. With these overviews, the correct mode for the application can be selected quickly. For a detailed functional description, refer to section 6.5.

6.1 Brief Description Homing

For parameter *Homing Mode* **1130** the following operation modes are available:

Homing Mode **1130**		**Function**
0 -	No Homing	**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 & Ref. - Signal	Homing to negative HW limit switch with detection of encoder ref. signal.
2 -	Pos. Limit Switch & Ref. - Signal	Homing to positive HW limit switch with detection of encoder ref. signal.
3 -	Pos. Home-Sw., Ref.-Signal left of Edge	Homing to positive home switch with detection of encoder ref. signal. Home position is the first encoder ref. signal to the left of the edge of the home switch signal.
4 -	Pos. Home-Sw., Ref.-Signal right of Edge	Homing to positive home switch with detection of encoder ref. signal. Home position is the first encoder ref. signal to the right of the edge of the home switch signal.
5 -	Neg. Home-Sw., Ref.-Signal right of Edge	Homing to negative home switch with detection of encoder ref. signal. Home position is the first encoder ref. signal to the right of the edge of the home switch signal.
6 -	Neg. Home-Sw.: Ref.-Signal left of Edge	Homing to negative home switch with detection of encoder ref. signal. Home position is the first encoder ref. signal to the left of the edge of the home switch signal.
7 -	Pos. Lim.-Sw., Ref.-Sig. left of left Edge of Home-Sw.	Homing to home switch with detection of encoder ref. signal. Homing direction positive (clockwise). Reversal of direction of rotation when positive HW limit switch is reached. Home position is the first encoder ref. signal to the left or right of the left or right edge of the home switch signal.
8 -	Pos. Lim.-Sw., Ref.-Sig. right of left Edge of Home-Sw.	
9 -	Pos. Lim.-Sw., Ref.-Sig. left of right Edge of Home-Sw.	
10 -	Pos. Lim.-Sw., Ref.-Sig. right of right Edge of Home-Sw.	

Homing Mode **1130**		**Function**
11 -	Neg. Lim.-Sw., Ref.-Sig. right of right Edge of Home-Sw.	Homing to home switch with detection of encoder ref. signal. Homing direction negative (anticlockwise). Reversal of direction of rotation when negative HW limit switch is reached. Home position is the first encoder ref. signal to the left or right of the left or right edge of the home switch signal.
12 -	Neg. Lim.-Sw., Ref.-Sig. left of right Edge of Home-Sw.	
13 -	Neg. Lim.-Sw., Ref.-Sig. right of left Edge of Home-Sw.	

14 -	Neg. Lim.-Sw., Ref.-Sig. left of left Edge of Home-Sw.	

17 … 30: like 1 … 14, but without encoder ref. signal		
17 -	Neg. Limit Switch	Homing to negative HW limit switch.
18 -	Pos. Limit Switch	Homing to positive HW limit switch.
19 -	Pos. Home-Sw., left of Edge	Homing to positive home switch. Home position is at the left of the edge of the home switch signal.
20 -	Pos. Home-Sw., right of Edge	Homing to positive home switch. Home position is at the right of the edge of the home switch signal.
21 -	Neg. Home-Sw., right of Edge	Homing to negative home switch. Home position is at the right of the edge of the home switch signal.
22 -	Neg. Home-Sw., left of Edge	Homing to negative home switch. Home position is at the left of the edge of the home switch signal.
23 -	Pos. Lim.-Sw., left of left Edge of Home-Sw.	Homing to home switch. Homing direction positive (clockwise). Reversal of direction of rotation when positive HW limit switch is reached. Home position is at the left or right of the left or right edge of the home switch signal.
24 -	Pos. Lim.-Sw., right of left Edge of Home-Sw.	
25 -	Pos. Lim.-Sw., left of right Edge of Home-Sw.	
26 -	Pos. Lim.-Sw., right of right Edge of Home-Sw.	
27 -	Neg. Lim.-Sw., right of right Edge of Home-Sw.	Homing to home switch. Homing direction negative (anticlockwise). Reversal of direction of rotation when negative HW limit switch is reached. Home position is at the left or right of the left or right edge of the home switch signal.
28 -	Neg. Lim.-Sw., left of right Edge of Home-Sw.	
29 -	Neg. Lim.-Sw., right of left Edge of Home-Sw.	
30 -	Neg. Lim.-Sw., left of left Edge of Home-Sw.	

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

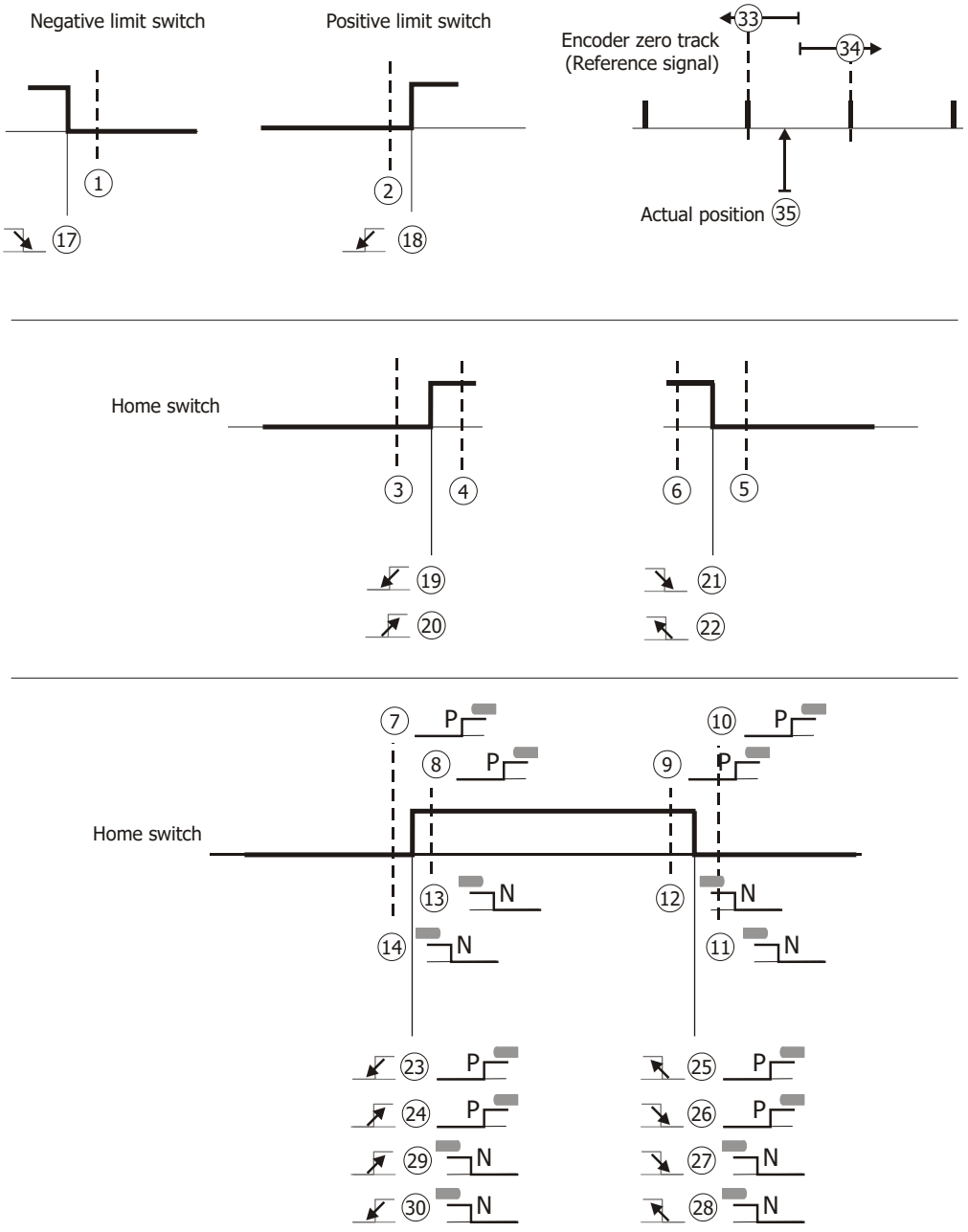
6.2 Overview Table of Homing Types

The following table provides an overview of which position is approached and which limit switch is used for reversal of the direction of rotation.

No.	Main destination		Fine destination (Ref. signal)	Limit Switch ?
1	Left	limit switch	Ref. signal right	Left limit switch
2	Right		Ref. signal left	Right limit switch
3	Negative	home switch	Ref. signal left	Without limit switch
4			Ref. signal right	
5	Positive		Ref. signal right	
6			Ref. signal left	
7	Left edge	home switch	Ref. signal left	Right limit switch
8			Ref. signal right	
9	Right edge		Ref. signal left	
10			Ref. signal right	
11	Right edge		Ref. signal right	Left limit switch
12			Ref. signal left	
13	Left edge		Ref. signal right	
14			Ref. signal left	
15	*Reserved*			
16	*Reserved*			
17	Left	limit switch	Falling edge	Left limit switch
18	Right		Falling edge	Right limit switch
19	Negative	home switch	Falling edge	Without limit switch
20			Rising edge	
21	Positive		Falling edge	
22			Rising edge	
23	Left edge	home switch	Falling edge	Right limit switch
24			Rising edge	
25	Right edge		Rising edge	
26			Falling edge	
27	Right edge		Falling edge	Left limit switch
28			Rising edge	
29	Left edge		Rising edge	
30			Falling edge	
31	*Reserved*			
32	*Reserved*			
33	Left	ref. signal		
34	Right			
35	Current	position		

NOTE:	Homing types 17 to 30 do not evaluate any encoder ref. signal.

6.3 Graphic Overview of Homing Modes



	Zero track left or right of edge	1	Number of homing mode
	Destination approached from **left** upon **rising** edge. When coming from the right, direction is reversed when passing the edge.		
	Destination approached from **right** upon **falling** edge. When coming from the left, direction is reversed when passing the edge.		
	Destination approached from **right** upon **rising** edge. When coming from the left, direction is reversed when passing the edge.		
	Destination approached from **left** upon **falling** edge. When coming from the right, direction is reversed when passing the edge.		
P	Positive hardware limit switch is used for reversal of direction of rotation.		
N	Negative hardware limit switch is used for reversal of direction of rotation.		

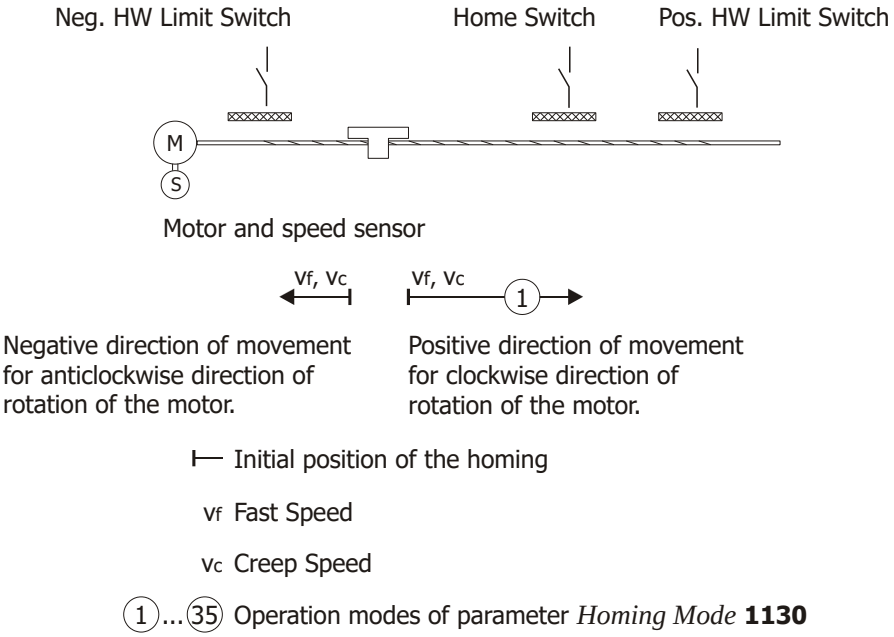
6.4 Terminology

To enable a better understanding of the homing modes, the terms used are explained in the following.

	Home switch	active = 1	"High" signal is present
		inactive = 0	"Low" signal is present
		not used	In this homing mode, no home switch is used
	Limit switch		Travel limit.
	Hardware limit switches		Travel limit. Design: Initiators connected to digital inputs.
	Software limit switches		Travel limit, managed centrally in frequency inverter. Only active after homing. Software limit switches stop the travel operation before the hardware limit switches as an additional safety function.
	Ref. signal		Pulse which occurs once every encoder rotation. Increases homing accuracy.
	Direction of rotation reversal		The search direction is changed when a status change (e.g. "limit switch reached") has occurred. This indicates that the home position is in opposite direction.
	Search direction	Positive direction	Motor turns in positive direction (clockwise when looking at shaft).
		Negative direction	Motor turns in negative direction (anticlockwise when looking at shaft).
	Edge	Rising edge	Status change of a signal from "0" to "1".
		Falling edge	Status change of a signal from "1" to "0".
		Left edge	Status change of a signal from "1" to "0" or "0" to "1" in the case of a cam on the left side.
		Right edge	Status change of a signal from "1" to "0" or "0" to "1" in the case of a cam on the right side.
	Speed	Fast speed	High speed at which the target is searched at the beginning.
		Creep speed	Low speed at which the target is approached exactly.

6.5 Description of Homing Modes

Application example setup:



The homing modes are described in tables, graphically and in texts. The terms and symbols are used uniformly.

In some homing modes, a limit switch is used for reversing the direction of rotation. This is either the positive or the negative limit switch. If the limit switch selected is actuated, the direction of rotation is reversed. In some cases, this also causes a speed change. If the other (non-selected) limit switch is actuated, the corresponding error message is triggered).

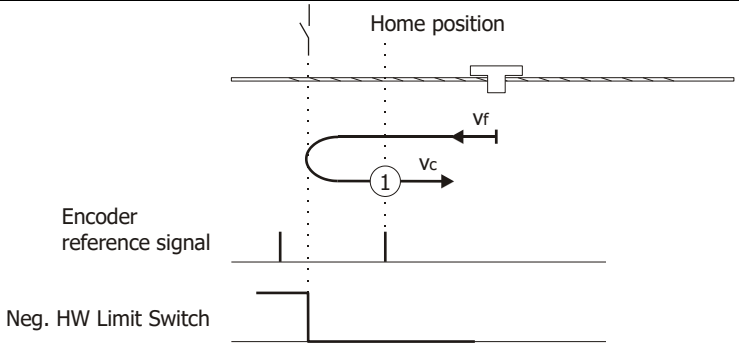
NOTE:	The manufacturer recommends that wire break proof limit switches be used ("0 - active").

NOTE:	The homing types are based on the CANopen specification DSP 4.02.

6.5.1 Homing Modes with Ref. Signal

Operation mode 1: Homing to negative limit switch with detection of encoder ref. signal

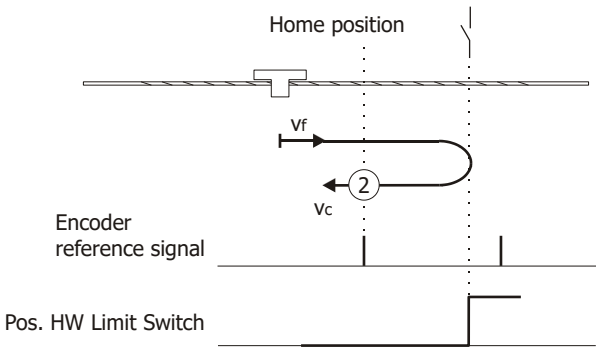
Dest.:	Ref. signal to the right of negative limit switch	
	Home switch not used	
	Search direction	Negative direction
	Speed (before reversal of direction of rotation)	*Fast Speed* **1132**
	Condition reversal of direction of rotation	Rising edge negative limit switch
	Speed (after reversal of direction of rotation)	*Creep Speed* **1133**



The homing direction (search direction) is negative at *Fast Speed* **1132**. When the limit switch is reached, the direction of rotation is reversed and homing is performed at *Creep Speed* **1133**. The home position is the first encoder ref. signal after the falling edge of the limit switch when traveling in positive direction (clockwise).

Operation mode 2: Homing to positive limit switch with detection of encoder ref. signal

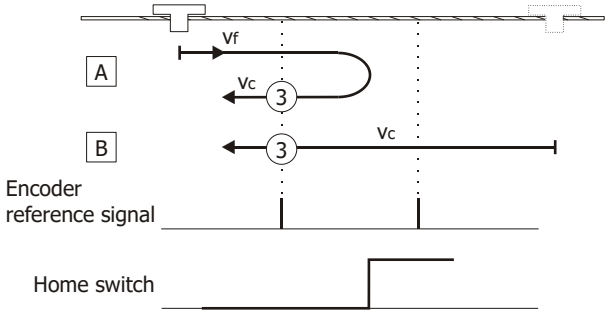
Dest.:	Ref. signal to the left of positive limit switch	
	Home switch not used	
	Search direction	Positive direction
	Speed (before reversal of direction of rotation)	*Fast Speed* **1132**
	Condition reversal of direction of rotation	Rising edge positive limit switch
	Speed (after reversal of direction of rotation)	*Creep Speed* **1133**



The homing direction (search direction) is positive at *Fast Speed* **1132**. When the limit switch is reached, the direction of rotation is reversed and homing is performed at *Creep Speed* **1133**. The home position is the first encoder ref. signal after the falling edge of the limit switch when traveling in negative direction (anticlockwise).

Operation mode 3: Homing to positive home switch with detection of encoder ref. signal, home position is the first ref. signal after the home switch signal has changed

Dest.:	Ref. signal to left of left edge of positive home switch	
A	Home switch inactive	0
	Search direction	Positive direction
	Speed (before reversal of direction of rotation)	*Fast Speed* 1132
	Condition reversal of direction of rotation	Rising edge home switch
	Speed (after reversal of direction of rotation)	*Creep Speed* 1133
B	Home switch active	1
	Search direction	Negative direction
	Speed	*Creep Speed* 1133

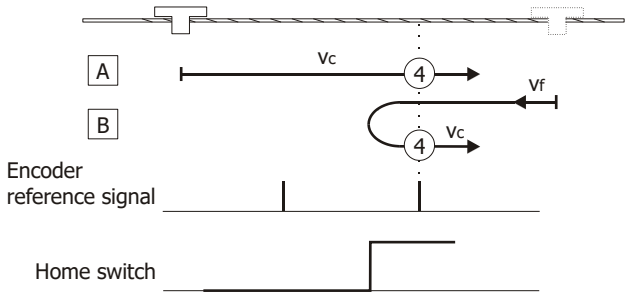


The homing direction (search direction) depends on the signal status of the home switch.
A: Homing direction is positive if the home switch is inactive. Travel to home switch is performed at *Fast Speed* **1132**. When the home switch is reached, the direction of rotation is reversed. Home position is the first encoder ref. signal after the falling edge of the home switch signal. Search for the home position is performed at *Creep Speed* **1133**.

B: Homing direction is negative if the home switch is active. Home position is the first encoder ref. signal after the status change of the home switch signal. Search for the home position is performed at *Creep Speed* **1133**.

Operation mode 4: Homing to positive home switch with detection of encoder ref. signal, home position is the first ref. signal after the home switch signal has changed

Dest.:	Ref. signal to right of left edge of positive home switch	
A	Home switch inactive	0
	Search direction	Positive direction
	Speed	*Creep Speed* 1133
B	Home switch active	1
	Search direction	Negative direction
	Speed (before reversal of direction of rotation)	*Fast Speed* 1132
	Condition reversal of direction of rotation	Falling edge home switch
	Speed (after reversal of direction of rotation)	*Creep Speed* 1133



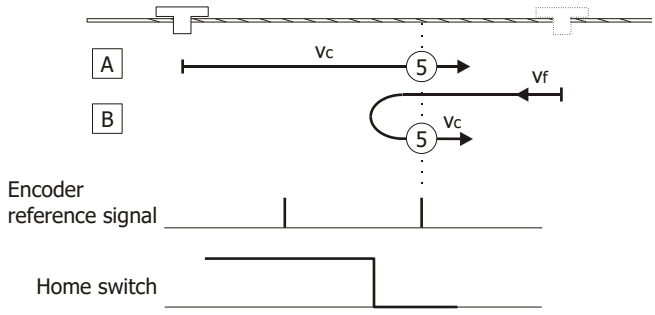
The homing direction (search direction) depends on the signal status of the home switch.

A: Homing direction is positive if the home switch is inactive. Home position is the first encoder ref. signal after the home switch is reached. Search for the home position is performed at *Creep Speed* **1133**.

B: Homing direction is negative if the home switch is active. Travel to falling edge of home switch is performed at *Fast Speed* **1132**. When the home switch is passed, the direction of rotation is reversed. Home position is the first encoder ref. signal after the rising edge of the home switch signal. Search for the home position is performed at *Creep Speed* **1133**.

Operation mode 5: Homing to negative home switch with detection of encoder ref. signal, home position is the first ref. signal after the home switch signal has changed

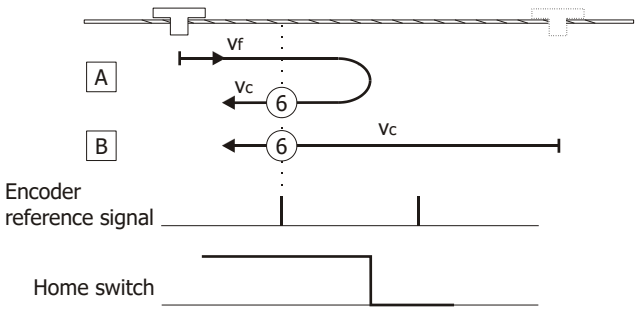
Dest.:	Ref. signal to right of left edge of negative home switch	
A	Home switch active	1
	Search direction	Positive direction
	Speed	*Creep Speed* 1133
B	Home switch inactive	0
	Search direction	Negative direction
	Speed (before reversal of direction of rotation)	*Fast Speed* 1132
	Condition reversal of direction of rotation	Rising edge home switch
	Speed (after reversal of direction of rotation)	*Creep Speed* 1133



The homing direction (search direction) depends on the signal status of the home switch.
A: Homing direction is positive if the home switch is active. Home position is the first encoder ref. signal after the falling edge of the home switch signal. Search for the home position is performed at *Creep Speed* **1133**.
B: Homing direction is negative if the home switch is inactive. Travel to home switch is performed at *Fast Speed* **1132**. When the home switch is reached, the direction of rotation is reversed. Home position is the first encoder ref. signal after the falling edge of the home switch signal. Search for the home position is performed at *Creep Speed* **1133**.

Operation mode 6: Homing to negative home switch with detection of encoder ref. signal, home position is the first ref. signal after the home switch signal has changed

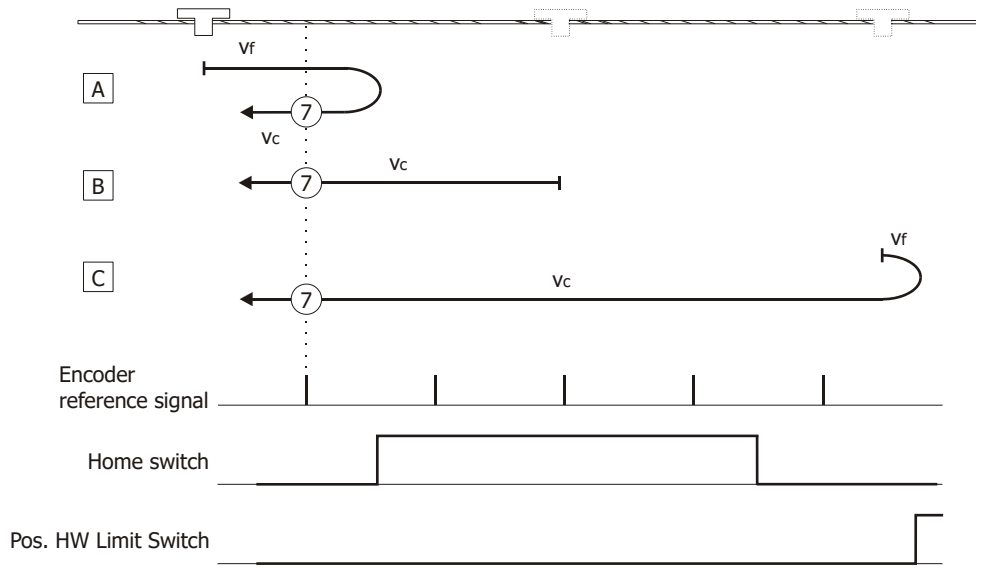
Dest.:	Ref. signal to left of right edge of negative home switch	
A	Home switch active	1
	Search direction	Positive direction
	Speed (before reversal of direction of rotation)	*Fast Speed* 1132
	Condition reversal of direction of rotation	Falling edge home switch
	Speed (after reversal of direction of rotation)	*Creep Speed* 1133
B	Home switch inactive	0
	Search direction	Negative direction
	Speed	*Creep Speed* 1133



The homing direction (search direction) depends on the signal status of the home switch.
A: Homing direction is positive if the home switch is active. Travel to falling edge of home switch is performed at *Fast Speed* **1132**. When the home switch is passed, the direction of rotation is reversed. Home position is the first encoder ref. signal after the rising edge of the home switch signal. Search for the home position is performed at *Creep Speed* **1133**.
B: Homing direction is negative if the home switch is inactive. Home position is the first encoder ref. signal after the rising edge of the home switch signal. Search for the home position is performed at *Creep Speed* **1133**.

Operation mode 7: 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

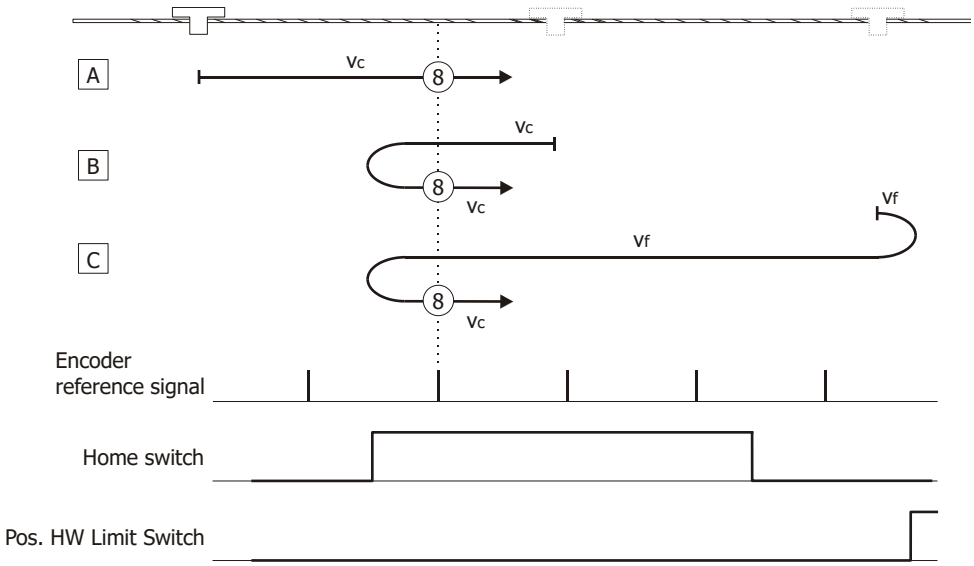
Dest.:	Ref. signal to left of left edge of home switch	
A	Home switch inactive	0
	Search direction	Positive direction
	Speed (before reversal of direction of rotation)	*Fast Speed* 1132
	Condition reversal of direction of rotation	Rising edge home switch
	Speed (after reversal of direction of rotation)	*Creep Speed* 1133
B	Home switch active	1
	Search direction	Negative direction
	Speed	*Creep Speed* 1133
C	Home switch inactive	0
	Search direction	Positive direction
	Speed (before reversal of direction of rotation)	*Fast Speed* 1132
	Condition reversal of direction of rotation	Rising edge positive HW limit switch
	Speed (after reversal of direction of rotation)	*Fast Speed* 1132
	Condition speed change	Rising edge home switch
	Speed (after speed change)	*Creep Speed* 1133



The homing direction (search direction) depends on the signal status of the home switch.
A: Homing direction (search direction) is clockwise toward positive HW limit switch if home switch and limit switch are inactive. The home switch is in search direction. Travel to rising edge of home switch is performed at *Fast Speed* **1132**. When the home switch is reached, the direction of rotation is reversed. Home position is the first encoder ref. signal after the falling edge of the home switch signal. Search for the home position is performed at *Creep Speed* **1133**.
B: When homing is started, the home switch is active. Homing direction (search direction) is anticlockwise toward negative HW limit switch. Home position is the first encoder ref. signal after the home switch is passed in negative direction. Search for the home position is performed at *Creep Speed* **1133**.
C: Homing direction (search direction) is clockwise toward positive HW limit switch. The home switch is not in search direction. The positive limit switch acts as a reversing switch. When the positive limit switch is reached, the direction of rotation is reversed, and homing is performed in negative direction. Travel to rising edge of home switch is performed at *Fast Speed* **1132**. Home position is the first encoder ref. signal after the home switch is passed. Search for the home position is performed at *Creep Speed* **1133**.

Operation mode 8: 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

Dest.:	Ref. signal to right of left edge of home switch	
A	Home switch inactive	0
	Search direction	Positive direction
	Speed	*Fast Speed* 1132
B	Home switch active	1
	Search direction	Negative direction
	Speed (before reversal of direction of rotation)	*Fast Speed* 1132
	Condition reversal of direction of rotation	Falling edge home switch
	Speed (after reversal of direction of rotation)	*Creep Speed* 1133
C	Home switch inactive	0
	Search direction	Positive direction
	Speed (before reversal of direction of rotation)	*Fast Speed* 1132
	Condition reversal of direction of rotation	Rising edge positive HW limit switch
	Speed (after reversal of direction of rotation)	*Fast Speed* 1132
	Condition reversal of direction of rotation	Falling edge home switch
	Speed (after reversal of direction of rotation)	*Creep Speed* 1133

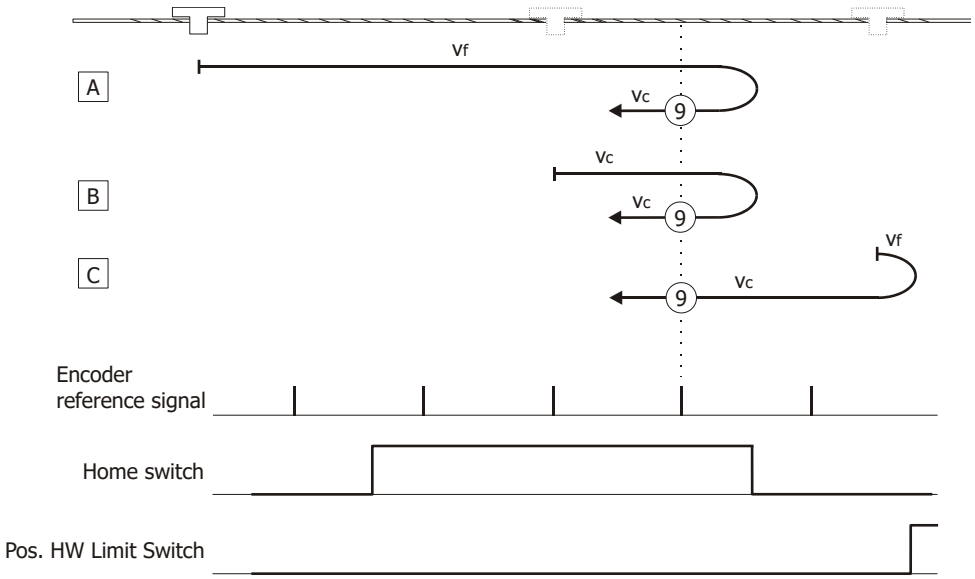


The homing direction (search direction) depends on the signal status of the home switch.
A: Homing direction (search direction) is clockwise toward positive HW limit switch if home switch and limit switch are inactive. The home switch is in search direction. Home position is the first encoder ref. signal after the home switch is reached. During the whole operation, homing is performed at *Fast Speed* **1132**.
B: When homing is started, the home switch is active. Homing direction (search direction) is anticlockwise toward negative HW limit switch. Travel to falling edge of home switch is performed at *Fast Speed* **1132**. When the home switch is passed in negative direction, the direction of rotation is reversed. Home position is the next encoder ref. signal. Search for the home position is performed at *Creep Speed* **1133**.
C: Homing direction (search direction) is clockwise toward positive HW limit switch. The home switch is not in search direction. The positive limit switch acts as a reversing switch. When the positive limit switch is reached, the direction of rotation is reversed, and homing is performed in negative direction. Travel to falling edge of home switch is performed at *Fast Speed* **1132**. When the home switch is passed, the direction of rotation is reversed again. Home position is the first encoder ref. signal after the status change of the home switch signal when traveling in positive direction. Search for the home position is performed at *Creep Speed* **1133**.

Operation mode 9: 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

Dest.:	Ref. signal to left of right edge of home switch	
A	Home switch inactive	0
	Search direction	Positive direction
	Speed (before reversal of direction of rotation)	*Fast Speed* 1132
	Condition reversal of direction of rotation	Falling edge home switch
	Speed (after reversal of direction of rotation)	*Creep Speed* 1133
B	Home switch active	1
	Search direction	Positive direction
	Speed (before reversal of direction of rotation)	*Fast Speed* **1132**
	Condition reversal of direction of rotation	Falling edge home switch
	Speed (after reversal of direction of rotation)	*Creep Speed* **1133**
C	Home switch inactive	0
	Search direction	Positive direction

	Speed (before reversal of direction of rotation)	*Fast Speed* 1132
	Condition reversal of direction of rotation	Rising edge positive HW limit switch
	Speed (after reversal of direction of rotation)	*Fast Speed* 1132

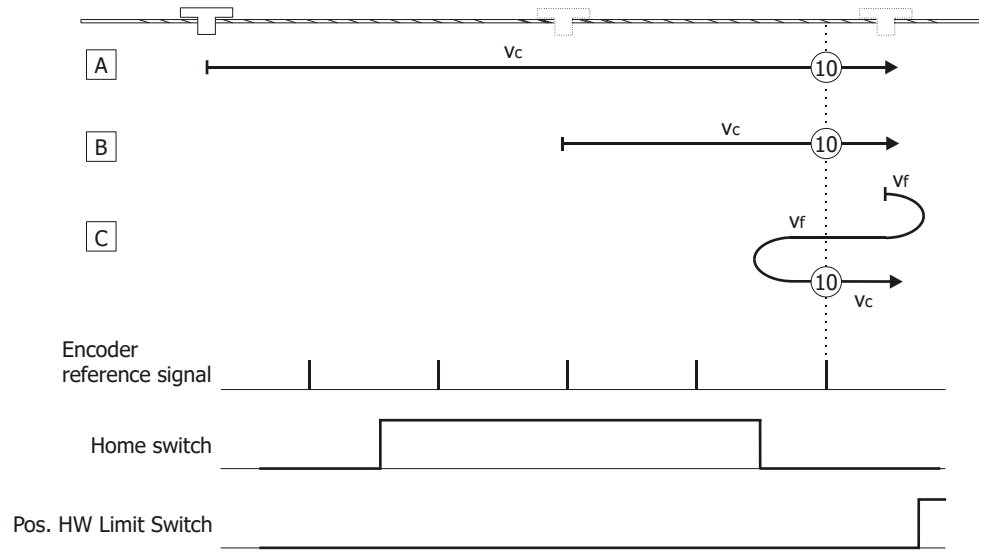


A: Homing direction (search direction) is clockwise toward positive HW limit switch if home switch and limit switch are inactive. The home switch is in search direction. Travel to falling edge of home switch is performed at *Fast Speed* **1132**. When the home switch is passed, the direction of rotation is reversed. Home position is the next encoder ref. signal. Search for the home position is performed at *Creep Speed* **1133**.
B: When homing is started, the home switch is active. Homing direction (search direction) is clockwise toward positive HW limit switch. Travel to falling edge of home switch is performed at *Fast Speed* **1132**. When the home switch is passed in positive direction, the direction of rotation is reversed. Home position is the next encoder ref. signal. Homing is performed at *Creep Speed* **1133**.
C: Homing direction (search direction) is clockwise toward positive HW limit switch. The home switch is not in search direction. The positive limit switch acts as a reversing switch. When the positive limit switch is reached, the direction of rotation is reversed, and homing is performed in negative direction. Home position is the first encoder ref. signal after the home switch is reached. During the whole operation, homing is performed at *Fast Speed* **1132**.

Operation mode 10: 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

Dest.:	Ref. signal to left of left edge of home switch	
A	Home switch inactive	0
	Search direction	Positive direction
	Speed (before speed change)	*Fast Speed* 1132
	Condition speed change	Rising edge home switch
	Speed (after speed change)	*Creep Speed* 1133
B	Home switch active	1
	Search direction	Positive direction
	Speed	*Creep Speed* 1133
C	Home switch inactive	0
	Search direction	Positive direction
	Speed (before reversal of direction of rotation)	*Fast Speed* 1132
	Condition reversal of direction of rotation	Rising edge positive HW limit switch

	Speed (after reversal of direction of rotation)	*Fast Speed* 1132
	Condition reversal of direction of rotation	Rising edge home switch
	Speed (after reversal of direction of rotation)	*Creep Speed* 1133



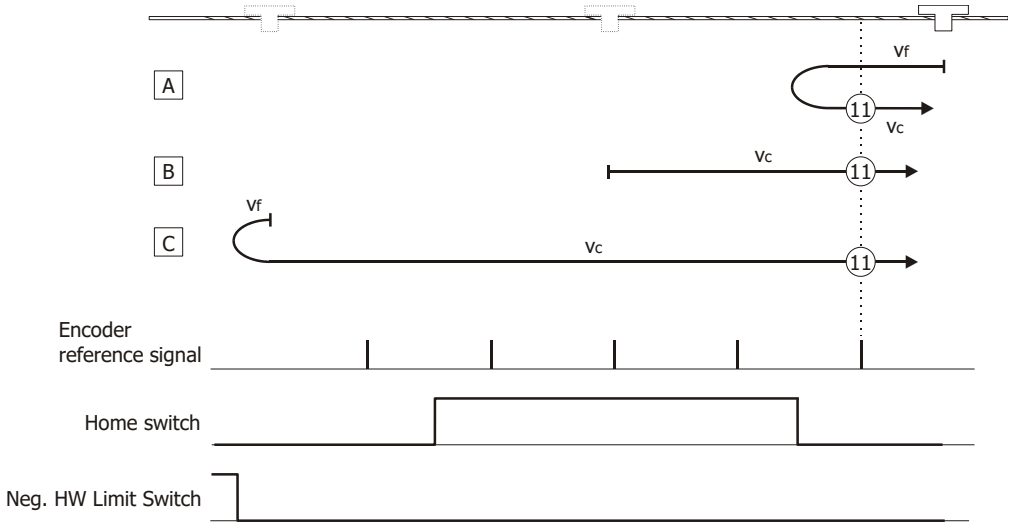
A: Homing direction (search direction) is clockwise toward positive HW limit switch if home switch and limit switch are inactive. The home switch is in search direction. Home position is the first encoder ref. signal after the home switch is passed. Travel to rising (left) edge of home switch is performed at *Fast Speed* **1132**. Search for the home position is performed at *Creep Speed* **1133**.

B: When homing is started, the home switch is active. Homing direction (search direction) is clockwise toward positive HW limit switch. Home position is the first encoder ref. signal after the home switch is passed in positive direction. Search for the home position is performed at *Creep Speed* **1133**.

C: Homing direction (search direction) is clockwise toward positive HW limit switch. The home switch is not in search direction. The positive limit switch acts as a reversing switch. When the positive limit switch is reached, the direction of rotation is reversed, and homing is performed in negative direction. When the home switch is reached, the direction of rotation is reversed again. Home position is the first encoder ref. signal after the status change of the home switch signal when traveling in positive direction. Travel to rising (right) edge of home switch is performed at *Fast Speed* **1132**. Search for the home position is performed at *Creep Speed* **1133**.

Operation mode 11: Homing to home switch with detection of encoder ref. signal, homing direction negative (anticlockwise), reversal of direction of rotation when negative HW limit switch is reached

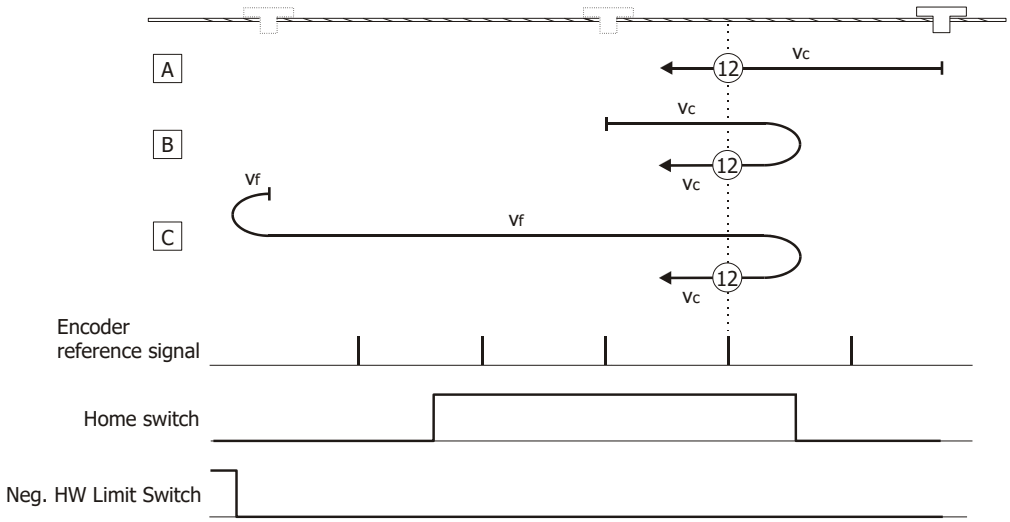
Dest.:	Ref. signal to right of right edge of home switch	
A	Home switch inactive	0
	Search direction	Negative direction
	Speed (before reversal of direction of rotation)	*Fast Speed* 1132
	Condition reversal of direction of rotation	Rising edge home switch
	Speed (after reversal of direction of rotation)	*Creep Speed* 1133
B	Home switch active	1
	Search direction	Positive direction
	Speed	*Creep Speed* 1133
C	Home switch inactive	0
	Search direction	Positive direction
	Speed (before reversal of direction of rotation)	*Fast Speed* 1132
	Condition reversal of direction of rotation	Rising edge negative HW limit switch
	Speed (after reversal of direction of rotation)	*Fast Speed* 1132
	Condition speed change	Rising edge home switch
	Speed (after speed change)	*Creep Speed* 1133



A: Homing direction (search direction) is anticlockwise toward negative HW limit switch if home switch and limit switch are inactive. The home switch is in search direction. Travel to right edge of home switch is performed at *Fast Speed* **1132**. When the home switch is reached, the direction of rotation is reversed. Home position is the first encoder ref. signal after travel in positive direction. Search for the home position is performed at *Creep Speed* **1133**.
B: When homing is started, the home switch is active. Homing direction (search direction) is clockwise toward positive HW limit switch. Home position is the first encoder ref. signal after the home switch is passed in positive direction. Homing is performed at *Creep Speed* **1133**.
C: Homing direction (search direction) is anticlockwise toward negative HW limit switch. The home switch is not in search direction. The negative limit switch acts as a reversing switch. When the negative limit switch is reached, the direction of rotation is reversed, and homing is performed in positive direction. At first, the operation is performed at *Fast Speed* **1132**, when the left edge of the home switch is reached, the speed is changed to *Creep Speed* **1133**. Home position is the first encoder ref. signal after the right edge of the home switch is passed.

Operation mode 12: Homing to home switch with detection of encoder ref. signal, homing direction negative (anticlockwise), reversal of direction of rotation when negative HW limit switch is reached

Dest.:	Ref. signal to left of right edge of home switch	
A	Home switch inactive	0
	Search direction	Negative direction
	Speed	*Fast Speed* 1132
B	Home switch active	1
	Search direction	Positive direction
	Speed (before reversal of direction of rotation)	*Fast Speed* 1132
	Condition reversal of direction of rotation	Falling edge home switch
	Speed (after reversal of direction of rotation)	*Creep Speed* 1133
C	Home switch inactive	0
	Search direction	Negative direction
	Speed (before reversal of direction of rotation)	*Fast Speed* 1132
	Condition reversal of direction of rotation	Rising edge negative HW limit switch
	Speed (after reversal of direction of rotation)	*Fast Speed* 1132
	Condition reversal of direction of rotation	Rising edge home switch
	Speed (after reversal of direction of rotation)	*Creep Speed* 1133



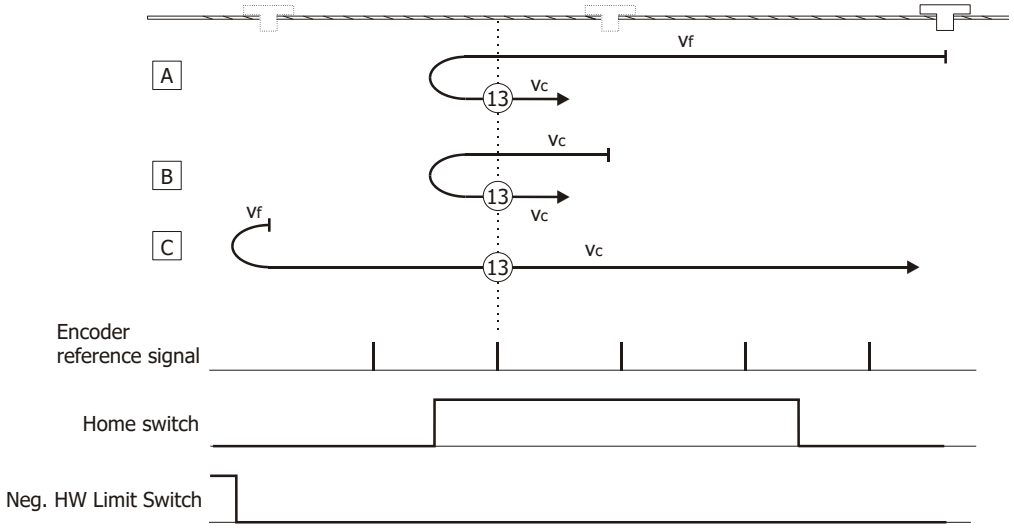
A: Homing direction (search direction) is anticlockwise toward negative HW limit switch if home switch and limit switch are inactive. The home switch is in search direction. Home position is the first encoder ref. signal after the home switch is reached. During the operation, homing is performed at *Fast Speed* **1132**.

B: When homing is started, the home switch is active. Homing direction (search direction) is clockwise toward positive HW limit switch. Travel to falling edge of home switch is performed at *Fast Speed* **1132**. When the home switch is passed in positive direction, the direction of rotation is reversed. Home position is the first encoder ref. signal after traveling in negative direction. Homing is performed at *Creep Speed* **1133**.

C: Homing direction (search direction) is anticlockwise toward negative HW limit switch. The home switch is not in search direction. The negative limit switch acts as a reversing switch. When the negative limit switch is reached, the direction of rotation is reversed, and homing is performed in positive direction. When the home switch is passed, the direction of rotation is reversed again. Home position is the first encoder ref. signal after traveling in negative direction. Travel to right edge of home switch is performed at *Fast Speed* **1132**. Search for the home position is performed at *Creep Speed* **1133**.

Operation mode 13: Homing to home switch with detection of encoder ref. signal, homing direction negative (anticlockwise), reversal of direction of rotation when negative HW limit switch is reached

Dest.:	Ref. signal to right of left edge of home switch	
A	Home switch inactive	0
	Search direction	Negative direction
	Speed (before reversal of direction of rotation)	*Fast Speed* **1132**
	Condition reversal of direction of rotation	Falling edge home switch
	Speed (after reversal of direction of rotation)	*Creep Speed* **1133**
B	Home switch active	1
	Search direction	Negative direction
	Speed (before reversal of direction of rotation)	*Fast Speed* **1132**
	Condition reversal of direction of rotation	Falling edge home switch
	Speed (after reversal of direction of rotation)	*Creep Speed* **1133**
C	Home switch inactive	0
	Search direction	Negative direction
	Speed (before reversal of direction of rotation)	*Fast Speed* **1132**
	Condition reversal of direction of rotation	Rising edge negative HW limit switch
	Speed (after reversal of direction of rotation)	*Fast Speed* **1132**



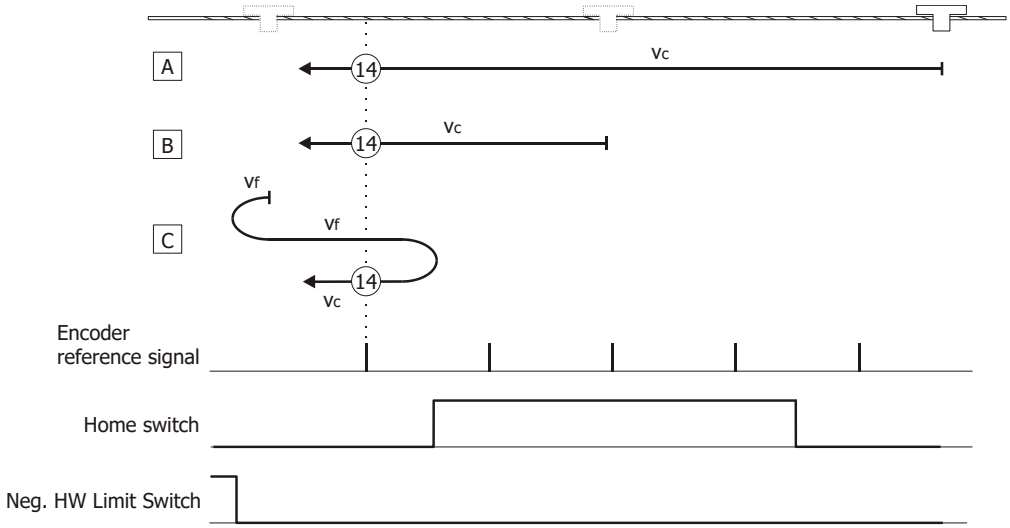
A: Homing direction (search direction) is anticlockwise toward negative HW limit switch if home switch and limit switch are inactive. The home switch is in search direction. Travel to left edge of home switch is performed at *Fast Speed* **1132**. When the home switch is passed, the direction of rotation is reversed. Home position is the first encoder ref. signal after travel in positive direction. Search for the home position is performed at *Creep Speed* **1133**

B: When homing is started, the home switch is active. Homing direction (search direction) is anticlockwise toward negative HW limit switch. Travel to left edge of home switch is performed at *Fast Speed* **1132**. When the home switch is passed in negative direction, the direction of rotation is reversed. Home position is the first encoder ref. signal after traveling in positive direction. Homing is performed at *Creep Speed* **1133**.

C: Homing direction (search direction) is anticlockwise toward negative HW limit switch. The home switch is not in search direction. The positive limit switch acts as a reversing switch. When the negative limit switch is reached, the direction of rotation is reversed, and homing is performed in positive direction. Home position is the first encoder ref. signal after the home switch is reached. During the whole operation, homing is performed at *Fast Speed* **1132**.

Operation mode 14: Homing to home switch with detection of encoder ref. signal, homing direction negative (anticlockwise), reversal of direction of rotation when negative HW limit switch is reached

Dest.:	Ref. signal to left of left edge of home switch	
A	Home switch inactive	0
	Search direction	Negative direction
	Speed (before speed change)	*Fast Speed* 1132
	Condition speed change	Rising edge home switch
	Speed (after speed change)	*Creep Speed* 1133
B	Home switch active	1
	Search direction	Negative direction
	Speed	*Creep Speed* 1133
C	Home switch inactive	0
	Search direction	Negative direction
	Speed (before reversal of direction of rotation)	*Fast Speed* 1132
	Condition reversal of direction of rotation	Rising edge negative HW limit switch
	Speed (after reversal of direction of rotation)	*Fast Speed* 1132
	Condition reversal of direction of rotation	Rising edge home switch
	Speed (after reversal of direction of rotation)	*Creep Speed* 1133



A: Homing direction (search direction) is anticlockwise toward negative HW limit switch if home switch and limit switch are inactive. The home switch is in search direction. Travel to rising (right) edge of home switch is performed at *Fast Speed* **1132**. Home position is the first encoder ref. signal after the home switch is passed. Search for the home position is performed at *Creep Speed* **1133**.

B: When homing is started, the home switch is active. Homing direction (search direction) is anticlockwise toward negative HW limit switch. Home position is the first encoder ref. signal after the home switch is passed in negative direction. Homing is performed at *Creep Speed* **1133**.

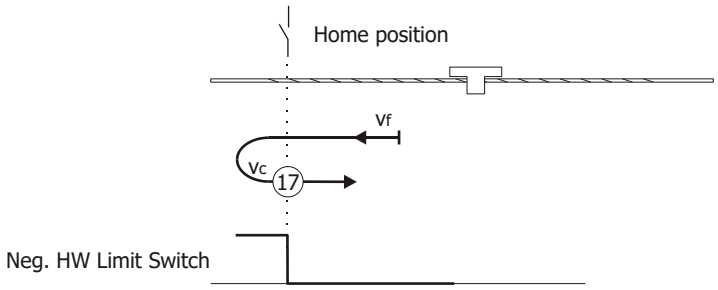
C: Homing direction (search direction) is anticlockwise toward negative HW limit switch. The home switch is not in search direction. The negative limit switch acts as a reversing switch. When the negative limit switch is reached, the direction of rotation is reversed, and homing is performed in positive direction. When the home switch is reached, the direction of rotation is reversed again. At first, the operation is performed at *Fast Speed* **1132**, when the left edge of

the home switch is reached, the speed is changed to *Creep Speed* **1133**. Home position is the first ref. signal in negative direction after the falling edge of the home switch signal.

6.5.2 Homing modes without reference signal

Operation mode 17: Homing to negative HW limit switch without encoder ref. signal.

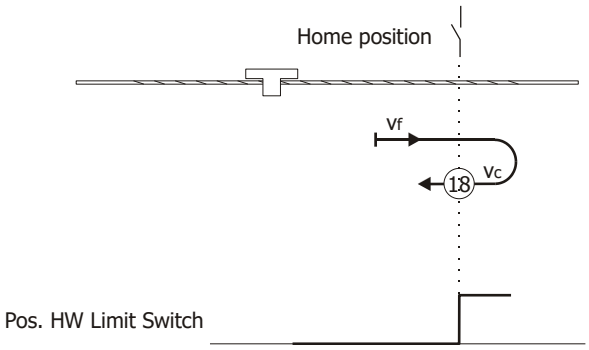
Dest.:	Negative limit switch	
	Home switch active	
	Search direction	Negative direction
	Speed (before reversal of direction of rotation)	*Fast Speed* **1132**
	Condition reversal of direction of rotation	Rising edge negative limit switch
	Speed (after reversal of direction of rotation)	*Creep Speed* **1133**



The homing direction (search direction) is negative at *Fast Speed* **1132**. When the limit switch is reached, the direction of rotation is reversed and homing is performed at *Creep Speed* **1133**. Home position is the falling edge of the limit switch.

Operation mode 18: Homing to positive HW limit switch without encoder ref. signal.

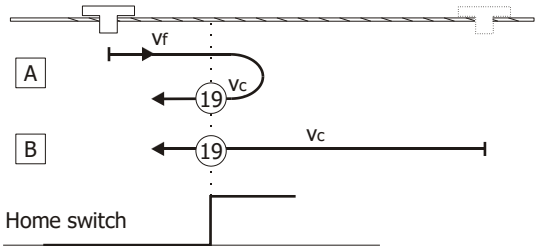
Dest.:	Positive limit switch	
	Home switch active	
	Search direction	Positive direction
	Speed (before reversal of direction of rotation)	*Fast Speed* **1132**
	Condition reversal of direction of rotation	Rising edge positive limit switch
	Speed (after reversal of direction of rotation)	*Creep Speed* **1133**



The homing direction (search direction) is positive at *Fast Speed* **1132**. When the limit switch is reached, the direction of rotation is reversed and homing is performed at *Creep Speed* **1133**. Home position is the falling edge of the limit switch.

Operation mode 19: Homing to positive home switch without encoder ref. signal., falling edge

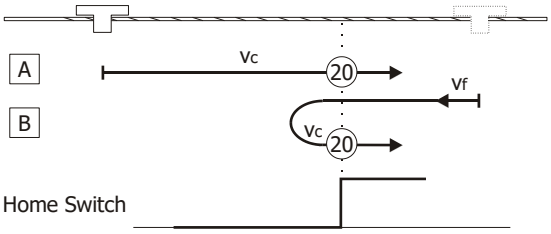
Dest.:	Falling left edge of home switch	
A	Home switch active	0
	Search direction	Positive direction
	Speed (before reversal of direction of rotation)	*Fast Speed* 1132
	Condition reversal of direction of rotation	Rising edge home switch
	Speed (after reversal of direction of rotation)	*Creep Speed* 1133
B	Home switch active	1
	Search direction	Negative direction
	Speed	*Creep Speed* 1133



The homing direction (search direction) depends on the signal status of the home switch.
A: Homing direction is positive if the home switch is inactive. Travel to home switch is performed at *Fast Speed* **1132**. When the home switch is reached, the direction of rotation is reversed. Home position is the falling edge of the home switch. Search for the home position is performed at *Creep Speed* **1133**.
B: Homing direction is negative if the home switch is active. Home position is the falling edge of the home switch. Search for the home position is performed at *Creep Speed* **1133**.

Operation mode 20: Homing to positive home switch without encoder ref. signal., rising edge

Dest.:	Rising left edge of home switch	
A	Home switch active	0
	Search direction	Positive direction
	Speed	*Fast Speed* 1132
B	Home switch active	1
	Search direction	Negative direction
	Speed (before reversal of direction of rotation)	*Fast Speed* 1132
	Condition reversal of direction of rotation	Falling edge home switch
	Speed (after reversal of direction of rotation)	*Creep Speed* 1133

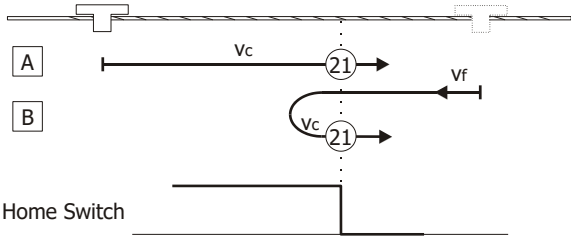


The homing direction (search direction) depends on the signal status of the home switch.
A: Homing direction is positive if the home switch is inactive. Home position is the rising edge of the home switch. Search for the home position is performed at *Creep Speed* **1133**.
B: Homing direction is negative if the home switch is active. Travel to falling edge of home switch is performed at *Fast Speed* **1132**. When the home switch is passed, the direction of

rotation is reversed. Home position is the rising edge of the home switch signal. Search for the home position is performed at *Creep Speed* **1133**.

Operation mode 21: Homing to negative home switch without encoder ref. signal., falling edge

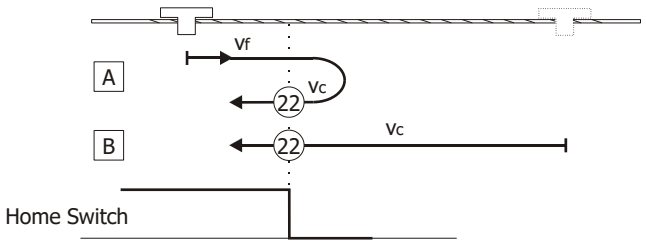
Dest.:	Falling right edge of home switch	
A	Home switch active	1
	Search direction	Positive direction
	Speed	*Creep speed* 1133
B	Home switch active	0
	Search direction	Negative direction
	Speed (before reversal of direction of rotation)	*Fast Speed* 1132
	Condition reversal of direction of rotation	Rising edge home switch
	Speed (after reversal of direction of rotation)	*Creep Speed* 1133



The homing direction (search direction) depends on the signal status of the home switch.
A: Homing direction is positive if the home switch is active. Home position is the falling edge of the home switch. Search for the home position is performed at *Creep Speed* **1133**.
B: Homing direction is negative if the home switch is inactive. Travel to rising edge of home switch is performed at *Fast Speed* **1132**. When the home switch is passed, the direction of rotation is reversed. Home position is the falling edge of the home switch signal. Search for the home position is performed at *Creep Speed* **1133**.

Operation mode 22: Homing to negative home switch without encoder ref. signal., rising edge

Dest.:	Rising right edge of home switch	
A	Home switch active	1
	Search direction	Positive direction
	Speed (before reversal of direction of rotation)	*Fast Speed* 1132
	Condition reversal of direction of rotation	Falling edge home switch
	Speed (after reversal of direction of rotation)	*Creep Speed* 1133
B	Home switch active	0
	Search direction	Negative direction
	Speed	*Creep Speed* 1133

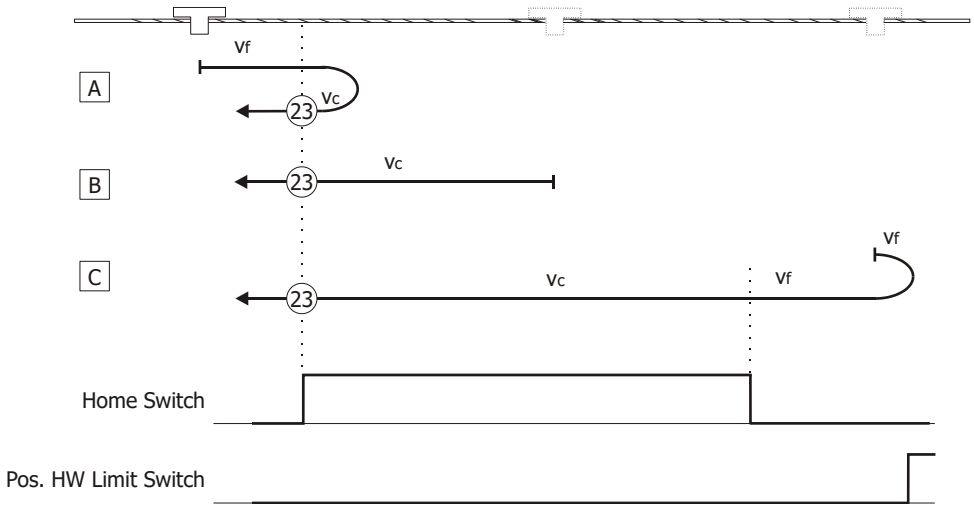


The homing direction (search direction) depends on the signal status of the home switch.
A: Homing direction is positive if the home switch is active. Travel to falling edge of home switch is performed at *Fast Speed* **1132**. When the home switch is passed, the direction of rotation is reversed. Home position is the rising edge of the home switch signal. Search for the home position is performed at *Creep Speed* **1133**.

B: Homing direction is negative if the home switch is inactive. Home position is the rising edge of the home switch. Search for the home position is performed at *Creep Speed* **1133**.

Operation mode 23: Homing to left falling edge of home switch without encoder ref. signal with positive hardware limit switch

Dest.:	Falling left edge of home switch	
A	Home switch active	0
	Search direction	Positive direction
	Speed (before reversal of direction of rotation)	*Fast Speed* 1132
	Condition reversal of direction of rotation	Rising edge home switch
	Speed (after reversal of direction of rotation)	*Creep Speed* 1133
B	Home switch active	1
	Search direction	Negative direction
	Speed	*Creep Speed* 1133
C	Home switch active	0
	Search direction	Positive direction
	Speed (before reversal of direction of rotation)	*Fast Speed* 1132
	Condition reversal of direction of rotation	Rising edge positive HW limit switch
	Speed (after reversal of direction of rotation)	*Fast Speed* 1132
	Condition speed change	Rising edge home switch
	Speed (after speed change)	*Creep Speed* 1133



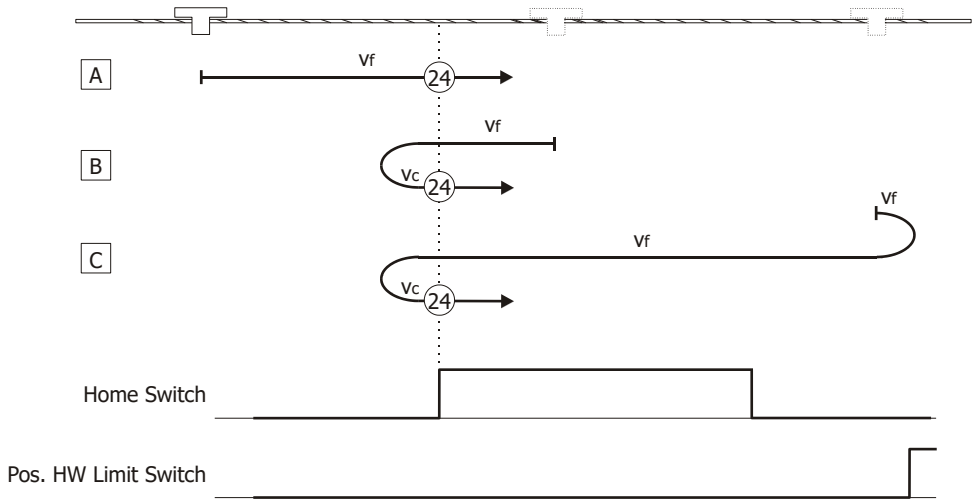
A: Homing direction (search direction) is clockwise toward positive HW limit switch if home switch and limit switch are inactive. The home switch is in search direction. Travel to rising edge of home switch is performed at *Fast Speed* **1132**. When the home switch is reached, the direction of rotation is reversed. Home position is the falling edge of the home switch. Search for the home position is performed at *Creep Speed* **1133**.

B: When homing is started, the home switch is active. Homing direction (search direction) is anticlockwise toward negative HW limit switch. Home position is the falling edge of the home switch. Search for the home position is performed at *Creep Speed* **1133**.

C: Homing direction (search direction) is clockwise toward positive HW limit switch. The home switch is not in search direction. The positive limit switch acts as a reversing switch. When the positive limit switch is reached, the direction of rotation is reversed, and homing is performed in negative direction. Travel to rising (right) edge of home switch signal is performed at *Fast Speed* **1132**. Home position is the falling edge of the home switch. Search for the home position is performed at *Creep Speed* **1133**.

Operation mode 24: Homing to left rising edge of home switch without encoder ref. signal with positive hardware limit switch

Dest.:	Rising left edge of home switch	
A	Home switch active	0
	Search direction	Positive direction
	Speed	*Fast Speed* 1132
B	Home switch active	1
	Search direction	Negative direction
	Speed (before reversal of direction of rotation)	*Fast Speed* 1132
	Condition reversal of direction of rotation	Falling edge home switch
	Speed (after reversal of direction of rotation)	*Creep Speed* 1133
C	Home switch active	0
	Search direction	Positive direction
	Speed (before reversal of direction of rotation)	*Fast Speed* 1132
	Condition reversal of direction of rotation	Rising edge positive HW limit switch
	Speed (after reversal of direction of rotation)	*Fast Speed* 1132
	Condition reversal of direction of rotation	Falling edge home switch
	Speed (after reversal of direction of rotation)	*Creep Speed* 1133



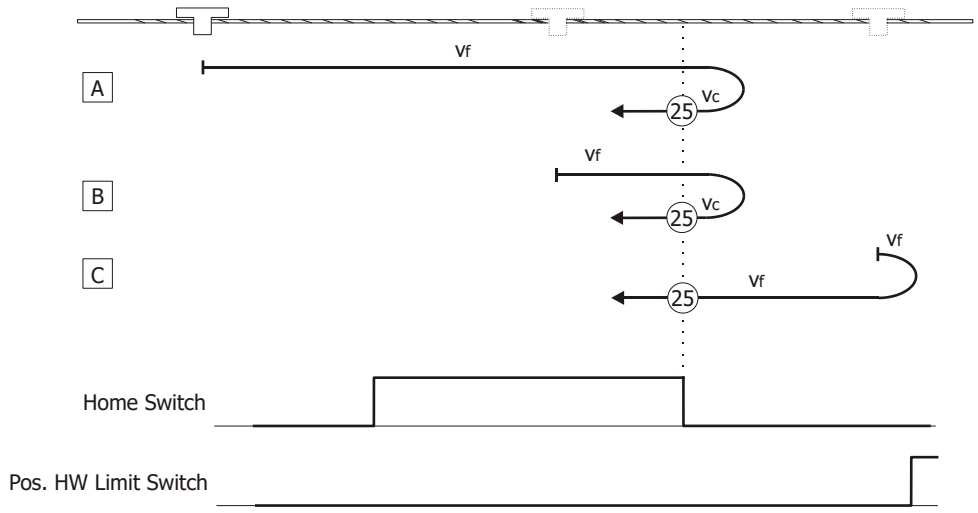
A: Homing direction (search direction) is clockwise toward positive HW limit switch if home switch and limit switch are inactive. The home switch is in search direction. Home position is the rising edge of the home switch. During the whole operation, homing is performed at *Fast Speed* **1132**.

B: When homing is started, the home switch is active. Homing direction (search direction) is anticlockwise toward negative HW limit switch. Travel to falling edge of home switch signal is performed at *Fast Speed* **1132**. When the home switch is passed in negative direction, the direction of rotation is reversed. Home position is the rising edge of the home switch. Homing is performed at *Creep Speed* **1133**.

C: Homing direction (search direction) is clockwise toward positive HW limit switch. The home switch is not in search direction. The positive limit switch acts as a reversing switch. When the positive limit switch is reached, the direction of rotation is reversed, and homing is performed in negative direction. When the home switch is passed, the direction of rotation is reversed again. At first, the operation is performed at *Fast Speed* **1132**, when the left edge of the home switch is reached, the speed is changed to *Creep Speed* **1133**. Home position is the rising edge of the home switch.

Operation mode 25: Homing to right rising edge of home switch without encoder ref. signal with positive hardware limit switch

Dest.:	Rising right edge of home switch	
A	Home switch active	0
	Search direction	Positive direction
	Speed (before reversal of direction of rotation)	*Fast Speed* 1132
	Condition reversal of direction of rotation	Falling edge home switch
	Speed (after reversal of direction of rotation)	*Creep Speed* 1133
B	Home switch active	1
	Search direction	Negative direction
	Speed (before reversal of direction of rotation)	*Fast Speed* 1132
	Condition reversal of direction of rotation	Falling edge home switch
	Speed (after reversal of direction of rotation)	*Creep Speed* 1133
C	Home switch active	0
	Search direction	Positive direction
	Speed (before reversal of direction of rotation)	*Fast Speed* 1132
	Condition reversal of direction of rotation	Rising edge positive HW limit switch
	Speed (after reversal of direction of rotation)	*Fast Speed* 1132



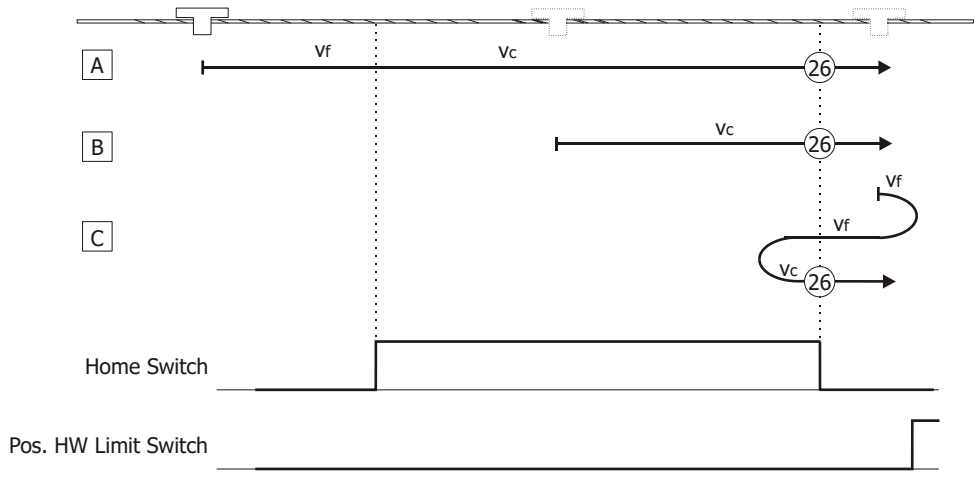
A: Homing direction (search direction) is clockwise toward positive HW limit switch if home switch and limit switch are inactive. The home switch is in search direction. Travel to right edge of home switch is performed at *Fast Speed* **1132**. When the home switch is passed, the direction of rotation is reversed. Home position is the rising edge of the home switch signal. Search for the home position is performed at *Creep Speed* **1133**.

B: When homing is started, the home switch is active. Homing direction (search direction) is clockwise toward positive HW limit switch. Travel to falling edge of home switch signal is performed at *Fast Speed* **1132**. When the home switch is passed in positive direction, the direction of rotation is reversed. Home position is the rising edge of the home switch signal. Homing is performed at *Creep Speed* **1133**.

C: Homing direction (search direction) is clockwise toward positive HW limit switch. The home switch is not in search direction. The positive limit switch acts as a reversing switch. When the positive limit switch is reached, the direction of rotation is reversed, and homing is performed in negative direction. Home position is the rising edge of the home switch signal. During the whole operation, homing is performed at *Fast Speed* **1132**.

Operation mode 26: Homing to right falling edge of home switch without encoder ref. signal with positive hardware limit switch

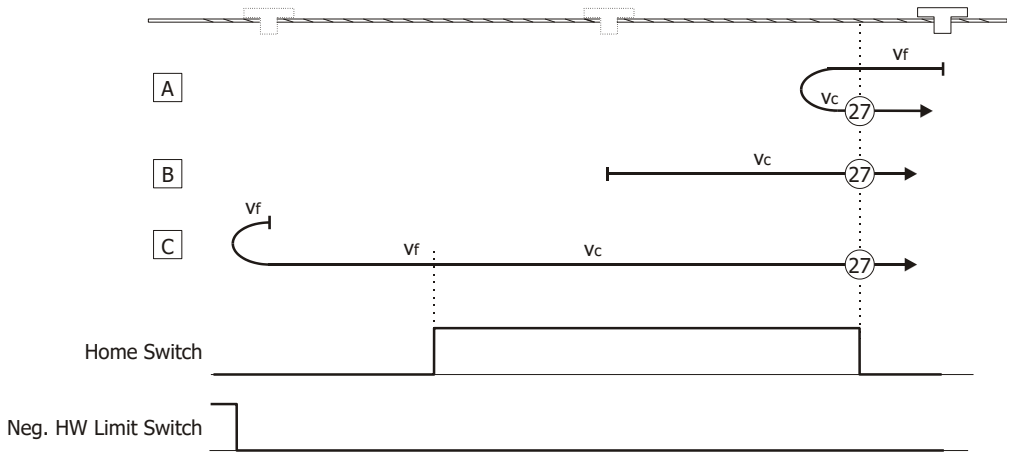
Dest.:	Falling right edge of home switch	
A	Home switch active	0
	Search direction	Positive direction
	Speed (before speed change)	*Fast Speed* 1132
	Condition speed change	Rising edge home switch
	Speed (after speed change)	*Creep Speed* 1133
B	Home switch active	1
	Search direction	Positive direction
	Speed	*Creep Speed* 1133
C	Home switch active	0
	Search direction	Positive direction
	Speed (before reversal of direction of rotation)	*Fast Speed* 1132
	Condition reversal of direction of rotation	Rising edge positive HW limit switch
	Speed (after reversal of direction of rotation)	*Fast Speed* 1132
	Condition reversal of direction of rotation	Rising edge home switch
	Speed (after reversal of direction of rotation)	*Creep Speed* 1133



A: Homing direction (search direction) is clockwise toward positive HW limit switch if home switch and limit switch are inactive. The home switch is in search direction. Home position is the falling edge of the home switch. At first, the operation is performed at *Fast Speed* **1132**, when the left edge of the home switch is reached, the speed is changed to *Creep Speed* **1133**.
B: When homing is started, the home switch is active. Homing direction (search direction) is clockwise toward positive HW limit switch. Home position is the falling edge of the home switch. Homing is performed at *Creep Speed* **1133**.
C: Homing direction (search direction) is clockwise toward positive HW limit switch. The home switch is not in search direction. The positive limit switch acts as a reversing switch. When the positive limit switch is reached, the direction of rotation is reversed, and homing is performed in negative direction. When the home switch is reached, the direction of rotation is reversed again. At first, the operation is performed at *Fast Speed* **1132**, when the right edge of the home switch is reached, the speed is changed to *Creep Speed* **1133**. Home position is the falling edge of the home switch.

Operation mode 27: Homing to right falling edge of home switch without encoder ref. signal with negative hardware limit switch

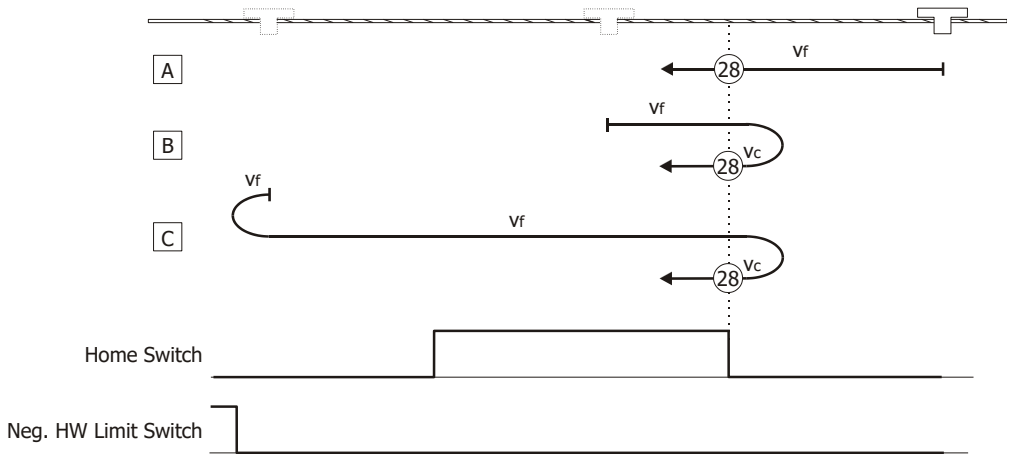
Dest.:	Falling right edge of home switch	
A	Home switch active	0
	Search direction	Negative direction
	Speed (before reversal of direction of rotation)	*Fast Speed* 1132
	Condition reversal of direction of rotation	Rising edge home switch
	Speed (after reversal of direction of rotation)	*Creep Speed* 1133
B	Home switch active	1
	Search direction	Positive direction
	Speed	*Creep Speed* 1133
C	Home switch active	0
	Search direction	Negative direction
	Speed (before reversal of direction of rotation)	*Fast Speed* 1132
	Condition reversal of direction of rotation	Rising edge negative HW limit switch
	Speed (after reversal of direction of rotation)	*Fast Speed* 1132
	Condition speed change	Rising edge home switch
	Speed (after speed change)	*Creep Speed* 1133



A: Homing direction (search direction) is anticlockwise toward negative HW limit switch if home switch and limit switch are inactive. The home switch is in search direction. Travel to right edge of home switch is performed at *Fast Speed* **1132**. When the home switch is reached, the direction of rotation is reversed. Home position is the falling edge of the home switch. Search for the home position is performed at *Creep Speed* **1133**.
B: When homing is started, the home switch is active. Homing direction (search direction) is clockwise toward positive HW limit switch. Home position is the falling edge of the home switch. Homing is performed at *Creep Speed* **1133**.
C: Homing direction (search direction) is anticlockwise toward negative HW limit switch. The home switch is not in search direction. The negative limit switch acts as a reversing switch. When the negative limit switch is reached, the direction of rotation is reversed, and homing is performed in positive direction. Home position is the falling edge of the home switch. At first, the operation is performed at *Fast Speed* **1132**, when the left edge of the home switch is reached, the speed is changed to *Creep Speed* **1133**.

Operation mode 28: Homing to right rising edge of home switch without encoder ref. signal with negative hardware limit switch

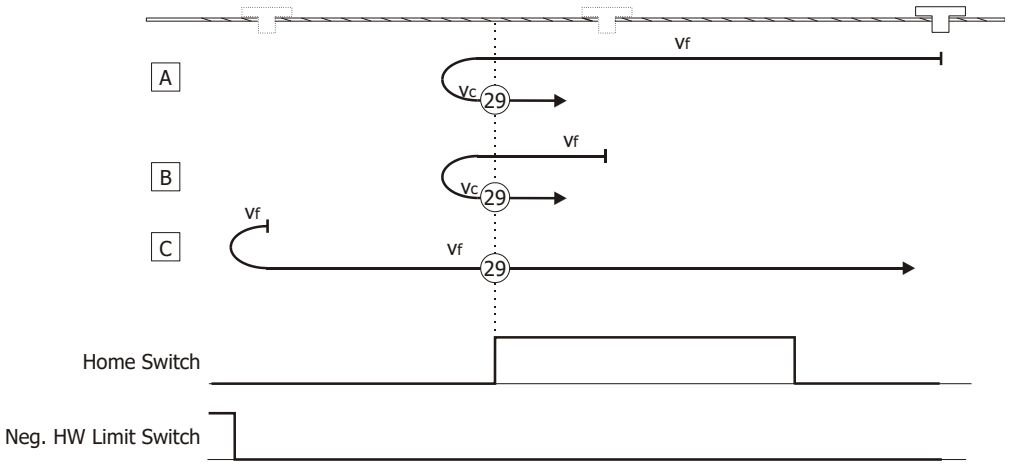
Dest.:	Rising right edge of home switch	
A	Home switch active	0
	Search direction	Negative direction
	Speed	*Fast Speed* 1132
B	Home switch active	1
	Search direction	Positive direction
	Speed (before reversal of direction of rotation)	*Fast Speed* 1132
	Condition reversal of direction of rotation	Falling edge home switch
	Speed (after reversal of direction of rotation)	*Creep Speed* 1133
C	Home switch active	0
	Search direction	Negative direction
	Speed (before reversal of direction of rotation)	*Fast Speed* 1132
	Condition reversal of direction of rotation	Rising edge negative HW limit switch
	Speed (after reversal of direction of rotation)	*Fast Speed* 1132
	Condition reversal of direction of rotation	Rising edge home switch
	Speed (after reversal of direction of rotation)	*Creep Speed* 1133



A: Homing direction (search direction) is anticlockwise toward negative HW limit switch if home switch and limit switch are inactive. The home switch is in search direction. Home position is the rising edge of the home switch. Homing is performed at *Fast Speed* **1132**.
B: When homing is started, the home switch is active. Homing direction (search direction) is clockwise toward positive HW limit switch. Travel to falling edge of home switch signal is performed at *Fast Speed* **1132**. When the home switch is passed in positive direction, the direction of rotation is reversed. Home position is the rising edge of the home switch. Homing is performed at *Creep Speed* **1133**.
C: Homing direction (search direction) is anticlockwise toward negative HW limit switch. The home switch is not in search direction. The negative limit switch acts as a reversing switch. When the negative limit switch is reached, the direction of rotation is reversed, and homing is performed in positive direction. When the home switch is passed, the direction of rotation is reversed again. At first, the operation is performed at *Fast Speed* **1132**, when the left edge of the home switch is reached, the speed is changed to *Creep Speed* **1133**. Home position is the rising edge of the home switch.

Operation mode 29: Homing to left rising edge of home switch without encoder ref. signal with negative hardware limit switch

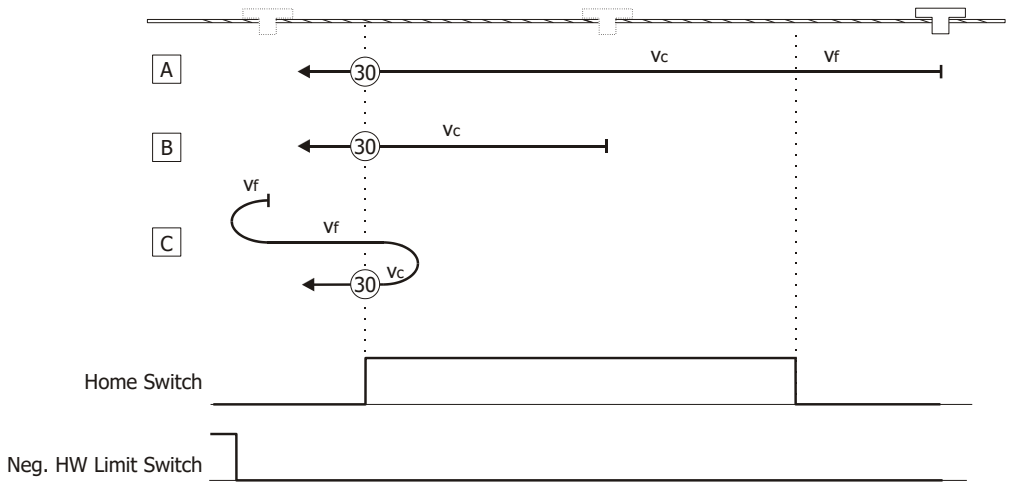
Dest.:	Rising left edge of home switch	
A	Home switch active	0
	Search direction	Negative direction
	Speed (before reversal of direction of rotation)	*Fast Speed* 1132
	Condition reversal of direction of rotation	Falling edge home switch
	Speed (after reversal of direction of rotation)	*Creep Speed* 1133
B	Home switch active	1
	Search direction	Negative direction
	Speed (before reversal of direction of rotation)	*Fast Speed* 1132
	Condition reversal of direction of rotation	Falling edge home switch
	Speed (after reversal of direction of rotation)	*Creep Speed* 1133
C	Home switch active	0
	Search direction	Negative direction
	Speed (before reversal of direction of rotation)	*Fast Speed* 1132
	Condition reversal of direction of rotation	Rising edge negative HW limit switch
	Speed (after reversal of direction of rotation)	*Fast Speed* 1132



A: Homing direction (search direction) is anticlockwise toward negative HW limit switch if home switch and limit switch are inactive. The home switch is in search direction. Travel to falling edge of home switch is performed at *Fast Speed* **1132**. When the home switch is passed, the direction of rotation is reversed. Home position is right of the left edge of the home switch. Search for the home position is performed at *Creep Speed* **1133**.
B: When homing is started, the home switch is active. Homing direction (search direction) is anticlockwise toward negative HW limit switch. Travel to falling edge of home switch signal is performed at *Fast Speed* **1132**. When the home switch is passed in negative direction, the direction of rotation is reversed. Home position is right of the left edge of the home switch. Search for the home position is performed at *Creep Speed* **1133**.
C: Homing direction (search direction) is anticlockwise toward negative HW limit switch. The home switch is not in search direction. The negative limit switch acts as a reversing switch. When the negative limit switch is reached, the direction of rotation is reversed, and homing is performed in positive direction. Home position is right of the left edge of the home switch. During the whole operation, homing is performed at *Fast Speed* **1132**.

Operation mode 30: Homing to left falling edge of home switch without encoder ref. signal with negative hardware limit switch

Dest.:	Falling left edge of home switch	
A	Home switch active	0
	Search direction	Negative direction
	Speed (before speed change)	*Fast Speed* 1132
	Condition speed change	Rising edge home switch
	Speed (after speed change)	*Creep Speed* 1133
B	Home switch active	1
	Search direction	Negative direction
	Speed	*Creep Speed* 1133
C	Home switch active	0
	Search direction	Negative direction
	Speed (before reversal of direction of rotation)	*Fast Speed* 1132
	Condition reversal of direction of rotation	Rising edge negative HW limit switch
	Speed (after reversal of direction of rotation)	*Fast Speed* 1132
	Condition reversal of direction of rotation	Rising edge home switch
	Speed (after reversal of direction of rotation)	*Creep Speed* 1133

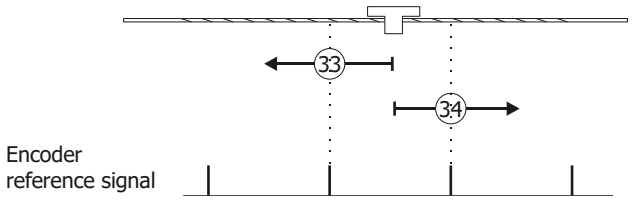


A: Homing direction (search direction) is anticlockwise toward negative HW limit switch if home switch and limit switch are inactive. The home switch is in search direction. Home position is left of the left edge of the home switch. Travel to rising (right) edge of home switch is performed at *Fast Speed* **1132**. Search for the home position is performed at *Creep Speed* **1133**.
B: When homing is started, the home switch is active. Homing direction (search direction) is anticlockwise toward negative HW limit switch. Home position is left of the left edge of the home switch. Search for the home position is performed at *Creep Speed* **1133**.
C: Homing direction (search direction) is anticlockwise toward negative HW limit switch. The home switch is not in search direction. The negative limit switch acts as a reversing switch. When the negative limit switch is reached, the direction of rotation is reversed, and homing is performed in positive direction. When the home switch is reached, the direction of rotation is reversed again. Home position is left of the left edge of the home switch. Travel to rising (left) edge of home switch is performed at *Fast Speed* **1132**. Search for the home position is performed at *Creep Speed* **1133**.

6.5.3 Homing modes, only ref. signal and actual position

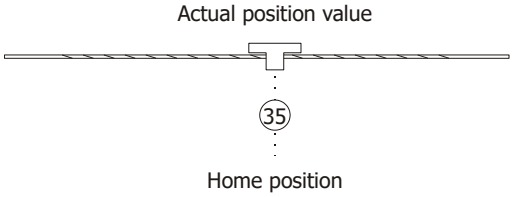
Operation modes 33 and 34: Homing to first encoder ref. signal

Home position is the first encoder ref. signal in negative (operation mode 33) or positive (operation mode 34) direction.



Operation mode 35: Current position is home position

Current position is home position. Home offset (Parameter 1131) is taken over as actual position value.



Note: Without encoder ref. signal, homing modes 1 to 14 as well as 33 and 34 are not possible.

7 Output Signals and fault messages

7.1 Actual positioning values

The display of actual values in VPlus is refreshed after the window for parameterizing of motion blocks VTable has been closed.

Note:	For information on other actual values, refer to the operating instructions of the frequency inverter.

Application Warnings **273** shows warning messages affecting the positioning functions.
Actual Appl. Warning Mask **627**shows current warning mask.
Act. Speed **1107**shows current speed in unit [u/s].
Act. Position **1108**shows the current position in unit [u].
Act. Contouring Error **1109**shows the current contouring error in unit [u].
Peak Value Contouring Error **1121** The contouring error peak value can be monitored in the actual value memory.
With parametersetting *Reset Memory* **237** = "18 - Peak Value Contouring Error", you can reset the saved value.
Act. Master Speed **1129** shows the speed of the master on the output of the electronic gear in the operation modes with electronic gear (*Motion Mode* **1208**).
Actual Motion Block **1246** shows the motion block currently processed.
Value -10 indicates homing.
Motion Block to Resume **1249** shows the motion block which was interrupted after an error message or by reset of the "Start Positioning" signal and can then be resumed.
Parameter value is "-1" when the resume function is disabled. Resume function is disabled in teach-in mode or if *Homing Mode* **1130** is set to "0 – No Homing Done".

7.2 Status word of the positioning

The positioning offers advanced information via a positioning status word. This status word is output during operation by parameter *Actual Motion Mode* **1255**.
Additional the same information is available for other device functions (system bus, scope) via the signal source "880 - Actual Motion Mode".
Actual Motion Mode **1255**
The decimal value with text shows:

- if a homing operation is started
- if a positioning operation is started
- the motion mode of the actual motion block
- the operation mode "Teach-In" of the control
- the JOG-Mode

The displaed decimal value can be converted into binary representation. The resultant bits of the status word indicate the active motion mode.

Deci-mal	Bit-No.	Is set in Motion Mode or Operation Mode
0	0	**JOG-Mode**. JOG-Mode is enabled via parameter *Jog-Mode Active* **1231**.
2	1	**Homing** is started: Manually via parameter *Start Homing (manual)* **1235** in *Operation Mode* **1220** = "1 - manual" or Automatically via controller release and signal at *Start Positioning* **1222** in *Operation Mode* **1220** = "2 - automatic".
4	2	**Teach-In.** Parameter *Operation Mode* **1221** is set to: "301 - Teach-In, Motion Block Sel. via Digital Inputs" or "302 - Teach-In, Motion Block Sel. via P. 1228"

Decimal	Bit-No.	Is set in Motion Mode or Operation Mode
8	3	**Positioning** operation is started.
16	4	**Absolute.** Parameter *Motion Mode* **1208** of the actual motion block is set to "0 - absolute".
32	5	**Relative.** Parameter *Motion Mode* **1208** of the actual motion block is set to "1 - relative".
64	6	**Touch-Probe.** Parameter *Motion Mode* **1208** of the actual motion block is set to: "2 - Touch-Probe: Rising Edge" or "3 - Touch-Probe: Falling Edge" or "12 - gearing, Touch-Probe: Rising Edge" or "13 - gearing, Touch-Probe: Falling Edge" or "22 - gearing, direct sync., Touch-Probe: Rising Edge" or "23 - gearing, direct sync., Touch-Probe: Falling Edge"
128	7	**Velocity.** Parameter *Motion Mode* **1208** of the actual motion block is set to "4 - Velocity".
256	8	**Gearing.** Parameter *Motion Mode* **1208** of the actual motion block is set to: "10 - gearing, absolute" or "11 - gearing, relative" or "12 - gearing, Touch-Probe: Rising Edge" or "13 - gearing, Touch-Probe: Falling Edge" or "14 - gearing" or "20 - gearing, direct sync., absolute" or "21 - gearing, direct sync., relative" or "22 - gearing, direct sync., Touch-Probe: Rising Edge" or "23 - gearing, direct sync., Touch-Probe: Falling Edge" or "24 - gearing, direct synchronization"
512	9	**Phasing.** A Phasing is currently executed.
1024	10 … 15	The bit will not be set. No function assigned.

Example:
Value 328 decimal is displayed in parameter *Actual Motion Mode* **1255**.
Status word after conversion from 328 decimal to binary representation:

0	0	0	0	0	0	0	1	0	1	0	0	1	0	0	0

Bit-Numbers of the status word:

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

Meaning: Active is a positioning (bit 3) in Motion Mode "gearing (bit 8), Touch-Probe (bit 6)".

Note: The status word can be transmitted as signal source "880 - Actual Motion Mode" via system bus. This requires an expansion module with system bus interface.

7.3 Status word 411

Parameter *Status word* **411** includes two specific bits of the positioning. These bits can be evaluated by the logic control.

Note:	The applicable status word depends on the operation mode *Local/Remote* **412**. The status word is used in most of the operation modes for parameter *Local/Remote* **412**. If the inverter is controlled via statemachine (*Local/Remote* **412** = „1 - Control via Statemachine") a different status word is applicable. Refer to the operating instructions of the communication modules or expansion modules.

Statusword **411**	
Bit-No.	**Function**
0	Ready for being switched on
1	Switched on
2	Operation – released
3	Error
4	Voltage – disabled
5	Quick Stop
6	Starting lock-out
7	Warning
8	**Homing Done**
9	Remote
10	Reference value reached
11	Limit value reached
12	-
13	-
14	**Target Position Reached**
15	Warning 2

8	**Homing Done** Homing is carried out successfully. The home position is set. This bit stays set until homing is restarted. The bit is only output in the settings of parameter *Local/Remote* **412** ≠ "1 - Control via Statemachine".

14	**Target Position Reached** *Target Position/Distance* **1202** of a positioning operation was reached, and current actual position is within the range set in parameter *Target window* **1165** for a minimum period of *Target window time* **1166**. The bit is only output in the settings of parameter *Local/Remote* **412** ≠ "1 - Control via Statemachine". The bit is **reset** if: – The drive travels out of the range set in parameter *Target window* **1165** or – JOG-Mode is enabled or – Homing is started or – Operation mode "Teach-In" is enabled

7.4 Digital Positioning Output Signals

Parameters *OP. Mode Digital Output 1* **530** of digital output S1OUTD and *Op. Mode Digital Output 3* **532** of f the relay output link the digital outputs to various functions.
The use of the multifunctional output MFO1 as a digital output requires parametersetting *Operation mode* **550** = "1 - Digital" and linking via parameter *Digital operation MFO1* **554**.
The following output signals of the positioning function can be assigned to the digital outputs.

Note:	For information on other operation modes, refer to the operating instructions of the frequency inverter.

Digital signals		Function
26 -	Warning, Application	Warning messages of error/warning behavior function (HW limit switches, SW limit switches and contouring error monitoring of positioning function). The warnings are displayed as actual values via parameter *Application Warnings* **273**.
27 -	Warning Mask, Application	Message of the configurable parameter *Create Warning Mask Application* **626.**
56 -	Phasing Done	Master position evaluated by slave was offset by value of parameter *Phasing: Offset* **1125**.

57 -	In Gear	In *Motion Mode* **1208** with electronic gear (operation modes 10 to 14), synchronous operation of electronic gear was reached. Slave drive is engaged at current position and operates at a synchronous angle with master. Slave drive is synchronized with master frequency.
58 -	Position Comparator	Current position value is in the range between *On-Position* **1243** and *Off-Position* **1244**. The value selected in parameter *Hysteresis* **1245** is considered.
59 -	Homing Done	Message is triggered by homing operation or in *Motion Mode* **1208** with touch probe by taking over current position as reference position.
60 -	Target Position Reached	*Target Position / Distance* **1202** of a positioning operation was reached, and current act. position is within the range set in parameter *Target window* **1165** for a minimum period of *Target window time* **1166**.
61 -	Warning Deviation of Position	The contouring error monitoring *Warning Threshold* **1105** was exceeded.
62 -	Motion-Block Digital Signal 1	Message on status of a travel order during a positioning operation. The conditions set for parameter *Digital Signal 1* **1218** were fulfilled.
63 -	Motion-Block Digital Signal 2	Message on status of a travel order during a positioning operation. The conditions set for parameter *Digital Signal 2* **1219** were fulfilled.
64 -	Motion-Block Digital Signal 3	Message on status of a travel order during a positioning operation. The conditions set for parameter *Digital Signal 3* **1247** were fulfilled.
65 -	Motion-Block Digital Signal 4	Message on status of a travel order during a positioning operation. The conditions set for parameter *Digital Signal 4* **1248** were fulfilled.
	126-165	Operation modes 26 to 65, inverted.

7.5 Logic Signal Sources for Positioning

Logic signal sources can be assigned to the software functions for further processing. In addition to the signals on the digital control inputs, the following signal sources of the positioning functions are available. For information on other signal sources, refer to the operating instructions of the frequency inverter.

Logic signal		Function
215 -	Warning Mask, Application	Message of the configurable parameter *Create Warning Mask Application* **626.**
216 -	Application Warning	Warning messages of error/warning behavior function (HW limit switches, SW limit switches and contouring error monitoring of positioning function). The warnings are displayed as actual values via parameter *Application Warnings* **273**.
282 -	Target Position Reached	*Target Position / Distance* **1202** of a positioning operation was reached, and current position is within the range set in parameter *Target window* **1165** for a minimum period of *Target window time* **1166**.
604 -	Warning Position Controller	The contouring error monitoring *Warning Threshold* **1105** was exceeded.
614 -	Homing Done	Reference position is set. This is done by homing (parameters 1220 and 1130 to 1135) or in *Motion Mode* **1208** with touch probe (operation modes 2, 3, 12, 13) by taking over current position as reference position
615 -	Homing Requested	A homing operation was started. The signal is reset at the end of the homing operation.
616 -	Phasing Done	Master position evaluated by slave was offset by value of parameter *Phasing: Offset* **1125**. Parameters of phasing function are available in master settings of positioning function.
617 -	Latched Position	The stored actual position value of the drive. With a rising or falling signal edge (according to *Operation Mode* **1280**) at digital input S2IND the actual position value is stored in the EEPROM. The value is displayed via parameter *Latched Position* **1281**.
624 -	In Gear	In *Motion Mode* **1208** with electronic gear (operation modes 10 to 14), synchronous operation of electronic gear was reached. Slave drive is engaged at current position and operates at a synchronous angle with master. Slave drive is synchronized with master frequency.
876 -	Position Comparator Out	Current position value is in the range between *On-Position* **1243** and *Off-Position* **1244**. The value selected in parameter *Hysteresis* **1245** is considered.
877 -	Position Comparator Out inverted	Logic signal 876 inverted.

Logic signal		Function
887 -	MBC: Start Clockwise	Status message of clockwise operation of positioning control.
888 -	MBC: Start Anti-clockwise	Status message of anticlockwise operation of positioning control.
891 -	Motion-Block Digital Signal 1	Message on status of a travel order during a positioning operation. The conditions set for parameter *Digital Signal 1* **1218** were fulfilled.
892 -	Motion-Block Digital Signal 2	Message on status of a travel order during a positioning operation. The conditions set for parameter *Digital Signal 2* **1219** were fulfilled.
893 -	Motion-Block Digital Signal 3	Message on status of a travel order during a positioning operation. The conditions set for parameter *Digital Signal 3* **1247** were fulfilled.
894 -	Motion-Block Digital Signal 4	Message on status of a travel order during a positioning operation. The conditions set for parameter *Digital Signal 4* **1248** were fulfilled.
895 -	Motion-Block Digital Signal 1 inverted	Logic signal 891 inverted.
896 -	Motion-Block Digital Signal 2 inverted	Logic signal 892 inverted.
897 -	Motion-Block Digital Signal 3 inverted	Logic signal 893 inverted.
898 -	Motion-Block Digital Signal 4 inverted	Logic signal 894 inverted.

7.6 Positioning Error Messages

The following error messages may occur during positioning operations. For information on other error messages, refer to the operating instructions of the frequency inverter.

Error	Error message	Description/Action
F0404	Control Deviation Position Controller	The current contouring error has exceeded the value defined in *Error Threshold* **1106** for a time longer than the time defined in parameter *Contouring Error Time* **1119**. Optimize settings for speed (parameters 419, 1203, 1236) and acceleration pilot control (parameters 725 to 727)
F1442	Pos. SW-Limit Switch	Current position or target position of current motion order exceeds value for parameter *Positive SW Limit Switch* **1145**. Check *Target Position / Distance* **1202** parameter values entered in motion blocks.
F1443	Neg. SW-Limit Switch	Current position or target position of current motion order exceeds value for parameter *Negative SW Limit Switch* **1146.** Check *Target Position / Distance* **1202** values entered in motion blocks.
F1444	Pos. SW-Lim. Switch < Neg. SW-Lim. Switch	Value of parameter *Positive SW Limit Switch* **1145** smaller than value of parameter *Negative SW Limit Switch* **1146**. Check and, if necessary, change parameter values.
F1445	Pos. and Neg. HW-Lim Switch Simultaneously	Both hardware limit switches are active at the same time. Check limit switches and wiring of application.
F1446	Limit Switch Incorrect Wired!	Positive hardware limit switch activated although positioning performed in negative direction (motor rotates anticlockwise). Or: Negative hardware limit switch activated although positioning performed in positioning direction (motor rotates clockwise). Check plant and wiring.
F1447	Pos. HW Limit Switch	The positive hardware limit switch was reached. Check *Target Position / Distance* **1202** values entered in motion blocks.
F1448	Neg. HW Limit Switch	The negative hardware limit switch was reached. Check *Target Position / Distance* **1202** values entered in motion blocks.

Error	Error message	Description/Action
F1451	Clockwise Operation Locked	Positive hardware limit switch or positive software limit switch reached. After acknowledgement of error it was tried to move in positive direction (clockwise). Positive direction is disabled as long as positive limit switch is active. Move axis in defined travel range again: In JOG mode, move in opposite direction or start positioning in opposite direction.
F1452	Anti-Clockwise Operation Locked	Negative hardware limit switch or negative software limit switch reached. After acknowledgement of error it was tried to move in negative direction (anticlockwise). Negative direction is disabled as long as negative limit switch is active. Move axis in defined travel range again: In JOG mode, move in opposite direction or start positioning in opposite direction.
F1453	System bus-Synchronization not activated	Parameter *Master Position Source* **1122** of electronic gear is set to operation mode "11 - RxPDO1.Long1 extrapolated", but frequency inverter is not synchronized with data telegrams of system bus. Switch on system bus synchronization: Set Parameter *Operation Mode* **1180** to "1 - RxPDO1" or "10 - SYNC" (chapter "Master position source").
F1460	Pos. HW-Lim. Switch: Illegal Signal Source	*Pos. HW Limit Switch* **1138** is set to an illegal logic signal source or to a digital input of an expansion module (EM-S1IND, EM-S2IND or EM-S3IND) although no expansion module is installed. The parameter must be set to an available digital input.
F1461	Pos. HW-Lim. Switch: Input disabled by PWM-/FF-Input	The digital input for *Pos. HW Limit Switch* **1138** is set as PWM- or repetition frequency input. Set parameter *Operation Mode* **496** of the PWM-/repetition frequency input to "0 - off" or to another digital input to use the digital input as HW-limit switch input.
F1462	Pos. HW-Lim. Switch: Input disabled by Index-Contr.	The digital input for *Pos. HW Limit Switch* **1138** is set as input for index control. Check the settings of *Operation Mode* **598** of the index control and *Index Controller Release* **96**. Alternatively use another digital input for the connection of the HW-limit switch.
F1463	Pos. HW-Lim. Switch: Wrong Op.-Mode for MFI1	The multifunction input MFI1 at terminal X210B.6 is set as voltage input or current input via parameter *Operation Mode* **452**. Set *Operation Mode* **452** to "3 - Digital Input" to use the multifunction input as HW-limit switch input.
F1464	Pos. HW-Lim. Switch: Input disabled by Encoder 1	The digital input for *Pos. HW Limit Switch* **1138** is set as encoder input. Set *Operation Mode* **490** of the speed sensor 1 to "0 - off" to use the digital input as HW-limit switch input. Alternatively use another digital input for the connection of the HW-limit switch.
F1465	Pos. HW-Lim. Switch: Input disabled by Encoder 2	The digital input for *Pos. HW Limit Switch* **1138** is set as encoder input. Set *Operation Mode* **493** of the speed sensor 2 to "0 - off" to use the digital input as HW-limit switch input. Alternatively use another digital input for the connection of the HW-limit switch.
F1466	Pos. HW-Lim. Switch: Wrong Op.-Mode for EM-S1IOD	The digital port EM-S1IOD of an expansion module is misadjusted for the evaluation of a HW-limit switch. The parameter *Operation Mode* **558** must be set to "0 - input".
F1470	Neg. HW-Lim. Switch: Illegal Signal Source	*Neg. HW Limit Switch* **1137** is set to an illegal logic signal source or to a digital input of an expansion module (EM-S1IND, EM-S2IND or EM-S3IND) although no expansion module is installed. The parameter must be set to an available digital input.
F1471	Neg. HW-Lim. Switch: Input disabled by PWM-/FF-Input	The digital input for *Neg. HW Limit Switch* **1137** is set as PWM- or repetition frequency input. Set parameter *Operation Mode* **496** of the PWM-/repetition frequency input to "0 - off" or to another digital input to use the digital input as HW-limit switch input.
F1472	Neg. HW-Lim. Switch: Input disabled by Index-Contr.	The digital input for *Neg. HW Limit Switch* **1137** is set as input for index control. Check the settings of *Operation Mode* **598** of the index control and *Index Controller Release* **96**. Alternatively use another digital input for the connection of the HW-limit switch.
F1473	Neg. HW-Lim. Switch: Wrong Op.-Mode for MFI1	The multifunction input MFI1 at terminal X210B.6 is set as voltage input or current input via parameter *Operation Mode* **452**. Set *Operation Mode* **452** to "3 - Digital Input" to use the multifunction input as HW-limit switch input.
F1474	Neg. HW-Lim. Switch: Input disabled by Encoder 1	The digital input for *Neg. HW Limit Switch* **1137** is set as encoder input. Set *Operation Mode* **490** of the speed sensor 1 to "0 - off" to use the digital input as HW-limit switch input. Alternatively use another digital input for the connection of the HW-limit switch.

Error	Error message	Description/Action
F1475	Neg. HW-Lim. Switch: Input disabled by Encoder 2	The digital input for *Neg. HW Limit Switch* **1137** is set as encoder input. Set *Operation Mode* **493** of the speed sensor 2 to "0 - off" to use the digital input as HW-limit switch input. Alternatively use another digital input for the connection of the HW-limit switch.
F1476	Neg. HW-Lim. Switch: Wrong Op.-Mode for EM-S1IOD	The digital port EM-S1IOD of an expansion module is misadjusted for the evaluation of a HW-limit switch. The parameter *Operation Mode* **558** must be set to "0 - input".
F15xx	User-Defined Error in Motion Block xx ($1 \leq xx \leq 32$)	The parameterized behavior for Delay or "Next Motion Block" (after event) is effective. A delay is expired or an event is triggered and one of the following operation modes is assigned to a parameter for "Next Motion Block" Parameter for "Next Motion Block": — Operation Mode: *Delay: Next Motion Block* **1213**, *Event 1: Next Motion Block* **1215**, *Event 2: Next Motion Block* **1217**, *Int.-Event 1: Next Motion Block* **1262**, *Int.-Event 2: Next Motion Block* **1265** — **-**1 (Minus 1) – Error Switch-Off; **-**2 (Minus 2) – Stop, error; **-**3 (Minus 3) – Em. stop, error
F1570	No Homing Done	An Absolute Positioning was started without prior homing. Signal "59 – Homing Done" is not set and there is no point of reference for an absolute positioning. Start homing. Before starting absolute positioning, wait until signal "59 – Homing Done" is set. Please note, that relative positioning modes and velocity operations can be executed without homing.
F1571	Homing : Encoder-Mode w.o. Z-Impulse	For *Homing Mode* **1130**, an operation mode with zero impulse was selected for setting the reference position. However, an operation mode without zero impulse is selected to evaluate the encoder.
F1572	Both Directions Locked	Settings of SW limit switches or connections of HW limit switches is not correct. Check parameter configuration, particularly settings of parameters *Positive SW Limit Switch* **1145** and *Negative SW Limit Switch* **1146**. Check limit switches and wiring of application. Switch frequency inverter off and on again to reset this error.
F1573	No Touch Probe Signal Detected	No touch-probe signal received within the range set in parameter *Touch-Probe-Window* **1209**. Check position and wiring of touch probe sensor. Touch probe sensor must be connected on digital input S3IND. If necessary, increase touch probe window.

The display of actual values in VPlus is refreshed after the window for parameterizing of motion blocks VTable has been closed.

7.7 Positioning Warning Status

Warnings of the positioning functions are displayed in the error environment by parameter *Application Warning Status* **367** and can be used for an early message of a critical operational condition. Combinations of various warnings can be created in parameter *Create Appl. Warning Mask* **626**. If a warning is present, this is indicated by the flashing red LED and the display field WARN of the control unit KP500.
Meaning of code displayed by parameter *Application Warning Status* **367**

7.8 Diagnosis and fault clearance

Diagnosis and monitoring in operation and in the case of error messages is represented clearly by parameter groups "Actual Values of Frequency Inverter" and "Actual Values of Machine". In these parameter groups, the operating status and values can be analyzed.

For the error messages of parameter *Current Error* **259**, refer to section "Positioning Error Messages" of positioning function.

Code	Warning status	
A	0000 NO WARNING	No warning message present.
A	0002 SW-LIM CW	The positive SW limit switch was reached during clockwise operation of the motor (parameter *Positive SW limit switch* **1145**).
A	0004 SW-LIM CCW	The negative SW limit switch was reached during anticlockwise operation of the motor (parameter *Negative SW limit switch* **1146**).
A	0008 HW-LIM CW	The positive HW limit switch was reached during clockwise operation of the motor (parameter *Positive HW limit switch* **1138**).
A	0010 HW-LIM CCW	The negative HW limit switch was reached during anticlockwise operation of the motor (parameter *Negative HW limit switch* **1137**).
A	0020 CONT	The contouring error monitoring range adjusted with parameter *Warning Threshold* **1105** was left.

- Check wiring and units for damage.
- Check if all units (including bus clients, encoders, etc.) are supplied with power and ready for operation.
- If a limit switch is active, the corresponding direction of rotation is disabled. First, the drive must be moved into the permissible range in opposite direction (e.g. in JOG mode).
- Check if homing was completed and "614 – Homing Done" was signaled.

The positioning functionality is very complex. Due to this complexity in combination with other devices (e.g. PLC), diagnosis must generally be performed across the whole system.
The following descriptions of anomalous operating behaviours help to find the cause of failures.

7.8.1 Touch probe: Drive is decelerated or stops

Description:
Touch probe input is used in parameterization. As soon as the touch probe input is activated, the drive is decelerated or stopped.

Remedy:
Change parameter *Stop Positioning* **1223** to an input other than S3IND. Change wiring accordingly.

7.8.2 Drive jerks/is very loud

Description:
Drive jerks during positioning and is very loud.

Remedy:
If the resolution is too coarse, the number of increments (units) per revolution is too low which results in inexact positioning. Increase precision in application via *Feed Constant* **1115** (factor 100 or 1000 typical). Change positioning data in motion blocks, too. Then perform homing operation. Software limit switches must be adjusted to new environment, too.

7.8.3 The drive gets faster than set in the Maximum frequency

Description:
The drive offers speeds above the preset maximum frequency.
Possible causes:

- Engagement of the position controller. The position controller can add up to its set *Limitation* **1118** frequency to the *Maximum frequency* **419** to compensate a contouring error
- External (generator) influences

Remedy:

- Set *Limitation* **1118** and *Maximum frequency* **419** fitting to each other.
- Use stiffer settings in the Speed Controller.

NOTE:	For converting user units [u] into a Frequency [Hz] you can find a formula collection in chapter 10.2 “Conversions”.

8 Motion Control Interface (MCI) – Positioning via Fieldbus

In the previous chapters, the Positioning was explained in detail for the motion block table. The motion block table is very well suited in applications where changes in the profiles (particularly the target position) happen seldom or not at all.
In connection with a programmable logic control (PLC) the profiles are often calculated from the control and the profile should be used in the drive for positioning. In ACTIVE Cube the so-called Motion Control Interface (MCI) can be used as an interface for such a profile.
The supported modes according to CANopen standard DS402 are:

- 1 – Profile Position mode
- 2 – Velocity mode [rpm]
- 3 – Profile Velocity mode [u/s]
- 6 – Homing
- 7 – Interpolated mode

Bonfiglioli Vectron defined Modes

- -1 (oder 0xFF) – Table Travel record mode (Fahrsatztabellenmodus)
- -2 (oder 0xFE) – Move Away from Limit Switch (Endschalter freifahren)
- -3 (oder 0xFD) – Electronic Gear: Slave (Elektronisches Getriebe als Slave)

To use the Motion Control Interface, set **412** *Local/Remote* = „1 – Control via Statemachine".
The use of the Motion Control Interface depends on the used Fieldbus and is therefore described in the corresponding Communication manual.
The following fieldbus modules support the Motion Control Interface:
CANopen CM-CAN
Profibus DP-V1 CM-DPV1 (no Interpolated Mode)

NOTE:	The Motion Control Interface has a significant impact on the Control word and Status word. An overview of the Control word and Status word is also listed in the corresponding Communication manual.

8.1 Used Parameters

The main parameters of the Motion Control Interface are listed in the following table.

Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Fact. sett.**
1292	S. Modes of Operation	Selection		801 – Obj. 0x6060 Modes of Operation
1293	S. Target Position	Selection		802 – Obj. 0x607A Target Position
1294	S. Profile Velocity [1)]	Selection		803 – Obj. 0x6081 Profile Velocity
1295	S. Acceleration [2)]	Selection		804 – Obj. 0x6083 Profile Acceleration
1296	S. Deceleration [3)]	Selection		805 – Obj. 0x6084 Profile Deceleration
1297	S. Target Velocity	Selection		806 – Obj. 0x6042 Target Velocity

9 Parameter List

The parameter list is ordered numerically. For better clarity, the parameters are marked with pictograms.

	The parameter is available in the four data sets.
☑	Parameter value is displayed in VSetup
⊗	This parameter cannot be written when the frequency inverter is in operation.
	This parameter can be edited using VTable in VPlus.

NOTE:	At the control unit KP500 parameter numbers > 999 are displayed hexadecimal at the leading digit (999, A00 … B5 … C66).

9.1 Actual Value Menu (VAL)

No.	Description	Unit	Display range	Chapter
Actual Values of the Frequency Inverter				
273	Application Warnings	-	A0000 ... A003F	7.1; 5.9.6
Error Environment				
367	Application Warning Status	-	A0000 ... A003F	7.7; 5.9.6
Digital Outputs				
627	Actual Appl. Warning Mask	-	A0000 ... A003F	7.1; 5.9.6
Actual Values of the Machine				
1107	Act. Speed	u/s	-2^{31} ... $2^{31}-1$	7.1
1108	Act. Position	u	-2^{31} ... $2^{31}-1$	7.1
1109	Act. Contouring Error	u	0 ... $2^{31}-1$	7.1; 5.9.5
Actual value memory				
1121	Peak Value Contouring Error	u	0 ... $2^{31}-1$	7.1; 5.9.5
Actual Values of the Machine				
1129	Act. Master Speed	u/s	-2^{31} ... $2^{31}-1$	7.1; 5.5.1.5
1246	Actual Motion Block	-	-10 [1], -3 ... 32	7.1; 5.5.2.4
1249	Motion Block to Resume	-	-1 ... 32	7.1; 5.5.5.2
Actual Values of the Machine				
1255	Actual Motion Mode	-	Status word decimal code & text	7.1
Latching function				
1281	Latched Position	u	-2^{31} ... 2^{31}	5.14

[1] -10: Homing

9.2 Parameter Menu (PARA)

	No.	Description	Unit	Setting range	Fact. sett.	Chapter
Warning application						
	626	Create Appl. Warning Mask	-	Selection: 0 … 115	0 – no change	5.9.6
Position Controller						
	1104	Time Constant	ms	0.00 ... 300.00	10.00 [1] 100.00 [2]	5.13
Contouring Error Monitoring						
	1105	Warning Threshold	u	0 ... $2^{31}-1$	32768	5.9.5
	1106	Error Threshold	u	0 ... $2^{31}-1$	65536	5.9.5

[1] For parameter setting *Configuration* **30** = 240 or 540

[2] For parameter setting *Configuration* **30** = 340, 440 or 640

	No.	Description	Unit	Setting range	Fact. sett.	Chapter
Reference System						
☑ ⊗	1115	Feed Constant	u/U	1 ... $2^{31}-1$	2^{16}	4.4.2
☑ ⊗	1116	Gear Box: Driving shaft revo-lutions	-	1 ... 65535	1	4.4.2

	No.	Description	Unit	Setting range	Fact. sett.	Chapter
☑ ⊗	1117	Gear Box: Motor shaft revolutions	-	1 ... 65535	1	4.4.2
		Position Controller				
	1118	Limitation	u/s	0 ... 2^{31}-1	327680	5.13
		Contouring error supervision				
	1119	Contouring Error Time	ms	0 ... 65535	10	5.9.5
	1120	Fault Reaction	-	Selection: 0 ... 3	0 – Off	5.9.5
		Master Settings (el. gear)				
	1122	Master Position Source	-	0 ... 11	0 – Off	5.8.1
	1123	Gear Factor Numerator	-	-32767 ... 32767	1	5.8.2
	1124	Gear Factor Denominator	-	1 ... 65535	1	5.8.2
	1125	Phasing: Offset	u	-(2^{31}-1) ... 2^{31}-1	65536	5.8.4
	1126	Phasing: Speed	u/s	1 ... 2^{31}-1	327680	5.8.4
	1127	Phasing: Acceleration	u/s^2	1 ... 2^{31}-1	327680	5.8.4
	1128	Start Phasing	-	Selection: Logic signal	7 – Off	5.8.4
		Homing				
	1130	Homing Mode	-	Selection: 0 ... 35	0 – no homing done	5.2.3
	1131	Home-Offset	u	-(2^{31}-1) ... 2^{31}-1	0	5.2.4
	1132	Fast Speed	u/s	1 ... 2^{31}-1	327680	5.2.5
	1133	Creep Speed	u/s	1 ... 2^{31}-1	163840	5.2.5
	1134	Acceleration	u/s^2	1 ... 2^{31}-1	327680	5.2.5
	1135	Ramp Rise Time	ms	0 ... 2000	0	5.2.5
		Digital inputs				
	1137	Neg. HW Limit Switch	-	Selection: Digital input	7 – Off	5.9.2
	1138	Pos. HW Limit Switch	-	Selection: Digital input	7 – Off	5.9.2
	1139	Home Switch	-	Selection: Digital input	75 – S6IND	5.2; 5.2.3; 5.1.1
		Act. Position Channel				
	1141	Actual Position Source	-	Selection 0 ... 3	0 – As P. 766 Actual Speed Source	4.4.1
		Master Settings (el. gear)				
	1142	Resync. on Change of Gear-Factor	-	Selection: 0 ... 1	1 – On	5.8.3
		Hardware Limit Switch				
	1143	Fault Reaction	-	Selection: 0 ... 3, 10	1 – Error-Switch-Off	5.9.2.2
		Software limit switches				
	1144	Fault Reaction	-	Selection: 0 ... 3, 10	0 – Off	5.9.3
	1145	Pos. SW Limit Switch	u	-(2^{31}-1) ... 2^{31}-1	65536	5.9.3
	1146	Neg. SW Limit Switch	u	-(2^{31}-1) ... 2^{31}-1	-65536	5.9.3
		Hardware Limit Switch				
	1149	Hysteresis	u	0 ... 2^{31}-1	182	5.9.2.1
		Target Window				
	1165	Target Window	u	0 ... 2^{20}-1	182	5.9.4
	1166	Target Window Time	ms	1 ... 65535	1	5.9.4
		Master Settings (el. gear)				
	1168	"In-Gear"-Threshold	u	1 ... 2^{31}-1	0	5.5.1.5
	1169	"In-Gear"-Time	ms	1 ... 65535	10	5.5.1.5
		Fixed Speed-Values				
☑	1170	Fixed Speed 1	u/s	-(2^{31}-1) ... 2^{31}-1	163480	5.6.1
	1171	Fixed Speed 2	u/s	-(2^{31}-1) ... 2^{31}-1	327680	5.6.1
	1172	Fixed Speed 3	u/s	-(2^{31}-1) ... 2^{31}-1	655360	5.6.1
	1173	Fixed Speed 4	u/s	-(2^{31}-1) ... 2^{31}-1	1310720	5.6.1
	1174	Jog-Speed Keypad	u/s	-(2^{31}-1) ... 2^{31}-1	163840	5.6.1

No.	Description	Unit	Setting range	Fact. sett.	Chapter
Ramps					
1175	Acceleration	u/s²	1 ... 2³¹-1	327680	5.6.2
1176	Ramp Rise Time	ms	0 ... 2000	0	5.6.2
1177	Deceleration	u/s²	1 ... 2³¹-1	327680	5.6.2
1178	Ramp Fall Time	ms	0 ... 2000	0	5.6.2
1179	Emergency Ramp	u/s²	1 ... 2³¹-1	655360	5.6.2
System bus Synchronization					
1180	Operation mode	-	Selection: 0 ... 10	0 – Off	5.8.1
Motion Blocks					
1200	Motion Block Sel. (Writing)	-	0 ... 65	1	5.4.1
1201	Motion Block Sel. (Reading)	-	0 ... 65	1	5.4.1
1202	Target Position / Distance	u	-2³¹ ... 2³¹-1	65536	5.5.2.1
1203	Speed	u/s	-(2³¹ - 1) ... 2³¹-1	163840	5.5.2.2
1204	Acceleration	u/s²	1 ... 2³¹-1	327680	5.5.2.3
1205	Ramp Rise Time	ms	0 ... 2000	0	5.5.2.3
1206	Deceleration	u/s²	1 ... 2³¹-1	327680	5.5.2.3
1207	Ramp Fall Time	ms	0 ... 2000	0	5.5.2.3
1208	Motion Mode	-	Selection: 0 ... 14	0 - absolute	5.5.1
1209	Touch-Probe-Window	u	0 ... 2³¹-1	65536	5.5.1.3
1210	Touch-Probe-Error: Next Motion Block	-	-3 ... 32	-2 – shutdown, error	5.5.1.3
1211	No. of Repetitions	-	0 ... 255	0	5.5.2.4
1212	Delay	ms	0 ... 65535	0	5.5.2.4
1213	Delay: Next Motion Block	-	-3 ... 32	0	5.5.2.4
1214	Event 1	-	Selection: Logic signal	7 – Off	5.5.2.4
1215	Event 1: Next Motion Block	-	-3 ... 32	0	5.5.2.4
1216	Event 2	-	Selection: Logic signal	7 – Off	5.5.2.4
1217	Event 2: Next Motion Block	-	-3 ... 32	0	5.5.2.4
1218	Digital Signal 1	-	Selection: 0 ... 212	0 – unv.	5.5.6
1219	Digital Signal 2	-	Selection: 0 ... 212	0 – unv.	5.5.6
Homing					
1220	Operation mode	-	Selection: 1 ... 2	2 – automatic	5.2.1
Control					
1221	Operation mode	-	Selection: 0 ... 302	102 – Sequence Mode w/o Restart	5.1; 5.1.2
Digital inputs					
1222	Start Positioning	-	Selection: Logic signal	71 – S2IND	5.5.5.1
1223	Stop Positioning	-	Selection: Logic signal	72 – S3IND	5.5.5.1
Digital inputs					
1224	Motion Block Change-Over 1	-	Selection: Logic signal	320 – EM-S1IND	5.5.3.1
1225	Motion Block Change-Over 2	-		321 – EM-S2IND	5.5.3.1
1226	Motion Block Change-Over 3	-		322 – EM-S3IND	5.5.3.1
1227	Motion Block Change-Over 4	-		7 – Off	5.5.3.1
Control					
1228	Starting-Record Number	-	1 ... 32	1	5.5.3.2
Digital inputs					
1230	Resume Motion Block	-	Selection:	7 – Off	5.5.5.2

No.	Description	Unit	Setting range	Fact. sett.	Chapter
1231	Jog-Mode Active	-	Logic signal	76 – MFI1D	5.6
1232	Jog Clockwise	-		71 – S2IND	5.6
1233	Jog Anticlockwise	-		72 – S3IND	5.6
1235	Start Homing (manual)	-		7 – Off	5.2.1
Control					
1236	Speed Override	-	Selection: 0 ... 1	0 – Off	5.10
Digital inputs					
1239	Teach-In-Signal	-	Selection: Logic signal	76 – MFI1D	5.7
Rotary Table Function					
1240	Operation mode	-	Selection: 0 ... 4	0 – Off	5.12
1241	Units Per Revolution	u	1 ... 2^{31}-1	65536	5.12
Position Comparator					
1242	Operation mode	-	Selection: Position source	9 – Off	5.11
1243	On-Position	u	-2^{31} ... 2^{31}-1	0	5.11
1244	Off-Position	u	-2^{31} ... 2^{31}-1	65536	5.11
1245	Hysteresis	u	0 ... 2^{31}-1	182	5.11
Motion Blocks					
1247	Digital Signal 3	-	Selection: 0 ... 212	0 – unv.	5.5.6
1248	Digital Signal 4	-	Selection: 0 ... 212	0 – unv.	5.5.6
Digital inputs					
1254	Motion Block Change-Over 5	-	Selection: Logic signal	7 – Off	5.5.3.1
Motion Blocks					
1260	Interrupt-Event 1	-	Selection: Logic signal	7 – Off	5.5.2.4
1261	Int.-Event 1: Eval.-Mode	-	1 ... 6	1 – Level Control-led	5.5.2.4
1262	Int.-Event 1: Next Motion Block	-	-3 ... 32	0 – Disabled	5.5.2.4
1263	Interrupt-Event 2	-	Selection: Logic signal	7 – Off	5.5.2.4
1264	Int.-Event 2: Eval.-Mode	-	1 ... 6	1 – Level Control-led	5.5.2.4
1265	Int.-Event 2: Next Motion Block	-	-3 ... 32	0 – Disabled	5.5.2.4
Latching function					
1280	Operation Mode	-	0 ... 2	0 – Off	5.14
Motion Control Interface					
1292	S. Modes of Operation	-	Selection	801 – 0x6060	8.1
1293	S. Target Position	-	Selection	802 – 0x607A	8.1
1294	S. Profile Velocity	-	Selection	803 – 0x6081	8.1
1295	S. Acceleration	-	Selection	804 – 0x6083	8.1
1296	S. Deceleration	-	Selection	805 – 0x6084	8.1
1297	S. Target Velocity	-	Selection	806 – 0x6042	8.1
Motion Control Override					
1454	Override Modes of Operation	-	Selection	0	Fieldbus
1455	Override Target Position	-		-1 u	Fieldbus
1456	Override Profile Velocity	-		-1 u/s	Fieldbus
1457	Override Profile Acceleration	-		-1 u/s²	Fieldbus
1458	Override Profile Deceleration	-		-1 u/s²	Fieldbus
1459	Override Target velocity vl [rpm]	-		-1 rpm	Fieldbus

9.3 Field bus: The parameter is described in the used Fieldbus manual.Parameter list, sorted by function

The parameter list is sorted by positioning functions. For the setting and display ranges, refer to numerically sorted parameter lists in chapters "Parameter Menu (PARA)" and "Actual Value Menu (VAL)".

Chapter	No.	Name of parameter
Reference system		
4.4.2	1115	Feed Constant
4.4.2	1116	Gear Box: Driving shaft revolutions
4.4.2	1117	Gear Box: Motor shaft revolutions
Homing		
5.2.1	1220	Operation Mode
5.2.1	1235	Start Homing (manual)
5.2.3	1130	Homing Mode
	1131	Home-Offset
5.2.5	1132	Fast Speed
5.2.5	1133	Creep Speed
5.2.5	1134	Acceleration
5.2.5	1135	Ramp Rise Time
5.2.2	1139	Home Switch
JOG Mode		
5.6	1231	Jog-Mode Active
5.6	1232	Jog Clockwise
5.6	1233	Jog Anticlockwise
5.6.1	1170	Fixed Speed 1
5.6.1	1171	Fixed Speed 2
5.6.1	1172	Fixed Speed 3
5.6.1	1173	Fixed Speed 4
5.6.1	1174	Jog-Speed Keypad
Ramps		
5.6.2	1175	Acceleration
5.6.2	1176	Ramp Rise Time
5.6.2	1177	Deceleration
5.6.2	1178	Ramp Fall Time
5.6.2	1179	Emergency Ramp
Positioning control		
5.1.2	1221	Operation mode
5.5.5.1	1222	Start Positioning
5.5.5.1	1223	Stop Positioning
5.5.5.2	1230	Resume Motion Block
5.5.3.1	1224	Motion Block Change-Over 1
5.5.3.1	1225	Motion Block Change-Over 2
5.5.3.1	1226	Motion Block Change-Over 3
5.5.3.1	1227	Motion Block Change-Over 4
5.5.3.1	1254	Motion Block Change-Over 5
5.5.3.2	1228	Starting-Record Number
Teach-In		
5.7	1239	Teach-In-Signal
Position Comparator		
5.11	1242	Operation mode
5.11	1243	On-Position
5.11	1244	Off-Position
5.11	1245	Hysteresis

Chapter	No.	Name of parameter
Motion Blocks		
5.4.1	1200	Motion Block Sel. (Writing)
5.4.1	1201	Motion Block Sel. (Reading)
5.5.2.1	1202	Target position / Distance
5.5.2.2	1203	Speed
5.5.2.2	1204	Acceleration
5.5.2.2	1205	Ramp Rise Time
5.5.2.2	1206	Deceleration
5.5.2.2	1207	Ramp Fall Time
5.5.1	1208	Motion Mode
5.5.1.3	1209	Touch-Probe-Window
5.5.1.3	1210	Touch-Probe-Error: Next Motion Block

Chapter	No.	Name of parameter
Automatic sequence		
5.5.2.4	1211	No. of Repetitions
5.5.2.4	1212	Delay
5.5.2.4	1213	Delay: Next Motion Block
5.5.2.4	1214	Event 1
5.5.2.4	1215	Event 1: Next Motion Block
5.5.2.4	1216	Event 2
5.5.2.4	1217	Event 2: Next Motion Block
5.5.2.4	1260	Interrupt-Event 1
5.5.2.4	1261	Int.-Event 1: Eval.-Mode
5.5.2.4	1262	Int.-Event 1: Next Motion Block
5.5.2.4	1263	Interrupt-Event 2
5.5.2.4	1264	Int.-Event 2: Eval.-Mode
5.5.2.4	1265	Int.-Event 2: Next Motion Block
	Status indication	
5.5.6	1218	Digital Signal 1
5.5.6	1219	Digital Signal 2
5.5.6	1247	Digital Signal 3
5.5.6	1248	Digital Signal 4
	Actual values:	
7.1; 5.5.2.4	1246	Actual Motion Block
7.1; 5.5.5.2	1249	Motion Block to Resume
7.1	1255	Actual Motion Mode

Chapter	No.	Name of parameter
Master Settings (el. gear)		
5.8.1	1122	Master Position Source
5.8.2	1123	Gear Factor Numerator
5.8.2	1124	Gear Factor Denominator
5.8.3	1142	Resync. on Change of Gear-Factor
5.8.4	1125	Phasing: Offset
5.8.4	1126	Phasing: Speed
5.8.4	1127	Phasing: Acceleration
5.8.4	1128	Start Phasing
5.5.1.5	1168	"In-Gear"-Threshold
5.5.1.5	1169	"In-Gear"-Time
	Actual value:	
7.1; 5.5.1.5	1129	Act. Master Speed
Monitoring functions:		
Hardware Limit Switch		
5.9.2.2	1143	Fault Reaction
5.9.2	1137	Neg. HW Limit Switch
5.9.2	1138	Pos. HW Limit Switch
5.9.2.1	1149	Hysteresis
Software limit switches		
5.9.3	1144	Fault Reaction
5.9.3	1145	Pos. SW Limit Switch
5.9.3	1146	Neg. SW Limit Switch
Contouring error monitoring		
5.9.5	1105	Warning Threshold
5.9.5	1106	Error Threshold
5.9.5	1119	Contouring Error Time
5.9.5	1120	Fault Reaction
	Actual values:	
7.1; 5.9.5	1109	Act. Contouring Error
7.1; 5.9.5	1121	Peak Value Contouring Error
Target Window		
5.9.4	1165	Target Window

Chapter	No.	Name of parameter
5.9.4	1166	Target Window Time
Warning application		
5.9.6	626	Create Appl. Warning Mask
	Actual values:	
7.1; 5.9.6	273	Application Warnings
7.7; 5.9.6	367	Application Warning Status
7.1; 5.9.6	627	Actual Appl. Warning Mask

Chapter	No.	Name of parameter
Speed Override		
5.10	1236	Speed Override
Rotary table		
5.12	1240	Operation Mode
5.12	1241	Units per Revolution
Position controller		
5.13	1104	Time Constant
5.13	1118	Limitation
Position encoder		
4.4.1	1141	Actual Position Source
Act. values		
7.1	1107	Act. Speed
7.1	1108	Act. Position
Latching function		
5.14	1280	Operation Mode
Actual value:		
5.14	1281	Latched Position
Latching function		
7.1	1292	S. Modes of Operation
7.1	1293	S. Target Position
7.1	1294	S. Profile Velocity
7.1	1295	S. Acceleration
7.1	1296	S. Deceleration
7.1	1297	S. Target Velocity

10 Appendix

10.1 Fault Messages

An overview of the fault messages of the Positioning functionality are displayed in chapter 7.6 "Positioning Error Messages".

10.2 Conversions

The speeds can be converted into other speed formats using the formulas in this chapter:

Frequency [Hz] to	Speed [rpm]	See chapter 10.2.2
	Speed in user units [u/s]	See chapter 10.2.4
Speed [rpm] to	Frequency [Hz]	See chapter 10.2.1
	Speed in user units [u/s]	See chapter 10.2.6
Speed in user units [u/s]	Speed [rpm]	See chapter 10.2.5
	Frequency [Hz]	See chapter 10.2.3

10.2.1 Speed [rpm] to Frequency [Hz]

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

10.2.2 Frequency [Hz] to Speed [rpm]

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

10.2.3 Speed in user units [u/s] to Frequency [Hz]

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

10.2.4 Frequency [Hz] to Speed in user units [u/s]

$$v\ [\frac{\mathrm{u}}{\mathrm{s}}] = f\ [\mathrm{Hz}] \times \frac{Feed\ Constant\ (P.1115)}{Polpaarzahl\ (P.373)} \times \frac{Gear\ Box: Driving\ Shaft\ Revolutions (P.1116)}{Gear\ Box: Motor\ Shaft\ Revolutions\ (P.1117)}$$

10.2.5 Speed in user units [u/s] to Speed [rpm]

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

10.2.6 Speed [rpm] to Speed in user units [u/s]

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

INDEX

S

T

U

V

W

Bonfiglioli Worldwide Locations

Australia
Bonfiglioli Transmission (Aust.) Pty Ltd
2, Cox Place Glendenning NSW 2761
Locked Bag 1000 Plumpton NSW 2761
Tel. +61 2 8811 8000

Brazil
Bonfiglioli Redutores do Brasil Ltda
Travessa Cláudio Armando 171 - Bloco 3
CEP 09861-730 - Bairro Assunção
São Bernardo do Campo - São Paulo
Tel. +55 11 4344 2322

China
Bonfiglioli Drives (Shanghai) Co. Ltd.
#68, Hui-Lian Road, QingPu District,
201707 Shanghai
Tel. +86 21 6700 2000

France
Bonfiglioli Transmission s.a.
14 Rue Eugène Pottier
Zone Industrielle de Moimont II
95670 Marly la Ville
Tel. +33 1 34474510

Germany
Bonfiglioli Deutschland GmbH
Sperberweg 12 - 41468 Neuss
Tel. +49 0 2131 2988 0

Bonfiglioli Vectron GmbH
Europark Fichtenhain B6 - 47807 Krefeld
Tel. +49 0 2151 8396 0

O&K Antriebstechnik GmbH
Ruhrallee 8-12 - 45525 Hattingen
Tel. +49 0 2324 2050 1

India
Bonfiglioli Transmission Pvt. Ltd.
Mobility & Wind Industries
AC 7 - AC 11 Sidco Industrial Estate
Thirumudivakkam Chennai - 600 044
Tel. +91 844 844 8649

Discrete Manufacturing & Process Industries - Mechatronic & Motion
Survey No. 528/1
Perambakkam High Road Mannur Village,
Sriperumbudur Taluk Chennai - 602 105
Tel. +91 844 844 8649

Discrete Manufacturing & Process Industries
Plot No.A-9/5, Phase IV MIDC Chakan,
Village Nighoje Pune - 410 501
Tel. +91 844 844 8649

Italy
Bonfiglioli Riduttori S.p.A.
Discrete Manufacturing & Process Industries
Via Bazzane, 33/A
40012 Calderara di Reno
Tel. +39 051 6473111

Mobility & Wind Industries
Via Enrico Mattei, 12 Z.I. Villa Selva
47100 Forlì
Tel. +39 0543 789111

Discrete Manufacturing & Process Industries
Via Sandro Pertini lotto 7b
20080 Carpiano
Tel. +39 02985081

Bonfiglioli Mechatronic Research S.p.A
Via Unione 49 - 38068 Rovereto
Tel. +39 0464 443435/36

New Zealand
Bonfiglioli Transmission (Aust.) Pty Ltd
88 Hastie Avenue, Mangere Bridge,
2022 Auckland
PO Box 11795, Ellerslie
Tel. +64 09 634 6441

Singapore
Bonfiglioli South East Asia Pte Ltd
8 Boon Lay Way, #04-09,
8@ Tadehub 21, Singapore 609964
Tel. +65 6268 9869

Slovakia
Bonfiglioli Slovakia s.r.o.
Robotnícka 2129
Považská Bystrica, 01701 Slovakia
Tel. +421 42 430 75 64

South Africa
Bonfiglioli South Africa Pty Ltd.
55 Galaxy Avenue, Linbro Business Park,
Sandton, Johannesburg
2090 South Africa
Tel. +27 11 608 2030

Spain
Tecnotrans Bonfiglioli S.A
Pol. Ind. Zona Franca, Sector C,
Calle F, n° 6 - 08040 Barcelona
Tel. +34 93 447 84 00

Turkey
Bonfiglioli Turkey Jsc
Atatürk Organize Sanayi Bölgesi,
10007 Sk. No. 30
Atatürk Organize Sanayi Bölgesi,
35620 Çiğli - Izmir
Tel. +90 0 232 328 22 77

United Kingdom
Bonfiglioli UK Ltd.
Unit 1 Calver Quay, Calver Road, Winwick
Warrington, Cheshire - WA2 8UD
Tel. +44 1925 852667

USA
Bonfiglioli USA Inc.
3541 Hargrave Drive
Hebron, Kentucky 41048
Tel. +1 859 334 3333

Vietnam
Bonfiglioli Vietnam Ltd.
Lot C-9D-CN My Phuoc Industrial Park 3
Ben Cat - Binh Duong Province
Tel. +84 650 3577411

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HEADQUARTERS
Bonfiglioli S.p.A
Registered Office: Via Bazzane, 33
40012 Calderara di Reno BO
Head office: Via Isonzo, 65/67/69
40033 Casalecchio di Reno BO
ITALY

tel: +39 051647 3111
www.bonfiglioli.com