SIEMENS

Function manual

SIMATIC

S7-1500

S7-1500T Motion Control V4.0 in TIA Portal V15

Edition 12/2017

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S7-1500
S7-1500T Motion Control V4.0 in TIA Portal V15

Function Manual

TIA Portal V15

12/2017

A5E37577655-AB

Legal information

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This manual contains notices you have to observe in order to ensure your personal safety, as well as to prevent damage to property. The notices referring to your personal safety are highlighted in the manual by a safety alert symbol, notices referring only to property damage have no safety alert symbol. These notices shown below are graded according to the degree of danger.

⚠ DANGER

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⚠ WARNING

indicates that death or severe personal injury **may** result if proper precautions are not taken.

⚠ CAUTION

indicates that minor personal injury can result if proper precautions are not taken.

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The product/system described in this documentation may be operated only by **personnel qualified** for the specific task in accordance with the relevant documentation, in particular its warning notices and safety instructions. Qualified personnel are those who, based on their training and experience, are capable of identifying risks and avoiding potential hazards when working with these products/systems.

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A5E37577655-AB
℗ 11/2017 Subject to change

Preface

Purpose of the documentation

This documentation provides important information that you need to configure and commission the integrated Motion Control functionality of the S7-1500 Automation systems.

Required basic knowledge

In order to understand this documentation, the following knowledge is required:

- General knowledge in the field of automation
- General knowledge in the field of drive engineering and motion control

Validity of the documentation

This documentation is valid for the S7-1500 product range.

Conventions

- For the path settings in the project navigation it is presumed that the "Technology objects" object is opened in the CPU subtree. The "Technology object" placeholder represents the name of the technology object.

  Example: "Technology object > Configuration > Basic parameters".
- The <TO> placeholder represents the name set in tags for the respective technology object.

  Example: <TO>.Actor.Type
- This documentation contains pictures of the devices described. The pictures may differ in minor details from the devices supplied.

You should also observe the notes that are marked as follows:

Note

A note contains important information about the product described in the documentation, about the handling of the product, and about sections in this documentation demanding your particular attention.

Further support

- The range of technical documentation for the individual SIMATIC products and systems is available on the Internet (http://www.siemens.com/simatic-tech-doku-portal).
- The online catalog and the online ordering system is available on the Internet (http://mall.industry.siemens.com).

Security information

Siemens provides products and solutions with industrial security functions that support the secure operation of plants, systems, machines and networks.

In order to protect plants, systems, machines and networks against cyber threats, it is necessary to implement – and continuously maintain – a holistic, state-of-the-art industrial security concept. Siemens' products and solutions constitute one element of such a concept.

Customers are responsible for preventing unauthorized access to their plants, systems, machines and networks. Such systems, machines and components should only be connected to an enterprise network or the internet if and to the extent such a connection is necessary and only when appropriate security measures (e.g. firewalls and/or network segmentation) are in place.

For additional information on industrial security measures that may be implemented, please visit (https://www.siemens.com/industrialsecurity).

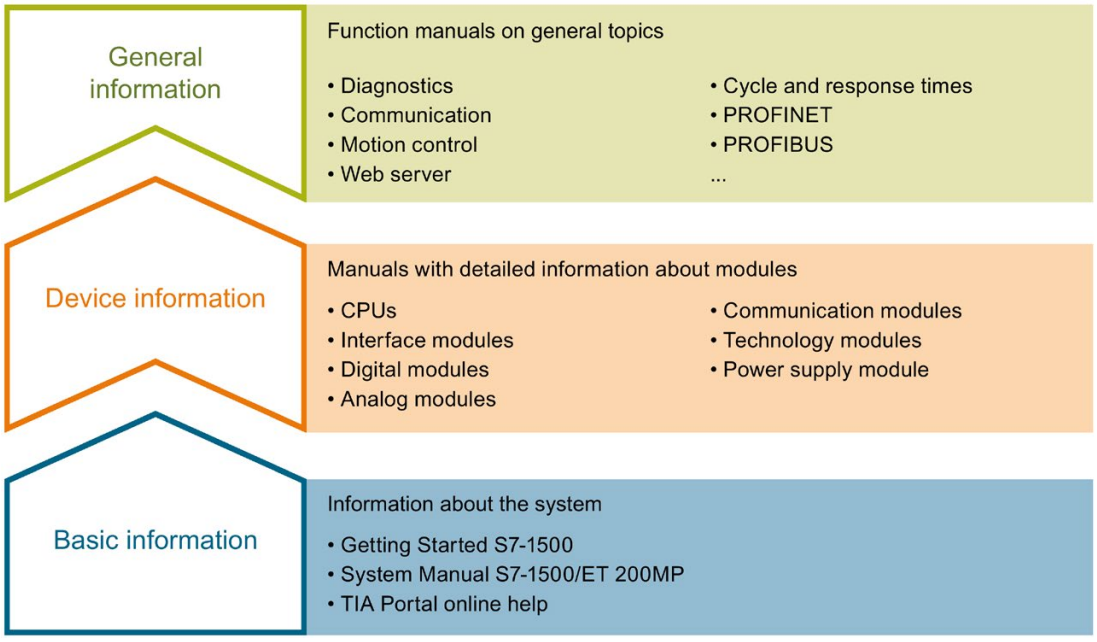
Siemens' products and solutions undergo continuous development to make them more secure. Siemens strongly recommends that product updates are applied as soon as they are available and that the latest product versions are used. Use of product versions that are no longer supported, and failure to apply the latest updates may increase customers' exposure to cyber threats.

To stay informed about product updates, subscribe to the Siemens Industrial Security RSS Feed under (https://www.siemens.com/industrialsecurity).

Table of contents

Documentation guide 1

The documentation for the SIMATIC S7-1500 automation system and the SIMATIC ET 200MP distributed I/O system is arranged into three areas. This arrangement enables you to access the specific content you require.



Basic information

The System Manual and Getting Started describe in detail the configuration, installation, wiring and commissioning of the SIMATIC S7-1500 and ET 200MP systems. The STEP 7 online help supports you in the configuration and programming.

Device information

Product manuals contain a compact description of the module-specific information, such as properties, wiring diagrams, characteristics and technical specifications.

General information

The function manuals contain detailed descriptions on general topics regarding the SIMATIC S7-1500 and ET 200MP systems, e.g. diagnostics, communication, motion control, Web server, OPC UA.

You can download the documentation free of charge from the Internet (https://support.industry.siemens.com/cs/ww/en/view/109742691).

Changes and supplements to the manuals are documented in a Product Information.

You can download the product information free of charge from the Internet (https://support.industry.siemens.com/cs/us/en/view/68052815).

Manual Collection S7-1500/ET 200MP

The Manual Collection contains the complete documentation on the SIMATIC S7-1500 automation system and the ET 200MP distributed I/O system gathered together in one file.

You can find the Manual Collection on the Internet (https://support.industry.siemens.com/cs/ww/en/view/86140384).

SIMATIC S7-1500 comparison list for programming languages

The comparison list contains an overview of which instructions and functions you can use for which controller families.

You can find the comparison list on the Internet (https://support.industry.siemens.com/cs/ww/en/view/86630375).

"mySupport"

With "mySupport", your personal workspace, you make the best out of your Industry Online Support.

In "mySupport", you can save filters, favorites and tags, request CAx data and compile your personal library in the Documentation area. In addition, your data is already filled out in support requests and you can get an overview of your current requests at any time.

You must register once to use the full functionality of "mySupport".

You can find "mySupport" on the Internet (https://support.industry.siemens.com/My/ww/en).

"mySupport" - Documentation

In the Documentation area in "mySupport" you can combine entire manuals or only parts of these to your own manual.
You can export the manual as PDF file or in a format that can be edited later.

You can find "mySupport" - Documentation on the Internet (http://support.industry.siemens.com/My/ww/en/documentation).

"mySupport" - CAx data

In the CAx data area in "mySupport", you can access the current product data for your CAx or CAe system.

You configure your own download package with a few clicks.

In doing so you can select:

- Product images, 2D dimension drawings, 3D models, internal circuit diagrams, EPLAN macro files
- Manuals, characteristics, operating manuals, certificates
- Product master data

You can find "mySupport" - CAx data on the Internet (http://support.industry.siemens.com/my/ww/en/CAxOnline).

Application examples

The application examples support you with various tools and examples for solving your automation tasks. Solutions are shown in interplay with multiple components in the system - separated from the focus on individual products.

You will find the application examples on the Internet (https://support.industry.siemens.com/sc/ww/en/sc/2054).

TIA Selection Tool

With the TIA Selection Tool, you can select, configure and order devices for Totally Integrated Automation (TIA).
This tool is the successor of the SIMATIC Selection Tool and combines the known configurators for automation technology into one tool.
With the TIA Selection Tool, you can generate a complete order list from your product selection or product configuration.

You can find the TIA Selection Tool on the Internet (http://w3.siemens.com/mcms/topics/en/simatic/tia-selection-tool).

SIMATIC Automation Tool

You can use the SIMATIC Automation Tool to perform commissioning and maintenance activities simultaneously on various SIMATIC S7 stations as a bulk operation independent of the TIA Portal.

General function overview:

- Network browsing and creation of a table showing the accessible devices in the network.
- Flashing of device LEDs or HMI display to locate a device
- Downloading of addresses (IP, subnet, gateway) to a device
- Downloading the PROFINET name (station name) to a device
- Placing a CPU in RUN or STOP mode
- Setting the time in a CPU to the current time of your PG/PC
- Downloading a new program to a CPU or an HMI device
- Downloading from CPU, downloading to CPU or deleting recipe data from a CPU
- Downloading from CPU or deleting data log data from a CPU
- Backup/restore of data from/to a backup file for CPUs and HMI devices
- Downloading service data from a CPU
- Reading the diagnostics buffer of a CPU
- Performing a CPU memory reset
- Resetting devices to factory settings
- Downloading a firmware update to a device

You can find the SIMATIC Automation Tool on the Internet (https://support.industry.siemens.com/cs/ww/en/view/98161300).

PRONETA

With SIEMENS PRONETA (PROFINET network analysis), you analyze the PROFINET network during commissioning. PRONETA features two core functions:

- The topology overview independently scans PROFINET network and all connected components.
- The IO check is a fast test of the wiring and the module configuration of a system.

You can find SIEMENS PRONETA on the Internet (https://support.industry.siemens.com/cs/ww/en/view/67460624).

SINETPLAN

SINETPLAN, the Siemens Network Planner, supports you in planning automation systems and networks based on PROFINET. The tool facilitates professional and predictive dimensioning of your PROFINET installation as early as in the planning stage. In addition, SINETPLAN supports you during network optimization and helps you to exploit network resources optimally and to plan reserves. This helps to prevent problems in commissioning or failures during productive operation even in advance of a planned operation. This increases the availability of the production plant and helps improve operational safety.

The advantages at a glance

- Network optimization thanks to port-specific calculation of the network load
- Increased production availability thanks to online scan and verification of existing systems
- Transparency before commissioning through importing and simulation of existing STEP 7 projects
- Efficiency through securing existing investments in the long term and optimal exploitation of resources

You can find SINETPLAN on the Internet (https://www.siemens.com/sinetplan).

Introduction 2

2.1 Interplay of the various documents

For a better overview, the documentation of the Motion Control functions is divided into the following documents:

- Using S7-1500T Motion Control (Page 23)
- Using S7-1500T Kinematics Functions (https://support.industry.siemens.com/cs/ww/en/view/109749264)

"Using S7-1500 Motion Control" describes the Motion Control functions for the following technology objects:

- Speed axis
- Positioning axis
- Synchronous axis
- External encoder
- Measuring input
- Output cam
- Cam track
- Cam (S7-1500T)

"Using S7-1500T Kinematics Functions" describes the Motion Control functions for the kinematics technology object. This document assumes that the Motion Control functions described in "Using S7-1500 Motion Control functions" are known.

2.2 Integrated Motion Control functionality

S7-1500 Motion Control supports controlled positioning and moving of axes and is an integral part of every CPU S7-1500 as well as every CPU S7-1500SP. The S7-1500T Technology CPUs provide enhanced functions.

The Motion Control functionality supports the following technology objects:

- Speed axis
- Positioning axis
- Synchronous axis
- External encoder
- Measuring input
- Output cam
- Cam track
- Cam (S7-1500T)
- Kinematics (S7-1500T)

Drives with PROFIdrive capability and drives with analog setpoint interface and stepper motors are controlled by means of standardized Motion Control instructions according to PLCopen.

The axis control panel and comprehensive online and diagnostic functions support easy commissioning and optimization of drives.

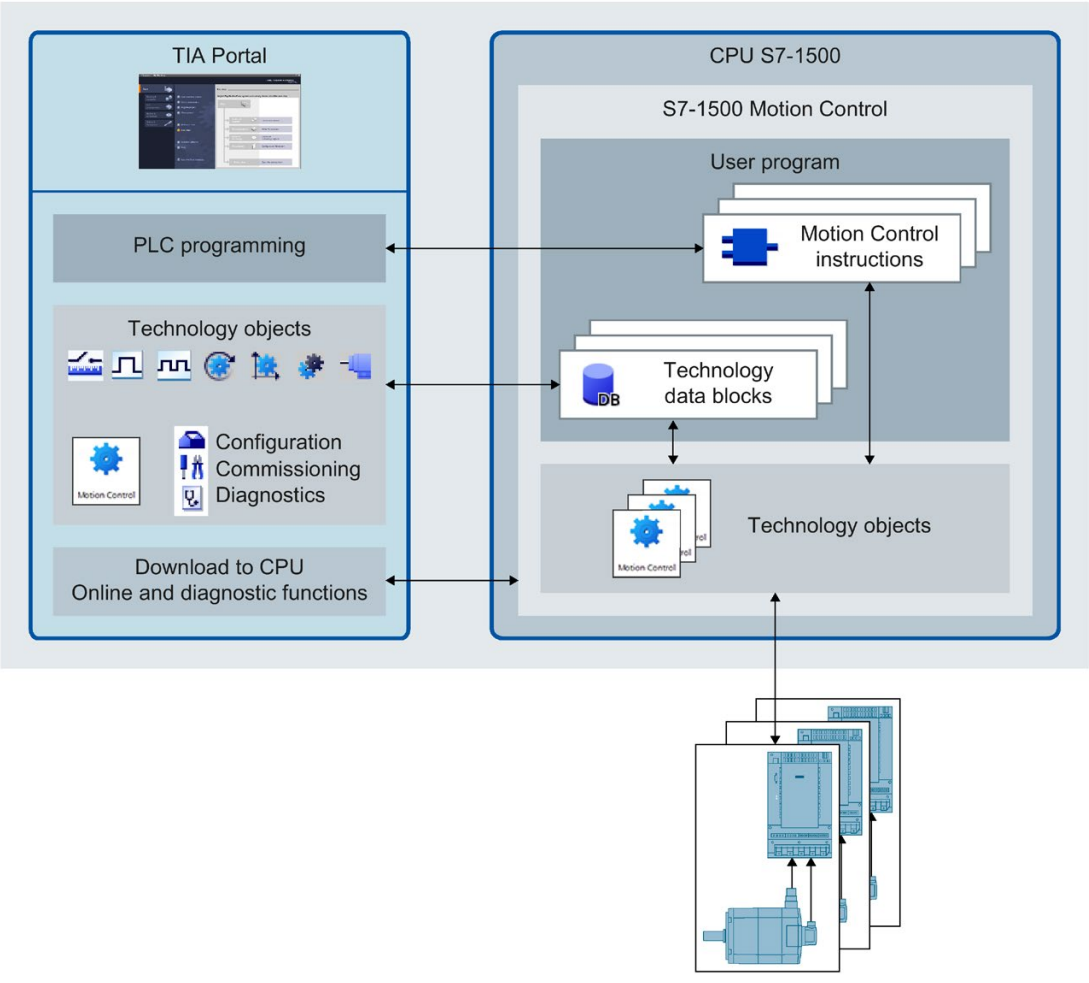
S7-1500 Motion Control is fully integrated into the system diagnostics of the S7-1500 CPU.

2.3 Principle of operation of S7-1500 Motion Control

Overview

You create a project, configure technology objects, and download the configuration to the CPU with the TIA Portal. The Motion Control functionality is processed in the CPU.
You control the technology objects with the Motion Control instructions in your user program.
The TIA Portal provides additional functions for commissioning, optimization (Page 388) and diagnostics (Page 402).

The following figure provides a schematic representation of the user interfaces and the integration of Motion Control into the S7-1500 CPU. The concepts are then briefly explained:



TIA Portal

The TIA Portal supports you in the planning and commissioning of Motion Control functionality:

- Integrating and configuring hardware
- Creating and configuring technology objects
- Creating the user program
- Downloading to CPU
- Commissioning of axes
- Optimization of drives
- Diagnostics

You use the TIA Portal to configure the hardware, the technology objects as well as your user program. You download the program you created to the CPU. You test your user program and diagnose the hardware with the online and diagnostic functions of the TIA Portal.

Technology objects

Technology objects represent real objects (e.g. a drive) in the controller. You call the functions of the technology objects by means of Motion Control instructions in your user program. The technology objects provide open- and closed-loop control of the movement of the real objects, and report status information (e.g. the current position).

The configuration of the technology objects represents the properties of the real object. The configuration data is stored in a technology data block.

The following technology objects are available for Motion Control:

-  **Speed axis technology object**

  The speed axis technology object ("TO_SpeedAxis") is used to specify the speed for a drive. You program the motion of the axis with motion control instructions.

-  **Positioning axis technology object**

  The positioning axis technology object ("TO_PositioningAxis") is used to position a drive with closed-loop position control. You issue positioning jobs to the axis with Motion Control instructions in your user program.

-  **Synchronous axis technology object**

  The synchronous axis technology object ("TO_SynchronousAxis") includes all functions of the positioning axis technology object. The axis can also be interconnected with a leading value so that the axis follows the position change of a leading axis in synchronous operation.

- **External encoder technology object**

  The external encoder technology object ("TO_ExternalEncoder") detects a position and makes it available to the controller. The detected position can be evaluated in the user program.

- **Measuring input technology object**

  The measuring input technology object ("TO_MeasuringInput") detects actual positions quickly, accurately and event triggered.

- **Output cam technology object**

  The output cam technology object ("TO_OutputCam") generates switching signals depending on the position of an axis or external encoder. You can evaluate the switching signals in the user program or feed them to digital outputs.

- **Cam track technology object**

  The cam track technology object ("TO_CamTrack") generates a switching signal sequence depending on the position of an axis or external encoder. In this process, up to 32 individual cams are superimposed and the switching signals are output as a track. You can evaluate the switching signals in the user program or feed them to digital outputs.

- **Cam technology object (S7-1500T)**

  The cam technology object ("TO_Cam") defines a function f(x) by means of interpolation points and/or segments. Missing function ranges are interpolated.

- **Kinematic technology object (S7-1500T)**

  The Kinematic technology object ("TO_Kinematics") is used to interconnect positioning axes to a kinematic. When you configure the kinematics technology object, you interconnect the axes in accordance with the configured kinematics type.

Technology data block

The properties of real objects are configured by means of the technology objects and saved in a technology data block (Page 356). The technology data block contains all configuration data, setpoint and actual values, and status information of the technology object. The TIA Portal automatically creates the technology data block when the technology object is created. You access the data of the technology data block (read/write access) with your user program.

Motion Control instructions

With the Motion Control instructions you perform the desired functionality in the technology objects. The Motion Control instructions are available in the TIA Portal under "Instructions > Technology > Motion Control".

The Motion Control instructions conform to PLCopen (version 2.0).

User program

The Motion Control instructions and the technology data block represent the programming interfaces for the technology objects. You use Motion Control instructions to transfer Motion Control jobs for the technology objects in your user program. You track the status of running jobs via the output parameters of the Motion Control instructions. You access status information of the technology object and change specific configuration parameters during runtime using the technology data block.

Drives and encoders

Drives ensure the motion of the axis. They are integrated in the hardware configuration.

When you execute a Motion Control job in your user program, the technology object takes over the control of the drive and the reading in of values of encoders.

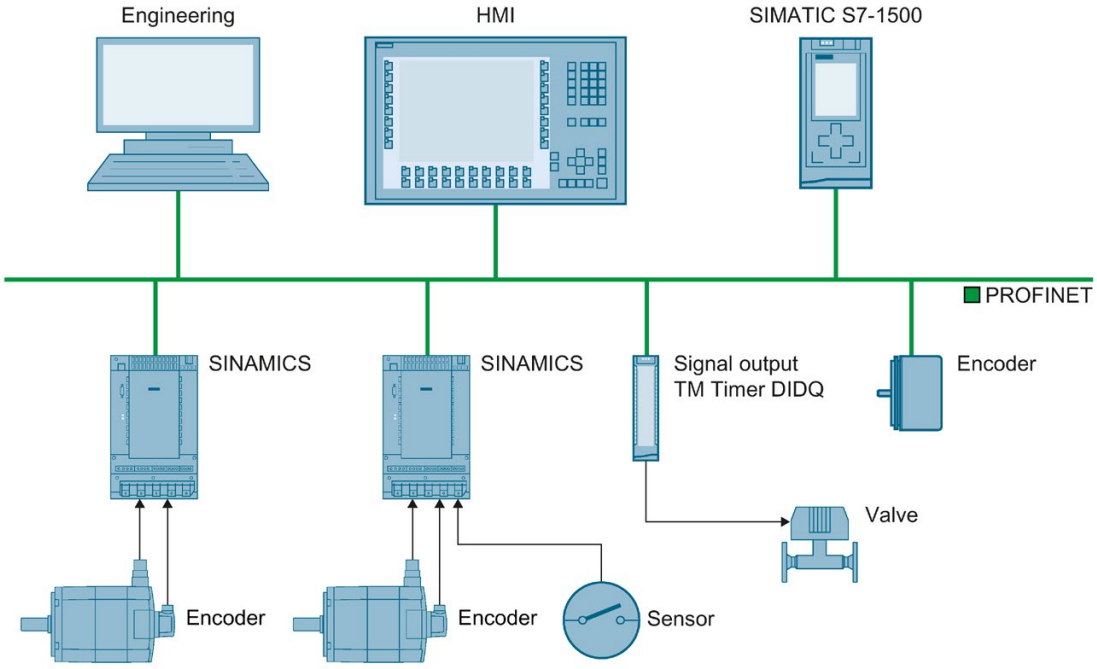
Drives and encoders with PROFIdrive capability are connected by means of PROFIdrive telegrams. The following connections are possible:

- PROFINET IO
- PROFIBUS DP
- Technology module (TM)

Drives with analog setpoint interfaces are connected using an analog output (AQ) and an optional enable signal. Analog inputs and outputs are made available by means of corresponding I/O modules.

A drive is also called an actuator, and an encoder is also called a sensor.

The figure below shows an example configuration in which all components are connected to the CPU by means of PROFINET IO:



2.4 Functions

2.4.1 Functions - Axes

You execute the functions of the speed axis, positioning axis and synchronous axis technology objects using Motion Control instructions in your user program or using the TIA Portal (under "Technology object > Commissioning").

The following table shows the functions that are supported by technology objects:

Function	Technology object		
	Speed axis (Page 111)	Positioning axis (Page 112)	Synchronous axis (Page 113)
Motion Control instructions (user program)			
"MC_Power (Page 430)" Enable, disable technology objects	X	X	X
"MC_Home (Page 438)" Home technology objects, set home position	-	X	X
"MC_MoveJog (Page 458)" Move axes in Jog mode	X	X	X
"MC_MoveVelocity (Page 453)" Move axes at predefined velocity	X	X	X
"MC_MoveRelative (Page 449)" Relative positioning of axes	-	X	X
"MC_MoveAbsolute (Page 445)" Absolute positioning of axes	-	X	X
"MC_MoveSuperimposed (Page 462)" Positioning axes overlapping	-	X	X
"MC_GearIn (Page 484)" Start gearing	-	-	X
"MC_Halt (Page 442)" Halt axes	X	X	X
"MC_TorqueLimiting (Page 525)" Limit torque using torque reduction	X	X	X
"MC_Reset (Page 436)" Acknowledge alarms, restart technology objects	X	X	X
"MC_TorqueAdditive (Page 530)" Specify additive torque and activate/ deactivate	X	X	X
"MC_TorqueRange (Page 533)" Specify high and low torque limits	X	X	X

Function	Technology object		
	Speed axis (Page 111)	Positioning axis (Page 112)	Synchronous axis (Page 113)
TIA Portal			
"Axis control panel (Page 391)" Move and home axes using the TIA Portal	X	X	X
"Optimization (Page 396)" Optimization of closed loop position control	-	X	X

2.4.2 Functions - Other technology objects

You execute the functions of the other technology objects by means of Motion Control instructions in your user program.

The following table shows the Motion Control instructions that are supported by the technology objects:

Motion Control instruction	Technology object			
	External encoder (Page 131)	Measuring input (Page 133)	Output cam (Page 146)	Cam track (Page 161)
Motion Control instructions (user program)				
"MC_Power (Page 430)" Enable, disable technology objects	X	-	-	-
"MC_Home (Page 438)" Home technology objects, set home position	X	-	-	-
"MC_MeasuringInput (Page 469)" Start measuring job once	-	X	-	-
"MC_MeasuringInputCyclic (Page 472)" Start cyclic measuring job	-	X	-	-
"MC_AbortMeasuringInput (Page 476)" End measuring job	-	X	-	-
"MC_OutputCam (Page 477)" Activate/deactivate output cam	-	-	X	-
"MC_CamTrack (Page 480)" Activate/deactivate cam track	-	-	-	X
"MC_Reset (Page 436)" Acknowledge alarms, restart technology objects	X	X	X	X

2.4.3 Extended functions of the technology CPU

In addition to the functionality of the S7-1500 CPU, the S7-1500T CPU provides additional functions and the cam technology object and kinematic:

Additional function		Description
Multiple encoders for positioning axis/synchronous axis (Page 49)		Up to four encoders can be connected to a positioning axis/synchronous axis. The encoders can be switched over during operation. Only one encoder at a time is active for closed loop position control.
Actual value coupling (Page 115)		As an alternative to the setpoint, the extrapolated actual value can be interconnected as a leading value for synchronous operation. As a result, an external encoder technology object can also be used as a leading value.
Gearing with MC_GearInPos (Page 120)		During gearing, the leading axis and following axis are coupled, similar to a mechanical gear unit, by a linear synchronous operation function. You use the gear ratio to specify the synchronous operation function. The synchronous positions of the leading and following axes starting at which the axes move synchronously can be specified in "MC_GearInPos".
	Cam technology object (Page 174)	The cam technology object ("TO_Cam") defines a function f(x) by means of interpolation points and/or segments. Gaps between the defined interpolation points and segments of the cam are closed by interpolation during runtime of the user program.
Camming (Page 122)		During camming, the leading axis and following axis are coupled by a synchronous operation function, which you specify using a cam.
Synchronization in advance using leading value distance (Page 128) or dynamic parameters (Page 127)		Gearing with "MC_GearInPos" and camming with "MC_CamIn" are synchronized in advance of the user-specified synchronous position.
MotionIn functions (Page 71)		With the "MC_MotionInVelocity" and "MC_MotionInPosition" Motion Control instructions, you specify cyclically applicable calculated motion setpoints as a basic motion for the axis. No velocity profile is calculated for this, the values are directly active at the technology object.
	Kinematics technology object (Page 178)	The Kinematic technology object ("TO_Kinematics") is used to interconnect positioning axes to a kinematic. When you configure the kinematics technology object, you interconnect the axes in accordance with the configured kinematics type.

You execute the extended functions of the technology CPU S7-1500T by means of Motion Control instructions in your user program. The following table shows the additional Motion Control instructions that are supported by the technology objects:

Motion Control instruction	Technology object		
	Positioning axis (Page 112)	Synchronous axis (Page 113)	Cam (Page 174)
"MC_SetSensor (Page 466)" Switch active encoder	X	X	-
"MC_GearInPos (Page 488)" Start gearing with specified synchronous positions	-	X	-
"MC_PhasingAbsolute (Page 493)" Absolute shift of leading value for gearing with MC_GearIn and MC_GearInPos	-	X	-
"MC_PhasingRelative (Page 497)" Relative shift of leading value for gearing with MC_GearIn and MC_GearInPos	-	X	-

Motion Control instruction	Technology object		
	Positioning axis (Page 112)	Synchronous axis (Page 113)	Cam (Page 174)
"MC_CamIn (Page 502)" Start camming	-	X	-
"MC_InterpolateCam (Page 512)" Interpolating a cam	-	-	X
"MC_GetCamFollowingValue (Page 514)" Read a following value with first and second derivative for the corresponding leading value from a cam	-	-	X
"MC_GetCamLeadingValue (Page 515)" Read a leading value for the corresponding following value from a cam	-	-	X
"MC_SynchronizedMotionSimulation (Page 510)" Start synchronous operation simulation and keep it active when following axis is disabled	-	X	-
MC_MotionInPosition (Page 521) Set motion setpoints for position, velocity and acceleration	X	X	-
MC_MotionInVelocity (Page 517) Set motion setpoints for velocity and acceleration	X[1]	X	-

[1] Also speed axis

Additional information

You can find additional information on the Motion Control instructions of the technology object kinematics in the "S7-1500T Kinematics Functions" function manual (https://support.industry.siemens.com/cs/ww/en/view/109749264):

2.5 Guidelines on use of motion control

The guidelines described here present the basic procedure for using Motion Control with the CPU S7-1500. These guidelines serve as recommendations.

Requirements

- A project with a CPU S7-1500 has been created.

Procedure

Proceed as follows to use Motion Control with the CPU S7-1500:

1. Add technology object (Page 199)
2. Working with the configuration editor (Page 202)
3. Programming (Page 356)
4. Downloading to CPU (Page 387)
5. Functional test in the Commissioning window (Page 388)
6. Diagnostics (Page 402)

Technology objects 3

3.1 Configuration limits

Motion Control resources

Each CPU offers a defined set of Motion Control resources. For information on the available Motion Control resources, refer to the technical specifications of the utilized CPU.

Each technology object uses Motion Control resources:

Technology object	Motion Control resources used
Speed axis	40
Positioning axis	80
Synchronous axis	160
External encoder	80
Measuring input	40
Output cam	20
Cam track	160

You can find an overview of the Motion Control resources of a CPU in the TIA Portal under "Tools > Resources".

Extended Motion Control Resources (S7-1500T)

The cam and kinematics technology objects use "Extended Motion Control resources". For information on the maximum number of cams and kinematics that can be used in addition to the Motion Control resources, refer to the technical specifications of the relevant CPU.

Technology object	Extended Motion Control resources used
Cam	2
Kinematics	30

Application cycle

As the number of technology objects used increases, the computing time needed by CPU to process the technology objects increases. The Motion Control application cycle (Page 104) can be adapted according to the number of technology objects used.

3.2 Basics - Axes

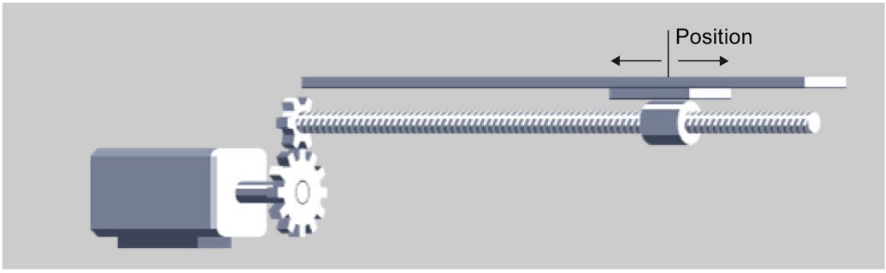
3.2.1 Axis types

Axes can be configured with different axis types:

- Positioning and synchronous axes can be configured as rotary or linear axis.
- Speed axes are always rotary axes.

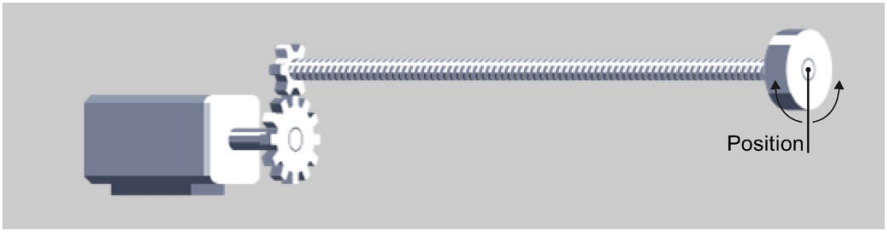
Depending on the execution of the mechanics, an axis is implemented as a linear axis or rotary axis:

- Linear axis



For linear axes, the position of the axis is specified as a linear measure, e.g. millimeters (mm).

- Rotary axis



For rotary axes, the position of the axis is specified as an angular measure, e.g. degrees (°).

3.2.2 Units of measure

The supported units of measure for speed (revolutions per time unit) are 1/s, 1/min and 1/h.

The table below shows the supported units of measure for position and velocity:

Position	Velocity
nm, µm, mm, m, km	mm/s, mm/min, mm/h, m/s, m/min, m/h, km/min, km/h
in, ft, mi	in/s, in/min, ft/s, ft/min, mi/h
°, rad	°/s, °/min, rad/s, rad/min

The acceleration is set accordingly as the position/s² unit of measure.

The jerk is set accordingly as the position/s² unit of measure.

The table below shows the supported units of measure for force and torque:

Force	Torque
N, kN	Nm, kNm
lbf, ozf, pdl	lbf in, lbf ft, ozf in, ozf ft, pdl in, pdl ft

The unit of measure for time is permanently specified for the following technology objects:

Technology object	Time
Speed axis, positioning/synchronous axis, external encoder	s
Output cam, cam track, measuring input	ms

Note

When setting or changing the units of measure, take into consideration the effect on the display of parameter values and the user program:

- Display of parameter values in the technology data block
- Assignment of parameters in the user program
- Input and display of the position and velocity in the TIA Portal
- Setpoint settings by leading axes in synchronous operation

All information and displays correspond to the selected unit of measure.

The set units are displayed in the tag structure of the technology object <TO>.Units. The tag structure is described in the Appendix (Page 539) under the tags of the respective technology object.

3.2.3 Modulo setting

For the positioning axis, synchronous axis and external encoder technology objects, the "Modulo" setting can be activated.

When an axis moves in only one direction, the position value continually increases. To limit the position value to a recurring reference system, you can activate the "Modulo" setting.

When the "Modulo" setting is activated, the position value of the technology object is mapped onto a recurring modulo range. The modulo range is defined by the start value and the length.

For example, to limit the position value of a rotary axis to a full rotation, the modulo range can be defined with start value = 0° and length = 360°. As a result, the position value is mapped onto the modulo range 0° to 359.999°.

3.2.4 Long-term accuracy

Long-term accuracy means that the technological position from the accumulated encoder increments can be exactly determined (without a rounding error) and are thus always accurate.

The long-term accuracy ensures the following:

- The axis position indicated by the control always corresponds to the real position. This means that the axis position can be exactly represented from the accumulated encoder increments.
- The calculated position in the controller does not deviate from the real position. Deviations occur without long-term accuracy, for example, due to rounding errors or conversions with finite accuracy.

Non-modulo axes are stable over the long term until the numerical traversing range limit is reached. Modulo axes are accordingly stable at least as long as they do not exceed the numerical traversing range of 9.0E12 mm at 1000 increments per unit.

You can use the following equation to estimate the time after which the traversing range is exceeded.

$$\text{Travel time} = \frac{\text{Maximum position}}{\text{Velocity}}$$

Example of the maximum traversing time

Maximum position = 9.0E12 mm with a resolution of 1000 Ink / mm

Velocity = 20.0 m/min = 2.0E4 mm/min

$$\text{Travel time} = \frac{9.0\text{E}12\ \text{mm}}{2.0\text{E}4\ \text{mm/min}} = 4.5\text{E}8\ \text{min} \quad \triangleq 856\ \text{years}$$

The traversing time restarts when one of the following conditions is fulfilled:

- You have homed the axis with "MC_Home".
- You have changed the velocity of the axis

  A change in the velocity has the consequence that the traversing time changes accordingly.

Avoiding exceeding the traversing range

To prevent exceeding the traversing range, do the following before the maximum traversing time expires:

- Incremental encoder: Home the incremental encoder again.
- Absolute encoder: Perform an absolute encoder calibration with the default of the currently known position.

3.2.5 Drive and encoder connection

3.2.5.1 Brief description

A drive is assigned to the "Speed axis" technology object. A drive and one to four encoders (only with S7-1500T) are assigned to the "Positioning axis" and "Synchronous axis" technology objects. An encoder is assigned to the "External encoder" technology object.

The setpoint for the drive is specified either with PROFIdrive telegrams or using an analog output.

The following connection options are available for an encoder:

- Encoder connected to drive
- Encoder to technology module
- PROFIdrive encoder connected directly to PROFIBUS DP/PROFINET IO

The actual encoder value is transmitted exclusively via PROFIdrive telegrams.

PROFIdrive

PROFIdrive is the standardized drive technology profile for connecting drives and encoders via PROFIBUS DP and PROFINET IO. Drives that support the PROFIdrive profile are connected according to the PROFIdrive standard.

The current PROFIdrive specification is available at:

http://www.profibus.com (http://www.profibus.com)

Communication between the controller and drive/encoder is performed using various PROFIdrive telegrams. Each of the telegrams has a standardized structure. You can select the appropriate telegram according to the application. Control words and status words as well as setpoints and actual values are transmitted in the PROFIdrive telegrams.

The PROFIdrive profile likewise supports the "Dynamic Servo Control" (DSC) control concept. DSC uses rapid closed loop position control in the drive. This can be used to solve highly dynamic Motion Control tasks.

Analog drive connection

Drives with analog setpoint interfaces are connected using an analog output and an optional enable signal. The speed setpoint is specified via an analog output signal (e.g. from -10 V to +10 V) from the PLC.

Stepper motors

Drives with a stepper motor interface are connected using telegram 3 and with the help of PTO (Pulse Train Output) pulse generators.

For functional support of stepper motor operation, quantization of the control deviation can be set.

Through the specification of a quantization, a range around the target position is defined in which no correction of the actual position is to be made. This prevents a possible oscillation of the stepper motor around the target position. Two types of quantization can be set:

- Quantization of the control deviation corresponding to the encoder resolution

  (<TO>.PositionControl.ControlDifferenceQuantization.Mode = 1)

  This prevents oscillation of the stopped motor between two increment values, for example. This mode is especially helpful when using multiple encoders. With this setting, the quantization is adapted appropriately at an encoder switchover. This mode is helpful for stepper motors with encoders in which the resolution of the encoder is lower than the step size of the stepper motor.

- Direct specification of a value for quantization of the control deviation.

  (<TO>.PositionControl.ControlDifferenceQuantization.Mode = 2,
  value setting in <TO>.PositionControl.ControlDifferenceQuantization.Value)

  This mode is helpful for stepper motors with encoders in which the resolution of the encoder is greater than the step size of the stepper motor.

3.2.5.2 PROFIdrive telegrams

PROFIdrive telegrams are used to transfer setpoints and actual values, control and status words and other parameters between the controller and drive/encoder.

When a PROFIdrive telegram is used for connection, the drives and encoders are handled and switched on in accordance with the PROFIdrive profile.

The following table shows the possible PROFIdrive telegrams for various technology objects.

Technology object			Possible PROFIdrive telegrams
Speed axis			• 1, 2 • 3, 4, 5, 6, 102, 103, 105, 106 (actual encoder value is not evaluated)
Positioning axis/synchronous axis			
	Setpoint and actual encoder value in one drive telegram		3, 4, 5, 6, 102, 103, 105, 106
	Setpoint and actual encoder value separately		
		Setpoint in drive telegram	1, 2, 3, 4, 5, 6, 102, 103, 105, 106
		Actual value from telegram	81, 83
External encoder			81, 83
Measuring input [1)]			391, 392, 393

1) When using SINAMICS drives (measuring using SINAMICS measuring input)

Telegram types

The following table shows the supported PROFIdrive telegram types for the assignment of drives and encoders:

Telegram	Brief description
Standard telegrams	
1[1)]	• Control word STW1, status word ZSW1 • Speed setpoint 16 bit (NSET), actual speed value 16 bit (NACT)
2	• Control words STW1 and STW2, status words ZSW1 and ZSW2 • Speed setpoint 32 bit (NSET), actual speed value 32 bit (NACT)
3	• Control words STW1 and STW2, status words ZSW1 and ZSW2 • Speed setpoint 32 bit (NSET), actual speed value 32 bit (NACT) • Actual encoder value 1 (G1_XIST1, G1_XIST2)
4	• Control words STW1 and STW2, status words ZSW1 and ZSW2 • Speed setpoint 32 bit (NSET), actual speed value 32 bit (NACT) • Actual encoder value 1 (G1_XIST1, G1_XIST2) • Actual encoder value 2 (G2_XIST1, G2_XIST2)

Telegram	Brief description
5	• Control words STW1 and STW2, status words ZSW1 and ZSW2 • Speed setpoint 32 bit (NSET), actual speed value 32 bit (NACT) • Actual encoder value 1 (G1_XIST1, G1_XIST2) (motor encoder) • Dynamic Servo Control (DSC)[2)] – Speed precontrol value – Position difference (XERR) – Kpc - Velocity precontrol of the closed loop position control
6	• Control words STW1 and STW2, status words ZSW1 and ZSW2 • Speed setpoint 32 bit (NSET), actual speed value 32 bit (NACT) • Actual encoder value 1 (G1_XIST1, G1_XIST2) (motor encoder) • Actual encoder value 2 (G2_XIST1, G2_XIST2) • Dynamic Servo Control (DSC)[2)] – Speed precontrol value – Position difference (XERR) – Kpc - Velocity precontrol of the closed loop position control
Siemens telegrams (with torque limiting)	
102	• Control words STW1 and STW2, status words ZSW1 and ZSW2 • Speed setpoint 32 bit (NSET), actual speed value 32 bit (NACT) • Actual encoder value 1 (G1_XIST1, G1_XIST2) • Torque limiting
103	• Control words STW1 and STW2, status words ZSW1 and ZSW2 • Speed setpoint 32 bit (NSET), actual speed value 32 bit (NACT) • Actual encoder value 1 (G1_XIST1, G1_XIST2) • Actual encoder value 2 (G2_XIST1, G2_XIST2) • Torque limiting
105	• Control words STW1 and STW2, status words ZSW1 and ZSW2 • Speed setpoint 32 bit (NSET), actual speed value 32 bit (NACT) • Actual encoder value 1 (G1_XIST1, G1_XIST2) (motor encoder) • Dynamic Servo Control (DSC)[2)] – Speed precontrol value – Position difference (XERR) – Kpc - Velocity precontrol of the closed loop position control • Torque limiting

Telegram	Brief description
106	• Control words STW1 and STW2, status words ZSW1 and ZSW2 • Speed setpoint 32 bit (NSET), actual speed value 32 bit (NACT) • Actual encoder value 1 (G1_XIST1, G1_XIST2) (motor encoder) • Actual encoder value 2 (G2_XIST1, G2_XIST2) • Dynamic Servo Control (DSC)[2)] – Speed precontrol value – Position difference (XERR) – Kpc - Velocity precontrol of the closed loop position control • Torque limiting
SIEMENS additional telegrams (torque data)	
750[3)]	• Additive setpoint torque • High and low torque limits • Torque actual values
SIEMENS telegrams (measuring input) [4)]	
391	• Control word CU_STW1, status word CU_ZSW1 • Measuring input control word (MT_STW), measuring input status word (MT_ZSW) • Measuring input time stamp of negative (MT1…2_ZS_F) or positive edges (MT1…2_ZS_S) • Digital output 16 bit, digital input 16 bit
392	• Control word CU_STW1, status word CU_ZSW1 • Measuring input control word (MT_STW), measuring input status word (MT_ZSW) • Measuring input time stamp of negative (MT1…6_ZS_F) or positive edges (MT1…6_ZS_S) • Digital output 16 bit, digital input 16 bit
393	• Control word CU_STW1, status word CU_ZSW1 • Measuring input control word (MT_STW), measuring input status word (MT_ZSW) • Measuring input time stamp of negative (MT1…8_ZS_F) or positive edges (MT1…8_ZS_S) • Digital output 16 bit, digital input 16 bit • Analog input 16 bit

Telegram	Brief description
Standard telegrams - encoder	
81	• Control word STW2_ENC, status word ZSW2_ENC • Actual encoder value 1 (G1_XIST1, G1_XIST2)
83	• Control word STW2_ENC, status word ZSW2_ENC • Actual speed value 32 bit (NACT) • Actual encoder value 1 (G1_XIST1, G1_XIST2)

1) Isochronous mode is not possible.

2) For use of Dynamic Servo Control (DSC), the motor encoder (first encoder in the telegram) of the drive must be used as the first encoder for the technology object.

3) Can also be used for the telegrams 1, 2, 3, 4, 5, 6, 102, 103, 105, 106

4) When using SINAMICS drives (measuring using SINAMICS measuring input)

See also

Data connection drive/encoder via data block (Page 57)

3.2.5.3 Actual values

Brief description

For position-controlled motion and positioning, the controller must know the actual position value.

The actual position value is provided by a PROFIdrive telegram.

The actual values are represented as incremental or absolute values in the PROFIdrive telegram. The actual values are normalized in the controller to the technological unit taking into account the configuration of the mechanics. The reference to a physical position of the axis or external encoder is established by homing.

The controller supports the following types of actual values (encoder types):

- Incremental actual value
- Absolute actual value with the setting absolute (measuring range > traversing range of the axis)
- Absolute actual value with the setting absolute (measuring range < traversing range of the axis)

Actual value calculation for virtual axis or axis in simulation

The actual value of a virtual axis or an axis in simulation is formed from the setpoint taking time delays into account.

You calculate the time delay from actual value to the setpoint (T_t) as follows:

- With precontrol: $T_t = T_{ipo} + T_{servo} + T_{vtc} + T_{addPtc}$
- Without precontrol, without DSC: $T_t = T_{ipo} + 1/Kv + T_{addPtc}$
- Without precontrol, with DSC[1]: $T_t = T_{ipo} + T_{servo} + 1/Kv + T_{addPtc}$

  [1] Only applies to axis in simulation.

T_t	Time delay from the actual value to the setpoint
T_{ipo}	CPU time of MC-Interpolator [OB92]
T_{servo}	CPU time of MC-Servo [OB91]
T_{vtc}	Speed control loop substitute time (T_{vtc} off <TO>.DynamicAxisModel.VelocityTimeConstant)
T_{addPtc}	Additive position control loop equivalent time (T_{addPtc} from <TO>.DynamicAxisModel.AdditionalPositionTimeConstant)
kV	Gain factor (Kv off <TO>.PositionControl.Kv)

See also

Virtual axis (Page 56)

Axis in simulation (Page 56)

Incremental actual value

The actual value in the PROFIdrive telegram is based on an incremental value.

After POWER ON, position zero is displayed. A transition of the CPU to RUN mode starts the actual value update. The actual value is then also updated in CPU STOP mode. The relationship between the technology object and the mechanical position must be re-established by means of homing.

Absolute actual value

The actual value in the PROFIdrive telegram is based on an absolute value.

After POWER ON, position zero is displayed. The first transition of the CPU to RUN mode starts the actual value update. The actual value is then also updated in CPU STOP mode. The supplied absolute value is assigned to the associated mechanical axis position by means of the absolute encoder adjustment. The absolute encoder adjustment must be performed once. The absolute value offset is retentively saved beyond the switching on/off of the controller.

Differentiation of absolute values:

- The measuring range of the encoder is larger than the traversing range of the axis:

  Absolute value with setting absolute

- The measuring range of the encoder is smaller than the traversing range of the axis:

  Absolute value with setting cyclic absolute

Absolute actual value with setting absolute (measuring range > traversing range)

The axis position results directly from the current actual encoder value. The traversing range must be within an encoder measuring range. This means that the zero passage of the encoder must not be located in the traversing range.

When the controller is switched on, the axis position is determined from the absolute actual encoder value.

Absolute actual value with setting cyclic absolute (measuring range < traversing range)

The encoder supplies an absolute value within its measuring range. The controller includes the traversed measuring ranges and thus determines the correct axis position beyond the measuring range.

When the controller is switched off, the traversed measuring ranges are saved in the retentive memory area of the controller.
At the next power-on, the saved traversed measuring ranges are taken into account in the calculation of the actual position value.

NOTICE
Movements of the axis while the controller is switched off can skew the actual value If the axis or the encoder is moved by more than half of the encoder measuring range while the controller is switched off, then the actual value in the controller is no longer in accord with the mechanical axis position.

See also

Absolute value adjustment (Page 95)

Tags

The tags named in the Homing (Page 97) section are relevant for adapting actual values.

3.2.5.4 Automatic transfer of drive and encoder parameters in the device

Identical reference values for the drive and encoder connections must be set in the controller and in the drive and encoder for the operation.

The speed setpoint NSET and the actual speed value NACT are transferred in the PROFIdrive telegram as a percentage of the reference speed. The reference value for the speed must be set identically in the controller and in the drive.

The resolution of the actual value in the PROFIdrive telegram must likewise be set identically in the controller and in the drive and encoder modules

Automatic transfer of parameters

The drive and encoder parameters can be automatically applied in the CPU for the following drives and encoders.

- SINAMICS drives (see compatibility list (Page 665))
- PROFIdrive encoder as of product version A16

The corresponding parameters are transferred after the (re-)initialization of the technology object or (re)start of the drive and the CPU. Changes in the drive configuration are transferred after restart of the drive or technology object.

Successful transfer of the parameters can be checked in the controller in the value of the tags of the technology objects <TO>.StatusDrive.AdaptionState = 2 and <TO>.StatusSensor[n].AdaptionState = 2.

Parameters

The controller settings are made in the TIA Portal under "Technology object > Configuration > Hardware interface > Data exchange with the drive/encoder".

The drive and encoder settings are made in the configuration or the respective hardware.

The following table compares the settings in the TIA Portal, in the controller and the corresponding drive/encoder parameters:

Setting in the TIA Portal	Controller tag in the technology data block	Drive parameter	Automatic transfer
Drive			
Telegram number	Telegram input address <TO>.Actor.Interface.AddressIn	Telegram number P922	-
	Telegram output address <TO>.Actor.Interface.AddressOut		
Reference speed in [1/min]	<TO>.Actor.DriveParameter.ReferenceSpeed	(SINAMICS drives: P2000)	X
Maximum speed of motor in [1/min]	<TO>.Actor.DriveParameter.MaxSpeed	(SINAMICS drives: P1082)	X
Reference torque in [NM]	<TO>.Actor.DriveParameter.ReferenceTorque	(SINAMICS drives: P2003)	X

Setting in the TIA Portal	Controller tag in the technology data block	Drive parameter	Automatic transfer
Encoder			
Telegram	<TO>.Sensor[n].Interface.AddressIn	P922	-
	<TO>.Sensor[n].Interface.Addressout		
Encoder type	<TO>.Sensor[n].Type 0: incremental 1: absolute 2: cyclic absolute	P979[5] Encoder 1 P979[15] Encoder 2	-
Measuring system	<TO>.Sensor[n].System 0: linear 1: rotary	P979[1] Bit0 Encoder 1 P979[11] Bit0 Encoder 2	X
Resolution (linear encoder) The grid spacing is specified on the nameplate of the encoder as a separation distance of the marks on the linear measuring system.	<TO>.Sensor[n].Parameter.Resolution	P979[2] Encoder 1 P979[12] Encoder 2	X
Increments per revolution (rotary encoder)	<TO>.Sensor[n].Parameter.StepsPerRevolution	P979[2] Encoder 1 P979[12] Encoder 2	X
Number of bits for fine resolution XIST1 (cyclic actual encoder value, linear or rotary encoder)	<TO>.Sensor[n].Parameter.FineResolutionXist1	P979[3] Encoder 1 P979[13] Encoder 2	X
Number of bits for fine resolution XIST2 (absolute encoder value, linear or rotary encoder)	<TO>.Sensor[n].Parameter.FineResolutionXist2	P979[4] Encoder 1 P979[14] Encoder 2	X
Differentiable encoder revolutions (rotary absolute encoder)	<TO>.Sensor[n].Parameter.DeterminableRevolutions	P979[5] Encoder 1 P979[15] Encoder 2	X

3.2.5.5 Using multiple encoders

The S7-1500T technology CPU offers the option of using up to 4 encoder or measuring systems per positioning axis and synchronous axis as the actual position for the closed loop position control

Only one encoder at a time is active for closed loop position control. You can switch between the 4 encoder or measuring systems.

However, the actual values of all configured encoders can be evaluated in the user program.

This opens up the following possible application areas, among others:

- Use of additional machine encoders (besides the motor encoder),
  e.g. as direct measuring systems for more accurate detection of actual positions of machining processes.
- Use of alternative encoder systems following a tool change in a flexible manufacturing process.

You configure the encoders in the axis configuration. You control the switchover of the encoders in the user program with the Motion Control instruction "MC_SetSensor".

Configuring an axis with multiple encoders

Note the following configuration windows when using multiple encoders:

- In the configuration window "Hardware interface > Encoder", configure which alternative encoders are to be used and their corresponding encoder type
  (incremental, absolute or cyclic absolute).
  All encoders marked as used supply continually updated actual values to the closed loop position control regardless of their use.
- In the configuration window "Hardware interface > Encoder", configure an encoder as "Encoder at power-up". This is necessary because an encoder must always be assigned to the positioning axis and synchronous axis.
- In the configuration window "Hardware interface > Data exchange with encoder", configure additional encoder details and the telegram that is to be used to connect the encoders. The configuration must be performed for each encoder used.
  Each encoder or measuring system to be used may differ with regard to its encoder mounting type.
- In the configuration window "Extended parameters > Mechanics", configure the encoder mounting type and any gear parameters. The configuration must be performed for each encoder used.
- The axis can be homed with any configured encoder. In the configuration window "Extended parameters > Homing", configure the parameters for active and passive homing. The configuration can be performed for each encoder used.
  When the axis is homed with an encoder, the axis is homed and has the "homed" status following encoder switchover.

Encoder switchover in the user program

For closed loop position control of the positioning and synchronous axes, an encoder must always be active. Individual encoders may fail as long as they are not involved in closed loop position control.

With the Motion Control instruction "MC_SetSensor", you switch over the encoder for closed loop position control of the axis.

The switchover can occur during an active motion job or at a standstill. The axis does not have to be enabled.

A switchover during an active homing or restart job is not possible.

Note

Homing

Homing with the Motion Control instruction "MC-Home" or the axis control panel is always performed with the encoder involved in closed loop position control.

The homing status of the axis is not changed following an encoder switchover.

Simulation

When the axis is simulated, all encoders configured as "used" are simulated.

Following the switchover to an alternative encoder or encoder system, you can select what happens if the actual positions of the encoders are different.

You define how to deal with the difference in the actual positions of the encoders using input parameter "Mode" of the Motion Control instruction "MC_SetSensor".

- **Switch over encoder and transfer current position to the new encoder (Mode = 0)**

  With this encoder switchover, step changes in the actual position are prevented. Bumpless switchover of the encoders is possible.

- **Switch over sensor without transferring the actual position (Mode = 1)**

  Following a switchover to an encoder without adjustment, a step change of the actual position may occur. This can be desirable if the new encoder is intended to compensate for possible mechanical influences (such as slip) in the positioning.

  The position difference is not implemented immediately but rather after a delay using time constant <TO>.PositionControl.SmoothingTimeByChangeDifference in order to prevent step changes in the actual position with active closed loop position control.

- **Transfer actual position (Mode = 2)**

  The actual position of the axis is transferred to the encoder specified in the "Sensor" parameter.

- **Transfer actual position of the reference encoder (Mode = 3)**

  The actual position of the "Reference encoder" ("ReferenceSensor" parameter) is transferred to the encoder specified in the "Sensor" parameter.

(Mode 2 and 3 can be used to prepare a switchover)

See also

MC_SetSensor: Set alternative encoder as operationally active encoder V4 (Page 466)

3.2.5.6 Safety functions in the drive

Safety functions ("Safety Integrated Basic Functions") in the SINAMICS drive are safety-oriented, internal drive functions with the goal of shutting down the respective drive safely. In addition, additional safety functions are available to monitor definable limits ("Safety Integrated Extended Functions"). The goal of these safety functions is to monitor that the respective limit is maintained, to signal the violation or to subsequently shut down the drive safely. To prevent the monitoring function from being triggered, it is necessary to switch the axis to the monitored operating mode with the user program or to keep it in this mode.

The cooperation of the safety functions in the drive and the SIMATIC S7-1500 and S7-1500T are necessary to ensure fault-free plant operation.

The technology objects speed axis, positioning axis and synchronous axis support the "Safety Integrated Basic Functions" of the drive. The technology object detects that the Basic Safety function is triggered and displays a corresponding warning (technology alarm 550 - alarm response: Track setpoints) or alarm (technology alarm 421 - alarm response: Remove enable).

No additional response must take place in the user program, especially for technology alarm 550, at the "Enable" input of the Motion Control instruction "MC_Power" in the sense of a "shutdown". Shutdown of the Motion Control instruction "MC_Power" by the user after technology alarm 421 is possible but not necessary.

After acknowledgment and release of the drive by the actual safety function, the technology alarm can also be acknowledged at the respective technology object with the Motion Control instruction "MC_Reset". The technology object is then enabled automatically, if "MC_Power.Enable" is still "TRUE".

The "Safety Integrated Extended Functions" are **not** supported by the technology object independently.

To prevent the extended safety functions from being triggered and thus preventing a disruption in plant operation, we recommend that you evaluate the status of the safety functions. This evaluation can take place in the user program by using or evaluating the status information of the "Safety Info Channels" (SIC). With the help of the corresponding Motion Control instruction, the axis can now stay within the monitored limit or reach it before a deviation is detected.

If a safety function is applied to a following axis in active synchronous operation, one of the following two responses is required:

- End synchronous operation
- Adjust velocity of the leading axis accordingly

Four status words are available in the SIC:

- S_ZSW1B
- S_ZSW2B
- S_ZSW3B
- S_V_LIMIT_B

Two predefined PROFIdrive telegrams are available for transmission:

- Tel. 700 (contains the status words S_ZSW1B & S_V_LIMIT_B)
- Tel. 701 (contains all four status words and two additional control words)

Additional information

Additional information on the safety functions in SINAMICS drives and on the SIC is available in the SINAMICS S120 Safety Integrated Function Manual.

https://support.industry.siemens.com/cs/document/99668646
(https://support.industry.siemens.com/cs/ww/en/view/99668646)

The tables below provide an overview of the four SIC status words and the required response for each to prevent faults in plant operation.

S_ZSW1B

S_ZSW1B		Meaning		Recommended response of the respective axis in the user program
Bit	Assignment			
0	STO (active)	1	Safe Torque Off active	MC_Power can remain enabled (waiting).
		0	Not active	None
1	SS1 (active)	1	Safe Stop 1 active	Drive brakes autonomously and goes into STO. MC_Power remains enabled until STO.
		0	Not active	None
2	SS2 (active)	1	Safe Stop 2 active	Drive brakes autonomously and goes into SOS. MC_Power remains enabled.
		0	Not active	None
3	SOS (active)	1	Safe Operating Stop active	MC_Power remains enabled. The drive must not move (monitoring takes place in the drive)
		0	Not active	None
4	SLS (active)	1	Safety-Limited Speed active	MC_Power remains enabled. Velocity must be less than active velocity limit (see "Active SLS stage" or S_V_LIMIT_B).
		0	Not active	None
5	SOS (selected)	1	Safe Operating Stop selected	MC_Power remains enabled. Braking with MC_Halt within the time permitted by SOS.
		0	Deselected	None
6	SLS (selected)	1	Safety-Limited Speed selected	Drop below velocity limit within the time specified by SLS. For example, by specifying an override or a new dynamic limit (restriction with synchronous motion).
		0	Deselected	None
7	Internal event	1	Group alarm that a safety function was selected or became active	Additional evaluation of the status words required to determine the triggering safety function. The bit indicates that a safety function is active. (See also "Safety alarm")

S_ZSW1B		Meaning		Recommended response of the respective axis in the user program
Bit	Assignment			
		0	No event	None
8	Reserved	-		-
9	Active SLS level	SLS velocity limit Display bit 0		Additional information on SLS (bit 6) – shows active velocity limit for SLS in levels (1… 4). This limit can be evaluated in the program to limit the current velocity of the axis as needed.
10		SLS velocity limit Display bit 1		
11	Reserved	-		-
12	SDI positive	1	Safe Direction positive selected	Reaching standstill or the positive velocity of the actual value of the axis (when SDI negative = 0) within the time specified by SDI.
		0	Deselected	None monitoring for positive direction.
13	SDI negative	1	Safe Direction negative selected	Reaching standstill or the negative velocity of the actual value of the axis (when SDI positive = 0) within the time specified by SDI.
		0	Deselected	None monitoring for negative direction.
14	ESR retraction	1	Extended stop and retraction required (not a Safety function)	To be considered individually. You can find additional information in the SINAMICS S120 Safety Integrated Function Manual. https://support.industry.siemens.com/cs/document/99668646 (https://support.industry.siemens.com/cs/ww/en/view/99668646)
		0	Not requested	None
15	Safety alarm	1	Effective	If necessary, evaluate bit as group alarm to see whether a Safety alarm is pending in the alarm buffer.
		0	Not effective	None

S_V_LIMIT_B

S_V_LIMIT_B		Meaning	Explanation
Bit	Assignment		
0 … 31	Velocity setpoint limit	SLS Speed limit (32-bit resolution with sign)	Additional information on SLS (S_ZSW1B bit 6) Shows the selected / active velocity limit for SLS. If necessary, the velocity limit can be evaluated in the program to limit the current velocity of the axis as needed.

S_ZSW2B

S_ZSW2B		Meaning		Recommended response of the respective axis
Bit	Assignment			
0 … 3	Reserved	-		-
4	SLP selected position area	1	SLP area 2 selected	Safe position in the area 2. Do not change the position using the user program any longer.
		0	SLP area 1 selected	Safe position in the area 1. Do not change the position using the user program any longer.
5, 6	Reserved	-		-
7	SLP selected and user approval set	1	Safety-Limited Position selected and user approval is set	Status message (if required in the user program) Application-dependent evaluation (means that the SLP is selected and the safe position was confirmed by the user – see "Safe homing")
		0	SLP not selected or user approval missing	Application-dependent evaluation
8	SDI positive	1	Safe Direction positive selected	Reaching standstill or the positive velocity of the actual value of the axis within the time specified by SDI. (when SDI negative = 0)
		0	Deselected	None monitoring for positive direction
9	SDI negative	1	Safe Direction negative selected	Reaching standstill or the negative velocity of the actual value of the axis within the time specified by SDI. (when SDI positive = 0)
		0	Deselected	None monitoring for negative direction
10, 11	Reserved	-		-
12	Test stop active	1	Test stop active	Status message (if required in the user program) Application-dependent evaluation
		0	Not active	None
13	Test stop required	1	Test stop required	Perform test stop
		0	Not required	None
14, 15	Reserved	-		-

S_ZSW3B

S_ZSW3B		Meaning		Recommended response of the respective axis
Bit	Assignment			
0	Brake test	1	Brake test selected	MC_Power remains enabled. Do not start travel motion with user program.
		0	Deselected	None – brake test is inactive (normal plant operation)
1	Setpoint value specification drive / external	1	Specification for drive	The speed setpoint is specified by the SBT function. Application-dependent evaluation
		0	External specification (control)	The "normal" speed setpoint is in effect. Application-dependent evaluation – setpoint value specification through user program required
2	Active brake	1	Test brake 2 active	Status message (if required in the user program) Application-dependent evaluation
		0	Test brake 1 active	Status message (if required in the user program) Application-dependent evaluation
3	Brake test active	1	Test active	Status message (if required in the user program) Application-dependent evaluation
		0	Inactive	None
4	Brake test result	1	Test required	Status message (if required in the user program) Application-dependent evaluation
		0	With error(s)	Status message (if required in the user program) Application-dependent evaluation, test must usually be successful to guarantee safety of the brake.
5	Brake test complete	1	Run test	Status message (if required in the user program) Application-dependent evaluation
		0	Incomplete	Status message (if required in the user program) Application-dependent evaluation, usually test is repeated
6	External brake request	1	Closing the brake	Closing external brake (when controlled by user program) Application-dependent evaluation
		0	Opening the brake	Opening external brake (when controlled by user program) Application-dependent evaluation
7	Current load sign	1	Negative sign	Status of the load sign if required in the user program Application-dependent evaluation
		0	Positive sign	
8 … 13	Reserved	-		-
14	Acceptance test SLP(SE) selected	1	Acceptance test SLP(SE) selected	Status message (if required in the user program) Application-dependent evaluation
		0	Deselected	None
15	Acceptance test mode selected	1	Acceptance test mode selected	Status message (if required in the user program) Application-dependent evaluation
		0	Deselected	None

3.2.5.7 Axis in simulation

S7-1500 Motion Control offers the option to move real axes in simulation mode. Speed, positioning and synchronous axes can thus be simulated without a connected drive and encoder in the CPU.

When the simulation mode is activated, the drive and encoder connection does not need to be configured in the axis configuration, for example, if the drive configuration is not yet available at this time. The "Simulation" configuration can be changed during runtime of the user program (<TO>.Simulation.Mode). A valid drive and encoder connection is required when exiting the simulation.

To use a technology object in simulation mode or with SIMATIC S7 PLCSIM, you need to use encoder 1 for closed loop position control of the axis.

Applications

- For example, an axis is simulated for programming the machine application and assigned to the configured hardware later for commissioning.
- During commissioning, for example, not all hardware components are available.
- No axis motions should take place during commissioning.

Characteristics in simulation mode

An axis in simulation does not output setpoints to the drive and does not read any actual values of the encoder. The actual values (Page 44) are formed with a time delay from the setpoints.

Hardware limit switches and home position switches have no effect.

The technology objects measuring input (with signal detection via TM_Timer_DIDQ or SINAMICS measurement sensing input), output cam and cam track can also be used for axes in simulation.

The following table shows the Motion Control instructions with adapted behavior in simulation mode:

Motion Control instruction	Characteristics in simulation mode
MC_Power	The axis is enabled immediately without waiting for feedback from the drive.
MC_Home	Homing jobs are executed immediately without simulated axis motion.
MC_TorqueLimit	The specified torque is not output to the drive.

3.2.5.8 Virtual axis

S7-1500 Motion Control offers the possibility to configure an axis as a virtual axis. A virtual axis has motion control, but, in contrast to real axes, no drive and encoder connection. The setpoints are only processed within the controller and no real drive is controlled.

Application:

A virtual axis, for example, is often used as a virtual leading axis in order to generate the setpoints for several real following axes in synchronous operation.

The "Virtual axis" configuration can only be changed by a new download to the CPU (in STOP mode) (<TO>.VirtualAxis.Mode).

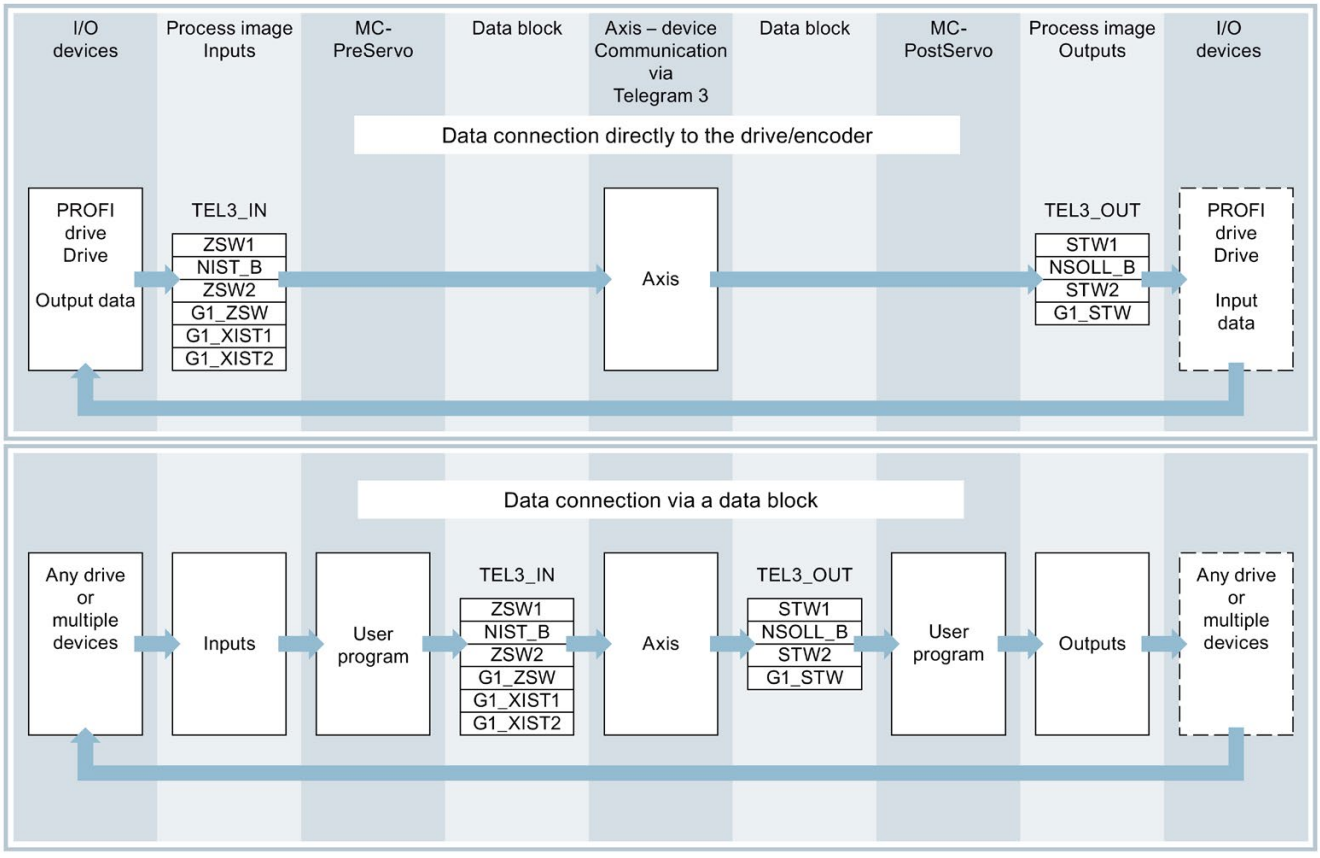
The behavior of a virtual axis is identical to the behavior of an axis in simulation (Page 56).

3.2.5.9 Data connection drive/encoder via data block

The data connection of PROFIdrive drives and encoders occurs either directly via the PROFIdrive telegram or via a data block.

Use the system-generated tags of the PROFIdrive telegrams if you want to evaluate the telegram contents.

Use the connection via data block if you want to influence or evaluate telegram contents in the user program for process-specific reasons.



Principle of data connection via data block

Generally, at the start of closed loop position control of the axis (by MC-Servo [OB91]), the input area of the drive or encoder telegram is read.

At the end of closed loop position control, the output area of the drive or encoder telegram is written.

To influence or evaluate telegram contents for process-specific reasons, a data interface via a data block must be connected in between before and after the closed loop position control.

- The input area of the telegram can be edited using the MC-PreServo [OB67] organization block. The MC-PreServo is called before the MC-Servo.
- The input area of the telegram can be edited using the MC-PostServo [OB95] organization block. The MC-PostServo is called after the MC-Servo.

The data block must be created by the user and contain a data structure of data type "PD_TELx" for the data connection. Here, "x" stands for the telegram number of the drive or encoder configured in the device configuration.

The organization blocks MC-PreServo and MC-PostServo can be programmed by the user and must be added with the command "Add new block". The connection to the I/O via telegram must be programmed in this organization block. When you use DSC you have to edit the signs of life in the telegrams in MC-PreServo and MC-PostServo yourself according to the PROFIdrive standard.

See also

PROFIdrive telegrams (Page 40)

Organization Blocks for Motion Control (Page 104)

Connect drive/encoder via data block (Page 342)

3.2.5.10 Tags

The following technology object tags are relevant for the drives and encoder connections:

Drive telegram	
<TO>.Actor.Interface.AddressIn	Input address for the PROFIdrive telegram
<TO>.Actor.Interface.AddressOut	Output address for the PROFIdrive telegram or the analog setpoint
<TO>.Actor.DriveParameter.ReferenceSpeed	Reference value (100%) for the speed setpoint (NSET) of the drive
<TO>.Actor.DriveParameter.MaxSpeed	Maximum value for the speed setpoint of the drive (NSET)
<TO>.Actor.DriveParameter.ReferenceTorque	Reference torque for the torque transferred as a percentage
Encoder telegram	
<TO>.Sensor[n].Interface.AddressIn	Input address for the PROFIdrive telegram
<TO>.Sensor[n].Interface.AddressOut	Output address for the PROFIdrive telegram
<TO>.Sensor[n].System	Encoder system linear or rotary
<TO>.Sensor[n].Type	Encoder type, incremental, absolute or cyclic absolute
<TO>.Sensor[n].Parameter.Resolution	Resolution for linear encoder The grid spacing corresponds to the distance between two marks.
<TO>.Sensor[n].Parameter.StepsPerRevolution	Steps per revolution for rotary encoder
<TO>.Sensor[n].Parameter.DeterminableRevolutions	Number of differentiable encoder revolutions for a multi-turn absolute encoder
Fine resolution	
<TO>.Sensor[n].Parameter.FineResolutionXist1	Number of bits for fine resolution XIST1 (cyclic actual encoder value)
<TO>.Sensor[n].Parameter.FineResolutionXist2	Number of bits for fine resolution XIST2 (absolute value of encoder)
Simulation mode	
<TO>.Simulation.Mode	Simulation mode 0: No simulation, normal operation 1: Simulation mode

3.2.6 Mechanics

3.2.6.1 Brief description

For the display and processing of the technology object's position, the decisive factor is whether the position is represented as a unit of length (linear axis) or a unit of angle (rotary axis).

Examples of units of length: mm, m, km

Examples of units of angle: °, rad

For the determination of the physical position from an actual encoder value, the system must know the various properties and configurations of the mechanics.

Positioning axis/synchronous axis

The following configuration options for mechanics are supported:

- Load gear
- Leadscrew pitch (linear axes only)
- Encoder mounting type:
  - Motor side (before the load gear)
  - Load side (after the load gear and as applicable the leadscrew)
  - External (e.g. odometer)
- Inversion of drive direction
- Inversion of encoder direction

External encoder

The following configuration options for mechanics are supported:

- Measuring gear (for rotary encoders)
- Leadscrew pitch (only with linear system of units and rotary encoders)
- Inversion of encoder direction

Speed axis

The following configuration options for mechanics are supported:

- Load gear
- Inversion of drive direction

3.2.6.2 Tags

The following technology object tags are relevant for the setting of the mechanics:

Type of motion	
<TO>.Properties.MotionType	Indication of linear or rotary motion 0: Linear motion 1: Rotary motion
Load gear	
<TO>.LoadGear.Numerator	Load gear numerator
<TO>.LoadGear.Denominator	Load gear denominator
Leadscrew pitch	
<TO>.Mechanics.LeadScrew	Leadscrew pitch
Encoder mounting type	
<TO>.Sensor[n].MountingMode	Encoder mounting type
<TO>.Sensor[n].Parameter.DistancePerRevolution	Load distance per encoder revolution with an externally mounted encoder
Inversion	
<TO>.Actor.InverseDirection	Setpoint inversion
<TO>.Actor.Efficiency	Efficiency of leadscrew pitch
<TO>.Sensor[n].InverseDirection	Actual value inversion
Modulo	
<TO>.Modulo.Enable	Enable modulo
<TO>.Modulo.Length	Modulo length
<TO>.Modulo.StartValue	Modulo start value

3.2.7 Traversing range limitation

3.2.7.1 Brief description

Hardware and software limit switches limit the permissible traversing range and operating range of the positioning axis/synchronous axis. Before use, they must be enabled in the configuration or in the user program.

The following figure shows the relationship between the operating range, maximum traversing range and limit switches:

① Mechanical endstop
② Hardware limit switches
③ Software limit switches
④ Maximum traversing range
⑤ Operating range

3.2.7.2 Hardware limit switches

Hardware limit switches are limit position switches that limit the maximum permissible traversing range of the axis.

Select the positions of the hardware limit switches so that there is adequate braking distance for the axis when needed. The axis should come to a standstill before a mechanical endstop.

Approaching the hardware limit switches

In the monitoring of range limitation, no distinction is made as to whether the switches are reached or crossed.

If a hardware limit switch is reached, technology alarm 531 is output, and the technology object is disabled (alarm response: remove enable).

Exception

If the hardware limit switches are used as reversing cams or reference cams during homing, then the monitoring of the hardware limit switches has no effect.

When hardware limit switches are used as reversing cams, the axis is braked with the deceleration configured in the dynamic defaults.

This must be taken into account when planning the distance of the hardware limit switch to the mechanical endstop.

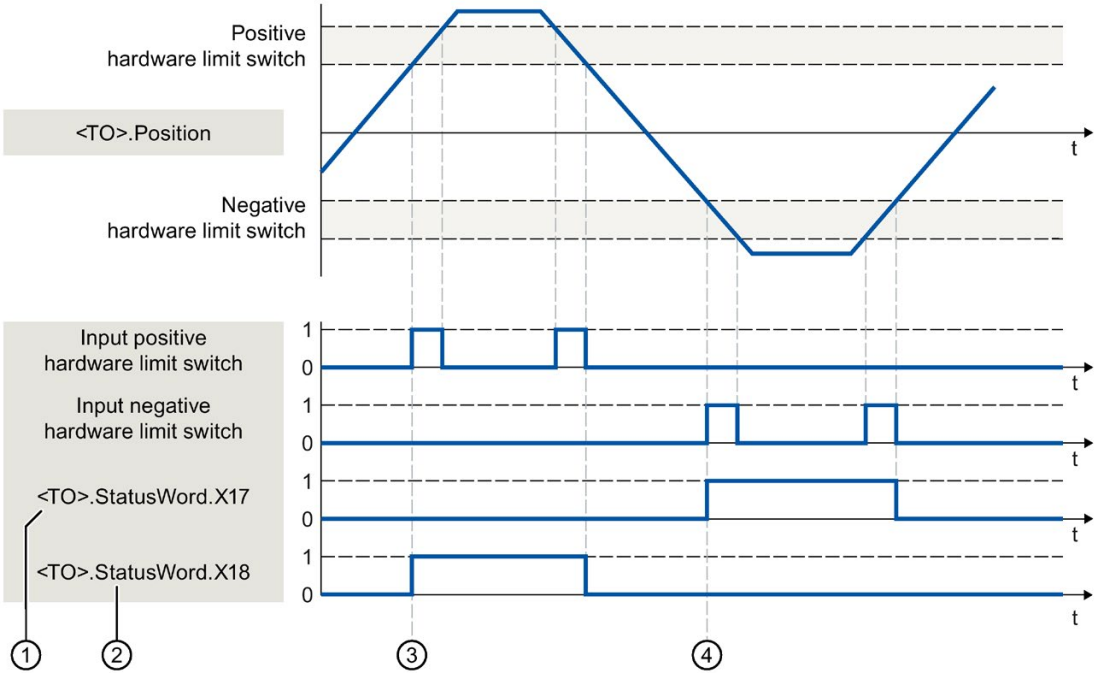
Retracting

The position of the axis when the hardware limit switch is detected is stored internally on the CPU. The status of the reached hardware limit switch is reset only after the hardware limit switch is left and the axis is once again in the maximum traversing range.

To retract the axis after it reaches the hardware limit switch and to reset the status of the hardware limit switch, follow the steps below:

1. To enable motion in the retraction direction, acknowledge the technology alarm.
2. Traverse the axis in the retraction direction until the hardware limit switch is left.
   The axis must then be within the maximum traversing range.
   If you move the axis opposite the retraction direction before the hardware limit switch is left, the monitoring will be triggered again.

The following chart shows the behavior of the status word when the hardware limit switch is reached and when the axis is retracted:



① <TO>.StatusWord.X17 (HWLimitMinActive)
0: Negative hardware limit switch not reached
1: Negative hardware limit switch reached or overtraveled

② <TO>.StatusWord.X18 (HWLimitMaxActive)
0: Positive hardware limit switch not reached
1: Positive hardware limit switch reached or overtraveled

③ The position of the axis when the **positive** hardware limit switch is detected is saved internally in the CPU. To reset the status of the hardware limit switch, the axis position must fall short of this position.

④ The position of the axis when the **negative** hardware limit switch is detected is saved internally in the CPU. To reset the status of the hardware limit switch, the axis position must go past this position.

3.2.7.3 Software limit switch

The operating range of the axis is limited with software limit switches. Relative to the traversing range, always position the software limit switches within the hardware limit switches. Since the positions of the software limit switches can be flexibly configured, the operating range of the axis can be individually adapted in accordance with the current velocity profile.

Software limit switches are only in effect when there is a valid actual value after homing the technology object. The monitoring of the software limit switches is relative to the setpoint.

Modulo enabled

With modulo enabled, the modulo position is monitored.

The software limit switches are configured and activated in the axis configuration. The software limit switches can be activated or deactivated in the user program using the <TO>.PositionLimits_SW.Active tag, If the positions of both software limit switches are outside the modulo range, the monitoring has no effect. No check is made to determine whether the positions of the software limit switches are within the modulo range.

Approaching the software limit switches

The axis continually checks the position of the software limit switch during motion and brakes to exactly this position, if necessary.

If the software limit switches are reached, then technology alarm 533 is output, and the axis is stopped with the maximum dynamic values (alarm response: Stop with maximum dynamic values). The technology object remains enabled.

Overrun of the software limit switches

If a software limit switch is crossed, technology alarm 534 is output, and the technology object is disabled (alarm response: remove enable).

Retracting

To retract the axis after violation of the software limit switch, follow the steps below:

1. Acknowledge the technology alarm.
2. Move the axis in the retraction direction until the software limit switch is left.

   If you move the axis opposite the retraction direction before the software limit switch is left, the monitoring with be triggered again.

3.2.7.4 Tags

The following technology object tags are relevant for software limit switches:

Status indicators	
<TO>.StatusWord.X15 (SWLimitMinActive)	Negative software limit switch is active
<TO>.StatusWord.X16 (SWLimitMaxActive)	Positive software limit switch is active
<TO>.ErrorWord.X8 (SWLimit)	An alarm is pending, that a software limit switch was violated
Control bits	
<TO>.PositionLimits_SW.Active	Enables / disables the monitoring of the software limit switches
Position values	
<TO>.PositionLimits_SW.MinPosition	Position of the negative software limit switch
<TO>.PositionLimits_SW.MaxPosition	Position of the positive software limit switch

The following technology object tags are relevant for hardware limit switches:

Status indicators	
<TO>.StatusWord.X17 (HWLimitMinActive)	Negative hardware limit switch is active
<TO>.StatusWord.X18 (HWLimitMaxActive)	Positive hardware limit switch is active
<TO>.ErrorWord.X9 (HWLimit)	An alarm is pending; a hardware limit switch was violated
Control bits	
<TO>.PositionLimits_HW.Active	Enables / disables the monitoring of the hardware limit switches
Parameters	
<TO>.PositionLimits_HW.MinSwitchLevel	Level selection for activation of the low hardware limit switch: FALSE: At low level, the signal is active TRUE: At high level, the signal is active
<TO>.PositionLimits_HW.MinSwitchAddress	Byte number of the I/O address of the hardware limit switch for the low or minimum position
<TO>.PositionLimits_HW.MaxSwitchLevel	Level selection for activation of the high hardware limit switch: FALSE: At low level, the signal is active TRUE: At high level, the signal is active
<TO>.PositionLimits_HW.MaxSwitchAddress	Byte number of the I/O address of the hardware limit switch for the high or maximum position

3.2.8 Motion control and limits for dynamics

3.2.8.1 Brief description

Motion control of the axis occurs by means of velocity profiles (Page 67). The velocity profiles are calculated in accordance with the specifications for dynamics. A velocity profile defines the behavior of the axis during approach, braking and changes in velocity. During positioning a velocity profile is calculated, that moves the axis to the target point.

Maximum values for velocity, acceleration and jerk result from the properties of the drive and the mechanics. These maximum values can be configured in the limits for dynamics. The limits for dynamics are in effect as limits for every motion generated by means of the technology object. The dynamic limits have no effect on a following axis in synchronous operation.

The configurable emergency stop deceleration (Page 68) is triggered by the Motion Control instruction MC_Power or by a technology alarm.

The jerk limit reduces the mechanical load during an acceleration ramp or deceleration ramp. A "smoothed" velocity profile results.

See also

Dynamic limits in synchronous operation (Page 69)

3.2.8.2 Velocity profile

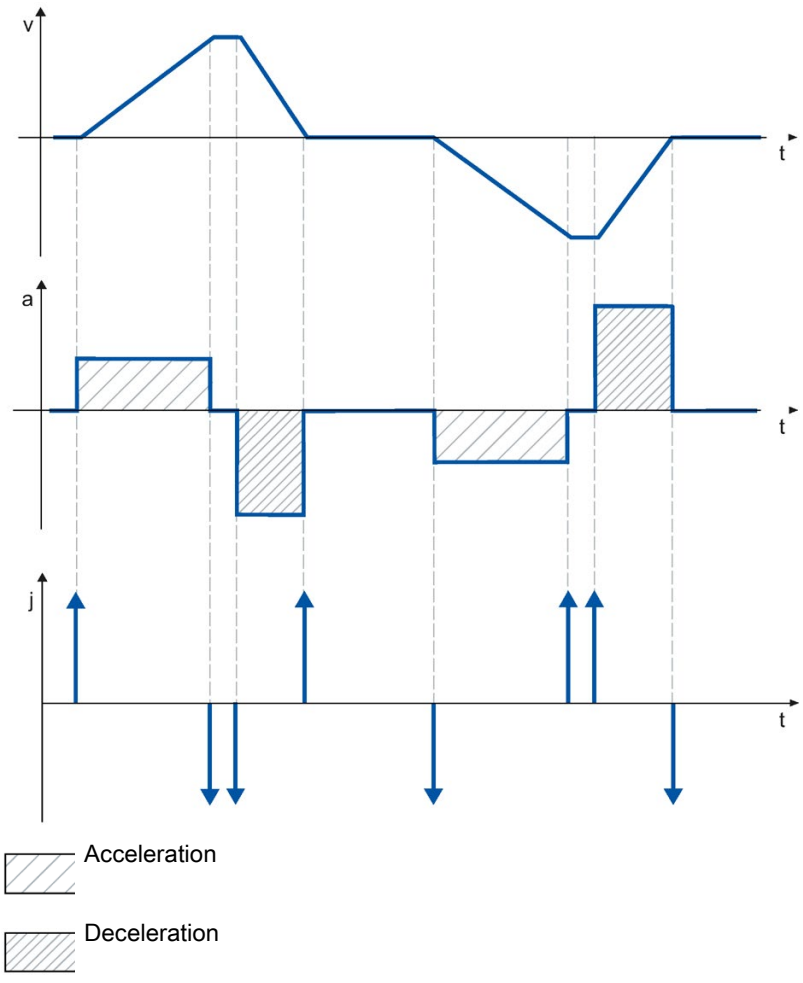
Velocity profiles with or without jerk limitation are supported for motion control of the axis.

The dynamic values for the motion are specified in the Motion Control job. Alternatively, the values of the dynamic defaults (Page 234) can be used. The defaults and the limits for velocity, acceleration, deceleration and jerk are set in the configuration.

To influence velocity, a velocity override can override the current traversing velocity.

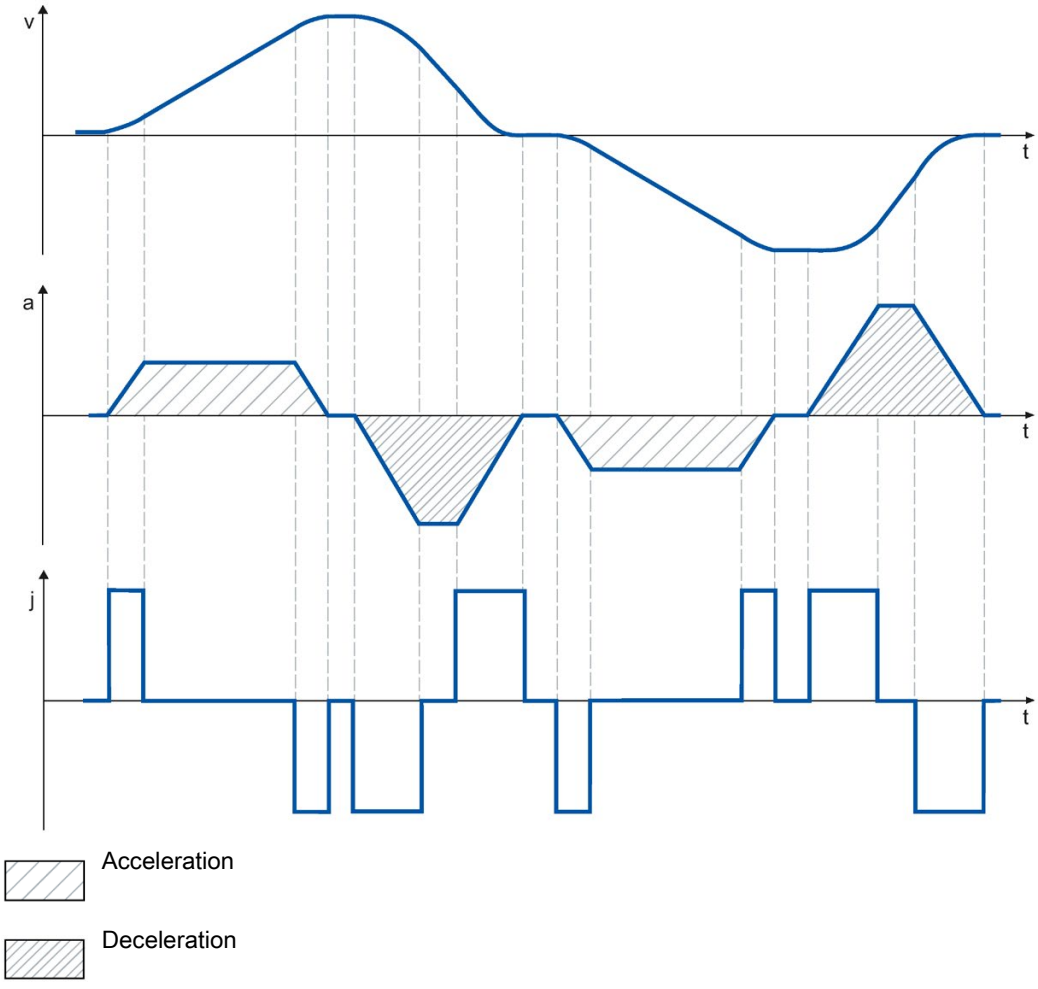
Velocity profile without jerk limitation

The following figure shows velocity, acceleration and jerk:



Velocity profile with jerk limitation

The following figure shows velocity, acceleration and jerk:



A velocity profile with jerk limitation is employed for a continuous acceleration and deceleration sequence. The jerk can be specified.

3.2.8.3 Emergency stop deceleration

When stopping with the emergency stop ramp, the axis is braked to a standstill without a jerk limit, using the configured emergency stop deceleration.

In the following cases the configured emergency stop deceleration is in effect:

- For an emergency stop ramp that has been enabled via the Motion Control instruction "MC_Power" with parameter "StopMode" = 0.
- For a technology alarm with the local alarm response "Stop with emergency stop ramp".

This emergency stop deceleration can be set greater than the maximum deceleration. If the emergency stop deceleration is set lower than this, it may occur that the axis does not stop until after the limit switch in the case of "Stop at software limit switch" and the occurrence of a technology alarm with the local alarm response "Stop with emergency stop ramp".

3.2.8.4 Dynamic limits in synchronous operation

Dynamic limits in synchronous operation with MC_GearIn

Leading axis

The dynamic limits configured for the technology object are always in effect for the leading axis.

Following axis

If a synchronous axis is operated as a following axis in synchronous operation with MC_GearIn, the following dynamic limits apply depending on the phase of the synchronous operation.

- Synchronization

  During the synchronizing phase, dynamic limits configured for the technology object apply to the following axis.

- Synchronous motion

  When the synchronous axis is moving synchronously to the leading axis as a following axis, the dynamics of the following axis is limited only to the maximum speed of the drive (<TO>.Actor.DriveParameter.MaxSpeed). The dynamics of the following axis results from the synchronous operation function.

  If the dynamic limits configured for the following axis are exceeded, this will be indicated in the technology object tag <TO.>StatusSynchronizedMotion.StatusWord.

  If the following axis cannot follow the leading value, this results in a following error, which is monitored by the following error monitoring.

- Synchronous operation override

  As soon as synchronous operation has been overridden, the dynamic limits configured for the technology object apply to the following axis again. With the start of the overriding job, the active dynamics is transitioned (smoothed) to the configured dynamic limits and the specifications for the Motion Control instruction.

See also

StatusSynchronizedMotion tags (synchronous axis) (Page 578)

Override response V4: Synchronous operation jobs (Page 537)

Dynamic limits in synchronous operation with MC_GearInPos/MC_CamIn

Leading axis

The dynamic limits configured for the technology object are always in effect for the leading axis.

Following axis

If a synchronous axis is operated as a following axis in synchronous operation with MC_GearInPos/MC_CamIn, the following dynamic limits apply depending on the phase of the synchronous operation.

- **Pending synchronous operation**

  If synchronous operation is not active, the configured dynamic limits apply. If a synchronous operation is already active, these limits are overridden by the previous synchronous operation.

- **Synchronization/synchronous motion**

  During synchronization/synchronous motion, the dynamics of the following axis is limited only to the maximum speed of the drive (<TO>.Actor.DriveParameter.MaxSpeed). The dynamics of the following axis results from the synchronous operation function.

  If the dynamic limits configured for the following axis are exceeded, this will be indicated in the technology object tag <TO.>StatusSynchronizedMotion.StatusWord.

  If the following axis cannot follow the leading value, this results in a following error, which is monitored by the following error monitoring.

- **Synchronous operation override**

  As soon as synchronous operation has been overridden, the dynamic limits configured for the technology object apply to the following axis again. With the start of the overriding job, the active dynamics is transitioned (smoothed) to the configured dynamic limits and the specifications for the Motion Control instruction.

See also

StatusSynchronizedMotion tags (synchronous axis) (Page 578)

Override response V4: Synchronous operation jobs (Page 537)

3.2.8.5 Motion specification via MotionIn

In contrast to the Motion Control instructions such as "MC_MoveAbsolute" and "MC_MoveRelative", no motion profile is calculated by the system when "MC_MotionInVelocity" and "MC_MotionInPosition" are used. Each individual setpoint of the motion profile (motion vector) must be specified with the MotionIn instruction in the application cycle. This allows you to calculate your own motion profile.

The setpoints are typically adapted in the processing cycle of the technology object. For this purpose, the MotionIn instruction is called in the organization block MC-PreServo [OB67] or MC-PostServo [OB95]. The setpoints are then transferred directly to the axis in MC-Interpolator [OB92].

WARNING

Uncontrolled axis motions

When using the motion specification via the Motion Control instructions "MC_MotionInVelocity" and "MC_MotionInPosition", the axis can perform uncontrolled motions.

Consider the current dynamics of the axis when specifying the new motion vectors. The motion vectors must be consistent with each other.

Set up the following protective measures before operating with the Motion Control instructions "MC_MotionInVelocity" and "MC_MotionInPosition":

- Ensure that the EMERGENCY OFF switch is within the reach of the operator.
- Enable the hardware limit switches.
- Enable the software limit switches.
- Ensure that following error monitoring is enabled.

Note that a following axis that is coupled to the axis is also moved.

Overriding with MotionIn instructions

If a Motion Control instruction is overridden by a MotionIn instruction, the setpoints take immediate effect with the current application cycle. The dynamic results exclusively through the setpoint specifications of the user program. It is not limited and no smooth transition takes place from the current motion state. Consider the current dynamics of the axis when specifying the new motion vectors. Note that dynamic limits set on the technology object have no effect. Only limits set on the drive side are in effect.

Stopping MotionIn instructions

The MotionIn instructions can be canceled by the following means:

- Overriding them with another Motion Control instruction

  The MotionIn instructions are overridden according to the behavior described in the section "Override response V4: Homing and motion jobs (Page 536)". As a rule, the current dynamics are overridden by the new motion.

- Set the parameter "Enable" to FALSE

  If you set "Enable" parameter to FALSE, the setpoint is immediately set to zero. Note that the dynamic limits set on the technology object have no effect. Only limits set on the drive side are in effect.

MC_MotionInVelocity

Use the "MC_MotionInVelocity" instruction to specify the velocity and acceleration of the motion. The instruction is applicable for speed, positioning and constant axes.

To execute the instruction, you must at least specify the velocity. Acceleration is usually only required for the substituting running motions. By default, the value of the acceleration is zero.

MC_MotionInPosition

Use the "MC_MotionInPosition" instruction to specify the position, velocity and acceleration of the motion. The instruction is used for velocity, positioning and synchronous axes.

To execute the instruction, you must at least specify the position and velocity. Acceleration is usually only required for the substituting running motions. By default, the value of the acceleration is zero. The specified setpoints must be consistent with each other.

The position specification is position-controlled. If you use a velocity precontrol, the velocity specification is processed via the velocity precontrol.

See also

MC_MotionInVelocity: Specify motion setpoints V4 (Page 517)

MC_MotionInPosition: Specify motion setpoints V4 (Page 521)

3.2.8.6 Torque limits

Force/torque limiting

Adjustable force/torque limiting is available for the speed axis, positioning axis and synchronous axis technology objects. The force/torque limiting can be activated and deactivated before and during a motion job. To use force/torque limiting, the drive and the PROFIdrive telegram must support torque reduction. A telegram 10x can be used.

The limit value can be configured as a default value during configuration of the axis or it can be defined in the user program using Motion Control instruction "MC_TorqueLimiting".

The user specifies the limiting values in the configured unit of measure for force or torque. The units of measure are defined in the "Basic parameters" configuration window.

The following configuration options are available for force/torque limiting.

- "Linear" axis type
  - Torque limiting is active on motor side
  - Force limiting is active on the load side
- "Rotary" axis type
  - Torque limiting is active on load side or motor side

The force/torque limit defined by the user in accordance with the specification in the PROFIdrive telegrams 10x are transferred internally to the drive as a percentage torque reduction. The reference torque set in the "Data exchange with the drive" configuration dialog must match the reference torque set for the drive.

Linear axis type

Load-side force limitation you have defined is converted by the technology into torque reduction. If the limiting relates to the load side, the gear and leadscrew parameters defined in the "Mechanics" configuration dialog are taken into consideration. If the gear and leadscrew efficiency is crucial, you can set them in the <TO>.Actor.Efficiency tag.

Rotary axis type:

The torque is reduced on the load side with the rotary axis type. The gear parameters defined in the "Mechanics" configuration window are taken into consideration. If the efficiency of the gear is crucial, you can set them in the <TO>.Actor.Efficiency tag.

The defined limiting values act as an absolute value and thus in the same way for positive and negative forces/torques.

Positioning and following error monitoring with active force/torque limiting

As a result of force/torque limiting, a larger setpoint-actual value difference can build up for position-controlled axes, which may cause unwanted activation of the positioning and following error monitoring.

Therefore, in the "Torque limiting" configuration window, the positioning and following error monitoring of the axis can be set as deactivated by default when force/torque limiting is active. If necessary, the positioning and following error monitoring can also be kept active even when force/torque limiting is active.

Typical behavior of a positioning or synchronous axis with active force/torque limiting

With active force/torque limiting, a larger setpoint-actual value difference can build up than during motion without force/torque limiting.

Given a constant setpoint, the axis makes repeated attempts to reduce the following error.

When the limiting values are increased or limiting is deactivated during active closed loop position control, the axis can accelerate briefly to reduce the following error. If the axis is switched to non-position-controlled operation, e.g. using "MC_MoveVelocity" with "PositionControlled" = FALSE, the following error is no longer in effect.

Stopping an axis with active force/torque limiting

When stopping an axis in position-controlled mode with "MC_Halt", the position setpoint and the velocity setpoint are used as basis. Torque limiting still remains active and any accumulated following error is reduced. The axis is at a standstill when the actual velocity "0.0" is reached and the minimum dwell time in the standstill window has expired. The axis remains enabled.

When stopping an axis with "MC_Power" and an emergency stop ramp, the actual position value and the actual velocity are used as a basis. The axis is braked with the configured emergency stop deceleration without any jerk limit and brought to a standstill. The axis is then disabled when at a standstill.

When the limitation is deactivated the drive attempts to compensate for the resulting following error with maximum dynamic values. To avoid this reaction, use "MC_MoveVelocity" with deactivated closed loop position control.

See also

MC_TorqueLimiting: Activate and deactivate force/torque limit / fixed stop detection V4 (Page 525)

Fixed stop detection (Page 74)

Configuration - Torque limits (Page 215)

Configuration - Torque limits (Page 241)

Fixed stop detection

With the Motion Control instruction "MC_TorqueLimiting", you activate and monitor a fixed stop detection.

Together with a position-controlled motion job, a "Travel to fixed stop" can be realized. The operation is also referred to as clamping.

"Travel to fixed stop" can be used, for example, to move quills against the workpiece with a specified torque.

The fixed stop detection is configured in the configuration window "Extended parameters" > "Limits" > "Fixed stop detection".

The fixed stop detection is only possible in position-controlled operation of the axis.

If the drive and telegram support force/torque limiting, this is active during travel to fixed stop and for clamping.

Detection of the fixed stop using following error

If the drive is stopped by a mechanical fixed stop during a motion job, the following error is increased. When the following error configured in the configuration window "Extended parameters" > "Limits" > "Fixed stop detection" is exceeded, this is regarded as the fixed stop having been reached.

When following error monitoring is activated, the configured following error must be greater than the following error for fixed stop detection.

Clamping at the mechanical endstop

When the fixed stop is reached, the active position-controlled motion job is aborted with CommandAborted. The setpoint is no longer changed and the following error remains constant. The closed loop position control remains active and the monitoring of the configured "Positioning tolerance" is activated The drive is in "Clamping" state.

If the drive and frame support force/torque limiting, this continues to be active with active fixed stop detection. During clamping, the clamping force or clamping torque can be changed. The value in input parameter "Limit" of the Motion Control instruction "MC_TorqueLimiting" can be changed for this.

Monitoring of the clamping

If the actual position changes by a value greater than the configured "Positioning tolerance" during active clamping, this is regarded as the breaking away or turning back of the fixed stop. An alarm is triggered; the axis is disabled and the drive is stopped according to its configuration.

If the position setpoint is within the configured "Positioning tolerance", the breaking away or turning back of the fixed stop cannot be detected.

The configured position tolerance must be less than the configured following error for detection of clamping.

Retracting

Retracting from the fixed stop is only possible with a position-controlled motion job in the opposite direction to the fixed stop.

The "Travel to fixed stop" or "Clamping" function is ended when the "Positioning tolerance" is left in the retraction direction.

See also

Force/torque limiting (Page 73)

Configuration - Fixed stop detection (Page 242)

MC_TorqueLimiting: Activate and deactivate force/torque limit / fixed stop detection V4 (Page 525)

Additive setpoint torque

The Motion Control instruction "MC_TorqueAdditive" allows you to apply additional torque in the drive.

The additive setpoint torque is used for example in torque feedforward control or the specification of the tensile torque for winding applications.

The following requirements must be fulfilled to set the additive torque setpoint:

- SINAMICS drive (see compatibility list (Page 665))
- SIEMENS supplementary telegram 750 for transmitting the torque data to the drive

The additional torque can be either positive or negative. The value specified in the instruction is a technological value, not a percentage. Set the unit of measure for the torque at the axis (default value: Nm).

See also

MC_TorqueAdditive: Specify additive torque V4 (Page 530)

Permissible torque range

The Motion Control instruction "MC_TorqueRange" allows you to set torque limits for the drive.

The motion control instruction is used, for example, for winding applications in order to prevent the tearing of the material.

The following requirements must be fulfilled to set the torque data:

- SINAMICS drive (see compatibility list (Page 665))
- SIEMENS supplementary telegram 750 for transmitting the torque data to the drive

The value specified in the instruction is a technological value, not a percentage. Set the unit of measure for the torque at the axis (default value: Nm). If you invert the setpoints at the technology object of the axis, the values for the high and low torque limit are output inverted and reversed.

If the torque limitation is activated by specifying the high and low torque limit, the following monitorings and limits are deactivated:

- Following error monitoring
- Time limits for positioning monitoring
- Time limits for standstill monitoring

Monitoring remains in effect if you have selected the option
"Leave position-related monitoring enabled" under
"Technology object > Configuration > Extended parameters > Limits > Torque limiting".

See also

MC_TorqueRange: Set high and low torque limits V4 (Page 533)

3.2.8.7 Tags

The following technology object tags are relevant for motion control:

Status	
<TO>.StatusWord	Status indicator for an active motion
<TO>.Position	Position setpoint
<TO>.Velocity	Velocity setpoint / speed setpoint
<TO>.ActualPosition	Actual position
<TO>.ActualVelocity	Actual velocity
<TO>.ActualSpeed	Actual speed of the motor (only with PROFIdrive drive type)
<TO>.Acceleration	Setpoint acceleration
<TO>.ActualAcceleration	Actual acceleration
<TO>.StatusSynchronizedMotion.StatusWord.X0 (MaxVelocityExceeded)	Set to value TRUE when the maximum velocity configured for the following axis is exceeded during synchronous operation.
<TO>.StatusSynchronizedMotion.StatusWord.X1 (MaxAccelerationExceeded)	Set to value TRUE when the maximum acceleration configured for the following axis is exceeded during synchronous operation.
<TO>.StatusSynchronizedMotion.StatusWord.X2 (MaxDecelerationExceeded)	Set to value TRUE when the maximum deceleration configured for the following axis is exceeded during synchronous operation.
<TO>.StatusMotionIn.FunctionState	Status of the MotionIn function 0: No function activated 1: MotionInVelocity activated 2: MotionInPosition activated

Override	
<TO>.Override.Velocity	Velocity or speed override

Dynamic limit values	
<TO>.DynamicLimits.MaxVelocity	Dynamic limitation for maximum speed (mechanical)
<TO>.DynamicLimits.Velocity	Dynamic limitation for maximum speed (programmable)
<TO>.DynamicLimits.MaxAcceleration	Dynamic limitation for maximum acceleration
<TO>.DynamicLimits.MaxDeceleration	Dynamic limitation for maximum deceleration
<TO>.DynamicLimits.MaxJerk	Dynamic limitation for maximum jerk

Defaults for the dynamics	
<TO>.DynamicDefaults.Velocity	Default velocity
<TO>.DynamicDefaults.Acceleration	Default acceleration
<TO>.DynamicDefaults.Deceleration	Default deceleration
<TO>.DynamicDefaults.Jerk	Default jerk
<TO>.DynamicDefaults.EmergencyDeceleration	Emergency stop deceleration

Torque limiting	
<TO>.TorqueLimiting.LimitDefaults.Torque	Limiting torque
<TO>.TorqueLimiting.LimitDefaults.Force	Limiting force
<TO>.TorqueLimiting.LimitBase	Torque limiting motor or drive side 0: Motor side 1: Load side
<TO>.TorqueLimiting.PositionBasedMonitorings	Disable/enable positioning and following error monitoring 0: Deactivate 1: Keep active
<TO>.StatusTorqueData.CommandAdditiveTorqueActive	Additive torque setpoint function 0: Deactivated 1: Activated
<TO>.StatusTorqueData.CommandTorqueRangeActive	Torque limits function 0: Deactivated 1: Activated
<TO>.StatusTorqueData.ActualTorque	Actual torque of the axis

Fixed stop detection	
<TO>.Clamping.FollowingErrorDeviation	Value of the following error starting from which the fixed stop is detected
<TO>.Clamping.PositionTolerance	Position tolerance for the clamping monitoring

3.2.9 Homing

3.2.9.1 Brief description

With homing, you create the relationship between the position in the technology object and the mechanical position. The actual position value in the technology object is assigned to a homing mark at the same time. This homing mark represents a known mechanical position.

With incremental actual values this process is called homing; with absolute actual values it is called absolute encoder adjustment.

Homing is a requirement for display of the correct position for the technology object and for absolute positioning.

Homing is activated with the Motion Control instruction "MC_Home".

Homing status

The technology object tag <TO>.StatusWord.X5 (HomingDone) indicates whether the axis or external encoder technology object is homed.

Type of homing

Homing can occur by means of an independent homing motion (active homing), the detection of a homing mark during a motion initiated on the user side (passive homing) or a direct position assignment.

A distinction is made between the following types of homing:

- **Active homing**

  Active homing initiates a homing movement and performs the necessary homing mark approach. When the homing mark is detected, the actual position is set to the value specified in MC_Home. It is possible to specify a home position offset. Retraction to the home position offset occurs automatically during the home position approach.

  When active homing starts, current traversing movements are aborted.

- **Passive homing**

  The homing job does not perform its own homing motion. When the homing mark is detected during a motion initiated on the user side, the actual position is set to the value specified in "MC_Home".

  Passive homing is also called homing on the fly.

- **Direct homing**

  With the homing job, the actual position is set directly to the value specified in "MC_Home" or is offset by this value.

- **Absolute encoder adjustment**

  The absolute encoder adjustment compares the existing absolute actual value with the value specified in "MC_Home".

Homing mode

Depending on the type of homing mark and homing mark search, a distinction is made among the following homing modes (Page 81):

- Homing with homing cam and zero mark via PROFIdrive telegram
- Homing with zero mark via PROFIdrive telegram
- Homing with digital input

3.2.9.2 Terms

Homing mark

A homing mark is an input signal, on whose occurrence a known mechanical position can be assigned to the actual values.

A homing mark can be:

- **A zero mark**

  The zero mark of an incremental encoder or an external zero mark is used as a homing mark.

  The zero mark is detected at the drive module or encoder module and transmitted in the PROFIdrive frame. Perform the setting and evaluation as an encoder zero mark or external zero mark at the drive module and encoder module.

- **An edge at the digital input**

  The negative or positive edge at a digital input is used as a homing mark.

Reference cam

If there are several zero marks in the traversing range, the reference cam is used to select a specific zero mark before or after the reference cam.

Homing mark position

This is the position assigned to the homing mark.

The homing mark position corresponds to the home position minus the home position offset.

Home position

At the end of the active homing motion, the axis arrives at the home position.

Home position offset

The difference between the home position and the homing mark position is the home position offset.

A home position offset only has an effect with active homing. The offset is traversed after the synchronization of the axis using the Motion Control instruction "MC_Home". For axes with modulo setting, the home position offset is always traversed with the direction setting for the shortest path.

Direction reversal at the hardware limit switch (reversing cam)

Hardware limit switches can be used as reversing cams in active homing. If the homing mark was not detected or was approached from the wrong side, the motion continues in the opposite direction after the reversing cam.

3.2.9.3 Homing mode

Various homing modes are available for the positioning axis/synchronous axis and external encoder technology objects with incremental encoders. The homing mode is set in the configuration.

Homing with homing cam and zero mark via PROFIdrive telegram

The system checks for when the reference cam is reached. After the reference cam has been reached and left again in the assigned homing direction, zero mark detection is enabled via the PROFIdrive telegram.

When the zero mark is reached in the pre-selected direction, then the actual position of the technology object is set to the homing mark position.

Homing with zero mark via PROFIdrive telegram

The system enables zero mark detection, as soon as the actual value of the technology object moves in the assigned homing direction.

When the zero mark is reached in the specified homing direction, the actual position of the technology object is set to the homing mark position.

Homing with digital input

The system checks the state of the digital input, as soon as the actual value of the axis or encoder moves in the assigned homing direction.

When the homing mark is reached (setting of the digital input) in the specified homing direction, the actual position of the technology object is set to the homing mark position.

Note

The digital inputs must be placed into the process image partition "PIP OB Servo".

The filter time of the digital inputs must be set smaller than the duration of the input signal at the reference point switch.

See also

Homing SINAMICS drives with external zero marks (Page 665)

3.2.9.4 Active homing with homing cam and zero mark

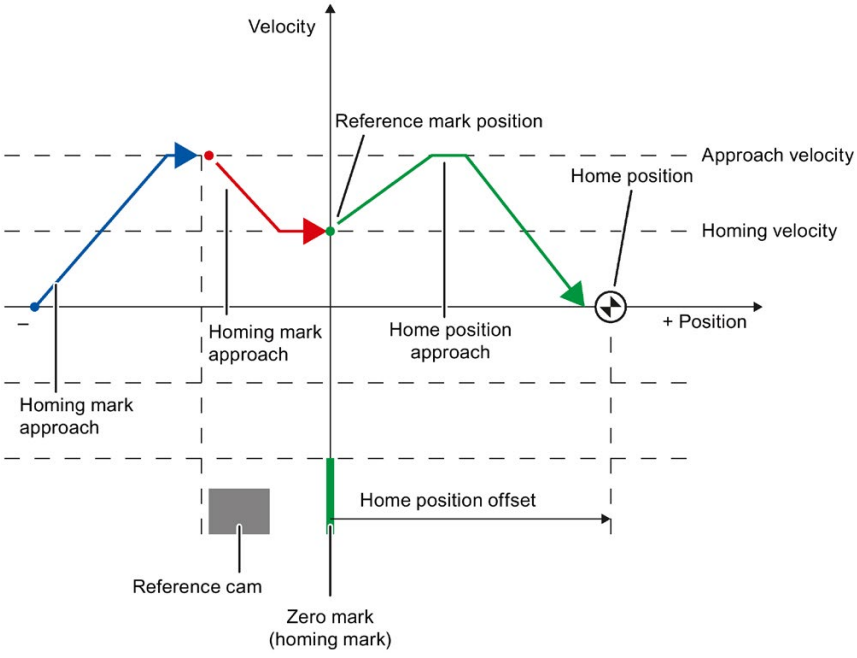
The following examples show homing motions in the positive and negative directions.

Example of homing in the positive direction

The approach to the homing mark and the home position occurs in the positive direction.

The following figure shows the homing motion with the following settings:

- Active homing with homing cam and zero mark
- Approach in the positive direction
- Homing in the positive direction
- Positive home position offset

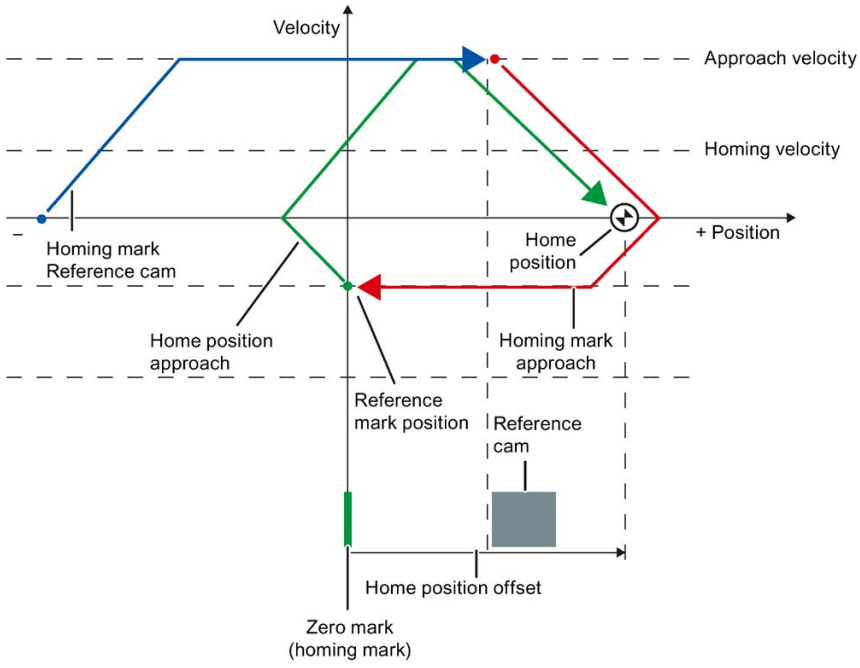


Example of homing in the negative direction

The approach to the homing mark occurs in the negative direction by means of a direction reversal during the homing process. The approach to home position causes another direction reversal and occurs in the positive direction.

The following figure shows the homing motion with the following settings:

- Active homing with homing cam and zero mark
- Approach in the positive direction
- Homing in the negative direction
- Positive home position offset



Motion sequence

The motion occurs in the following sequence:

1. Start of active homing via the "MC_Home" Motion Control instruction
2. Approach to reference cam
3. Detection of the reference cam in the homing direction and travel with homing velocity
4. Departure from the reference cam and travel to the homing mark

   With the departure from the reference cam, the detection of the homing mark is enabled.
5. Detection of the homing mark

   When the homing mark is detected, the position of the technology object is set depending on the configured mode:

   – Parameter "Mode" in "MC_Home" = 3

     Position = value in parameter "Position" minus <TO>.Sensor[n].ActiveHoming.HomePositionOffset

   – Parameter "Mode" in "MC_Home" = 5

     Position = value in the tag <TO>.Homing.HomePosition minus <TO>.Sensor[n].ActiveHoming.HomePositionOffset

   Note

   Parameter "MC_Home.Mode"

   The "MC_Home.Mode" parameter for S7-1200 Motion Control and S7-1500 Motion Control has been standardized within the framework of technology version V2.0. This results in a new assignment of the parameter values for the "MC_Home.Mode" parameter. A comparison of the "MC_Home.Mode" parameter for technology versions V1.0 and V2.0 is available in the section Version overview (Page 179).

6. Approach to the home position

   – Parameter "Mode" in "MC_Home" = 3

     The axis moves to the position that is specified in the "Position" parameter.

   – Parameter "Mode" in "MC_Home" = 5

     The axis moves to the position that is specified in the <TO>.Homing.HomePosition tag.

   Note

   If the velocity cannot be reduced to the reference velocity between detection of the reference cam and the zero mark, homing is performed at the velocity present when the zero mark is crossed.

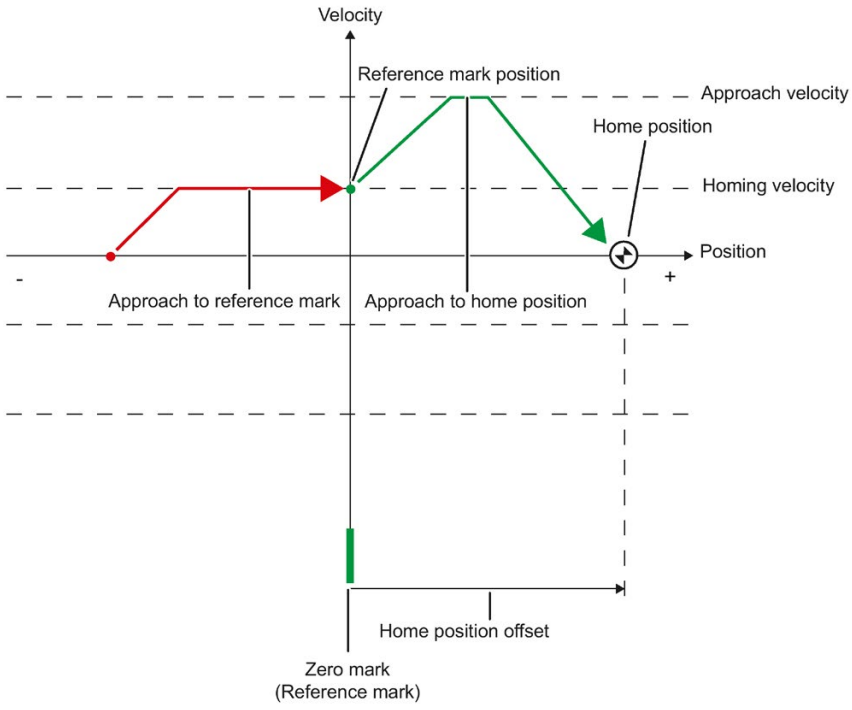
See also

Homing SINAMICS drives with external zero marks (Page 665)

3.2.9.5 Active homing with zero mark

The following figure shows an example of the homing motion with the following settings:

- Active homing with zero mark
- Homing in the positive direction
- Positive home position offset



Motion sequence

The motion occurs in the following sequence:

1. **Start of active homing via the Motion Control instruction "MC_Home"**
2. **Move to the homing mark in the homing direction with the homing velocity**
3. **Detection of the homing mark**

   When the homing mark is detected, the position of the axis or encoder is set depending on the configured mode:

   – Parameter "Mode" in "MC_Home" = 3

     Position = value in parameter "Position" minus <TO>.Sensor[n].ActiveHoming.HomePositionOffset

   – Parameter "Mode" to "MC_Home" = 5

     Position = value in the tag <TO>.Homing.HomePosition minus <TO>.Sensor[n].ActiveHoming.HomePositionOffset

   Note

   Parameter "MC_Home.Mode"

   The "MC_Home.Mode" parameter for S7-1200 Motion Control and S7-1500 Motion Control has been standardized within the framework of technology version V2.0. This results in a new assignment of the parameter values for the "MC_Home.Mode" parameter. A comparison of the "MC_Home.Mode" parameter for technology versions V1.0 and V2.0 is available in the section Version overview (Page 179).

4. **Move to homing point**

   – Parameter "Mode" in "MC_Home" = 3

     The axis moves to the position that is specified in the "Position" parameter.

   – Parameter "Mode" to "MC_Home" = 5

     The axis moves to the position that is specified in the <TO>.Homing.HomePosition tag.

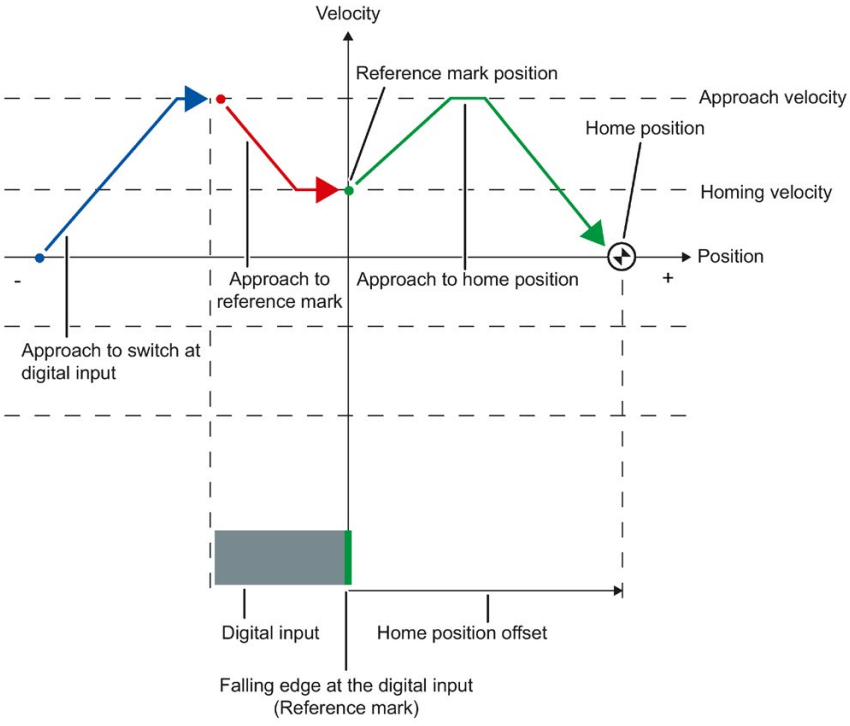
See also

Homing SINAMICS drives with external zero marks (Page 665)

3.2.9.6 Active homing with digital input

The following figure shows an example of the homing motion with the following settings:

- Active homing with digital input
- Approach in the positive direction
- Homing mark on the positive side of the digital input
- Positive home position offset



Motion sequence

The motion occurs in the following sequence:

1. **Start of active homing via the Motion Control instruction "MC_Home"**
2. **Detection of the positive edge at the digital input, while moving with homing velocity**
3. **Approach to the homing mark**
4. **Detection of the homing mark**

   In the example, the negative edge of the switch at the digital input represents the homing mark.

   When the homing mark is detected, the position of the axis or encoder is set depending on the configured mode:

   – Parameter "Mode" in "MC_Home" = 3

     Position = value in parameter "Position" minus <TO>.Sensor[n].ActiveHoming.HomePositionOffset

   – Parameter "Mode" in "MC_Home" = 5

     Position = value in the tag <TO>.Homing.HomePosition minus <TO>.Sensor[n].ActiveHoming.HomePositionOffset

   Note

   Parameter "MC_Home.Mode"

   The "MC_Home.Mode" parameter for S7-1200 Motion Control and S7-1500 Motion Control has been standardized within the framework of technology version V2.0. This results in a new assignment of the parameter values for the "MC_Home.Mode" parameter. A comparison of the "MC_Home.Mode" parameter for technology versions V1.0 and V2.0 is available in the section Version overview (Page 179).

5. **Move to homing point**

   – Parameter "Mode" in "MC_Home" = 3

     The axis moves to the position that is specified in the "Position" parameter.

   – Parameter "Mode" in "MC_Home" = 5

     The axis moves to the position that is specified in the <TO>.Homing.HomePosition tag.

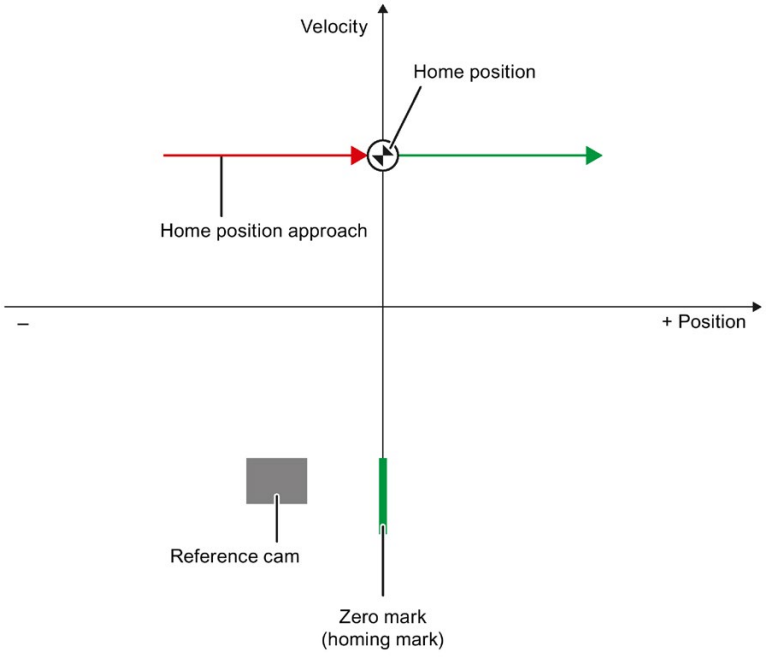
   Note

   If the velocity on the span from the detection of the positive edge to the negative edge cannot be reduced to the homing velocity, then homing occurs at the velocity that exists when the homing mark is traversed.

3.2.9.7 Passive homing with homing cam and zero mark

The following figure shows an example of the homing motion with the following settings:

- Passive homing with homing cam and zero mark
- Homing in the positive direction



Motion sequence

The motion occurs in the following sequence:

1. Activation of passive homing using the Motion Control instruction "MC_Home".
2. Motion due to a Motion Control job from the application

   The detection of the reference cam and homing mark is enabled when the actual position value of the axis or encoder moves in the assigned homing direction.
3. Detection of the reference cam
4. Departure from the reference cam

   The departure from the reference cam enables the detection of the homing mark.
5. Detection of the homing mark

   When the homing mark is detected, the position of the axis or encoder is set depending on the configured mode:

   – Parameter "Mode" in "MC_Home" = 2, 8

     Position = value in parameter "Position"

   – Parameter "Mode" in "MC_Home" = 10

     Position = value in tag <TO>.Homing.HomePosition

Note

Parameter "MC_Home.Mode"

The "MC_Home.Mode" parameter for S7-1200 Motion Control and S7-1500 Motion Control has been standardized within the framework of technology version V2.0. This results in a new assignment of the parameter values for the "MC_Home.Mode" parameter. A comparison of the "MC_Home.Mode" parameter for technology versions V1.0 and V2.0 is available in the section Version overview (Page 179).

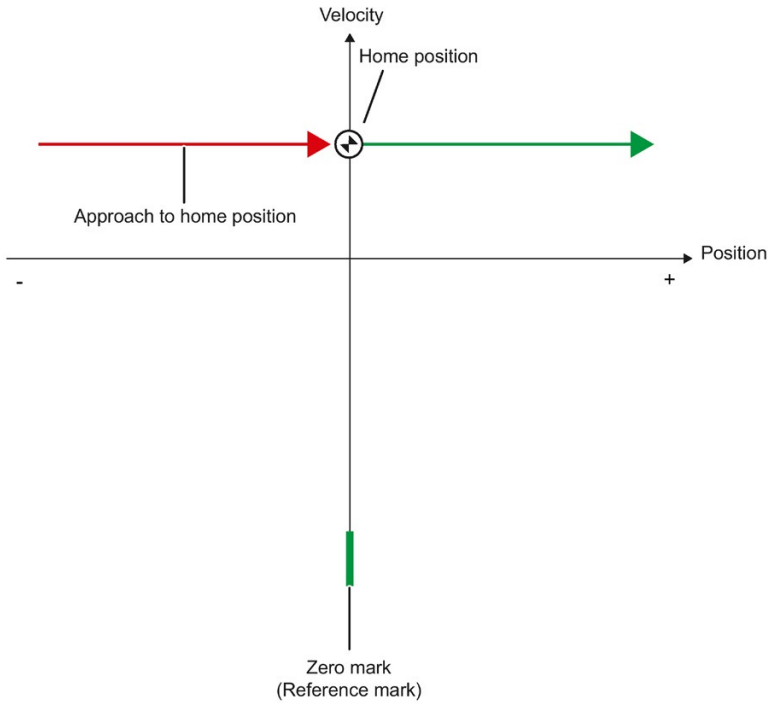
Note

If the motion direction changes after departure from the reference cam and before detection of the homing mark, the reference cam must be detected again. The Motion Control instruction "MC_Home" remains enabled.

3.2.9.8 Passive homing with zero mark

The following figure shows an example of the homing motion with the following settings:

- Passive homing with zero mark
- Homing in the positive direction



Motion sequence

The motion occurs in the following sequence:

1. **Enablement of passive homing via the Motion Control instruction "MC_Home".**
2. **Motion due to a Motion Control job from the application**

   The detection of the homing mark is enabled when the actual position value of the axis or encoder moves in the assigned homing direction.
3. **Detection of the homing mark**

   When the homing mark is detected, the position of the axis or encoder is set depending on the configured mode:

   – Parameter "Mode" to "MC_Home" = 2, 8

     Position = value in parameter "Position"

   – Parameter "Mode" to "MC_Home" = 10

     Position = value in tag <TO>.Homing.HomePosition

Note

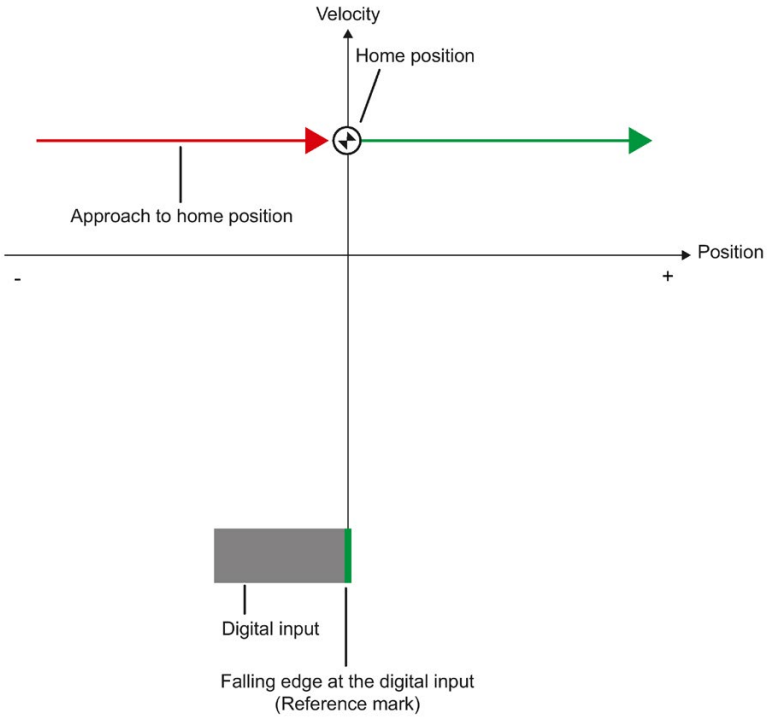
Parameter "MC_Home.Mode"

The "MC_Home.Mode" parameter for S7-1200 Motion Control and S7-1500 Motion Control has been standardized within the framework of technology version V2.0. This results in a new assignment of the parameter values for the "MC_Home.Mode" parameter. A comparison of the "MC_Home.Mode" parameter for technology versions V1.0 and V2.0 is available in the section Version overview (Page 179).

3.2.9.9 Passive homing with digital input

The following figure shows an example of the homing motion with the following settings:

- Passive homing with digital input
- Homing in the positive direction
- Homing mark on the positive side of the digital input



Motion sequence

The motion occurs in the following sequence:

1. **Enablement of passive homing via the Motion Control instruction "MC_Home".**
2. **Motion due to a Motion Control job from the application**

   The detection of the homing mark at the digital input is enabled when the actual position value of the axis or encoder moves in the assigned homing direction.
3. **Detection of the homing mark**

   In the example, the falling edge of the switch at the digital input represents the homing mark.

   When the homing mark is detected, the position of the axis or encoder is set depending on the configured mode:

   – Parameter "Mode" to "MC_Home" = 2, 8

     Position = value in parameter "Position"

   – Parameter "Mode" to "MC_Home" = 10

     Position = value in tag <TO>.Homing.HomePosition

Note

Parameter "MC_Home.Mode"

The "MC_Home.Mode" parameter for S7-1200 Motion Control and S7-1500 Motion Control has been standardized within the framework of technology version V2.0. This results in a new assignment of the parameter values for the "MC_Home.Mode" parameter. A comparison of the "MC_Home.Mode" parameter for technology versions V1.0 and V2.0 is available in the section Version overview (Page 179).

3.2.9.10 Direction reversal at the hardware limit switch (reversing cam)

During active homing, the hardware limit switch can optionally be used as a reversing cam. If the homing mark is not detected or the motion was not in the homing direction, the motion continues in the opposite direction with the approach velocity after the reversing cam.

When the hardware limit switch is reached, the default settings for dynamics take effect. Deceleration with the emergency stop deceleration does not occur.

NOTICE

Avoid moving to a mechanical endstop

Ensure by one of the following measures, that in a direction reversal the machine does not move to a mechanical endstop.

- Keep the approach velocity low.
- Increase the configured acceleration / deceleration.
- Increase the distance between the hardware limit switch and the mechanical endstop.

3.2.9.11 Direct homing

Depending on the configured mode, the position of the positioning axis/synchronous axis or external encoder technology objects can be absolutely or relatively set with "MC_Home".

Set actual position absolutely

Proceed as follows to set the position absolutely:

1. In the "MC_Home" Motion Control instruction, enter the absolute position in the "Position" parameter.
2. Call the "MC_Home" Motion Control instruction with the "Mode" = 0 parameter.

The position is set to the value specified in the "Position" parameter.

Set actual position relatively

Proceed as follows to set the position relatively:

1. In the "MC_Home" Motion Control instruction, enter the relative position in the "Position" parameter.
2. Call the "MC_Home" Motion Control instruction with the "Mode" = 1 parameter.

The position is set to the current position plus the value specified in the "Position" parameter.

3.2.9.12 Absolute value adjustment

In absolute value adjustment, Motion Control determines an absolute value offset, that is retentively stored on the CPU.

Depending on the configured mode, the position of the axis or the encoder is absolutely or relatively set in the "MC_Home" Motion Control instruction.

- Parameter "Mode" = 7 (absolute specification of position)

  Position = value in parameter "Position"
- Parameter "Mode" = 6 (relative specification of position)

  Position = current position + value in parameter "Position"

3.2.9.13 Resetting the "Homed" status

Incremental encoder

In the following cases, the "Homed" status is reset, and the technology object must be rehomed.

- Error in sensor system/encoder failure
- Initiation of active homing with the Motion Control instruction "MC_Home" with "Mode" = 3, 5 (after successful completion of the homing process, the status "Homed" is set again.)

Note

Parameter "MC_Home.Mode"

The "MC_Home.Mode" parameter for S7-1200 Motion Control and S7-1500 Motion Control has been standardized within the framework of technology version V2.0. This results in a new assignment of the parameter values for the "MC_Home.Mode" parameter. A comparison of the "MC_Home.Mode" parameter for technology versions V1.0 and V2.0 is available in the section Version overview (Page 179).

- Initiation of passive homing with the Motion Control instruction "MC_Home" with "Mode" = 2, 8, 10 (after successful completion of the homing process, the status "Homed" is set again.)
- Replacement of the CPU
- Replacement of the SIMATIC Memory Card
- POWER OFF
- Memory reset
- Modification of the encoder configuration
- Restart of the technology object
- Restoration of the CPU factory settings
- Transfer of a different project into the controller

Absolute encoder

In the following cases, the "Homed" status is reset, and the technology object must be rehomed.

- Replacement of the CPU
- Modification of the encoder configuration
- Restoration of the CPU factory settings
- Transfer of a different project into the controller

When you use a new absolute value encoder you need to home the absolute encoder once again.

Resetting the memory of the CPU or upgrading a project does not require another absolute value adjustment.

3.2.9.14 Tags

The following technology object tags are relevant for homing:

Status indicators	
<TO>StatusWord.X11 (HomingCommand)	Homing job running
<TO>StatusWord.X5 (HomingDone)	Technology object is homed
<TO>ErrorWord.X10 (HomingFault)	Error occurred during homing
Approach to reference cam	
<TO>.Homing.ApproachDirection	Start direction or approach direction for the approach to the reference cam
<TO>.Homing.ApproachVelocity	Velocity for the approach to the reference cam
Approach to the homing mark	
<TO>.Sensor[n].ActiveHoming.Direction	Homing direction
<TO>.Homing.ReferencingVelocity	Velocity for the approach to the homing mark
Move to homing point	
<TO>.Homing.ApproachVelocity	Velocity for the move to homing point
Positions	
<TO>.Homing.AutoReversal	Reversal at the hardware limit switches
<TO>.Homing.HomePosition	Home position
<TO>.StatusSensor[n].AbsEncoderOffset	Calculated offset after the absolute encoder adjustment
Parameters for active homing	
<TO>.Sensor[n].ActiveHoming.Mode	Homing mode
<TO>.Sensor[n].ActiveHoming.SideInput	Side of the digital input
<TO>.Sensor[n].ActiveHoming.Direction	Homing direction or approach direction
<TO>.Sensor[n].ActiveHoming.DigitalInputAddress	Address of digital input
<TO>.Sensor[n].ActiveHoming.HomePositionOffset	Offset of the homing mark from the home position
Parameters for passive homing	
<TO>.Sensor[n].PassiveHoming.Mode	Homing mode
<TO>.Sensor[n].PassiveHoming.SideInput	Side of the digital input
<TO>.Sensor[n].PassiveHoming.Direction	Homing direction or approach direction
<TO>.Sensor[n].PassiveHoming.DigitalInputAddress	Address of digital input

Note

Evaluation of the bits in StatusWord, ErrorWord and WarningWord

Read the information provided in section Evaluate StatusWord, ErrorWord and WarningWord (Page 359).

3.2.10 Position monitoring functions

3.2.10.1 Brief description

The following functions are available in the positioning axis/synchronous axis technology object for monitoring positioning and motion:

- Positioning monitoring (Page 98)

  The actual position value must reach a positioning window within a specified time, and remain in this positioning window for a minimum dwell time.
- Following error monitoring (Page 99)

  The following error is monitored based on a velocity-dependent following error limit. The permissible maximum following error depends on the velocity setpoint.

If monitored conditions are violated, then technology alarms are output. The technology object responds in accordance with the alarm response.

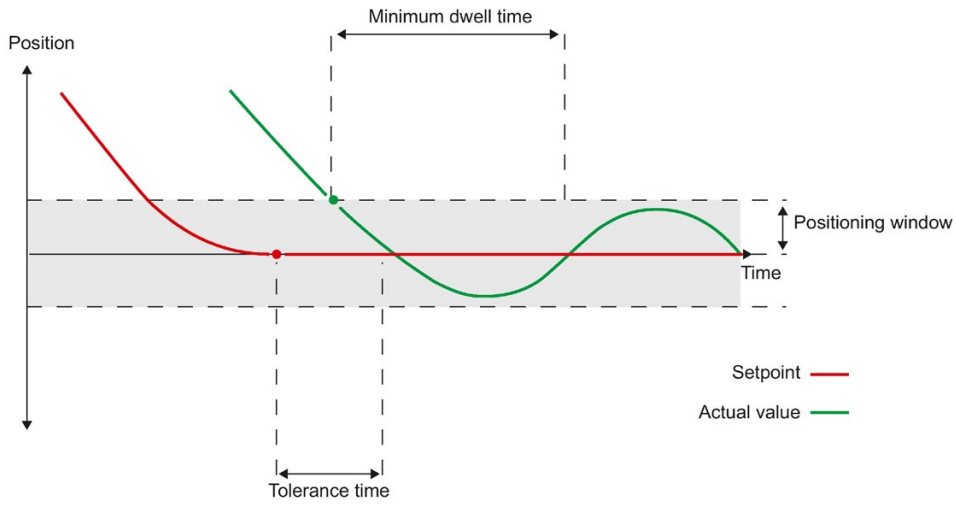
3.2.10.2 Positioning monitoring

Positioning monitoring monitors the behavior of the actual position at the end of the setpoint calculation.

As soon as the velocity setpoint reaches the value zero, the actual position value must be located in the positioning window within a tolerance time. The actual value must not exit the positioning window during the minimum dwell time.

If the actual position is reached at the end of a positioning motion within the tolerance time and remains in the positioning window for the minimum dwell time, then <TO>.StatusWord.X6 (Done) is set in the technology data block. After expiration of the minimum dwell time, the "Done" parameter of the corresponding Motion Control instruction is also set. This completes a motion job.

The following figure shows the chronological sequence and the positioning window:



Positioning monitoring does not make any distinction between how the setpoint interpolation was completed. The end of setpoint interpolation can for example be reached as follows:

- by reaching of the target position on the part of the setpoint
- by position controlled stopping during the motion by the Motion Control instruction "MC_Halt"

Violation of positioning monitoring

In the following cases, technology alarm 541 is output by the positioning monitoring, and the technology object is disabled (alarm reaction: remove enable).

- The actual value does not reach the positioning window during the tolerance time.
- The actual value exits the positioning window during the minimum dwell time.

3.2.10.3 Following error monitoring

The following error in the positioning axis/synchronous axis technology object is monitored based on a velocity-dependent following error limit. The permissible following error depends on the velocity setpoint.

A constant permissible following error can be specified for velocities lower than an adjustable velocity low limit.

Above this low velocity limit, the permissible following error increases in proportion to the velocity setpoint. The configurable maximum permissible following error is the maximum velocity limit.

Calculation of the following error

The following error is the difference between the position setpoint and the actual position value. The transmission times of the setpoint to the drive, and of the actual position value to the controller, are taken into account in the calculation of the following error, i.e. subtracted out.

Warning limit

A warning limit can be specified for the following error. The warning limit is input as a percentage value and operates relative to the current permissible following error. If the warning limit of the following error is reached, then technology alarm 522 is output. This is a warning and contains no alarm response.

Violation of the permissible following error

If the permissible following error is exceeded, then technology alarm 521 is output, and the technology object is disabled (alarm response: remove enable).

When force/torque limiting is activated, the monitoring of the permissible following error can be deactivated.

3.2.10.4 Standstill signal

When the actual velocity reaches the standstill window and remains there for the minimum dwell time, the standstill of the axis is indicated.

3.2.10.5 Tags

The following technology object tags are relevant for position monitoring and for the standstill:

Status indicators	
<TO>.StatusWord.X7 (Standstill)	Set to the value TRUE when the actual velocity reaches the standstill window and does not exit it within the minimum dwell time. The standstill signal is only present for the positioning axis/synchronous axis.
<TO>.StatusWord.X6 (Done)	**Positioning axis/synchronous axis** Set to the TRUE, when the actual velocity value reaches the positioning window within the tolerance time and remains in the window for the minimum dwell time. **Speed axis** Set to TRUE, when the motion is complete and the speed setpoint is therefore equal to zero.
<TO>.ErrorWord.X12 (PositioningFault)	A positioning error has occurred.
Positions and times	
<TO>.PositioningMonitoring.ToleranceTime	Maximum permissible time until positioning window is reached The time is started with the end of the setpoint interpolation.
<TO>.PositioningMonitoring.MinDwellTime	Minimum dwell time in the positioning window
<TO>.PositioningMonitoring.Window	Positioning window
Standstill signal	
<TO>.StandstillSignal.VelocityThreshold	Velocity threshold for the standstill signal
<TO>.StandstillSignal.MinDwellTime	Minimum dwell time below the velocity threshold

The following technology object tags are relevant for following error monitoring:

Status indicators	
<TO>.StatusPositioning.FollowingError	Current following error
<TO>.ErrorWord.X11 (FollowingErrorFault)	Status indication, that the following error is too large
<TO>.WarningWord.X11 (FollowingErrorWarning)	Status indication, that the following error warning limit has been reached
Control bits	
<TO>.FollowingError.EnableMonitoring	Enabling / disabling following error monitoring
Limit values	
<TO>.FollowingError.MinVelocity	Lower velocity setpoint for the characteristic curve of the maximum following error
<TO>.FollowingError.MinValue	Permissible following error below the <TO>.FollowingError.MinVelocity
<TO>.FollowingError.MaxValue	Maximum permissible following error at maximum axis velocity
<TO>.FollowingError.WarningLevel	Warning limit as a percentage value relative to the maximum permissible following error (velocity-dependent in accordance with the characteristic curve)

3.2.11 Closed-loop control

3.2.11.1 Brief description

The position controller of the positioning axis / synchronizing axis is a proportional controller with velocity precontrol.

Velocity precontrol

The velocity precontrol can be used to minimize the velocity-based following error during position control. As a result, faster positioning is achieved, if needed, because the position controller only has to compensate disturbances.

When using the velocity precontrol, the velocity setpoint is additionally added to the output of the position controller. You can weight this additional setpoint by a factor.

Dynamic Servo Control (DSC)

In drives that support Dynamic Servo Control (DSC), you can optionally use the closed-loop position controller in the drive. If you use telegrams that support DSC, DSC is automatically activated. The position controller in the drive is usually implemented with a rapid speed-control cycle. This improves the control performance for digitally coupled drives.

The following requirements must be met to use DSC:

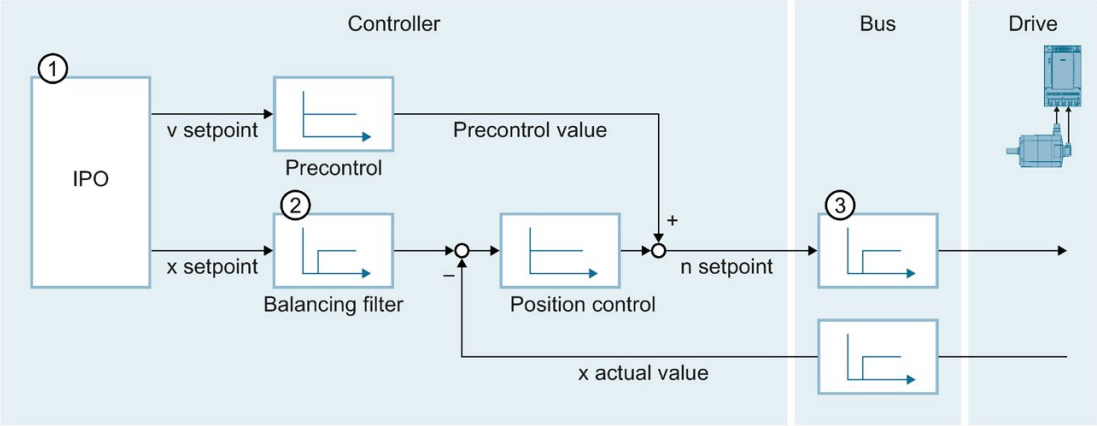
- The motor encoder (first encoder in the telegram) of the drive is used as the first encoder for the technology object.
- One of the following PROFIdrive telegrams is used for the drive:
  - Standard telegram 5 or 6
  - SIEMENS telegram 105 or 106

See also

PROFIdrive telegrams (Page 40)

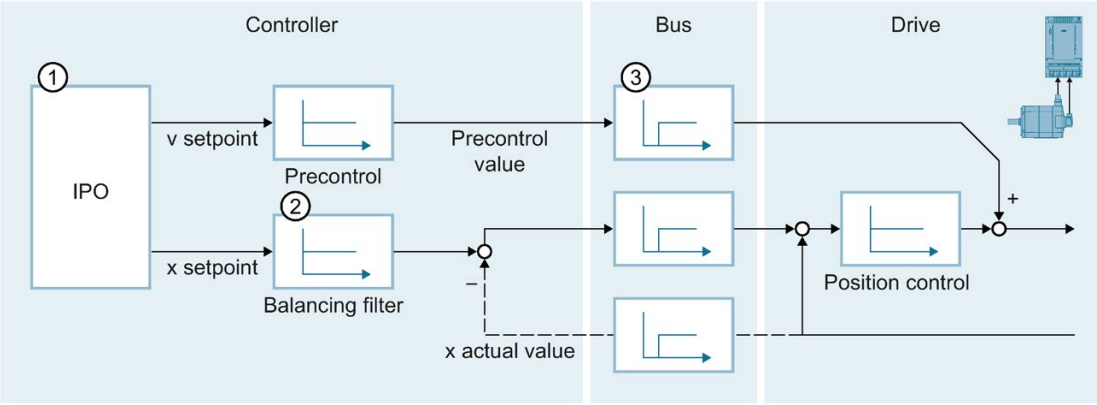
3.2.11.2 Control structure

The following figure shows the effective closed loop control structure **without** DSC:



① Interpolator with motion control
② Internal consideration of the signal propagation times and the speed-control loop substitute time
③ Communication between controller and drive

The following figure shows the effective closed loop control structure **with** DSC:



① Interpolator with motion control
② Internal consideration of speed control loop substitute time
③ Communication between controller and drive

See also

Configuration - Control loop (Page 255)

3.2.11.3 Tags

The following technology object tags are relevant for the closed-loop control:

Parameters	
<TO>.PositionControl.Kv	Proportional gain of the closed loop position control
<TO>.PositionControl.Kpc	Velocity precontrol of the positioning system (in %)
<TO>.PositionControl.EnableDSC	Enable DSC
<TO>.DynamicAxisModel.Velocity TimeConstant	Speed control loop substitute time [s]
<TO>.PositionControl.ControlDifference-Quantization.Mode	Type of quantification Configuration of a quantization when a drive with stepper motor interface is connected 0: No quantification 1: Quantization corresponding to encoder resolution 2: Quantization to a direct value (value input in <TO>.PositionControl.ControlDifferenceQuantization.-Value) (configuration is performed using the parameter view (data structure))
<TO>.PositionControl.ControlDifference-Quantization.Value	Value of quantification Configuration of a value for quantization to a direct value (<TO>.PositionControl.ControlDifferenceQuantization.-Mode = 2) The quantization value is specified in the position unit of the axis. (configuration is performed using the parameter view (data structure))

3.2.12 Process response

3.2.12.1 Organization Blocks for Motion Control

Description

When you create a technology object, organization blocks are automatically created for processing the technology objects. The Motion Control functionality of the technology objects creates its own execution level, and is called according to the Motion Control application cycle.

The following blocks are created:

- MC-Servo [OB91]

  Calculation of the position controller

- MC-Interpolator [OB92]

  Evaluation of the Motion Control instructions, generation of setpoints and monitoring functionality

The organization blocks are protected (know-how protection). The program code cannot be viewed or changed.

The frequency relationship of the two organization blocks to one another is always 1:1. MC-Servo [OB91] is always executed before MC-Interpolator [OB92].

You can set the application cycle and the priority of the organization blocks according to your requirements for control quality and system load.

MC-PreServo [OB67] and MC-PostServo [OB95]

In addition, you can create the organization blocks MC-PreServo [OB67] and MC-PostServo [OB95].

The organization blocks MC-PreServo [OB67] and MC-PostServo [OB95] can be programmed. They are called in the configured application cycle. This means you can use the organization blocks MC-PreServo [OB67] and MC-PostServo [OB95] for consistent data processing or time-critical events, such as starting of motions or homing functions for the process that may have to run synchronously with the application cycle.

Application cycle

You can set the application cycle in which the MC-Servo [OB91] is called in the properties of the organization block in "General > Cycle Time":

- **Synchronous to the bus**

  MC-Servo [OB91] is called synchronously with or at a reduced ratio to a bus system. You set the send clock in the properties of the selected bus system. In the "Distributed I/O" drop-down list, you can select the following bus systems:

  – Isochronous PROFIBUS DP

  – Isochronous PROFINET IO

  You cannot call the MC-Servo [OB91] synchronously with a bus system that is connected to the CPU via a communications processor/communications module (CP/CM).

- **Cyclic**

  The MC-Servo [OB91] is called cyclically with the specified application cycle.

The selected application cycle must be long enough to be able to process the technology objects in one cycle. If the processing time of the technology objects is longer than the application cycle, overflows (Page 107) will occur. In order to achieve optimal control quality, the calculations of the organization blocks MC-PreServo [OB67], MC-Servo [OB91] and MC-PostServo [OB95] must be performed within a send cycle.

You can check the runtime of MC-Servo [OB91] and MC-Interpolator [OB92] with the expanded instruction "RT_INFO".

The current application cycle (information in µs) of the organization blocks MC-PreServo [OB67] and MC-PostServo [OB95] can be read using the start information.

Reduction ratio (CPU V1.5 and higher)

You can reduce the application cycle of the MC-Servo [OB91] relative to the send clock of an isochronous PROFINET IO system. You can set an integer multiple of the send clock as the factor. Values up to 14 times the send clock (maximum 32 ms) are possible for the application cycle.

If you call an isochronous mode interrupt OB and the MC-Servo [OB91] synchronously with the same PROFINET IO system, you must set the same application cycle for both organization blocks.

Priority

You can configure the priority of the organization blocks as needed in their properties under "General > Properties > Priority":

- **MC-Servo [OB91]**

  Priority 17 to 26 (default value 26)

- **MC-Interpolator [OB92]**

  Priority 16 to 25 (default value 24)

The priority of MC-Servo [OB91] must be at least one higher than the priority of MC-Interpolator [OB92].

The priority of the organization blocks MC-PreServo [OB67] and MC-PostServo [OB95] correspond to the priority of the MC-Servo [OB91]. MC-PreServo [OB67] is called immediately before MC-Servo [OB91]. MC-PostServo [OB95] is called immediately after MC-Servo [OB91].

See also

Data connection drive/encoder via data block (Page 57)

3.2.12.2 Process image partition "OB Servo PIP"

The process image partition "OB Servo PIP" is made available in isochronous mode for Motion Control when MC-Servo [OB91] is called. All drives and encoders used by Motion Control are assigned to this process image partition.

Because the organization blocks MC-PreServo [OB67] and MC-PostServo [OB95] are called automatically by the MC-Servo [OB91], the process image partition is also available automatically. If you use a MC-PreServo [OB67], the data are read in when the MC-PreServo [OB67] starts. If you use a MC-PostServo [OB95], the data are output after the MC-PostServo [OB95].

Additionally, you should assign all I/O modules used by Motion Control to this process image partition (e.g. hardware limit switches). The assignment results in chronologically synchronous processing with the technology object.

The input process image partition is also updated in STOP mode.

Process image partition in the user program

As of CPU version V1.5, you can access the process image partition "OB Servo PIP" in your user program. This makes it possible to evaluate the process image partition using the trace function.

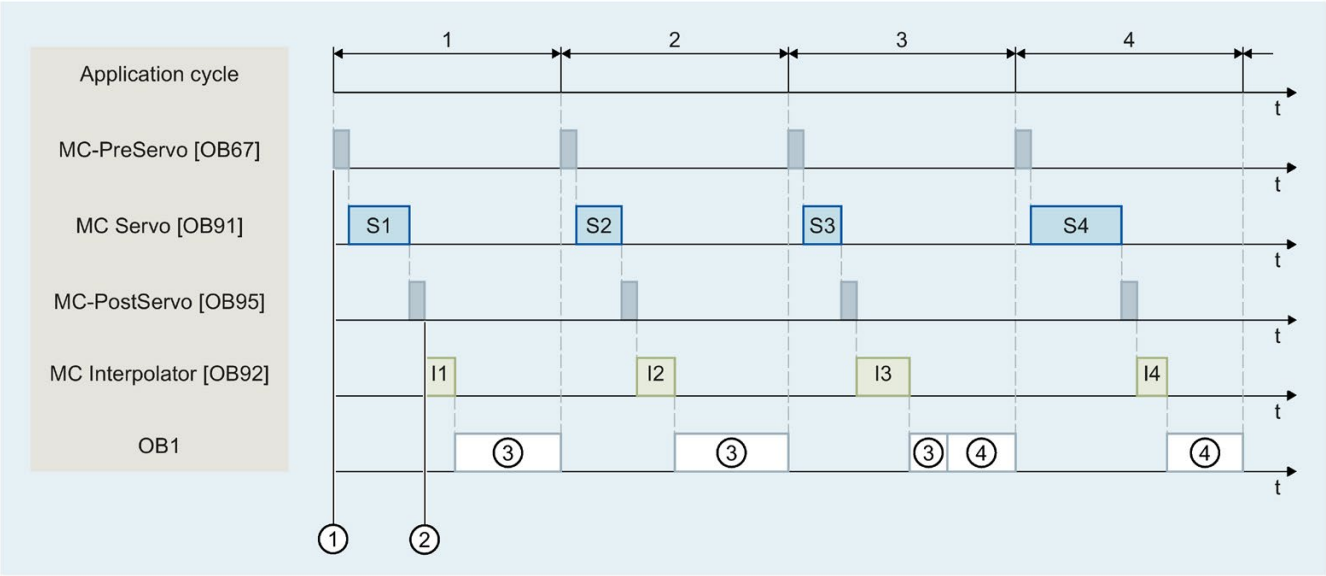
3.2.12.3 Operational Sequence and Timeouts

When processing the Motion Control functionality, the organization blocks MC-Servo [OB91] and MC-Interpolator [OB92] are called and processed in each application cycle. The remaining cycle time is available for the processing of your user program.

For error-free program execution, keep to the following rules:

- In each application cycle, MC-Servo [OB91] must be started and executed completely.
- In each application cycle, the relevant MC-Interpolator [OB92] must at least be started.

The following figure shows an example of the error-free operational sequence for the processing of organization block OB1:



① "TPA OB Servo" input
② "TPA OB Servo" output
③ First OB1 cycle
④ Second OB1 cycle

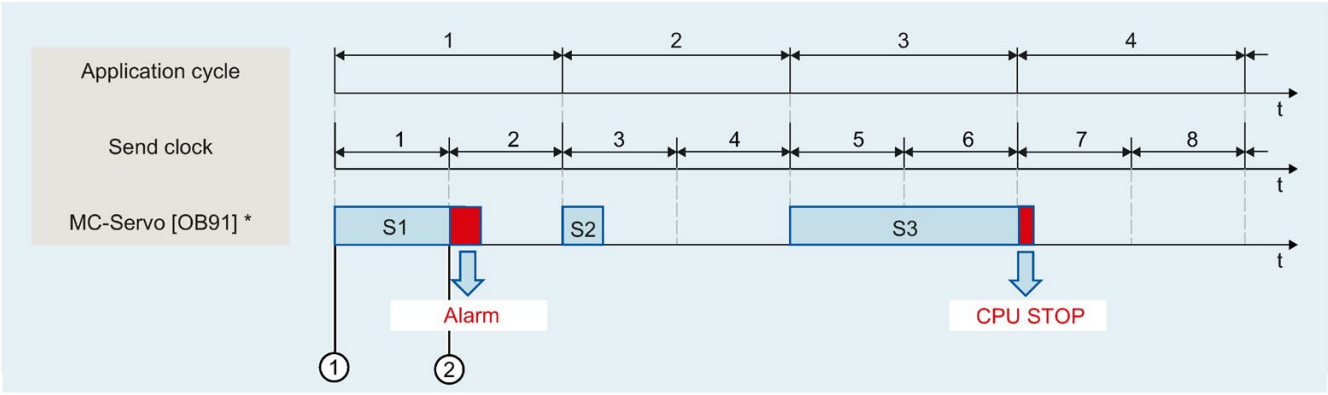
Overflows

Overflows can occur if the configured application cycle is not adhered to, for example because additional technology objects or programs are added in the MC-PreServo [OB67] or MC-PostServo [OB95]. The application cycle must be adapted in this case to prevent overflows.

A message is generated in the diagnostic buffer of the CPU in the case of an overflow of MC-Servo [OB91] in the send clock. The controller no longer runs isochronously.

The CPU switches to STOP mode in the case of an overflow of MC-Servo [OB91] in the application cycle.

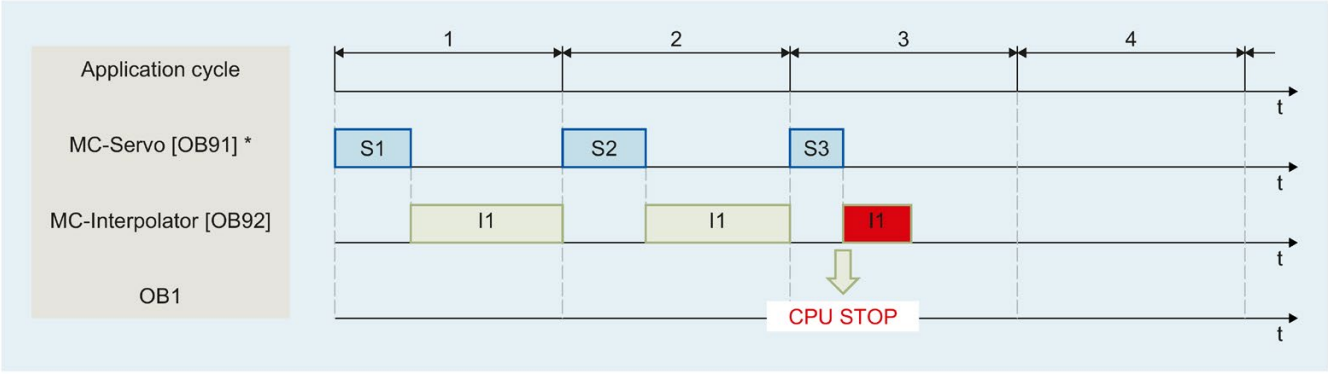
The following figure shows the behavior in the case of overflow of MC-Servo [OB91] in the application cycle and in the send clock with a reduction ratio of 2:



① "TPA OB Servo" input
② "TPA OB Servo" output
* Including MC-PreServo [OB67] and/or MC-PostServo [OB95], when in use

The execution of an MC-Interpolator [OB92] may only be interrupted by an MC-Servo [OB91] call. If more interruptions occur, the CPU switches to STOP mode.

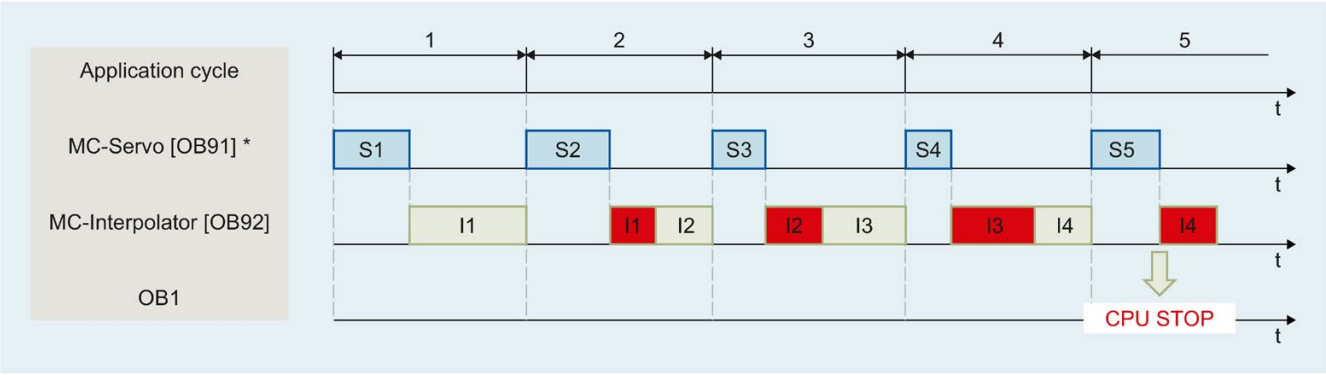
The following figure shows the operational sequence when an MC-Interpolator [OB92] is interrupted over two time slices:



* Including MC-PreServo [OB67] and/or MC-PostServo [OB95], when in use

The CPU tolerates a maximum of three consecutive overflows of MC-Interpolator [OB92]. If more overflows occur, the CPU switches to STOP mode.

The following figure shows the operational sequence if there are four consecutive individual overflows of MC-Interpolator [OB92]:



* Including MC-PreServo [OB67] and/or MC-PostServo [OB95], when in use

3.2.12.4 Operating modes

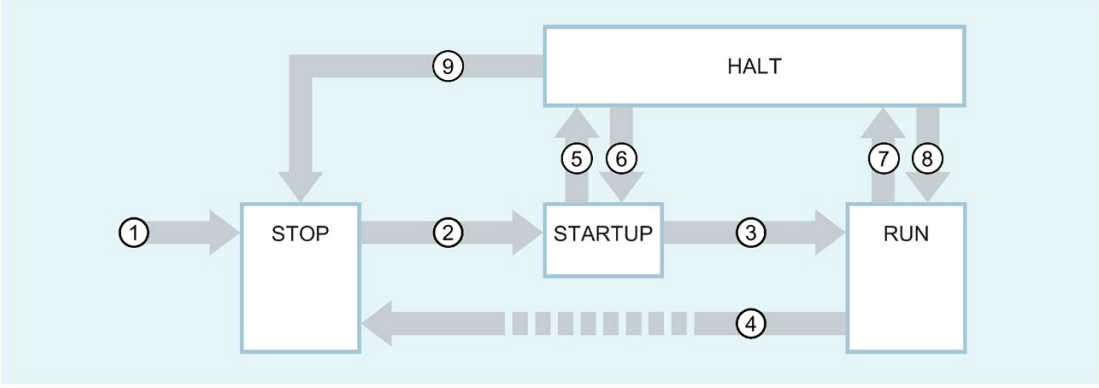
This section examines the behavior of the Motion Control in the respective operating modes and in the transitions between operating modes. A general description of the operating modes can be found in the S7-1500 System Manual

Operating modes and transitions

The CPU has the following operating modes:

- STOP
- STARTUP
- RUN
- HOLD

The following figure shows the operating modes and the operating mode transitions:



Operating mode transitions

The following table shows the behavior of the Motion Control in the transitions between the operating modes:

No.	Operating mode transition	Behavior
①	POWER ON → STOP	The CPU performs a restart of the technology objects. The technology objects are reinitialized with the values from the load memory.
②	STOP → STARTUP	Not relevant for Motion Control.
③	STARTUP → RUN	The process outputs are enabled.
④	RUN → STOP	When the CPU changes from RUN mode to STOP mode, all technology objects are disabled in accordance with the alarm response "remove enable". Active Motion Control jobs are aborted. If restart-relevant data has been changed for technology objects in RUN, the CPU performs a restart of the corresponding technology objects.
⑤	STARTUP → HOLD	Breakpoint in the start-up routine reached.
⑥	HOLD → STARTUP	Not possible when using technology objects
⑦	RUN → HOLD	Breakpoint reached
⑧	HOLD → RUN	Not possible when using technology objects
⑨	HOLD → STOP	By operation of switch/display or by setting to STOP from programming device.

STOP mode

In STOP mode the user program is not processed and all process outputs are disabled. Thus no Motion Control jobs are executed.

The technology data blocks are updated.

STARTUP mode

Before the CPU starts processing of the cyclical user program, the startup OBs are processed one time.

In STARTUP mode, the process outputs are disabled. Motion Control jobs are rejected.

The technology data blocks are updated.

RUN mode

The user program is processed in RUN mode.

In RUN mode, the programmed Motion Control jobs are cyclically called and processed.

The technology data blocks are updated.

HOLD operating state

Working with breakpoints is not supported when technology objects are used. An overflow of the MC-Servo occurs in each case. This leads to an immediate switch to STOP mode.

In HOLD operating state, events are not initiated and the user program is not executed.

All outputs are disabled or react according to the parameter settings. Outputs supply a configured substitute value or keep the last value output and bring the controlled process to a safe operating state.

When you reach a breakpoint, the CPU executes an implicit restart of the technology object. Homing the technology once again.

3.3 Speed-controlled axis technology object

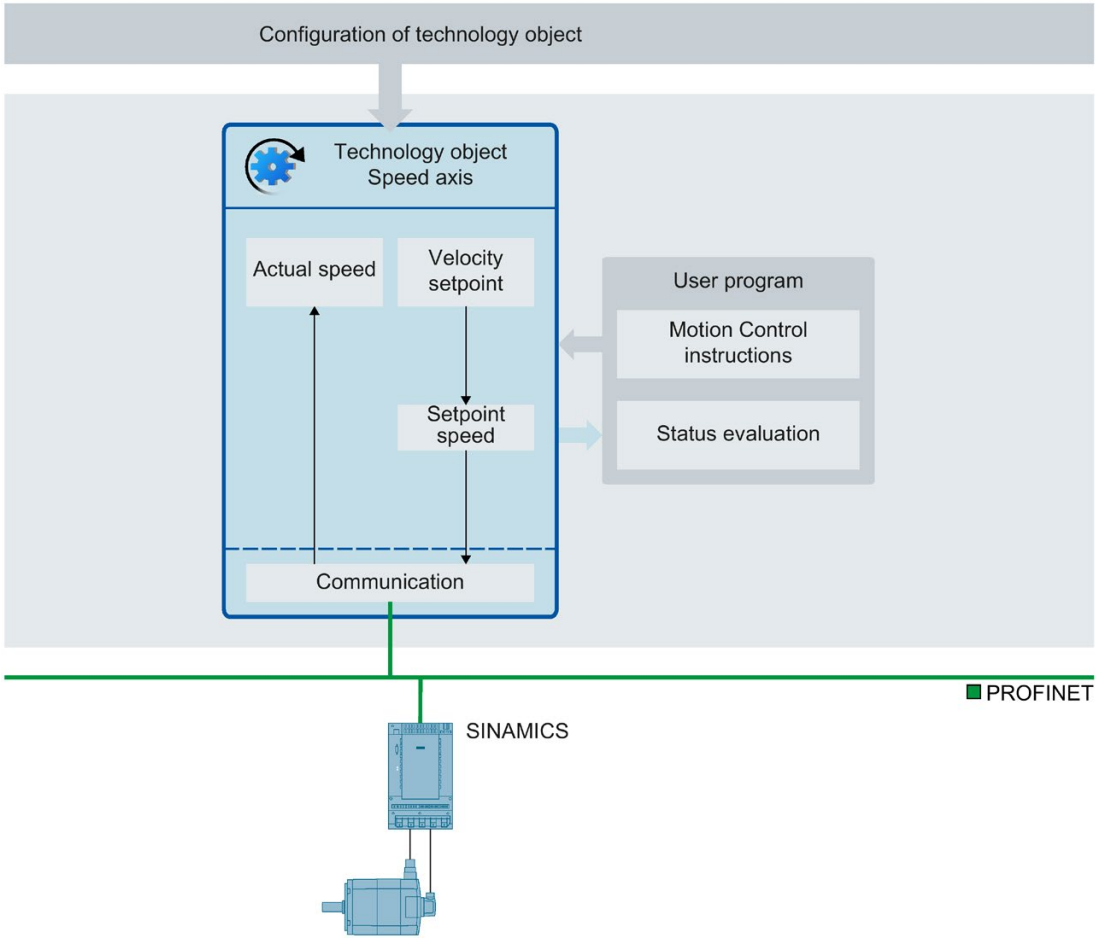
The speed axis technology object calculates speed setpoints, taking into account the dynamic settings, and outputs them to the drive. All motions of the speed axis take place as speed-controlled motions. An existing load gear is taken into account on the system side.

You can find an overview of the functions of the speed axis technology object in the Functions (Page 29) section.

A drive is assigned to each speed axis by means of a PROFIdrive telegram or an analog setpoint interface.

The speed is specified in revolutions per unit of time.

The following figure shows the basic principle of operation of the speed axis technology object:



3.4 Positioning axis technology object

The positioning axis technology object calculates position setpoints, taking into account the encoderc settings, and outputs corresponding speed setpoints to the drive. In position-controlled mode, all movements of the positioning axis take place as position-controlled movements. For absolute positioning, the physical position must be known to the positioning axis technology object.

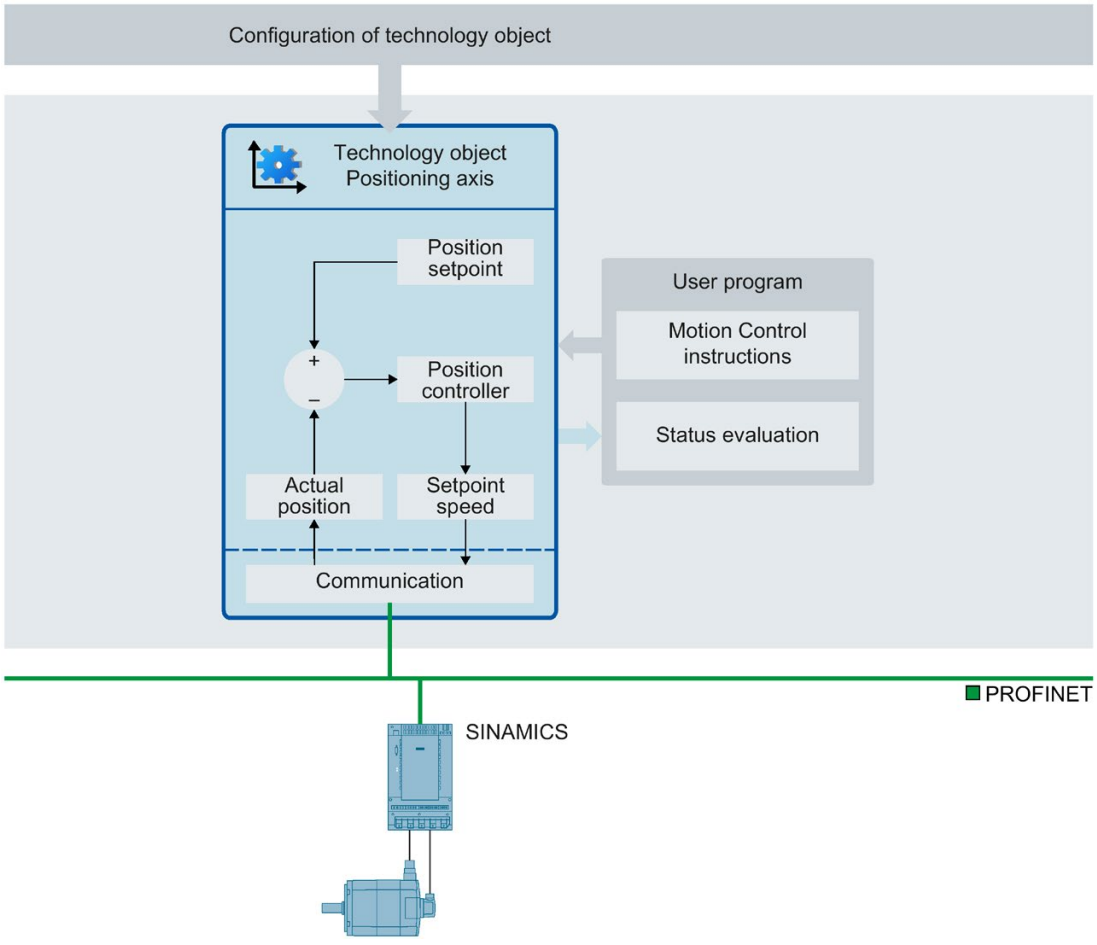
You can find an overview of the functions of the positioning axis technology object in the Functions (Page 29) section.

Each positioning axis is assigned a drive by means of a PROFIdrive telegram or an analog setpoint interface as well as an encoder by means of a PROFIdrive telegram.

The relationship between the encoder values and a defined position is established by the parameter assignment of the mechanical properties and encoder settings and by a homing operation. The technology object can also perform movements without a position relationship, and relative position movements, even without being in a homed status.

A positioning axis can be configured as a linear axis or rotary axis (Page 35), depending on the design of the mechanics.

The figure below shows the basic principle of operation of the positioning axis technology object:



3.5 Synchronous axis technology object

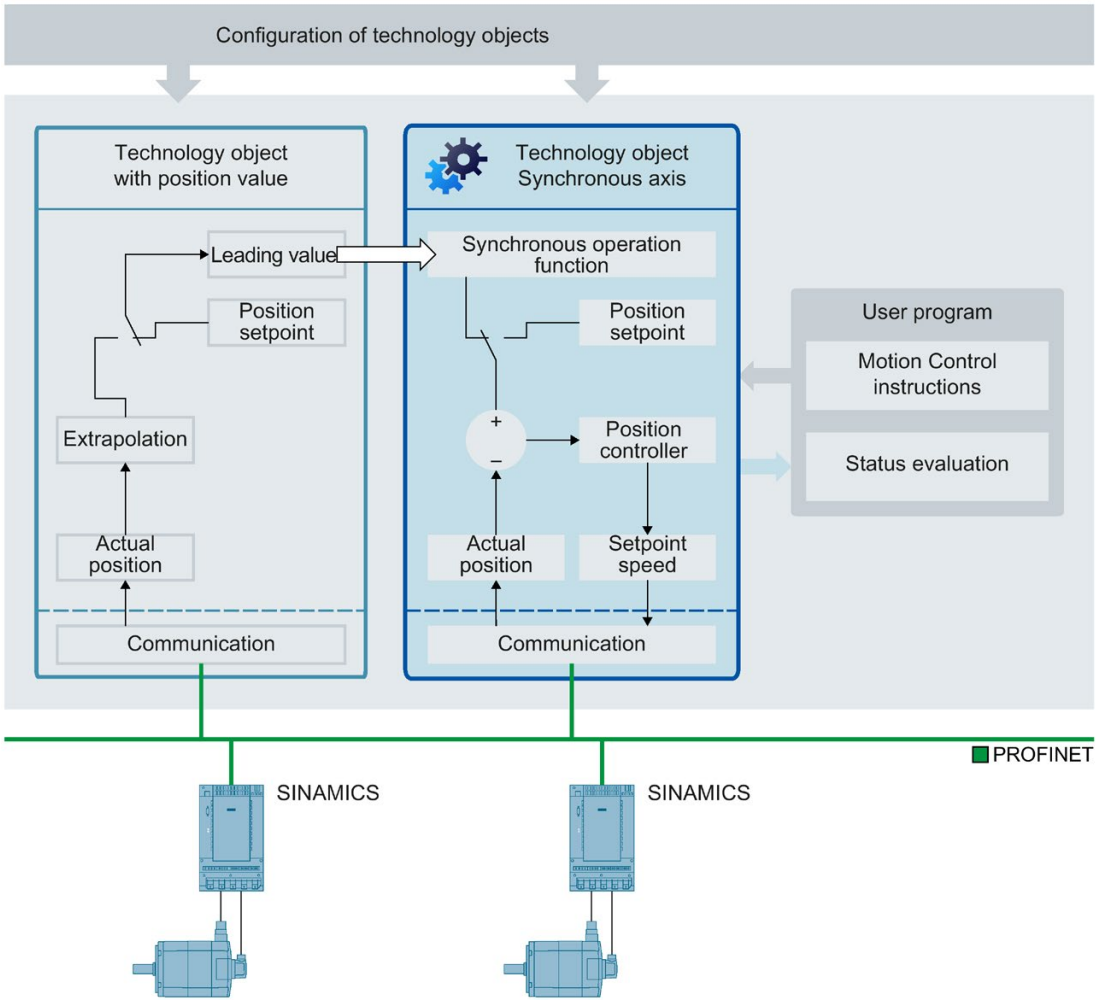
3.5.1 Short description for synchronous axis

The synchronous axis technology object includes all functions of the positioning axis technology object.

A synchronous axis can also follow the motions of a leading axis. The synchronous operation relationship between the leading and following axes is specified by a synchronous operation function.

You can find an overview of the functions of the synchronous axis technology object in the Functions (Page 29) section.

The figure below shows the basic principle of operation of the synchronous axis technology object:



See also

Axis types (Page 35)

3.5.2 Synchronous operation phases

By means of synchronous operation, a following axis can be linked to a leading axis and move synchronously with it.

The synchronous operation proceeds in the following phases:

- Pending synchronous operation (S7-1500T)

  The following axis waits for the start conditions of the synchronizing motion.

- Synchronization

  The following axis is synchronized to the leading value.

- Synchronous motion

  The following axis follows the position of the leading axis according to the synchronous operation function.

- Synchronous operation override

  An active synchronous operation is overridden by motion jobs (e.g. MC_Halt) issued to the following axis.

During these phases the dynamic limits apply as described in section Dynamic limits in synchronous operation (Page 69).

Avoid homing the leading axis during an active synchronous operation. Homing the leading axis during synchronous operation corresponds to a setpoint step change on the following axis. The following axis compensates for the step change according to the synchronous operation function and limited only to the maximum speed of the drive.

Note

The leading values and following values are coupled without conversion into the relevant configured user unit. If, for example, a linear leading axis moves by 10 mm, a rotary following axis moves by 10° with at a gear ratio of 1:1.

3.5.3 Leading value coupling

3.5.3.1 Short description for leading value coupling

The leading value for synchronous operation is provided by a leading axis. The leading value is specified and coupled in the user program with the call of the corresponding Motion Control instruction for synchronous operation. The leading value is switched when you call the Motion Control instruction again specifying a different leading axis.

The following rules apply to the leading value coupling:

- A leading axis can output the leading value to several following axes.
- The synchronous axis can be interconnected with different leading values. All interconnections required during operation must be set up during configuration of the technology object.
- Only one leading value at a time is coupled and evaluated.

3.5.3.2 Setpoint coupling

With setpoint coupling, the position setpoint of the leading axis is used as the leading value for synchronous operation.

The position setpoint of the following technology objects can be interconnected as the leading value for synchronous operation:

- Positioning axis
- Synchronous axis

3.5.3.3 Actual value coupling

For applications in which setpoint coupling is not possible, e.g. when using an external encoder, the S7-1500T CPU additionally offers actual value coupling for synchronous operation. With actual value coupling, the extrapolated actual position (Page 116) of a technology object is used as the leading value.

The actual position of the following technology objects can used as the leading value:

- Positioning axis
- Synchronous axis
- External encoder

3.5.3.4 Extrapolation of the leading values for actual value coupling

With actual value coupling (Page 115), delay times result from the processing of the actual values. To compensate for these delay times, the actual value is extrapolated on the leading value side. This means that the leading value is extrapolated based on previously known values.

Actual value discrepancies at constant velocity or at constant acceleration/deceleration can be compensated for with the extrapolation. For technical reasons, changes of acceleration/deceleration (jerk) during extrapolation always cause a displacement of the following axis relative to the leading value.

The extrapolation time consists of two parts: a leading axis dependent portion and a following-axis dependent portion resulting from a user setting:

- **Leading axis-caused part**

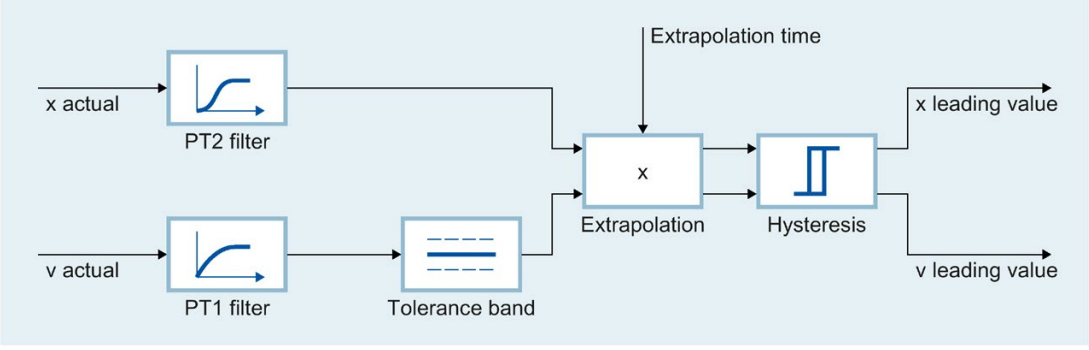
  The part caused by the leading axis is calculated automatically and displayed for the leading axis in the technology object tag <TO>.Extrapolation.LeadingAxisDependentTime.

- **Following axis-caused part**

  The part caused by the following axis is calculated automatically and displayed for the following axis in the technology object tag <TO>.StatusPositioning.SetpointExecutionTime. You specify the value of this tag (unchanged or compensated with user-specific runtimes) in the leading axis configuration (<TO>.Extrapolation.FollowingAxisDependentTime).

The extrapolated actual value is evaluated with a configurable hysteresis before it is output as the leading value. The hysteresis evaluation prevents an inversion of the leading value, which may result from extrapolation of a noisy value.

The following figure shows the sequence of the actual value extrapolation.



NOTICE
Machine damage If you change the extrapolation time during runtime of your user program in too large of increments, damage to the machine may occur. Change the extrapolation time only by a small amount.

Filtering the actual values

Noisy encoder signals lead to high velocity step changes, which also affect the extrapolation. These step changes can be reduced or compensated for by using suitable filter settings. The actual position filter is a PT2 filter. The velocity filter is a PT1 filter with configurable tolerance bandwidth.

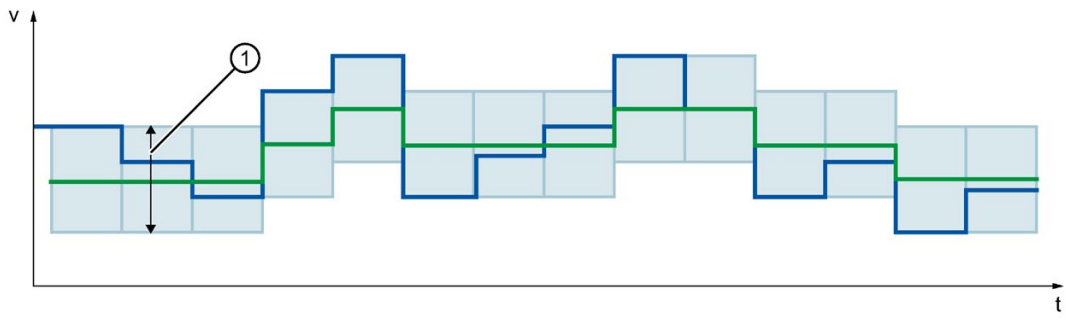
The actual value is first smoothed by the actual position filter. The velocity is smoothed by the velocity filter and further "calmed" by the tolerance band. The filtered actual position is then extrapolated taking into account the filtered velocity.

Recommended settings.

Set the total of the time constants T1 and T2 the position filter much smaller than the time constant T1 of the velocity filter.

Tolerance band

The tolerance band acts on the filtered velocity value in the interpolation cycle. The position of the tolerance band is automatically shifted to the direction of the velocity value as soon as it changes in one direction by more than half of the tolerance band from the last output value. A new output value is simultaneously formed with the shift of the tolerance band. This corresponds to the filtered velocity value minus half the tolerance band. As long as the velocity value remains within the tolerance band, no new output value is formed.



① Tolerance band

Extrapolation velocity before tolerance band

Extrapolation velocity after tolerance band

Hysteresis

The hysteresis acts on the filtered extrapolated position value in the interpolation cycle. A change of direction only takes effect when the position value changes in the direction opposite at least by the hysteresis value.

3.5.3.5 Tags

The following technology object tags are relevant for the actual value extrapolation:

Configuration	
<TO>.Extrapolation.LeadingAxisDependentTime	(for the leading axis) Leading axis-caused part of the extrapolation time, which results from T_i, T_{ipo}, and T_{Filter}.
<TO>.Extrapolation.FollowingAxisDependentTime	(for the leading axis) Following-axis dependent portion of the extrapolation time Enter the value from the <TO>.StatusPositioning.SetpointExecutionTime tag of the following axis (unchanged or compensated with user-specific times).
<TO>.StatusPositioning.SetpointExecutionTime	(for the following axis) Setpoint execution time that results from T_{Ipo}, T_{vtc} or 1/kv, T_{Send} and T_O of the axis.
<TO>.Extrapolation.PositionFilter.T1	Position filter time constant T1
<TO>.Extrapolation.PositionFilter.T2	Position filter time constant T2
<TO>.Extrapolation.VelocityFilter.T1	Velocity filter time constant T1
<TO>.Extrapolation.VelocityTolerance.Range	Tolerance band width for velocity
<TO>.Extrapolation.Hysteresis.Value	Hysteresis value (in the configured unit of length)

3.5.4 Gearing with MC_GearIn

During gearing the position of the following axis results from the position of the leading axis multiplied by the gear ratio. You specify the gear ratio as a ratio of two integers. The result is a linear synchronous operation function.

Synchronous operation with MC_GearIn begins after synchronization when the following axis has reached the velocity and acceleration of the leading axis, taking into account the gear ratio.

Synchronization

Synchronization begins with the start of an "MC_GearIn (Page 484)" job. When a synchronous axis is synchronizing to a leading value, this is indicated in the technology object tag <TO>.StatusWord.X21 (Synchronizing). Active motion jobs are overridden. The dynamic values (acceleration, delay, jerk) of the following axis for the synchronization are specified at "MC_GearIn".

The synchronization duration and distance are dependent on the following parameters:

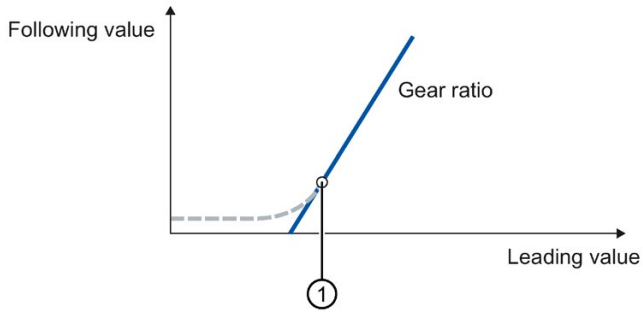
- Start time of the "MC_GearIn" job
- Dynamics of the following axis at the start time
- Dynamic value settings for "MC_GearIn"
- Dynamics of the leading axis

If the following axis has reached the velocity and the acceleration of the leading axis, taking into account the gear ratio, the following axis is synchronized. The following axis travels synchronously with the leading axis.

Synchronous motion

When a synchronous axis is synchronized to a leading value, the "Synchronous" status is indicated by parameter "MC_GearIn.InGear" = TRUE as well as in the technology object tag <TO>.StatusWord.X22 (Synchronous). The following axis follows the dynamics of the leading axis according to the gear ratio.

The response characteristic during gearing is expressed by a linear relationship between the leading value and following value.



Gear ratio	Slope of line/transmission ratio Gear ratio = MC_GearIn.RatioNumerator/MC_GearIn.RatioDenominator
- - - - -	Synchronization
①	Position starting from which the leading and following axes move synchronously Position ① is dependent on the above-named parameters (see Synchronization).

The following value is calculated according to the following function:

Position of following axis (following value) = Position ① of following axis + gear ratio × (Position of leading axis - Position ① of leading axis)

Direction

The numerator of the gear ratio is specified as positive or negative. This yields the following behavior:

- **Positive gear ratio:**
  The leading and following axes move in the same direction.
- **Negative gear ratio**:
  The following axis moves in the opposite direction of the leading axis.

See also

MC_GearIn: Start gear synchronization V4 (Page 484)

Tags for synchronous operation (Page 130)

MC_MoveSuperimposed: Position axes overlapping V4 (Page 462)

Dynamic limits in synchronous operation (Page 69)

3.5.5 Gearing with "MC_GearInPos" with specified synchronous positions

3.5.5.1 Short description for gearing with MC_GearInPos

During gearing the position of the following axis results from the position of the leading axis multiplied by the gear ratio. You specify the gear ratio as a ratio of two integers. The result is a linear synchronous operation function.

Synchronous operation with MC_GearInPos starts after synchronization when the specified synchronous positions are reached.

Synchronization

You specify the synchronous positions of the leading and following axes starting from which they are to move synchronously in the Motion Control instruction "MC_GearInPos (Page 488)". The synchronous operation is synchronized in advance of the specified synchronous positions for the leading and following axis.

The synchronization in advance (Page 127) is performed using the dynamic parameters (velocity, acceleration, deceleration, jerk) or the leading value distance. The dynamic parameters and the leading value distance are specified in "MC_GearInPos" and influence the start position for synchronization. After the start of a "MC_GearInPos" job, synchronization occurs in such a way that the leading and following axis move synchronously when the synchronous positions are reached.

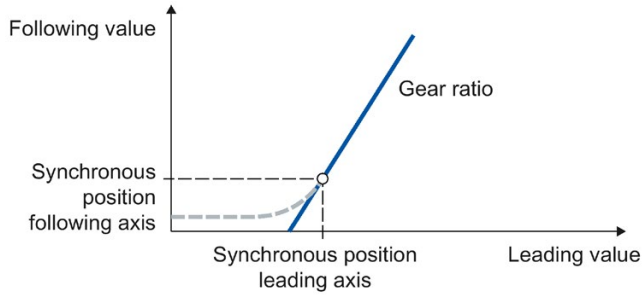
The synchronization is indicated by parameter "MC_GearInPos.StartSync" = TRUE as well as in the technology object tag <TO>.StatusWord.X21 (Synchronizing).

The leading value must not be reversed during synchronization.

Synchronous motion

Synchronous motion is synchronous starting from the specified synchronous positions. The "Synchronous" status is indicated by parameter "MC_GearInPos.InSync" = TRUE as well as in the technology object tag <TO>.StatusWord.X22 (Synchronous). The following axis follows the position of the leading axis according to the gear ratio.

The response characteristic during gearing is expressed by a linear relationship between the leading value and following value.



Gear ratio	Slope of line/transmission ratio Gear Factor = MC_GearInPos.RatioNumerator / MC_GearInPos.RatioDenominator
- - - - -	Synchronization

The following value is calculated according to the following function:

Position of following axis (following value) = Synchronous position of following axis + gear ratio × (Position of leading axis - Synchronous position of leading axis)

Direction

The numerator of the gear ratio is specified as positive or negative. This yields the following behavior:

- **Positive gear ratio:**
  The leading and following axes move in the same direction.
- **Negative gear ratio**:
  The following axis moves in the opposite direction of the leading axis.

See also

MC_PhasingAbsolute: Absolute shift of leading value on the following axis V4 (Page 493)

MC_PhasingRelative: Relative shift of leading value on the following axis V4 (Page 497)

MC_GearInPos: Start gearing with specified synchronous positions V4 (Page 488)

MC_MoveSuperimposed: Position axes overlapping V4 (Page 462)

Dynamic limits in synchronous operation (Page 69)

3.5.5.2 Tags for gearing with MC_GearInPos

The following technology object tags are relevant for gearing with MC_GearInPos:

Status indicators	
<TO>.StatusSynchronizedMotion.FunctionState	Indication of which synchronous operation function is active: 0: No synchronous operation active 1: Gearing (MC_GearIn) 2: Gearing with specified synchronous positions (MC_GearInPos) 3: Camming (MC_CamIn)
<TO>.StatusSynchronizedMotion.PhaseShift	Current absolute leading value shift in synchronous operation

See also

Tags for synchronous operation (Page 130)

3.5.6 Leading value shift in gearing

With the Motion Control instructions "MC_PhasingRelative (Page 497)" and "MC_PhasingAbsolute (Page 493)", the leading value can be shifted in gearing with MC_GearIn and MC_GearInPos. The leading value shift is executed on the following axis. The leading axis is not affected.

The leading value shift only has an effect in the "Synchronous" status. If the synchronous operation is overridden, the leading value shift is reset to zero.

3.5.7 Camming

3.5.7.1 Short description for camming

During camming, the leading axis and following axis are coupled by a synchronous operation function, which you specify using a cam (Page 174).

Synchronous operation starts after synchronization when the specified synchronous position of the leading axis is reached. The corresponding synchronous position of the following axis is the result of the cam.

The utilized cam can be scaled on a job-related basis and applied shifted. To use the cam for camming, it must be interpolated. You interpolate the cam in your user program with the Motion Control instruction "MC_InterpolateCam (Page 512)".

Synchronization in advance

You specify the synchronous position of the leading axis relative to which the axes are to move synchronously in the Motion Control instruction "MC_CamIn (Page 502)". The synchronous operation is synchronized in advance of the specified synchronous position.

The synchronous position of the leading axis is determined by the following parameters:

- Start position of the cam (<TO_Cam>.StatusCam.StartLeadingValue)
- "MC_CamIn.MasterOffset" - Offset/position of the cam
- "MC_CamIn.MasterSyncPosition" - Starting point within the cam

The synchronous position is calculated using the following equation:

Synchronous position = Start position of the cam + MasterOffset + MasterSyncPosition

The synchronization in advance (Page 127) is performed using the dynamic parameters (velocity, acceleration, deceleration, jerk) or the leading value distance. The dynamic parameters and the leading value distance are specified in "MC_CamIn" and influence the starting position for synchronization. After the start of a "MC_CamIn" job, synchronization occurs in such a way that the leading and following axis move synchronously when the synchronous position is reached.

The synchronization is indicated by parameter "MC_CamIn.StartSync" = TRUE as well as in the technology object tag <TO>.StatusWord.X21 (Synchronizing).

The leading value must not be reversed during synchronization.

Direct synchronization

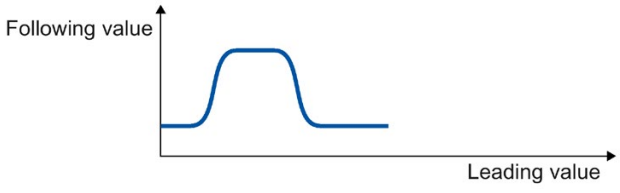
When you set the "MC_CamIn.SyncProfileReference" = 2 parameter, the status is set synchronously directly at the current leading value position and at the current following value position.

Synchronous motion

Synchronous operation is achieved when the following axis has reached the synchronous position and the dynamic values of the leading axis according to the synchronous operation function.

When a synchronous axis is synchronized to a leading value, the "Synchronous" status is indicated by parameter "MC_CamIn.InSync" = TRUE as well as in the technology object tag <TO>.StatusWord.X22 (Synchronous). The following axis follows the position of the leading axis according to the synchronous operation function.

The response characteristic during camming is expressed by the cam curve.



Following value = f(leading value)

See also

MC_CamIn: Start camming V4. (Page 502)

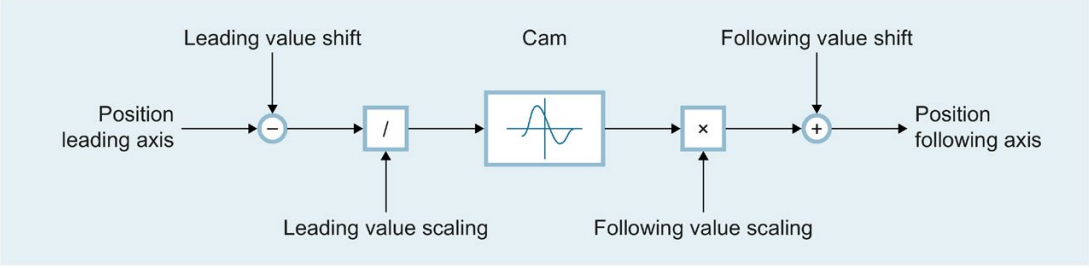
MC_MoveSuperimposed: Position axes overlapping V4 (Page 462)

Dynamic limits in synchronous operation (Page 69)

3.5.7.2 Scaling and offset of the cam

The scaling and shifting of the cam can be specified for camming in the Motion Control instruction "MC_CamIn". The configured cam is not changed by calling "MC_CamIn".

The following figure shows the basic sequence for scaling/shifting the cam:



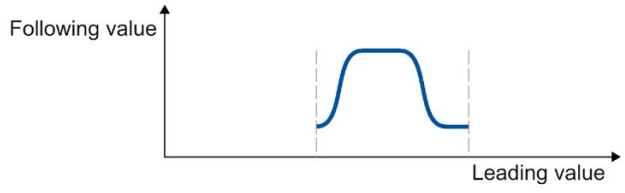
Position following axis = f[(Position leading axis - Leading value shift) / Leading value scaling] × Following value scaling + Following value shift

3.5.7.3 Cyclic and non-cyclic application of the cam

The "MC_CamIn.ApplicationMode" parameter can be used to set whether or not the cam is to be applied cyclically for synchronous operation:

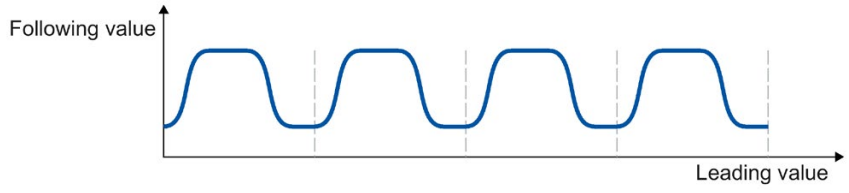
- **Not cyclic**

  The cam is run exactly once. When the cam is run in the positive direction, synchronous operation is ended when the end point of the cam is reached. When the cam is run in the negative direction, synchronous operation is ended when the starting point of the cam is reached. To prevent step changes in the dynamic values, the velocity of the following axis must be zero at the starting and end points of the cam.



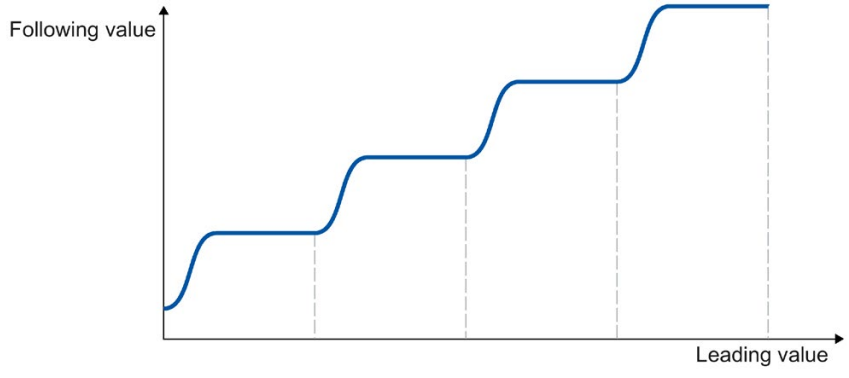
- **Cyclic**

  The cam is run cyclically. When the cam is run in the positive direction, the cam is repeated from the starting point when the end point of the cam is reached. When the cam is run in the negative direction, the cam is repeated from the end point when the starting point of the cam is reached. To prevent step changes in the dynamic values, the starting and end points of the cam must match.



- **Cyclic appending**

  The cam is run cyclically. When the cam is run in the positive direction, the end point of the cam is used as the starting point for the next run. When the cam is run in the negative direction, the starting point of the cam is used as the starting point for the next run. The position difference between the starting and end points on the following value side is added up. To prevent step changes in the dynamic values, the velocity in the boundary points must be continuous.



3.5.7.4 Tags for camming

The following technology object tags are relevant for camming:

Status indicators	
<TO>.StatusSynchronizedMotion.FunctionState	Indication of which synchronous operation function is active: 0: No synchronous operation active 1: Gearing (MC_GearIn) 2: Gearing with specified synchronous positions (MC_GearInPos) 3: Camming (MC_CamIn)
<TO>.StatusSynchronizedMotion.CurrentCam	Cam that is currently being used for camming
<TO>.StatusSynchronizedMotion.MasterOffset	Current shift of the leading value range of the cam
<TO>.StatusSynchronizedMotion.MasterScaling	Current scaling of the leading value range of the cam
<TO>.StatusSynchronizedMotion.SlaveOffset	Current shift of the following value range of the cam
<TO>.StatusSynchronizedMotion.SlaveScaling	Current scaling of the following value range of the cam

See also

Tags for synchronous operation (Page 130)

3.5.8 Synchronization in advance with MC_GearInPos/MCCamIn

3.5.8.1 Synchronization using dynamic parameters

For synchronization using dynamic parameters, you specify the dynamics (velocity, acceleration, deceleration, jerk). The required travel distance (synchronization length) is calculated.

After the start of the corresponding Motion Control job, a motion profile for the following axis is calculated continuously. The motion profile is calculated based on the following parameters:

- Specified synchronous positions of the Motion Control instruction
- Specified dynamics of the Motion Control instruction
- Current position and dynamics of the leading and following axes
- Synchronous operation function

The calculation yields a synchronization length.

The calculation is ended and the following axis is moved to the specified synchronous position when the following position has been reached:

Start position = Synchronous position of leading axis - Synchronization length

The start of synchronization is indicated in the Motion Control instruction with parameter "StartSync" = TRUE.

The dynamics of the following axis during synchronization is obtained from the calculated motion profile and the current dynamics of the leading axis. Changes in the dynamics of the leading axis during synchronization are superimposed on the calculated motion profile. This causes an increase in the dynamic value settings for the following axis, if necessary,

When the following axis has reached the synchronous position, the following axis is synchronized. The following axis travels synchronously with the leading axis. The "Synchronous" status is indicated in the Motion Control instruction with parameter "InSync" = TRUE.

When the leading axis is in its synchronous position when the corresponding Motion Control job is started, the leading axis must first cross the start position to start synchronization.

3.5.8.2 Synchronization using leading value distance

For synchronization using the leading value difference, you specify the synchronization length.

After the start of the corresponding Motion Control command, a motion profile with the required dynamics is calculated for the following-axis dependent on the specified leading value distance. For this, the leading axis must be at least the leading value distance from the synchronous position.

The following axis is moved to the specified synchronous position as soon as the leading value reaches the following position:

Start position = Synchronous position of leading axis - Synchronization length

The start of synchronization is indicated in the Motion Control instruction with parameter "StartSync" = TRUE.

The dynamics of the following axis during synchronization is obtained from the calculated motion profile and the current dynamics of the leading axis. Changes in the dynamics of the leading axis during synchronization are superimposed on the calculated motion profile in accordance with the synchronous operation function. This causes an increase in the dynamic value settings for the following axis, if necessary,

When the following axis has reached the synchronous position, the following axis is synchronized. The following axis travels synchronously with the leading axis. The "Synchronous" status is indicated in the Motion Control instruction with parameter "InSync" = TRUE.

3.5.9 Synchronous direct setting with MC_CamIn

This setting of the type of synchronization at MC_CamIn (Page 502) is suitable for synchronizing at standstill.

After the corresponding Motion Control job has started, the status is set synchronously directly at the current leading value position and at the current following value position ("InSync" = TRUE).

The point specified in the "MasterSyncPosition" parameter in the cam is assigned in the leading value range of the set position of the leading axis and in the following value range of the set position of the following axis. The cam is offset accordingly. The current offset results from the cam and is displayed at the tags of the technology object <TO>.StatusSynchronizedMotion.MasterOffset and <TO>.StatusSynchronizedMotion.SlaveOffset.

3.5.10 Simulate synchronous operation

An active synchronous operation connection is triggered when access enables are removed or four motion jobs on a following axis. It is possible to keep the synchronous operation active, without overriding it, by setting the synchronous operation in simulation.

With the ""MC_SynchronizedMotionSimulation"" Motion Control instruction, you can simulate an active synchronous operation in simulation. The leading axis should be stopped at this time.

The synchronized motion simulation only affects the synchronized motion of the following axis. No setpoints are output from the synchronous operation to the drive. The setpoint output to the drive continues to come from the possibly superimposed motions of the following axis. The same applies to single axis commands during the synchronous operation.

Start a "MC_SynchronizedMotionSimulation" job only if following axis is in synchronous operation. The status bit "Synchronous" (<TO>.StatusWord.X22) is then active (=TRUE). If the following axis is not or not yet in synchronous operation, the instruction is aborted with error.

The synchronous operation remains active in simulation, including the motions through single axis commands or disables of the leading and/or following axis, for example by opening a safety door. The following axis does not have to be synchronized again after the synchronized motion simulation has been completed.

To avoid the setpoint of the following axis jumping when the simulation has been completed, note the following points:

- When the simulation finishes, the leading in the following axis must both be at the starting positions that you had when the simulation was switched on.
- If the leading axis is at a different position than that where it was when the simulation was switched on, the following axis must be at the position that results from the synchronous operation relationship.

  You can calculate this position of the following axis beforehand in the user program and approach it with a motion job.

See also

MC_SynchronizedMotionSimulation: Simulate synchronous operation V4 (Page 510)

3.5.11 Tags for synchronous operation

The following technology object tags are relevant for synchronous operation:

Status indicators	
<TO>.StatusSynchronizedMotion.ActualMaster	When a synchronous operation job is started, the number of the technology data block of the currently used leading axis is displayed. "ActualMaster" = 0 when synchronous operation is inactive
<TO>.StatusSynchronizedMotion.PhaseShift	Current absolute leading value shift
<TO>.StatusWord.X21 (Synchronizing)	Set to value TRUE when the synchronous axis synchronizes to a leading value.
<TO>.StatusWord.X22 (Synchronous)	Set to value TRUE when the synchronous axis is synchronized and moves synchronously to the leading axis,
<TO>.ErrorWord.X14 (SynchronousError)	Error during synchronous operation The leading axis specified in the Motion Control instruction was not configured as a possible leading axis.
<TO>.StatusSynchronizedMotion.StatusWord.X0 (MaxVelocityExceeded)	Set to value TRUE when the maximum velocity configured for the following axis is exceeded during synchronous operation.
<TO>.StatusSynchronizedMotion.StatusWord.X1 (MaxAccelerationExceeded)	Set to value TRUE when the maximum acceleration configured for the following axis is exceeded during synchronous operation.
<TO>.StatusSynchronizedMotion.StatusWord.X2 (MaxDecelerationExceeded)	Set to value TRUE when the maximum deceleration configured for the following axis is exceeded during synchronous operation.

See also

Tags for camming (Page 126)

Tags for gearing with MC_GearInPos (Page 122)

3.6 Technology object external encoder

The external encoder technology object detects a position, and makes it available to the controller.

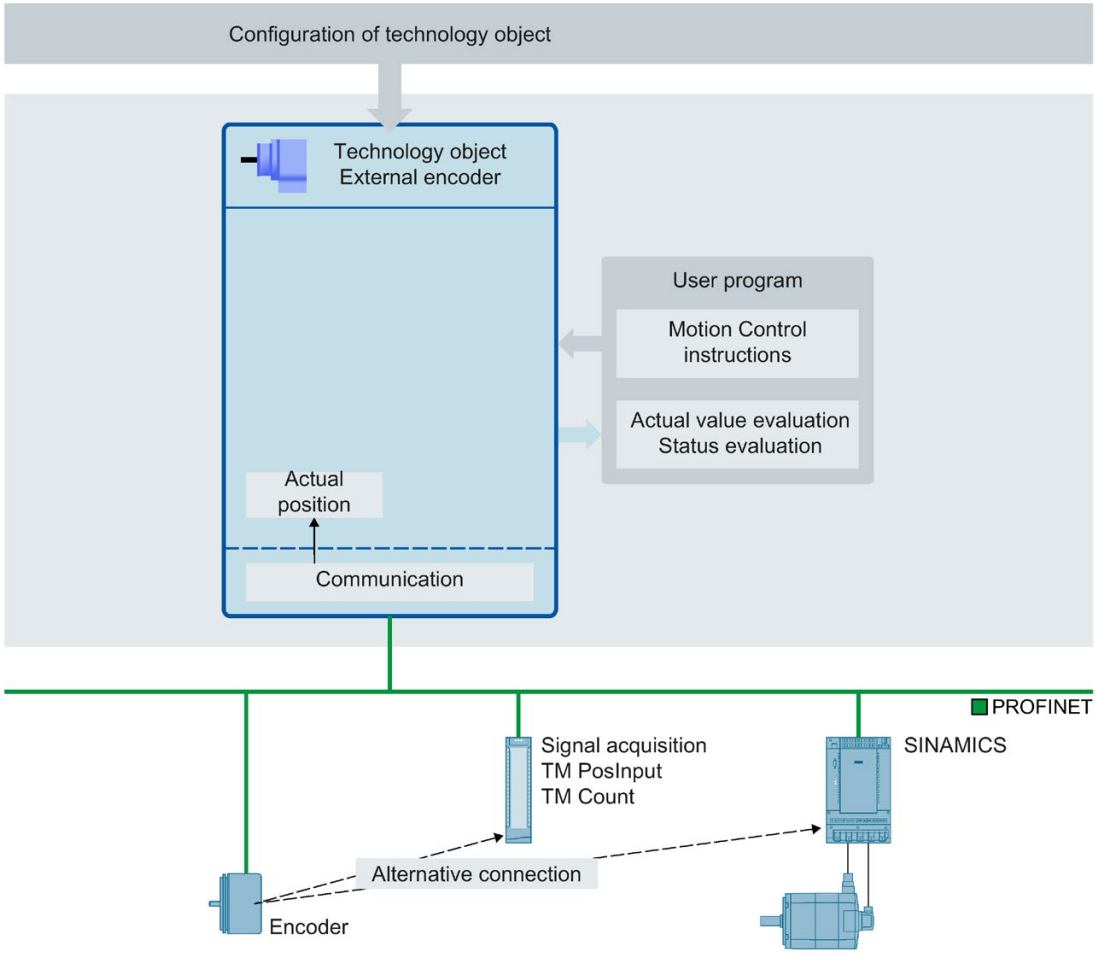
The actual position detected by the external encoder can be used for the following functions, for example:

- Measured value acquisition by a measuring input
- Position-dependent generation of switching signals and switching signal sequences by output cam and cam track with actual value reference.
- As a leading value of a synchronous axis (S7-1500T)

You can find an overview of the functions of the external encoder technology object in the Functions (Page 29) section.

The relationship between the encoder values and a defined position is established by the parameter assignment of the mechanical properties and encoder settings and by a homing operation.

The following figure shows the basic principle of operation of the external encoder technology object:



Specification of the position occurs according to the selected system of units:

- **Linear system of units**

  The position is specified as a linear measure, e.g. millimeters.

- **Rotary system of units**

  The position is specified as an angular measure, e.g. degrees.

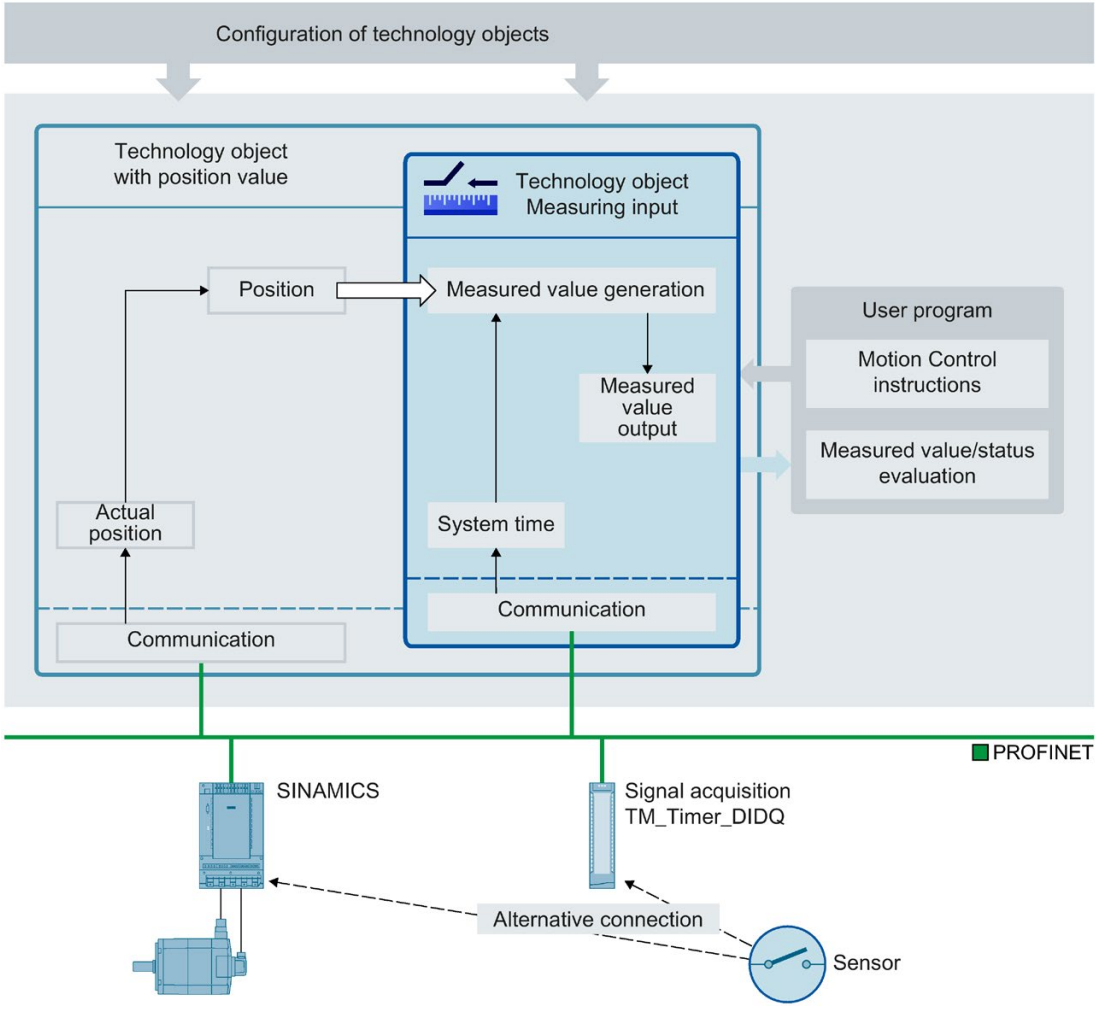
3.7 Technology object measuring input

3.7.1 Brief description

The measuring input technology object acquires the actual position of an axis or external encoder at a signal change at the measuring input.

You can find an overview of the functions of the measuring input technology object in the Functions (Page 29) section.

The figure below shows the basic principle of operation of the measuring input technology object:



Measurement types

Two types of measurement can be performed:

- One-time measurement (Page 136)

  Up to two measured values are acquired with edge accuracy with one measuring job. A one-time measuring job is started with "MC_MeasuringInput".

- Cyclic measuring (Page 137)

  With cyclic measuring, up to two measured values are acquired with edge accuracy in each position control cycle.

  A cyclic measuring job is started with "MC_MeasuringInputCyclic". The measurements are continued cyclically until they are ended per command.

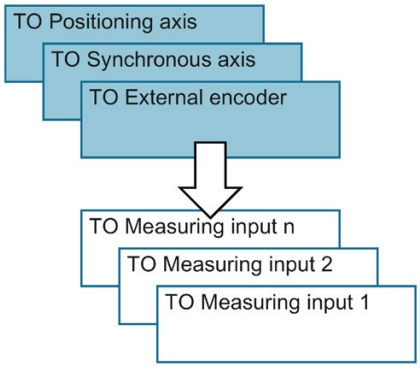
The edges to be detected are selected when starting the measurement using Motion Control instruction "MC_MeasuringInput" or "MC_MeasuringInputCyclic".

Assignment

The measuring input technology object must always be assigned to another technology object whose position will be evaluated by the measuring input.

The measuring input technology object can be assigned to the following technology objects:

- Synchronous axis
- Positioning axis
- External encoder



Exactly one axis or one external encoder can be assigned to a measuring input technology object.

An axis or external encoder can be assigned multiple measuring input technology objects.

Measured value determination

The position can be detected using support from the hardware in one of the following ways:

- Measuring using TM Timer DIDQ (time-based)
- Measuring with SINAMICS measuring input (time-based)

  Measurements via a measuring input are only possible for SINAMICS drives as of (see compatibility list (Page 665)).
- Measuring using PROFIdrive telegram (drive or external encoder)

A measuring job is activated using Motion Control instruction "MC_MeasuringInput" or "MC_MeasuringInputCyclic".

With time-based measuring ("TIME_BASED"), a signal change of the external trigger signal for the measurement is detected via a corresponding module such as TM Timer DIDQ or SINAMICS Drive. The time stamp is transferred to the controller and the associated actual position is determined in the technology object.

With direct position detection ("PROFIDRIVE"), the measurement input is connected to the drive device and the measurement is implemented in the drive. The drive or encoder module directly supplies the acquired position value to the technology object via the PROFIdrive telegram.

The resulting measured value is indicated at the respective output of the Motion Control instruction "MC_MeasuringInput" or "MC_MeasuringInputCyclic".

Cyclic measuring is only possible when measuring using TM Timer DIDQ. One-time measuring is always possible.

Measuring using TM Timer DIDQ requires isochronous mode.

For measuring using a PROFIdrive telegram, only one measuring input at a time can be active on an actual value or encoder in the PROFIdrive telegram. A maximum of two measuring inputs via PROFIdrive can be configured on an actual value or encoder in the PROFIdrive telegram Refer to Automatic transfer of drive and encoder parameters in the device (Page 47).

The measuring input technology object cannot be used with SIMATIC S7-PLCSIM. The measuring input technology object and the measuring input jobs used in the user program can be loaded into SIMATIC S7-PLCSIM, but have no function. Measured values are not shown.

Correction time

The time of the measurement can be corrected by setting a correction time (<TO>.Parameter.CorrectionTime) for the measuring input technology object.

Corrections may be required for the following examples:

- Times for mechanical displacement of the measuring input
- Times for the generation of the measured signal before the input at the measurement module
- Filter times at the input or filter times for the measurement inputs on the SINAMICS drive unit

The correction time is calculated by the measuring input technology object for time-based measured value acquisition ("TIME_BASED") and for direct position detection ("PROFIDRIVE").

Also note the time delay when measuring on a virtual axis. See section Brief description (Page 44).

3.7.2 Measuring

3.7.2.1 One-time measurement

With one-time measurement, up to two edges can be detected with one measuring job. The associated actual positions are signaled back in the function block and in the technology DB and can be further processed in the user program.

Measuring job

A measuring job is started using the Motion Control instruction "MC_MeasuringInput". The <TO>.Status tag in the technology data block changes to "WAITING_FOR_TRIGGER". The technology object activates the measurement when the selected edge is detected.

The measurement occurs at the measurement input in the form of up to two system times. Based on the times, the associated position is determined and output, taking into consideration a correction time, if present.

With direct position detection, the detected position value is supplied directly from the drive or encoder module to the technology object via the PROFIdrive telegram.

The measurement is then finished. An additional measurement must be restarted using Motion Control instruction "MC_MeasuringInput".

Table 3- 1 Mode and display of the results of measurement results when using one-time measurement

Configured "Mode" parameter in Motion Control instruction "MC_MeasuringInput"	Output of Motion Control instruction "MC_MeasuringInput"	
	MeasuredValue1	MeasuredValue2
Measure positive edge only	Actual position at the time of the edge	–
Measure negative edge only		
Measure the next two edges	Actual position at the time of the first edge	Actual position at the time of the second edge
Measure the next two edges starting with the positive edge	Actual position at the time of the positive edge	Actual position at the time of the negative edge
Measure the next two edges starting with the negative edge	Actual position at the time of the negative edge	Actual position at the time of the positive edge

The last detected values are set in the technology data block. If a new job is initiated with the function block, the outputs of the function block are initialized. The technology data block is not initialized. After detecting the first valid measuring cycle, the values in the technology data block and function block are consistent with one another.

The finished measuring command is indicated in the function block in "MC_MeasuringInput.DONE" = TRUE or in the technology data block in <TO>.Status = "TRIGGER_OCCURRED".

Time requirements for measurement jobs via "MC_MeasuringInput"

The hardware-related restrictions to measurement via the PROFIdrive telegram or measuring via the SINAMICS measurement sensing input, there are time requirements for the period until the measuring event can be recorded.

When measuring once via "MC_MeasuringInput" with mode 3 (measurement at both edges, beginning with the rising edge) or mode 4 (measurement at both edges, beginning with the falling edge), a minimum interval of several servo cycles is therefore required between the first edge to be measured and the previous edge, in order for the first edge to be measured can be recorded.

You can find information on the temporal boundary conditions in the section Time-related boundary conditions (Page 142).

See also

Time-related boundary conditions (Page 142)

MC_MeasuringInput: Start measuring once V4 (Page 469)

3.7.2.2 Cyclic measuring

With cyclic measuring, up to two measuring events can be acquired by the system in each position control cycle of the technology object and the associated measuring positions can be displayed. The measurements are continued cyclically until they are ended per command.

The determined measured values are displayed and can be read by the user program.

Cyclic measuring requires the measured value to be determined using the following type of hardware support: "Measuring using Timer DIDQ".

Measuring edges at which a measured value could not be determined are indicated in a lost edge counter in the technology DB as well as in function block "MC_MeasuringInputCyclic".

Measuring job

A cyclic measuring job is started with Motion Control instruction "MC_MeasuringInputCyclic", and the measuring job is issued to the corresponding technology module. Depending on the functionality of the technology module, up to two measuring events and thus measuring times can be captured with edge reference in each position control cycle and then forwarded to the technology object. The technology object determines the measuring positions for the measuring times taking into consideration any specified correction times.

The technology data block tag "<TO>.Status" changes from "INACTIVE" to "WAITING_FOR_TRIGGER" and remains in this status as long as additional events are awaited.

The mode set in the Motion Control instruction specifies the edges for which the measured values are to be acquired. At most, the following edges can be detected in each position control cycle:

- Two positive edges when detecting positive edges
- Two negative edges when detecting negative edges
- One positive edge and one negative edge when detecting positive and negative edges

Measured values and counters

With a positive edge at the input MC_MeasuringInputCyclic.Execute, outputs MeasuredValue1Counter and MeasuredValue2Counter are reset to "0". As a result, new events can be tracked immediately and new measured value entries can be detected.

All measuring event occurrences of the measuring job are incremented by "1" in the corresponding event counters <TO>.MeasuredValues.MeasuredValue1Counter and <TO>.MeasuredValues.MeasuredValue2Counter of the technology data block.

The acquired measured values are continuously captured in the technology data block irrespective of individual jobs and the values are only reset to "0" at power-up or restart of the technology object.

After a completed measurement, the measured values are output in the function block. The counters of the function block are set to "0" at a new measuring job. The measured value output in the technology data block always indicates the last acquired measured value.

Lost edge counter (LEC)

If more than two edges to be detected occur within one position control cycle, a measured value cannot be evaluated for the other edges to be detected. The number of lost edges is recorded in the LEC.

The lost edges that are recorded in the LEC depend on the mode set in the Motion Control instruction. For example, if only positive edges are to be measured, the LEC records only the non-measured positive edges.

A maximum of seven lost edges can be counted and displayed in the LEC.

The number of lost edges is indicated in the function block and in the technology data block in:

- LostEdgeCounter1

  Lost cleared edges from the position control cycle in which MeasuredValue1 was acquired.

  ⇒ The displayed value in LostEdgeCounter1 is updated when counter MeasuredValueCounter1 is incremented.

- LostEdgeCounter2

  Lost cleared edges from the position control cycle in which MeasuredValue2 was acquired.

  ⇒ The displayed value in LostEdgeCounter2 is updated when counter MeasuredValueCounter2 is incremented.

Display of measurement results when using cyclic measuring

Edges selected in the command	Display per position control cycle			
	MeasuredValue1	MeasuredValue2	LostEdgeCounter1	LostEdgeCounter2
Detect positive edges only "MC_MeasuringInputCyclic.Mode" = 0	Actual position at the time of the first positive edge	Actual position at the time of the second positive edge	Number of positive or negative edges in excess of two in the position control cycle of acquisition of MeasuredValue1 and MeasuredValue2. The following applies here: • If a MeasuredValue1 **and** a MeasuredValue2 are acquired, the number of acquired and lost edges indicated in LostEdgeCounter1 and LostEdgeCounter2 are the same. • If **only** one MeasuredValue1 is acquired, the LostEdgeCounter1 is reset to "0". The value in LostEdgeCounter2 remains changed.	
Detect negative edges only "MC_MeasuringInputCyclic.Mode" = 1	Actual position at the time of the first negative edge	Actual position at the time of the second negative edge		
Detect positive and negative edges "MC_MeasuringInputCyclic.Mode" = 2	Actual position at the time of the first positive edge in the position control cycle	Actual position at the time of the first negative edge in the position control cycle	Number of edges in excess of two in the position control cycle of acquisition of MeasuredValue1 and MeasuredValue2. The following applies here: • If a MeasuredValue1 **and** a MeasuredValue2 are acquired, the number of acquired and lost edges indicated in LostEdgeCounter1 and LostEdgeCounter2 are the same. • If **only** one MeasuredValue1 is acquired, the LostEdgeCounter1 is reset to "0". The value in LostEdgeCounter2 remains changed. • If **only** one MeasuredValue2 is acquired, the LostEdgeCounter2 is reset to "0". The value in LostEdgeCounter1 remains changed.	

The following figures show examples of divergence of MeasuredValue1Counter and MeasuredValue2Counter as a result of lost edges.

Example of measurement at positive edges (Mode = 0)

Processing cycle clock TO Measuring input	N	N+1	N+2	N+3	N+4	N+5	N+6	N+7	N+8	N+9	N+10
Measuring input											
MeasuredValue1Counter	...	6	7	7	8	9	9	10	11	12	13
LostEdgeCounter1	...	0	0	0	0	0	0	1	0	1	0
MeasuredValue2Counter	...	6	7	7	7	7	7	8	8	9	9
LostEdgeCounter2	...	0	0	0	0	0	0	1	1	1	1

Example of measurement at negative edges (Mode = 1)

Processing cycle clock TO Measuring input	N	N+1	N+2	N+3	N+4	N+5	N+6	N+7	N+8	N+9	N+10
Measuring input											
MeasuredValue1Counter	...	6	7	8	9	10	10	11	11	12	13
LostEdgeCounter1	...	0	0	0	1	0	0	1	1	1	0
MeasuredValue2Counter	...	6	7	7	8	8	8	9	9	10	10
LostEdgeCounter2	...	0	0	0	1	1	1	1	1	1	1

Example of measurement at positive and negative edges (Mode = 2)

Processing cycle clock TO Measuring input	N	N+1	N+2	N+3	N+4	N+5	N+6	N+7	N+8	N+9	N+10
Measuring input											
MeasuredValue1Counter	...	6	7	7	8	9	9	10	11	12	13
LostEdgeCounter1	...	0	2	2	0	0	0	3	0	4	0
MeasuredValue2Counter	...	6	7	8	8	9	10	11	12	13	14
LostEdgeCounter2	...	0	2	0	0	0	0	3	0	4	0

See also

MC_MeasuringInputCyclic: Start cyclic measuring V4 (Page 472)

3.7.3 Measuring with measuring range

A measuring job can be activated directly or restricted to a defined measuring range.

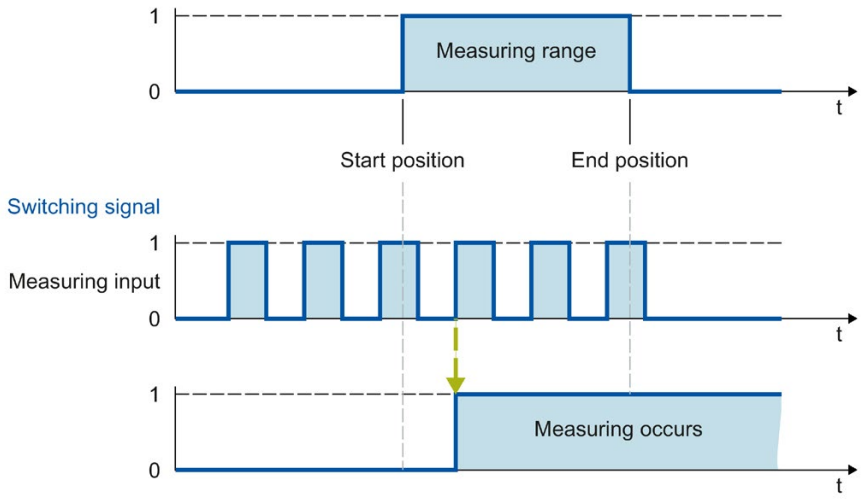
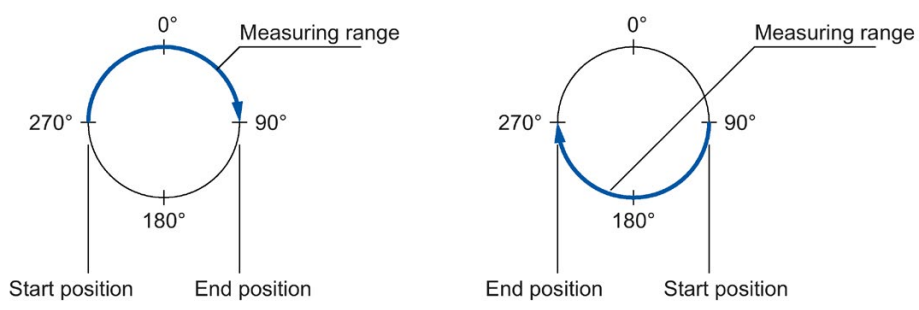


Figure 3-1 Example of measuring with measuring range in Mode = 0 (measurement of next positive edge)

Only measured values within the measuring range are displayed for the technology object.

- If no measuring edge within the measuring range is detected during a one-time measurement, the measuring job is canceled and an alarm is triggered.
- Cyclic measuring remains active even if no measuring edge within the measuring range was detected.

For axes without modulo function, it is immaterial in which order the start and end positions are specified. If the start position is greater than the end position, the two values are interchanged in the application. If the start position for an axis with modulo function is greater than the end position, the measuring range is extended from the start position past the modulo transition of the axis to the end position.



The measuring range positions are specified in Motion Control instruction MC_MeasuringInput or MC_MeasuringInputCyclic.

Activation time for the measuring range

The measuring function must be active at the measurement input when the start of the measuring range is reached. To compensate for the communication time for activation in the TM Timer DIDQ or drive, for example, the activation of the measurement in the technology object begins earlier then the measuring range start by the amount of the activation time.

The activation time for measuring with measuring range is divided up as follows:

- The activation time allocation defined and active on the system side is indicated in the <TO>.Parameter.MeasuringRangeActivationTime tag.
- An additional activation time can also be set by the user with the <TO>.Parameter.MeasuringRangeAdditionalActivationTime tag.

3.7.4 Time-related boundary conditions

Depending on the hardware configuration and selection of edges to be detected, different system-inherent requirements apply to the time allowed after calling the Motion Control instruction "MC_MeasuringInput" or "MC_MeasuringInputCyclic" until a measurement occurs and the results are displayed.

The following times must be distinguished here:

- Time until the measuring event can be captured
- Time until the measurement result is displayed or the measurement is finished.

The times calculated taking into account the current settings are indicated in configuration window "Extended parameters" of a measuring input.

Measuring using TM Timer DIDQ / Measuring using SINAMICS measuring input

Measurement using PROFIdrive telegram (drive or external encoder)

Definition of tags:

Measurement using TM Timer DIDQ/Measurement using SINAMICS measuring input

- Time from output of an MC_MeasuringInput job until measuring event detection becomes effective:
  - MeasuringRangeActivationTime: 2 x T_{servo}
- Time after measuring event until measured value is available in the controller:
  - One-time measurement: 2 x T_{servo} + T_{Send}
  - Cyclic measuring: T_{servo} + T_{Send}
- Activation time for a measurement with measuring range:
  - MeasuringRangeActivationTime + MeasuringRangeAdditionalActivationTime

Measurement using PROFIdrive telegram (drive or external encoder)

- MeasuringRangeActivationTime: 4 x T_{servo}
- Time from output of an MC_MeasuringInput job until measuring event detection becomes effective:
  - Measuring a positive/negative edge or two edges:

    MeasuringRangeActivationTime + 2 x T_{servo}
  - Measuring two dedicated edges:

    MeasuringRangeActivationTime + 3 x T_{servo}
- Time after measuring event until measured value is available in the controller:
  - Measuring an edge: 7 x T_{servo}
  - Measuring two edges: 13 x T_{servo}
- Activation time for a measurement with measuring range:
  - Measuring a positive/negative edge or two edges:

    MeasuringRangeActivationTime + MeasuringRangeAdditionalActivationTime + 2 x T_{servo}
  - Measuring two dedicated edges:

    MeasuringRangeActivationTime + MeasuringRangeAdditionalActivationTime + 3 x T_{servo}

Definition of tags

- T_{servo} = Call interval of the technology object in the servo cycle clock [ms]
- T_{Send} = Send clock [ms]
- MeasuringRangeActivationTime = See section Measuring with measuring range (Page 141)

To prevent asynchronous processing from overwriting a measured value that was just determined, a new one-time measuring job cannot be started until the active measurement has concluded. The sum of the activation time and the time until display or conclusion must be taken into account for this.

With cyclic measuring, evaluation or temporary storage of the measurement results in the synchronous MC-PostServo [OB95] is recommended from the user perspective.

3.7.5 Tags

Status display	
<TO>.Status	Measuring input function status 0: Measurement is not active ("INACTIVE") 1: The measuring input is waiting for a measuring event ("WAITING_FOR_TRIGGER") 2: The measuring input has acquired one or more measured values ("TRIGGER_OCCURRED"). 3: Error during the measurement ("MEASURING_ERROR")
<TO>.InputState	Measuring input input status
Parameters	
<TO>.Parameter.MeasuringInputType	Measuring input type
<TO>.Parameter.PROFIdriveProbeNumber	Number of the measuring input to be used for a measurement using PROFIdrive telegram
<TO>.Parameter.MeasuringRangeActivationTime	System-defined activation time allocation [ms]
<TO>.Parameter.MeasuringRangeAdditionalActivationTime	Additional user-defined activation time allocation [ms]
<TO>.Parameter.CorrectionTime	User-defined correction time for the measurement result [ms]
Interface	
<TO>.Interface.Address	I/O address for the digital measuring input
Units	
<TO>.Units.LengthUnit	Unit of the length data
<TO>.Units.TimeUnit	Unit of the time data
MeasuredValues	
<TO>.MeasuredValues.MeasuredValue1	First measured value
<TO>.MeasuredValues.MeasuredValue2	Second measured value (when measuring two or more edges in one position control cycle)
<TO>.MeasuredValues.MeasuredValue1Counter	Count value for the first measured value
<TO>.MeasuredValues.MeasuredValue2Counter	Count value for the second measured value
<TO>.MeasuredValues.LostEdgeCounter1	Lost edges in the cycle clock of the first measured value acquisition (zero in the case of one-time measurement)
<TO>.MeasuredValues.LostEdgeCounter2	Lost edges in the cycle clock of the second measured value acquisition (zero in the case of one-time measurement)
StatusWord	
<TO>.StatusWord.X0 (Control)	The technology object is in operation.
<TO>.StatusWord.X1 (Error)	An error occurred at the technology object.
<TO>.StatusWord.X2 (RestartActive)	The technology object is being reinitialized. The tags of the technology data block are not updated with active restart.
<TO>.StatusWord.X3 (OnlineStartValuesChanged)	Data relevant for the restart has been changed. The changes are applied only after a restart of the technology object.
<TO>.StatusWord.X5 (CommunicationOk)	The measuring input is synchronized with the measuring module and can be used.

ErrorWord	
<TO>.ErrorWord.X0 (SystemFault)	A system-internal error has occurred.
<TO>.ErrorWord.X1 (ConfigFault)	Configuration error One or more configuration parameters are inconsistent or invalid. The technology object was incorrectly configured, or editable configuration data were incorrectly modified during runtime of the user program.
<TO>.ErrorWord.X2 (UserFault)	Error in user program at a Motion Control instruction or its use.
<TO>.ErrorWord.X3 (CommandNotAccepted)	Command cannot be executed. A Motion Control instruction cannot be executed because necessary requirements have not been met.
<TO>.ErrorWord.X13 (PeripheralError)	Error accessing a logical address.
ErrorDetail	
<TO>.ErrorDetail.Number	Alarm number
<TO>.ErrorDetail.Reaction	Effective alarm reaction 0: No reaction 6: End measuring input processing

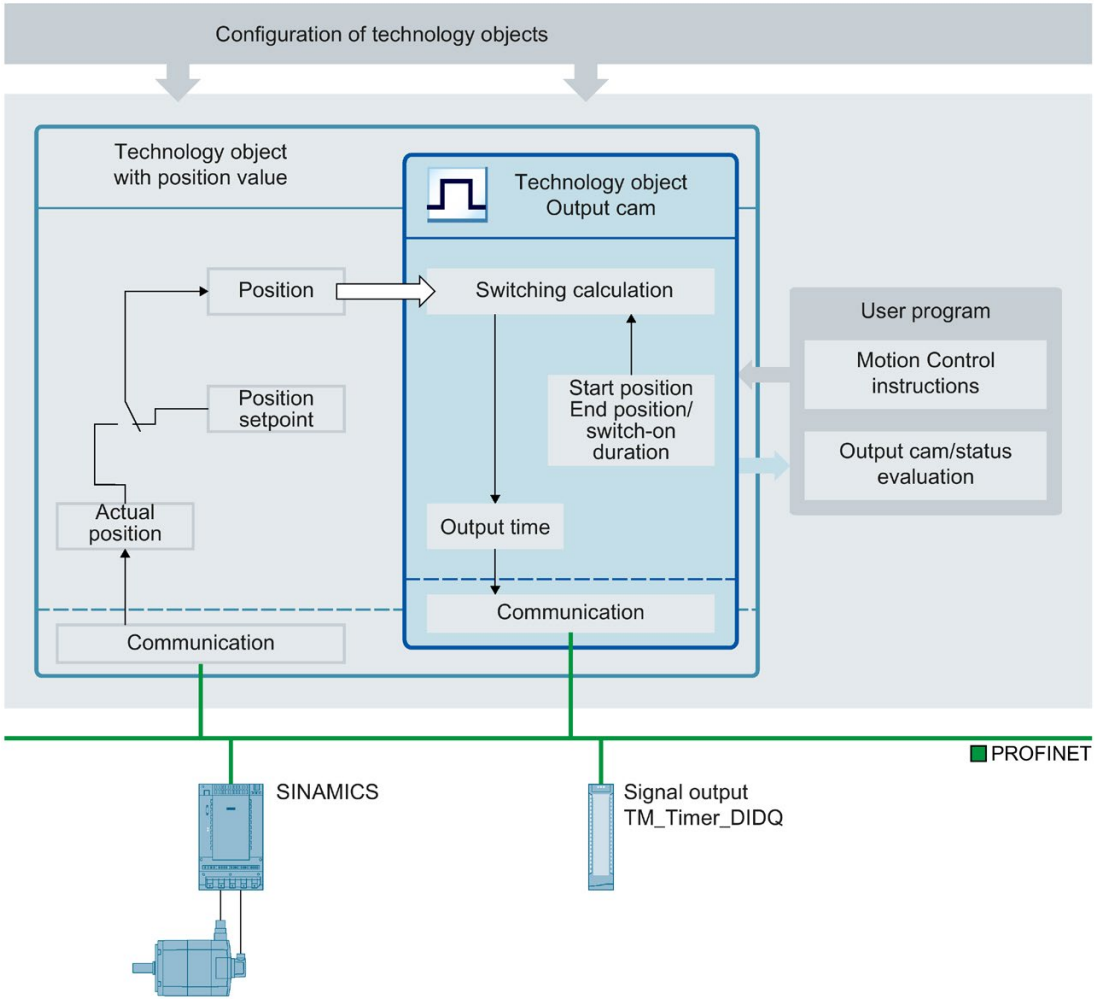
3.8 Technology object output cam

3.8.1 Brief description

The output cam technology object generates switching signals depending on the position of an axis or external encoder. The switching states can be evaluated in the user program and fed to digital outputs.

You can find an overview of the functions of the output cam technology object in the Functions (Page 29) section.

The figure below shows the basic operating principle of the output cam technology object:



Output cam types

The following output cam types can be used:

- Distance output cam (Page 149)

  Distance output cams switch on between the start position and end position. Outside this range, the distance output cam is switched off.

- Time-based output cam (Page 151)

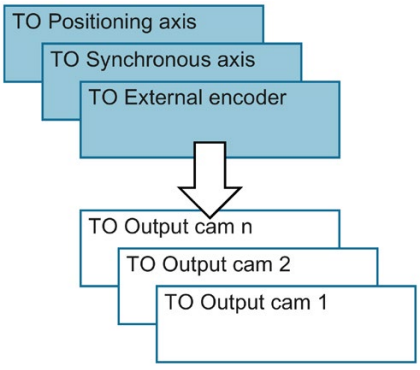
  Time-based output cams switch on for a defined time period when the start position is reached.

Assignment

The output cam technology object must always be assigned to another technology object whose position will be evaluated.

The output cam technology object can be assigned to the following technology objects:

- Synchronous axis
- Positioning axis
- External encoder



Exactly one axis or one external encoder can be assigned to an output cam.

Multiple output cams can be assigned to one axis or external encoder.

Output cam calculation and output cam output

The output cam technology object calculates the exact switching time, thereby ensuring exact adherence to the switching positions. The switching time is calculated two position control cycles before the output.

The following output options are available for the digital cam output:

- TM Timer DIDQ

  Digital output with high degree of accuracy and reproducibility in the microsecond range on ET 200MP TM Timer DIDQ 16x24V and ET 200SP TM Timer DIDQ 10x24V time-based IO modules

  Output by TM Timer DIDQ requires isochronous mode. Isochronous mode is only possible with PROFINET interface modules.

- Digital output module

  Digital output with switching accuracy depending on the output cycle of the I/O used

When output is deactivated, the output cam status is not output at the hardware output. The output cam status can be used internally in the user program by evaluating the relevant "<TO>.CamOutput" tag.

Inverted output

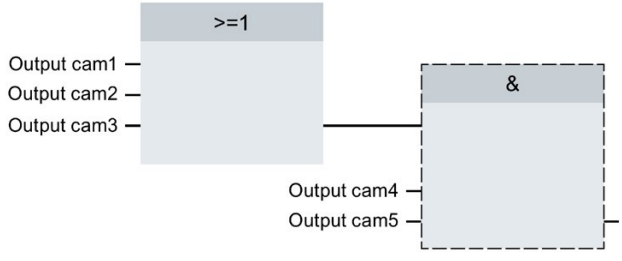
In the case of the inverted output, the range in which the cam output is switched on and the range in which it is switched off are swapped.

The inverted output is set in Motion Control instruction "MC_OutputCam" and is active when the instruction is enabled.

The inverted output can be used for both distance output cams and time-based output cams.

Output of multiple output cams to one output

The output of multiple output cams to one output is performed with either an AND or OR logic operation of the output cam signals to the output.



Display of the switching state

The switching state of the output cam is displayed in the associated technology DB in "<TO>.CamOutput".

Position reference

The switching points of the output cams can be referenced to the following positions, depending on the interconnected technology object.

- Actual position of a synchronous axis/positioning axis
- Position setpoint of a synchronous axis/positioning axis
- Position of an external encoder

Homing the interconnected technology object

A change to the position of an axis or external encoder using Motion Control instruction "MC_Home" is regarded as a sudden position change.

- Distance output cams are either skipped or correspondingly output.
- Time-based output cams are skipped. A time-based output cam is switched on only when the start position is crossed and remains switched on for the on-load factor.
- Switched time-based output cams are not canceled by a homing operation.

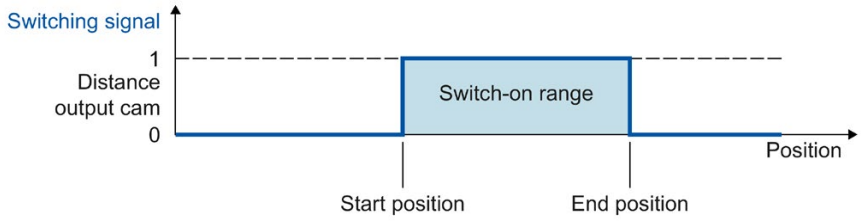
3.8.2 Distance output cam

Switch-on range

The switch-on range of distance output cams is basically defined by the start position and end position.

Start position smaller than end position

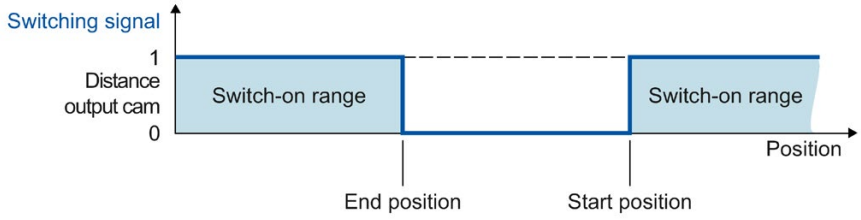
When the start position is less than the end position, the switch-on range begins with the start position and ends with the end position.



Start position greater than end position

When the start position is greater than the end position, there are two switch-on ranges as follows:

- Switch-on range beginning with the start position and ending with the positive range end (e.g. positive software limit switch, end of modulo range)
- Switch-on range beginning with the negative range end (e.g. negative software limit switch, start of modulo range) and ending with the end position



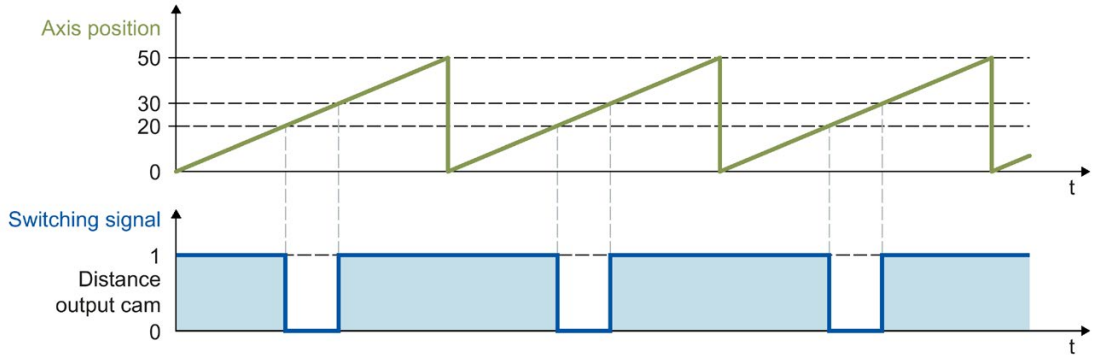
Mapping to an axis with modulo function

With active modulo function of the interconnected technology object, the start and end positions of the output cam are automatically mapped to values within the modulo range.

Example

- Modulo range = 0° to 50°
- Output cam start position = 80°
- Output cam end position = 220°

⇒ The distance output cam switches on at 30° and switches off again at 20°.



Switching characteristics

After activation, a distance output cam switches on in the following cases:

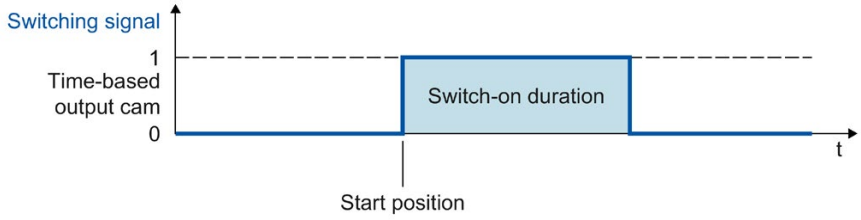
- The position of the interconnected technology object reaches the start or end position in the activation direction configured in Motion Control instruction "MC_OutputCam".
- The position of the interconnected technology object is moved into the switch-on range of the output cam (e.g. during homing) in the activation direction configured in Motion Control instruction "MC_OutputCam". If both activation directions are enabled in Motion Control instruction "MC_OutputCam", the output cam switches on even when the interconnected technology object is at a standstill.
- The output cam is switched on permanently using Motion Control instruction "MC_OutputCam" with "Mode" = 3.

An active distance output cam switches off in the following cases:

- The position is outside the switch-on range of the output cam.
- The position value is moved outside the switch-on range of the output cam.
- Motion Control instruction "MC_OutputCam" is set to "Enable" = FALSE.
- The motion direction of the interconnected technology object is reversed and no longer agrees with the enabled activation direction.

3.8.3 Time-based output cam

A time-based output cam switches on at the start position and remains set for the on-load factor.



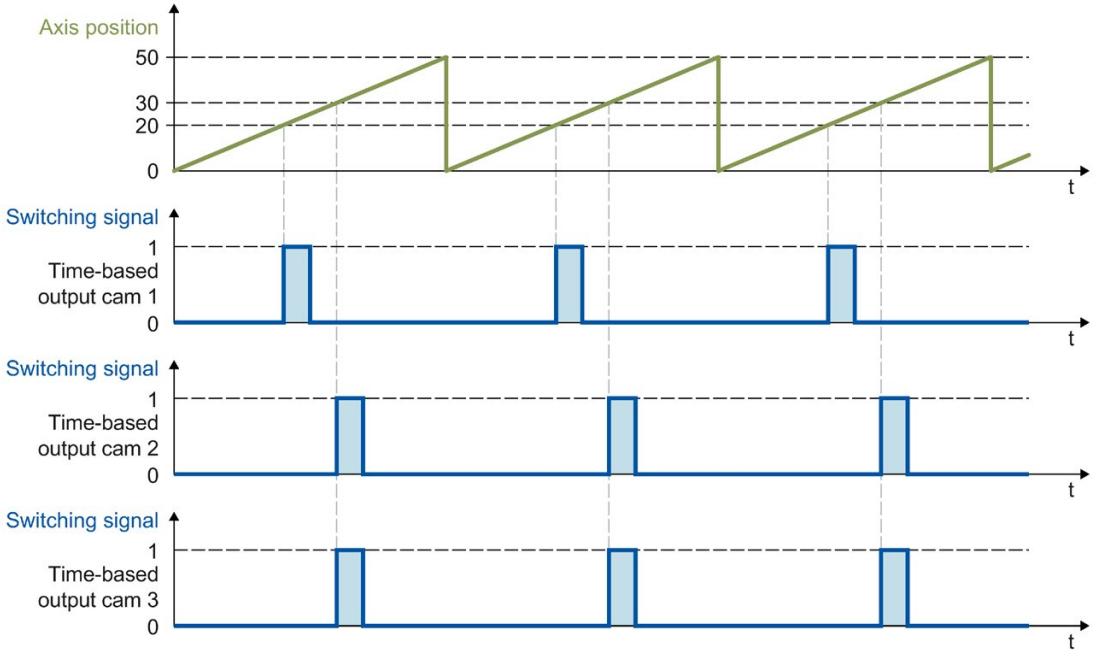
Mapping to an axis with modulo function

In the case of active modulo function of the interconnected technology object, the start position of the output cam is automatically mapped to the value within the modulo range.

Example

- Modulo range = 0° to 50°
- Output cam start positions:
  - Output cam 1 = 20°
  - Output cam 2 = 30°
  - Output cam 3 = 80°

⇒ The time-based output cam 1 switches on at 20°, the time-based output cams 2 and 3 switch on at 30°. All three output cams remain active the set on-load factor in each case.



Switching characteristics

A time-based output cam switches on in the following cases:

- The start position has been reached and the motion direction of the interconnected technology object corresponds to the effective direction enabled by the instruction.

Note

- If the start position is reached again while an output cam is switched on, the on-load factor is not re-triggered.
- If due to the Motion Control instruction "MC_Home", the position value of the interconnected technology object is placed directly on or behind the start position of the output cam during the motion, the output cam does not switch on.

A time-based output cam switches off in the following cases:

- The configured on-load factor has expired.
- Motion Control instruction "MC_OutputCam" is set to "Enable" = FALSE.

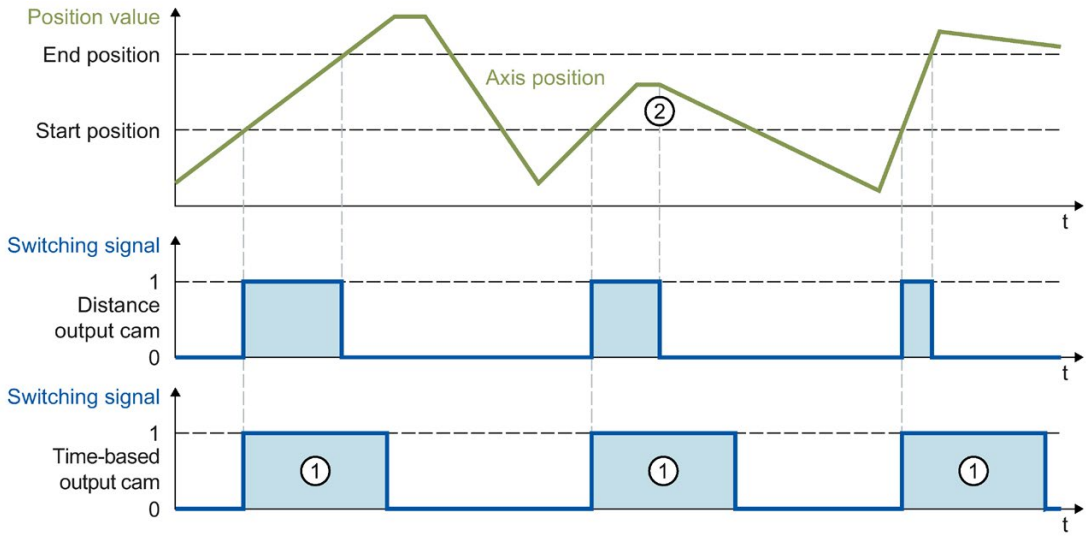
3.8.4 Activation direction of cam

An output cam can be switched depending on the motion direction of the interconnected technology object. It is possible to output an output cam with positive or negative motion direction only or even independent of direction.

The effective direction is set in "MC_OutputCam.Direction".

The following examples show the behavior of the output cam as a function of the effective direction setting.

Example of "positive" effective direction ("Direction" = 1)



Distance output cam

The output cam switches on when the switch-on range is reached in the **positive** direction. At a direction reversal ②, the output cam switches off.

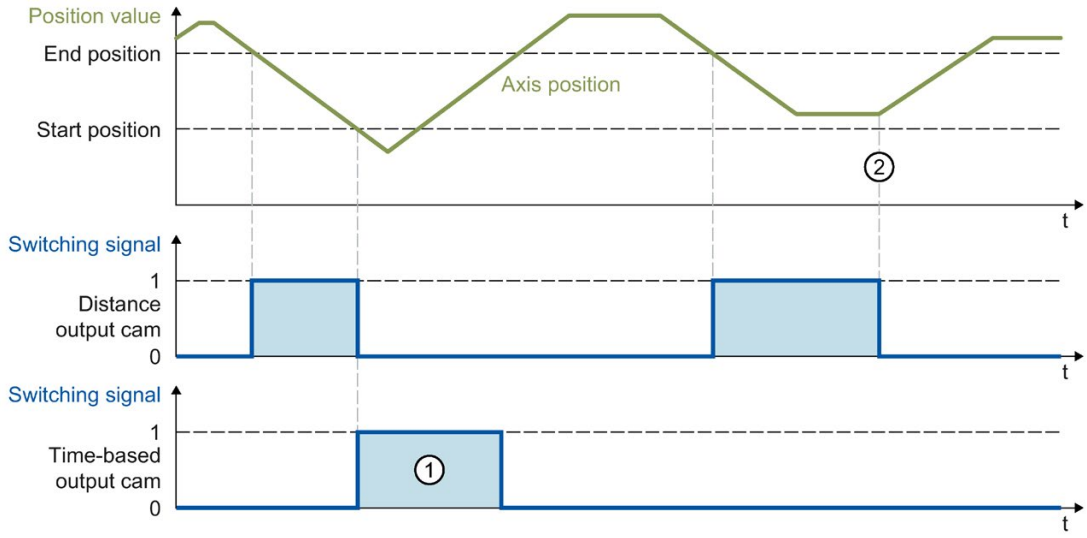
If the position value is moved into the switch-on range of the output cam, the cam switches on when there is positive motion direction of the interconnected technology object. The output cam remains switched off when the interconnected technology object is at a standstill.

Time-based output cam

The output cam switches on when the start position is reached in the **positive** direction. At a direction reversal, the output cam remains switched on for the specified on-load factor ①.

If during the homing motion, the position value of the interconnected technology object is directly on or behind the start position of the output cam, the output cam does not switch on.

Example of "negative" effective direction ("Direction" = 2)



Distance output cam

The output cam switches on when the switch-on range is reached in the **negative** direction. At a direction reversal ②, the output cam switches off.

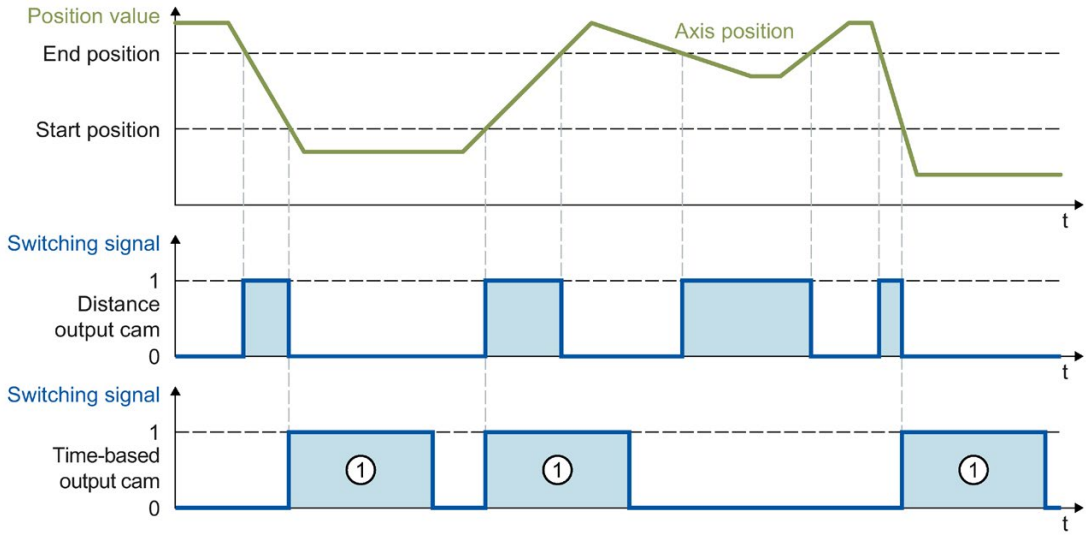
If the position value is moved into the switch-on range of the output cam, the output cam switches on when there is negative motion direction of the interconnected technology object. The output cam remains switched off when the interconnected technology object is at a standstill.

Time-based output cam

The output cam switches on when the start position is reached in the **negative** direction. At a direction reversal, the output cam remains switched on for the specified on-load factor ①.

If during the homing motion, the position value of the interconnected technology object is directly on or behind the start position of the output cam, the output cam does not switch on.

Example of "both directions" effective direction ("Direction" = 3)



Distance output cam

The output cam switches on when the position of the interconnected technology object is within the switch-on range.

If the position value of the interconnected technology object is moved into the switch-on range of the output cam, the cam switches on even when the interconnected technology object is at a standstill.

Time-based output cam

The output cam switches on when the start position is reached. At a direction reversal, the output cam remains switched on for the specified on-load factor ①.

If during the homing motion, the position value of the interconnected technology object is directly on or behind the start position of the output cam, the output cam does not switch on.

3.8.5 Hysteresis

Possible variations in the actual position/position setpoint can result in unwanted switch-on and switch-off of cams.

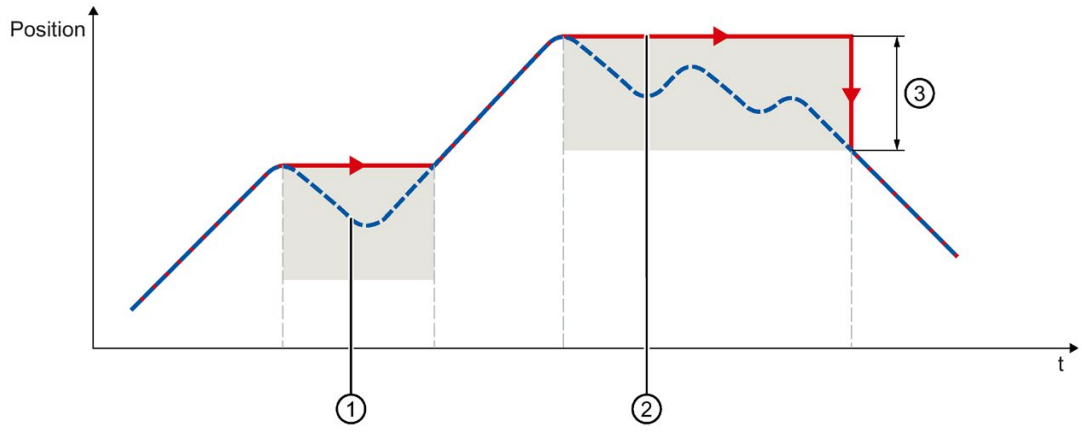
Minimal changes of the actual value of an axis at standstill can result in switch-on or switch-off of an actual value output cam with specified positive or negative effective direction. Even minimal changes of the setpoints of a switched-off axis in follow-up mode can result in switch-on or switch-off of an actual value output cam with specified positive or negative effective direction. Such unwanted switching states can be prevented by configuring a hysteresis (> 0.0). The configuration of a hysteresis value (> 0.0) is recommended in particular with reference to the actual position.

The hysteresis is a position tolerance within which the position values may vary without changing the switching state of the output cam. Changes of direction detected within the hysteresis are ignored.

The hysteresis is set for the technology object in <TO>.Parameter.Hysteresis.

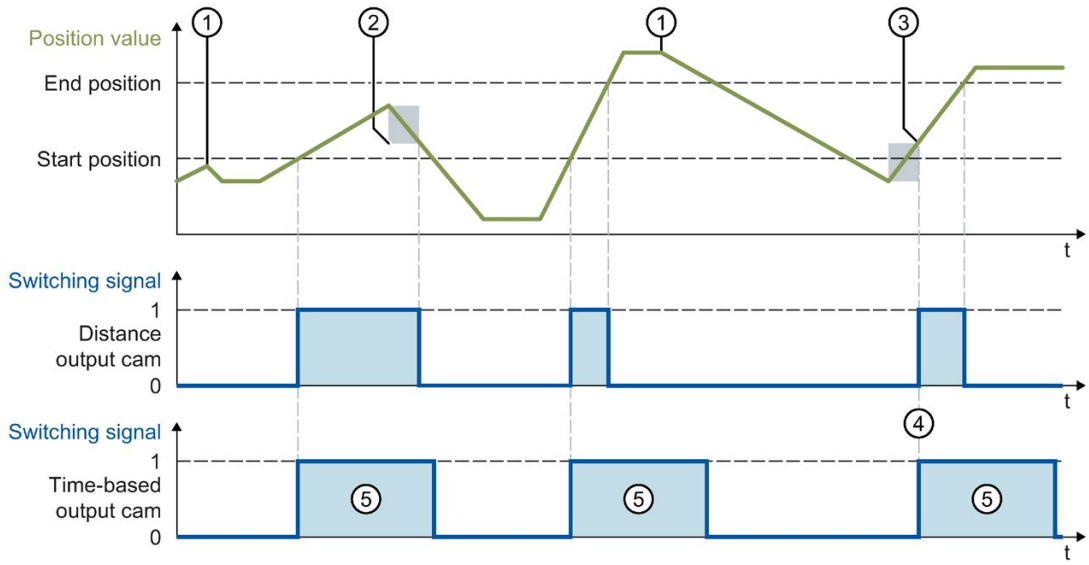
Behavior

- The hysteresis is activated at a direction reversal.
- The following applies within the hysteresis:
  - The switching state of distance output cams is not changed.
  - The motion direction is not determined again.
  - If the start position of a time-based output cam is within the hysteresis, the time-based output cam is switched on when leaving the hysteresis with the corresponding effective direction.
  - The on-load factor of time-based output cams remains unchanged.
- After the hysteresis range is exited, distance output cams are set according to the output cam settings.



① Actual position
② Effective position
③ Hysteresis range

The following examples show the effects of the hysteresis on the switching behavior of output cams with positive activation direction.



① Direction reversal without hysteresis effect
② Hysteresis in effect
③ The switch-on position of the distance output cam is influenced according to the direction reversal and hysteresis.
④ The start position of the time-based output cam is located within the hysteresis. The time-based output cam is switched on when leaving the hysteresis with the corresponding effective direction.
⑤ Switch-on duration

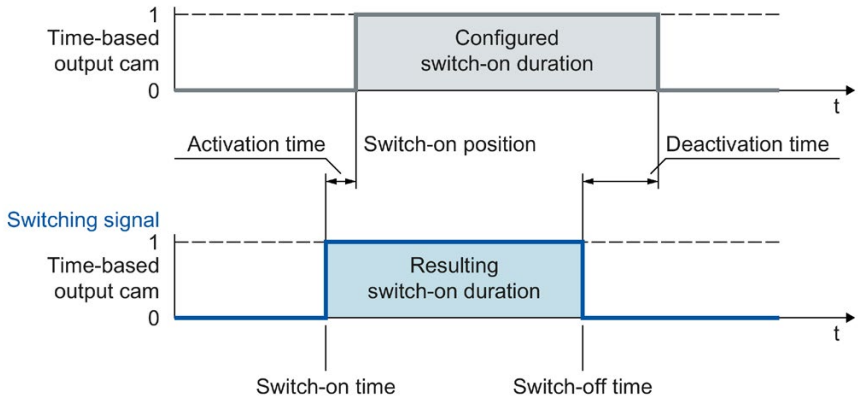
Hysteresis range

The maximum size of the hysteresis range in the system is as follows: for an axis with modulo function, one quarter of the modulo range; for an axis without modulo function, one quarter of the operating range.

3.8.6 Compensation of actuator switching times

Switching times of the output and the connected actuator (e.g. valve) can be compensated for using the activation time or deactivation time of the output cam technology object.

The activation time is specified as the lead time for the switch-on edge, and the deactivation time as the lead time for the switch-off edge.



The activation time is set in the technology object <TO>.OnCompensation.

The deactivation time is set in the technology object <TO>.OffCompensation.

Note

- The following must be met for the times:

  On-load factor > deactivation time - activation time

  (The on-load factor for distance output cams is determined by the switching positions and the current velocity)
- If the output cam has been switched taking the lead times into consideration, this action has taken place from the system perspective and will not be restarted in response to any subsequent variation in the actual speed.
- System-dependent runtimes are automatically taken into consideration when output by TM Timer DIDQ is used.

  When the output with a digital output module is used, system-dependent runtimes are not taken into consideration and must be set as correction times in the activation time or deactivation time.

3.8.7 Tags

Status display	
<TO>.CamOutput	The output cam is switched.
Parameters	
<TO>.Parameter.OutputCamType	Output cam type 0: Distance output cam 1: Time-based output cam
<TO>.Parameter.PositionType	Position reference 0: Position setpoint 1: Actual position
<TO>.ParameterOnCompensation	Activation time (lead time for the switch-on edge)
<TO>.Parameter.OffCompensation	Deactivation time (lead time for the switch-off edge)
<TO>.Parameter.Hysteresis	Hysteresis value
Interface	
<TO>.Interface.EnableOutput	Activation of the output cam output FALSE: No output TRUE: Output
<TO>.Interface.Address	I/O address of the output cam
<TO>.Interface.LogicOperation	Logical operation of the output cam signals at the output 0: OR operation 1: AND operation
Units	
<TO>.Units.LengthUnit	Unit of the length data
<TO>.Units.TimeUnit	Unit of the time data
StatusWord	
<TO>.StatusWord.X0 (Control)	The technology object is in operation.
<TO>.StatusWord.X1 (Error)	An error occurred at the technology object.
<TO>.StatusWord.X2 (RestartActive)	The technology object is being reinitialized. The tags of the technology data block are not updated with active restart.
<TO>.StatusWord.X3 (OnlineStartValuesChanged)	Data relevant for the restart has been changed. The changes are applied only after a restart of the technology object.
<TO>.StatusWord.X4 (OutputInverted)	The output cam output is inverted.
<TO>.StatusWord.X5 (CommunicationOk)	The cam is synchronized with the output module and available for use.
ErrorWord	
<TO>.ErrorWord.X0 (SystemFault)	A system-internal error has occurred.
<TO>.ErrorWord.X1 (ConfigFault)	Configuration error One or more configuration parameters are inconsistent or invalid. The technology object was incorrectly configured, or editable configuration data were incorrectly modified during runtime of the user program.
<TO>.ErrorWord.X2 (UserFault)	Error in user program at a Motion Control instruction or its use.
<TO>.ErrorWord.X3 (CommandNotAccepted)	Command cannot be executed. A Motion Control instruction cannot be executed because necessary requirements have not been met.
<TO>.ErrorWord.X13 (PeripheralError)	Error accessing a logical address.

ErrorDetail	
<TO>.ErrorDetail.Number	Alarm number You can find a list of the technology alarms and alarm reactions in the Technology Alarms (Page 626) appendix.
<TO>.ErrorDetail.Reaction	Effective alarm reaction 0: No reaction 6: Output cam processing is complete. You can find a list of the technology alarms and alarm reactions in the Technology Alarms (Page 626) appendix.

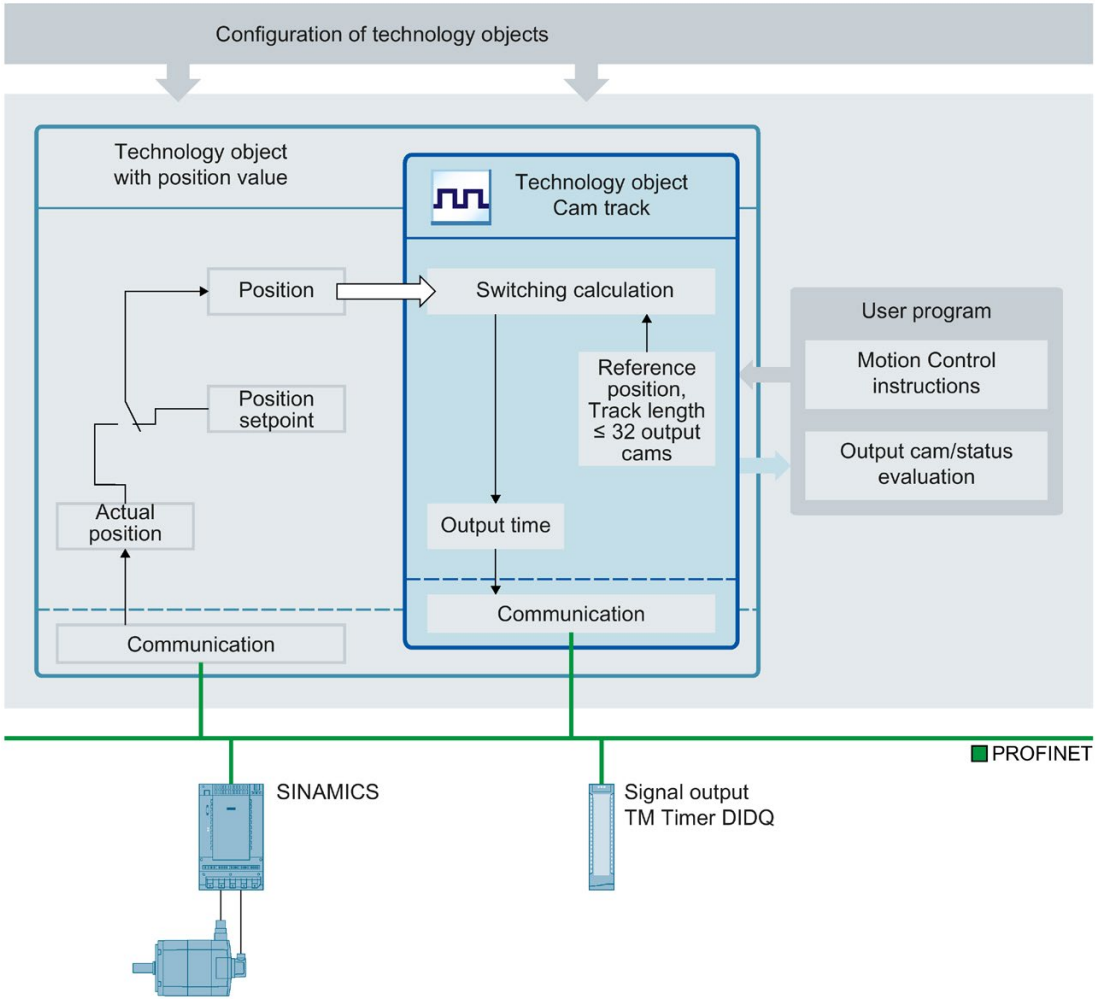
3.9 Cam track technology object

3.9.1 Brief description

The cam track technology object generates a switching signal sequence dependent on the position of an axis or external encoder. A cam track can consist of up to 32 individual output cams and be output to one output. The switching states can be evaluated in the user program or fed to digital outputs.

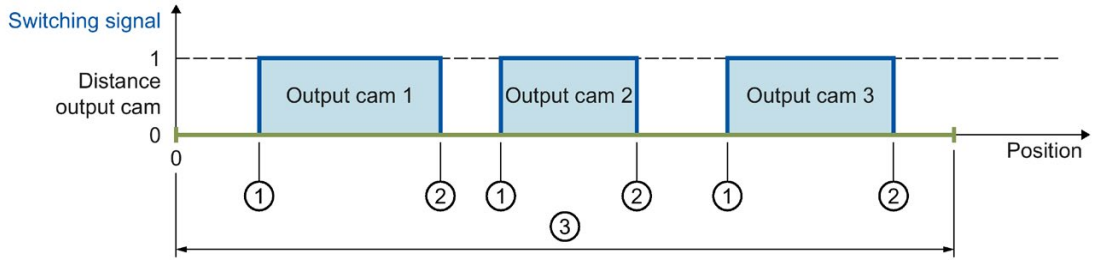
You can find an overview of the functions of the cam track technology object in the Functions (Page 29) section.

The figure below shows the basic principle of operation of the cam track technology object:



Definition of cam track

A cam track consists of up to 32 individual output cams that are specified within an adjustable track length.



① Start position
② End position
③ Cam track length

Figure 3-2 Cam track with distance output cam

The output cam positions are defined relative to the cam track. The start of the cam track is always 0.0. The output cam positions on the cam track are thus always positive.

When the cam track is processed, the output cams with start position within the track length are taken into consideration.

If the end of a cam track is crossed, connected output cams behave as follows within the cam track:

- Time-based output cams remain switched on for the set on-load factor.
- Distance output cams whose end position lie outside the cam track are switched off when the cam track is left.

Cams whose start and end positions lie outside the cam track length are ignored. They become active only if the cam track length is increased so that at least the respective start position of an output cam is within the new track length.

Mapping of the cam track to the position of an axis or external encoder.

The start of the cam track is placed at the specified reference position of the interconnected technology object. Thus, the switching positions result from the cam track positions mapped onto the interconnected technology object starting from the reference position. The cam track is continued in both directions of the interconnected technology object.

The setting for the reference position can be either positive or negative.

Example

- Axis range = -1000 mm to +1000 mm
- Desired switching points of the output cam with reference to axis position:
  - Start position = -200 mm
  - End position = -100 mm
- Cam track length = 2000 mm
- Definition of output cam on the track:
  - Start position = 800 mm
  - End position = 900 mm

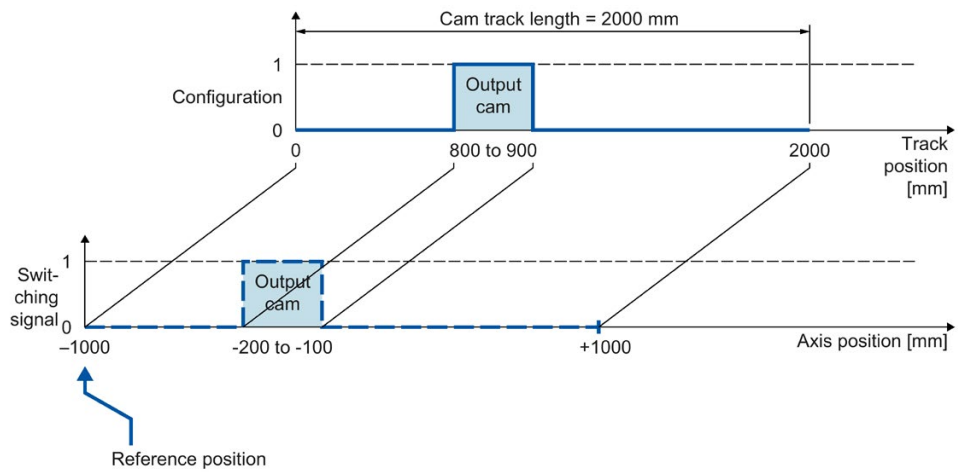


Figure 3-3 Cam track with output cam output at negative axis position

Processing of a cam track

The processing of a cam track occurs cyclically.

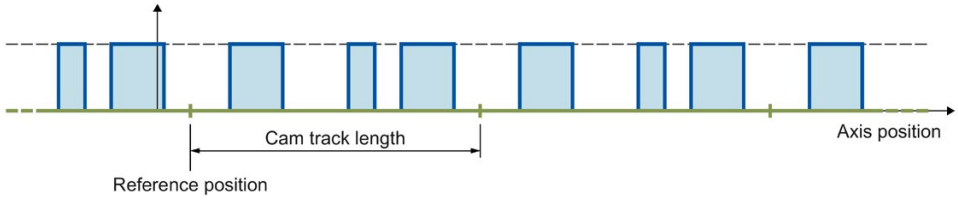


Figure 3-4 Cyclic mapping of a cam track

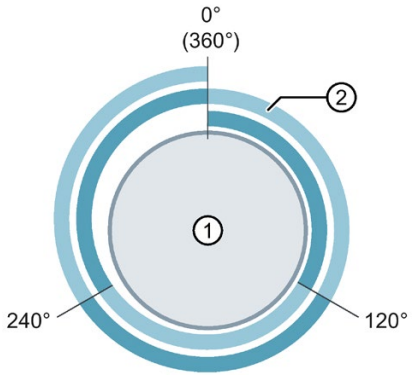
The cam track is mapped onto the position of the interconnected technology object starting from the reference position and is continued cyclically in both directions.

Track length and mapping to an axis with modulo function

When a cam track is mapped onto an axis with modulo function, a reference position specified outside the modulo range is mapped within the modulo range.

The track length can be less than or greater than the modulo length of the axis. In order for the cam track to be mapped without offset in the modulo range and to prevent unwanted overrides, an integer ratio of modulo length to track length, and vice versa, is required.

Example Mapping without offset



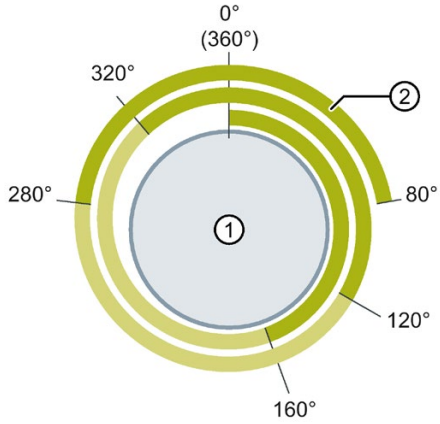
① Axis with modulo length 360°

② Cam track with track length 120°

⇒ Ratio = 360° / 120° = **3**

The cam track is output 3 times on a modulo length.

Example Mapping with offset



① Axis with modulo length 360°

② Cam track with track length 160°

⇒ Ratio = 360° / 160° = **2.25**

The cam track is output 2.25 times on the first modulo length and continued correspondingly in the other modulo lengths.

During cyclic processing of the cam track, the continued reference position of the current cam track is displayed in the <TO>.MatchPosition tag. The continued reference position is independent of direction and always the position of the left boundary of the cam track. The unique detection and output of the position is only possible when the assigned technology object is in motion. The distance to the current reference position of the current cam track (<TO>.MatchPosition) is displayed in the <TO>.TrackPosition tag.

Output cam types

The following output cam types are used:

- Distance output cam
- Time-based output cam

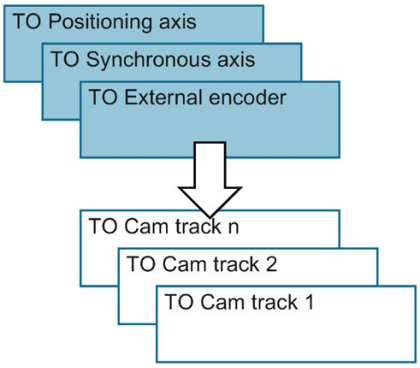
The output cams of the cam track can be set as distance output cams or time-based output cams, whereby only one of the two output cam types can be used in one cam track.

Assignment

The cam track technology object must always be assigned to another technology object whose position is evaluated.

The cam track technology object can be assigned to the following technology objects:

- Synchronous axis
- Positioning axis
- External encoder



Exactly one axis or one external encoder can be assigned to a cam track.

Multiple cam tracks can be assigned to one axis or external encoder.

Position reference

The switching points of the output cams of a cam track can be referenced to the following positions, depending on the interconnected technology object.

- Actual position of a synchronous axis/positioning axis
- Position setpoint of a synchronous axis/positioning axis
- Position of an external encoder

Homing the interconnected technology object

A change to the position of an axis or external encoder using Motion Control instruction "MC_Home" is regarded as a sudden position change. An enabled cam track is referenced to the changed position and processed further from there.

- For axes with modulo function, homing also has an effect on the current position of the cam track (<TO>.TrackPosition). The position is formed again as quickly as possible due to the offset.
- Distance output cams are either skipped or correspondingly output.
- Time-based output cams are skipped. A time-based output cam is switched on only when the start position is crossed and remains switched on for the on-load factor.
- Switched time-based output cams are not canceled by a homing operation.

We recommend locking the cam track before or during homing.

Output of a cam track

The following output options are available for the digital cam track output:

- TM Timer DIDQ

  Digital output with high degree of accuracy and reproducibility in the microsecond range on ET 200MP TM Timer DIDQ 16x24V and ET 200SP TM Timer DIDQ 10x24V time-based IO modules

  Output by TM Timer DIDQ requires isochronous mode. Isochronous mode is only possible with PROFINET interface modules.

- Digital output module

  Digital output with switching accuracy depending on the output cycle of the I/O used

A maximum of two edges (by TM Timer DIDQ, positive and negative) or one edge (via digital output module, positive or negative) can be output per position control cycle clock. If multiple switch-on edges or switch-off edges are transmitted in one position control cycle clock, the last written values in each case are valid.

Masking of individual output cams of a cam track

In order for output cams to processed, they must be configured as valid in the technology data block with "<TO>.Parameter.Cam[1 … 32].Existent" = TRUE. In addition, output cams of a cam track configured as valid can be masked in the user program using bit masking ("<TO>.Parameter.CamMasking"). In the default setting, all valid output cams are enabled ("<TO>.Parameter.CamMasking" = 0xFFFFFFFF). The cam track itself is activated/deactivated using the Motion Control instruction "MC_CamTrack".

3.9.2 Effective direction

The cam track is always active for both directions of the position of the interconnected technology object.

Output of a cam track with distance output cam

Distance output cams are switched when the switch-on range is overtraveled.

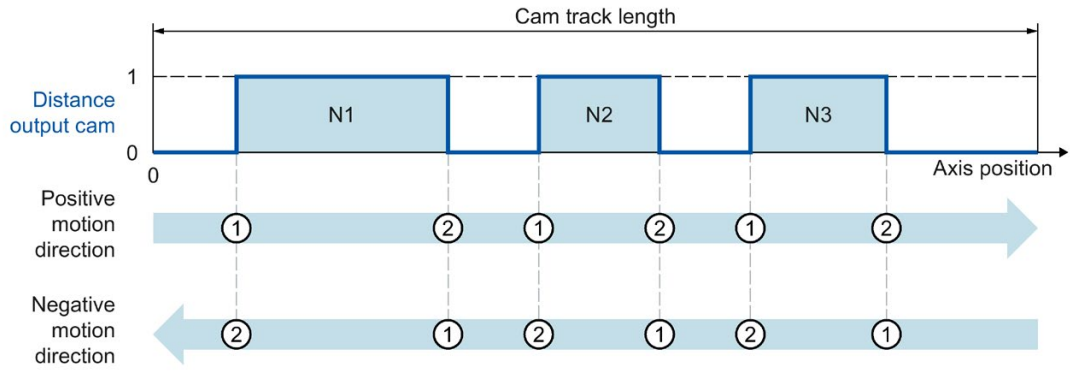


Figure 3-5 Executing a cam track with distance output cams dependent on the motion direction of the axis

- With positive motion direction, the output cams of the cam track are output in the order Output Cam N1, Output Cam N2, Output Cam N3
- In the case of negative motion direction, the output cams of the cam track are output in the order Output Cam N3, Output Cam N2, Output Cam N1
- The distance output cams switch on at ① and switch off at ②

Output of a cam track with time-based output cam

The time-based output cams are switched when the start position is crossed.

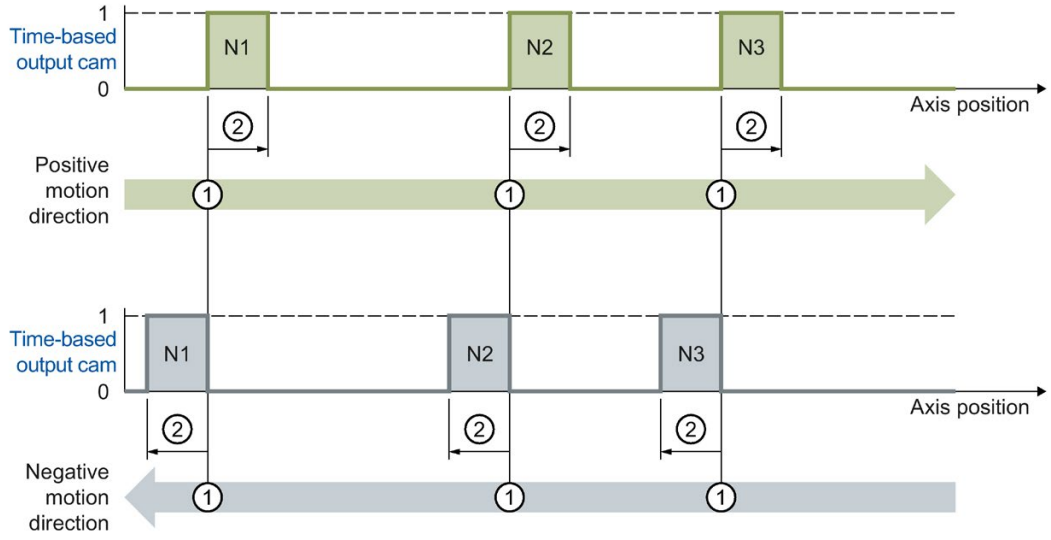


Figure 3-6 Executing a cam track with time-based output cams dependent on the motion direction of the axis

- With positive motion direction, the output cams of the cam track are output in the order Output Cam N1, Output Cam N2, Output Cam N3
- In the case of negative motion direction, the output cams of the cam track are output in the order Output Cam N3, Output Cam N2, Output Cam N1
- The time-based output cams switch on at ① and remain switched on for the set switch-on duration ②

3.9.3 Changing the cam track data during operation

The data of a cam track and the parameters of the associated Motion Control instruction "MC_CamTrack" can be changed while track processing is enabled. The active Motion Control instruction "MC_CamTrack" is not aborted. The modified parameters, however, only take effect at the next call of Motion Control instruction "MC_CamTrack".

The following parameters can be changed during operation and are in effect after another call of Motion Control instruction "MC_CamTrack".

- Cam track data in technology data block
  - Reference position (<TO>.Parameter.ReferencePosition)
  - Track length (<TO>.Parameter.CamTrackLength)
  - Bit masking of individual output cams (<TO>.Parameter.CamMasking)
  - Activation time (<TO>.Parameter.OnCompensation)
  - Deactivation time (<TO>.Parameter.OffCompensation)
  - Hysteresis value (<TO>.Parameter.Hysteresis)
  - Output cam data (<TO>.Parameter.Cam[1 … 32])
- Parameters in the function block
  - Enable (MC_CamTrack.Enable)
  - Mode (MC_CamTrack.Mode)
  - Inverted output (MC_CamTrack.InvertOutput)

Note the different activation behavior (Page 170) when changing the cam track data.

3.9.4 Activation behavior

A cam track is activated by the call of Motion Control instruction "MC_CamTrack" with "Enable" = TRUE. A distinction must be made here between:

- A first-time activation of the cam track
- The call after a change of the cam track data during active cam track processing

The difference relates to how the cam track data is applied. Depending on the set mode ("MC_CamTrack.Mode"), the configuration (cam track data, data in the function block) is applied at different times.

- **First-time switch-on of a cam track**

  The call of Motion Control instruction "MC_CamTrack" with "Enable" = TRUE activates the cam track immediately (<TO>.Status changes to 1) and configured cam track data takes effect immediately. This behavior is the same when "MC_CamTrack.Mode" = 0 and "MC_CamTrack.Mode" = 1.
- **Change of cam track data of an already activated cam track**(<TO>.Status = 1)
  - With the call of Motion Control instruction "MC_CamTrack" with "Enable" = TRUE and "Mode" = 0, the modified cam track data takes effect immediately.

    Previously activated distance output cams are aborted if their track signals are not still set due to the changed cam track data. Previously activated time-based output cams are always aborted.
  - With the call of Motion Control instruction "MC_CamTrack" with "Enable" = TRUE and "Mode" = 1, the cam track continues to be output with the prior configuration up to the cam track end. Modified cam track data takes effect at the end of the current track cycle.

    If you change a cam track with "MC_CamTrack.Mode" = 1 during runtime of the user program, keep in mind the lead time of the cam track as reserve for the first output cam. Define the first output cam position in the cam track only after the following position:

    Position of first output cam > velocity of axis x lead time of the cam track (<TO>.Parameter.OnCompensation)

    Also keep in mind the internal system time for output cam calculation, even if you set the lead time 0.0.

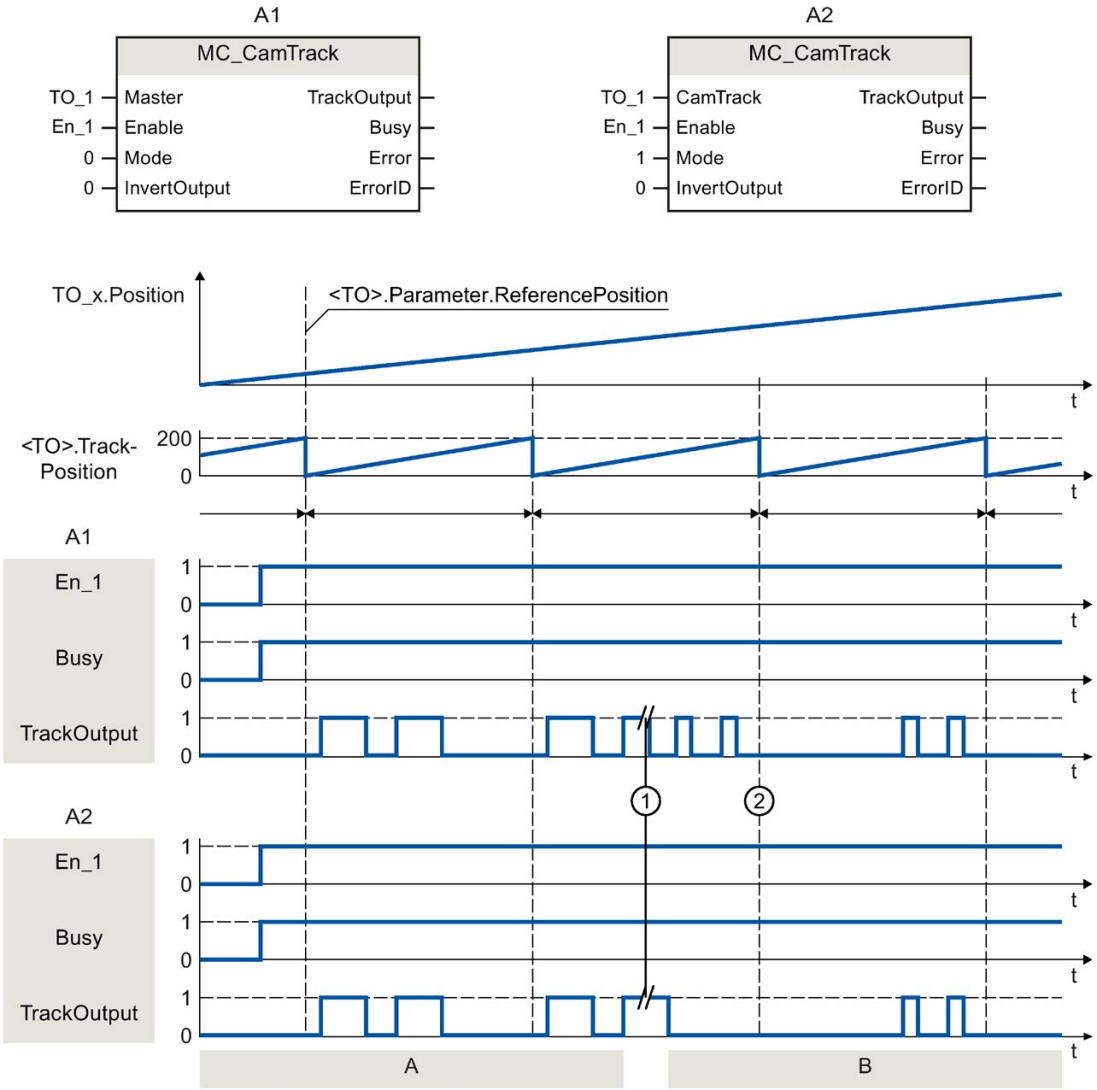
Changing cam track data when modulo length is not a multiple of the track length

For the switching times to be set correctly, we recommend the following procedure for changes:

- Enter changes as soon as possible after start of a new cam track
- Enter a new reference position (<TO>.Parameter.ReferencePosition) for the changed cam track. The new reference position is composed as follows depending on the direction:
  - Positive effective direction: Current reference position (<TO>.MatchPosition) + cam track length (<TO>.Parameter.CamTrackLength)
  - Negative effective direction: Current reference position (<TO>.MatchPosition) - cam track length (<TO>.Parameter.CamTrackLength)
- Output the changes of the cam track when calling the Motion Control instruction "MC_CamTrack" and "Mode" = 1.

Example

The following figure shows an example of the differences in the activation behavior.



A1	A	The cam track is activated the first time with "MC_CamTrack.Enable" = TRUE and the output cams are output immediately with set "MC_CamTrack.Mode" = 0.
	B	After cam track data were changed (①), the cam track is activated by calling Motion Control instruction "MC_CamTrack" with "Enable" = TRUE and the modified data takes effect immediately (①) with set "MC_CamTrack.Mode" = 0.
A2	A	The cam track is activated the first time with "MC_CamTrack.Enable" = TRUE and the output cams are output immediately with set "MC_CamTrack.Mode" = 1.
	B	After cam track data were changed (①), the cam track is activated by calling Motion Control instruction "MC_CamTrack" with "Enable" = TRUE and the modified data takes effect at the end of the current track cycle (②) with set "MC_CamTrack.Mode" = 1.

3.9.5 Hysteresis

The hysteresis is set in the cam track technology object. The behavior and effect of the hysteresis setting corresponds to the hysteresis (Page 155) for the cam technology object.

3.9.6 Time offset of cam switching points

Switching times of the output and the connected actuator (e.g. valve) can be compensated for using the activation time or deactivation time of the cam track technology object.

The time offset of cam switching points corresponds to the activation time or deactivation time (Page 158) for the cam technology object.

3.9.7 Tags

Status display	
<TO>.Status	0: Inactive 1: Active 2: Active and waiting for next track
<TO>.TrackOutput	A cam of cam track is switched.
<TO>.SingleCamState	Switched on output cam (bit-masked)
<TO>.TrackPosition	Display of the current position within the cam track The distance to the current reference position of the current cam track (<TO>.MatchPosition) is displayed.
<TO>.MatchPosition	Reference position of the current cam track During cyclic processing of the cam track, the continued reference position of the current cam track is displayed. The unique detection and output of the position is only possible when the assigned technology object is in motion.
Parameters	
<TO>.Parameter.CamTrackType	Output cam type 0: Distance output cam 1: Time-based output cam
<TO>.Parameter.PositionType	Position reference 0: Position setpoint 1: Actual position
<TO>.Parameter.ReferencePosition	Reference position
<TO>.Parameter.CamTrackLength	Track length
<TO>.Parameter.CamMasking	Bit masking of individual output cams
<TO>.Parameter.OnCompensation	Activation time (lead time for the switch-on edge)
<TO>.Parameter.OffCompensation	Deactivation time (lead time for the switch-off edge)
<TO>.Parameter.Hysteresis	Hysteresis value
<TO>.Parameter.Cam[1 … 32].OnPosition	Start position (distance and time-based output cams)
<TO>.Parameter.Cam[1 … 32].OffPosition	End position (distance output cam)
<TO>.Parameter.Cam[1 … 32].Duration	Switch-on duration (time-based output cam)

<TO>.Parameter.Cam[1 … 32].Existent	Validity of an output cam FALSE: Output cam not used TRUE: Output cam is used
Interface	
<TO>.Interface.EnableOutput	Output cam output at the bit specified under "Address" FALSE: No output TRUE: Output
<TO>.Interface.Address	I/O address for digital cam output
Units	
<TO>.Units.LengthUnit	Unit of the length data
<TO>.Units.TimeUnit	Unit of the time data
StatusWord	
<TO>.StatusWord.X0 (Control)	The technology object is in operation.
<TO>.StatusWord.X1 (Error)	An error occurred at the technology object.
<TO>.StatusWord.X2 (RestartActive)	The technology object is being reinitialized. The tags of the technology data block are not updated with active restart.
<TO>.StatusWord.X3 (OnlineStartValuesChanged)	Data relevant for the restart has been changed. The changes are applied only after a restart of the technology object.
<TO>.StatusWord.X4 (OutputInverted)	The output cam output is inverted.
<TO>.StatusWord.X5 (CommunicationOk)	The cam track is synchronized with the output module and available for use.
<TO>.StatusWord.X6 (CamDataChanged)	The data of individual output cams has been changed but not yet taken effect with Motion Control instruction "MC_CamTrack".
ErrorWord	
<TO>.ErrorWord.X0 (SystemFault)	A system-internal error has occurred.
<TO>.ErrorWord.X1 (ConfigFault)	Configuration error One or more configuration parameters are inconsistent or invalid. The technology object was incorrectly configured, or editable configuration data were incorrectly modified during runtime of the user program.
<TO>.ErrorWord.X2 (UserFault)	Error in user program at a Motion Control instruction or its use.
<TO>.ErrorWord.X3 (CommandNotAccepted)	Command cannot be executed. A Motion Control instruction cannot be executed because necessary requirements have not been met.
<TO>.ErrorWord.X13 (PeripheralError)	Error accessing a logical address.
ErrorDetail	
<TO>.ErrorDetail.Number	Alarm number
<TO>.ErrorDetail.Reaction	Effective alarm reaction 0: No reaction 5: Cam track processing Is complete.

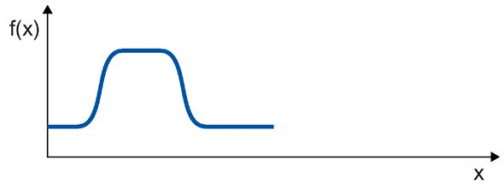
3.10 Cam technology object

3.10.1 Brief description

The cam technology object defines a transfer function y = f(x). The dependency of an output value on an input value is described in this transfer function in a unit-neutral manner. A cam technology object can be used multiple times.

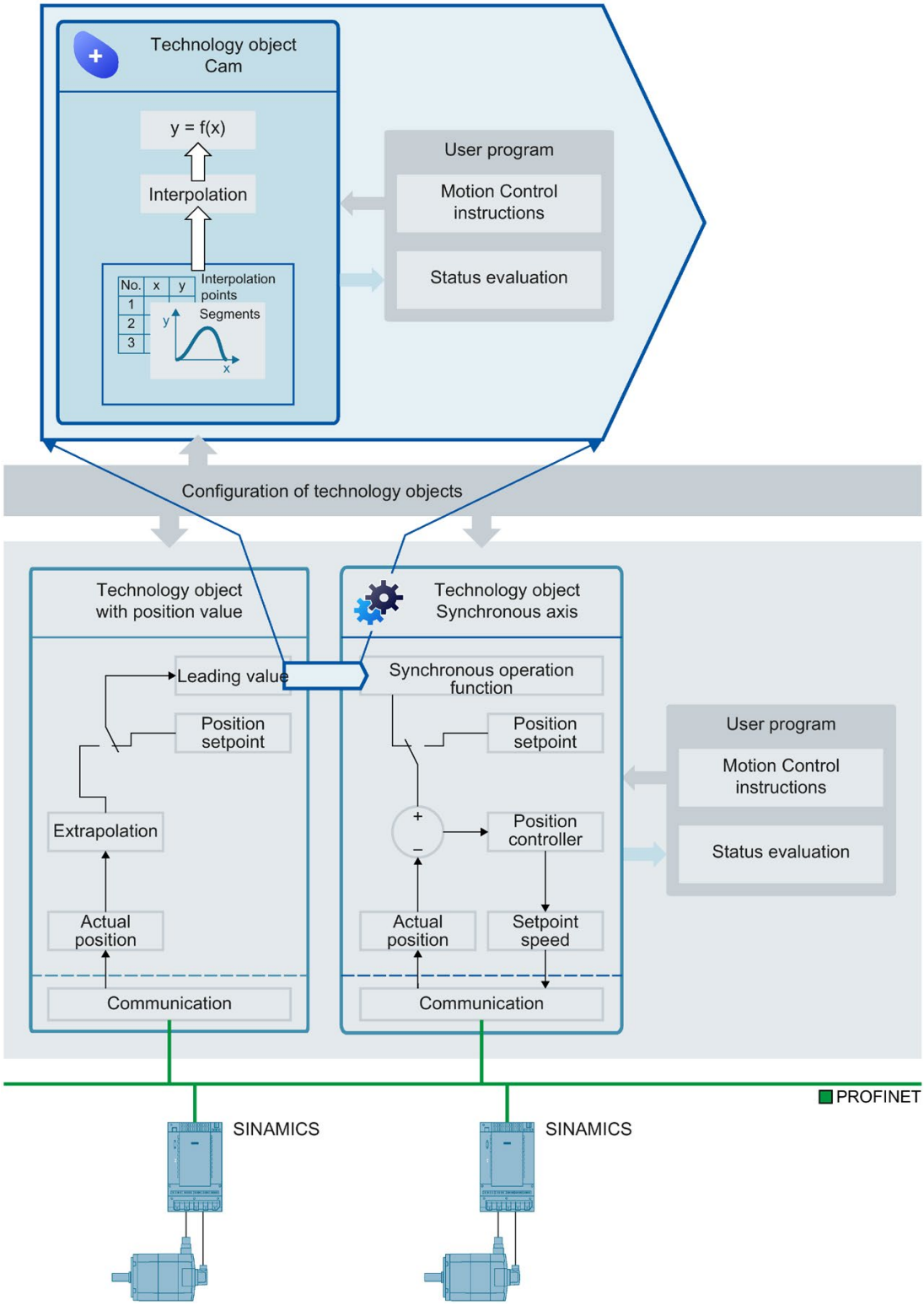
You can find an overview of the functions of the cam technology object in the Functions (Page 29) section.

You define the function y = f(x) in the configuration of the technology object (Page 284) using interpolation points and/or segments. Ranges between interpolation points and segments are interpolated using the Motion Control instruction "MC_InterpolateCam (Page 512)". The settings can be changed/redefined during runtime of the user program with the technology data block according to the appendix Tags of the cam technology object (Page 620).



An interpolated cam can be applied as a synchronous operation function for camming (Page 122).

The figure below shows the basic operating principle of the cam technology object:



3.10.2 Interpolation

To use a cam in the user program, it must be interpolated after downloading to the CPU. Following the interpolation, the gaps between the defined interpolation points and segments of the cam are closed. The cam is interpolated from the minimum value in the leading value range to the maximum value.

You interpolate a cam in your user program with the Motion Control instruction "MC_InterpolateCam". When a cam is interpolated, this is indicated by parameter "MC_InterpolateCam.Done" = TRUE and via technology data block tag "<TO>.StatusWord.X5 (Interpolated)" = 1.

You specify the interpolation in the configuration of the technology object (Page 284). The following methods are possible:

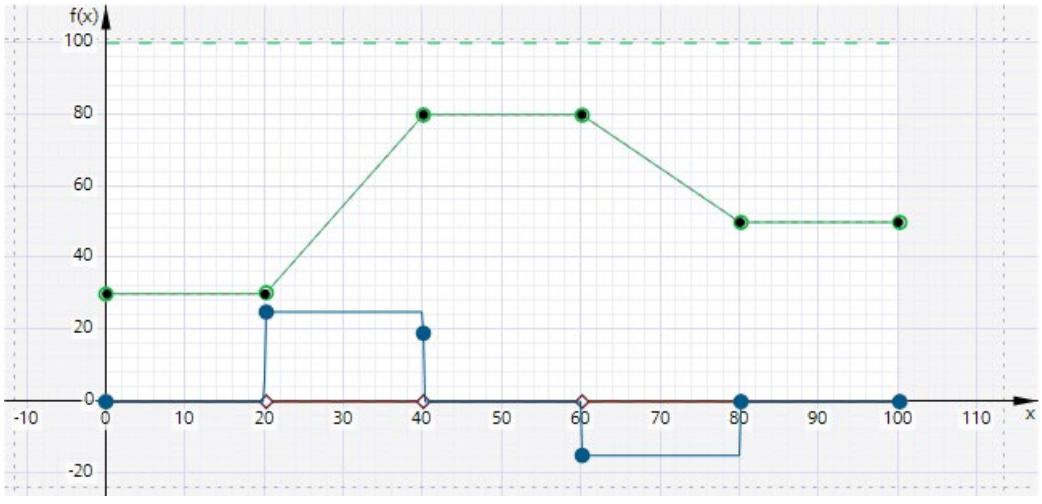
- System interpolation
- Optimization of transitions according to VDI Guideline 2143

System interpolation

With system interpolation, the transitions are interpolated according to the interpolation type and the response in the boundary points of the transition segment.. The following interpolation methods are possible:

- **Linear interpolation**

  Gaps in the cam are closed with a straight line.



Specified position (point)

Interpolated position

Resulting velocity (scaled)

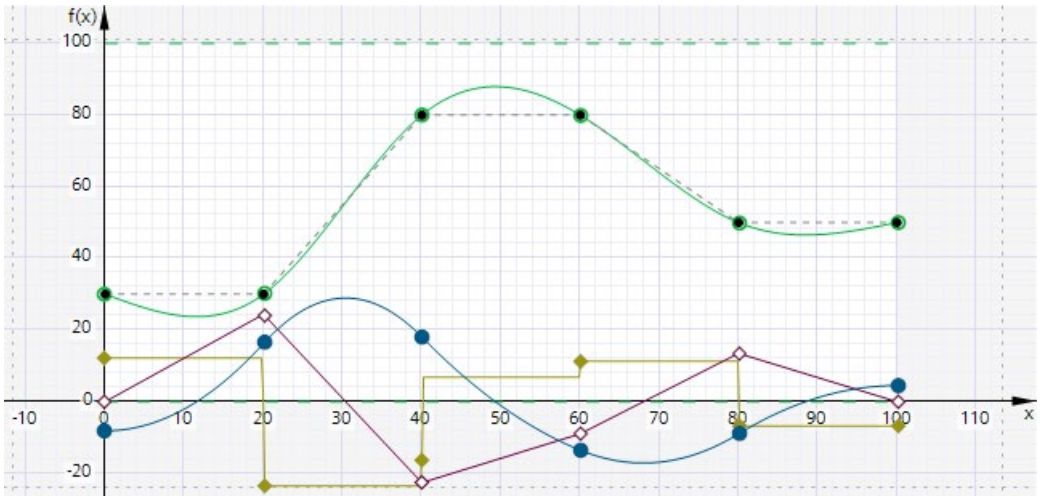
Resulting acceleration

Resulting jerk

- **Interpolation with cubic splines**

  The interpolated curve runs through the interpolation points or segments of the curve.

  After completion of interpolation, the range of the cam can be greater than before interpolation.



Specified position (point)

Interpolated position

Resulting velocity (scaled)

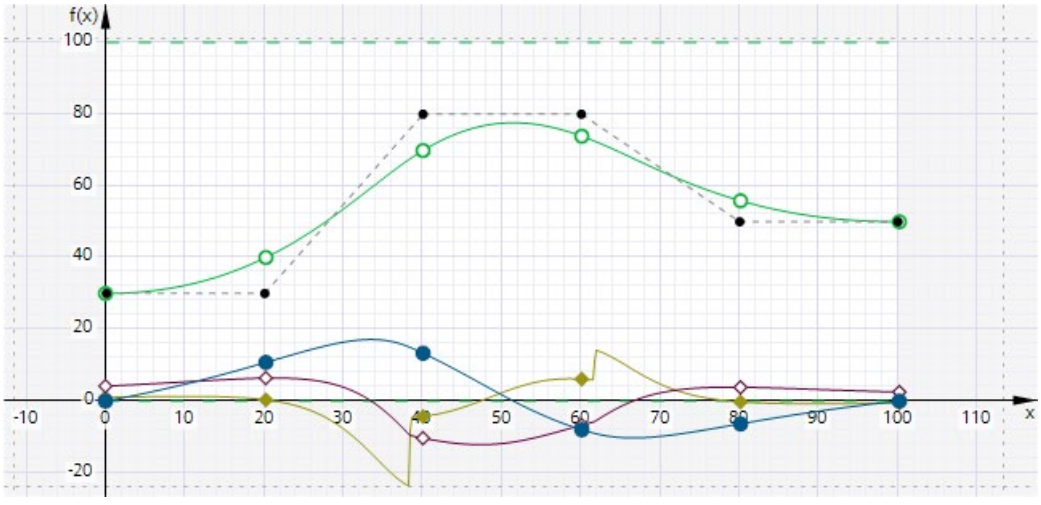
Resulting acceleration (scaled)

Resulting jerk (scaled)

- **Interpolation with Bézier splines**

  The interpolated curve runs along the interpolation points or curve segments.

  The range of the cam is not changed by interpolation.



Specified position (point)

Interpolated position

Resulting velocity (scaled)

Resulting acceleration (scaled)

Resulting jerk (scaled)

Optimization of transitions according to VDI Guideline 2143

The transitions are specified according to the motion command and the optimization settings according to the VDI Guideline 2143.

Note that the optimization of transitions according to VDI guideline 2143 directly occupies segments in the technology object data block contrary to system interpolation. This optimization type is thus possible via MC_InterpolateCam during the runtime.

See also

MC_InterpolateCam: Interpolate cam disc V4 (Page 512)

3.11 Kinematics technology object

The Kinematics technology object is described in the "S7-1500T Kinematics Functions" function manual. (https://support.industry.siemens.com/cs/ww/en/view/109749264)

Using versions 4

4.1 Overview of versions

For S7-1500 Motion Control, a distinction is made between the version of the technology, the technology objects and the Motion Control instructions. The overview shown below includes S7-1500 and S7-1500T. Only one technology version can be operated on a CPU.

When changing to a CPU ≥ V1.6, you must change the technology version accordingly. Card replacement from a CPU < V1.6 to a ≥ CPU V1.6 is supported. In the TIA Portal, you can use a CPU ≥ 1.6 only to work on projects with a correspondingly higher technology version.

There are two ways of changing the technology version:

- Changing the version of the Motion Control instructions

  You change the version of the Motion Control instructions in the "Instructions" task card in the folder "Technology > Motion Control > S7-1500 Motion Control".

  If the Motion Control instruction version used does not correspond to the compatibility list, the relevant Motion Control instructions are highlighted in red in the program editor.

- Adding a technology object with an alternative version

  If a technology object with an alternative version is added in the "Add new object" dialog, the technology version is changed to the alternative version.

The technology objects and Motion Control instructions are only converted to the selected version of the technology during compilation.

The version of a technology object or a Motion Control instruction is indicated in the properties of the technology object, "General > Information" tab, "Version" field.

Compatibility list

The table below shows the compatibility of the technology version with the CPU version:

CPU	Technology	Technology object
V2.5	V4.0	Speed Axis V4.0 Positioning Axis V4.0 External Encoder V4.0 Synchronous Axis V4.0 Measuring input V4.0 Cam V4.0 Cam track V4.0 Cam V4.0 (S7-1500T) Kinematics V4.0 (S7-1500T)
V2.0, V2.1	V3.0	Speed Axis V3.0 Positioning axis V3.0 External encoder V3.0 Synchronous axis V3.0 Measuring input V3.0 Output cam V3.0 Cam track V3.0 Cam V3.0 (S7-1500T)
V1.6, V1.7, V1.8	V2.0	Speed Axis V2.0 Positioning axis V2.0 External encoder V2.0 Synchronous axis V2.0
V1.0, V1.1, V1.5[1]	V1.0	Speed Axis V1.0 Positioning axis V1.0 External encoder V1.0

1) Card replacement from a CPU < V1.6 to a CPU ≥ V1.6 is supported.

Parameter "Mode" of the Motion Control instruction "MC_Home"

The "MC_Home.Mode" parameter for S7-1200 Motion Control and S7-1500 Motion Control has been standardized within the framework of technology version V2.0. This results in a new assignment of the parameter values for the "MC_Home.Mode" parameter.

The table below shows a comparison of the "MC_Home.Mode" parameter for technology V1.0 and ≥ V2.0:

MC_Home.HomingMode V1.0	Parameter value	MC_Home.Mode ≥ V2.0
Direct homing (absolute)	0	Direct homing (absolute)
Direct homing (relative)	1	Direct homing (relative)
Passive homing	2	Passive homing (without reset)
Passive homing (with configured home position)	3	Active homing
Active homing	4	Reserved
Active homing with configured home position)	5	Active homing (with configured home position)
Absolute encoder adjustment (relative)	6	Absolute encoder adjustment (relative)
Absolute encoder adjustment (absolute)	7	Absolute encoder adjustment (absolute)
Passive homing (without reset)	8	Passive homing
Abort passive homing	9	Abort passive homing
-	10	Passive homing (with configured home position)

You can find additional information about the "MC_Home.Mode" parameter in the description of the Motion Control instruction "MC_Home" (Page 438).

Tags of the technology object

Starting from technology version V3.0, all input and output addresses are specified using data type VREF. This results in the following changes to the tags of the technical object:

Tag of technology object	Changes starting from V3.0
<TO>.Actor.Interface.AddressIn	Data type: VREF
<TO>.Actor.Interface.AddressOut	Data type: VREF
<TO>.Sensor[n].Interface.AddressIn	Data type: VREF
<TO>.Sensor[n].Interface.AddressOut	Data type: VREF
<TO>.Actor.Interface.EnableDriveOutputAddress	Data type: VREF
<TO>.Actor.Interface.EnableDriveOutputBitNumber	Tag eliminated
<TO>.Actor.Interface.DriveReadyInputAddress	Data type: VREF
<TO>.Actor.Interface.DriveReadyInputBitNumber	Tag eliminated
<TO>.Sensor[n].ActiveHoming.DigitalInputAddress	Data type: VREF
<TO>.Sensor[n].ActiveHoming.DigitalInputBitNumber	Tag eliminated
<TO>.Sensor[n].PassiveHoming.DigitalInputAddress	Data type: VREF
<TO>.Sensor[n].PassiveHoming.DigitalInputBitNumber	Tag eliminated
<TO>.PositionLimits_HW.MinInputAddress	Data type: VREF
<TO>.PositionLimits_HW.MinInputBitNumber	Tag eliminated
<TO>.PositionLimits_HW.MaxInputAddress	Data type: VREF
<TO>.PositionLimits_HW.MaxInputBitNumber	Tag eliminated

4.2 Version V4.0

Innovations

Technology Version V4.0 contains the following new features:

- Exchange of torque data with the drive in the technological units of the technology object.
  - Additive setpoint torque
  - Current actual torque
  - Permissible torque range
- Extension of the data structure of the positioning axis and synchronous axis for using technology object kinematics
- Use of optimized data blocks (drive/encoder connection)

Additional innovations for S7-1500T:

Technology Version V4.0 contains the following additional features:

- Kinematic technology object (S7-1500T)
- Motion specification via MotionIn instructions (S7-1500T)
- Direct synchronous setting with MC_CamIn V4.0 (S7-1500T)

Motion Control instructions

Technology Version V4.0 contains the following Motion Control instructions:

- MC_Power V4.0
- MC_Reset V4.0
- MC_Home V4.0
- MC_Halt V4.0
- MC_MoveAbsolute V4.0
- MC_MoveRelative V4.0
- MC_MoveVelocity V4.0
- MC_MoveJog V4.0
- MC_MoveSuperimposed V4.0
- MC_SetSensor V4.0 (S7-1500T)
- MC_TorqueLimit V4.0
- MC_MeasuringInput V4.0
- MC_MeasuringInputCyclic V4.0
- MC_AbortMeasuringInput V4.0
- MC_OutputCam V4.0

- MC_CamTrack V4.0
- MC_GearIn V4.0
- MC_GearInPos V4.0 (S7-1500T)
- MC_PhasingAbsolute V4.0 (S7-1500T)
- MC_PhasingRelative V4.0 (S7-1500T)
- MC_CamIn V4.0 (S7-1500T)
- MC_SynchronizedMotionSimulation V4.0 (S7-1500T)
- MC_InterpolateCam V4.0 (S7-1500T)
- MC_GetCamFollowingValue V4.0 (S7-1500T)
- MC_GetCamLeadingValue V4.0 (S7-1500T)
- MC_MotionInVelocity V4.0 (S7-1500T)
- MC_MotionInPosition V4.0 (S7-1500T)
- MC_TorqueAdditive V4.0
- MC_TorqueRange V4.0
- MC_GroupInterrupt V4.0 (S7-1500T)
- MC_GroupContinue V4.0 (S7-1500T)
- MC_GroupStop V4.0 (S7-1500T)
- MC_MoveLinearAbsolute V4.0 (S7-1500T)
- MC_MoveLinearRelative V4.0 (S7-1500T)
- MC_MoveCircularAbsolute V4.0 (S7-1500T)
- MC_MoveCircularRelative V4.0 (S7-1500T)
- MC_DefineWorkspaceZone V4.0 (S7-1500T)
- MC_DefineKinematicsZone V4.0 (S7-1500T)
- MC_SetWorkspaceZoneActive V4.0 (S7-1500T)
- MC_SetWorkspaceZoneInactive V4.0 (S7-1500T)
- MC_SetKinematicsZoneActive V4.0 (S7-1500T)
- MC_SetKinematicsZoneInactive V4.0 (S7-1500T)
- MC_DefineTool V4.0 (S7-1500T)
- MC_SetTool V4.0 (S7-1500T)
- MC_SetOcsFrame V4.0 (S7-1500T)

Version-based UDT names

The following table shows the version-based UDT names for the control words and status words of the SIEMENS telegrams 10x:

UDT name <V4.0	UDT name ≥V4.0	WORD data type
PD_STW1	PD_STW1_611Umode	Control word 1 (STW1)
PD_STW2	PD_STW2_611Umode	Control word 2 (STW2)
PD_ZSW1	PD_ZSW1_611Umode	Status word 1 (ZSW1)
PD_ZSW2	PD_ZSW2_611Umode	Status word 2 (ZSW2)

If you switch from a technology version <V4.0 to ≥V4.0 or vice versa, an error occurs during the compilation. You have to adapt the UDT names manually.

4.3 Version V3.0

Innovations

Technology Version V3.0 contains the following new features:

- Technology object measuring input
- Technology object output cam
- Cam track technology object
- Force/torque limiting
- Fixed stop detection
- Axis type virtual axis
- MC-PreServo [OB67] and MC-PostServo [OB95]
- Technology CPU S7-1500T

Additional innovations for S7-1500T:

Technology Version V3.0 contains the following additional improvements:

- Cam technology object (S7-1500T)
- Gearing with MC_GearInPos (S7-1500T)
- Camming with MC_CamIn (S7-1500T)
- Using multiple encoders (S7-1500T)

Motion Control instructions

Technology Version V3.0 contains the following Motion Control instructions:

- MC_Power V3.0
- MC_Reset V3.0
- MC_Home V3.0
- MC_Stop V3.0
- MC_MoveAbsolute V3.0
- MC_MoveRelative V3.0
- MC_MoveVelocity V3.0
- MC_MoveJog V3.0
- MC_MoveSuperimposed V3.0
- MC_SetSensor V3.0 (S7-1500T)
- MC_TorqueLimit V3.0
- MC_MeasuringInput V3.0
- MC_MeasuringInputCyclic V3.0

- MC_AbortMeasuringInput V3.0
- MC_OutputCam V3.0
- MC_CamTrack V3.0
- MC_GearIn V3.0
- MC_GearInPos V3.0 (S7-1500T)
- MC_PhasingAbsolute V3.0 (S7-1500T)
- MC_PhasingRelative V3.0 (S7-1500T)
- MC_CamIn V3.0 (S7-1500T)
- MC_SynchronizedMotionSimulation V3.0 (S7-1500T)
- MC_InterpolateCam V3.0 (S7-1500T)
- MC_GetCamFollowingValue V3.0 (S7-1500T)
- MC_GetCamLeadingValue V3.0 (S7-1500T)

4.4 Version V2.0

Innovations

Technology Version V2.0 contains the following new features:

- Synchronous axis technology object
- Gearing with MC_GearIn
- Superimposed positioning with MC_MoveSuperimposed
- Standardization of the "MC_Home.Mode" parameter for S7-1200 Motion Control and S7-1500 Motion Control
- Simulation mode
- Support of safety functions of the drive

Motion Control instructions

Technology Version V2.0 contains the following Motion Control instructions:

- MC_Power V2.0
- MC_Reset V2.0
- MC_Home V2.0
- MC_Halt V2.0
- MC_MoveAbsolute V2.0
- MC_MoveRelative V2.0
- MC_MoveVelocity V2.0
- MC_MoveJog V2.0
- MC_MoveSuperimposed V2.0
- MC_GearIn V2.0

4.5 Version V1.0

Motion Control instructions

Technology Version V1.0 contains the following Motion Control instructions:

- MC_Power V1.0
- MC_Reset V1.0
- MC_Home V1.0
- MC_Halt V1.0
- MC_MoveAbsolute V1.0
- MC_MoveRelative V1.0
- MC_MoveVelocity V1.0
- MC_MoveJog V1.0

4.6 Changing a technology version

Before you can access all the benefits of a new technology version, you need to change the technology version for existing projects.

Changing a technology version

To change the technology version, follow these steps:

1. Replace the CPU in the project with a CPU with an appropriate higher version.
2. Open the program editor (e.g. by opening the OB1).

   The technology objects and Motion Control instructions are highlighted in red after the CPU is replaced.
3. In the "Instructions" task card, select the appropriate higher technology version in the "Technology > Motion Control" folder.
4. Save and compile the project.

   The version of the technology objects and Motion Control instructions is changed to the appropriate higher technology version during compilation of the project.

   Pay attention to any error information that is displayed during compilation. Deal with the causes of the errors indicated.
5. Check the configuration of the technology objects.

Resetting the "Mode" parameter of the Motion Control instruction "MC_Home"

When the technology version is changed from V1.0 to ≥ V2.0, the "MC_Home.HomingMode" parameter (V1.0) is renamed to "MC_Home.Mode" (≥ V2.0). The assignment of the parameter values is changed as well.

To reset the "MC_Home.Mode" parameter (V2.0), follow these steps:

1. To change the technology version, follow the instructions given above.

   When compiling the project, the "MC_Home.HomingMode"parameter (V1.0) is renamed to "MC_Home.Mode" (≥ V2.0):

   – The assignment of the parameter values is changed. A comparison of the "MC_Home.Mode" parameter for technology versions V1.0 and ≥ V2.0 is available in section Version overview (Page 179).

     You can find additional information about the "MC_Home.Mode" parameter in the description of the Motion Control instruction "MC_Home" (Page 438).

   – The value configured at the "MC_Home.HomingMode" parameter (V1.0) is lost. As a note on renaming, the following text is entered as the parameter value in the "MC_Home.Mode" parameter (≥ V2.0).

     "The interface has changed. You can find additional information in the description of the Motion Control instruction "MC_Home".

   – There is a message in the "Info > Compile" tab in the Inspector window stating that the operand has the wrong data type.
2. Change the value of the "MC_Home.Mode" parameter (≥ V2.0) in your user program according to the new assignment.
3. Save and compile the project.

4.7 Replacing devices

You can replace an S7-1500 with an S7-1500T and vice versa. The behavior with respect to functions and the existing configuration is different depending on what is being replaced.

- S7-1500 ⇒ S7-1500T

  The functions of the S7-1500 are expanded to include additional parameters for the extended functions of the S7-1500T. The additional parameters are preassigned with default values and must be configured appropriately.

- S7-1500T ⇒ S7-1500
  - Extended functions are only supported by an S7-1500T and are no longer available after a replacement with S7-1500.
  - Unsupported function blocks are marked.
  - Unsupported technology objects are displayed in an error message after compilation and must be deleted.

Configuring 5

5.1 Adding and configuring drives in the device configuration

5.1.1 Introduction

Adding and configuring a drive is described in the following section with the example of a SINAMICS S120 drive. If you use a SINAMICS V90 PN or a SINAMICS drive with Startdrive, you can find additional information in the following documentation.

Using SINAMICS V90 PN

You need the Hardware Support Package (HSP) V90 two add and configure a SINAMICS V90 PN drive in the TIA Portal. Information on configuring a SINAMICS V90 PN drive with SIMATIC S7-1500 in the TIA Portal is available in the Getting Started "SIMATIC/SINAMICS First Steps SINAMICS V90 PN on S7-1500 Motion Control":

https://support.industry.siemens.com/cs/document/109739497
(https://support.industry.siemens.com/cs/ww/en/view/109739497)

Using Startdrive

If you use a SINAMICS drive with Startdrive, you can find additional information in the hardware catalog in the "Drives & Starter" folder. For additional information on connecting via Startdrive, refer to:

- "Getting Started SINAMICS S120 in the Startdrive V14 SP1":

  https://support.industry.siemens.com/cs/document/109747452
  (https://support.industry.siemens.com/cs/ww/en/view/109747452)

- Application example "Positioning an S120 (Startdrive) with SIMATIC S7-1500 (TO)":

  https://support.industry.siemens.com/cs/document/109743270
  (https://support.industry.siemens.com/cs/ww/en/view/109743270)

Drives compatibility list

In the appendix (Page 665) you can find an overview of drives that can be interconnected with an S7-1500 CPU.

5.1.2 Add and configure PROFINET IO drives

Adding and configuring a PROFINET IO drive is described below with the example of a SINAMICS S120 drive. Adding and configuring other PROFINET IO drives may differ from the description in certain respects.

When you use a S7-1500C CPU you can use the inputs/outputs of the CPU as interface to the drive.

Requirements

- The SIMATIC S7-1500 device is created in the project.
- The desired drive can be selected in the hardware catalog.

If the drive is not available in the hardware catalog, it must be installed in the "Options" menu as a device description file (GSD).

Adding a drive and telegram in the device configuration

1. Open the device configuration and change to the network view.
2. In the hardware catalog, open the folder "Additional field devices > PROFINET IO > Drives > Siemens AG > SINAMICS".
3. Select the desired drive with the desired version, then drag it to the network view.
4. Assign the drive to the PROFINET interface of the PLC.
5. Open the drive in the device view.
6. Drag a Drive Object (DO) and a telegram from the hardware catalog and drop it onto a slot of the device overview of the drive.
7. Make sure that the order of the telegrams in the device configuration and in the drive parameter assignment are identical.

Depending on the version of the SINAMICS S120 drive, select "DO with telegram X", or "DO Servo" and a "Telegram X" for the telegram.

For more information on suitable telegrams, refer to the section PROFIdrive telegrams (Page 40).

Repeat step 6, if you want to add another drive and another standard telegram.

Activating isochronous mode of the drive in the device configuration

PROFINET drives can always be operated in isochronous mode or clock synchronized mode. Isochronous mode, however, increases the quality of the closed loop position control of the drive and is therefore recommended for drives such as SINAMICS S120.

To control the drive in isochronous mode, follow these steps:

1. Open the device view of the drive.
2. In the properties window, select the tab "PROFINET interface [X1] > Advanced options > Isochronous mode".
3. Select the "Isochronous mode" check box in this tab.

The entry for the telegram also has to be selected for isochronous mode in the detailed view.

Interconnecting the port of the PLC with the port of the drive

1. Open the topology view in the device configuration.
2. Interconnect the port of the drive as in the real configuration with the port of the PLC. At the same time, note the rules for topology configuration.

Configuring the PLC as the sync master and setting isochronous mode

1. Select the device view of the PLC.
2. In the Properties window, select the tab "PROFINET interface [X1] > Advanced options > Real-time settings > Synchronization".
3. Select "Sync master" from the "Synchronization role" drop-down list.
4. Click the "Domain settings" button.
5. Open the "Domain Management > Sync Domains" tab and set the desired "Send clock" (isochronous clock).

Select drive in the configuration of the technology object

1. Add a new technology object axis, or open the configuration of an existing axis.
2. Open the configuration "Hardware interface > Drive".
3. Select from the "PROFIdrive" entry in the "Drive type" drop-down list.
4. Select the Drive Object of the PROFINET drive from the "Drive" list.

For information on how to add a technology object, refer to the section Add technology object (Page 199).

Result

The technology object is connected to the drive and the "MC Servo" organization block can be checked / configured.

The telegram of the configured drive is assigned to the "PIP OB Servo" process image.

Checking/configuring the properties of the "MC-Servo"

1. Open the "Program blocks" folder in the project navigator.
2. Select the "MC-Servo" organization block.
3. Select the "Properties" command in the shortcut menu.
4. Select the "Cycle time" entry in the area navigation.
5. The option "Synchronous to the bus" must be selected in the dialog box.
6. A "PROFINET IO_System" must be selected in the "Distributed I/O" drop-down list.
7. The application cycle of "MC-Servo" must correspond to the send clock of the bus or be reduced by an integral factor relative to the send clock of the bus.

Result

The PROFINET IO drive is configured in such a way that it can be controlled in isochronous mode in the PROFINET IO network.

The properties of the SINAMICS drive must be configured according to the configuration of the axis with the STARTER software or SINAMICS Startdrive.

Checking isochronous mode on the drive

If the configuration sequence described above is not adhered to during configuration of the axis, and drive-specific error occurs when the project is compiled, the setting for isochronous mode on the drive must be checked.

1. Open the device view of the drive.
2. Select standard telegram in the device overview.
3. Select the properties dialog "General > I/O Addresses".
4. The following settings apply for the input and output addresses:
   - "Isochronous mode" is enabled.
   - "MC-Servo" must be selected for the "Organization block".
   - "PIP OB Servo" must be select the "Process image".

See also

PROFIdrive telegrams (Page 40)

Add technology object (Page 199)

5.1.3 Add and configure PROFIBUS DP drives

Adding and configuring a PROFIBUS drive is described below with the example of a SINAMICS S120 drive. Adding and configuring other PROFIBUS drives may differ from the description in certain respects.

When you use a S7-1500C CPU you can use the inputs/outputs of the CPU as interface to the drive.

Requirements

- The SIMATIC S7-1500 device is created in the project.
- The desired drive can be selected in the hardware catalog.

If the drive is not available in the hardware catalog, you must install the drive in the "Options" menu as a device description file (GSD).

Adding a drive and telegram in the device configuration

1. Open the device configuration and change to the network view.
2. In the hardware catalog, open the folder "Additional Field Devices > PROFIBUS DP > Drives > Siemens AG > SINAMICS".
3. Select the folder of the desired drive with the desired version, then drag the drive object to the network view.
4. Assign the drive to the PROFIBUS interface of the PLC.
5. Open the drive in the device view.
6. Drag-and-drop a telegram from the hardware catalog onto a slot in the device overview of the drive.

For more information on suitable telegrams, refer to the section PROFIdrive telegrams (Page 40).

If you want to add another drive and another telegram to the device overview, use the "Axis disconnector" in the hardware catalog.

Activating isochronous mode of the drive in the device configuration

PROFIBUS drives can be operated in cyclic mode or isochronous mode. Isochronous mode, however, increases the quality of the position control of the drive.

If you want to control the drive in isochronous mode, follow these steps:

1. Open the device view of the drive.
2. In the properties dialog, select the tab "General > Isochronous Mode".
3. Select the "Synchronize DP slave to constant DP bus cycle time" check box .

Setting isochronous mode

1. Select the network view.
2. Select the DP master system.
3. In the properties dialog, select the tab "General > Constant bus cycle time".
4. Select the desired "Constant DP bus cycle times".

Select drive in the configuration of the technology object

1. Add a new technology object axis, or open the configuration of an existing axis.
2. Open the configuration "Hardware interface > Drive".
3. Select from the "PROFIdrive" entry in the "Drive type" drop-down list.
4. Select the telegram of the PROFIBUS drive from the "Drive" list.

For information on how to add a technology object, refer to the section Add technology object (Page 199).

Result

The technology object is connected to the drive and the "MC-Servo" organization block can be checked / configured.

The telegram of the configured drive is assigned to the "PIP OB Servo" process image.

Checking/configuring the properties of the "MC-Servo"

1. Open the "Program blocks" folder in the project navigator.
2. Select the "MC-Servo" organization block.
3. Select the "Properties" command in the shortcut menu.

   The "MC-Servo" dialog opens.
4. Select the "Synchronous to the bus" option under "General > Cycle time".
5. In the "Distributed I/O" drop-down list, select a "PROFIBUS DP-System".

   The application cycle of "MC-Servo" must correspond to the send clock of the bus or be reduced by an integral factor relative to the send clock of the bus.

You can select a drive connected to the CPU via a communications processor/communications module (CP/CM) in the configuration of the technology object. You cannot select the DP master system of the CP/CM as the source clock for MC-Servo [OB91].

Result

The PROFIBUS DP drive is configured in such a way that it can be controlled in isochronous mode in the PROFIBUS network.

The properties of the SINAMICS drive must be configured according to the configuration of the axis with the STARTER software or SINAMICS Startdrive.

Checking isochronous mode on the drive

If the configuration sequence described above is not adhered to during configuration of the axis, and drive-specific error occurs when the project is compiled, isochronous mode can be checked on the drive.

1. Open the device view of the drive.
2. Select the entry of the telegram in the device overview.
3. Select the properties dialog "General > I/O Addresses".
4. The following settings apply for the input and output addresses:
   - "MC-Servo" must be selected for the "Organization block".
   - "PIP OB Servo" must be select the "Process image".

See also

PROFIdrive telegrams (Page 40)

Add technology object (Page 199)

5.1.4 Adding and configuring drives with analog connections

A description is provided below of how to add and configure a drive with an analog drive connection and an encoder. The connection is made for example as a positioning axis with an incremental encoder and using a technology module in the rack of the PLC.

When you use a S7-1500C CPU you can use the inputs/outputs of the CPU as interface to the drive.

Requirements

The SIMATIC S7-1500 device is created in the project.

Adding and configuring an analog output module in the device configuration

1. Open the device configuration of the PLC.
2. Select an analog output module from the hardware catalog and drag the module to the rack of the PLC.
3. Select the analog output module in the device view.
4. Open the "General" tab in the properties dialog and select there "Name of the Analog Output Module > I/O Addresses".
5. Enter the desired start address.
6. In the properties dialog, select the tab "General > IO Tags".
7. Enter the tag name for the desired analog output.

Adding and configuring a technology module

1. Switch to the device view of the PLC.
2. In the hardware catalog, open the folder "TM > Count > TM Count 2X24V".
3. Drag the counter module to a free slot in the rack.
   (When inserted in the rack of the PLC, the technology module cannot be operated in isochronous mode.)
4. Select the technology module in the device view.
5. In the properties dialog, open the "General" tab and select there "Count 2x24V > Basic Parameters > Channel X > Operating Mode" of the channel to be used.
6. Select "Position input for Motion Control" option for "Selection of the operating mode for the channel".
7. Under "Module parameters", adapt the parameters of the incremental encoder (steps per revolution = increments per revolution).
8. Under "Reaction to CPU STOP", select the item "Continue working".

Selecting the drive and encoder in the configuration of the technology object

1. Add a new positioning axis/synchronous axis technology object, or open the configuration of an existing positioning axis/synchronous axis.
2. Open the configuration "Hardware interface > Drive".
3. Select "Analog drive connection" from the "Drive type" drop-down list.
4. Select the previously defined tag name of the analog output from the "Output" list.
5. Open the configuration "Hardware interface > Encoder".
6. Under "Select encoder connection" select "Encoder on technology module (TM)".
7. Select the channel of the incremental encoder from the "Technology module" list under "local modules".
8. Open the configuration "Hardware interface > Data exchange with encoder > Fine resolution" and enter the "0" value for "bits in the incr. actual value".

For information on how to add a technology object, refer to the section Add technology object (Page 199)

Result

The analog drive connection and the encoder connection are configured.

The analog addresses and the addresses of the TM module are assigned to the process image "PIP OB Servo".

Checking the encoder connection / drive connection

The encoder data are applied to the position control cycle clock. If in doubt, check the following settings:

1. Switch to the device view of the PLC.
2. Select the module technology.
3. Open the properties dialog "Basic Parameters > I/O Addresses".
4. The following settings apply for the input and output addresses:
   - "MC-Servo" must be selected for the "Organization block".
   - "PIP OB Servo" must be select the "Process image".
5. Select the analog module.
6. Open the properties dialog "Name of the Analog Module > I/O Addresses".
7. The settings from Step 4 apply for the input and output addresses

See also

Add technology object (Page 199)

5.2 Configuration basics

5.2.1 Add technology object

The following describes how to add a technology object in the project tree.

Requirement

- A project with a CPU S7-1500 has been created.
- For the output cam, cam track, measuring input technology objects:

  A speed axis, positioning axis, synchronous axis or external encoder technology object is created in the project.

Procedure

To add a technology object, follow these steps:

1. Open the CPU's folder in the project navigator.
2. Open the "Technology Objects" folder.
3. Double-click "Add new object".

   The "Add new object" dialog opens.
4. Select the required technology object. You can infer the function of the technology object from the displayed description.
5. If you add output cams, cam tracks, measuring inputs to a technology object, select the higher-level technology object in the "Axis or external encoder that is to be assigned".
6. In the "Name" input field, adapt the name to your requirements.
7. To change the suggested data block number, select the "Manual" option.
8. To add your own information about the technology object, click "Additional information".
9. To open the configuration after adding the technology object, select the "Add new and open" check box.
10. To add the technology object, click "OK".

Result

The new technology object was created and created in the "Technology objects" folder in the project tree.

If the "MC-Servo" and "MC-Interpolator" organizational units were not yet available, they were added.

5.2.2 Copy technology object

You can copy a technology object in the following ways:

- Copying a technology object within a CPU
- Copying a technology object from a CPU S7-1500 to a CPU S7-1500T

  Additional parameters for the extended functions are pre-defined with default values and must be configured accordingly.
- Copying a technology object from a CPU S7-1500T to a CPU S7-1500

  Additional parameters, which are not supported by the CPU S7-1500, are reset to the default values.

When you copy a technology object that has lower-level technology objects such as output cams, cam tracks or measuring inputs, the lower-level technology object are also copied.

The following describes how to copy a technology object within a CPU. The procedure also applies accordingly to the other copying methods mentioned.

Requirement

- A project with a CPU S7-1500 has been created.
- You have created an technology object in the project.

Procedure

To copy a technology object, follow these steps:

1. Open the CPU's folder in the project navigator.
2. Open the "Technology Objects" folder.
3. If necessary, open the higher-level technology object.
4. Select the technology object to be copied.
5. Select "Copy" in the shortcut menu.
6. Select the "Technology objects" folder or the higher-level technology object.
7. Select "Paste" in the shortcut menu.

Result

The selected technology object, including lower-level technology objects, has been copied and created in the "Technology objects" folder of the project tree.

5.2.3 Delete technology object

You can delete technology objects in the project tree.

When you delete a technology object that has lower-level technology objects such as output cams, cam tracks or measuring inputs, the lower-level technology object are also deleted.

Requirement

- A project with a CPU S7-1500 has been created.
- You have created an technology object in the project.

Procedure

To delete a technology object, follow these steps:

1. Open the CPU's folder in the project navigator.
2. Open the "Technology Objects" folder.
3. Select the technology object to be deleted.
4. Select the "Delete" command in the shortcut menu.

   The "Confirm delete" dialog is opened.
5. To delete the technology object, click "Yes".

Result

The selected technology object has been deleted.

5.2.4 Working with the configuration editor

You configure the properties of a technology object in the configuration window. To open the configuration window of the technology object in the project view, follow these steps:

1. Open the device "Technology objects" group in the project navigator.
2. Select the technology object and double-click on "Configuration".

The configuration is divided into categories which depend on the object type, for example: Basic parameters, hardware interface, extended parameters.

Configuration editor icons

Icons in the area navigation of the configuration show additional details about the status of the configuration:

	The configuration contains default values and is complete. The configuration contains only default values. With these default values you can use the technology object without additional changes.
	The configuration contains user-defined or automatically adapted values and is complete. All input fields of the configuration contain valid values and at least one preset value has changed.
	The configuration is incomplete or incorrect. At least one input field or drop-down list contains an invalid value. The corresponding field or the drop-down list is displayed on a red background. Click the field shows you the roll-out error message that indicates the cause of error.

5.2.5 Compare values

If an online connection to the CPU is available, the "Monitor all" function appears in the configuration of the technology object.

The "Monitor all" function provides the following options:

- Comparison of configured start values of the project with the start values in the CPU and the actual values
- Direct editing of actual values and the start values of the project
- Immediate detection and display of input errors with suggested corrections
- Backup of actual values in the project
- Transfer of start values of the project to the CPU as actual values

---

Note

Differences between online and offline values

By adding or deleting technology objects that have a connection to other technology objects, such as cams, cam tracks, measuring inputs or synchronized axes, differences can occur when online and offline values are compared. These differences can be eliminated by re-compiling the project and then uploading it to the CPU.

Icons and operator controls

If there is an online connection to the CPU, the actual values are displayed at the parameters.

In addition to the actual values of the parameters, the following symbols appear:

Symbol	Description
	Start value in CPU matches the configured start value in project
	Start value in CPU does not match the configured start value in project
	Software error in lower-level component: The online and offline versions differ in at least one lower-level software component.
	The comparison of the Start value in CPU with the configured start value in project cannot be performed.
	Comparison of the online and offline values is not advisable.
	Use this button to show the start value of the CPU and the start value of the project for the respective parameter.

You can change the start value of the CPU directly and then download it to the CPU. For directly editable parameters, the actual value can also be changed and the change will be transferred directly to the CPU.

5.3 Configuring the Speed-Control Axis technology object

5.3.1 Configuration - Basic Parameters

Configure the basic properties of the technology object in the "Basic Parameters" configuration window.

Name

Define the name of the speed axis in this field. The technology object is listed under this name in the project tree. You can use the variables of the speed axis in the user program under this name.

Axis type

If you want to use the axis in the CPU exclusively as a virtual leading axis for synchronization, for example, select the "Virtual axis" check box. The configuration of a drive and encoder connection is not relevant.

Speed unit of measure

Select the desired unit of measure for speed in the drop-down list.

Simulation

If you want to move a real axis in the simulation mode, select the "Activate simulation" check box.

In simulation mode, speed, positioning and synchronous axes can be simulated in the CPU without connected drives and encoders. Simulation mode is possible as of Technology Version V3.0 even without a configured drive and encoder connection.

For simulation mode without hardware connected to the CPU, you can influence the startup time of the CPU via the "Configuration time for central and distributed I/Os" parameter. You can find the parameter in the CPU properties in the "Startup" area navigation.

See also

Units of measure (Page 36)

Axis in simulation (Page 56)

5.3.2 Hardware interface

5.3.2.1 Configuration - Drive

In the "Drive" configuration window, configure which drive type and which drive you want to use.

Drive type

In the drop-down list, select whether you want to deploy a PROFIdrive drive or a drive with an analog drive connection.

PROFIdrive drives are connected to the controller by means of a digital communication system (PROFINET or PROFIBUS). The communication is performed via PROFIdrive telegrams.

Drives with an analog drive connection receive the speed setpoint via an analog output signal (e.g. from -10 V to +10 V) from the PLC.

Drive type: PROFIdrive

Data connection

In the drop-down list, select whether the data connection is to be made directly with the drive device or via an editable data block in the user program.

Drive/data block

In the "Drive" field, select an already configured PROFIdrive drive/slot. If a PROFIdrive drive was selected, it can be configured using the "Device configuration" button.

Switch to the device configuration, and add a PROFIdrive drive in the network view, in the event that no PROFIdrive drive can be selected.

If "Data block" was selected for the data connection, a previously created data block containing a variable structure of data type "PD_TELx" must be selected here ("x" stands for the telegram number used).

Drive type: Analog drive connection

Analog output

In the "Output" field, select the PLC tag of the analog output over which the drive is to be controlled.

In order to be able to select an output, an analog output module must have been added in the device configuration, and the PLC tag name for the analog output must be defined.

Activating enable output

In the "Enable output" field, select the PLC tag of the digital output to enable the drive. With the enable output, the speed controller in the drive is enabled, or disabled.

In order to be able to select an enable output, a digital output module must have been added in the device configuration, and the PLC tag name for the digital output must be defined.

Note

If you do not use an enable output, the drive cannot be immediately disabled on the part of the system due to error reactions or monitoring functions. A controlled stop of the drive is not guaranteed.

Enable ready input

In the "Ready input" field, select the PLC tag of the digital input with which the drive is to report its operational readiness to the technology object. The power module is switched on and the analog speed setpoint input is enabled.

In order to be able to select a ready input, a digital input module must have been added in the device configuration, and the PLC tag name for the digital input must be defined.

Note

The enable output and the ready input can be separately enabled.

The following boundary conditions apply to the activated ready input:

- The axis is only enabled (MC_Power Status = TRUE) when a signal is present at the ready input.
- If the signal at the ready input goes away for an enabled axis, the axis is disabled with the alarm reaction "Remove enable".
- If the axis is disabled with the instruction MC_Power (Enable = FALSE), the axis is disabled even when a signal is present at the ready input.

See also

Configuration - Data exchange with the drive (Page 207)

Connect drive/encoder via data block (Page 342)

Drive and encoder connection (Page 38)

5.3.2.2 Configuration - Data exchange with the drive

You configure the data transmission to the drive in this configuration window.

Drive type: PROFIdrive

Drive telegram

The telegram to the drive that is set in the device configuration is preselected in the drop-down list.

Automatic data exchange for drive values (offline)

Select the check box if you want to transfer the offline values of the drive "Reference speed", "Maximum speed" and "Reference torque" to the configuration of the technology object in the project.

Automatic data exchange for drive values (online)

Select the check box if you want to transfer the effective values "Reference speed", "Maximum speed" and "Reference torque" online in the drive to the CPU during runtime. The drive parameters are transferred from the bus after the (re-)initialization of the technology object or the (re)start of the drive or the CPU.

Alternatively, you must synchronize the following parameters manually:

- **Reference speed**

  Configure the reference speed of the drive in accordance with the manufacturer's specifications in this field. The specification of the drive speed is a percentage of the reference speed in the range -200% to +200%.

- **Maximum speed**

  Configure the maximum speed of the drive in this field.

- **Reference torque**

  Configure the reference torque of the drive corresponding to its configuration in this field.

  The reference torque is needed for force/torque reduction, which is supported with telegram 10x.

Supplementary data

Select the "Torque data" check box if you want to configure the data connection of the torque data. If you have selected a drive with which the additional telegram 750 has been configured, the "Torque data" check box is preselected.

Data connection

In the drop-down list, define whether the data connection should be made via additional telegrams or data blocks:

- If you select the entry "Additional telegram" in the "Data connection" drop-down list, you can edit the "Additional telegram" drop-down list.
- If you select the "Data block" entry in the "Data connection" drop-down list, you can select the previously created data block which contains a tag structure of the "PD_TELx" data type ("x" stands for the additional telegram number that is used).

Data block / additional telegram

Select an additional telegram configured in the "Additional telegram" field.

Select the "Show all modules" check box if you want to display all submodules of the connected drive. You can also find self-defined additional telegrams with this function.

In the "Data block" field, select the data block which you want to use to integrate the torque data.

Note

Automatic transfer of drive parameters is only possible with SINAMICS drives as of V4.x. For this, "Drive" must be selected for the data connection in configuration window "Hardware interface > Drive".

Drive type: Analog drive connection

Reference speed

The reference speed of the drive is the speed at which the drive rotates when there is an output of 100% at the analog output. The reference speed must be configured for the drive and transferred in the configuration of the technology object.

The analog value that is output at 100% depends on the type of the analog output. For example, for an analog output with +/- 10 V, the value 10 V is output at 100%.

Analog outputs can be overdriven by about 17%. This means that an analog output can be operated in the range from -117% to 117%, insofar as the drive permits this.

See also

Automatic transfer of drive and encoder parameters in the device (Page 47)

Connect drive/encoder via data block (Page 342)

Drive and encoder connection (Page 38)

5.3.3 Extended Parameters

5.3.3.1 Configuration - Mechanics

Configure the connection of the load to the drive in the "Mechanics" configuration window.

Invert drive direction

Select the check box if the direction of rotation of the drive is to be inverted.

Load gear

Number of motor revolutions / number of load revolutions

The gear ratio of the load gear is specified as the ratio between motor revolutions and load revolutions. Specify here an integral number of motor revolutions and the resulting number of load revolutions.

See also

Mechanics (Page 60)

5.3.3.2 Configuration - Dynamic Defaults

In the "Dynamic default values" configuration window, configure the default values for speed, acceleration, deceleration jerk of the axis.

The default values have an effect, when values < 0 are specified in Motion Control instructions for the "Velocity", "Acceleration", "Deceleration" or "Jerk" parameters. The default values can be applied separately for each of the parameters just listed.

Speed

In this field, define the default value for the speed of the axis.

Acceleration / Deceleration - Ramp-up time / Ramp-down time

Set the desired default value for acceleration in the "Ramp-up time" or "Acceleration" fields. The desired deceleration can be set in the "Ramp-down time" or "Deceleration" fields.

The following equations show the relationship between the ramp-up time and acceleration and the ramp-down time and deceleration:

$$\text{Ramp-up time} = \frac{\text{Speed}}{\text{Acceleration}}$$

$$\text{Ramp-down time} = \frac{\text{Speed}}{\text{Deceleration}}$$

Note

A change in the velocity influences the acceleration and deceleration values of the axis. The ramp-up and ramp-down times are retained.

Smoothing time / jerk

You can enter the jerk limit parameters in the "Smoothing time" box, or alternatively in the "Jerk" box:

- Set the desired jerk for the acceleration and deceleration ramp in the "Jerk" field. The value 0 means that jerk limiting is deactivated.
- Set the desired smoothing time for the acceleration ramp in the "Smoothing time" field.

Note

The jerk value is identical for the acceleration and deceleration ramp. The smoothing time in effect for the deceleration ramp results from the following relationships:

- **Acceleration > Deceleration**
  A shorter smoothing time is used for the deceleration ramp compared with the acceleration ramp.
- **Acceleration < Deceleration**
  A longer smoothing time is used for the deceleration ramp compared with the acceleration ramp.
- **Acceleration = Deceleration**
  The smoothing times of the acceleration and deceleration ramp are equal.

If an error occurs, the axis decelerates with the configured emergency stop deceleration. A configured jerk limit is not taken into account for this.

The following equations show the relationship between the smoothing times and the jerk:

$$\text{Smoothing time (acceleration ramp)} = \frac{\text{Acceleration}}{\text{Jerk}}$$

$$\text{Smoothing time (deceleration ramp)} = \frac{\text{Deceleration}}{\text{Jerk}}$$

Motion jobs started in the user program are performed with the selected jerk.

See also

Velocity profile (Page 67)

5.3.3.3 Configuration - Emergency stop

In the "Emergency stop" configuration window, you can configure the emergency stop deceleration of the axis. In the event of an error, and when disabling the axis, the axis is brought to a standstill with this deceleration using the Motion Control instruction "MC_Power" (input parameter StopMode = 0).

Emergency stop deceleration / Emergency stop ramp-down time

Configure the deceleration value for emergency stop in the "Emergency stop deceleration" field or the "Emergency stop ramp-down time" field.

The relationship between emergency stop ramp-down time and emergency stop deceleration can be seen in the following equation:

$$\textit{Emergency stop ramp-down time} = \frac{\textit{Maximum speed}}{\textit{Emergency stop deceleration}}$$

The configuration of the emergency stop deceleration is related to the configured maximum speed of the axis. If the maximum speed of the axis changes, then the value of the emergency stop deceleration also changes (the emergency stop ramp-down time remains unchanged).

See also

Emergency stop deceleration (Page 68)

5.3.3.4 Limits

Configuration - Dynamic limits

In the "Dynamic limits" configuration window, configure the maximum values for speed, acceleration, deceleration and jerk of the axis.

Maximum speed

In this field, define the maximum permitted speed of the axis.

Maximum acceleration/maximum deceleration - ramp-up time/ramp-down time

Set the desired acceleration in the "Ramp-up time" or "Acceleration" fields. The desired deceleration can be set in the "Ramp-down time" or "Deceleration" fields.

The following equations show the relationship between the ramp-up time and acceleration and the ramp-down time and deceleration:

$$\text{Ramp-up time} = \frac{\text{Maximum velocity}}{\text{Acceleration}}$$

$$\text{Ramp-down time} = \frac{\text{Maximum speed}}{\text{Deceleration}}$$

Note

Change of maximum speed

A change in the maximum speed influences the acceleration and deceleration values of the axis. The ramp-up and ramp-down times are retained.

Smoothing time / jerk

You can enter the jerk limit parameters in the "Smoothing time" box, or alternatively in the "Jerk" box:

- Set the desired jerk for the acceleration ramp and the deceleration ramp in the "Maximum jerk" box. The value 0 means that the jerk is not limited.
- Set the desired smoothing time for the acceleration ramp in the "Smoothing time" field.

Note

Various acceleration and deceleration values

The configured smoothing time displayed in the configuration, applies only to the acceleration ramp.

If the values of the acceleration and deceleration differ, the smoothing time of the deceleration ramp is calculated and used according to the jerk of the acceleration ramp.

The smoothing time of the deceleration is adapted as follows:

- **Acceleration > Deceleration**
  A shorter smoothing time is used for the deceleration ramp compared with the acceleration ramp.
- **Acceleration < Deceleration**
  A longer smoothing time is used for the deceleration ramp compared with the acceleration ramp.
- **Acceleration = Deceleration**
  The smoothing times of the acceleration and deceleration ramp are equal.

If an error occurs, the axis decelerates with the configured emergency stop deceleration (Page 67) (alarm reaction "Stop with maximum dynamic values"). A configured jerk limit is not taken into account for this.

The following equations show the relationship between the smoothing times and the jerk:

$$\text{Smoothing time (acceleration ramp)} = \frac{\text{Acceleration}}{\text{Jerk}}$$

$$\text{Smoothing time (deceleration ramp)} = \frac{\text{Deceleration}}{\text{Jerk}}$$

Motion jobs started in the user program are performed with the selected jerk.

See also

Emergency stop deceleration (Page 68)

Dynamic limits in synchronous operation (Page 69)

Configuration - Torque limits

Configure the torque limiting of the drive in the "Torque limits" configuration window.

The configuration is now available if a drive that supports force/torque limiting is selected and a telegram 10x is used.

Effective

In the drop-down list, select whether the limit value is to be in effect "on load side" or "on motor side".

Torque limiting

Enter a default value for the torque limit in the specified unit of measure in this field.

The default value is in effect when the torque limiting is specified using Motion Control instruction "MC_TorqueLimiting", input parameter "Limit" < 0.

If the gear efficiency is critical, this can be set in the <TO>.Actor.Efficiency tag.

See also

Force/torque limiting (Page 73)

5.4 Configuring the positioning axis/synchronous axis technology object

5.4.1 Configuration - Basic Parameters

Configure the basic properties of the technology object in the "Basic Parameters" configuration window.

Name

Define the name of the positioning axis/synchronous axis in this field. The technology object is listed under this name in the project tree. The variables of the technology object can be used in the user program under this name.

Axis type

If you want to use the axis in the CPU exclusively as a virtual leading axis for synchronization, for example, select the "Virtual axis" check box. The configuration of a drive and encoder connection is not relevant.

In this selection, configure whether the axis should perform linear or rotary motions.

Units of measure

In the drop-down list, select the desired units of measure for the position, velocity, torque and force of the axis.

Modulo

Select the "Enable modulo" check box if you want to use a recurring system of units for the axis (e.g. 0 to 360° for an axis of the "rotary" axis type).

- **Modulo start value**

  In this field, define the position at which the modulo range should begin (e.g. 0° for an axis of the "rotary" axis type).

- **Modulo length**

  In this field, define the length of the modulo range (e.g. 360° for an axis of the "rotary" axis type).

Simulation

If you want to move a real axis in the simulation mode, select the "Activate simulation" check box.

In simulation mode, speed, positioning and synchronous axes can be simulated in the CPU without connected drives and encoders. Simulation mode is possible as of Technology Version V3.0 even without a configured drive and encoder connection.

For simulation mode without hardware connected to the CPU, you can influence the startup time of the CPU via the "Configuration time for central and distributed I/Os" parameter. You can find the parameter in the CPU properties in the "Startup" area navigation.

See also

Axis in simulation (Page 56)

Units of measure (Page 36)

Modulo setting (Page 37)

Mechanics (Page 60)

Positioning axis technology object (Page 112)

Synchronous axis technology object (Page 113)

5.4.2 Hardware interface

5.4.2.1 Configuration - Drive

In the "Drive" configuration window, configure which drive type and which drive you want to use.

Drive type

In the drop-down list, select whether you want to deploy a PROFIdrive drive or a drive with an analog drive connection.

PROFIdrive drives are connected to the controller by means of a digital communication system (PROFINET or PROFIBUS). The communication is performed via PROFIdrive telegrams.

Drives with an analog drive connection receive the speed setpoint via an analog output signal (e.g. from -10 V to +10 V) from the PLC.

Drive type: PROFIdrive

Data connection

In the drop-down list, select whether the data connection is to be made directly with the drive device or via an editable data block in the user program.

Drive/data block

In the "Drive" field, select an already configured PROFIdrive drive/slot. If you have selected a PROFIdrive drive, you can configure the PROFIdrive drive using the "Device configuration" button.

If no PROFIdrive drive is available for selection, switch to the device configuration, and add a PROFIdrive drive in the network view.

If you have selected "Data block" under the data connection, select a previously created data block which contains a variable structure of the data type "PD_TELx"
("x" stands for the telegram number to be used).

Drive type: Analog drive connection

Analog output

In the "Analog output" field, select the PLC tag of the analog output via which the drive is to be controlled.

In order to be able to select an output, you first need to add an analog output module in the device configuration and define the PLC tag name for the analog output.

Activating enable output

Select the "Activate enable output" check box if the drive supports an enable.

Select the PLC tag of the digital output for the drive enable in the corresponding field. With the enable output, the speed controller in the drive is enabled, or disabled.

In order to be able to select an enable output, a digital output module must be added in the device configuration and the PLC tag name must be defined for the digital output.

Note

If you do not use an enable output, the drive cannot be immediately disabled on the part of the system due to error reactions or monitoring functions. A controlled stop of the drive is not guaranteed.

Enable ready input

Select the "Enable ready input" check box if the drive can signal its readiness.

Select the PLC tag of the digital input via which the drive is to signal its operational readiness to the technology object in the corresponding field. The power module is switched on and the analog speed setpoint input is enabled.

In order to be able to select a ready input, you first need to add a digital input module in the device configuration and define the PLC tag name for the digital input.

Note

The enable output and the ready input can be separately enabled.

The following boundary conditions apply to the activated ready input:

- The axis is only enabled (MC_Power Status = TRUE) when a signal is present at the ready input.
- If a signal is not present at the ready input on an enabled axis, the axis is disabled with an error.
- If the axis is disabled with the instruction MC_Power (Enable = FALSE), the axis is disabled even when a signal is present at the ready input.

See also

Connect drive/encoder via data block (Page 342)

Data connection drive/encoder via data block (Page 57)

Positioning axis technology object (Page 112)

Synchronous axis technology object (Page 113)

5.4.2.2 Configuration - Encoder

For closed loop position control, positioning axes/synchronous axes require an actual position value in the form of an encoder position. The encoder position is transmitted to the controller by means of a PROFIdrive telegram.

Configure the encoder and encoder type in the "Encoder" configuration window.

Data connection

In the drop-down list, select whether the data connection should be established directly with the encoder or via a data block that can be edited in the user program.

The selection is only possible for encoders that are connected via PROFIdrive and support parameter P979.

Encoder / data block

Select a previously configured encoder in this configuration field.

The following encoders can be selected:

- **Connection to the drive (not with analog drive connection)**

  The encoder is configured via the configuration of the PROFIdrive drive. The drive evaluates the encoder signals and sends them to the controller in the PROFIdrive telegram.

- **Encoder on technology module (TM)**

  Select a previously configured technology module and the channel to be used. Only technology modules set to the "Position input for Motion Control" mode are displayed for selection.

  If no technology module is available for selection, change to the device configuration and add a technology module. If you have selected a technology module, you can access the configuration of the technology module using the "Device configuration" button.

  You can operate the technology module centrally on an S7-1500 CPU or decentrally on a distributed I/O. Isochronous mode is not possible with central operation in the CPU.

  You can identify the technology modules suitable for position detection for Motion Control in the documentation for the technology module and the catalog data.

- **PROFIdrive encoder on PROFINET/PROFIBUS (PROFIdrive)**

  In the "PROFIdrive encoder" field, select a configured encoder on PROFINET/PROFIBUS. If an encoder was selected, it can be configured using the "Device configuration" button.

  Switch to the device configuration in the network view, and add an encoder, in the event that no encoder can be selected.

If "Data block" was selected for the data connection, a previously created data block containing a variable structure of data type "PD_TELx" must be selected here ("x" stands for the telegram number used).

Encoder type

Select the encoder type of the encoder in the drop-down list. The following encoder types are available:

- Incremental
- Absolute
- Cyclic absolute

See also

Configuration - Encoder (multiple encoders) (Page 221)

Positioning axis technology object (Page 112)

Data connection drive/encoder via data block (Page 57)

Connect drive/encoder via data block (Page 342)

Synchronous axis technology object (Page 113)

5.4.2.3 Configuration - Encoder (multiple encoders)

With the S7-1500T technology CPU, you can switch between 4 encoder systems. You control the changeover in the user program with the Motion Control instruction "MC_SetSensor".

You configure the 4 encoders, their use and their type in the "Encoder" configuration window.

Encoder on startup

In the drop-down list, select the encoder that is to be active after startup of the CPU (STARTUP). The encoder must be configured and marked as "used".

This encoder is used after startup of the CPU and after a restart of the technology object (Page 386). At an operating mode transition from STOP → RUN of the CPU (without restart of the technology object), the encoder that was also active before the STOP is still being used.

Use encoder

Select the "Use encoder" check box if you want to use this encoder alternatively for closed loop position control.

See also

Using multiple encoders (Page 49)

Configuration - Encoder (Page 219)

Positioning axis technology object (Page 112)

Synchronous axis technology object (Page 113)

5.4.2.4 Configuration - Data exchange with the drive

Configure the data exchange with the drive in the "Data exchange with the drive" configuration window.

The configuration differs according to the selected drive type:

Drive type: PROFIdrive

Drive telegram

The telegram to the drive that is set in the device configuration is preselected in the drop-down list.

Automatic data exchange for drive values (offline)

Select the check box if you want to transfer the offline values of the drive "Reference speed", "Maximum speed" and "Reference torque" to the configuration of the technology object in the project.

Automatic data exchange for drive values (online)

Select the check box if you want to transfer the effective values "Reference speed", "Maximum speed" and "Reference torque" online in the drive to the CPU during runtime. The drive parameters are transferred from the bus after the (re-)initialization of the technology object or the (re)start of the drive or the CPU.

Alternatively, you must synchronize the following parameters manually:

- **Reference speed**

  Configure the reference speed of the drive in accordance with the manufacturer's specifications in this field. The specification of the drive speed is a percentage of the reference speed in the range -200% to +200%.

- **Maximum speed**

  Configure the maximum speed of the drive in this field.

- **Reference torque**

  Configure the reference torque of the drive corresponding to its configuration in this field.

  The reference torque is needed for force/torque reduction, which is supported with telegram 10x.

Supplementary data

Select the "Torque data" check box if you want to configure the data connection of the torque data. If you have selected a drive with which the supplemental telegram 750 has been configured, the "Torque data" check box is preselected.

Data connection

In the drop-down list, define whether the data connection should be made via supplemental telegrams or data blocks:

- If you select the entry "Supplemental telegram" in the "Data connection" drop-down list, you can edit the "Supplemental telegram" drop-down list.
- If you select the "Data block" entry in the "Data connection" drop-down list, you can select the previously created data block which contains a tag structure of the "PD_TELx" data type ("x" stands for the additional telegram number that is used).

Data block / supplemental telegram

Select an supplemental telegram configured in the "Supplemental telegram" field.

Select the "Show all modules" check box if you want to display all submodules of the connected drive. You can also find self-defined supplemental telegrams with this function.

In the "Data block" field, select the data block which you want to use to integrate the torque data.

Note

Automatic transfer of drive parameters is only possible with SINAMICS drives as of V4.x. To do this, set the "Drive" data connection in the configuration window "Hardware interface > Drive".

Drive type: Analog drive connection

Reference speed

The reference speed of the drive is the speed at which the drive rotates when there is an output of 100% at the analog output. The reference speed must be configured for the drive and transferred in the configuration of the technology object.

The analog value that is output at 100% depends on the type of the analog output. For example, for an analog output with +/- 10 V, the value 10 V is output at 100%.

Analog outputs can be overdriven by about 17%. This means that an analog output can be operated in the range from -117% to 117%, insofar as the drive permits this.

Maximum speed

Specify the maximum speed of the drive in this field.

See also

Positioning axis technology object (Page 112)

Automatic transfer of drive and encoder parameters in the device (Page 47)

Connect drive/encoder via data block (Page 342)

Synchronous axis technology object (Page 113)

5.4.2.5 Configuration - Data exchange with encoder

Configure detailed encoder parameters and the data exchange with the encoder in the "Data exchange with encoder" configuration window.

The display and selection of the configuration parameters described here is dependent on the following parameters:

- Configuration window "Basic parameters": Drive type (linear/rotary)
- Configuration window "Hardware interface > Encoder": Encoder type (incremental/absolute/cyclic absolute)
- Configuration window - "Extended parameters > Mechanics": Encoder mounting type

Encoder telegram

The telegram to the encoder that is set in the device configuration is preselected in the drop-down list.

Automatic data exchange for encoder values (offline)

Select the check box if you want to transfer the offline values of the encoder to the configuration of the technology object in the project.

Note

Automatic transfer of encoder parameters is only possible with PROFIdrive encoders as of product version A16. For this, "Hardware interface > Encoder" must be selected as the "Encoder" data connection in the configuration window.

Automatic data exchange for encoder values (online)

Select the check box if you want to transfer the effective values online in the encoder to the CPU during runtime. The encoder parameters are transferred from the bus after the (re-)initialization of the technology object and (re)start of the encoder or the CPU.

Note

Automatic transfer of encoder parameters is only possible with PROFIdrive encoders as of product version A16. For this, "Hardware interface > Encoder" must be selected as the "Encoder" data connection in the configuration window.

Alternatively, you must manually calibrate the following parameters, depending on encoder type.

Encoder type

Depending on the selected encoder type, configure the following parameters:

Encoder type	Rotary incremental
Increments per revolution	Configure the number of increments that the encoder resolves per revolution in this field.
Bits for fine resolution in the incremental actual value (Gx_XIST1)	Configure the number of bits for fine resolution within the incremental actual value (Gx_XIST1) in this field.

Encoder type	Rotary absolute
Increments per revolution	Configure the number of increments that the encoder resolves per revolution in this field.
Number of revolutions	Configure the number of revolutions that the absolute encoder can detect in this field.
Bits for fine resolution in the incremental actual value (Gx_XIST1)	Configure the number of bits for fine resolution within the incremental actual value (Gx_XIST1) in this field.
Bits for fine resolution in the absolute actual value (Gx_XIST2)	Configure the number of bits for fine resolution within the absolute actual value (Gx_XIST2) in this field.

Encoder type	Rotary cyclic absolute
Increments per revolution	Configure the number of increments that the encoder resolves per revolution in this field.
Number of revolutions	Configure the number of revolutions that the absolute encoder can detect in this field.
Bits for fine resolution in the incremental actual value (Gx_XIST1)	Configure the number of bits for fine resolution within the incremental actual value (Gx_XIST1) n this field.
Bits for fine resolution in the absolute actual value (Gx_XIST2)	Configure the number of bits for fine resolution within the absolute actual value (Gx_XIST2) in this field.

Encoder type	Linear incremental
Distance between two increments	Configure the distance between two increments of the encoder in this field.
Bits for fine resolution in the incremental actual value (Gx_XIST1)	Configure the number of bits for fine resolution within the incremental actual value (Gx_XIST1) in this field.

Encoder type	Linear absolute
Distance between two increments	Configure the distance between two increments of the encoder in this field.
Bits for fine resolution in the incremental actual value (Gx_XIST1)	Configure the number of bits for fine resolution within the incremental actual value (Gx_XIST1) in this field.
Bits for fine resolution in the absolute actual value (Gx_XIST2)	Configure the number of bits for fine resolution within the absolute actual value (Gx_XIST2) in this field.

Encoder type	Linear cyclic absolute
Distance between two increments	Configure the distance between two increments of the encoder in this field.
Bits for fine resolution in the incremental actual value (Gx_XIST1)	Configure the number of bits for fine resolution within the incremental actual value (Gx_XIST1) in this field.
Bits for fine resolution in the absolute actual value (Gx_XIST2)	Configure the number of bits for fine resolution within the absolute actual value (Gx_XIST2) in this field.

See also

Configuration - Data exchange with encoder (multiple encoders) (Page 227)

Positioning axis technology object (Page 112)

Automatic transfer of drive and encoder parameters in the device (Page 47)

Connect drive/encoder via data block (Page 342)

Synchronous axis technology object (Page 113)

Configuration - Data exchange (Page 259)

5.4.2.6 Configuration - Data exchange with encoder (multiple encoders)

Settings for

In the drop-down list, select the encoder for which the following configurations are to apply.

See also

Using multiple encoders (Page 49)
Configuration - Data exchange with encoder (Page 224)
Configuration - Mechanics (Page 228)
Positioning axis technology object (Page 112)
Synchronous axis technology object (Page 113)

5.4.3 Configuration - leading value interconnections (synchronous axis only)

You can interconnect a synchronous axis with multiple leading value-capable technology objects. Leading value-capable technology objects are:

- Positioning axes
- Synchronous axes
- External encoders (only with S7-1500T CPU)

You can select only one leading value during runtime of your user program.

All interconnection required during operation must be set up during configuration of the technology object.

Possible leading values

In the "Possible leading values" column of the "Leading value interconnections" list, add all leading value-capable technology objects that you need during operation as a leading value for the synchronous axis.

You can interconnect the axes added in the list with the synchronous axis as a leading value with the corresponding Motion Control instruction.

All configured leading value interconnections for the technology object are displayed in the cross-reference list of the technology object.

Coupling type

In the "Type of coupling" column, configure whether the leading value is to be coupled via setpoint or actual value.

"Actual value" is available only for the S7-1500T CPU.

See also

Leading value coupling (Page 115)
Synchronous axis technology object (Page 113)

5.4.4 Extended Parameters

5.4.4.1 Configuration - Mechanics

Configuration - Mechanics

In the "Mechanics" configuration window, configure the mounting type of the encoder, and the adaptation of the actual encoder value to the mechanical conditions.

Settings for (S7-1500T)

In the drop-down list, select the encoder for which the following configurations are to apply.

Encoder mounting type

In the drop-down list, select how the encoder is mounted to the mechanics.

The configuration differs depending on the axis type and the encoder mounting type selected in the "Basic parameters" configuration window.

Axis type: Linear

- Linear - On motor shaft (Page 229)
- Linear - On load side (Page 230)
- Linear - External Measuring System (Page 231)

Axis type: Rotary

- Rotary - On motor shaft (Page 232)
- Rotary - On load side (Page 232)
- Rotary - External Measuring System (Page 233)

Invert encoder direction

Select this check box if you must invert the direction of rotation of the encoder.

See also

Configuration - Data exchange with encoder (multiple encoders) (Page 227)

Positioning axis technology object (Page 112)

Using multiple encoders (Page 49)

Synchronous axis technology object (Page 113)

Axis type: Linear

Linear - On motor shaft

The encoder is connected to the motor shaft in a mechanically fixed manner. Motor and encoder form a unit.

Invert drive direction

Select the check box if the direction of rotation of the drive is to be inverted.

Load gear

The gear ratio of the load gear is specified as the ratio between motor revolutions and load revolutions.

Number of motor revolutions

In this configuration field, configure the integer number of motor revolutions.

Number of load revolutions

In this configuration field, configure the integer number of load revolutions.

Position parameters

Leadscrew pitch

In this configuration field, configure the distance by which the load is moved when the leadscrew makes one revolution.

See also

Positioning axis technology object (Page 112)

Synchronous axis technology object (Page 113)

Linear - On load side

The encoder is mechanically connected to the load side of the gear.

Invert drive direction

Select the check box if the direction of rotation of the drive is to be inverted.

Load gear

The gear ratio of the load gear is specified as the ratio between motor revolutions and load revolutions.

Number of motor revolutions

In this configuration field, configure the integer number of motor revolutions.

Number of load revolutions

In this configuration field, configure the integer number of load revolutions.

Position parameters

Leadscrew pitch

In this configuration field, configure the distance by which the load is moved when the leadscrew makes one revolution.

See also

Positioning axis technology object (Page 112)

Synchronous axis technology object (Page 113)

Linear - External Measuring System

An external measuring system provides the position values of the linear load motion.

Distance per encoder revolution

In this configuration field, configure the linear load travel per encoder revolution.

Invert drive direction

Select the check box if the direction of rotation of the drive is to be inverted.

Load gear

The gear ratio of the load gear is specified as the ratio between motor revolutions and load revolutions.

Number of motor revolutions

In this configuration field, configure the integer number of motor revolutions.

Number of load revolutions

In this configuration field, configure the integer number of load revolutions.

Position parameters

Leadscrew pitch

In this configuration field, configure the distance by which the load is moved when the leadscrew makes one revolution.

See also

Positioning axis technology object (Page 112)

Synchronous axis technology object (Page 113)

Axis type: Rotary

Rotary - On motor shaft

The encoder is connected to the motor shaft in a mechanically fixed manner. Motor and encoder form a unit.

Invert drive direction

Select the check box if the direction of rotation of the drive is to be inverted.

Load gear

The gear ratio of the load gear is specified as the ratio between motor revolutions and load revolutions.

Number of motor revolutions

In this configuration field, configure the integer number of motor revolutions.

Number of load revolutions

In this configuration field, configure the integer number of load revolutions.

See also

Positioning axis technology object (Page 112)

Synchronous axis technology object (Page 113)

Rotary - On load side

The encoder is mechanically connected to the load side of the gear.

Invert drive direction

Select the check box if the direction of rotation of the drive is to be inverted.

Load gear

The gear ratio of the load gear is specified as the ratio between motor revolutions and load revolutions.

Number of motor revolutions

In this configuration field, configure the integer number of motor revolutions.

Number of load revolutions

In this configuration field, configure the integer number of load revolutions.

See also

Positioning axis technology object (Page 112)

Synchronous axis technology object (Page 113)

Rotary - External Measuring System

An external measuring system provides the position values of the rotary load motion.

Distance per encoder revolution

In this configuration field, configure the linear load travel per encoder revolution.

Invert drive direction

Select the check box if the direction of rotation of the drive is to be inverted.

Load gear

The gear ratio of the load gear is specified as the ratio between motor revolutions and load revolutions.

Number of motor revolutions

In this configuration field, configure the integer number of motor revolutions.

Number of load revolutions

In this configuration field, configure the integer number of load revolutions.

See also

Positioning axis technology object (Page 112)

Synchronous axis technology object (Page 113)

5.4.4.2 Configuration - Dynamic Defaults

In the "Dynamic default values" configuration window, configure the default values for velocity, acceleration, deceleration and jerk of the axis.

The default values take effect, when values < 0 are specified in Motion Control instructions for the "Velocity", "Acceleration", "Deceleration" or "Jerk" parameters. The default values can be applied separately for each of the parameters just listed.

The default values for acceleration and deceleration also act on the traversing motions of active homing.

Velocity

In this field, define the default value for the velocity of the axis.

Acceleration / Deceleration - Ramp-up time / Ramp-down time

Configure the desired default value for acceleration in the "Ramp-up time" or "Acceleration" fields. The desired deceleration can be set in the "Ramp-down time" or "Deceleration" fields.

The following equations show the relationship between the ramp-up time and acceleration and the ramp-down time and deceleration:

$$\text{Ramp-up time} = \frac{\text{Velocity}}{\text{Acceleration}}$$

$$\text{Ramp-down time} = \frac{\text{Velocity}}{\text{Deceleration}}$$

Note

A change in the velocity influences the acceleration and deceleration values of the axis. The ramp-up and ramp-down times are retained.

Smoothing time / jerk

You can enter the jerk limit parameters in the "Smoothing time" box, or alternatively in the "Jerk" box:

- Set the desired jerk for the acceleration and deceleration ramp in the "Jerk" field. The value 0 means that jerk limiting is deactivated.
- Set the desired smoothing time for the acceleration ramp in the "Smoothing time" field.

Note

The jerk value is identical for the acceleration and deceleration ramp. The smoothing time in effect for the deceleration ramp results from the following relationships:

- **Acceleration > Deceleration**
  A shorter smoothing time is used for the deceleration ramp compared with the acceleration ramp.
- **Acceleration < Deceleration**
  A longer smoothing time is used for the deceleration ramp compared with the acceleration ramp.
- **Acceleration = Deceleration**
  The smoothing times of the acceleration and deceleration ramp are equal.

If an error occurs, the axis decelerates with the configured emergency stop deceleration. A configured jerk limit is not taken into account for this.

The following equations show the relationship between the smoothing times and the jerk:

$$\text{Smoothing time (acceleration ramp)} = \frac{\text{Acceleration}}{\text{Jerk}}$$

$$\text{Smoothing time (deceleration ramp)} = \frac{\text{Deceleration}}{\text{Jerk}}$$

Motion jobs started in the user program are performed with the selected jerk.

See also

Positioning axis technology object (Page 112)

Velocity profile (Page 67)

Synchronous axis technology object (Page 113)

5.4.4.3 Configuration - Emergency stop

In the "Emergency stop" configuration window, you can configure the emergency stop deceleration of the axis. In the event of an error, and when disabling the axis, the axis is brought to a standstill with this deceleration using the Motion Control instruction "MC_Power" (input parameter StopMode = 0).

Emergency stop deceleration / Emergency stop ramp-down time

Configure the deceleration value for emergency stop in the "Emergency stop deceleration" field or the "Emergency stop ramp-down time" field.

The relationship between emergency stop ramp-down time and emergency stop deceleration can be seen in the following equation:

$$\textit{Emergency stop ramp-down time} = \frac{\textit{Maximum velocity}}{\textit{Emergency stop deceleration}}$$

The configuration of the emergency stop deceleration is related to the configured maximum velocity of the axis. If the maximum velocity of the axis changes, then the value of the emergency stop deceleration also changes (the emergency stop ramp-down time remains unchanged).

See also

Positioning axis technology object (Page 112)

Emergency stop deceleration (Page 68)

Synchronous axis technology object (Page 113)

5.4.4.4 Limits

Configuration - Position limits

Configure the hardware and software limit switches of the axis in the "Position limits" configuration window.

Enable HW limit switches

The check box activates the function of the negative and positive hardware limit switches. The negative hardware limit switch is located on the side in the negative direction of travel, and the positive hardware limit switch on the side in the positive direction of travel.

If a hardware limit switch is reached, technology alarm 531 is output, and the technology object is disabled (alarm response: remove enable).

Exception: If a hardware limit switch is crossed during an active home position approach with activated direction reversal at the hardware limit switch, the axis stops with the configured maximum deceleration and continues the home position approach in the opposite direction.

Note

Only use hardware limit switches that remain permanently switched after the approach. This switching state may only be canceled after the return into the permitted traversing range.

The digital inputs of the hardware limit switches are evaluated by default in cyclic data exchange. In the settings for the input module under "I/O addresses", select the entry "MC-Servo" for "Organization block" and the entry "TPA OB Servo" for "Process image" if the hardware limit switches are to be evaluated in the position control cycle clock of the drive.

Negative / positive HW limit switch input

In these fields, select the PLC tag of the digital input for the negative and positive HW limit switches.

In order to be able to select an input, a digital input module must have been added in the device configuration, and the PLC tag name for the digital input must be defined.

CAUTION

During installation of hardware limit switches, attention must be paid to the filter times of the digital inputs.

Based on the time for one position control cycle clock and the filter time of the digital inputs, the resulting delay times must be taken into account.

The filter time is configurable in individual digital input modules in the device configuration.

The digital inputs are set to a filter time of 6.4 ms by default. If these are used as hardware limit switches, undesired decelerations may occur. If this occurs, reduce the filter time for the relevant digital inputs.

The filter time can be set under "Input filter" in the device configuration of the digital inputs.

Negative / positive HW limit switch level selection

In the drop-down list, select the triggering signal level ("Low level" / "High level") of the hardware limit switch. With "Low level", the input signal is FALSE after the axis has reached or crossed the hardware limit switch. With "High level", the input signal is TRUE after the axis has reached or crossed the hardware limit switch.

Enable software limit switch

This check box activates the high and low software limit switches. When software switches are activated, an active motion comes to a stop at the position of the software limit switch. The technological object signals an error. After acknowledgment of the error, the axis can again be moved in the direction of its operating range.

Note

Activated software limit switches act only on a homed axis.

Position of negative / positive SW limit switch

Configure the operating range of the axis with the positions of the negative and positive software limit switches.

See also

Positioning axis technology object (Page 112)

Synchronous axis technology object (Page 113)

Configuration - Dynamic limits

In the "Dynamic limits" configuration window, configure the maximum values for velocity, acceleration, deceleration and jerk of the axis.

Maximum velocity

In this field, define the maximum permitted velocity of the axis.

Maximum acceleration / maximum deceleration - ramp-up time / ramp-down time

Set the desired acceleration in the "Ramp-up time" or "Acceleration" fields. The desired deceleration can be set in the "Ramp-down time" or "Deceleration" fields.

The following equations show the relationship between the ramp-up time and acceleration and the ramp-down time and deceleration:

$$\text{Ramp-up time} = \frac{\text{Maximum velocity}}{\text{Acceleration}}$$

$$\text{Ramp-down time} = \frac{\text{Maximum velocity}}{\text{Deceleration}}$$

Note

A change in the maximum velocity influences the acceleration and deceleration values of the axis. The ramp-up and ramp-down times are retained.

The "maximum deceleration" for active homing with change of direction at the hardware limit switch must be set sufficiently large, to brake the axis before reaching the mechanical endstop.

Smoothing time / jerk

You can enter the jerk limit parameters in the "Smoothing time" box, or alternatively in the "Jerk" box:

- Set the desired jerk for the acceleration and deceleration ramp in the "Jerk" field. The value 0 means that the jerk is not limited.
- Set the desired smoothing time for the acceleration ramp in the "Smoothing time" field.

Note

The configured smoothing time displayed in the configuration, applies only to the acceleration ramp.

If the values of the acceleration and deceleration differ, the smoothing time of the deceleration ramp is calculated and used according to the jerk of the acceleration ramp.

The smoothing time of the deceleration is adapted as follows:

- **Acceleration > Deceleration**
  A shorter smoothing time is used for the deceleration ramp compared with the acceleration ramp.
- **Acceleration < Deceleration**
  A longer smoothing time is used for the deceleration ramp compared with the acceleration ramp.
- **Acceleration = Deceleration**
  The smoothing times of the acceleration and deceleration ramp are equal.

If an error occurs, the axis decelerates with the configured emergency stop deceleration. A configured jerk limit is not taken into account for this.

The following equations show the relationship between the smoothing times and the jerk:

$$\text{Smoothing time (acceleration ramp)} = \frac{\text{Acceleration}}{\text{Jerk}}$$

$$\text{Smoothing time (deceleration ramp)} = \frac{\text{Deceleration}}{\text{Jerk}}$$

Motion jobs started in the user program are performed with the selected jerk.

See also

Velocity profile (Page 67)

Dynamic limits in synchronous operation (Page 69)

Positioning axis technology object (Page 112)

Synchronous axis technology object (Page 113)

Configuration - Torque limits

Configure the force/torque limiting of the drive in the "Torque limiting" configuration window.

The configuration is now available if a drive that supports force/torque limiting is selected and a telegram 10x is used. Telegram 101 cannot be used.

Effective

In the drop-down list, select whether the limit value is to be in effect "on load side" or "on motor side".

Torque limits

Enter a default value for the torque limiting in the specified unit of measurement in this field.

The default value is in effect when the torque limiting is specified using Motion Control instruction "MC_TorqueLimiting", input parameter "Limit" < 0.

Torque limiting applies to the following axis configurations:

- Axis type is "Rotary" and limit value is in effect "On load side" or "On motor side"
- Axis type is "Linear" and limit value is in effect "On motor side"

Force limit

Enter a default value for the force limit in the specified unit of measure in this field.

The default value is in effect when the force limit is specified using Motion Control instruction "MC_TorqueLimiting", input parameter "Limit" < 0.

The force limit applies to the following axis configuration: Axis type is "Linear" and limit value is in effect "On load side"

If the gear and leadscrew efficiency is crucial, this can be set in the <TO>.Actor.Efficiency tag.

Disable/enable position-based monitoring

As a result of the force/torque limiting on the drive, a larger following error may occur or the axis standstill may not be detected reliably in positioning monitoring.

Deactivate "Position-related monitoring" in order to deactivate monitoring of the following error and the positioning monitoring during force/torque limiting.

Interconnection in the SINAMICS drive

The following interconnection is required in the SINAMICS drive:

- P1522 must be interconnected to a fixed value of + 100%,
- P1523 to a fixed value of -100% (e.g. through interconnection to fixed value parameter P2902[i]).

See also

Force/torque limiting (Page 73)

Positioning axis technology object (Page 112)

Synchronous axis technology object (Page 113)

Configuration - Fixed stop detection

Configure the fixed stop detection in the configuration window.

A "Travel to fixed stop" can be realized by activating fixed stop detection using the Motion Control instruction "MC_TorqueLimiting" and a position-controlled motion job. The operation is also referred to as clamping.

Positioning tolerance

In this configuration field, configure the positioning tolerance that is regarded as a breaking away or turning back of the fixed stop when exceeded. To detect the breaking away or turning back of the fixed stop, the position setpoint must be located outside the positioning tolerance. The configured position tolerance must be less than the configured following error.

Following error

If the drive is stopped by a mechanical fixed stop during a motion job, the following error is increased. The accumulating following error serves as a criterion for fixed stop detection. In the "Following error" configuration field, configure the value of the following error starting from which the fixed stop detection is to take effect. The configured following error must be greater than the configured position tolerance.

Note

If the following error monitoring was activated in the position monitoring configuration, the "Maximum following error" configured there must be greater than the "Following error" of the fixed stop detection.

See also

Fixed stop detection (Page 74)

Positioning axis technology object (Page 112)

Synchronous axis technology object (Page 113)

5.4.4.5 Homing

Homing means matching the position value of a technology object to the real, physical location of the drive. Absolute target positions of the axis can only be approached with a homed axis.

In S7-1500 Motion Control, the axis is homed with the Motion Control instruction, "MC_Home". A distinction is made between the following operating modes of the Motion Control instruction:

Operating modes of the Motion Control instruction "MC_Home"

- **Active homing (incremental encoder)**

  With active homing, the Motion Control instruction "MC_Home" performs the configured home position approach. Active traversing motions are aborted. When the homing mark is detected, the position of the axis is set according to the configuration.

- **Passive homing (incremental encoder)**

  With passive homing, the Motion Control instruction "MC_Home" instruction does not carry out any homing motion. The traversing motion required for this must be implemented by the user with other Motion Control instructions. Active traversing motions are not aborted upon start of passive homing. When the homing mark is detected, the axis is set according to the configuration.

- **Direct homing absolute (incremental encoder or absolute encoder)**

  The axis position is set without taking into consideration the home position switch. Active traversing motions are not aborted. The value of input parameter "Position" of Motion Control instruction "MC_Home" is set immediately as the actual position of the axis.

- **Direct homing (relative) (incremental encoder or absolute encoder)**

  The axis position is set without taking into consideration the home position switch. Active traversing motions are not aborted. The following statement applies to the axis position after homing:

  New axis position = Current axis position + Value of parameter "Position" of instruction "MC_Home".

See also

Positioning axis technology object (Page 112)

Synchronous axis technology object (Page 113)

Homing (Page 78)

Active homing

Configuration - Active homing

In the "Active Homing" configuration window, configure the parameters for active homing. "Active homing" is performed using the Motion Control instruction "MC_Home " Mode = 3 and 5.

Note

Parameter "MC_Home.Mode" (S7-1500 CPU)

The "MC_Home.Mode" parameter for S7-1200 Motion Control and S7-1500 Motion Control has been standardized within the framework of technology version V2.0. This results in a new assignment of the parameter values for the "MC_Home.Mode" parameter. A comparison of the "MC_Home.Mode" parameter for technology versions V1.0 and V2.0 is available in the section Version overview (Page 179).

Settings for

In the drop-down list, select the encoder for which the homing settings are to apply (only for S7-1500T).

Select the homing mode

Select from among the following homing modes:

- Reference cam and zero mark via PROFIdrive telegram (Page 245)
- Use zero mark via PROFIdrive telegram (Page 246)
- Homing mark via digital input (Page 247)

See also

Homing (Page 78)

Using multiple encoders (Page 49)

Positioning axis technology object (Page 112)

Synchronous axis technology object (Page 113)

Reference cam and zero mark via PROFIdrive telegram

Enable direction reversal at the hardware limit switch

Select this check box to use the hardware limit switch as a reversing cam for the home position approach. After the axis has reached the hardware limit switch during active homing, it is ramped down at the configured maximum deceleration rate and the direction is then reversed. The reference cam is then searched for in the reverse direction. If this function is not enabled and the axis reaches the hardware limit switch during active homing, then the drive is disabled and braked with the ramp configured in the drive.

Approach direction

Select the approach direction for the reference cam search.

"Positive" is the approach direction in the direction of positive position values; "negative" in the direction of negative position values.

Homing direction

Select the direction in which the zero mark should be approached for homing.

Approach velocity

In this field, specify the velocity at which the reference cam is searched for during the homing procedure. Any configured home position offset is traversed at the same velocity.

Homing velocity

In this field, specify the velocity at which the axis approaches the zero mark for homing. For zero mark detection, the reference cam must be exited.

Home position offset

In the case of a differing zero mark position and home position, enter the corresponding home position offset in this field. The axis approaches the home position at approach velocity.

Home position

In this field, configure the absolute coordinate of the home position. The home position configured here is in effect, when the Motion Control instruction "MC_Home" is executed with Mode = 5.

See also

Positioning axis technology object (Page 112)

Synchronous axis technology object (Page 113)

Homing (Page 78)

Use zero mark via PROFIdrive telegram

Enable direction reversal at the hardware limit switch

Select this check box to use the hardware limit switch as a reversing cam for the home position approach. After the axis has reached the hardware limit switch during active homing, it is ramped down at the configured maximum deceleration rate and the direction is then reversed. The zero mark is then sought in the reverse direction. If this function is not enabled and the axis reaches the hardware limit switch during active homing, then the drive is disabled and braked with the ramp configured in the drive.

Homing direction

Select the direction in which the next zero mark should be approached for homing.

"Positive" is the homing direction in the direction of positive position values; "negative" in the direction of negative position values.

Approach velocity

In the "Zero mark via PROFIdrive frame" homing mode, the approach velocity for traversing the home position offset is used.

Homing velocity

In this field, specify the velocity at which the axis approaches the zero mark for homing.

Home position offset

In the case of a differing zero mark position and home position, enter the corresponding home position offset in this field. The axis approaches the home position at approach velocity.

Home position

In this field, configure the absolute coordinate of the home position. The home position configured here is in effect, when the Motion Control instruction "MC_Home" is executed with Mode = 5.

See also

Positioning axis technology object (Page 112)

Synchronous axis technology object (Page 113)

Homing (Page 78)

Homing mark via digital input

When a digital input is used as a homing mark, the accuracy of the homing process is not as high as for hardware-supported homing using zero marks.

You can improve the accuracy by using a low homing velocity.

Pay attention to the setting of short filter times for the digital input as well.

Digital input homing mark/cam

In this configuration field, select the PLC tag of the digital input that is to act as a homing mark (reference cam). Also select the level at which the homing mark is to be detected.

In order to be able to select an input, a digital input module must have been added in the device configuration, and the PLC tag name for the digital input must be defined.

Enable direction reversal at the hardware limit switch

Select this check box to use the hardware limit switch as a reversing cam for the home position approach. After the axis has reached the hardware limit switch during active homing, it is ramped down at the configured maximum deceleration rate and then reversed. The homing mark is then sensed in reverse direction. If this function is not enabled and the axis reaches the hardware limit switch during active homing, then the drive is disabled and braked with the ramp configured in the drive.

Approach direction

Select the approach direction for the homing mark search.

"Positive" is the approach direction in the direction of positive position values; "negative" in the direction of negative position values.

Homing direction

Select the direction in which the homing mark for homing is to be approached.

Homing mark

Select the switch position of the "digital input" that is to be used as the homing mark.

When a "digital input" is crossed, two switching edges that are spatially separated from one another are generated. The selection of the positive or negative side ensures that the homing mark is always evaluated at the same mechanical position.

The positive side is the switch position with a greater position value; the negative side is the switch position with the lesser position value.

The selection of the side is independent of the approach direction, and independent of whether it causes a rising or falling edge.

Approach velocity

In this field, specify the velocity at which the axis searches for the "digital input" during the home position approach. Any configured home position offset is traversed at the same velocity.

Homing velocity

In this field, specify the velocity at which the axis approaches the home position for homing.

Home position offset

If the homing mark position is different from the home position, enter the corresponding home position offset in this field. The axis approaches the home position at approach velocity.

Home position

In this field, configure the absolute coordinate of the home position. The home position configured here is in effect, when the Motion Control instruction "MC_Home" is executed with Mode = 5.

See also

Positioning axis technology object (Page 112)

Synchronous axis technology object (Page 113)

Homing (Page 78)

Passive homing

Configuration - Passive homing

Configure the parameters for passive homing in the "Passive Homing" (homing on the fly) configuration window. Passive homing is performed using the Motion Control instruction "MC_Home" Mode = 2, 8 and 10.

Note

Parameter "MC_Home.Mode" (S7-1500 CPU)

The "MC_Home.Mode" parameter for S7-1200 Motion Control and S7-1500 Motion Control has been standardized within the framework of technology version V2.0. This results in a new assignment of the parameter values for the "MC_Home.Mode" parameter. A comparison of the "MC_Home.Mode" parameter for technology versions V1.0 and V2.0 is available in the section Version overview (Page 179).

Settings for

In the drop-down list, select the encoder for which the homing settings are to apply (only for S7-1500T).

Select the homing mode

Select from among the following homing modes:

- Zero mark via PROFIdrive frame (Page 250)
- Zero mark via PROFIdrive telegram and reference cam (Page 251)
- Homing mark via digital input (Page 252)

See also

Homing (Page 78)

Using multiple encoders (Page 49)

Positioning axis technology object (Page 112)

Synchronous axis technology object (Page 113)

Zero mark via PROFIdrive frame

Homing direction

Select the direction in which the next zero mark should be approached for homing. The following options are available:

- **Positive**

  Axis moves in the direction of higher position values.

- **Negative**

  Axis moves in the direction of lower position values.

- **Current**

  The currently effective approach direction is used for homing.

Home position

In this field, configure the absolute coordinate of the home position. The home position configured here is in effect when the Motion Control instruction "MC_Home" is executed with Mode = 10.

Note

Parameter "MC_Home.Mode"

The "MC_Home.Mode" parameter for S7-1200 Motion Control and S7-1500 Motion Control has been standardized within the framework of technology version V2.0. This results in a new assignment of the parameter values for the "MC_Home.Mode" parameter. A comparison of the "MC_Home.Mode" parameter for technology versions V1.0 and V2.0 is available in the section Version overview (Page 179).

See also

Positioning axis technology object (Page 112)

Synchronous axis technology object (Page 113)

Homing (Page 78)

Zero mark via PROFIdrive telegram and reference cam

Homing direction

Select the direction in which the zero mark should be approached for homing. The next zero mark after leaving the reference cam is used.

The following options are available:

- **Positive**

  Axis moves in the direction of higher position values.

- **Negative**

  Axis moves in the direction of lower position values.

- **Current**

  The currently effective approach direction is used for homing.

Home position

In this field, configure the absolute coordinate of the home position. The home position configured here is in effect when the Motion Control instruction "MC_Home" is executed with Mode = 10.

Note

Parameter "MC_Home.Mode"

The "MC_Home.Mode" parameter for S7-1200 Motion Control and S7-1500 Motion Control has been standardized within the framework of technology version V2.0. This results in a new assignment of the parameter values for the "MC_Home.Mode" parameter. A comparison of the "MC_Home.Mode" parameter for technology versions V1.0 and V2.0 is available in the section Version overview (Page 179).

See also

Positioning axis technology object (Page 112)

Synchronous axis technology object (Page 113)

Homing (Page 78)

Homing mark via digital input

Digital input homing mark/cam

In this dialog field, select a digital input that is to act as a homing mark (reference cam). Also select the level at which the homing mark is to be detected.

Homing direction

Select the direction in which the homing mark for homing is to be approached.

The following options are available:

- **Positive**

  Axis moves in the direction of higher position values.
- **Negative**

  Axis moves in the direction of lower position values.
- **Current**

  The currently effective approach direction is used for homing.

Homing mark

Select which switch position of the "digital input" is to be used as the homing mark.

When a "digital input" is crossed, two switching edges that are spatially separated from one another are generated. The selection of the positive or negative side ensures that the homing mark is always evaluated at the same mechanical position.

The positive side is the switch position with a greater position value; the negative side is the switch position with the lesser position value.

The selection of the side is independent of the approach direction, and independent of whether it causes a rising or falling edge.

Home position

In this field, configure the absolute coordinate of the home position. The home position configured here is in effect when the Motion Control instruction "MC_Home" is executed with Mode = 10.

Note

Parameter "MC_Home.Mode"

The "MC_Home.Mode" parameter for S7-1200 Motion Control and S7-1500 Motion Control has been standardized within the framework of technology version V2.0. This results in a new assignment of the parameter values for the "MC_Home.Mode" parameter. A comparison of the "MC_Home.Mode" parameter for technology versions V1.0 and V2.0 is available in the section Version overview (Page 179).

See also

Positioning axis technology object (Page 112)

Synchronous axis technology object (Page 113)

Homing (Page 78)

5.4.4.6 Position monitoring functions

Configuration - Positioning monitoring

In the "Positioning monitoring" configuration window, configure the criteria for monitoring the target position.

Positioning window:

Configure the size of the positioning window in this field. If the axis is located within this window, the position is considered to be "reached".

Tolerance time

In this field, configure the tolerance time within which the position value must reach the positioning window.

Minimum dwell time in positioning window:

Configure the minimum dwell time in this field. The current position value must be located in the positioning window for at least the "minimum dwell time".

If one of the criteria is violated, then the axis is stopped and a positioning alarm is displayed.

See also

Positioning axis technology object (Page 112)

Synchronous axis technology object (Page 113)

Position monitoring functions (Page 98)

Configuration - Following error

In the "Following Error" configuration window, configure the permissible deviation of the actual position of the axis from the position setpoint. The following error can be dynamically adapted to the current velocity of the axis.

Enable following error monitoring

Select this check box, if you want to enable following error monitoring. When following error monitoring is enabled, the axis will be stopped in the error range (orange); in the warning range an alarm will be displayed.

When following error monitoring is disabled, the configured limits have no effect.

Maximum following error:

Configure the following error that is permissible at maximum velocity in this field.

Warning level:

Configure a percentage of the current following error limit, above which a following error warning should be output in this field.

Example: The current maximum following error is 100 mm; the warning level is configured at 90%. If the current following error exceeds a value of 90 mm, then a following error warning will be output.

Following error:

In this field, configure the permissible following error for low velocities (without dynamic adjustment of the following error).

Start of dynamic adjustment:

Configure the velocity starting from which the following error is to be dynamically adjusted in this field. Starting from this velocity, the following error up to the maximum velocity will be adjusted to the maximum following error.

See also

Positioning axis technology object (Page 112)

Synchronous axis technology object (Page 113)

Position monitoring functions (Page 98)

Configuration - Standstill signal

In the "Standstill signal" configuration window, configure the criteria for standstill detection.

Standstill window:

Configure the size of the standstill window in this field. For standstill to be indicated, the velocity of the axis must be within this window.

Minimum dwell time in standstill window:

Configure the minimum dwell time in the standstill window in this field. The velocity of the axis must also be in the standstill window for the specified duration.

If both criteria are met, then the standstill of the axis is indicated.

See also

Positioning axis technology object (Page 112)

Standstill signal (Page 99)

Synchronous axis technology object (Page 113)

5.4.4.7 Configuration - Control loop

In the "Control loop" configuration window, configure the precontrol and the gain Kv of the position control loop.

The Kv factor affects the following parameters:

- Positioning accuracy and stop control
- Uniformity of motion
- Positioning time

The better the mechanical conditions of the axis are (high stiffness), the higher the Kv factor can be configured. This reduces the following error, and a higher dynamic response is achieved.

For basic information, refer to the section Closed-loop control (Page 101).

Precontrol

Configure the percentage velocity precontrol in this field.

Speed control loop substitute time

Configure the speed control loop substitute time in this field (T_{vtc}).

When speed precontrol is activated, the setpoint is delayed by the speed control loop substitute time before the control deviation is established. This prevents an overshoot or a leading of the actual value compared with the position setpoint. The speed control loop substitute time is a simplified substitute model of the dynamic behavior of the speed control loop. The speed control loop substitute time is included in the balancing filter.

Gain (Kv factor)

In the input field, enter the gain Kv of the position control loop.

Dynamic Servo Control (DSC)

For position-controlled axes (positioning axes/synchronous axes), the closed loop position control can occur either in the CPU or in the drive, provided the drive supports Dynamic Servo Control (DSC). Select your preferred control process:

- **Position control in the drive (DSC enabled)**
  With the Dynamic Servo Control (DSC) function, the position controller is executed in the drive in the cycle clock of the speed control loop. This enables you to set a much larger position controller gain factor Kv. This increases the dynamics for setpoint sequence and disturbance variable correction for highly dynamic drives.
- **Position control in the PLC**

Note

Dynamic Servo Control (DSC) is only possible with one of the following PROFIdrive telegrams:

- Standard telegram 5 or 6
- SIEMENS telegram 105 or 106

See also

Closed-loop control (Page 101)

Control structure (Page 102)

Function and structure of the optimization (Page 396)

Positioning axis technology object (Page 112)

Synchronous axis technology object (Page 113)

5.4.4.8 Configuration - Actual value extrapolation

Configure the properties of the extrapolation for an actual value coupling for synchronous operation in the "Actual value extrapolation" configuration window. The values set here only apply when the actual values of this axis are used as leading value.

Position filter T1 and T2

Enter the time constants for the filtering of the actual position.

Velocity filter T1 and tolerance band width

Enter the time constant for the smoothing of the velocity and the tolerance band width.

For optimized application of the tolerance band, enter the same width for the tolerance band as the width of the noise signal.

Following-axis dependent extrapolation time

Enter the part caused by the following axis for calculation of the extrapolation time.

Hysteresis value

Enter a value for application of the hysteresis function to the extrapolated actual value. The specification is made in the configured length unit.

See also

Positioning axis technology object (Page 112)

Extrapolation of the leading values for actual value coupling (Page 116)

Synchronous axis technology object (Page 113)

5.5 Configuring the technology object external encoder

5.5.1 Configuration - Basic Parameters

Configure the basic properties of the technology object in the "Basic Parameters" configuration window.

Name

Define the name of the external encoder in this field. The technology object is listed under this name in the project tree. The tags of the external encoder can be used in the user program under this name.

External encoder type

In this selection, configure whether the external encoder records linear or rotary motions.

Units of measure

In the drop-down list, select the desired units of measure for the position and velocity of the external encoder.

Modulo

Select the check box "Enable modulo", if you want to use a recurring measuring system for the external encoder (e.g. 0-360° for an external encoder of the "rotary" type).

- **Modulo start value**

  In this field, define the position at which the modulo range should begin (e.g. 0° for an external encoder of the "rotary" type).

- **Modulo length**

  In this field, define the length of the modulo range (e.g. 360° for an external encoder of the "rotary" type).

See also

Units of measure (Page 36)

Modulo setting (Page 37)

Technology object external encoder (Page 131)

5.5.2 Hardware interface

5.5.2.1 Configuration - Encoder

The external encoder records the position of an externally controlled drive. The encoder required for this purpose communicates the encoder position to the controller by means of a PROFIdrive telegram. Configure the encoder and encoder type in the "Encoder" configuration window.

Data connection

In the drop-down list, select whether the data connection should be established directly with the encoder or via a data block that can be edited in the user program.

The selection is only possible for encoders that are connected via PROFIdrive and support parameter P979.

Encoder / Data block

Select the encoder you have configured in the device configuration in this area.

The following encoders can be used:

- Encoder on technology module (TM)

  In the "Encoder" configuration field, select a previously configured technology module and the channel to be used. Only technology modules set to the "Position input for Motion Control" mode are displayed for selection.

  You can operate the technology module centrally on an S7-1500 PLC or decentrally on a distributed I/O. Isochronous mode is not possible with central operation in the CPU.

  You can identify the technology modules suitable for position detection for Motion Control in the documentation for the technology module and the catalog data.

- Encoder via PROFINET/PROFIBUS (PROFIdrive)

  In the " Encoder" configuration field, select a configured encoder on the PROFINET/PROFIBUS.

If "Data block" was selected for the data connection, a previously created data block containing a variable structure of data type "PD_TELx" must be selected here ("x" stands for the telegram number used).

Encoder type

Select the encoder type in this configuration field. The following encoder types are available for selection:

- Incremental encoder
- Absolute encoder
- Absolute encoder cyclic absolute

See also

Technology object external encoder (Page 131)

Data connection drive/encoder via data block (Page 57)

Connect drive/encoder via data block (Page 342)

5.5.2.2 Configuration - Data exchange

Configuration - Data exchange

Configure detailed encoder parameters and the data exchange with the encoder in the "Data exchange with encoder" configuration window. The configuration varies according to the encoder connection:

- Encoder to technology module (Page 259)
- Encoder to PROFINET/PROFIBUS (Page 262)

See also

Technology object external encoder (Page 131)

Encoder to technology module

Data exchange with encoder

In this area, you can configure the encoder telegram and the criteria for how the encoder data are to be evaluated. The specifications must match those in the device configuration.

Encoder telegram

In the drop-down list for the technology module, select the telegram that you have configured in the technology module.

Automatic data exchange for encoder values (offline)

Select the check box if you want to transfer the offline values of the encoder to the configuration of the technology object in the project.

Note

Automatic transfer of encoder parameters is only possible with PROFIdrive encoders as of product version A16. For this, "Hardware interface > Encoder" must be selected as the "Encoder" data connection in the configuration window.

Automatic data exchange for encoder values (online)

Select the check box if you want to transfer the effective values online in the encoder to the CPU during runtime. The encoder parameters are transferred from the bus after the (re-)initialization of the technology object and (re)start of the encoder or the CPU.

Note

Automatic transfer of encoder parameters is only possible with PROFIdrive encoders as of product version A16. For this, "Hardware interface > Encoder" must be selected as the "Encoder" data connection in the configuration window.

Alternatively, you must calibrate the following parameters manually:

Encoder type

Configure how the encoder data are to be evaluated in this area. The specifications must match those in the device configuration.

Encoder type	Rotary incremental
Increments per revolution:	Configure the number of increments that the encoder resolves per revolution in this field.
Bits for fine resolution in the incremental actual value (Gx_XIST1)	Configure the number of bits for fine resolution within the incremental actual value (Gx_XIST1) in this field.

Encoder type	Rotary absolute
Increments per revolution:	Configure the number of increments that the encoder resolves per revolution in this field.
Number of revolutions:	Configure the number of revolutions that the absolute encoder can detect in this field.
Bits for fine resolution in the incremental actual value (Gx_XIST1)	Configure the number of bits for fine resolution within the incremental actual value (Gx_XIST1) in this field.
Bits for fine resolution in the absolute actual value (Gx_XIST2)	Configure the number of bits for fine resolution within the absolute actual value (Gx_XIST2) in this field.

Encoder type	Rotary cyclic absolute
Increments per revolution:	Configure the number of increments that the encoder resolves per revolution in this field.
Number of revolutions:	Configure the number of revolutions that the absolute encoder can detect in this field.

Encoder type	Rotary cyclic absolute
Bits for fine resolution in the incremental actual value (Gx_XIST1)	Configure the number of bits for fine resolution within the incremental actual value (Gx_XIST1) in this field.
Bits for fine resolution in the absolute actual value (Gx_XIST2)	Configure the number of bits for fine resolution within the absolute actual value (Gx_XIST2) in this field.

Encoder type	Linear incremental
Distance between two increments:	Configure the distance between two increments of the encoder in this field.
Bits for fine resolution in the incremental actual value (Gx_XIST1)	Configure the number of bits for fine resolution within the incremental actual value (Gx_XIST1) in this field.

Encoder type	Linear absolute
Distance between two increments:	Configure the distance between two increments of the encoder in this field.
Bits for fine resolution in the incremental actual value (Gx_XIST1)	Configure the number of bits for fine resolution within the incremental actual value (Gx_XIST1) in this field.
Bits for fine resolution in the absolute actual value (Gx_XIST2)	Configure the number of bits for fine resolution within the absolute actual value (Gx_XIST2) in this field.

Encoder type	Linear cyclic absolute
Distance between two increments	Configure the distance between two increments of the encoder in this field.
Bits for fine resolution in the incremental actual value (Gx_XIST1)	Configure the number of bits for fine resolution within the incremental actual value (Gx_XIST1) in this field.
Bits for fine resolution in the absolute actual value (Gx_XIST2)	Configure the number of bits for fine resolution within the absolute actual value (Gx_XIST2) in this field.

See also

Configuration - Data exchange (Page 259)

Encoder to PROFINET/PROFIBUS (Page 262)

Technology object external encoder (Page 131)

Encoder to PROFINET/PROFIBUS

Data exchange with encoder

In this area, you can configure the encoder telegram and the criteria for how the encoder data are to be evaluated. The specifications must match those in the device configuration.

Encoder telegram

The telegram to the encoder that is set in the device configuration is preselected in the drop-down list.

Automatic data exchange for encoder values (offline)

Select the check box if you want to transfer the offline values of the encoder to the configuration of the technology object in the project.

Note

Automatic transfer of encoder parameters is only possible with PROFIdrive encoders as of product version A16. For this, "Hardware interface > Encoder" must be selected as the "Encoder" data connection in the configuration window.

Automatic data exchange for encoder values (online)

Select the check box if you want to transfer the effective values online in the encoder to the CPU during runtime. The encoder parameters are transferred from the bus after the (re-)initialization of the technology object and (re)start of the encoder or the CPU.

Note

Automatic transfer of encoder parameters is only possible with PROFIdrive encoders as of product version A16. For this, "Hardware interface > Encoder" must be selected as the "Encoder" data connection in the configuration window.

Alternatively, you must calibrate the following parameters manually:

Encoder type

Depending on the selected encoder type, configure the following parameters:

Encoder type	Rotary incremental
Increments per revolution	Configure the number of increments that the encoder resolves per revolution in this field.
Bits for fine resolution in the incremental actual value (Gx_XIST1)	Configure the number of bits for fine resolution within the incremental actual value (Gx_XIST1) in this field.

Encoder type	Rotary absolute
Increments per revolution	Configure the number of increments that the encoder resolves per revolution in this field.
Number of revolutions	Configure the number of revolutions that the absolute encoder can detect in this field.
Bits for fine resolution in the incremental actual value (Gx_XIST1)	Configure the number of bits for fine resolution within the incremental actual value (Gx_XIST1) in this field.
Bits for fine resolution in the absolute actual value (Gx_XIST2)	Configure the number of bits for fine resolution within the absolute actual value (Gx_XIST2) in this field.

Encoder type	Rotary cyclic absolute
Increments per revolution	Configure the number of increments that the encoder resolves per revolution in this field.
Number of revolutions	Configure the number of revolutions that the absolute encoder can detect in this field.
Bits for fine resolution in the incremental actual value (Gx_XIST1)	Configure the number of bits for fine resolution within the incremental actual value (Gx_XIST1) in this field.
Bits for fine resolution in the absolute actual value (Gx_XIST2)	Configure the number of bits for fine resolution within the absolute actual value (Gx_XIST2) in this field.

Encoder type	Linear incremental
Distance between two increments	Configure the distance between two increments of the encoder in this field.
Bits for fine resolution in the incremental actual value (Gx_XIST1)	Configure the number of bits for fine resolution within the incremental actual value (Gx_XIST1) in this field.

Encoder type	Linear absolute
Distance between two increments	Configure the distance between two increments of the encoder in this field.
Bits for fine resolution in the incremental actual value (Gx_XIST1)	Configure the number of bits for fine resolution within the incremental actual value (Gx_XIST1) in this field.
Bits for fine resolution in the absolute actual value (Gx_XIST2)	Configure the number of bits for fine resolution within the absolute actual value (Gx_XIST2) in this field.

Encoder type	Linear cyclic absolute
Distance between two increments	Configure the distance between two increments of the encoder in this field.
Bits for fine resolution in the incremental actual value (Gx_XIST1)	Configure the number of bits for fine resolution within the incremental actual value (Gx_XIST1) in this field.
Bits for fine resolution in the absolute actual value (Gx_XIST2)	Configure the number of bits for fine resolution within the absolute actual value (Gx_XIST2) in this field.

See also

Configuration - Data exchange (Page 259)

Encoder to technology module (Page 259)

Technology object external encoder (Page 131)

5.5.3 Extended Parameters

5.5.3.1 Configuration - Mechanics

Configuration - Mechanics

Configure the encoder parameters for the position of the externally controlled drive in the "Mechanics" configuration window.

The configuration varies according to the type of encoder:

- Linear (Page 266)
- Rotary (Page 266)

See also

Technology object external encoder (Page 131)

Mechanics (Page 60)

Linear

Invert encoder direction

Select this check box if you would like to invert the actual value of the encoder.

Load gear

Number of motor revolutions / number of load revolutions

The gear ratio of the measuring gearbox is specified as the ratio between motor revolutions and load revolutions. Specify here an integer number of motor revolutions and the resulting number of load revolutions.

Select the same values for the number of motor revolutions and load revolutions, if no load gear is present.

Position parameters

Leadscrew pitch

In this configuration field, configure the distance by which the load is moved when the leadscrew makes one revolution.

See also

Configuration - Mechanics (Page 265)

Rotary (Page 266)

Technology object external encoder (Page 131)

Mechanics (Page 60)

Rotary

Invert encoder direction

Select this check box if you would like to invert the actual value of the encoder.

Load gear

Number of motor revolutions / number of load revolutions

The gear ratio of the measuring gearbox is specified as the ratio between encoder revolutions and load revolutions. Specify here an integral number of load revolutions and the resulting number of encoder revolutions.

Select the same values for the number of motor revolutions and load revolutions, if no load gear is present.

See also

Configuration - Mechanics (Page 265)

Linear (Page 266)

Technology object external encoder (Page 131)

Mechanics (Page 60)

5.5.3.2 Homing

Configuration - Homing

Configure the parameters for homing the external encoder in the "Homing" configuration window. Homing is performed using the Motion Control instruction "MC_Home" Mode = 2, 8 and 10.

Note

Parameter "MC_Home.Mode"

The "MC_Home.Mode" parameter for S7-1200 Motion Control and S7-1500 Motion Control has been standardized within the framework of technology version V2.0. This results in a new assignment of the parameter values for the "MC_Home.Mode" parameter. A comparison of the "MC_Home.Mode" parameter for technology versions V1.0 and V2.0 is available in the section Version overview (Page 179).

Select the homing mode

Select from among the following homing modes:

- Reference cam and zero mark via PROFIdrive telegram (Page 268)
- Use zero mark via PROFIdrive telegram (Page 269)
- Homing mark via digital input (Page 270)

See also

Technology object external encoder (Page 131)

Reference cam and zero mark via PROFIdrive telegram

Homing direction

Select the direction in which the zero mark should be approached for homing. The next zero mark after leaving the reference cam is used.

The following options are available:

- **Positive**

  Axis moves in the direction of higher position values.

- **Negative**

  Axis moves in the direction of lower position values.

- **Current**

  The currently effective approach direction is used for homing.

Home position

In this field, configure the absolute coordinate of the home position. The home position configured here is in effect when the Motion Control instruction "MC_Home" is executed with Mode = 10.

Note

Parameter "MC_Home.Mode"

The "MC_Home.Mode" parameter for S7-1200 Motion Control and S7-1500 Motion Control has been standardized within the framework of technology version V2.0. This results in a new assignment of the parameter values for the "MC_Home.Mode" parameter. A comparison of the "MC_Home.Mode" parameter for technology versions V1.0 and V2.0 is available in the section Version overview (Page 179).

See also

Configuration - Homing (Page 267)

Use zero mark via PROFIdrive telegram (Page 269)

Homing mark via digital input (Page 270)

Technology object external encoder (Page 131)

Use zero mark via PROFIdrive telegram

Homing direction

Select the direction in which the next zero mark should be approached for homing. The following options are available:

- **Positive**

  Axis moves in the direction of higher position values.

- **Negative**

  Axis moves in the direction of lower position values.

- **Current**

  The currently effective approach direction is used for homing.

Home position

In this field, configure the absolute coordinate of the home position. The home position configured here is in effect when the Motion Control instruction "MC_Home" is executed with Mode = 10.

Note

Parameter "MC_Home.Mode"

The "MC_Home.Mode" parameter for S7-1200 Motion Control and S7-1500 Motion Control has been standardized within the framework of technology version V2.0. This results in a new assignment of the parameter values for the "MC_Home.Mode" parameter. A comparison of the "MC_Home.Mode" parameter for technology versions V1.0 and V2.0 is available in the section Version overview (Page 179).

See also

Configuration - Homing (Page 267)

Reference cam and zero mark via PROFIdrive telegram (Page 268)

Homing mark via digital input (Page 270)

Technology object external encoder (Page 131)

Homing mark via digital input

Digital input homing mark

In this configuration field, select a digital input that is to act as a homing mark (reference cam). Also select the level at which the homing mark is to be detected.

Homing direction

Select the direction in which the homing mark for homing is to be approached.

The following options are available:

- Positive

  Axis moves in the direction of higher position values.
- Negative

  Axis moves in the direction of lower position values.
- Current

  The currently effective approach direction is used for homing.

Homing mark

Select which switch position of the "digital input" is to be used as the homing mark.

When a "digital input" is crossed, two switching edges that are spatially separated from one another are generated. The selection of the positive or negative side ensures that the homing mark is always evaluated at the same mechanical position.

The positive side is the switch position with a greater position value; the negative side is the switch position with the lesser position value.

The selection of the side is independent of the approach direction, and independent of whether it causes a rising or falling edge.

Home position

In this field, configure the absolute coordinate of the home position. The home position configured here is in effect when the Motion Control instruction "MC_Home" is executed with Mode = 10.

Note

Parameter "MC_Home.Mode"

The "MC_Home.Mode" parameter for S7-1200 Motion Control and S7-1500 Motion Control has been standardized within the framework of technology version V2.0. This results in a new assignment of the parameter values for the "MC_Home.Mode" parameter. A comparison of the "MC_Home.Mode" parameter for technology versions V1.0 and V2.0 is available in the section Version overview (Page 179).

See also

Configuration - Homing (Page 267)

Use zero mark via PROFIdrive telegram (Page 269)

Reference cam and zero mark via PROFIdrive telegram (Page 268)

Technology object external encoder (Page 131)

5.5.3.3 Actual value extrapolation

Configure the properties of the extrapolation for an actual value coupling for synchronous operation in the "Actual value extrapolation" configuration window. The values set here only apply when the actual values of this encoder are used as leading value.

Position filter T1 and T2

Enter the time constants for the filtering of the actual position.

Velocity filter T1 and tolerance band width

Enter the time constant for the smoothing of the velocity and the tolerance band width.

For optimized application of the tolerance band, enter the same width for the tolerance band as the width of the noise signal.

Following-axis dependent extrapolation time

Enter the part caused by the following axis for calculation of the extrapolation time.

Hysteresis value

Enter a value for application of the hysteresis function to the extrapolated actual value. The specification is made in the configured length unit.

See also

Technology object external encoder (Page 131)

Extrapolation of the leading values for actual value coupling (Page 116)

5.6 Configuring the technology object measuring input

5.6.1 Configuration - Basic Parameters

Configure the basic properties of the technology object in the "Basic Parameters" configuration window.

Name

Define the name of the measuring input in this field. The technology object is listed under this name in the project tree. The tags of the measuring input can be used in the user program under this name.

Assigned axis or external encoder

The axis or external encoder assigned to the measuring input is displayed. You can use the link to directly access the configuration of the basic parameters of the higher-level technology object.

Unit of measure

The indicated unit of measure for the position of the measuring input corresponds to the unit of measure of the higher-level technology object.

See also

Units of measure (Page 36)

Technology object measuring input (Page 133)

5.6.2 Configuration - Hardware interface

Measuring input type

Select the measuring input type.

- Measuring using TM Timer DIDQ
- Measurement via SINAMICS measuring input
- Measurement using PROFIdrive telegram (drive or external encoder)

Measurement using TM Timer DIDQ

Select a measurement input for a measurement using a Timer DI. The selection box shows all channels that are configured correctly.

Measurement via SINAMICS measuring input

Select a measuring input for a measurement via SINAMICS measurement sensing input. The selection box shows all compatible telegram types. You are shown all terminals that can potentially be used as measuring inputs. For the assignment, note that the inputs of must be assigned to the measuring inputs (P680) in the telegram without gaps and in ascending order.

With P728.8 to P728.15, you configure all DI/DOs used as a measurement input on the control unit. Use P680 of the control unit to specify the terminals for the global measuring inputs.

Measurement using PROFIdrive telegram (drive or external encoder)

For a measurement via PROFIdrive telegram, select the number of the measuring input in the telegram in the "Number of the measuring input" drop-down list. The input field is preset with the value "1".

Two communication channels are available for the transmission of measured values in the PROFIdrive telegram. These communication channels are assigned to one measurement input/digital input each in the drive. Use the PROFIdrive parameters to configure the digital input on the drive that is to be used for the configured communication channel.

- Measurement input for the first communication channel

  (<TO>.Parameter.PROFIdriveProbeNumber = 1)

  If you use two encoders, you must select the associated DI in the SINAMICS for each encoder. Various results are the transferred to the technology object depending on the selected encoder. The sensors are configured using the parameters P488[0] and P488[1].

- Measurement input for the second communication channel

  (<TO>.Parameter.PROFIdriveProbeNumber = 2)

  If you use two encoders, you must select the associated DI in the SINAMICS for each encoder. Various results are the transferred to the technology object depending on the selected encoder. The sensors are configured using the parameters P489[0] and P489[1].

Correction time for the measuring signal

Specify a correction time if possible delay times in the measurement signal are to be compensated.

See also

Automatic transfer of drive and encoder parameters in the device (Page 47)

Technology object measuring input (Page 133)

Configuring technology modules for Motion Control (Page 328)

5.6.3 Configuration - Extended parameters

Adjustment for activation time of the measuring range

To adjust the activation time defined on the system side, enter an additional activation time here.

The configuration window also displays the following times calculated on the system side:

- Time after the measuring job request until the measuring event can be recoreded
- Time after the measuring event until the measurement result is displayed (for measuring of one or two edges)

See also

Measuring with measuring range (Page 141)

Time-related boundary conditions (Page 142)

Technology object measuring input (Page 133)

5.7 Configuring the cam technology object

5.7.1 Configuration - Basic Parameters

Configure the basic properties of the technology object in the "Basic Parameters" configuration window.

Name

Define the name of the output cam in this field. The technology object is listed under this name in the project tree. The tags of the output cam can be used in the user program under this name.

Assigned axis or external encoder

The axis or external encoder assigned to the output cam is displayed. You can use the link to directly access the configuration of the basic parameters of the higher-level technology object.

Output cam type

Select based on the desired switching behavior of an output cam type:

- Distance output cam (position-dependent switch-on/switch-off)
- Time-based output cam (position-dependent switch-on and position-independent or time-dependent switch-off)

Output cam reference

Configure in this selection whether the switching points of the output cam are to reference the actual position or the position setpoint.

Unit of measure

The indicated unit of measure for the position of the output cam corresponds to the unit of measure of the higher-level technology object.

When a time-based output cam is selected as the output cam type, the unit of measure for the switch-on duration and other times is also indicated. For output cams, this is always ms.

See also

Units of measure (Page 36)

Technology object output cam (Page 146)

5.7.2 Configuration - Hardware interface

Output cam output

Select whether the generated switching signals are to be output at the digital output.

- **Activate output**

  Select one of the following two output options for the output cam output:

  – **Output by TM Timer DIDQ**

    For output by TM Timer DIDQ, select a previously configured technology module and the channel to be used in the "Output" field.

    If no technology module is available for selection, change to the device configuration and add a technology module.

  – **Output by digital output module**

    For output by a digital output module, select this in the "Cam output" field. Only the digital outputs with previously defined PLC tags are displayed for selection.

  Select the logical operation of the output cam signal at the output. The logic operation relates to the last signal to be output after the set inversion, if any.

  All output cams that use the selected output are shown graphically.

- **Output deactivated**

  When the output is deactivated, the output cam is evaluated only in the software.

See also

Technology object output cam (Page 146)

Configuring technology modules for Motion Control (Page 328)

5.7.3 Extended parameters

5.7.3.1 Configuration - Activation time

The specified output cam type is indicated in the upper area of the "Activation time" configuration window.

Activation time and deactivation time

For a time shift of the switch-on and switch-off times of an output cam, enter an activation time and a deactivation time.

See also

Compensation of actuator switching times (Page 158)

Technology object output cam (Page 146)

5.7.3.2 Configuration - Hysteresis

To prevent unwanted changes in the switching state of the output cam of a cam track, enter a hysteresis value.

When using an output cam with reference to actual position, always enter a hysteresis value (> 0.0).

See also

Hysteresis (Page 155)

Technology object output cam (Page 146)

5.8 Configuring the cam track technology object

5.8.1 Configuration - Basic Parameters

Configure the basic properties of the technology object in the "Basic Parameters" configuration window.

Name

Define the name of the cam track in this field. The technology object is listed under this name in the project tree. The tags of the cam track can be used in the user program under this name.

Assigned axis or external encoder

The axis or external encoder assigned to the cam track is displayed. You can use the link to directly access the configuration of the basic parameters of the higher-level technology object.

Output cam type

Select based on the desired switching behavior of an output cam type for the cam track:

- Distance output cam (position-dependent switch-on/switch-off)
- Time-based output cam
  (position-dependent switch-on and position-independent or time-dependent switch-off)

Output cam reference

In this selection, configure whether the switching points of the cam track are to reference the actual position or the position setpoint.

Unit of measure

The indicated unit of measure for the position of the cam track corresponds to the unit of measure of the higher-level technology object.

When a time-based output cam is selected as the output cam type, the unit of measure for the switch-on duration and other times is also indicated. For output cams, this is always ms.

See also

Units of measure (Page 36)

Cam track technology object (Page 161)

5.8.2 Configuration - Hardware interface

Output cam track

Select whether the generated switching signals are to be output at the digital output.

- **Activate output**

  Select one of the following two output options for the output track:

  - **Output by TM Timer DIDQ**

    For output by TM Timer DIDQ, select a previously configured technology module and the channel to be used in the "Output" field.

    If no technology module is available for selection, change to the device configuration and add a technology module.

  - **Output by digital output module**

    For output by a digital output module, select this in the "Cam output" field. Only the digital outputs with previously defined PLC tags are displayed for selection.

- **Output deactivated**

  When the output is deactivated, the cam track is evaluated only in the software.

See also

Cam track technology object (Page 161)

Configuring technology modules for Motion Control (Page 328)

5.8.3 Extended parameters

5.8.3.1 Track data

Configuration - Activation time

The specified output cam type is displayed.

Activation time and deactivation time

Enter the activation time and the deactivation time.

For a time shift of the switch-on and switch-off times of the output cam of a cam track, enter an activation time and a deactivation time.

See also

Time offset of cam switching points (Page 172)

Cam track technology object (Page 161)

Configuration - Hysteresis

To prevent unwanted changes in the switching state of the output cam of a cam track, enter a hysteresis value.

When using an output cam with reference to actual position, always enter a hysteresis value (> 0.0).

See also

Hysteresis (Page 172)

Cam track technology object (Page 161)

Configuration - Track dimensions

Track length

Enter the corresponding track length.

Also take into account the output cam data of the individual output cams when defining the track length. Output cams, the start position of which lies outside the cam track length are not included. They become active only if the cam track length is increased so that at least the respective start position of an output cam is within the new track length.

Axis reference position

Enter the position of an axis or external encoder starting from which the output of the cam track is to occur. The start of the cam track is placed at the entered position.

You can enter a negative or positive value for the reference position.

Modulo length of the axis

When an axis with modulo function is used, the modulo length of the axis is displayed.

See also

Cam track technology object (Page 161)

5.8.3.2 Configuration - Output cam data

The specified output cam type is displayed.

Enter the properties for the output cams of the cam track that are to be output. You can set up to 32 individual output cams on a cam track.

Also take into account any previously defined track length when defining the output cam data. Output cams, the start position of which lies outside the cam track length are not included. They become active only if the cam track length is increased so that at least the respective start position of an output cam is within the new track length.

The input options described below are displayed in the Output cam data configuration window according to the configured output cam type.

- Valid

  Only output cams set as "valid" are output and have a status display.

- Start position
  - The start position may not be greater than the end position for distance output cams.
  - If the start position is equal to the end position, the distance output cam does not switch.
  - The switching ranges of individual output cams are permitted to overlap.

- End position
  - The "End position" column is only displayed when distance output cam is set for the output cam type.
  - The end position must not be less than the start position.

- Switch-on duration

  The "Switch-on duration" column is only displayed when time-based output cam is set for the cam type.

See also

Cam track technology object (Page 161)

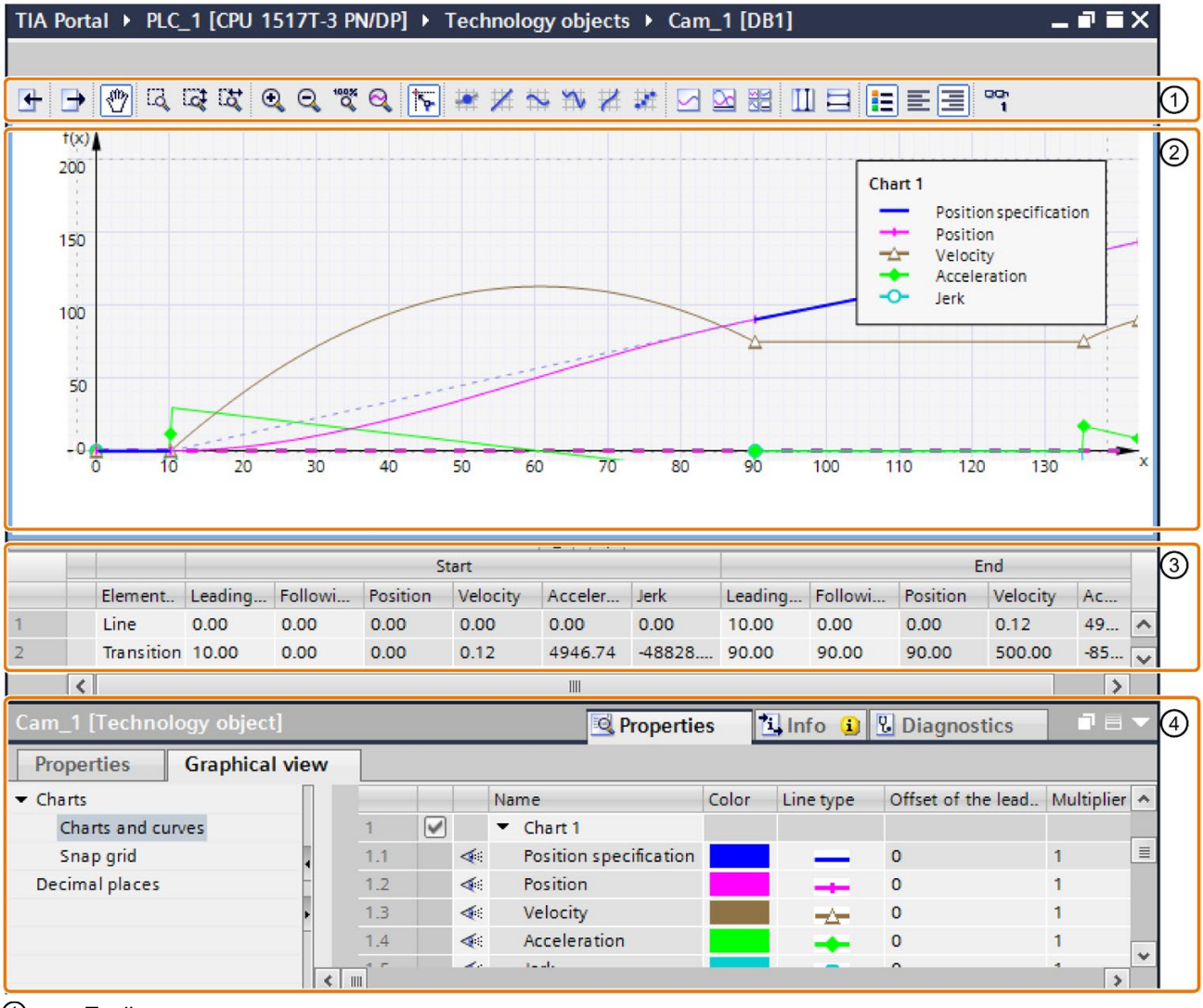
5.9 Configuring the cam technology object

5.9.1 Overview

You configure the cam technology object (Page 174) with an editor.

You create the cam using a diagram, a table containing the elements of the curve and the properties of the elements. Transitions are calculated between the individual elements of the cam (e.g. points, lines, polynomials). The curve reflects the path-related dependency between the leading axis (leading values, abscissa in the chart) and following axis (following values, ordinate in the chart).

The following figure shows the structure of the editor.



① Toolbar
② Graphical editor
The leading value range (definition range) is displayed on the abscissa (x axis).
The following value range (value range) is displayed on the ordinate (y axis).
③ Tabular editor
④ Properties (Inspector window)

Toolbar

You use the toolbar to operate the graphical editor and to import/export cams.

Graphical editor

In the graphical editor, you edit the elements of the curve graphically. The elements can be added, edited and deleted. Up to four charts can be created one above the other with synchronized abscissa. The setpoint curve as well as the curves for the effective position, velocity, acceleration and jerk can be displayed in the charts.

Tabular editor

All elements of the curve are listed in the tabular editor. Existing elements can be edited. New elements can be added.

Properties (Inspector window)

In the Inspector window, you configure the properties of the trend and of the selected element in the "Properties" tab, and the graphical view in the "Display" tab:

- Profile (e.g. leading and following value range, optimization and interpolation of the profile, number of elements used)
- Element (e.g. derivatives, polynomial coefficients, optimization of the element)
- Graphical view (e.g. line type, line color, scaling of the view)

Elements of the curve

The following table shows the elements that can be used to define the curve:

Element	Description
Point	A point assigns a following value to a leading value. The curve runs through the point with these coordinates. The velocity, acceleration and jerk can be defined in this point using the first, second and third derivations.
Point group	A point group combines two or more points into an commonly interpolated element and allows precise interpolation between these points.
Line	A line describes a motion with constant velocity from the start point of the line to the end point. The incline of the line specifies the constant velocity.
Sine	A sine element describes a motion according to the sine function. The sine function can be adjusted with the phase angle in the start point and end point, the period length, the amplitude as well as the oscillation zero point (offset).
Polynomial	A polynomial describes a motion according to a polynomial function of the 7th degree maximum. Polynomials can be defined by entering the boundary conditions or the polynomial coefficients. Optionally, you can configure a trigonometric polynomial component.
Inverse sine (approximated)	An inverse sine describes a motion according to the arcsine function. An inverse sine is approximated using interpolation points of the arcsine function.
Transition	Transitions interpolate the range between two elements. The ranges are automatically interpolated by the controller or using a configurable optimization according to VDI Guideline 2143. Transitions are added automatically.

5.9.2 Operating the cam editor

The procedure described here shows the basic operation of the cam editor. This procedure serves as a recommendation.

The basic operation can include the follow tasks:

- Adapting defaults
- Creating and adapting the curve
- Interpolation/optimization of the transitions

Adapting defaults

To adjust the leading and following value range of the cam profile as well as the graphical view, follow these steps:

1. In the properties (Inspector window), open the "Profile > General (Page 302)" configuration window.
2. Configure the leading value range and the following value range of the curve definition.

   The graphical view is automatically adapted to the inputs.
3. Open the "Display (Page 321)" tab in the area navigation of the Inspector window.
4. Configure the configuration windows:
   - The display of the charts and curves
   - The grid spacing for aligning inputs in the graphical editor
   - The decimal places displayed in the cam editor.

Creating and adapting the curve

To create and adapt the curve, follow these steps:

1. Use the graphical editor and/or the tabular editor to add the elements of the cam:
   - Select the tool required for inserting the respective element in the toolbar. Place the element at the required position in the graphical editor.
   - Use <Add> to insert the corresponding elements in the "Element type" column of the tabular editor. Adjust the position of the elements using the start and end values.

   Transitions between the elements are added automatically.
2. To edit an element, select it in the graphical or tabular editor.

   The element is highlighted in the graphical and in the tabular editor. The "Element > Parameter/Characteristic" configuration window is displayed in the properties (Inspector window).
3. The elements can be adjusted as follows:
   - Move the element or the drag handles of the element in the graphical editor.
   - Adjust the start and end values in the tabular editor.
   - Configure additional element-specific parameters in the properties (Inspector window) in the "Element > Parameter (Page 309)" configuration window.
   - Set the interpolation of the transitions with the properties (Inspector window).

The number of elements used is displayed in the properties (Inspector window) in the "Profile > Statistics (Page 307)" properties window.

Setting the interpolation of the transitions (system interpolation)

The interpolation (Page 176) can be set separately for each transition. The default for interpolation of the transitions is the system interpolation. You configure the system interpolation for all transitions in the properties (Inspector window) in the "Profile > System interpolation (Page 304)" configuration window.

Setting the optimization of the transitions (VDI Guideline 2143)

Each transition can also be adapted separately according to the VDI Guideline 2143. In doing so, the settings in the properties (Inspector window) in the "Profile > Default optimization settings (Page 303)" configuration window are taken into consideration.

To adapt the optimization of a transition according to the VDI Guideline 2143, follow these steps:

1. Select the transition in the graphical or tabular editor.
2. In the properties (Inspector window), open the "Element > Characteristic (Page 317)" configuration window.
3. Select the optimization method "VDI-based optimization" in the "Optimization method" drop-down list.
4. If necessary, change the default settings.

   The selection of the parameters is automatically limited to the settings that can be applied according to VDI Guideline 2143.

The optimization of the transitions according to VDI guidelines consumes additional points and/or segments (Page 307) in the cam.

See also

Configuration charts - Charts and curves (Page 321)

5.9.3 Graphical editor

5.9.3.1 Structure of the graphical editor

The graphical editor is divided into the following areas:

- Toolbar
- Curve diagram

Toolbar

The toolbar at the top of the graphical editor provides you with buttons for the following functions:

Button	Function	Description
	Importing cam from file	See section Importing/exporting cam (Page 323).
	Exporting cam to file	See section Importing/exporting cam (Page 323).
	Edit elements/ Move view	• Selecting and moving of individual elements and element • Moving the view using drag-and-drop To switch from any tool to the "Edit elements/Move view" tool, press the <Esc> key.
	Activate zoom selection	Zoom into selected area
	Activate vertical zoom	Vertical zoom into selected area without horizontal scaling Alternative: <Ctrl> +drag to ordinate keeping mouse button pressed
	Activate horizontal zoom	Horizontal zoom into selected area without vertical scaling Alternative: <Ctrl> +drag to abscissa keeping mouse button pressed
	Zoom in	Enlargement of the display Alternative: <Ctrl> + mouse wheel up in curve diagram
	Zoom out	Reduction of the display Alternative: <Ctrl> + mouse wheel down in curve diagram
	Show all	Display of entire definition and value range
	Zoom into curve	Zoom to the legend of the chart of the selected curve
	Activate snap grid	Inputs and element end points are aligned to the configurable snap grid and to other element end points.
	Inserting a point	Adding a point to the chart
	Inserting a line	Adding a line to the chart
	Inserting a sine	Adding a sine element to the chart
	Inserting a polynomial	Adding a polynomial to the chart

Button	Function	Description
	Inserting an inverse sine	Adding an inverse sine to the chart
	Insert point group	Add a point group to the chart
	View: A chart with positions	Display of one chart with the following curves of the cam opened in the editor: • Preset curve • Effective position
	View: A chart with all curves	Display of one chart with the following curves of the cam opened in the editor: • Preset curve • Effective position • Effective velocity • Effective acceleration • Effective jerk
	View: Four charts with all curves	Display of four charts with the following curves of the cam opened in the editor: • Chart with setpoint curve and effective position • Chart with effective velocity • Chart with effective acceleration • Chart with effective jerk
	Vertical measuring lines	Displaying and moving of vertical measuring lines Hold down the left mouse button and drag to draw a measuring range. The vertical position of the measuring lines can be moved. The function values for the measuring line positions are displayed in the chart. The difference of the measuring lines is displayed between the measuring lines.
	Horizontal measuring lines	Displaying and moving of horizontal measuring lines Hold down the left mouse button and drag to draw a measuring range. The horizontal position of the measuring lines can be moved. The function values for the measuring line positions are displayed in the chart. The difference of the measuring lines is displayed between the measuring lines.
	Show legend	Showing or hiding of the legend in the curve diagram. To display values for a specific curve on the ordinate, click on the name of the corresponding curve in the legend.
	Show legend left	Display of the legend on the left side of the curve diagram.
	Show legend right	Display of the legend on the right side of the curve diagram.
	Show online curve	Display of the position values of the cam read back from the CPU (orange)

Curve diagram

In the curve diagram, you enter the elements of the curve and adjust the curve by selecting and moving elements.

Chart areas outside of the leading value/following value range configured in "Profile > General (Page 302)" are grayed out. Elements outside the leading value / following value range are displayed with a warning ("Element is outside the definition range").

You can display various curves (position, velocity, acceleration and jerk) one above the other in up to four charts by configuring the graphical view accordingly. When multiple charts are displayed, you can adapt the graphs to match the separator lines.

The view can be zoomed in the manual mode by pressing <Ctrl > + Mouse wheel and <Ctrl > + while pressing the mouse button on the abscissa/ordinate.

The editor shows messages for checking the entered curve via warning triangles . The tooltip of the waring triangle shows the message text. Configure the checking of the curve in the "Check (Page 306)" configuration window.

Display of the online curve

When you click the button, the data from the technology object data black are uploaded once and displayed if necessary.

Cam status	Interpolation status	
Data modified (CamDataChanged = 0)	Not interpolated (Interpolated = 0)	Only the points and segments of the cam are displayed.
	Interpolated (Interpolated = 1)	The entire cam is displayed.
Data modified (CamDataChanged = 1)	Not interpolated (Interpolated = 0)	Only the points and segments of the cam are displayed.
	Interpolated (Interpolated = 1)	Only the points and segments of the cam are displayed and interpolated.

5.9.3.2 Inserting a point

A point assigns a following value to a leading value. The curve runs through the point with these coordinates.

By means of the first, second and third derivatives, the velocity, acceleration and jerk can be defined in this point. The derivations are taken into consideration during VDI-based optimization of transitions of the points to other elements.

Inserting a point

To add a point to the curve, follow these steps:

1. Select the "Insert point" tool in the toolbar.
2. Click on the position in chart 1 where you want to insert the point.

   The point is inserted. The coordinates are displayed for the point. The tabular editor and the view of the properties (Inspector window) are updated. A transition to any element is inserted automatically.

Moving a point

To move a point in the graphical editor, follow these steps:

1. Select the "Edit elements/Move view" tool in the toolbar.
2. Select the point in chart 1.
3. Use drag-and-drop to move the point to the desired position.

Adapting parameters

The parameters of the point can be adjusted in the tabular editor as well as in the properties (Inspector window) under "Element > Parameter (Page 310)".

5.9.3.3 Insert point group

A point group combines two or more points into an commonly interpolated element and allows precise interpolation between the points.

Insert point group

To add a point group to the trend, proceed as follows:

1. Select the "Insert point group" tool in the toolbar.
2. In Chart 1, click on the position at which you want to insert the point group.

   The point group is inserted. The coordinates of the start point and the end point are displayed at the point group. The tabular editor and the view of the properties (Inspector window) are updated. If a different element already exists, a transition to the existing element is automatically inserted.

Adapt point group

To adapt a point group in the graphical editor, proceed as follows:

1. Select the "Edit elements/Move view" tool in the toolbar.
2. Select the point group in Chart 1.

   The point group is highlighted graphically with drag handles. The following drag handles are displayed:

   – Start value of the point group
   – End value of the point group
3. Drag-and-drop the drag handles or the whole point group to the desired position.

   If further interpolation points are configured between the start point and the end point in the point group, the cam editor handles the interpolation points as follows:

   – Definition type of the leading value "Relative to the segment"

     The interpolation points are shifted relative to the start and end points.
   – Definition type of the leading value "Absolute in the profile"

     The interpolation points are not moved.

Adapting parameters

The parameters of the point group can be adapted in the graphical editor, in the tabular editor as well as in the properties (Inspector window) under "Element > Parameter (Page 310)".

5.9.3.4 Inserting a line

A line describes a motion with constant velocity from the start point of the line to the end point. The incline of the line specifies the constant velocity.

Inserting a line

To add a line to the curve, follow these steps:

1. Select the "Insert line" tool in the toolbar.
2. Use drag-and-drop in chart 1 to draw the line from the start position to the end position.

   The line is inserted. The coordinates of the start point and end point are displayed for the line. The tabular editor and the view of the properties (Inspector window) are updated. A transition to any element is inserted automatically.

Moving a line

To move a line in the graphical editor, follow these steps:

1. Select the "Edit elements/Move view" tool in the toolbar.
2. Select the line in chart 1.

   The line is graphically highlighted with drag handles. The following drag handles are displayed:

   – Start point of the line
   – End point of the line

3. Use drag-and-drop to move the drag handles or the entire line to the desired position.

Adapting parameters

The parameters of the line can be adjusted in the graphical editor, in the tabular editor as well as in the properties (Inspector window) under "Element > Parameter (Page 312)".

5.9.3.5 Inserting a sine

A sine element describes a motion according to the sine function. The sine function can be adjusted with the phase angle in the start point and end point, the period length, the amplitude as well as the oscillation zero point (offset).

Inserting a sine

To add a sine to the curve, follow these steps:

1. Select the "Insert sine" tool in the toolbar.
2. Click on the position in chart 1 where you want to insert the sine. The mouse pointer points to the start position of the sine here.

   The sine is inserted. The coordinates of the start point and end point are displayed for the sine. The tabular editor and the view of the properties (Inspector window) are updated. A transition to any element is inserted automatically.

Adjusting a sine

To adjust a sine in the graphical editor, follow these steps:

1. Select the "Edit elements/Move view" tool in the toolbar.
2. Select the sine in chart 1.

   The sine is graphically highlighted with drag handles and guide lines for the zero line and the amplitude. The following drag handles are displayed:

   – Leading value/shifting at left/right boundary

     These drag handles can also be used to adjust the inclination of an inclined sine.

   – Leading value at left/right boundary

   – Phase at left/right boundary

   – Amplitude
3. Use drag-and-drop to move the drag handles or the entire sine to the desired position.

Adapting parameters

The parameters of the sine can be adjusted in the graphical editor, in the tabular editor as well as in the properties (Inspector window) under "Element > Parameter (Page 313)".

5.9.3.6 Inserting a polynomial

A polynomial describes a motion according to a polynomial function of the 6th degree maximum. Polynomials can be defined by entering the boundary conditions or the polynomial coefficients. Optionally, you can configure a trigonometric polynomial component.

Inserting a polynomial

To add a polynomial to the curve, follow these steps:

1. Select the "Inserting polynomial" tool in the toolbar.
2. Click on the position in chart 1 where you want to insert the polynomial. In so doing, the mouse pointer points to the start position of the polynomial.

   The polynomial is inserted. The coordinates of the start point and end point are displayed for the polynomial. The tabular editor and the view of the properties (Inspector window) are updated. If a different element already exists, a transition to the existing element is automatically inserted.

Adjusting a polynomial

To adjust a polynomial in the graphical editor, follow these steps:

1. Select the "Edit elements/Move view" tool in the toolbar.
2. Select the polynomial in chart 1.

   The polynomial is graphically highlighted with drag handles. The following drag handles are displayed:

   – Leading value/following value at left/right boundary
   – Position of point of inflection
3. Use drag-and-drop to move the drag handles or the entire sine to the desired position.

Adapting parameters

The parameters of the polynomial can be adapted in the graphical editor, in the tabular editor as well as in the properties (Inspector window) under "Element > Parameter (Page 314)".

5.9.3.7 Inserting an inverse sine

An inverse sine describes a motion according to the arcsine function. The arcsine function is the inverse function of the sine function. An inverse sine is approximated using interpolation points of the arcsine function.

Inserting an inverse sine

To add an inverse sine to the curve, follow these steps:

1. Select the "Insert inverse sine" tool in the toolbar.
2. Click on the position in chart 1 where you want to insert the inverse sine. In so doing, the mouse pointer points to the start position of the inverse sine.

   The sine is inserted. The coordinates are displayed for the point. The tabular editor and the view of the properties (Inspector window) are updated. A transition to any element is inserted automatically.

Adjusting an inverse sine

To adjust an inverse sine in the graphical editor, follow these steps:

1. Select the "Edit elements/Move view" tool in the toolbar.
2. Select the inverse sine in chart 1.

   The inverse sine is graphically highlighted with drag handles. The following drag handles are displayed:

   – Start point of the inverse sine
   – End point of the inverse sine
3. Use drag-and-drop to move the drag handles or the entire inverse sine to the desired position.

Adapting parameters

The parameters of the inverse sine can be adjusted in the graphical editor, in the tabular editor as well as in the properties (Inspector window) under "Element > Parameter (Page 316)".

5.9.3.8 Deleting an element

To delete an element in the graphical editor, follow these steps:

1. Select the element.
2. Press the <Del> key.

   The element is deleted. The graphical editor and the view of the properties (Inspector window) are updated. A transition to any element present is also deleted.

5.9.3.9 Shortcut menu in the graphical editor

The following table shows the functions in the shortcut menu of the graphical editor:

Function	Description
Show all	Display of entire definition and value range
Zoom into curve	Displays the curve selected in the legend of the chart
Zoom in	Enlargement of the display
Zoom out	Reduction of the display
Cut	Removing the selected elements and copying them to the clipboard
Copy	Copying of the selected elements to the clipboard
Paste	Pasting of the elements from the clipboard to the last element
Delete	Deletion of the selected elements Transitions to existing elements are also deleted.
Paste special	Call of the "Paste elements (Page 326)" dialog
Group into points group	Combine the selected points into a group of points The entry is displayed under the following conditions: • Only points are selected in the graphic/tabular editor. • There are no other elements between the selected points.
Ungroup into points	Ungroups the selected point group into individual points
Move	Call of the "Move elements (Page 326)" dialog
Scale	Call of the "Scale elements (Page 326)" dialog

See also

Dialogs in the shortcut menu (Page 326)

5.9.4 Tabular editor

5.9.4.1 Structure of the tabular editor

The tabular editor shows all elements of the curve, sorted by their leading values. The elements can be adjusted. New elements can be added.

The following properties are displayed in the corresponding column for each element of the curve:

Column/Property		Description
First column		Sequential number of the element
Second column		Display of calculation problems that might occur with warning triangle ⚠ The alarm text is displayed in the tooltip of the warning triangle.
Element type		• Display/change of element type • Adding elements Possible element types: • Point • Line • Sine • Polynomial • Inverse sine • Transition
Start		Parameter values at start point of the element
	Leading value	Leading values at start point of the element
	Following value	Following values at start point of the element
	Position[1)]	Calculated effective position at start point of the element
	Velocity[1)]	Calculated effective velocity at start point of the element
	Acceleration[1)]	Calculated effective acceleration at start point of the element
	Jerk[1)]	Calculated effective jerk at start point of the element
End		Parameter values at end point of the element
	Leading value	Leading values at end point of the element
	Following value	Following values at end point of the element
	Position[1)]	Calculated effective position at end point of the element
	Velocity[1)]	Calculated effective velocity at end point of the element
	Acceleration[1)]	Calculated effective acceleration at end point of the element
	Jerk[1)]	Calculated effective jerk at end point of the element
Comment		Optional comment for element.

1) Displayed according to the configuration in "Properties (Inspector window) > Graphical view > Charts and curves".

5.9.4.2 Editing the curve

The tabular editor provides you with the following options for editing the curve:

- Pasting elements
- Deleting elements
- Changing the element type
- Adjusting the leading value and following value of the boundary points

Inserting an element

To add an element in the tabular editor, follow these steps:

1. Select the desired element type from the "Add" drop-down list in the "Element type" column. "Add" is always displayed in the line after the last added element.

   The element is inserted after the last element with suitable values. The tabular editor and the view of the properties (Inspector window) are updated. A transition to any element is inserted automatically.

   The parameters of the element can be adjusted in the graphical editor, tabular editor, and properties (Inspector window).

Deleting an element

To delete an element in the tabular editor, follow these steps:

1. Select the line of the element.
2. Press the <Del> key.

   The element is deleted. The tabular editor and the view of the properties (Inspector window) are updated. A transition to any element present is also deleted.

Converting the element type

To convert the element type of an element in the tabular editor, follow these steps:

1. Select the line of the element.
2. Select the desired element type from the drop-down list in the "Element type" column.

   The element type of the element is converted to the selected element type. The tabular editor and the view of the properties (Inspector window) are updated. A transition to any element present is adjusted automatically.

Adjusting the leading value and following value of the boundary points

To change the leading value/following value of the boundary points of an element in the tabular editor, follow these steps:

1. Select the input field of the parameter to be changed.
2. Enter the desired value.

   The tabular editor and the view of the properties (Inspector window) are updated. A transition to any element present is adjusted automatically.

5.9.4.3 Shortcut menu in the tabular editor

The following table shows the functions in the shortcut menu of the tabular editor:

Function	Description
Insert row	Insertion of an element (point) in front of the selected element
Add row	Insertion of an element (point) after the selected element
Cut	Removing the selected elements and copying them to the clipboard
Copy	Copying of the selected elements to the clipboard
Paste	Pasting of the elements from the clipboard to the last element
Delete	Deletion of the selected elements Transitions to existing elements are also deleted.
Paste special	Call of the "Paste elements (Page 326)" dialog
Group into points group	Combine the selected points into a group of points The entry is displayed under the following conditions: • Only points are selected in the graphic/tabular editor. • There are no other elements between the selected points.
Ungroup into points	Ungroups the selected point group into individual points
Move	Call of the "Move elements (Page 326)" dialog
Scale	Call of the "Scale elements (Page 326)" dialog

5.9.5 Properties (Inspector window)

5.9.5.1 Context-sensitive display

The parameters for the profile of the cam as well as for the elements are displayed in the properties (Inspector window). The corresponding parameters are displayed according to the selected element: If no element of the curve is selected, only the settings for the profile of the cam are displayed. If an element of the curve is selected, the parameters of the element are additionally displayed.

5.9.5.2 Configuration of profile - General

Configure the leading value and following value range (definition and value range) of the cam in the "General" configuration window.

Leading value range of the curve definition

Configure the leading value range (definition range) of the cam in this area:

Parameters	Description
Start	Configure the start point of the leading value range of the cam in this field.
End	Configure the end point of the leading value range of the cam in this field.

Following value range of the curve definition

Configure the restriction of the following value range (value range) of the cam in this area:

Parameters	Description
Minimum	Configure the lowest permissible value for the following value range of the cam in this field.
Maximum	Configure the maximum permissible value for the following value range of the cam in this field.

5.9.5.3 Configuration of profile - Default optimization settings

You configure the default values for optimization of transitions according to VDI Guideline 2143 in the "Default optimization settings" configuration window. The default values are used when you use the "VDI-based optimization" optimization method for a transition (Page 317) and when you select the setting "Default optimization setting" for the continuity or the optimization target.

The cam is interpolated with the Motion Control instruction MC_InterpolateCam (Page 512) according to the settings for the VDI optimization.

Defaults for the VDI optimization

Configure the default settings for continuity requirement and optimization target in this area:

Parameters	Description
Continuity	In the drop-down list, select which parameter is continuous in the boundary points and is to be taken into consideration for optimization. • Position • Velocity (bumpless) • Acceleration (jerkless) • Jerk
Optimization target	In the drop-down list, select the optimization target according the VDI guideline: • Not specified • Velocity (Cv) • Acceleration (Ca) • Jerk (Cj) • Minimum Dynamic Moment (Cmdyn)

5.9.5.4 Configuration of profile - System interpolation

In the "System interpolation" configuration window, configure the interpolation of transitions according to the system specifications. These settings are used when you use the "System interpolation" optimization method for a transition (Page 317) (default setting).

The cam is interpolated with the Motion Control instruction MC_InterpolateCam (Page 512).

System interpolation settings

Configure the interpolation type and the behavior of the boundary points in this area.

Parameters	Description
Interpolation type	In the drop-down list, select the interpolation type to be used for interpolating the curve: • Linear interpolation • Interpolation with cubic splines • Interpolation with Bézier splines
Behavior at boundary	In the drop-down list, select which behavior of the boundary points applies to the interpolation: • No restrictions • First derivative continuous (velocity continuous) The cam is interpolated in such a way that the first derivative (velocity) is equal at the start and end of the cam.

5.9.5.5 Configuration of profile - Effective runtime curves

Configure the values for the leading axis and following axis that are applied to the effective curve In the "Effective runtime curves" configuration window. The runtime emulation calculates the effective curve with these applied values and displays the curve in the graphical editor with the applied limits.

The inputs are not downloaded into the CPU. This means the cam is interpolated without these inputs. You can use these applied values to test and visualize how the cam behaves during operation, e.g. when entering a scaling at "MC_CamIn".

Settings of the leading axis

Configure the calculation and display of the curve on the leading value end in this area:

Parameters	Description
Copy from axis	Using the button and the "Copy leading value settings of axis" dialog, select an axis whose maximum velocity is applied as the velocity for the leading axis.
Scaling factor	Configure a leading value-side scaling factor in this field. This allows the acceptance that a scaling is specified for an "MC_CamIn" job.
Unit	In the drop-down list, select the unit of measure for the leading value.
Unit of the first derivative.	In the drop-down list, select the unit of measure for the first derivative of the leading value.
Velocity	Configure the velocity of the leading axis applied for the runtime emulation of the curve in this field.

Settings of the following axis

Configure the calculation and display of the curve on the following value side in this area:

Parameters	Description
Copy from axis	Using the button and the "Copy following value settings of axis" dialog, select an axis whose maximum dynamic values are applied as the limits to be checked during calculation and display of the curve.
Scaling factor	Configure a following value-side scaling factor in this field. This allows the acceptance that a scaling is specified for an "MC_CamIn" job.
Unit	In the drop-down list, select the unit of measure for the following value.
Unit of the first derivative.	In the drop-down list, select the unit of measure for the first derivative of the following value.
Maximum velocity	Configure the maximum velocity for the following axis in this field.
Maximum acceleration	Configure the maximum acceleration for the following axis in this field.
Maximum jerk	Configure the maximum jerk for the following axis in this field.

5.9.5.6 Configuration - Check

In the "Verification" configuration window, you configure which criteria the cam editor checks when entering the curve. When you activate a check, the graphical and the tabular editor display corresponding messages via a warning triangle on the element. Use the tooltip at the warning triangle to display the message text.

Examination of limit violations

Configure the checks for compliance with the configured limits in this area:

Check/Element	Description
Observe the curve definition of the leading and following value ranges	Select the "Check curve definition of the leading and following value ranges" check box to have the cam editor check the curve accordingly.
Check adherence to the maximum values of the derivatives of the effective runtime curve	Select the "Check adherence to the maximum values of the derivatives of the effective runtime curve" check box to have the cam editor check the curve accordingly.

Verification of VDI suitability

Select the "Check the suitability of transitions in accordance with VDI" check box to have the cam editor check the VDI suitability of the curve.

The cam editor checks the following with this:

- Support of the transition classification of the currently selected VDI transition
- Boundary value adjustment according to VDI

Verification of continuity

In the "Required continuity" list, select which parameter the cam editor checks for continuity:

- Position
- Velocity
- Acceleration
- Jerk

If a function or a derivative is discontinuous, all higher derivatives are also discontinuous.

5.9.5.7 Profile - Statistics

The "Statistics" properties window shows an overview of the number of elements of the cam, as well as the minimum and maximum values of the effective curves for the slave value and the derivatives. A cam consists of a maximum of 1000 points and a maximum of 50 segments.

Used elements

This area shows the number of used elements of the curve:

Parameters	Description
Points	This field shows the number of used points of the cam. A cam consists of a maximum of 1000 points.
Segments	This field shows the number of used segments of the cam. A cam consists of a maximum of 50 segments.

The use of points and segments depends on the compilation and configuration of the elements. The following table shows the use of points and segments per element:

Element	Number of used points	Number of used segments
Point	1	0
Point at a transition with VDI-based optimization	0	0
Point group with point approximation mapping method	Number of interpolation points configured. (Properties (Inspector window) > Element > Parameter > Approximation > Number of interpolation points) Default setting: 32	0
Point group with segment approximation mapping method	0	Number of interpolation points configured - 1
Line	0	1
Sine	0	1
Polynomial	0	1
Inverse sine	Number of interpolation points configured. (Properties (Inspector window) > Element > Parameter > Approximation > Number of interpolation points) Default: 32	0
Inverse sine to the right of a transition with VDI-based optimization	Number of interpolation points configured - 1	0

Element	Number of used points	Number of used segments
Transition with system interpolation	0	0
Transition with VDI-based optimization		
Motion rule		
Sine	0	1
Sine with relative Lambda ≠ 0.5	0	2
Inclined sine	0	1
Inclined sine with relative Lambda ≠ 0.5	0	2
Polynomial	0	1
Sinus with relative Lambda ≠ 0.5	0	2
Modified acceleration trapezoid		
Motion task		
Dwell-in-reverse	0	5
Reverse-in-dwell	0	5
Dwell-in-dwell	0	6
Modified sine		
Motion task		
Dwell-in-dwell	0	3
Constant velocity-in-constant velocity	0	4
Constant-velocity-in-dwell	0	4
Dwell-in-constant velocity	0	4
Sine line combination	0	3
Harmonic combination	0	3
Double-harmonic transition	Number of interpolation points configured. (Properties (Inspector window) > Element > Parameter > Approximation > Number of interpolation points) Default setting: 32	0
Quadratic parabola	0	2

Lambda = turning point of the curve

Value ranges

This area shows the minimum and maximum values of the effective curves for the following value and the derivatives.

Boundary conditions

The following boundary conditions apply to the input and use of points and segments:

- **Points**

  With points with the same leading values, the point that you have entered last or which is listed in the tabular editor is active.

- **Segments**
  - Gaps between segments are filled with a transition segment.
  - For gaps in the leading value range of less than 1.0E-4, segment end points and segment start points are pulled together.
  - For gaps in the leading value range greater than 1.0E-4, a new transition segment is inserted.
  - For overlaps, the new segment is inserted from the start point and used completely. When the previous segment is defined in excess of the new segment, the previous segment continues to be used after the end point of the new segment.

- **Interpolation points and segments** (mixed cams)

  The segment is used when points are defined in the same range.

5.9.5.8 Configuration of elements - Parameters

In the "Parameters/Characteristic" configuration window, configure the parameters of the selected element of the curve. The inputs are applied in the tabular and graphical editors. The element-specific parameters are displayed according to the selected element:

- Point (Page 310)
- Line (Page 312)
- Sine (Page 313)
- Polynomial (Page 314)
- Inverse sine (Page 316)
- Transition (characteristic) (Page 317)

5.9.5.9 Configuration of elements - Parameters (Point)

Configure the parameters of the selected element in the "Parameters" configuration window.

Parameters

Configure the parameters of the selected point in this area:

Parameter/Option		Description
Leading value of the point		
	Leading value	In this field, configure the leading value of the point (value in the definition area).
Following values of the point		
	Following value	Configure the following value of the point (value in the range of the function) in this field.
	Use first derivative	Select the check box to specify the first derivative in the selected point and to include it in the interpolation of the cam.
	First derivative	Configure the value of the first derivative in the selected point in this field.
	Use second derivative	Select the check box to specify the second derivative in the selected point and to include it in the interpolation of the cam.
	Second derivative	Configure the value of the second derivative in the selected point in this field.
	Use third derivative	Select the check box to specify the third derivative in the selected point and to include it in the interpolation of the cam.
	Third derivative	Configure the value of the third derivative in the selected point in this field.

The derivations are taken into consideration during VDI-based optimization of transitions of the points to other elements.

See also

Inserting a point (Page 292)

5.9.5.10 Configuration elements - Parameters (point group)

Configure the parameters of the selected element in the "Parameters" configuration window.

Parameters

In this area, configure the parameters of the selected point group:

Parameter/Option		Description
Leading values of the point group		
	Start	In this field, configure the start point of the point group in the leading value range (definition area).
	End	In this field, configure the end point of the point group in the leading value area (definition area).

Parameter/Option	Description
Interpolation points	
Definition type of the leading values	In the drop-down list, select how the leading values of the interpolation points are specified: • Relative to the segment You specify the leading values of the interpolation points relative to the group of points from 0.0 to 1.0. The value 0.0 corresponds to the beginning of the point group. The value 1.0 corresponds to the end of the point group. • Absolute in the profile You specify the leading values of the interpolation points as absolute values.
Definition type of the following values	In the drop-down list, select how the following values of the interpolation points are specified: • Relative to the segment You specify the following values of the interpolation points relative to the following value range of the point group from 0.0 to 1.0. The value 0.0 corresponds to the configured minimum following value of the point group. The value 1.0 corresponds to the configured maximum following value of the point group. • Absolute in the profile You specify the following values of the interpolation points as absolute values.
Minimum following value	In this field, configure the minimum following value for the point group in the following value range.
Maximum following value	In this field, configure the maximum following value of the point group in the following value range (value range).
	Use the "Add interpolation point" button to add an interpolation point to the point group.
Interpolation points	This table shows the configured interpolation points sorted by increasing leading value. Add breakpoints using the button. Delete interpolation points by marking a row and pressing <Delete>. If you delete all points except one, the element type is changed from "Point group" to "Point".
Leading value	In this field, configure the leading value of the interpolation point (value in the definition area).
Following value	In this field, configure the following value of the interpolation point (value in the value range).
Interpolation	
Interpolation type	In the drop-down list, select the interpolation type to be used for interpolating the point group: • Interpolation with cubic splines • Interpolation with Bézier splines
Approximation	
Mapping method	Select the mapping method in the drop-down list. • Point approximation • Segment approximation
Number of interpolation points	Configure the number of breakpoints for the point approximation in this field.
Maximum following value tolerance	In this field, enter the maximum permissible deviation (absolute) of the approximation from the interpolation points. If the configured value is exceeded, a warning is displayed in the graphical editor at the point group.

See also

Insert point group (Page 293)

5.9.5.11 Configuration of elements - Parameters (line)

Configure the parameters of the selected element in the "Parameters" configuration window.

Parameters

Configure the parameters of the selected line in this area:

Parameters		Description
Leading values of the line		
	Start	Configure the start point of the line in the leading value range (definition range) in this field.
	End	Configure the end point of the line in the leading value range (definition range) in this field.
Following values of the line		
	Definition by	In the drop-down list, select the parameters to be used to define the line: • Following values at start and end • Following value at the start and incline • Incline and following value at end The corresponding parameters are displayed based on the selection.
	Start	Configure the start point of the line in the following value range (value range) in this field.
	End	Configure the end point of the line in the following value range (value range) in this field.
	Incline	Configure the incline of the line in this field.

See also

Inserting a line (Page 294)

5.9.5.12 Configuration of elements - Parameters (sine)

Configure the parameters of the selected element in the "Parameters" configuration window.

Parameters

Configure the parameters of the selected sine element in this area:

Parameters		Description
Leading values of the sine		
	Start	Configure the start point of the sine element in the leading value range (definition range) in this field.
	End	Configure the end point of the sine element in the leading value range (definition range) in this field.
Trigonometric parameters		
	Amplitude	Configure the amplitude of the sine element in this field.
	Definition by	In the drop-down list, select how the sine element is defined: • Phase in start and end points • Phase in start point and period length • Phase in start point and frequency • Period length and phase in end point • Frequency and phase in end point The corresponding parameters are displayed based on the selection.
	Phase angle at start [°]	Configure the phase angle at the start of the sine element in this field.
	Phase angle at end [°]	Configure the phase angle at the end of the sine element in this field.
	Period length	Configure the period length of the sine element in this field.
	Frequency	Configure the frequency of the sine element in this field.
Extended parameters		
	Segment type	Select the variant of the sine element in the drop-down list. • Sine • Inclined sine The corresponding parameters are displayed based on the selection.
	Shift	Configure the oscillation midpoint of the sine element in this field.
	Definition of ascent via	In the drop-down list, select how the inclined sine element is defined: • Following values at start and end • Following value at the start and inclination • Inclination and following value at end The corresponding parameters are displayed based on the selection.
	Offset at start	Configure the following value at the start of the inclination of the sine element in this field.
	Offset at end	Configure the following value at the end of the inclination of the sine element in this field.
	Inclination	Configure the inclination of the sine element in this field. If you have configured an inclination, additional orientation lines are displayed in the editor for the amplitude and center position.

See also

Inserting a sine (Page 295)

5.9.5.13 Configuration of elements - Parameters (polynomial)

Configure the parameters of the selected element in the "Parameters" configuration window.

Parameters

Configure the parameters of the selected polynomial in this area:

Parameters		Description
Leading values of the polynomial		
	Start	Configure the start point of the polynomial in the leading value range (definition range) in this field.
	End	Configure the end point of the polynomial in the leading value range (definition range) in this field.
Polynomial parameters		
	Definition by	In the drop-down list, select how the polynomial is defined: • Coefficients • Boundary values The corresponding parameters are displayed based on the selection.
	Coefficients	Configure the coefficients of the 6th degree polynomial function in these fields: $P(x) = a_6x^6 + a_5x^5 + a_4x^4 + a_3x^3 + a_2x^2 + a_1x + a_0$ The coefficients are shown in scientific notation, e.g. "9.6450617283e-11".
	Following value - Left boundary value	Configure the following value at the start of the polynomial in this field.
	Following value - Right boundary value	Configure the following value at the end of the polynomial in this field.
	Use first derivative	Select the check box to specify the first derivative in the left/right boundary value of the polynomial and to include it in the interpolation of the cam.
	First derivative - left boundary value	Configure the first derivative (velocity) for the following value at the start of the polynomial in this field.
	First derivative - right boundary value	Configure the first derivative (velocity) for the following value at the end of the polynomial in this field.
	Use second derivative	Select the check box to specify the second derivative in the left/right boundary value of the polynomial and to include it in the interpolation of the cam.
	Second derivative - left boundary value	Configure the second derivative (acceleration) for the following value at the start of the polynomial in this field.
	Second derivative - right boundary value	Configure the second derivative (acceleration) for the following value at the end of the polynomial in this field.
	Use third derivative	Select the check box to specify the third derivative in the left/right boundary value of the polynomial and to include it in the interpolation of the cam.
	Third derivative - left boundary value	Configure the third derivative (jerk) for the following value at the start of the polynomial in this field.
	Third derivation - right boundary value	Configure the third derivative (jerk) for the following value at the end of the polynomial in this field.

Parameters		Description
	Lambda	In the drop-down list, select how the turning point of the polynomial is specified in the "Lambda position" field: • No lambda Do not enter any value. The position of the point of inflection is calculated automatically. • Relative to the element You specify the leading value of the turning point relative to the polynomial from 0.0 to 1.0. The value 0.0 corresponds to the beginning of the polynomial. The value 1.0 corresponds to the end of the polynomial. • Absolute in the profile You specify the leading value of the point of inflection as an absolute value.
	Lambda position	In this field, configure the leading value of the turning point for the polynomial according to the selection in the "Lambda" drop-down list.
Extended parameters		
	Segment type	In the drop-down list, select whether or not the polynomial is to have a trigonometric component. When "Polynomial with trigonometric portion" is selected, the corresponding trigonometric parameters are displayed, as they are with sine. When a sine element is converted to a polynomial, the sine element is configured as a polynomial with trigonometric portion. The shape of the element is retained.
	Amplitude	Configure the amplitude of the trigonometric component in this field.
	Definition by	In the drop-down list, select how the trigonometric component is defined: • Phase at start and at end • Phase at start and period length • Phase at start and frequency • Period length and phase at end • Frequency and phase at end The corresponding parameters are displayed based on the selection.
	Phase at start	Configure the phase angle at the start of the trigonometric component in this field.
	Phase at end	Configure the phase angle at the end of the trigonometric component in this field.
	Period length	Configure the period length of the trigonometric component in this field.
	Frequency	Configure the frequency of the trigonometric component in this field.

See also

Inserting a polynomial (Page 296)

5.9.5.14 Configuration of elements - Parameters (inverse sine)

Configure the parameters of the selected element in the "Parameters" configuration window.

The inverse sine is defined within the definition range [-1, 1]. The inverse sine can be calculated for the entire definition range or a restricted definition range of the arcsine function.

An inverse sine is approximated using interpolation points of the arcsine function.

Parameters

Configure the parameters of the selected inverse sine in this area:

Parameters		Description
Leading values of the inverse sine		
	Start	Configure the start point of the inverse sine in the leading value range (definition range) in this field.
	End	Configure the end point of the inverse sine in the leading value range (definition range) in this field.
Following values of the inverse sine		
	Minimum	Configure the minimum value of the inverse sine in the following value range (value range) in this field.
	Maximum	Configure the maximum value of the inverse sine in the following value range (value range) in this field.
Definition range		
	Not mir-rored/mirrored	Select whether or not the inverse sine is to be mirrored about the abscissa.
	Start	Configure the start point in the definition range of the arcsine function that is to be used in this field.
	End	Configure the end point in the definition range of the arcsine function that is to be used in this field.
Approximation		
	Number of interpolation points	Configure the number of interpolation points for the approximation in this field.
	Maximum following value tolerance	In this field, specify the maximum permitted deviation (absolute) of the approximation from the arcsine function. If the configured value is exceeded, a warning is displayed in the graphical editor for the arcsine element.

See also

Inserting an inverse sine (Page 297)

5.9.5.15 Configuration of elements - Characteristic (transition)

Configure the parameters of the selected transition in the "Characteristics" configuration window.

Characteristics

Configure the settings for optimization of the transition in this area:

Parameters		Description
Interpolation settings of the transition		
	Optimization method	Select the optimization method in the drop-down list. • System interpolation The CPU defines the optimization parameters automatically according to the settings of the system interpolation (Page 304). • VDI-based optimization You adjust the optimization manually. The inputs are applied automatically according to the VDI Guideline 2143.
	Motion task	The transition type is determined from the properties of the adjacent elements of the transition and displayed in this field.
	Continuity at start/end	In the drop-down lists, select which parameter is continuous in the boundary points and is to be included for optimization. • Default optimization setting (setting under "Profile > Default optimization settings (Page 303)") • Position • Velocity (bumpless) • Acceleration (jerkless) • Jerk (jerk continuity permitted on one side only)
	Optimization target	In the drop-down list, select the optimization target: • Default optimization setting (setting under "Profile > Default optimization settings") • Not specified • Velocity (Cv) • Acceleration (Ca) • Jerk (Cj) • Minimum Dynamic Moment (Cmdyn)

Parameters	Description
Selection of motion rule	
Motion rule	In the drop-down list, select the motion rule according to which optimization is to occur. • Line • Quadratic parabola • Sine • Polynomial • Inclined sine • Modified acceleration trapezoid • Modified sine • Harmonic combination • Double-harmonic transition • Sine line combination The selection is automatically limited to the motion rules that can be applied according to the motion task and the selected boundary conditions. Additional parameters are displayed depending on the selected motion rule.
Parameter used	In the drop-down list, select the parameters to be included in the optimization: • Lambda • Maximum acceleration (Ca) • Maximum deceleration (Ca*) The selection is automatically limited to the parameters that can be applied according to the motion rule.
Lambda	In the drop-down list, select the transition point in the "Lambda position" field: • No lambda Do not enter any value. The position of the point of inflection is calculated automatically. • Relative to the segment You specify the leading value of the turning point relative to the transition from 0.0 to 1.0. The value 0.0 corresponds to the beginning of the transition. The value 1.0 corresponds to the end of the transition. • Absolute in the profile You specify the leading value of the point of inflection as an absolute value.
Lambda position	In this field, configure the leading value of the turning point for the transition according to the selection in the "Lambda" drop-down list.
Maximum acceleration (Ca)	Configure the maximum acceleration (Ca) for the transition in this field.
Maximum deceleration (Ca*)	Configure the maximum deceleration (Ca*) for the transition in this field.
Approximation	
Number of interpolation points	In this field, configure the number of interpolation points for the transition.
Maximum following value tolerance	In this field, enter the maximum permitted deviation (absolute) of the approximation from the motion law. If the configured value is exceeded, a warning is displayed in the graphical editor at the transition.

Parameters	Description
Characteristic values of the transition	The characteristic values of the transition that are relevant according to VDI 2143 are displayed in this area. The maximum value and the standardized value are displayed for the following characteristic values: • Velocity (Cv) • Acceleration (Ca) • Deceleration (Ca*) • Jerk (Cj) • Dynamic torque (Cmdyn)

Motion jobs according to VDI Guideline 2143

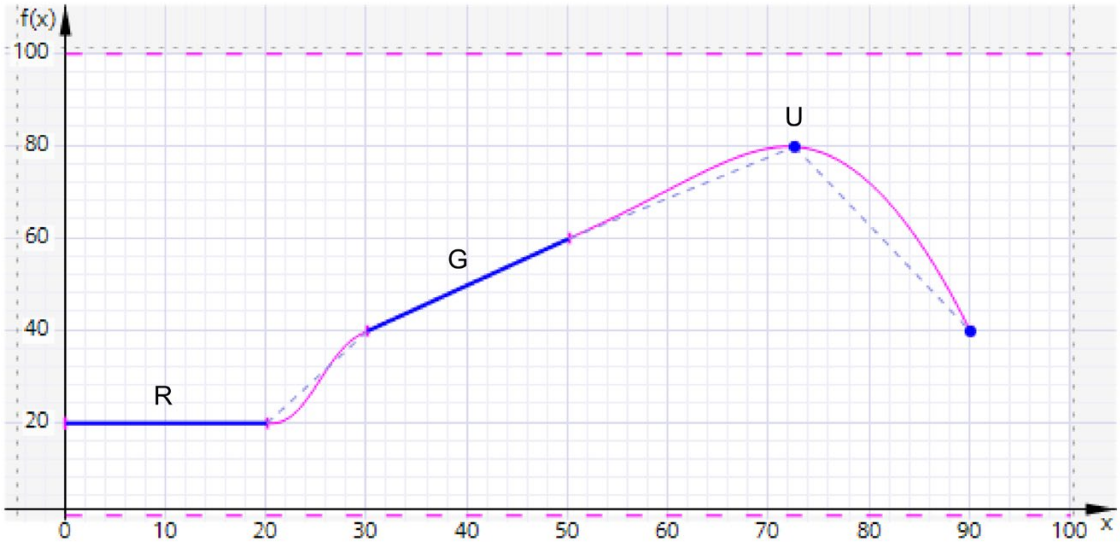
The VDI Guideline 2143 distinguishes between areas of usage and motion transitions:

- Areas of usage correspond to the sequences in a process, which means the inserted elements of the cam.
- Motion transitions are transitions between areas of usage that are not directly relevant to the process but must meet specific boundary conditions (e.g. velocity consistency).

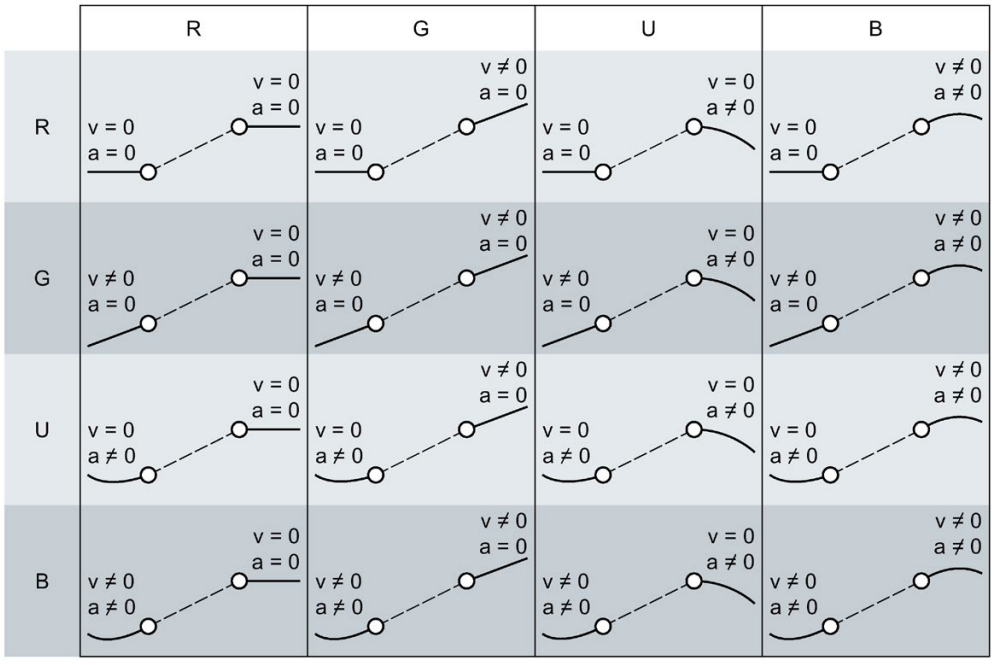
The following motion tasks are defined based on VDI guideline 2143:

Motion tasks	Designation	Properties
Dwell	R	Velocity = 0 Acceleration = 0
Constant velocity	G	Velocity ≠ 0 Acceleration = 0
Reverse	U	Velocity = 0 Acceleration ≠ 0
Motion	B	Velocity ≠ 0 Acceleration ≠ 0

The following figure shows an example of the motion tasks:



The figure below shows the possible combinations of motion tasks:



5.9.6 Representation (Inspector window)

5.9.6.1 Configuration charts - Charts and curves

In the "Charts and curves" configuration window, configure the display of the graphical editor.

"Reset to defaults" button

Use this button to reset all settings of the view of charts and curves to the default settings.

Configuration table

Configure the display of the graphical editor in the table:

Column	Description
Displaying	Displaying/hiding of charts 1 to 4
Visible	Displaying/hiding of curves in the chart
Name	Name of chart or curve New curves can be added. Existing curves can be removed. Curves of other cams can also be displayed. The name of the other cam is also displayed in the table and in the legend of the chart. A curve can be inserted multiple times in a chart, e.g. in order to display it with different scalings.
Color	Line color of the curve
Line type	Line type of the curve
Offset of the leading values*	Movement of the curve on the abscissa
Multiplier for leading values*	Scaling of abscissa
Offset of the following values*	Movement of the curve on the ordinate
Multiplier for following values*	Scaling of ordinate

* Only affects the display of the curve in the chart. You specify the scaling and shifting of the cam during camming in the Motion Control instruction "MC_CamIn".

5.9.6.2 Configuration charts - Snap grid

In the "Snap grid" configuration window, you configure the grid spacing for aligning inputs to the grid in the graphical editor. When "Snap" is activated, inputs and element end points are aligned to this grid and to other element end points.

Snap grid spacing

In this area, configure the grid spacing of the snap grid:

Parameter	Description
Grid spacing leading value	Configure the grid spacing on the abscissa (leading values) in this field.
Grid spacing following value	Configure the grid spacing on the ordinate (following values) in this field.

5.9.6.3 Configuration - Decimal places

In the "Decimal places" configuration window, you configure how many decimal places are used to represent the values in the graphical and tabular editor as well as in the configuration windows. The values are rounded in the displays. The settings do not affect the calculation of the curves. The curves are calculated with higher accuracy regardless of the settings.

Displayed decimal places

In this area, configure the displayed decimal places:

Parameter	Description
Tabular editor and configuration window	In this field, configure the number of decimal places for displaying values in the tabular editor and in the configuration windows.
Graphical editor	In this field, configure the number of decimal places for displaying values in the graphical editor.

5.9.7 Importing / exporting cam

You can use the toolbar to export cams from the cam editor and import cams into the cam editor.

Importing cam

NOTICE
Machine damage Importing corrupt files (.txt, .csv) can result in unwanted behavior of the axes. Each time you import a cam from a file, check the integrity of the imported data.

The following table shows the supported file formats for importing/exporting a cam:

File format	Comment
Import format	
SIMOTION SCOUT format/MCD .txt, .csv	MCD exchange format is automatically detected, imported data: • Interpolated points • Lines • Sine elements • Inverse sine elements • Polynomials • Transitions
Proprietary binary format .bin	The binary format is used for exchanging cams between multiple TIA Portal installations and external applications.

To import a cam, follow these steps:

1. In the toolbar, click the icon "Import cam from file".

   The "Cam import" dialog opens.
2. Select the file type of the file you want to import.
3. Select the file you want to import from the file directory.
4. Click the "Open" button.

   The cam is opened in the cam editor. All previous entries in the editor are discarded.

Exporting cam

The following table shows the structure of the "Cam export" dialog:

Parameter/Element		Description
Export format		
	Export as	Select the export formate in the drop-down list: • MCD exchange format* • Standard vector format • Point list • Binary format*
	Delimiters	In the drop-down list, select the delimiter with which the data fields are to be separated in the file: • Comma • Tab
	Number of points	In this field, configure the number of points to be exported to a point list. The more points exported, the more precise the configured cam formed by the point list. Possible values: 0 to 1E5 Default setting: 360

Parameter/Element		Description
Additional curves		Point list only
	Velocity	Select the "Velocity" check box when the derivative curve of the velocity is to be exported in addition to the position.
	Acceleration	Select the "Acceleration" check box if you want to export the derivative curve of the acceleration in addition to the position.
	Jerk	Select the "Jerk" check box when the derivative curve of the jerk is to be exported in addition to the position.
Directory for export		
	File name	Enter a file name in this field.
	Directory	In this field, enter the directory into which the file is to be written.
Export		Export the file
Cancel		Cancellation of export and closing of the dialog

*) Can be imported in TIA Portal

To export a cam, follow these steps:

1. In the toolbar, click the icon "Export cam to file".

   The "Cam export" dialog opens.
2. Select the export format in the "Export as" drop-down list.
3. Optionally, configure the delimiter, the number of points, and the additional curves for the export.
4. Enter a file name in the "File name" box.
5. Select the directory to which the file is written.
6. Click "Export".

See also

Structure of the graphical editor (Page 289)

5.9.8 Dialogs in the shortcut menu

The following dialogs can be called with the shortcut menu of the graphical and tabular editor:

- Pasting elements
- Moving elements
- Scaling elements

"Paste elements" dialog

The following table shows the structure of the "Paste elements" dialog:

Parameter/Element	Description	
Insert mode	Select the paste mode from the drop-down list:	
	Overwrite elements to left	Overwriting of the elements located to the left of the selection
	Overwrite elements to right	Overwriting of the elements located to the right of the selection
	Overwrite both directions	Overwriting of the elements located to the left and right of the selection
	Scale elements from the clipboard	Pasting of the elements from the clipboard to the last element
Paste	Pasting of the elements from the clipboard with the selected mode	
Cancel	Cancellation of paste operation and closing of the dialog	

"Move elements" dialog

The following table shows the structure of the "Move elements" dialog:

Parameter/Element	Description
Horizontal distance	In this field, enter the shift of the selection on the abscissa (x axis).
Vertical distance	In this field, enter the shift of the selection on the ordinate (y axis).
Move	Moving of the selection by the entered distance
Cancel	Cancellation of move operation and closing of the dialog

"Scale elements" dialog

The following table shows the structure of the "Scale elements" dialog:

Parameter/Element	Description	
Adjust to leading value range	In this field, enter the scaling length (leading value side) to which you want to scale the selection.	
Anchor point	Select the direction of scaling from the drop-down list:	
	Left boundary	The selection is adjusted by the left boundary point to the scaling length.
	Center	The selection is adjusted by the center point to the scaling length.
	Right boundary	The selection is adjusted by the right boundary point to the scaling length.
Scale	Scaling with the selected parameter values	
Cancel	Cancellation of scaling and closing of the dialog	

See also

Shortcut menu in the tabular editor (Page 301)

Shortcut menu in the graphical editor (Page 298)

5.10 Configuring technology modules for Motion Control

5.10.1 Overview

Use of technology modules with Motion Control

You can use technology modules as well as compact CPUs with Motion Control. To use the technology functions for Motion Control, the parameters of the device configuration of the technology module or the compact CPU and the parameters of the configuration of the technology object must be configured accordingly. Which parameters are relevant for the function is described below. You can set additional parameters that are not listed here. The description of the parameters is found in the documentation of the respective technology module.

The following technology modules support Motion Control functionalities:

S7-1500/ET 200MP	ET 200 SP
TM Count 2x24V (Page 329)	TM Count 1x24V (Page 329)
TM PosInput 2 (Page 331)	TM PosInput 1 (Page 331)
TM Timer DIDQ 16x24V (Page 333) *	TM Timer DIDQ 10x24V (Page 333) *
–	TM Pulse 2x24V (Page 334)
TM PTO 4 (Page 335)	–
CPU 1511C-1 PN / CPU 1512C-1 PN (Page 337)	–

* ET 200MP and ET 200SP: Isochronous mode required

Isochronous mode

Technology modules can be used centrally or distributed in the system. However, isochronous mode is supported only in distributed operation with suitable PROFINET interface modules.

5.10.2 TM Count 1x24V / TM Count 2x24V

For use with Motion Control, the following parameters must be configured:

Configuration		
Technology module TM Count 1x24V / TM Count 2x24V	Technology object	
	Axis	External encoder
TM Count 1x24V / TM Count 2x24V > Channel 0/1 > Operating mode	–	–
Select "Position detection for Motion Control technology object" mode		
TM Count 1x24V / TM Count 2x24V > Channel 0/1 > Module parameters	**Hardware interface > Encoder**	**Hardware interface > Encoder**
–	Select "Encoder" data connection and the channel configured for Motion Control on the technology module as encoder	Select "Encoder" data connection and the channel configured for Motion Control on the technology module as encoder
Signal type • Incremental encoder	Select encoder type corresponding to configuration for technology module • Incremental	Select encoder type corresponding to configuration for technology module • Incremental
–	**Hardware interface > Data exchange with encoder**	**Hardware interface > Data exchange**
	Telegram "DP_TEL83_STANDARD" is automatically selected after the selec-tion of the encoder.	Telegram "DP_TEL83_STANDARD" is automatically selected after the selec-tion of the encoder.
	Disable "Automatic transfer of encoder parameter values"	Disable "Automatic transfer of encoder parameter values"
	Select rotary or linear measuring system type	Select rotary or linear measuring system type
Signal evaluation • Single • Double • Quadruple	Select fine resolution corresponding to configuration for technology module • 0 = Single • 1 = Double • 2 = Quadruple	Select fine resolution corresponding to configuration for technology module • 0 = Single • 1 = Double • 2 = Quadruple
• Rotary type: Enter increments per revolution • Linear type: Configuration not relevant	• Rotary type: Enter increments per revolution corresponding to configuration at technology module (1:1) • Linear type: Enter distance between increments	• Rotary type: Enter increments per revolution corresponding to configuration at technology module (1:1) • Linear type: Enter distance between increments
–	**Hardware interface > Data exchange with the drive**	–

Configuration		
Technology module	**Technology object**	
TM Count 1x24V / TM Count 2x24V	**Axis**	**External encoder**
• Rotary type: Enter reference speed corresponding to configuration for technology object (1:1) • Linear type: Configuration not relevant	Enter reference speed	
–	**Homing**	**Homing**
Select the homing signal for homing mark 0: • Signal N of the incremental encoder • DI0	Use the homing mode "Use zero mark via PROFIdrive telegram".	Use the homing mode "Use zero mark via PROFIdrive telegram".
TM Count 2x24V > I/O addresses	–	–
The organization block ("MC-Servo") and the process image ("TPA OB Servo") are selected automatically for the input and output addresses by selecting the channel in the encoder configuration at the technology object.		
Process image: PIP OB servo		

5.10.3 TM PosInput 1 / TM PosInput 2

For use with Motion Control, the following parameters must be configured:

Configuration		
Technology module TM PosInput 1 / TM PosInput 2	Technology object	
	Axis	External encoder
TM PosInput 1/2 > Channel 0/1 > Operating mode	–	–
Select "Position detection for Motion Control technology object" mode		
TM PosInput 1/2 > Channel 0/1 > Module parameters You set the parameters for the encoder signals of the channel under "Module parameters" in the "Position input for Motion Control" mode. The parameters must be set depending on the encoder used. The configuration of the encoder is required for use with an SSI absolute encoder. Information on the configuration is available in the documentation for the respective technology module.	**Hardware interface > Encoder**	**Hardware interface > Encoder**
–	Select "Encoder" data connection and the channel activated and configured as encoder on the technology module	Select "Encoder" data connection and the channel activated and configured as encoder on the technology module
Signal type • Incremental encoder • Absolute encoder	Select encoder type corresponding to configuration for technology module • Incremental • Absolute / cyclic absolute	Select encoder type corresponding to configuration for technology module • Incremental • Absolute / cyclic absolute
–	**Hardware interface > Data exchange with encoder**	**Hardware interface > Data exchange**
	Telegram "DP_TEL83_STANDARD" is automatically selected after the selection of the encoder.	Telegram "DP_TEL83_STANDARD" is automatically selected after the selection of the encoder.
	Disable "Automatic transfer of encoder parameter values"	Disable "Automatic transfer of encoder parameter values"
	Select rotary or linear measuring system type	Select rotary or linear measuring system type
Signal evaluation • Single • Double • Quadruple	Select fine resolution corresponding to configuration for technology module • Incremental encoder: – 0 = Single – 1 = Double – 2 = Quadruple • Absolute encoder: – 0 = Single	Select fine resolution corresponding to configuration for technology module • Incremental encoder: – 0 = Single – 1 = Double – 2 = Quadruple • Absolute encoder: – 0 = Single

Configuration		
Technology module **TM PosInput 1 / TM PosInput 2**	**Technology object**	
	Axis	**External encoder**
• Rotary type: Enter increments per revolution • Linear type: Configuration not relevant	• Rotary type: Enter increments per revolution corresponding to configuration at technology module (1:1) • Linear type: Enter distance between increments	• Rotary type: Enter increments per revolution corresponding to configuration at technology module (1:1) • Linear type: Enter distance between increments
–	**Hardware interface > Data exchange with the drive**	–
• Rotary type: Enter reference speed corresponding to configuration for technology object (1:1) • Linear type: Configuration not relevant	Enter reference speed	
–	**Homing**	**Homing**
Select the homing signal for homing mark 0: • Signal N of the incremental encoder • DI0	Use the homing mode "Use zero mark via PROFIdrive telegram".	Use the homing mode "Use zero mark via PROFIdrive telegram".
TM PosInput 1/2 > I/O addresses	–	–
The organization block ("MC-Servo") and the process image ("TPA OB Servo") are selected automatically for the input and output addresses by selecting the channel in the encoder configuration at the technology object.		

"–" No configuration for technology module/technology object is required for these parameters

5.10.4 TM Timer DIDQ 10x24V / TM Timer DIDQ 16x24V

You can operate the TM Timer DIDQ technology module centrally on an S7-1500 CPU or decentrally on a distributed I/O. For use with a measuring input, output cam or cam track, the technology module must be used decentrally and with isochronous mode.

For use with Motion Control, the following parameters must be configured:

Use with output cam / cam track technology object

Configuration	
Technology module TM Timer DIDQ 10x24V / TM Timer DIDQ 16x24V	Technology object Output cam / Cam track
Basic parameters	–
Select desired number of outputs under channel configuration (ET 200MP TM Timer DIDQ 16x24V only)	
Channel parameters	**Hardware interface > Output cam output / Output cam track**
–	Activate output
	Select output by TM Timer DIDQ
Select "Timer DQ" mode for the respective output	Select output cam output
I/O addresses	–
Select "Isochronous mode"	
The organization block ("MC-Servo") and the process image ("TPA OB Servo") are updated automatically for the input and output addresses by selecting the channel in the encoder configuration at the technology object.	

"–" No configuration for technology module/technology object is required for these parameters

Use with technology object measuring input

Configuration	
Technology module TM Timer DIDQ 10x24V / TM Timer DIDQ 16x24V	Technology object Measuring input
Basic parameters	–
Select desired number of inputs under channel configuration	
Channel parameters	**Hardware interface > Measuring input**
Configuration of DI group: Use inputs individually	–
Select "Timer DI" mode for the respective input	Select measuring using TM Timer DIDQ
–	Select measuring input
Select application-dependent input delay	–
I/O addresses	
Select "Isochronous mode"	
The organization block ("MC-Servo") and the process image ("TPA OB Servo") are updated automatically for the input and output addresses by selecting the channel in the input configuration at the technology object.	

"–" No configuration for technology module/technology object is required for these parameters

5.10.5 TM Pulse 2x24V

For use with Motion Control, the parameters described below must each be configured:

Drive connection using PWM (pulse width modulation)

Configuration	
TM Pulse 2x24V	Technology object Axis
TM Pulse 2x24V > Channel configuration	–
Select if you want to use 1 or 2 channels.	
TM Pulse 2x24V > Channel > Operating mode	
Select "Pulse width modulation PWM" or "PWM with DC motor" operating mode	
TM Pulse 2x24V > Channel > Parameters	**Hardware interface > Drive**
Select "S7 analog output" output format	Select analog drive connection For the selection of the analog output, create a PLC tag of the "Int" type with corresponding address. The offset for the PLC tag to the start address is 2. To activate the output of the PWM signal, set the following two bits of the control interface of the PWM channel in the user program: • SW_ENABLE (= Bit 0 in Byte 9) • TM_CTRL_DQ (= Bit 1 in Byte 9) The offset for byte 9 to the start address of the PWM channel is 9.
TM Pulse 2x24V > Channel > I/O addresses	–
Select the organization block "MC-Servo" for the input and output addresses. The "TPA OB Servo" process image is selected automatically for the input and output addresses by selecting the organization block.	

"–" No configuration for technology object is required for these parameters

5.10.6 TM PTO 4

For use with Motion Control, the following parameters must be configured.

Configuration	
Technology module TM PTO 4	Technology object Axis
TM PTO 4 > Channel configuration	–
Configure the number of channels (1 to 4) you want to use.	
TM PTO 4 > Channel 0…3 > Operating mode	
Select signal type: • PTO (pulse (P) and direction (D)) • PTO (count up (A) and count down (B)) • PTO (A, B phase-shifted) • PTO (A, B phase-shifted - quadruple)	
Select signal interface: • RS422, symmetrical / TTL (5V), asymmetrical • 24V asymmetric	
Configure the interpulse pause for direction reversal.	
–	**Hardware interface > Drive**
	Select drive type "PROFIdrive" and "Drive" data connection. Select the pulse output configured at the technology module as drive.
	Hardware interface > Encoder
	The encoder of the actuator telegram (simulated encoder) is automatically selected. Alternatively, an existing encoder interface can be selected.
TM PTO 4 > Channel 0...3 > Diagnostic interrupts	-
When the "Enable diagnostic interrupts" check box is selected, diagnostic interrupts are activated if: • No supply voltage • Errors occur at digital outputs The detected error is displayed for the respective channel with feedback bit Fault_Present and Sensor_Error.	
TM PTO 4 > Channel 0…3 > Axis parameters	**Data exchange with the drive**
–	Telegram "DP_TEL3_STANDARD" is automatically selected after the selection of the drive.
	Deselect "Automatic transfer of drive parameter values"
Enter reference speed corresponding to configuration for technology object (1:1)	Enter reference speed of the drive
Enter maximum speed corresponding to configuration for technology object (1:1)	Enter maximum speed of the drive. If the maximum speed is exceeded, technology alarm 102 is triggered and displayed.
–	**Data exchange with encoder**

Configuration	
Technology module **TM PTO 4**	**Technology object**
	Axis
	Telegram "DP_TEL3_STANDARD" is automatically selected after the selection of the encoder.
	Disable "Automatic transfer of encoder parameter values"
	Select rotary measuring system type.
Enter increments per revolution	Enter increments per revolution corresponding to configuration at technology module (1:1)
Configure fine resolution • 0 = Single • 2 = Quadruple	Configure fine resolution corresponding to configuration for technology module. • 0 = Single • 2 = Quadruple
Configure stop behavior • Quick stop time • Ramp stop time	-
TM PTO 4 > Channel 0…3 > Hardware inputs/outputs	–
If you want to use a hardware output to enable the drive, select the "Use drive enable" check box. Next select one of the two hardware outputs DQ0 or DIQ2.	No setting required at the technology object. The output is automatically controlled by the MC_Power.
	Homing
Activate the hardware input (DI0) for the reference cam.	Use the homing mode "Use zero mark via PROFIdrive telegram".
Select the edge of the hardware input for triggering the reference cam function.	
When using a measuring input, select the "Use DI1 check box as measuring input".	**"Measuring input > Configuration > Hardware interface" technology object**
	Select the measuring input type "Measurement using PROFIdrive telegram (drive or external encoder)". Select the measuring input "1" under hardware connection.
Select the "Use "drive ready"" check box. In the ""Drive ready" input", select the hardware input that is to be used to display whether the drive is ready.	No setting required at the technology object. When the input is used, MC_Power waits until the input signal is present before it sets the drive enable.
Configuring input delay	–
TM PTO 4 > Channel 0…3 > Sign-of-life error	
Configure tolerated number of sign-of-life errors	
TM PTO 4 > I/O addresses	
The organization block ("MC-Servo") and the process image ("TPA OB Servo") are selected automatically for the input and output addresses by selecting the PTO channel for the technology object.	

"–" No configuration required for these parameters at the technology module/technology object

5.10.7 CPU 1511C-1 PN / CPU 1512C-1 PN

For use with Motion Control, the parameters described below must be configured.

Drive connection via PTO (Pulse Train Output)

Configuration	
CPU 1511C-1 PN / CPU 1512C-1 PN	Technology object Axis
Pulse generators (PTO/PWM) > PTO1…4/PWM1…4 > General	–
To activate a channel for PTO mode, select one of the following operating modes: • PTO (pulse (A) and direction (B)) • PTO (count up (A), count down (B)) • PTO (A,B phase shifted) • PTO (A,B phase shifted, quadruple)	
–	**Hardware interface > Drive**
	Select drive type "PROFIdrive" and "Drive" data connection. Select the pulse generator of the CPU configured for PTO mode as drive.
	Hardware interface > Encoder
	The encoder of the actuator telegram (simulated encoder) is automatically selected. Alternatively, an existing encoder interface can be selected.
Pulse generators (PTO/PWM) > PTO1…4/PWM1…4 > Axis parameters	**Hardware interface > Data exchange with the drive**
–	Telegram "DP_TEL3_STANDARD" is automatically selected after the selection of the drive.
	Deselect "Automatic transfer of drive parameter values"
Enter reference speed corresponding to configuration for technology object (1:1)	Enter reference speed of the drive
Enter reference speed corresponding to configuration for technology object (1:1)	Enter maximum speed of the drive. If the maximum speed is exceeded, technology alarm 102 is triggered and displayed.
–	**Hardware interface > Data exchange with encoder**
	Telegram "DP_TEL3_STANDARD" is automatically selected after the selection of the encoder.
	Disable "Automatic transfer of encoder parameter values"
	Select rotary measuring system type.
Enter increments per revolution	Enter increments per revolution corresponding to configuration for CPU (1:1)
The fine resolution has the fixed value "0 bit" (= single) and cannot be changed.	Enter the fine resolution corresponding to the configuration for CPU Bits in incr. actual value (G1_XIST1): 0 (= single)

Configuration	
CPU 1511C-1 PN / CPU 1512C-1 PN	Technology object
	Axis
Pulse generators (PTO/PWM) > PTO1…4/PWM1…4 > Hardware inputs/outputs	**Homing**
Select the hardware input for the reference switch In addition, configure the input delay for the selected hardware input. You configure the input delay in the device configuration at the corresponding DI channel (DI 16/DQ 16 > Inputs > Channel > Input parameters > Input delay).	Use the homing mode "Use zero mark via PROFIdrive telegram" for drive connection via PTO.
Select the edge of the hardware input for triggering the reference cam function.	
When using a measuring input, select the hardware input of the measuring input. The following table includes the configuration description.	–
Select the hardware input that is used to display whether the drive is ready. In addition, configure the input delay for the selected hardware input. You configure the input delay in the device configuration at the corresponding DI channel (DI 16/DQ 16 > Inputs > Channel > Input parameters > Input delay).	
With selected "PTO (PTO (pulse (A) and direction (B))" mode, the hardware output for the PTO signal A ("Pulse output (A)") is automatically selected through the device configuration and cannot be changed. For PTO signal B ("Direction output (B)") select one of the hardware outputs offered in the selection box. The hardware outputs for the PTO signals are selected through the device configuration for the following operating modes and cannot be changed: • PTO (count up (A), count down (B)) • PTO (A,B phase shifted) • PTO (A,B phase shifted, quadruple)	
Pulse generators (PTO/PWM) > PTO1…4/PWM1…4 > I/O addresses	
The organization block ("MC-Servo") and the process image ("TPA OB Servo") are selected automatically for the input and output addresses by selecting the PTO channel for the technology object.	

"–" No configuration for CPU/technology object is required for these parameters

Additional configuration for use with the technology object measuring input

Configuration	
Technology module CPU 1511C-1 PN / CPU 1512C-1 PN	Technology object Measuring input
Pulse generators (PTO/PWM) > PTO1…4/PWM1…4 > Hardware inputs/ outputs	**Hardware interface > Measuring input**
Select the hardware input of the measuring input. In addition, configure the input delay for the selected hardware input. You configure the input delay in the device configuration at the corresponding DI channel (DI 16/DQ 16 > Inputs > Channel > Input parameters > Input delay).	Measuring using PROFIdrive telegram (drive or external encoder) In the "Number of the measuring input" selection box, select "1" (measuring input 1).

Drive connection using PWM (pulse width modulation)

Note that only travel in the positive direction is possible with a drive connection using the integrated PWM function of the compact CPU.

Configuration	
CPU 1511C-1 PN / CPU 1512C-1 PN	Technology object Speed axis
Pulse generators (PTO/PWM) > PTO1…4/PWM1…4 > General	–
Select "Pulse width modulation PWM" mode	
Pulse generators (PTO/PWM) > PTO1…4/PWM1…4 > Hardware inputs/ outputs	
Select the hardware output to be used for pulse output.	
Select whether the set hardware output is to work as a fast push-pull switch or as P switch.	
Pulse generators (PTO/PWM) > PTO1…4/PWM1…4 > Parameters	**Hardware interface > Drive**
Select "S7 analog output" output format	Select analog drive connection For the selection of the analog output, create a PLC tag of the "Int" type with corresponding address. The offset for the PLC tag of the control interface of the PWM channel is 2. To activate the output of the PWM signal, set the following two bits of the control interface of the PWM channel in the user program: • SW_ENABLE (= Bit 0 in Byte 9) • TM_CTRL_DQ (= Bit 1 in Byte 9) The offset for byte 9 to the start address of the PWM channel is 9.
Select minimum pulse width of 0 µs	–
Select required period duration (e.g. 100 µs)	
Pulse generators (PTO/PWM) > PTO1…4/PWM1…4 > I/O addresses	
Select the organization block "MC-Servo" for the input and output addresses. The "TPA OB Servo" process image is selected automatically for the input and output addresses by selecting the organization block.	

"–" No configuration for technology object is required for these parameters

Encoder connection via HSC (High-speed counter)

Configuration		
CPU 1511C-1 PN / CPU 1512C-1 PN	Technology object	
	Axis	External encoder
High-speed counter (HSC) > HSC 1…6 > General > Enable	–	–
Enable high-speed counter		
High-speed counter (HSC) > HSC 1…6 > Basic parameters > Operating mode		
Select "Position input for Motion Control" mode		
High-speed counter (HSC) > HSC 1…6 > Basic parameters > Module parameters	**Hardware interface > Encoder**	**Hardware interface > Encoder**
–	Select "Encoder" data connection and the high-speed counter activated and configured as encoder on the CPU	Select "Encoder" data connection and the high-speed counter activated and configured as encoder on the CPU
Signal type • Incremental encoder	Select encoder type according to the device configuration of the CPU • Incremental	Select encoder type according to the device configuration of the CPU • Incremental
–	**Hardware interface > Data exchange with encoder**	**Hardware interface > Data exchange**
	Telegram "DP_TEL83_STANDARD" is automatically selected after the selection of the encoder.	Telegram "DP_TEL83_STANDARD" is automatically selected after the selection of the encoder.
	Deselect "Automatic transfer of encoder parameter values"	Deselect "Automatic transfer of encoder parameter values"
	Select rotary measuring system type.	Select rotary measuring system type.
Signal evaluation • Single • Double • Quadruple	Set fine resolution according to the configured signal evaluation set for the high-speed counter (HSC) • 0 = Single • 1 = Double • 2 = Quadruple	Set fine resolution according to the configured signal evaluation set for the high-speed counter (HSC) • 0 = Single • 1 = Double • 2 = Quadruple
Enter increments per revolution	Enter increments per revolution corresponding to device configuration for CPU (1:1)	Enter increments per revolution corresponding to device configuration for CPU (1:1)
–	**Hardware interface > Data exchange with the drive**	–
Enter reference speed corresponding to configuration for technology object (1:1)	Enter reference speed	

Configuration		
CPU 1511C-1 PN / CPU 1512C-1 PN	Technology object	
	Axis	External encoder
–	Homing	Homing
Select the homing signal for homing mark 0: • Signal N of the incremental encoder • DI0 (can be set with the hardware inputs/outputs) In addition, configure the input delay for the selected hardware input. You configure the input delay in the device configuration at the corresponding DI channel (DI 16/DQ 16 > Inputs > Channel > Input parameters > Input delay).	Use the homing mode "Use zero mark via PROFIdrive telegram".	Use the homing mode "Use zero mark via PROFIdrive telegram".
High-speed counter (HSC) > HSC 1…6 > I/O addresses	–	–
The organization block ("MC-Servo") and the process image ("TPA OB Servo") are selected automatically for the input and output addresses by selecting the HSC channel for the technology object.		

"–" No configuration for CPU/technology object is required for these parameters

Additional configuration for use with the technology object measuring input

Configuration	
Technology module CPU 1511C-1 PN / CPU 1512C-1 PN	Technology object
	Measuring input
High-speed counter (HSC) > HSC 1…6 > Hardware inputs/outputs	Hardware interface > Measuring input
Select the hardware input of the measuring input.	Measuring using PROFIdrive telegram drive or external encoder
In addition, configure the input delay for the selected hardware input. You configure the input delay in the device configuration at the corresponding DI channel (DI 16/DQ 16 > Inputs > Channel > Input parameters > Input delay).	In the "Number of the measuring input" selection box, select "1" (measuring input 1).

5.11 Connect drive/encoder via data block

Creating the data block for data connection

1. Create a new data block of type "Global DB".
2. Select the data block in the project tree and select "Properties" from the shortcut menu.
3. Disable the following attributes under Attributes and accept the change with "OK":
   - "Only store in load memory"
   - "Data block write-protected in the device"
   - "Optimized block access" for technology version < V4.0
4. Open the data block in the block editor.
5. Insert a tag structure of type "PD_TELx" textually in the block editor.

This tag structure contains the "Input" tag structure for the input area of the telegram and the "Output" tag structure for the output area of the telegram.

Note

"Input" and "Output" relate to the view of the closed loop position control. For example, the input area contains the actual values of the drive and the output area contains the setpoints for the drive.

The data block may contain the data structures of multiple axes and encoders and other contents.

Configuring data connection via a data block

1. Open the configuration window "Hardware interface > Drive" or "Hardware interface > Encoder".
2. In the Data block drop-down list, select "Data block".
3. In the "Data block" field, select the previously created data block.
   Open this data block and select the tag name defined for the drive and encoder.

Programming MC-PreServo and MC-PostServo

1. Assign the previously defined PLC tag of the input range of the data block to MC-PreServo .
2. Assign the previously defined PLC tag of the output range of the data block to MC-PostServo.

NOTICE
Machine damage Improper manipulation of drive and encoder telegrams may result in unwanted drive motions. Check your user program for consistency in the drive and encoder connection.

An application example for the use of MC-PreServo and MC-PostServo is available at:

https://support.industry.siemens.com/cs/document/109741575 (https://support.industry.siemens.com/cs/document/109741575)

See also

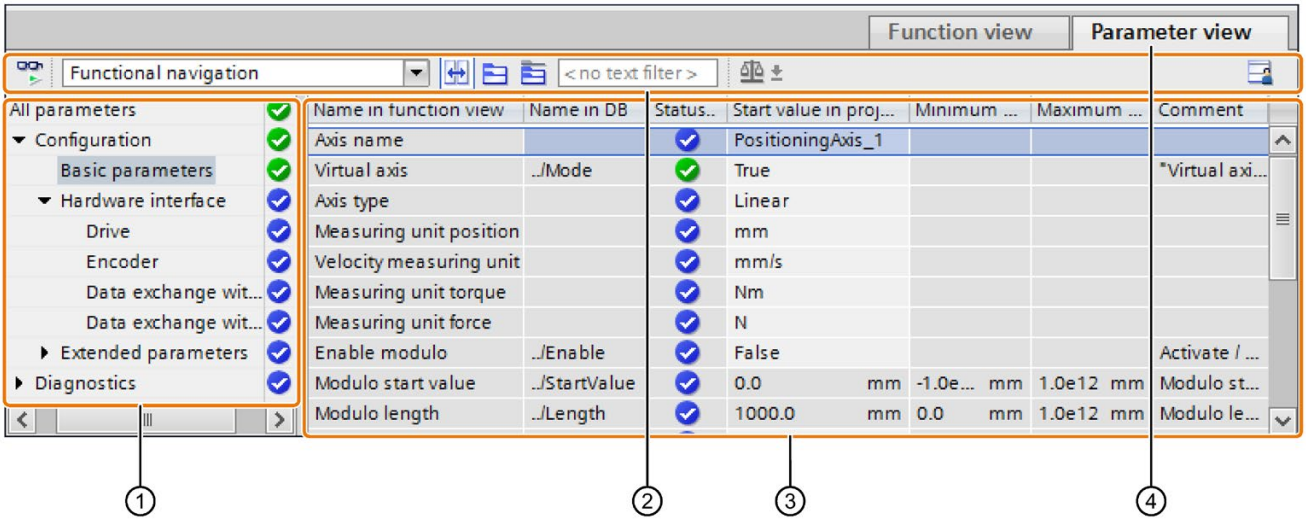
PROFIdrive telegrams (Page 40)

Data connection drive/encoder via data block (Page 57)

5.12 Parameter view

5.12.1 Introduction to the parameter view

The Parameter view provides you with a general overview of all relevant parameters of a technology object. You obtain an overview of the parameter settings and can easily change them in offline and online mode.



① Navigation (Page 346)
② Toolbar (Page 345)
③ Parameter table (Page 347)
④ "Parameter view" tab

Function scope

The following functions are available for analyzing the parameters of the technology objects and for enabling targeted monitoring and modification.

Display functions:

- Display of parameter values in offline and online mode
- Display of status information of the parameters
- Display of value deviations and option for direct correction
- Display of configuration errors
- Display of value changes as a result of parameter dependencies
- Display of all memory values of a parameter: Start value PLC, Start value in project, Monitor value
- Display of the parameter comparison of the memory values of a parameter

Operator control functions:

- Navigation for quickly changing between the parameters and parameter structures.
- Text filter for faster searches for particular parameters.
- Sorting function for customizing the order of parameters and parameter groups to requirements.
- Memory function for backing up structural settings of the Parameter view.
- Monitoring and modifying of parameter values online.
- Function for saving a snapshot of parameter values of the CPU in order to capture momentary situations and to respond to them.
- Function for applying a snapshot of parameter values as start values.
- Download of modified start values to the CPU.
- Comparison functions for comparing parameter values with one another.

5.12.2 Structure of the parameter view

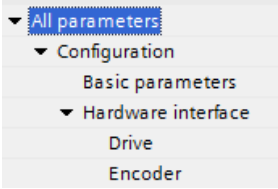
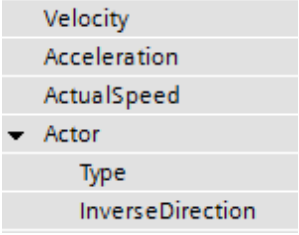
5.12.2.1 Toolbar

The following functions can be selected in the toolbar of the parameter view.

Symbol	Function	Explanation
	Monitor all	Starts monitoring of the visible tags in the active table.
Functional navigation	Select navigation structure	Toggle between function-based navigation and the view of the data structure of the technology data block.
	Couples the function view and parameter view for the objects selected in the navigation	Enables the targeted toggling between the parameter view and function-based view.
	Collapse/expand all nodes and objects	Collapses or expands all nodes and objects of the navigation or the data structure in the currently active view.
	Collapse/expand the nodes below the marked nodes	Collapses or expands the marked nodes and objects of the navigation or the data structure in the currently active view.
< no text filter >	Text filter...	After entry of a character string: Display of all parameters containing the entered string in one of the currently visible columns.
	Selection of compare values	Selection of parameter values that are to be compared with one another in online mode (Start value in project, Start value PLC) Only in online mode.
	Save window settings	Saves your display settings for the Parameter view (e.g. selected navigation structure, activated table columns, etc.)

5.12.2.2 Navigation

Within the "Parameter view" tab, the following alternative navigation structures can be selected.

Navigation		Explanation
Functional navigation		In the functional navigation, the structure of the parameters is based on the structure in the configuration window ("Function view" tab), commissioning window and diagnostics window.
Data structure		In the "Data structure" navigation, the structure of the parameters is based on the structure of the technology data block.

You can use the "Select navigation structure" drop-down list to toggle the navigation structure.

5.12.2.3 Parameter table

The table below shows the meaning of the individual columns of the parameter table. You can show or hide the columns as required.

- Column "Offline" = X: Column is visible in offline mode.
- Column "Online" = X: Column is visible in online mode (online connection to the CPU).

Column	Explanation	Offline	Online
Name in function view	Name of the parameter in the function view. The display field is empty for parameters that are not configured via the technology object.	X	X
Name in DB	Name of the parameter in the technology data block. If the parameter is part of a structure or UDT, the prefix "../" is added. The display field is empty for parameters that are not contained in the technology data block.	X	X
Full name in DB	Complete path of the parameter in the instance DB. The display field is empty for parameters that are not contained in the technology data block.	X	X
Status of configuration	Display of the completeness of the configuration using status symbols.	X	
Compare result	Result of the "Compare values" function. This column is displayed when there is an online connection.		X
Start value in project	Configured start value in project. Error indication if entered values have a syntax or process-related error.	X	X
Default value	Value that is pre-assigned to the parameter. The display field is empty for parameters that are not contained in the technology data block.	X	X
Start value PLC	Start value in the CPU. This column is displayed when there is an online connection.		X
Monitor value	Current value in the CPU. This column is displayed when there is an online connection.		X
Modify value	Value that is to be used to change the monitor value. This column is displayed when there is an online connection.		X
Minimum value	Minimum process-related value of the parameter. If the minimum value is dependent on other parameters, it is defined: • Offline: by the start value in the project. • Online: by the monitor values.	X	X
Maximum value	Maximum process-related value of the parameter. If the maximum value is dependent on other parameters, it is defined: • Offline: by the start value in the project. • Online: by the monitor values.	X	X
Setpoint	Designates the parameter as a setpoint. These parameters can be initialized online.	X	X
Data type	Data type of the parameter. The display field is empty for parameters that are not contained in the technology data block.	X	X

Column	Explanation	Offline	Online
Retain	Designates the value as a retentive value. The values of retentive parameters are retained even after the voltage supply is switched off.	X	X
Accessible from HMI	Indicates whether the HMI can access this parameter during runtime.	X	X
Visible in HMI	Indicates whether the parameter is visible in the selection list of the HMI by default.	X	X
Comment	Brief description of the parameter.	X	X

5.12.3 Opening the parameter view

Requirement

The technology object was added in the project navigator.

Procedure

1. Open the "Technology objects" folder in the project tree.
2. Open the technology object in the project tree.
3. Double-click the "Configuration" object.
4. Select the "Parameter view" tab in the top right corner.

Result

The Parameter view opens. Each displayed parameter is represented by one row in the parameter table.

The displayable parameter properties (table columns) vary depending on whether you are working with the Parameter view in offline or online mode.

In addition, you can selectively display and hide individual table columns.

5.12.4 Working with the parameter view

5.12.4.1 Overview

The following table provides an overview of the functions of the Parameter view in online and offline mode described in the following.

- Column "Offline" = X: This function is possible in offline mode.
- Column "Online" = X: This function is possible in online mode.

Function/action	Offline	Online
Filtering the parameter table (Page 350)	X	X
Sorting the parameter table (Page 350)	X	X
Transferring parameter data to other editors (Page 351)	X	X
Indicating errors (Page 351)	X	X
Editing start values in the project (Page 352)	X	X
Monitoring values online in the parameter view (Page 353)		X
Modifying values (Page 354)		X
Comparing values (Page 355)		X

5.12.4.2 Filtering the parameter table

You can filter the parameters in the parameter table in the following ways:

- With the text filter
- With the subgroups of the navigation

Both filter methods can be used simultaneously.

With the text filter

You can filter according to texts that are visible in the parameter table. This means that it can only be filtered by text in displayed parameter lines and displayed columns.

1. Enter the desired character string for filtering in the “Text filter...” input box.

   The parameter table displays only the parameters containing the character string.

The text filtering is reset.

- When another parameter group is selected in the navigation.
- When navigation is changed from data navigation to functional navigation, or vice versa.

With the subgroups of the navigation

1. Click the desired parameter group in the navigation, e.g., "Static".

   The parameter table only shows the static parameters. You can select further subgroups for some groups of the navigation.
2. Click “All parameters” in the navigation if all parameters are to be shown again.

5.12.4.3 Sorting the parameter table

The values of the parameters are arranged in rows. The parameter table can be sorted by any displayed column.

- In columns containing numerical values, sorting is based on the magnitude of the numerical value.
- In text columns, sorting is alphabetical.

Sort column-by-column

1. Position the cursor in the header cell of the desired column.

   The background of this cell turns blue.
2. Click the column header.

Result

The entire parameter table is sorted by the selected column. A triangle with tip facing up appears in the column header.

Clicking the column header again changes the sorting as follows:

- Symbol "▲": Parameter table is sorted in ascending order.
- Symbol "▼": Parameter table is sorted in descending order.
- No symbol: The sorting is removed again. The parameter table assumes the default display.

  The "../" prefix in the "Name in DB" column is ignored when sorting

5.12.4.4 Transferring parameter data to other editors

You can paste parameters of the parameter view in the following editors:

- Program editor
- Watch table
- Signal table for Trace

The following options are available for pasting:

- Drag-and-drop
- <Ctrl+C>/<Ctrl+V>
- Copy/Paste via shortcut menu

5.12.4.5 Indicating errors

Error display

Parameter assignment errors that result in compilation errors (e.g. limit violation) are indicated in the Parameter view.

Every time a value is entered in the Parameter view, a check is made for process-related and syntax errors and displayed with the following indicators:

- Red error symbol in the "Status of configuration" (offline mode) or "Compare result" (online mode, depending on the selected comparison type) columns
- Table field with red background

  If you click the bad field, a roll-out error message appears with information of the permissible value range or the required syntax (format)

Compilation error

From the error message of the compiler, you can directly open the Parameter view (functional navigation) containing the parameter causing the error in situations where the parameter is not displayed in the configuration window.

5.12.4.6 Editing start values in the project

With the Parameter view, you can edit the start values in the project in offline mode and online mode.

- You make value changes in the "Start value in project" column of the parameter table.
- In the "Status of configuration" column of the parameter table, the progress of the configuration is indicated by the familiar status symbols from the configuration window of the technology object.

Boundary conditions

- If other parameters depend on the parameter whose start value was changed, the start value of the dependent parameters are also adapted.
- If a parameter of a technology object is not editable, it is also not editable in the parameter view. The ability to edit a parameter can also depend on the values of other parameters.

Defining new start values

To define start values for parameters in the Parameter view, follow these steps:

1. Open the Parameter view of the technology object.
2. Enter the desired start values in the "Start value in project" column. The value must match the data type of the parameter and must not exceed the value range of the parameter.
   The limits of the value range can be seen in the "Maximum value" and "Minimum value" columns.

The "Status of configuration" column indicates the progress of the configuration with colored symbols.

Following adaptation of the start values and downloading of the technology object to the CPU, the parameters take the defined value at startup if they are not declared as retentive ("Retain" column).

Error display

When a start value is input, a check is made for process-related and syntax errors and the result is indicated.

Bad start values are indicated by:

- Red error symbol in the "Status of configuration" (offline mode) or "Compare result" (online mode, depending on the selected comparison type) columns

and/or

- Red background in the "Start value in project" field
  If you click on the bad field, a roll-out error message appears with information of the permissible value range or the necessary syntax (format)

Correcting bad start values

1. Correct bad start values using information from the roll-out error message.

   Red error symbol, red field background, and roll-out error message are no longer displayed.

The project cannot be successfully compiled unless the start values are error-free.

5.12.4.7 Monitoring values online in the parameter view

You can monitor the values currently taken by the parameters of the technology object in the CPU (monitor values) directly in the Parameter view.

Requirements

- There is an online connection.
- The technology object is downloaded to the CPU.
- The Parameter view of the technology object is open.

Procedure

As soon as the Parameter view is online, the following columns are additionally displayed:

- Compare result
- Start value PLC
- Monitor value
- Modify value
- Selection for transmission

The "Monitor value" column shows the current parameter values on the CPU.

Display

All columns that are only available online have an orange background:

- Values in light-orange cells can be changed.
- Values in cells with a dark orange background cannot be changed.

See also

Parameter table (Page 347)

5.12.4.8 Modifying values

With the Parameter view, you can modify values of the technology object in the CPU.

You can assign values to the parameter once (Modify value) and modify them immediately. The modify request is executed as quickly as possible without reference to any particular point in the user program.

DANGER

Danger when modifying:

Changing the parameter values while the plant is operating may result in severe damage to property and personal injury in the event of malfunctions or program errors.

Make sure that dangerous states cannot occur before you use the "Modify" function.

Requirements

- There is an online connection.
- The technology object is downloaded to the CPU.
- The Parameter view of the technology object is open.
- The parameter can be modified
  (associated field in the "Modify value" column has a light-orange background).

Procedure

To modify parameters immediately, follow these steps:

- Enter the desired modify values in the “Modify values” column of the parameter table.

The selected parameters are modified once and immediately with the specified values and can be monitored in the "Monitor values" column. The check boxes for modifying in the "Selection for transmission" column are automatically cleared after the modify request is complete.

Error display

When a start value is input, a check is made immediately for process-related and syntax errors and the result is indicated.

Bad start values are indicated by:

- Red background in the “Modify value” field

and

- If you click the bad field, a roll-out error message appears with information of the permissible value range or the necessary syntax (format)

Bad modify values

- Modify values with process-related errors can be transmitted.
- Modify values with syntax errors **cannot** be transmitted.

5.12.4.9 Comparing values

You can use comparison functions to compare the following memory values of a parameter:

- Start value in project
- Start value PLC

Requirements

- There is an online connection.
- The technology object is downloaded to the CPU.
- The Parameter view of the technology object is open.

Procedure

To compare the start values on the various target systems, follow these steps:

1. Click the "Selection of compare values" icon .

   A selection list containing the comparison options opens:

   – Start value in project - Start value PLC (default setting)

2. Select the desired comparison option.

   The selected comparison option is executed as follows:

   – A scales symbol appears in the header cells of the two columns selected for comparison.

   – Symbols are used in the "Compare result" column to indicate the result of the comparison of the selected columns.

Symbol in "Compare result" column

Symbol	Meaning
	The compare values are equal and error-free.
	The compare values are not equal and error-free.
	At least one of the two compare values has a process-related or syntax error.
	The comparison cannot be performed. At least one of the two compare values is not available (e.g., snapshot).

Symbol in the navigation

The symbols are shown in the same way in the navigation if the compare result applies to at least one of the parameters below the displayed navigation structure.

Programming 6

6.1 Introduction

The "Programming" section contains general information on supplying and evaluating the Motion Control instructions and on technology data blocks.

You can find an overview of the Motion Control instructions in the Functions (Page 29) section.

You can use Motion Control instructions in the user program to assign jobs to the technology object. You define the job using the input parameters of the Motion Control instructions. The current job status is indicated in the output parameters.

The technology data block is available to you as an additional interface to the technology object.

6.2 Technology data block

6.2.1 Introduction

The properties of real objects (e.g. drives) are configured by means of the technology objects and saved in a technology data block. The technology data block contains all configuration data, setpoint and actual values, and status information of the technology object. The TIA Portal automatically creates the technology data block when the technology object is created. You access the data of the technology data block (read/write access) with your user program.

A listing and description of the tags can be found in the Appendix (Page 539).

6.2.2 Evaluating the technology data block

Access to data in the technology data block occurs in accordance with the access to standard data blocks. Only tags with elementary data types can be accessed in the technology data block. It is not possible to access tags with composite data types (such as STRUCT, ARRAY).

Reading values from the technology data block

In your user program you can read actual values (e.g. current position) and status information, or detect error messages in the technology object. When you program a query in your user program (e.g. current velocity), the value is directly read from the technology object.

Reading values from the technology data block takes longer than for other data blocks. If you use these tags several times in a single cycle of your user program, it is recommended to copy the tag values to local tags, and use the local tags in your program.

Writing values to the technology data block

The configuration of the technology object in the TIA Portal is used to write the corresponding data to the technology data block. After they have been loaded into the CPU, these data are stored in the CPU on the SIMATIC Memory Card (load memory).

In the following cases, it may be necessary for the user program to write values to the technology data block:

- Adaptation of the configuration of the technology object (e.g. dynamic limits, software limit switches)
- Use of overrides
- Adaptation of position control (e.g. "Kv" parameter)

Changes to values in the technology data block by the user program can take effect at various points in time. The relevant property of the individual tags can be found in their descriptions in the Appendix (Page 539):

Effectiveness of changes	Description	
Direct (DIR)	You write changes using direct assignments. The changes are applied only at the start of the next MC-Servo [OB91]. The changes are retained until the next POWER OFF of the CPU or restart of the technology object.	
	LREAL (e.g. <TO>.Override.Velocity)	The technology object performs a range check on the written value, and immediately starts using the new value. If range limits are violated when writing, the technology object automatically corrects the values. If the value is below the range, then the value is set to the low limit of the range; if the range is exceeded, then the value is set to the high limit of the range.
	DINT/BOOL (e.g. <TO> .PositionLimits_SW.Active)	Changes are only permitted in the defined value range. Value changes outside the value range are not applied. If you enter invalid values, the programming error OB (OB 121) is started.
When Motion Control instruction is called (CAL) (e.g. <TO>.Sensor[n].ActiveHoming. HomePositionOffset)	You write changes using direct assignments. The changes are applied at the start of the next MC-Servo [OB91] after the call of the corresponding Motion Control instruction in the user program. The changes are retained until the next POWER OFF of the CPU or restart of the technology object.	
Restart (RES) (e.g. <TO>.Homing.AutoReversal)	Since restart-relevant tags have dependencies on other tags, value changes cannot be applied at any arbitrary time. The changes are only used after reinitialization (restart) of the technology object. During a restart the technology object is reinitialized with the data in load memory. You therefore write changes to the start value in the load memory with the extended instruction "WRIT_DBL" (write to data block in load memory). You trigger the restart in your user program using the Motion Control instruction "MC_Reset" with parameter "Restart" = TRUE. Additional information regarding the restart can be found in the Restarting technology objects (Page 386) section.	
Read only (RON) (e.g. <TO>.Position)	The tag cannot and must not be changed during runtime of the user program.	

Note

Save changes with "WRIT_DBL"

Changes to tags immediately in effect are lost on POWER OFF of the CPU, or restart of the technology object.

If changes in the technology data block should also be retained after POWER OFF of the CPU, or restart of the technology object, you must write the changes to the start value in the load memory with the extended instruction "WRIT_DBL".

Note

Using the "READ_DBL" and "WRIT_DBL" data block functions

The "READ_DBL" and "WRIT_DBL" data block functions may only be used on individual tags in conjunction with the tags of the technology object. The "READ_DBL" and "WRIT_DBL" data block functions must not be applied to data structures of the technology object.

Isochronous evaluation of data

If you want to process data of the technology data block in isochronous mode from a Motion Control application cycle, there is the option of evaluating this data in the MC-PreServo [OB67]/MC-PostServo [OB95] as of technology version V3.0.

See also

Organization Blocks for Motion Control (Page 104)

6.2.3 Evaluate StatusWord, ErrorWord and WarningWord

To be able to symbolically use individual status and error information from the "StatusWord", "ErrorWord" and "WarningWord" data double words, you can evaluate them as described below. For consistent evaluation, you should avoid using bit addressing to access these data double words in the technology data block. Access to an individual bit in the technology data block only lasts as long as the access to the entire data word.

When required, copy the required data double word to a tag of a data structure and query the individual bits of the tag.

The allocation of the individual bits in the data double words can be found in the Appendix (Page 539) in the description of the tags of the corresponding technology object.

Requirements

The technology object has been created.

Procedure

To evaluate the individual bits in the data word "StatusWord", follow these steps:

1. Crate a global data structure. Name the data structure, e.g. as "Status".
2. Create a double word (DWORD) in the data structure "Status". Name the double word, e.g. as "Temp".
3. Create 32 Boolean tags in the "Status" data structure. You can obtain a clearer overview by giving the individual Boolean tags identical names as the bits in the technology DB (e.g. name the fifth Boolean tag "HomingDone").
4. Copy the tag <TO>.StatusWord as needed from the technology data block to the double word "Temp" in your data structure.
5. Copy the individual bits of double word "Temp" to the corresponding Boolean tags with bit accesses.
6. Use the Boolean tags to query the status bits.

Evaluate the data words "ErrorWord" and "WarningWord" as specified in steps 1 to 6.

Example

The following example shows how you can read out and save the fifth bit "HomingDone" of the data word "StatusWord":

SCL	Explanation
`#Status.Temp := "TO".StatusWord;`	`//Copy status word`
`#Status.HomingDone := #Status.Temp.%X5;`	`//Copy individual bits per bit access`

STL	Explanation
`L "TO".StatusWord`	`//Copy status word`
`T #Status.Temp`	
`U #Status.Temp.%X5`	`//Copy individual bits per bit access`
`= #Status.HomingDone`	

6.2.4 Change restart-relevant data

In order to change restart-relevant data in the technology data block, write to the starting values of the tags in load memory using the extended instruction "WRIT_DBL". In order for the changes to be applied, a restart of the technology object must be performed.

Whether changes to the value of a tag are relevant for the restart can be found in the description of the tags in the Appendix (Page 554).

Requirement

The technology object has been created.

Procedure

To change restart-relevant data, proceed as follows:

1. Create a data block and fill it with the restart-relevant values, that you want to change in the technology data block. In doing so, the data types must match the tags to be changed.
2. Write the values from your data block to the starting values of the tags of the technology data block in load memory, using the extended instruction "WRIT_DBL".

   If restart-relevant data were changed, this will be indicated in the <TO>.StatusWord.X3 (OnlineStartValuesChanged) tag of the technology object.
3. Perform a restart of the technology object using the Motion Control instruction "MC_Reset" with parameter "Restart" = TRUE.

After the restart of the technology object, the new value is transferred into the technology data block in work memory, and is effective.

6.3 Motion Control instructions

6.3.1 Motion Control instruction parameters

Description

The individual Motion Control instructions are described in detail in the section MC_Power V4 (Page 430).

When creating your user program, take the following explanations of the Motion Control instruction parameters into account.

Reference to the technology object

The technology object is specified for the Motion Control instruction as follows:

- **Parameter "Axis"**

  The "Axis" input parameter of a Motion Control instruction contains a reference to the technology object that is to execute the corresponding job.

  The corresponding technology object is also referenced in the following parameters:

  – Parameter "Master"

  – Parameter "Slave"

  – Parameter "Cam"

  – Parameter "MeasuringInput"

  – Parameter "OutputCam"

  – Parameter "CamTrack"

  As of technology version V3.0, the reference to the technology object can also be specified with the data type DB_ANY.

Job start and transfer of input parameters of a Motion Control instruction

For the start of jobs and the transfer of modified parameter values, a distinction is made between the following Motion Control instructions:

- **Motion Control instructions with "Execute" parameter**

  With a positive edge at the "Execute" parameter, the job is started and the existing values for the input parameters are transferred.

  Subsequently changed parameter values are not transferred until the next job start.

  Resetting the "Execute" parameter does not end the job, but it does affect the display duration of the job status. As long as "Execute" is set to TRUE, the output parameters will be updated. If "Execute" is reset before the completion of a job, the parameters "Done", "Error" and "CommandAborted" are correspondingly set for only one call cycle.

- **Motion Control instructions with "Enable" parameter**

  The job is started by setting the "Enable" parameter.

  As long as "Enable" = TRUE, the job remains active and changed parameter values will be transferred each time the instruction is called in the user program.

  The job is ended by resetting the "Enable" parameter.

  The input parameters "JogForward" and "JogBackward" of the Motion Control instruction "MC_MoveJog" correspond in their behavior to the "Enable" parameter.

Job status

The following output parameters indicate the status of the job execution:

- **Motion Control instructions with "Done" parameter**

  The normal completion of a job is indicated with parameter "Done" = TRUE.

- **Motion Control instructions without "Done" parameter**

  The achievement of the job objective is indicated by other parameters (e.g. "Status", "InVelocity"). For more information, refer to the section Tracking running jobs (Page 373).

- **Parameter "Busy"**

  As long as a job is being processed, the "Busy" parameter shows the value TRUE. If a job was ended or aborted, "Busy" shows the value FALSE.

- **Parameter "CommandAborted"**

  If a job was aborted by another job, the CommandAborted parameter shows the value "TRUE".

- **Parameter "Error"**

  If a Motion Control instruction error occurs, the "Error" parameter shows the value TRUE. The ErrorID parameter indicates the cause of the error.

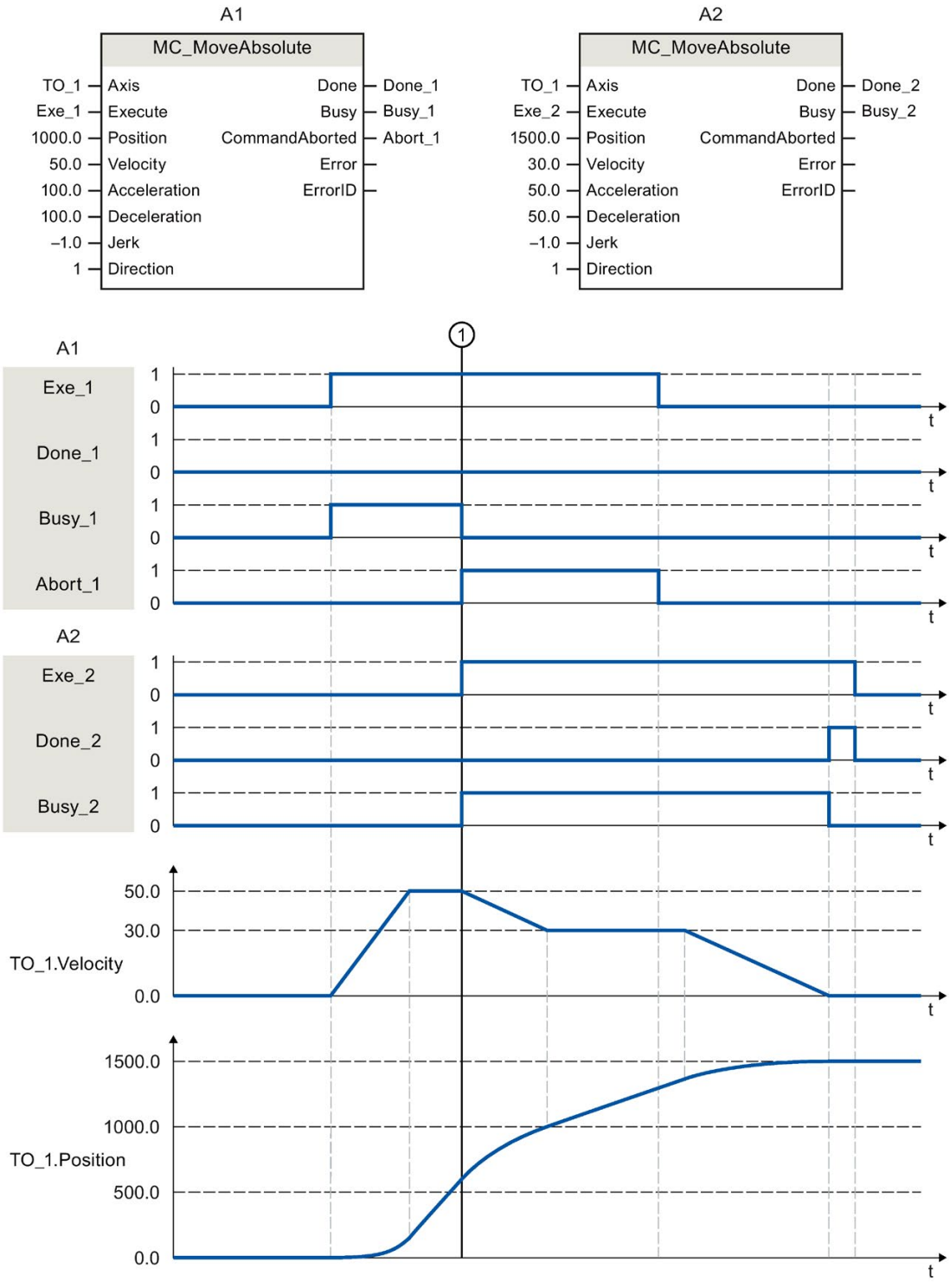
As long as the "Execute" or "Enable" parameter is set to TRUE, the output parameters will be updated. Otherwise the parameters "Done", "Error" and CommandAborted" are correspondingly set for only one cycle.

Abort of running jobs

An active Motion Control job is aborted by the start of a new Motion Control job. In the process, the current dynamic setpoints (acceleration, deceleration, jerk, velocity) are set to the values of the overriding job.

Example of parameter behavior

The behavior of the parameters of Motion Control instructions is shown in the following chart using the example of two "MC_MoveAbsolute" jobs.



Using "Exe_1", an "MC_MoveAbsolute" job (A1) with target position 1000.0 is initiated. "Busy_1" is set to TRUE. The axis is accelerated to the specified velocity and moved to the target position (see TO_1.Velocity and TO_1.Position). Before the target position is reached, the job is overridden at time ① by another "MC_MoveAbsolute" job (A2). The abort is signaled via "Abort_1", and "Busy_1" is set to FALSE. The axis is braked to the velocity specified in A2 and moved to the new target position 1500.0. When the axis reaches the target position, this is signaled via "Done_2".

Non position-controlled operation

The position control of the axis can be deactivated with the following parameters:

- MC_Power.StartMode = 0
- MC_MoveVelocity.PositionControlled = FALSE
- MC_MoveJog.PositionControlled = FALSE

For more information, refer to the section " Non position-controlled operation (Page 369).

See also

Instructions (Page 430)

6.3.2 Add Motion Control instructions

You add Motion Control instructions to a program block in the same way as other instructions. You control all available functions of the technology object using the Motion Control instructions.

Requirements

The technology object was created.

Procedure

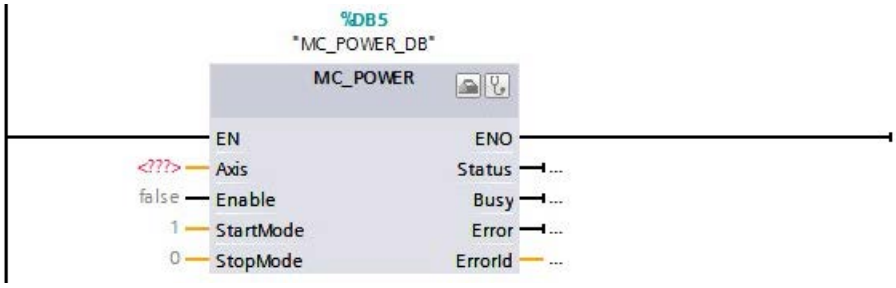
To add Motion Control instructions in your user program, proceed as follows:

1. Double click your program block in the project tree (the program block must be called in the cyclical program).

   The program block is opened in the programming editor, and the available instructions are displayed.
2. In the "Instructions" task card, open the "Technology > Motion Control" folder.
3. Using drag-and-drop, move the Motion Control instruction, e.g. "MC_Power", to the desired segment of the program block.

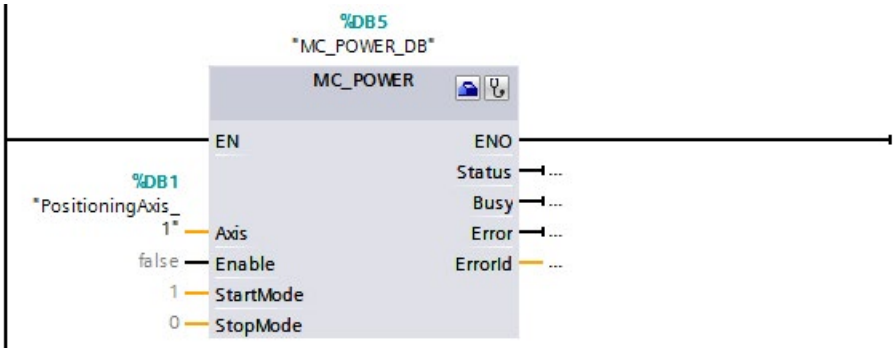
   The "Call options" dialog opens.
4. In the dialog, specify a name and a number for the instance data block of the Motion Control instruction.
5. Click "OK".

   The Motion Control instruction "MC_Power" is inserted into the network.



The instance data block is automatically created under "Program Blocks > System Blocks > Program Resources".

6. Input parameters without a default value (e.g. "Axis"), must be assigned. Select the technology object in the project tree and move it onto <...> in the "Axis" parameter using drag-and-drop.



Once the technology object is specified in the "Axis" parameter, the following buttons are available to you:

	To open the configuration of the technology object, click on the toolbox icon.
	To open the diagnostics of the technology object, click on the stethoscope icon.

7. Add additional Motion Control instructions in accordance with steps 3 through 6.

See also

Tracking active jobs (Page 373)

Tags of the positioning axis/synchronous axis technology object (Page 554)

6.3.3 Parameter transfer for function blocks

If you want to reuse a function block with Motion Control instructions for different technology objects, create an input parameter of the data type of the respective technology object in the block interface of the calling function block. You assign the data type in the block interface with a direct input. The parameter is then transferred as reference to the technology object to the "Axis" parameter of the Motion Control instructions. The data types of technology objects correspond to the structure of the associated technology data block.

By specifying the data type, you can address the tags of the technology object in the function block (<parameters of the block interface>.<tag of the technology object>).

The data types for the reference to the technology objects are available in the appendix (Page 665).

Example 1

The following table shows the declaration of the tags used:

Tag	Declaration	Data type	Description
axis	Input	TO_PositioningAxis	Reference to the technology object
on	Input	BOOL	Signal to enable the axis
actPosition	Output	LReal	Query of the actual position from the technology data block
instMC_POWER	Static	MC_POWER	Multiinctance of the Motion Control instruction MC_Power

The following SCL program shows how to implement this task:

SCL	Explanation
`#instMC_POWER(Axis := #axis, Enable := #on);`	`//Call of the Motion Control instruction MC_Power with enable of the axis`
`#actPosition := #axis.ActualPosition;`	`//Query of the actual position from the technology data block`

Example 2

The data type "DB_Any" provides a further option for the transfer of specific data types of the technology object. Unlike the data types of the technology object in the program, "DB_Any" can be assigned during runtime.

This example shows how you can program variable switching of up to four cams at "MC_CamIn".

To do this, tags of the data type "DB_Any" are first created as input parameter of the block. The cam to be used is assigned by an additional input parameter.

The following table shows the declaration of the tags used:

Tag	Declaration	Data type	Description
cam1	Input	DB_ANY	Cam 1
cam2	Input	DB_ANY	Cam 2
cam3	Input	DB_ANY	Cam 3
cam4	Input	DB_ANY	Cam 4
camToUse	Input	Int	Selection of cam 1 to 4
instMC_CAMIN	Static	MC_CAMIN	Multi-instance of the MC_CamIn
tempCamSel	Temp	DB_ANY	Current cam

The example below shows the basic procedure:

```
SCL                                                  Explanation
                                                     //Selection of the desired cam 1..4
                                                     //Using an input tag of data type Int
CASE #camToUse OF
     1:  #tempCamSel := #cam1;                       //Instruction for scenario 1
     2:  #tempCamSel := #cam2;                       //Instruction for scenario 2
     3:  #tempCamSel := #cam3;                       //Instruction for scenario 3
     4:  #tempCamSel := #cam4;                       //Instruction for scenario 4
   ELSE                                              //Instruction for Int ≤ 0 or > 4
     #tempCamSel := #cam1;                           //Corresponds to default cam 1
END CASE;
                                                     //Calling of the MC_CamIn with variable transfer
                                                     of the cam technology object using the temporary
                                                     tag "tempCamSel"

#instMC_CAMIN(Master := "PositioningAxis_1",         //Direct assignment of the technology object of
                                                     the leading axis
              Slave := "SynchronousAxis_1",          //Direct assignment of the technology object of
                                                     the following axis
              Cam := #tempCamSel);                   //Indirect assignment of the cam technology object
```

Additional information

You can find more program examples using the data type "DB_Any" in the following FAQ:

https://support.industry.siemens.com/cs/document/109750880
(https://support.industry.siemens.com/cs/ww/en/view/109750880)

6.3.4 Non position-controlled operation

The closed loop position control of an axis can be switched off/switched with the following Motion Control instructions:

- MC_Power
- MC_MoveVelocity
- MC_MoveJog

The non-position-controlled operation is displayed with <TO>.StatusWord.X28 (NonPositionControlled) = TRUE.

MC_Power

The axis is enabled without closed loop position control with "MC_Power" and the parameter "StartMode" = 0. The closed loop position control remain switched off until a different Motion Control instruction changes the status of the closed loop position control.

MC_MoveVelocity and MC_MoveJog

A "MC_MoveVelocity" or "MC_MoveJog" job with "PositionControlled" = FALSE forces non-position-controlled operation.

A "MC_MoveVelocity" or "MC_MoveJog" job with "PositionControlled" = TRUE forces position-controlled operation.

The selected mode remains in effect after the job is completed.

Influence of additional Motion Control instructions

Starting the following Motion Control instructions forces position-controlled operation of the axis:

- MC_Home with "Mode" = 3, 5
- MC_MoveAbsolute
- MC_MoveRelative
- MC_MoveSuperimposed
- MC_GearIn
- MC_GearInPos (S7-1500T)
- MC_CamIn (S7-1500T)

The closed loop position control remains active after completing the corresponding jobs.

The Motion Control instruction MC_Halt is executed in position-controlled and non-position-controlled operation. The status of the closed loop position control is not changed by "MC_Halt".

A torque limiting activated with "MC_TorqueLimiting" is in effect even with non-position-controlled operation.

Synchronous operation with setpoint coupling

A following axis is set into position-controlled operation with the start of a synchronous operation job. If the leading axis is in non-position-controlled operation at the start of the synchronous operation, the synchronous operation job remains waiting. Synchronization is started only after position control has been activated and the start position of the synchronization has been reached.

Note

If the leading axis is set to the non-position-controlled mode during active synchronization, your setpoint is then set to zero. A setpoint step change is obtained as a result of coupling the setpoint of following axis. The setpoint step change is compensated according to the constant function. The only limiting factor is the maximum speed of the drive.

Synchronous operation with actual value coupling (S7-1500T)

A following axis is set into position-controlled operation with the start of a synchronous operation job. If the leading axis is in non-position-controlled operation at the start of the synchronous operation and the actual values are valid, synchronization is started.

If the leading axis is set to the non-position-controlled mode during active synchronization, the synchronization remains active.

6.4 Starting Motion Control jobs

Description

Motion Control jobs are started by setting the "Execute" or "Enable" parameter of the Motion Control instruction. The call of the Motion Control instructions for a technology object should occur in an execution level.

When executing Motion Control jobs, you should also take note of the status of the technology object.

Starting Motion Control jobs should be performed in the following steps:

1. Query the status of the technology object.
2. Initiate new job for the technology object.
3. Check job status.

These steps are explained using the example of a job for absolute positioning.

1. Query the status of the technology object

Make sure that the technology object is in the appropriate status to perform the desired job:

- **Has the technology object been released?**

  To execute motion jobs, the technology object must be enabled.

  Enabling is performed using the Motion Control instruction "MC_Power".

  The "MC_Power.Status" parameter (<TO>.StatusWord.X0 (Enable)) must show the value TRUE.

- **Is a technology alarm pending?**

  To perform motion commands, no technology alarms or alarm responses may be pending. The tags of the technology objects <TO>.ErrorDetail.Number and <TO>.ErrorDetail.Reaction must show the value zero. After resolving the error, acknowledge any pending alarms using the Motion Control instruction "MC_Reset".

  A list of the technology alarms and alarm reactions can be found in the appendix, Technology alarms (Page 626).

- **Has the technology object been homed?**

  In order to perform a job for absolute positioning, the positioning axis/synchronous axis technology object must be homed. The referencing occurs via the Motion Control instruction "MC_Home". The "<TO>.StatusWord.X5 (HomingDone) " tag of the technology object must show the value TRUE .

2. Initiate new command for the technology object

In the "Position" parameter of the "MC_MoveAbsolute" instruction, specify the position to which the axis should be moved. Start the job with a positive edge at the "Execute" parameter.

3. Check command status

Parameter "Done" of the Motion Control instruction indicates successful completion of a job (target reached, in this case).

If an error is detected, the "Error" parameter of the Motion Control instruction is set to TRUE, and the job is rejected.

You can program an error handling routine for the Motion Control job. For this purpose, evaluate the error indicated in the "Error" parameter. The cause of the error is indicated in the ErrorID parameter. After resolving the cause of the error, restart the job.

Output of the "Error" = TRUE and "ErrorID" = 16#8001 status information during job processing indicates that a technology alarm was triggered.

You can find a list of the ErrorIDs in the Error detection (Page 652) appendix.

Additional information

An option for the evaluation of the individual status bits, error bits, and warning bits can be found in the Evaluating StatusWord, ErrorWord and WarningWord (Page 359) section.

6.5 Tracking active jobs

6.5.1 Introduction

The current status of the job processing is made available via the output parameters of the Motion Control instruction. These parameters are updated with each call of the Motion Control instruction.

When tracking jobs, a distinction is made between three groups:

- Motion Control instructions with "Done" parameter (Page 373)
- Motion Control instructions without "Done" parameter (Page 377)
- Motion Control instruction "MC_MoveJog" (Page 381)

6.5.2 Motion Control instructions with "Done" parameter

Description

Jobs of Motion Control instructions with the "Done" parameter are started with a positive edge at the "Execute" parameter. If the job was completed without errors or interruption by another job (e.g. "MC_MoveAbsolute": Target position reached), the "Done" parameter shows the value TRUE.

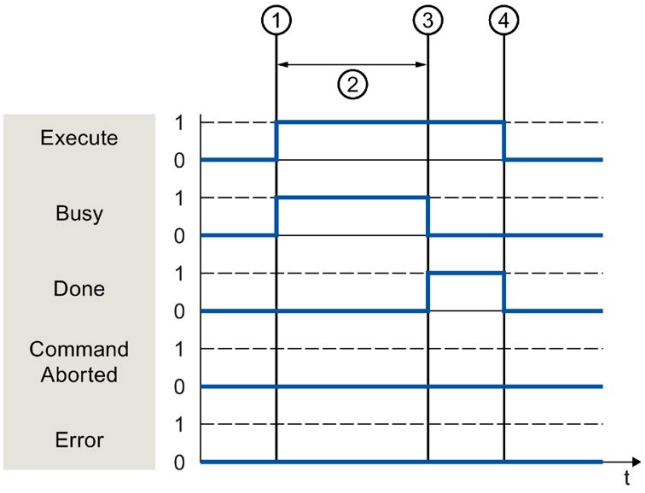
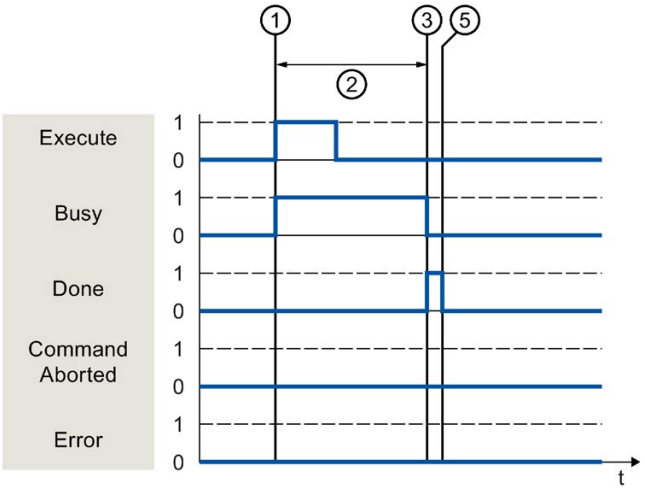
The following Motion Control instructions have a "Done" parameter:

- MC_Home
- MC_MoveRelative
- MC_MoveAbsolute
- MC_MoveSuperimposed
- MC_Halt
- MC_Reset
- MC_MeasuringInput
- MC_AbortMeasuringInput

The behavior of the parameters is shown below by way of example for various situations:

Complete execution of the job

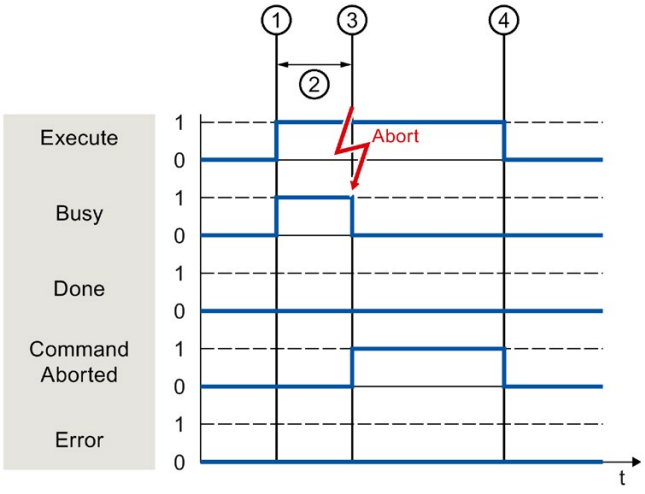
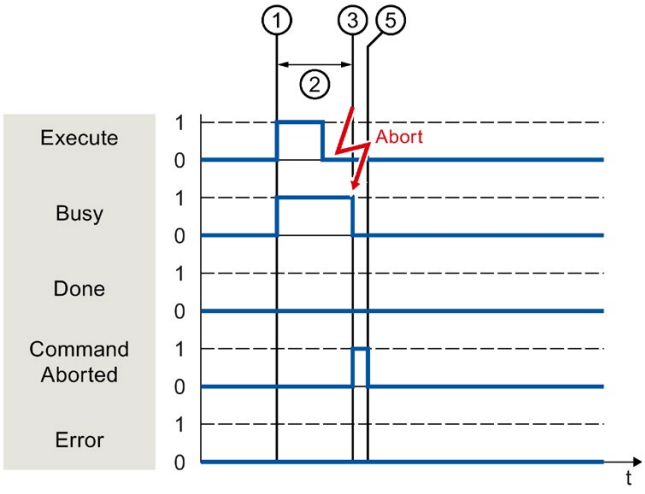
If the Motion Control job has been completely executed all the way to the end, this is indicated with parameter "Done" = TRUE. The signal state of the "Execute" parameter influences the display duration for the "Done" parameter:

You set "Execute" **after completion** of the job to FALSE.	You set "Execute" **during processing** of the job to FALSE.
	

①	The job is started with a positive edge at the "Execute" parameter. Depending on the programming, "Execute" can be reset to the value FALSE during the job or the value TRUE can be retained until after completion of the job.
②	While the job is being executed, the "Busy" parameter shows the value TRUE.
③	At the completion of the job (for example, with Motion Control instruction "MC_MoveAbsolute": Target position reached), the "Busy" parameter changes to FALSE and the "Done" parameter to TRUE.
④	As long as the "Execute" parameter retains the value TRUE after completion of the job, the "Done" parameter also retains the value TRUE.
⑤	If the "Execute" parameter was already set to FALSE before completion of the job, the "Done" parameter shows the value TRUE for only one execution cycle.

Job abort

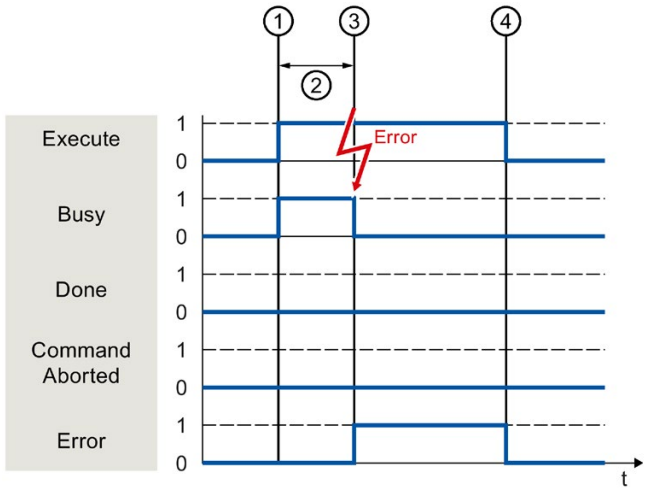
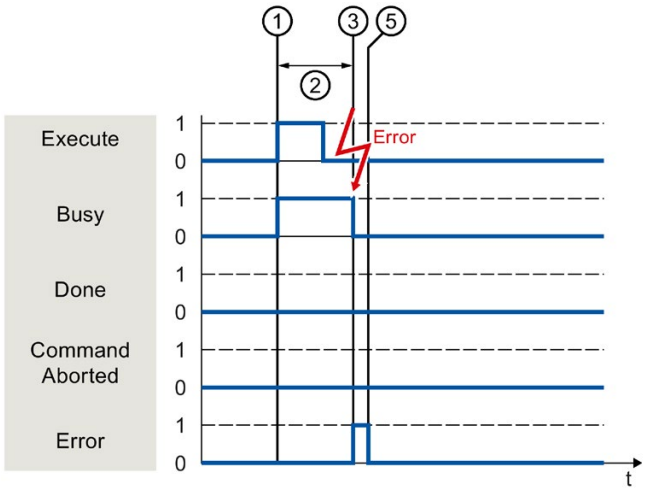
If the Motion Control job is aborted during processing by another job, this is indicated in the "CommandAborted" parameter with the value TRUE. The signal state of the "Execute" parameter influences the display duration for the "CommandAborted" parameter:

You set "Execute" **after** the job is aborted to FALSE.	You set "Execute" **before** the job is aborted to FALSE.
	

①	The job is started with a positive edge at the "Execute" parameter. Depending on the programming, "Execute" can be reset to the value FALSE during the job or the value TRUE can be retained until after completion of the job.
②	While the job is being executed, the parameter "Busy" shows the value TRUE.
③	During job execution, the job is aborted by another Motion Control job. When the job is aborted, the "Busy" parameter changes to "FALSE" and "CommandAborted" changes to TRUE.
④	As long as the "Execute" parameter retains the value TRUE after completion of the job, the "CommandAborted" parameter also retains the value TRUE.
⑤	If the "Execute" parameter was already set to FALSE before the job is aborted, the "CommandAborted" parameter shows the value TRUE for only one execution cycle.

Error during job execution

If an error occurs during execution of the Motion Control job, this is indicated with parameter "Error" = TRUE. The signal state of the "Execute" parameter influences the display duration for the "Error" parameter:

You set "Execute" **after** the occurrence of the error to FALSE.	You set "Execute" **before** the occurrence of the error to FALSE.
	

①	The job is started with a positive edge at the "Execute" parameter. Depending on the programming, "Execute" can be reset to the value FALSE during the job or the value TRUE can be retained until after completion of the job.
②	While the job is being executed, the "Busy" parameter shows the value TRUE.
③	An error occurs during the execution of the job. When the error occurs, the "Busy" parameter changes to FALSE and the "Error" parameter to TRUE.
④	As long as the "Execute" parameter retains the value TRUE after the occurrence of the error, the "Error" parameter also retains the value TRUE.
⑤	If the "Execute" parameter was already set to FALSE before the occurrence of the error, the "Error" parameter shows the value TRUE for only one execution cycle.

6.5.3 Motion Control instructions without "Done" parameter

Description

Motion Control instructions without the "Done" parameter use a special parameter to indicate that the command objective (e.g. "InVelocity", "InGear") has been achieved. The target state or motion is stopped until the job is aborted or an error occurs.

The following Motion Control instructions have a special parameter for indicating the job status:

- MC_Power ("Status" parameter)
- MC_MoveVelocity ("InVeloctity" parameter)
- MC_GearIn ("InGear" parameter)
- MC_MoveJog ("InVelocity" parameter)

  The special behavior of "MC_MoveJog" is described in the section Motion Control instruction MC_MoveJog (Page 381).
- MC_TorqueLimiting ("InClamping" and "InLimitation") parameters

The following Motion Control instructions have no special parameter for indicating the job status: Feedback is provided via the following tags:

- MC_MeasuringInputCyclic

  The execution of a measuring job is indicated with parameter "Busy" = TRUE. Completed measuring events are indicated in the corresponding event counters <TO>.MeasuredValues.MeasuredValue1Counter and <TO>.MeasuredValues.MeasuredValue2Counter of the technology data block.
- MC_OutputCam

  The execution of a job is indicated with parameter "Busy" = TRUE. The CamOutput tag in the associated technology data block indicates the switching state of the output cam.
- MC_CamTrack

  The execution of a job is indicated with parameter "Busy" = TRUE. The TrackOutput tag in the associated technology data block indicates the switching state of the output cam.

The behavior of the parameter is shown for various situations using the Motion Control instruction "MC_MoveVelocity" as an example:

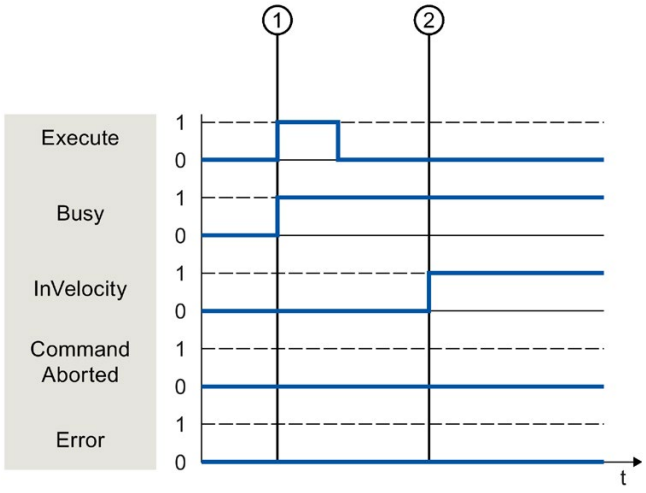
Example "MC_MoveVelocity"

An "MC_MoveVelocity" job is started with a positive edge at the "Execute" parameter. The job objective is fulfilled when the assigned velocity is reached and the axis travels at constant velocity. When the assigned velocity is reached and maintained, this is indicated in the "InVelocity" parameter with the value TRUE.

The motion of the axis can, for example, be stopped with an "MC_Halt" job.

The assigned velocity is reached and maintained

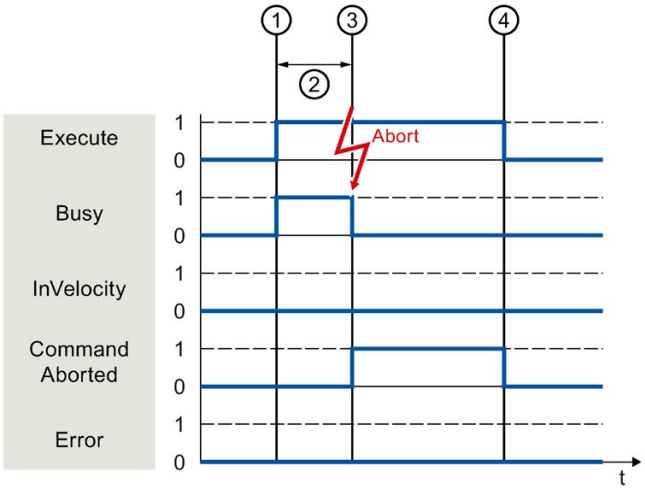
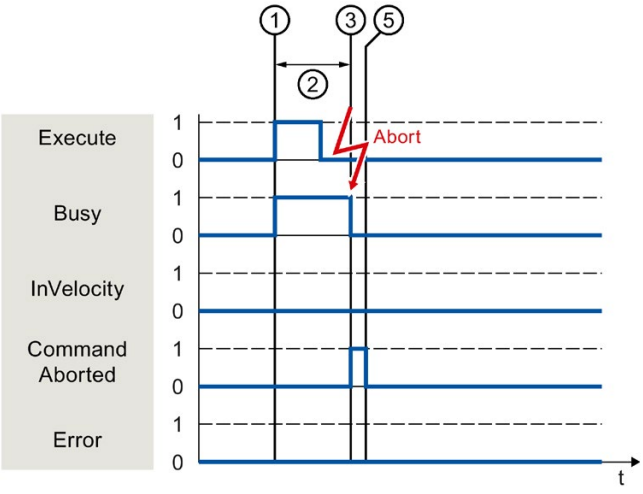
The achievement of the assigned velocity is indicated with parameter "InVelocity" = TRUE. The "Execute" parameter has no effect on the display duration for the "InVelocity" parameter.



①	The job is started with a positive edge at the "Execute" parameter. Depending on the programming, "Execute" can be reset to the value FALSE before or after the assigned velocity has been reached. While the job is being executed, the parameter "Busy" shows the value TRUE.
②	When the assigned velocity is reached, the "InVelocity" parameter changes to TRUE. The "Busy" and "InVelocity" parameters retain the value TRUE until another Motion Control job overrides the "MC_MoveVelocity" job.

The job is aborted before the assigned velocity is reached

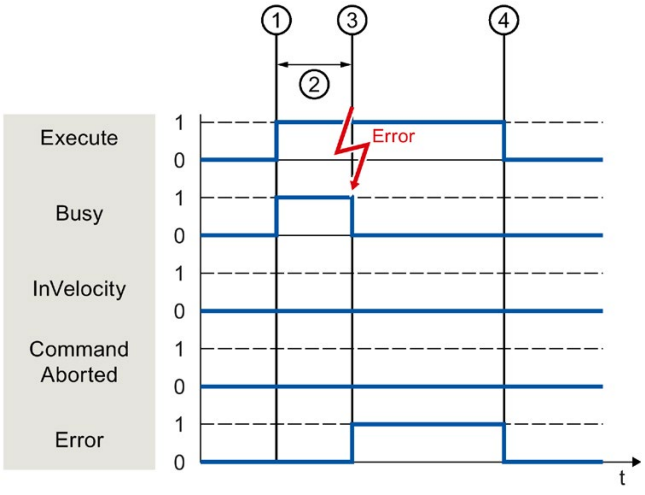
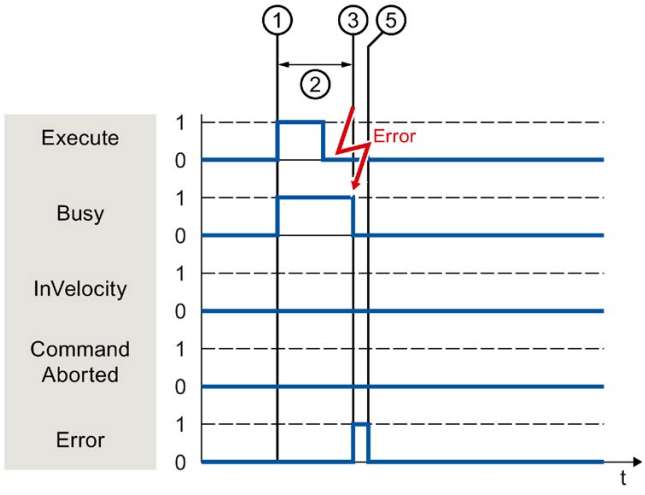
If the Motion Control job is aborted by another job before the assigned velocity is reached, this is indicated with parameter "CommandAborted" = TRUE. The signal state of the "Execute" parameter influences the display duration for the "CommandAborted" parameter.

You set "Execute" **after** the job is aborted to FALSE.	You set "Execute" **before** the job is aborted to FALSE.
	

①	The job is started with a positive edge at the "Execute" parameter. Depending on the programming, "Execute" can be reset to the value FALSE during the job or the value TRUE can be retained until after the job is aborted.
②	While the job is being executed, the "Busy" parameter shows the value TRUE.
③	During job execution, the job is aborted by another Motion Control job. When the job is aborted, the "Busy" parameter changes to "FALSE" and "CommandAborted" changes to TRUE.
④	As long as the "Execute" parameter retains the value TRUE after completion of the job, the "CommandAborted" parameter also retains the value TRUE.
⑤	If the "Execute" parameter was already set to FALSE before the job is aborted, the "CommandAborted" parameter shows the value TRUE for only one execution cycle.

An error has occurred prior to reaching the assigned velocity

If an error occurs during execution of the Motion Control job before the assigned velocity has been reached, this is indicated with parameter "Error" = TRUE. The signal state of the "Execute" parameter influences the display duration for the "Error" parameter.

You set "Execute" **after** the occurrence of the error to FALSE.	You set "Execute" **before** the occurrence of the error to FALSE.
	

①	The job is started with a positive edge at the "Execute" parameter. Depending on the programming, "Execute" can be reset to the value FALSE during the job or the value TRUE can be retained until after the error has occurred.
②	While the job is being executed, the "Busy" parameter shows the value TRUE.
③	An error occurs during the execution of the job. When the error occurs, the "Busy" parameter changes to FALSE, and the "Error" parameter to TRUE.
④	As long as the "Execute" parameter retains the value TRUE after completion of the job, the "Error" parameter also retains the value TRUE.
⑤	If the "Execute" parameter was already set to FALSE before the job is aborted, the "Error" parameter shows the value TRUE for only one execution cycle.

6.5.4 Motion Control instruction "MC_MoveJog"

Description

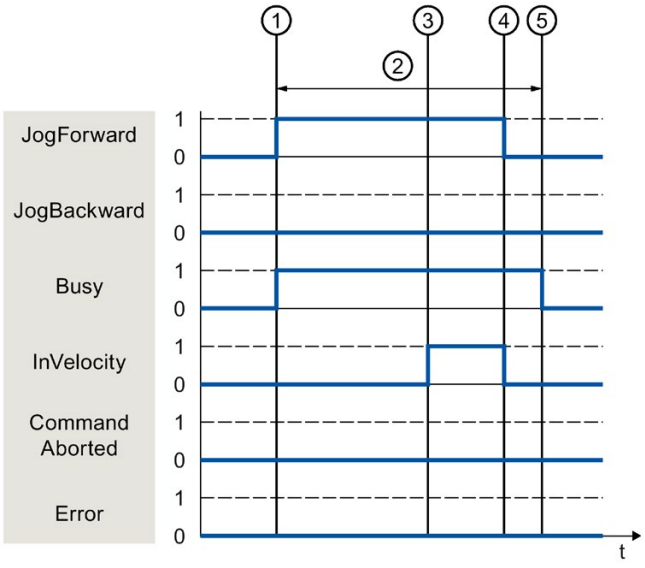
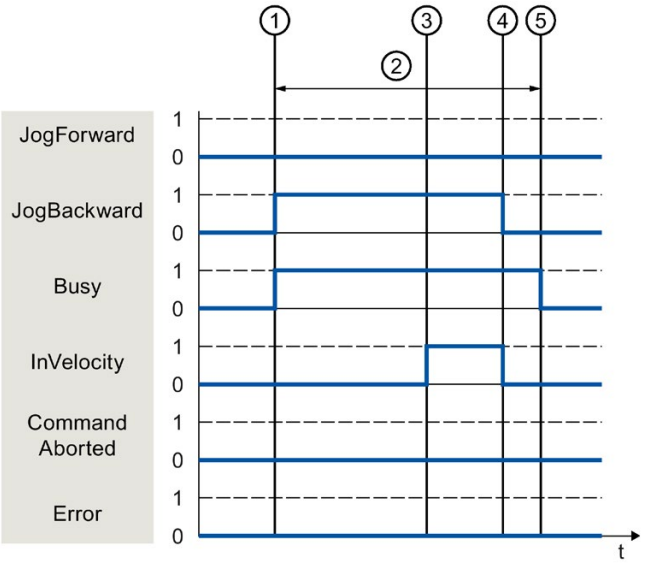
An "MC_MoveJog" job is started by setting the "JogForward" or "JogBackward" parameter. The job objective is fulfilled when the assigned velocity is reached and the axis travels at constant velocity. When the assigned velocity is reached and maintained, this is indicated in the "InVelocity" parameter with the value TRUE.

The job is complete when the "JogForward" or "JogBackward" parameter has been set to the value FALSE and the axis has come to a standstill.

The behavior of the parameters is presented below for various example situations:

The assigned velocity is reached and maintained

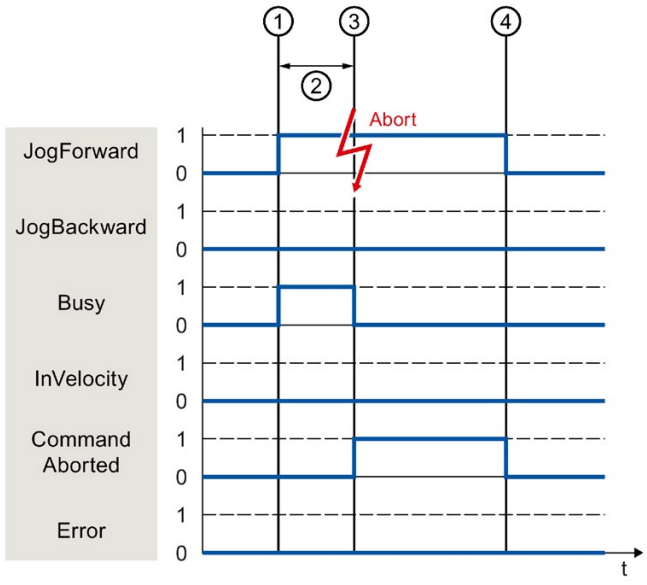
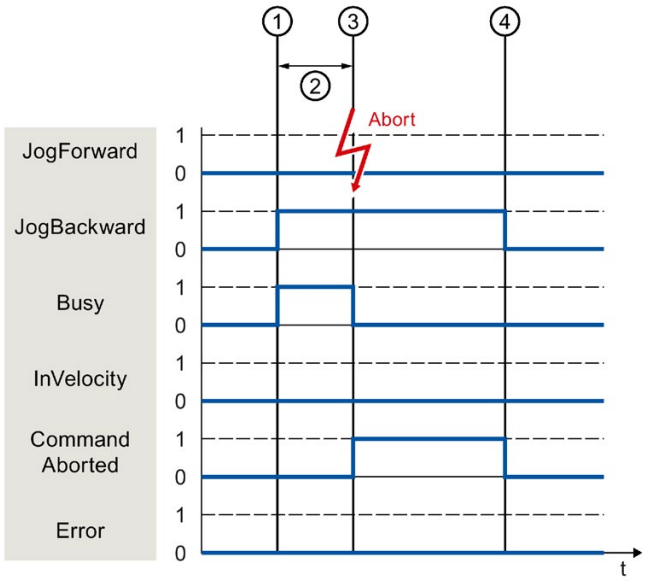
If the Motion Control job has been performed up to the point of reaching the assigned velocity, then this is indicated in the "InVelocity" parameter with the value TRUE.

Jog mode is controlled by the "JogForward" parameter.	Jog mode is controlled by the "JogBackward" parameter.
	

①	The job is started by setting the "JogForward" or "JogBackward" parameter.
②	While the job is being executed, the "Busy" parameter shows the value TRUE.
③	When the assigned velocity is reached, the "InVelocity" parameter changes to TRUE.
④	When the "JogForward" or "JogBackward" parameter is reset, the motion of the axis ends. The axis decelerates. The "InVelocity" parameter changes to FALSE.
⑤	If the axis has come to a standstill, then the Motion Control job is complete and the "Busy" parameter changes to FALSE.

The job is aborted during execution

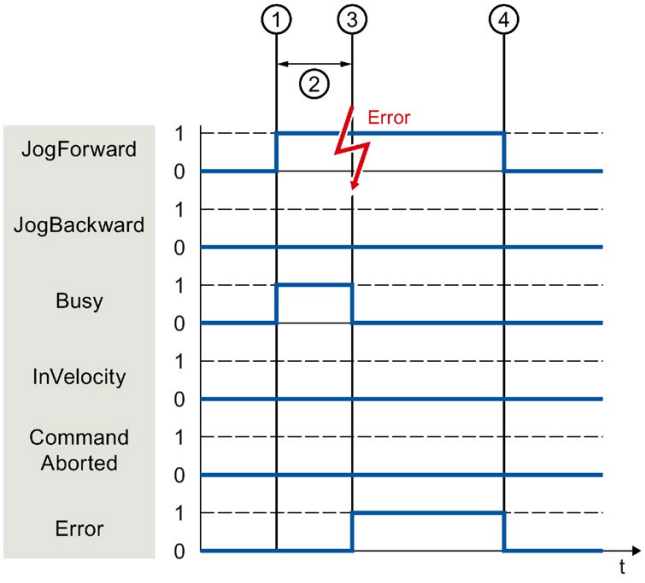
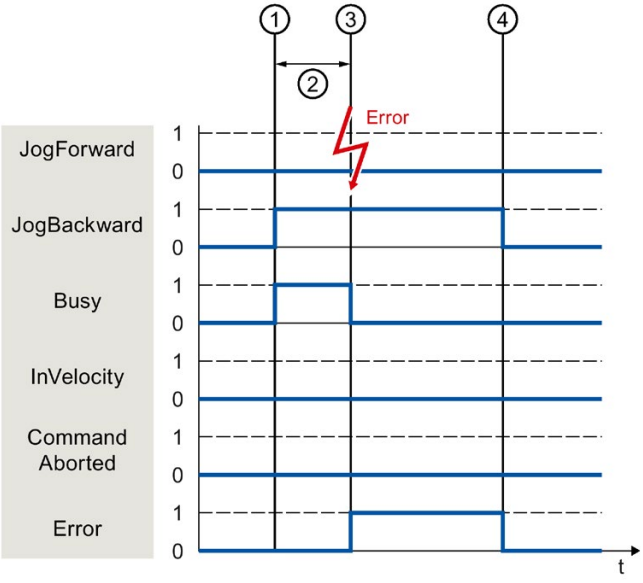
If the Motion Control job is aborted during processing by another job, this is indicated in the "CommandAborted" parameter with the value TRUE. The behavior of the "CommandAborted" parameter is independent of reaching the assigned velocity.

Jog mode is controlled by the "JogForward" parameter.	Jog mode is controlled by the "JogBackward" parameter.
	

①	The job is started by setting the "JogForward" or "JogBackward" parameter.
②	While the job is processing, the "Busy" parameter shows the value TRUE.
③	During job execution, the job is aborted by another Motion Control job. When the job is aborted, the "Busy" parameter changes to "FALSE" and "CommandAborted" changes to TRUE.
④	When the "JogForward" or "JogBackward" parameter is reset, the "CommandAborted" parameter likewise changes to FALSE.

An error occurs during the execution of the job

If an error occurs during execution of the Motion Control job, this is indicated in the "Error" parameter with the value TRUE. The behavior of the "Error" parameter is independent of reaching the assigned velocity.

Jog mode is controlled by the "JogForward" parameter.	Jog mode is controlled by the "JogBackward" parameter.
	

①	The job is started by setting the "JogForward" or "JogBackward" parameter.
②	While the job is being executed, the "Busy" parameter shows the value TRUE.
③	An error occurs during the execution of the job. When the error occurs, the "Busy" parameter changes to "FALSE", and "Error" changes to TRUE.
④	When the "JogForward" or "JogBackward" is reset to the value FALSE, the "Error" parameter likewise changes to FALSE.

6.5.5 Additional Motion Control instructions of the technology CPU

The additional Motion Control instructions of the S7-1500T CPU have the same parameter behavior as those of the S7-1500 CPU.

Motion Control instructions with "Done" parameter

The following Motion Control instructions have a "Done" parameter:

- MC_PhasingAbsolute
- MC_PhasingRelative
- MC_InterpolateCam
- MC_GetCamFollowingValue
- MC_GetCamLeadingValue

Motion Control instructions without "Done" parameter

The following Motion Control instructions have a special parameter for indicating the job status:

- MC_GearInPos ("InSync" parameter)
- MC_CamIn ("InSync" parameter)
- MC_SynchronizedMotionSimulation ("InSimulation" parameter)
- MC_MotionInVeloctiy (Parameter "Busy")
- MC_MotionInPosition (Parameter "Busy")

Motion Control instructions

You can find additional information on the Motion Control instructions of the technology object kinematics in the "S7-1500T Kinematics Functions" function manual (https://support.industry.siemens.com/cs/ww/en/view/109749264).

6.6 Ending Motion Control jobs

When a job is ended, a distinction is made between error-free completion of the job and a motion abort.

Completion of job

The completion of a Motion Control job is indicated as described in the Tracking running jobs (Page 373) section.

Job termination

The termination and substitution behavior are described in the section Override response of Motion Control jobs V4 (Page 536). Special pending jobs can be cancelled with "MC_Power".

Motion abort

If a motion must be aborted, you can perform the following measures:

- Execute "MC_Halt (Page 442)"

  To abort a motion and stop the axis, you can use the "MC_Halt" instruction.

- Deactivate "MC_Power (Page 430)"

  In an emergency, you can stop the axis via an emergency stop ramp. To do so, set the "Enable" parameter of the "MC_Power" instruction to FALSE. The axis is decelerated according to the selected "StopMode" and all jobs for the technology object are aborted.

Measuring job abort

With the Motion Control instruction "MC_AbortMeasuringInput", an active one-time or cyclic measuring job is aborted.

Cancellation of an active output cam/cam track

- "MC_OutputCam (Page 477)"

  An active output cam is disabled when the "Enable" parameter of Motion Control instruction "MC_OutputCam" is set to FALSE.

- "MC_CamTrack (Page 480)"

  An active cam track is disabled when the "Enable" parameter of Motion Control instruction "MC_CamTrack" is set to FALSE.

6.7 Restart of technology objects

Description

After the CPU is switched on, or after technology objects are downloaded into the CPU, the system automatically initializes the technology objects with the start values from the technology data blocks. If restart-relevant changes are detected during a reload into the CPU, a restart of the technology object is automatically performed.

If restart-relevant data have been changed in RUN mode by the user program, then the technology object must be reinitialized by the user in order for the changes to be used. At a RUN → STOP transition, the CPU automatically performs a restart of technology objects with restart-relevant changes.

If changes in the technology data block should also be retained after the restart of the technology object, then you must write the changes to the start value in load memory using the extended instruction "WRIT_DBL".

Restart required

A necessary TO restart is indicated at "Technology object > Diagnostics > Status and error bits > Axis status or Encoder status > Online start value changed", as well as in the tag of technology object <TO>.StatusWord.X3 (OnlineStartValuesChanged).

Restarting a technology object

A restart of the technology object is triggered by the user by means of the "MC_Reset" Motion Control instruction, with parameter "Restart" = TRUE.

During a restart, all configuration data of the technology object are loaded from load memory into work memory. In the process, the actual values in the technology data block are overwritten.

Note the following during a restart of the technology object:

- A restart resets the "Referenced" status of a technology object with incremental actual values (<TO>.StatusWord.X5 (HomingDone).
- While a restart is being performed, the technology object cannot perform any jobs. An active restart will be indicated under "Technology object > Diagnostics > Status and error bits > Axis status or Encoder status > Restart active", and in the <TO>.StatusWord.X2 (RestartActive) tag of the technology object.
- Motion Control jobs are rejected during a restart with the "Error" = TRUE and "ErrorID" = 16#800D parameters (job not executable, because a restart is active).
- While a restart is being executed, you cannot access the technology data block.

See also

Change restart-relevant data (Page 360)

Downloading to CPU 7

Description

When downloading to the CPU S7-1500, it is always verified that the project files are consistent online and offline after the download.

The data of the technology objects are saved in technology data blocks. The conditions for downloading blocks thus apply when loading new or modified technology objects.

Load in RUN mode

When loading in the CPU's RUN mode, it is checked whether a load without restart of the technology objects is possible.

If restart-relevant configuration values were changed, then a restart of the technology object is automatically performed after the load into the CPU.

Loading a technology object is only possible if the technology object is disabled.

You **cannot** download the following changes to the CPU in RUN mode:

- Changes to the MC-Servo clock speeds
- Changes to the hardware interface of the technology object in "Technology object > Configuration > Hardware interface"

Commissioning 8

8.1 Introduction

The following guidelines describe the steps that you should note when commissioning the Motion Control-specific components of your equipment.

The commissioning of other components of your automation system depends on the particular equipment configuration. Commissioning (not Motion Control) is described in the Automation System S7-1500 (http://support.automation.siemens.com/WW/view/en/59191792) system manual.

8.2 Commissioning guidelines

These guidelines serve as recommendations for commissioning equipment with Motion Control. The procedure is described using the example of a positioning axis technology object.

Requirement

- The configuration of the following components is complete:
  - CPU
  - BUS communication
  - Drives
  - Technology objects
- The user program has been created.
- The wiring of the CPU and of the associated I/O is complete.
- The commissioning and optimization of the drive is complete.

Procedure

Proceed as follows to commission the Motion Control-specific components of your equipment:

Step	Action to be performed	Supported by TIA Portal
Turn on CPU	Turn on the power supply and the CPU.	-
"Disable" position controller	Set the gain (Kv factor) of the position control loop to zero. (This setting avoids unwanted drive movements that may be caused by incorrect parameterization of the position control loop.)	"Technology object > Configuration > Extended parameters > Control loop"
Activate precontrol	Set the precontrol to 100 %.	"Technology object > Configuration > Extended parameters > Control loop"
Load project into the CPU	Bring the CPU to the STOP mode. Download your project to the CPU (load hardware and software).	• "Toolbar > Stop CPU" • "Toolbar > Download to device"
Create online connection to the CPU	Select the "Receive messages" check box under "Online & Diagnostics > Online Access". Configure the interface of the TIA Portal, and create an online connection with the CPU.	• Device configuration • "Online & Diagnostics > Online Access"
Disable Motion Control specific user program	In order to avoid conflicts with the axis control panel, lock the enabling of technology objects in your user program (MC_Power.Enable = FALSE).	• PLC programming • Motion Control instructions
Evaluating pending messages	Evaluate the message display in the inspector window. Resolve the causes of pending technology alarms. Acknowledge the technology alarms (Page 403).	"Inspector window > Diagnostics > Message display"
Check hardware limit switches	Click the hardware limit switches. Check for correct message display (technology alarm 531). Acknowledge the technology alarm.	"Inspector window > Diagnostics > Message display"
Check the connection and configuration of the drive (setpoint)	Bring the CPU into the RUN mode. Open the Axis control panel (Page 391) and take over control. Perform the following steps: • Enable the technology object. ⇒ The drive must turn itself on, and where applicable release the brake. The position is held. • Move the axis in jog mode at low velocity in the positive direction. ⇒ The drive must move. The actual position value must increase (positive direction). • Disable the technology object. ⇒ The drive must turn itself off, and where applicable apply the brake.	"Technology object > Commissioning > Axis control panel"
Check the connection and configuration of the encoder (actual value)	Check the scaling of the actual values (rotation direction, distance evaluation, and resolution of the encoder) ⇒ The change in the actual mechanical position must match the change in the actual values.	• "Technology object > Diagnostics > PROFIdrive frame" • "Technology object > Commissioning > Axis control panel"

Step	Action to be performed	Supported by TIA Portal
Checking the reference speed	Traverse the axis in jog mode at low velocity in the positive direction. ⇒ The displayed current velocity must match the velocity setpoint. If the displayed current velocity deviates significantly from the velocity setpoint, adjust the reference speed.	• "Technology object > Hardware interface > Data exchange" • "Technology object > Commissioning > Axis control panel"
Optimize position controller	Use the Optimization (Page 396) commissioning function to optimize the gain (Kv) of the position control loop. For this purpose, adapt following error limits as needed.	"Technology object > Commissioning > Optimization"
Transfer the gain Kv to the project.	Enter the gain Kv that you determined by means of the optimization function in your configuration data. Load your project into the CPU.	"Technology object > Configuration > Extended parameters > Control loop"
Enable Motion Control specific user program	Unlock the enabling technology objects lock in your user program (MC_Power.Enable = TRUE).	• PLC programming • Motion Control instructions
Check the functioning of the user program	Check the programmed functions of your user program.	• Watch and force tables • Online and diagnostic functions
End of commissioning for a positioning axis technology object	To commission additional technology objects, perform the corresponding steps again.	See above.

8.3 Axis control panel

8.3.1 Function and structure of the axis control panel

You traverse individual axes with the axis control panel. A user program is not necessary for the operation of the axis control panel. With the axis control panel, you assume master control for a technology object and control the motions of the axis.

WARNING

Uncontrolled axis motions

During operation with the axis control panel, the axis can execute uncontrolled motions (e.g. due to erroneous configuration of the drive or the technology object). Furthermore, any synchronized following axis is moved as well when moving a leading axis with the axis control panel.

Therefore, perform the following protective measures before operation with the axis control panel:

- Ensure that the EMERGENCY OFF switch is within the reach of the operator.
- Enable the hardware limit switches.
- Enable the software limit switches.
- Ensure that following error monitoring is enabled.
- Make sure that no following axis is coupled to the axis to be moved.

The axis control panel of the speed axis, positioning axis and synchronous axis can be found in the project tree under "Technology object > Commissioning".

The axis control panel is divided into the following areas:

- Master control
- Axis
- Operating mode
- Modify
- Axis status
- Actual values

Elements of the axis control panel

The following table lists the elements of the axis control panel:

Area	Element	Description
Master control		In the "Master control" area, you assume master control of the technology object or return it to your user program.

Area	Element	Description
	"Activate" button	With the "Activate" button, you set up an online connection to the CPU and take over master control for the selected technology object. • To take over master control, the technology object must be disabled in the user program. • Any synchronized following axis is moved as well when moving a leading axis with the axis control panel. • If the online connection to the CPU is lost during operation with the axis control panel, then after the sign of life monitoring has elapsed, the axis will be stopped with maximum deceleration. In this case, an error message is displayed ("ErrorID" = 16#8013) and the master control is passed back to the user program. • If the axis control panel is covered by a dialog, such as "Save as", during its operation with the axis control panel, the axis is stopped with maximum deceleration and the master control is returned to the user program. If the "Stop" button is covered during operation with the axis control panel, for example by scrolling or by another window, the master control is retained but the axis is stopped with maximum deceleration. If you change to another window within the TIA Portal, to the project tree for example, during operation with the axis control panel, the master control and motion of the axis is maintained, provided that the axis control panel is embedded in the TIA Portal. If the axis control panel is replaced by the TIA Portal and you change to another window within the TIA Portal, to the project tree for example, the master control is retained but the axis is stopped with maximum deceleration. If you change to another window outside the TIA Portal during operation with the axis control panel, the master control is retained but the axis is stopped with maximum deceleration. • When you click the "Activate" button, a warning message is displayed. In the warning, you can adapt the sign-of-life monitoring (100 to 60000 ms). If the master control of the axis control panel is lost repeatedly without a direct error message, the online connection to the CPU may be impaired because the communication load is too high. In this case, the message "Error during commissioning" is entered in the message display log. Sign-of-life failure between controller and TIA Portal" is displayed. To eliminate this error, adapt the sign-of-life monitoring in the warning. • Until master control is returned, the user program has no influence on the functions of the technology object. Motion Control jobs from the user program to the technology object are rejected with error ("ErrorID" = 16#8012: Axis control panel enabled). • When master control is taken over, the configuration of the technology object is adopted. Changes to the configuration of the technology object do not take effect until leading control has been returned. Therefore, make any necessary changes before master control is assumed again. • If master control has been taken over for the technology object, the axis control panel is blocked for access by another instance of the TIA Portal (Team Engineering as of CPU V1.5).
	"Deactivate" button	With the "Deactivate" button, you return master control to your user program.

Area	Element	Description
Axis		In the "Axis" area, you can enable or disable the technology object.
	"Enable" button	With the "Enable" button, you enable the selected technology object
	"Disable" button	With the "Disable" button, you disable the selected technology object
Operating mode		Select the required mode in the "Operating mode" drop-down list.
Modify		The "Control" area displays the parameters for traversing with the axis control panel according to the selected operating mode.
	Position	Position to which the axis is homed. ("Homing" and "Set home position" modes only)
	Distance	Distance the axis is traversed. ("Relative positioning" mode only)
	Target position	Position to which the axis is traversed. ("Absolute positioning" mode only)
	Velocity/ Velocity setpoint	Velocity or speed at which the axis is traversed. Default: 10% of the default value (Velocity/speed setpoint, "Jog" and "Positioning" modes only)
	Acceleration	Acceleration with which the axis is traversed. Default: 10% of the default value
	Deceleration	Deceleration with which the axis is traversed. Default: 10% of the default value
	Jerk	Jerk with which the axis is traversed. Default: 100% of default value
	"Start" button	With the "Start" button, you start a job according to the selected operating mode.
	"Forward" button	With the "Forward" button, you start a motion in the positive direction according to the selected operating mode.
	"Backward" button	With the "Backward" button, you start a motion in the negative direction according to the selected operating mode.
	"Stop" button	With the "Stop" button, you cancel a job or stop the axis. If the "Stop" button is covered during operation with the axis control panel, for example by scrolling or by another window, the master control is retained but the axis is stopped with maximum deceleration.
Axis status		The "Axis status" area displays the status of the axis and the status of the drive.
	Drive ready	Drive is ready to execute setpoints.
	Error	An error occurred at the technology object.
	Enabled	The technology object has been enabled. The axis can be moved with motion jobs.
	Homed	The technology object is homed.
	More	The "More" link takes you to the window "Technology object > Diagnostics > Status and error bits".
	Active errors	The error that occurred most recently is displayed in the "Active errors" text field.
	"Confirm" button	With the "Confirm" button, you acknowledge pending errors.
	Alarm display	You can access the alarm display in the Inspector window by clicking on the "Alarm display" link.
Actual values		The "Current values" area shows the actual values of the axis.
	Position	Actual position of the axis
	Velocity	Actual velocity of the axis

Note

No transfer of the parameters

The configured parameter values are discarded when master control is returned. Transfer the values as needed into your configuration.

If you have changed configuration values during operation with the axis control panel, these changes have no effect on the operation of the axis control panel.

Operating mode

The following table shows the operating modes of the axis control panel:

Operating mode	Description
Homing	This function corresponds to active homing. The parameters for homing (Page 78) must be configured. Homing is not possible with an absolute encoder. The technology object is not referenced when this mode is used with an absolute encoder.
Set home position	This function corresponds to direct homing (absolute). With the "Start" button, you set the actual position to the value specified in "Position" and the "Homed" status is set.
Jog	Motion commands occur by means of jogging. With the "Forward" or "Backward" button you start motion in the positive or negative direction. The motion runs for as long as you hold down the left mouse button.
Velocity specification/speed setpoint	The axis is moved at the specified velocity or speed until you stop the movement. The motion commands are performed according to the setpoints assigned under "Controller".
Positioning relative	The positioning is executed as a controlled, relative traversing motion according to the defaults assigned under "Controller".
Positioning absolute	The positioning is executed as a controlled, absolute traversing motion according to the defaults assigned under "Controller". If you have enabled the "Modulo" setting of the technology object, the buttons "Forward" and "Backward" are shown in the "Controller" area. The axis is positioned within the modulo range. Position settings outside the modular range are recalculated to the modulo range. If you have not enabled the "Modulo" setting of the technology object, only the "Start" button is shown in the "Controller" area. You can directly approach the entered position.

8.3.2 Using the axis control panel

You traverse individual axes with the axis control panel. You assume master control of a technology object and control the motions of the axis.

Requirement

- The project has been created and downloaded to the CPU.
- The CPU must be in the RUN mode.
- The technology object is disabled by your user program ("MC_Power.Enable" = FALSE).
- The axis control panel for the technology object is not used by another instance of the TIA Portal (Team Engineering as of CPU V1.5).

Procedure

Proceed as follows to enable control the axis using the axis control panel:

1. To assume master control of the technology object and to set up an online connection to the CPU, click "Activate" in the "Master control" area.

   A warning message is displayed.
2. If necessary, adapt the sign-of-life monitoring and click "OK".
3. To enable the technology object, click the "Enable" button in the "Axis" area.
4. In the drop-down list in the "Operation mode" area, select the desired function of the axis control panel.
5. In the "Control" area, specify the parameter values for your job.
6. Depending on the mode selected, click the "Start", "Forward" or "Backward" button to start the job.
7. Click the "Stop" button to stop the job.
8. Repeat steps 4 through 6 for additional jobs.
9. To disable the technology object, click the "Disable" button in the "Axis" area.
10. To return master control to your user program, click the "Deactivate" button in the "Master control" area.

8.4 Optimization

8.4.1 Function and structure of the optimization

Description

The "Optimization" function supports you in determining the optimal precontrol and gain (Kv factor) for the closed loop position control of the axis. The axis velocity profile is recorded by means of the Trace function for this purpose for the duration of a configurable positioning movement. You can then evaluate the recording, and adjust the precontrol and gain accordingly.

WARNING

Uncontrolled axis motions

During operation with the optimization, the axis can execute uncontrolled motions (for example, due to erroneous configuration of the drive or the technology object). In addition, when a leading axis is moved, any synchronized following axis is also moved.

Therefore, perform the following protective measures before operation with the optimization:

- Ensure that the EMERGENCY OFF switch is within the reach of the operator.
- Enable the hardware limit switches.
- Enable the software limit switches.
- Ensure that following error monitoring is enabled.
- Make sure that no following axis is coupled to the axis to be moved.

The "Optimization" function for the positioning axis and synchronous axis technology objects can be found in the project tree under "Technology object > Commissioning".

The "Tuning" dialog is divided into the following areas:

- Master control
- Axis
- Measurement configuration
- Optimize position controller
- Run measurement
- Trace

The following table lists the elements of optimization:

Area	Element	Description
Master control		In the "Master control" area, you take over master control of the technology object, or return it to your user program.
	"Activate" button	With the "Activate" button, you set up an online connection to the CPU and take over master control for the selected technology object. • To take over master control, the technology object must be disabled in the user program. • Any synchronized following axis is moved as well when moving a leading axis with the axis control panel. • If the online connection to the CPU is lost during operation with the axis control panel, then after the sign of life monitoring has elapsed, the axis will be stopped with maximum deceleration. In this case, an error message is displayed ("ErrorID" = 16#8013) and the master control is passed back to the user program. • When you click the "Activate" button, a warning message is displayed. You can adapt the sign-of-life monitoring here (100 to 60000 ms). If the master control of the axis control panel is lost repeatedly without a direct error message, the online connection to the CPU may be impaired because the communication load is too high. In this case, the message "Error during commissioning" is entered in the message display log. Sign-of-life failure between controller and TIA Portal" is displayed. To eliminate this error, adapt the sign-of-life monitoring in the warning. • Until master control is returned, the user program has no influence on the functions of the technology object. Motion Control jobs from the user program to the technology object are rejected with error ("ErrorID" = 16#8012: Axis control panel enabled). • When master control is taken over, the configuration of the technology object is adopted. Changes to the configuration of the technology object do not take effect until master control has been returned. For this reason, make any necessary changes before master control is taken over. • If master control has been taken over for the technology object, the axis control panel is blocked for access by another installation of the TIA Portal (Team Engineering as of CPU V1.5).
	"Deactivate" button	With the "Deactivate" button, you return master control to your user program.
Axis		In the "Axis" area, enable or disable the technology object.
	"Enable" button	With the "Enable" button, you enable the selected technology object
	"Disable" button	With the "Disable" button, you disable the selected technology object
Measurement configuration		In the "Measurement configuration" area, you configure the settings for a test step.
	Distance	Travel distance for a test step
	Measurement duration	Time for a test step
	"Customize dynamics" check box	The "Dynamics adapt" check box allows you to adapt the acceleration, deceleration and maximum velocity. As long as the "Commissioning" working area is open, the previously set values are displayed when the check box is selected again.

Area	Element	Description
	Acceleration	Presetting of the acceleration for a test step
	Deceleration	Default setting for delaying a test step
	Maximum velocity	Presetting of the maximum velocity for a test step
Optimize position controller		In the "Optimize position controller" area, you make the settings for optimization of the controller characteristics. You open a list of values using the symbol next to the field. The list of values contains the following values of the respective parameter: • Online actual value • Online start value • Project start value Enter the new value in the text field for the actual value. The new value is applied by clicking the "Forward" or "Backward" button in the "Run measurement" area.
	Precontrol	Current percentage velocity precontrol of the position controller
	Speed control loop substitute time	Current speed control loop substitute time With velocity precontrol, a simplified speed control loop model can be generated using the speed control loop substitute time. This prevents overmodulation by the position controller of the manipulated variable for velocity during the acceleration and deceleration phases. To accomplish this, the position setpoint of the position controller is delayed by the amount of the speed control loop substitute time in relation to the velocity precontrol.
	Gain	Current gain of the position controller (Kv)
Run measurement		In the "Run measurement" area, you perform the test steps.
	"Forward" button	With the "Forward" button, you start a test step for optimization in the positive direction.
	"Backward" button	With the "Backward" button, you start a test step for optimization in the negative direction.
	"Stop" button	You stop a test step with the "Stop" button. The axis decelerates with the configured maximum deceleration. If another window is superimposed on the "Stop" button, the axis stops.
Trace		The Trace function is displayed in the lower area of the "Tuning" dialog. With each test step, a Trace recording of the required parameters is automatically started and displayed after completion of the test step. After master control has been returned, the Trace recording is deleted. You can find a full description of the trace function in the section on using the trace and logic analyzer function.

Note

No automatic transfer of the parameters to the technology object

The configured parameter values are discarded after master control is returned.

Transfer the values as needed into your configuration. You can apply the values for the gain, precontrol and speed control loop substitute time in your configuration using the "Project start value" value.

See also

Closed-loop control (Page 101)

8.4.2 Optimize position controller

Requirements

- The CPU must be in the RUN mode.
- The project has been created and downloaded to the CPU.
- The technology object is disabled by your user program (MC_Power.Enable = FALSE).
- The axis control panel for the technology object is not used by another installation of the TIA Portal (Team Engineering as of CPU V1.5).

Optimizing position control gain (Kv)

Proceed as follows to optimize the gain (Kv):

1. In the "Master control" area, click the "Activate" button to activate master control for the technology object, and to establish an online connection to the CPU.

   A warning message is displayed.
2. If necessary, adapt the sign-of-life monitoring and confirm with "OK".
3. In the "Axis" area, click the "Enable" button to enable the technology object.
4. If necessary, configure values for the distance, duration, and dynamics of a test step in the "Measurement configuration" area.
5. If necessary, configure values for the precontrol and speed control loop substitute time of a test step in the "Configure position controller" area.
6. Enter a start value for the gain. Start with a low value.
7. Click the "Forward" or "Start" button to start a test step for the optimization.
   For the specified duration, a setpoint is output according to the specified distance. The axis moves by the specified distance. A trace recording of the motion (setpoint and actual values) is created automatically.

   You can find a full description of the trace function in the section on using the trace and logic analyzer function.

   Note

   Adapt following error limits

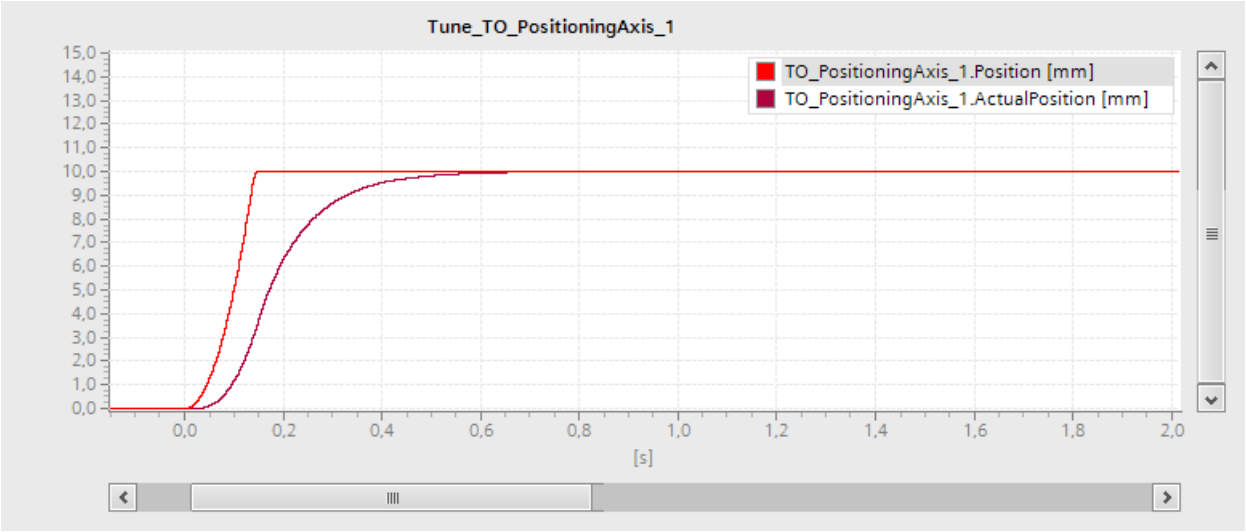
   If error messages from following error monitoring are repeatedly displayed during optimization, temporarily adapt the following error limits.

8. Evaluate the curve of the trace recording. Adapt the gain incrementally. Click the "Forward" or "Backward" button after each value you enter. This applies the value and start a new movement and trace recording each time.

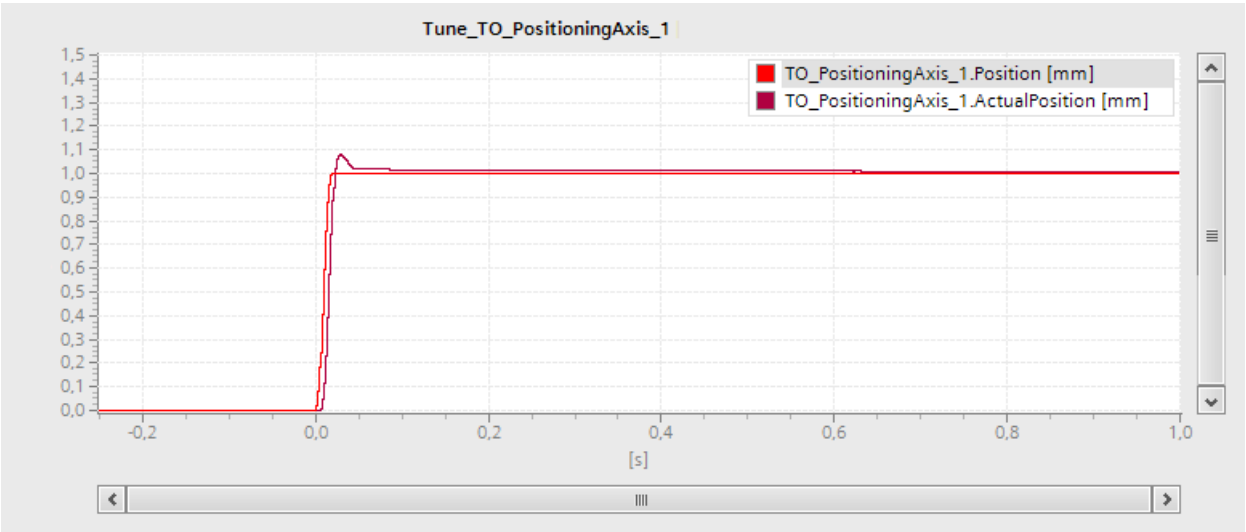
When adjusting the gain, pay attention to the following properties of the curve:

- The curve shows a brief compensation time.
- The curve does not show any motion reversal of the actual position.
- When approaching the position setpoint, no overshoot occurs.
- The curve shows a stable overall behavior (oscillation-free curve).

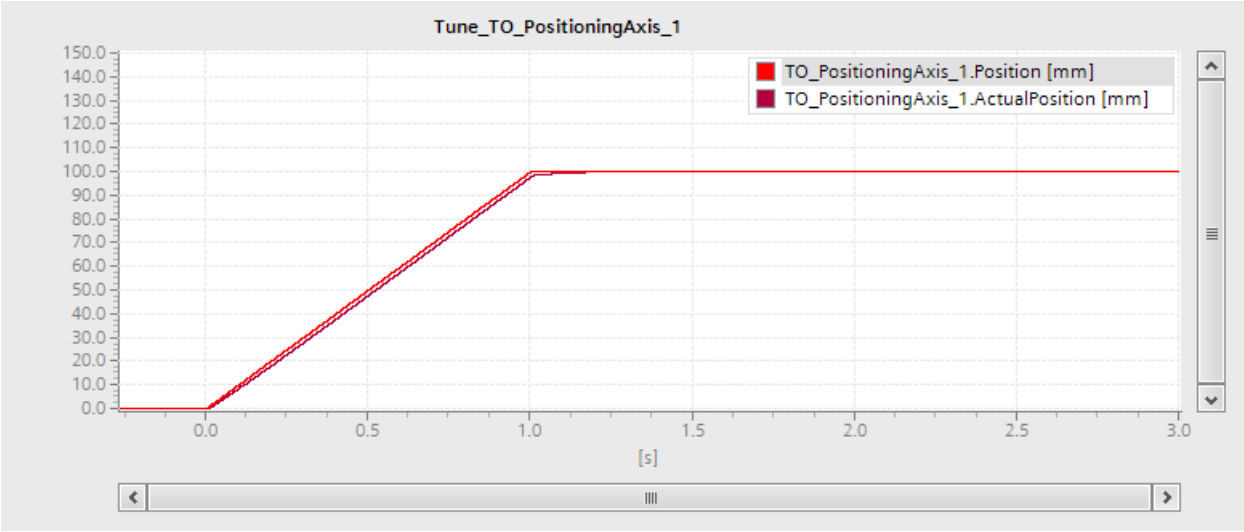
The following trace recording shows a curve with a long settling time:



The following trace recording shows a curve with overshoot when approaching the setpoint:



The following trace recording shows a curve in which the gain is optimal and the overall response is steady:



Transferring the parameter values of the position controller to the project

To transfer the determined parameter values of the position controller to your project, follow these steps:

1. Click the icon next to the field of the respective parameter.

   A list of values is displayed.

2. Enter the measured value in the "Project start value" field of the value list.
3. In the "Axis" area, click the "Disable" button to disable the technology object.
4. In the "Master control" area, click the "Deactivate" button to return master control to your user program.
5. Load your project into the CPU.

Diagnostics 9

9.1 Introduction

The Diagnostics section is limited to describing the diagnostic concept for Motion Control and describing the Diagnostics view of the individual technology objects in the TIA Portal.

For more information about system diagnostics with the S7-1500 CPU, refer to the "Diagnostics" (http://support.automation.siemens.com/WW/view/en/59192926) function manual.

9.2 Diagnostic concept

The diagnostic concept encompasses alarms and associated messages, as well as error messages in the Motion Control instructions. The TIA Portal also supports you with consistency checks during configuration of the technology objects, and during the creation of your user program.

All alarms in runtime (from the CPU, technology, hardware etc.) are displayed in the Inspector window of the TIA Portal. Diagnostic information that relates to technology objects (technology alarms, status information) are additionally displayed in the Diagnostics window of the respective technology object.

During motion control, if an error occurs at a technology object (e.g. approaching a hardware limit switch), then a technology alarm (Page 403) is triggered, and a corresponding message is displayed in the TIA Portal as well as on HMI devices.

In your user program, technology alarms are generally signaled via error bits in the technology data block. The number of the technology alarm with the highest priority is also displayed. In order to simplify error evaluation, the "Error" and "ErrorID" parameters of the Motion Control instructions also indicate that a technology alarm is pending.

Program errors (Page 407) can occur during parameter assignment or during the processing sequence of the Motion Control instructions (e.g. invalid parameter specification when calling the instruction, initiation of a job without enable via MC_Power). Motion Control instruction errors are indicated at the call of instructions using the "Error" and "ErrorID" parameters.

9.3 Technology alarms

Description

If an error occurs at a technology object (e.g. approaching a hardware limit switch), a technology alarm is triggered and indicated. The impact of a technology alarm on the technology object is specified by the alarm reaction.

Alarm classes

Technology alarms are divided into three classes:

- Acknowledgeable warning

  The processing of Motion Control job is continued. The current motion of the axis can be influenced, e.g. by limiting the current dynamic values to the configured limit values.

- Alarm requiring acknowledgment

  Motion jobs are aborted in accordance with the alarm reaction. You must acknowledge the alarms in order to continue execution of new jobs after eliminating the cause of the error.

- Fatal error

  Motion jobs are aborted in accordance with the alarm reaction.

  To be able to use the technology object again after eliminating the cause of the error, you must restart the technology object (Page 386).

Display of technology alarms

A technology alarm is displayed in the following locations:

- **TIA Portal**
  - **"Technology object > Diagnostics > Status and error bits"**

    Display of pending technology alarms for each technology object.
  - **"Technology object > Commissioning > Axis control panel"**

    Display of the last pending technology alarm for each technology object.
  - **"Inspector window > Diagnostics > Message display"**

    Select the "Receive messages" check box under "Online & Diagnostics > Online Access" in order to display technology alarms via the message display.

    With an online connection to the CPU, the pending technology alarms for all technology objects are displayed. Additionally, the archive view is available to you.

    The message display can also be activated and displayed on a connected HMI.
  - **"CPU > Online & diagnostics"**

    Display of the technology alarms that have been entered in the diagnostic buffer.
- **User program**
  - **Tags <TO>.ErrorDetail.Number and <TO>.ErrorDetail.Reaction**

    Indication of the number and the reaction of the technology alarm with the highest priority.
  - **Tag <TO>.StatusWord**

    A pending technology alarm is indicated with bit 1 ("Error").
  - **Tag <TO>.ErrorWord**

    Indication of alarms and fatal errors.
  - **Tag <TO>.WarningWord**

    Indication of warnings.
  - **Parameter "Error" and "ErrorID"**

    In a Motion Control instruction, the parameters "Error" = TRUE and "ErrorID" = 16#8001 indicate that a technology alarm is pending.
- **Display of the CPU**

  In order to show technology alarms on the CPU display, make the following setting when loading to the CPU:
  In the "Load preview" dialog, select the action "Consistent download" for the "Text libraries" entry.

Alarm reaction

A technology alarm always contains an alarm reaction, which describes the impact on the technology object. The alarm reaction is specified by the system.

The following table shows possible alarm reactions:

Alarm reaction	Description
Axes (speed axis, positioning axis, synchronous axis)	
No reaction (warnings only) <TO>.ErrorDetail.Reaction = 0	The processing of Motion Control job is continued. The current motion of the axis can be influenced, e.g. by limiting the current dynamic values to the configured limit values.
Stop with current dynamic values <TO>.ErrorDetail.Reaction = 1	Active motion commands are aborted. The axis is braked with the dynamic values that present in the Motion Control instruction and brought to a standstill.
Stop with maximum dynamic values <TO>.ErrorDetail.Reaction = 2	Active motion commands are aborted. The axis is braked with the dynamic values configured under "Technology object > Extended parameters > Dynamic limits", and brought to a standstill. The configured maximum jerk is hereby taken into account.
Stop with emergency stop ramp <TO>.ErrorDetail.Reaction = 3	Active motion commands are aborted. The axis is braked with the emergency stop deceleration configured under "Technology object > Extended parameters > Emergency stop ramp", without any jerk limit, and brought to a standstill.
Remove enable <TO>.ErrorDetail.Reaction = 4	Active motion commands are aborted. The setpoint zero is output and the enable is removed. The axis is braked to a standstill according to the configuration in the drive.
Track setpoints <TO>.ErrorDetail.Reaction = 5	Active motion commands are aborted. The setpoint zero is output and the enable is removed. The actual values supplied by the drive are automatically tracked as setpoints.
Other technology objects (output cam, cam track, measuring input, cam, external encoder)	
No reaction (warnings only) <TO>.ErrorDetail.Reaction = 0	The processing of Motion Control job is continued. The current motion of the axis can be influenced, e.g. by limiting the current dynamic values to the configured limit values.
Terminate processing of the technology object: • Output cam <TO>.ErrorDetail.Reaction = 6 • Cam track <TO>.ErrorDetail.Reaction = 7 • Measuring input <TO>.ErrorDetail.Reaction = 8 • Cam <TO>.ErrorDetail.Reaction = 9 • External encoder <TO>.ErrorDetail.Reaction = 10	Processing of the technology object is terminated. All running Motion Control jobs are aborted.

Acknowledging technology alarms

You can acknowledge technology alarms as follows:

- TIA Portal
  - "Technology object > Commissioning > Axis control panel"

    Click "Confirm" to acknowledge all alarms and warnings pending for the selected technology object.
  - "Inspector window > Diagnostics > Message display"

    You can acknowledge the alarms and warnings for all technology objects either individually, or all at once.
- HMI

  At an HMI with enabled message display, you can acknowledge the alarms and warnings for all technology objects either individually, or all at once.
- User program

  Acknowledge pending technology alarms for a technology object with the Motion Control instruction "MC_Reset".

Additional information

You can find a list of the technology alarms and alarm reactions in the Technology alarms (Page 626) appendix.

9.4 Errors in Motion Control instructions

Description

Errors in Motion Control instructions (e.g. invalid parameter value setting) are indicated by the "Error" and "ErrorID" output parameters.

Under the following conditions, "Error" = TRUE and "ErrorID" = 16#8xxx are indicated for the Motion Control instruction:

- Illegal status of the technology object, which prevents the execution of the job.
- Invalid parameter assignment of the Motion Control instruction, which prevents the execution of the job.
- As a result of the alarm reaction for a technology object error.

Error display

If there is a Motion Control instruction error, the "Error" parameter shows the value TRUE. The cause of the error is given in the "ErrorID" parameter.

Jobs to the technology object are rejected when "Error" = TRUE. Running jobs are not influenced by rejected jobs.

If "Error" = TRUE and "ErrorID" = 16#8001 is indicated during job execution, a technology alarm has occurred. In this case, evaluate the indication of the technology alarm.

If "Error" = TRUE is displayed during execution of a "MC_MoveJog" job, the axis is braked and brought to a standstill. In this case, the deceleration configured for the "MC_MoveJog" instruction takes effect.

Acknowledge error

Acknowledging errors in Motion Control instructions is not required.

Restart a job after resolving the error.

Additional information

You can find a list of the ErrorIDs in the Error detection (Page 652) appendix.

9.5 Speed-controlled axis technology object

9.5.1 Status and error bits

Description

You use the "Technology object > Diagnostics > Status and error bits" diagnostic function in the TIA Portal to monitor the status and error messages for the technology object. The Diagnostics function is available in online operation.

The meaning of the status and error messages is described in the following tables. The associated technology object tag is given in parentheses.

Axis status

The following table shows the possible axis status values:

Status	Description
Simulation active	The axis is simulated in the CPU. Setpoints are not output to the drive.
Enabled	The technology object has been enabled. The axis can be moved with motion jobs. (<TO>.StatusWord.X0 (Enable))
Error	An error occurred at the technology object. Detailed information about the error is available in the "Error" area, and in the <TO>.ErrorDetail.Number and <TO>.ErrorDetail.Reaction tags of the technology object. (<TO>.StatusWord.X1 (Error))
Restart active	The technology object is being reinitialized. (<TO>.StatusWord.X2 (RestartActive))
Axis control panel enabled	The axis control panel is active. The axis control panel has master control over the technology object. The axis cannot be controlled from the user program. (<TO>.StatusWord.X4 (ControlPanelActive))
Drive ready	Drive is ready to execute setpoints. (<TO>.StatusDrive.InOperation)
Restart required	Data relevant for the restart has been changed. The changes are applied only after a restart of the technology object. (<TO>.StatusWord.X3 (OnlineStartValuesChanged))

Motion status

The following table shows the possible axis motion status values:

Status	Description
Done (no job running)	No motion job is running for the technology object. (<TO>.StatusWord.X6 (Done))
Jog	The axis is being moved with a job for jog mode of Motion Control instruction "MC_MoveJog" or from the axis control panel. (<TO>.StatusWord.X9 (JogCommand))
Speed setpoint	The axis is traversed with a job with speed setpoint of the Motion Control instruction "MC_MoveVelocity" or using the axis control panel. (<TO>.StatusWord.X10 (VelocityCommand))
Constant speed	The axis is moved with constant speed or is stationary. (<TO>.StatusWord.X12 (ConstantVelocity))
Accelerating	Axis is being accelerated. (<TO>.StatusWord.X13 (Accelerating))
Decelerating	The axis is being decelerated. (<TO>.StatusWord.X14 (Decelerating))
Torque limiting enabled	The configured threshold for the force/torque affects the axis. (<TO>.StatusWord.X27 (InLimitation))

Warnings

The following table shows the possible warnings:

Warning	Description
Configuration	One or several configuration parameters are adapted internally at a given time. (<TO>.WarningWord.X1 (ConfigWarning))
Job rejected	A job cannot be executed. A Motion Control instruction cannot be executed because necessary requirements have not been met. (<TO>.WarningWord.X3 (CommandNotAccepted))
Dynamic limitation	The dynamic values are limited to the dynamic limits. (<TO>.WarningWord.X6 (DynamicError))

Error

The following table shows the possible errors:

Error	Description
System	A system-internal error has occurred. (<TO>.ErrorWord.X0 (SystemFault))
Configuration	A configuration error has occurred. One or more configuration parameters are inconsistent or invalid. The technology object was incorrectly configured, or editable configuration data were incorrectly modified during runtime of the user program. (<TO>.ErrorWord.X1 (ConfigFault))
User program	An error occurred in the user program with a Motion Control instruction or its use. (<TO>.ErrorWord.X2 (UserFault))
Drive	An error occurred in the drive. (<TO>.ErrorWord.X4 (DriveFault))
Data exchange	Communication with a connected device is faulty. (<TO>.ErrorWord.X7 (CommunicationFault))
I/O	An error occurred accessing a logical address. (<TO>.ErrorWord.X13 (PeripheralError))
Job rejected	A job cannot be executed. A Motion Control instruction cannot be executed because necessary requirements have not been met (e.g. technology object not homed). (<TO>.ErrorWord.X3 (CommandNotAccepted))
Dynamic limitation	The dynamic values are limited to the dynamic limits. (<TO>.ErrorWord.X6 (DynamicError))

Alarm display

For additional information and to acknowledge the error, go to the Inspector window by clicking on the "Alarm display" link.

Additional information

An option for the evaluation of the individual status bits can be found in the Evaluating StatusWord, ErrorWord and WarningWord (Page 359) section.

See also

StatusWord tag (speed axis) (Page 547)

ErrorWord tag (speed axis) (Page 549)

WarningWord tag (speed axis) (Page 551)

9.5.2 Motion status

Description

You use the "Technology object > Diagnostics > Motion status" diagnostic function in the TIA Portal to monitor the motion status of the axis. The Diagnostics function is available in online operation.

"Setpoints" area

The following table shows the meaning of the status data:

Status	Description
Speed setpoint	Speed setpoint of the axis (<TO>.Velocity)
Speed override	Speed setpoint correction as percentage The speed setpoint specified in motion control instructions or set by the axis control panel are superimposed with an override signal and corrected as a percentage. Valid speed correction values range from 0.0 % to 200.0 %. (<TO>.Override.Velocity)

"Current values" area

The following table shows the meaning of the status data:

Status	Description
Actual speed	Actual speed of the axis (<TO>.ActualSpeed)

"Dynamic limits" area

This area displays the limit values for the dynamic parameters.

The following table shows the meaning of the status data:

Status	Description
Speed	Configured maximum speed (<TO>.DynamicLimits.MaxVelocity)
Acceleration	Configured maximum acceleration (<TO>.DynamicLimits.MaxAcceleration)
Deceleration	Configured maximum deceleration (<TO>.DynamicLimits.MaxDeceleration)
Jerk	Configured maximum jerk (<TO>.DynamicLimits.MaxJerk)

9.5.3 PROFIdrive telegram

Description

The "Technology object > Diagnostics > PROFIdrive telegram" diagnostics function is used in the TIA Portal to monitor the PROFIdrive telegram that the drive returns to the controller. The Diagnostics function is available in online operation.

"Drive" area

This area displays the following parameters contained in the PROFIdrive telegram from the drive to the controller:

- Status words "ZSW1" and "ZSW2"
- The speed setpoint (NSET) that was output to the drive
- The actual speed that was signaled from the drive (NACT)

9.6 Positioning axis/synchronous axis technology object

9.6.1 Status and error bits

Description

You use the "Technology object > Diagnostics > Status and error bits" diagnostic function in the TIA Portal to monitor the status and error messages for the technology object. The Diagnostics function is available in online operation.

The meaning of the status and error messages is described in the following tables. The associated technology object tag is given in parentheses.

Axis status

The following table shows the possible axis status values:

Status	Description
Simulation active	The axis is simulated in the CPU. Setpoints are not output to the drive. (<TO>.StatusWord.X25 (AxisSimulation))
Enabled	The technology object has been enabled. You can move the axis with motion jobs. (<TO>.StatusWord.X0 (Enable))
Position-controlled mode	The axis is in position-controlled mode. (Inversion of <TO>.StatusWord.X28 (NonPositionControlled))
Homed	The technology object is homed. The relationship between the position in the technology object and the mechanical position was successfully created. (<TO>.StatusWord.X5 (HomingDone))
Error	An error occurred at the technology object. Detailed information about the error is available in the "Error" area, and in the <TO>.ErrorDetail.Number and <TO>.ErrorDetail.Reaction tags of the technology object. (<TO>.StatusWord.X1 (Error))
Restart active	The technology object is being reinitialized. (<TO>.StatusWord.X2 (RestartActive))
Axis control panel enabled	The axis control panel is active. The axis control panel has master control over the technology object. You cannot control the axis from the user program. (<TO>.StatusWord.X4 (ControlPanelActive))
Drive ready	Drive is ready to execute setpoints. (<TO>.StatusDrive.InOperation)
Encoder values valid	The actual encoder values are valid. (<TO>.StatusSensor[n].State)
Active encoder	Current encoder on the axis (<TO>.OperativeSensor)
Restart required	Data relevant for the restart has been changed. The changes are applied only after a restart of the technology object. (<TO>.StatusWord.X3 (OnlineStartValuesChanged))

Status limit switch

The following table shows the possibilities for enabling the software and hardware limit switches:

Status	Description
Negative SW limit switch approached.	The negative software limit switch was reached. (<TO>.StatusWord.X15 (SWLimitMinActive))
Positive SW limit switch approached.	The positive software limit switch was reached. (<TO>.StatusWord.X16 (SWLimitMaxActive))
Negative HW limit switch approached.	The negative hardware limit switch has been approached or overtraveled. (<TO>.StatusWord.X17 (HWLimitMinActive))
Positive HW limit switch approached.	The positive hardware limit switch has been approached or overtraveled. (<TO>.StatusWord.X18 (HWLimitMaxActive))

Motion status

The following table shows the possible axis motion status values:

Status	Description
Done (no job running)	No job active at technology object. (<TO>.StatusWord.X6 (Done))
Homing job	The technology object executes a homing job of the Motion Control instruction "MC_Home" or from the axis control panel. (<TO>.StatusWord.X11 (HomingCommand))
Jog	The axis is being moved with a command for jog mode of Motion Control instruction "MC_MoveJog". (<TO>.StatusWord.X9 (JogCommand))
Velocity specification	The axis is traversed with a job with velocity specification of the Motion Control instruction "MC_MoveVelocity" or from the axis control panel. (<TO>.StatusWord.X10 (VelocityCommand))
Positioning job	The axis is traversed with a positioning job of Motion Control instruction "MC_MoveAbsolute" or "MC_MoveRelative" or from the axis control panel. (<TO>.StatusWord.X8 (PositioningCommand))
Constant velocity	The axis is moved with constant velocity or is stationary. (<TO>.StatusWord.X12 (ConstantVelocity))
Standstill	The axis is in standstill. (<TO>.StatusWord.X7 (StandStill))
Accelerating	Axis is being accelerated. (<TO>.StatusWord.X13 (Accelerating))
Decelerating	The axis is being decelerated. (<TO>.StatusWord.X14 (Decelerating))
Torque limiting enabled	The configured threshold for the force/torque affects the axis. (<TO>.StatusWord.X27 (InLimitation))
Synchronization	Synchronous axis only The axis is synchronized to the leading value of a leading axis. (<TO>.StatusWord.X21 (Synchronizing))
Synchronous operation	Synchronous axis only The axis is synchronized and moves synchronously to the leading axis. (<TO>.StatusWord.X22 (Synchronous))

Warnings

The following table shows the possible warnings:

Warning	Description
Configuration	One or several configuration parameters are adjusted internally at a certain time. (<TO>.WarningWord.X1 (ConfigWarning))
Job rejected	Job cannot be executed. You cannot execute a Motion Control instruction because necessary requirements are not fulfilled. (<TO>.WarningWord.X3 (CommandNotAccepted))
Dynamic limitation	The dynamic values are limited to the dynamic limits. (<TO>.WarningWord.X6 (DynamicError))
Synchronization	Synchronous axis only An error occurred during synchronization. The leading axis specified for the corresponding Motion Control instruction was not configured as a possible leading axis. (<TO>.WarningWord.X14 (SynchronousError))

Error

The following table shows the possible errors:

Error	Description
System	A system-internal error has occurred. (<TO>.ErrorWord.X0 (SystemFault))
Configuration	A configuration error has occurred. One or more configuration parameters are inconsistent or invalid. The technology object was incorrectly configured, or editable configuration data were incorrectly modified during runtime of the user program. (<TO>.ErrorWord.X1 (ConfigFault))
User program	An error occurred in the user program with a Motion Control instruction or its use. (<TO>.ErrorWord.X2 (UserFault))
Drive	An error occurred in the drive. (<TO>.ErrorWord.X4 (DriveFault))
Encoder	An error occurred in the encoder system. (<TO>.ErrorWord.X5 (SensorFault))
Data exchange	Communication with a connected device is faulty. (<TO>.ErrorWord.X7 (CommunicationFault))
I/O	An error occurred accessing a logical address. (<TO>.ErrorWord.X13 (PeripheralError))
Job rejected	A job cannot be executed. You cannot execute a Motion Control instruction because necessary requirements are not fulfilled (for example, technology object not homed). (<TO>.ErrorWord.X3 (CommandNotAccepted))
Homing	An error occurred during a homing process. (<TO>.ErrorWord.X10 HomingFault))

Error	Description
Positioning	The positioning axis was not positioned correctly at the end of a positioning motion. (<TO>.ErrorWord.X12 (PositioningFault))
Dynamic limitation	The dynamic values are limited to the dynamic limits. (<TO>.ErrorWord.X6 (DynamicError))
Following error	The maximum permitted following error has been exceeded. (<TO>.ErrorWord.X11 (FollowingErrorFault))
SW limit switch	A software limit switch has been reached. (<TO>.ErrorWord.X8 (SwLimit))
HW limit switch	A hardware limit switch has been reached or overtraveled. (<TO>.ErrorWord.X9 (HWLimit))
Adaptation	An error occurred during data adaption. (<TO>.ErrorWord.X15 (AdaptionError))
Synchronization	Synchronous axis only An error occurred during synchronization. The leading axis specified for the corresponding Motion Control instruction was not configured as a possible leading axis. (<TO>.ErrorWord.X14 (SynchronousError))

Alarm display

For additional information and to acknowledge the error, go to the Inspector window by clicking on the "Alarm display" link.

Additional information

An option for the evaluation of the individual status bits can be found in the Evaluating StatusWord, ErrorWord and WarningWord (Page 359) section.

See also

StatusWord tag (positioning axis/synchronous axis) (Page 581)

ErrorWord tag (positioning axis/synchronous axis) (Page 584)

WarningWord tag (positioning axis/synchronous axis) (Page 586)

Additional displays for the technology CPU (Page 419)

9.6.2 Motion status

Description

You use the "Technology object > Diagnostics > Motion status" diagnostic function in the TIA Portal to monitor the motion status of the axis. The Diagnostics function is available in online operation.

"Setpoints" area

The following table shows the meaning of the status data:

Status	Description
Target position	Current target position of an active positioning job The target position value is only valid during execution of a positioning job. (<TO>.StatusPositioning.TargetPosition)
Position setpoint	Setpoint position of the axis (<TO>.Position)
Velocity setpoint	Velocity setpoint of the axis (<TO>.Velocity)
Velocity override	Percentage correction of the velocity specification The velocity setpoint specified in Motion Control instructions or set by the axis control panel is superimposed with an override signal and corrected as a percentage. Valid velocity correction values range from 0.0 % to 200.0 %. (<TO>.Override.Velocity)

"Current values" area

The following table shows the meaning of the status data:

Status	Description
Operative encoder	Operative encoder of the axis
Actual position	Actual position of the axis If the technology object is not homed, then the value is displayed relative to the position that existed when the technology object was enabled. (<TO>.ActualPosition)
Actual velocity	Actual velocity of the axis (<TO>.ActualVelocity)
Following error	Following error of the axis (<TO>.StatusPositioning.FollowingError)

"Dynamic limits" area

This area displays the limit values for the dynamic parameters.

The following table shows the meaning of the status data:

Status	Description
Velocity	Configured maximum velocity (<TO>.DynamicLimits.MaxVelocity)
Acceleration	Configured maximum acceleration (<TO>.DynamicLimits.MaxAcceleration)
Deceleration	Configured maximum deceleration (<TO>.DynamicLimits.MaxDeceleration)
Jerk	Configured maximum jerk (<TO>.DynamicLimits.Jerk)

See also

Additional displays for the technology CPU (Page 419)

9.6.3 PROFIdrive telegram

Description

The "Technology object > Diagnostics > PROFIdrive telegram" diagnostics function is used in the TIA Portal to monitor the PROFIdrive telegrams returned by the drive and encoder. The display of the Diagnostics function is available in online operation.

"Drive" area

This area displays the following parameters contained in the PROFIdrive telegram from the drive to the controller:

- Status words "ZSW1" and "ZSW2"
- The speed setpoint (NSET) that was output to the drive
- The actual speed that was signaled from the drive (NACT)

"Encoder" area

This area displays the following parameters contained in the PROFIdrive telegram from the encoder to the controller:

- Status word "Gx_ZSW"
- The actual position value "Gx_XIST1" (cyclic actual encoder value)
- The actual position value "Gx_XIST2" (absolute encoder value)

See also

Additional displays for the technology CPU (Page 419)

9.6.4 Additional displays for the technology CPU

The diagnostic functions contain expanded/additional displays for the S7-1500T technology CPU.

Status and error bits

The following table shows the expanded/additional displays of the status and error bits (Page 413):

Axis status	
Encoder values valid	The actual encoder values (encoder 1, encoder 2, encoder 3 or encoder 4) are valid. (<TO>.StatusSensor[n].State)
Active encoder	The encoder in effect operationally is encoder 1, encoder 2, encoder 3 or encoder 4. (<TO>.OperativeSensor)

Motion status

The following table shows the expanded/additional displays for the status of the motion (Page 417):

Current values	Description
Operative encoder	Operative encoder of the axis

PROFIdrive telegram

The "Encoder 1" to "Encoder 4" areas display the following parameters from the PROFIdrive telegram (Page 418) of the corresponding encoder to the controller:

- Status word "Gx_ZSW"
- The actual position value "Gx_XIST1" (cyclic actual encoder value)
- The actual position value "Gx_XIST2" (absolute encoder value)

See also

Status and error bits (Page 413)

Motion status (Page 417)

PROFIdrive telegram (Page 418)

9.7 Technology object external encoder

9.7.1 Status and error bits

Description

You use the "Technology object > Diagnostics > Status and error bits" diagnostic function in the TIA Portal to monitor the status and error messages for the technology object. The Diagnostics function is available in online operation.

The meaning of the status and error messages is described in the following tables. The associated technology object tag is given in parentheses.

Encoder status

The following table shows the possible external encoder status values:

Status	Description
Encoder enabled	The technology object has been enabled. (<TO>.StatusWord.X0 (Enable))
Homed	The technology object is homed. The relationship between the position in the technology object and the mechanical position was successfully created. (<TO>.StatusWord.X5 (HomingDone))
Error	An error occurred at the technology object. Detailed information about the error is available in the "Error" area, and in the <TO>.ErrorDetail.Number and <TO>.ErrorDetail.Reaction tags of the technology object. (<TO>.StatusWord.X1 (Error))
Restart active	The technology object is being reinitialized. (<TO>.StatusWord.X2 (RestartActive))
Encoder values valid	The actual encoder values are valid. (<TO>.StatusSensor[n].State)
Restart required	Data relevant for the restart has been changed. The changes are applied only after a restart of the technology object. (<TO>.StatusWord.X3 (OnlineStartValuesChanged))

Motion status

The following table shows the possible states of the job execution:

Status	Description
Done (no job running)	No Motion Control job is running for the technology object. (Enable by "MC_Power" job excepted) (<TO>.StatusWord.X6 (Done))
Homing job	The technology object executes a homing job of the Motion Control instruction "MC_Home". (<TO>.StatusWord.X11 (HomingCommand))

Error

The following table shows the possible errors:

Error	Description
System	A system-internal error has occurred. (<TO>.ErrorWord.X0 (SystemFault))
Configuration	A configuration error has occurred. One or more configuration parameters are inconsistent or invalid. The technology object was incorrectly configured, or editable configuration data were incorrectly modified during runtime of the user program. (<TO>.ErrorWord.X1 (ConfigFault))
User program	An error occurred in the user program with a Motion Control instruction or its use. (<TO>.ErrorWord.X2 UserFault))
Encoder	An error occurred in the encoder system. (<TO>.ErrorWord.X5 (SensorFault))
Data exchange	Missing or faulty communication. (<TO>.ErrorWord.X7 (CommunicationFault))
Adaptation	An error occurred during data adaption. (<TO>.ErrorWord.X15 (AdaptionError))

Alarm display

For additional information and to acknowledge the error, go to the Inspector window by clicking on the "Alarm display" link.

Additional information

An option for the evaluation of the individual status bits can be found in the Evaluating StatusWord, ErrorWord and WarningWord (Page 359) section.

See also

StatusWord tag (external encoder) (Page 596)

ErrorWord tag (external encoder) (Page 597)

WarningWord tag (external encoder) (Page 599)

9.7.2 Motion status

Description

You use the "Technology object > Diagnostics > Motion status" diagnostic function in the TIA Portal to monitor the actual encoder values. The Diagnostics function is available in online operation.

"Current values" area

The following table shows the meaning of the status data:

Status	Description
Actual position	Actual position of the axis If the technology object is not homed, then the value is displayed relative to the position that existed when the technology object was enabled. (<TO>.ActualPosition)
Actual velocity	Actual velocity of the axis (<TO>.ActualVelocity)

9.7.3 PROFIdrive frame

Description

The "Technology object > Diagnostics > PROFIdrive interface" diagnostic function is used in the TIA Portal to monitor the PROFIdrive frame of the encoder. The display of the diagnostics function is available in the online mode TO.

"Encoder" area

This area displays the following parameters contained in the PROFIdrive frame that the encoder returns to the controller:

- Status word "G1_ZSW"
- The actual position value "G1_XIST1" (cyclic actual encoder value)
- The actual position value "G1_XIST2" (absolute value of the encoder)

9.8 Technology object measuring input

9.8.1 Status and error bits

Description

You use the "Technology object > Diagnostics > Status and error bits" diagnostic function in the TIA Portal to monitor the status and error messages for the technology object. The Diagnostics function is available in online operation.

The meaning of the status and error messages is described in the following tables. The associated technology object tag is given in parentheses.

Measuring input status

The following table shows the possible states of the measuring input:

Status	Description
Active	The technology object is in operation. (<TO>.StatusWord.X0 (Control))
Waiting for measuring event	The measuring input is waiting for a measuring event. The technology data block tag "<TO>.Status" has the value "1" ("WAITING_FOR_TRIGGER").
Measured value present	The measuring input has acquired one or more measured values. The technology data block tag "<TO>.Status" has the value "2" ("TRIGGER_OCCURRED").
Error	An error occurred at the technology object. Detailed information about the error is available in the "Error" area, and in the <TO>.ErrorDetail.Number and <TO>.ErrorDetail.Reaction tags of the technology object. (<TO>.StatusWord.X1 (Error))
Restart active	The technology object is being reinitialized. The tags of the technology data block are not updated with active restart. (<TO>.StatusWord.X2 (RestartActive))
Measuring input ready	The measuring input is synchronized with the measuring module and can be used. (<TO>.StatusWord.X5 (CommunicationOK))
Restart required	Data relevant for the restart has been changed. The changes are applied only after a restart of the technology object. (<TO>.StatusWord.X3 (OnlineStartValuesChanged))

Error

The following table shows the possible errors:

Error	Description
System	A system-internal error has occurred. (<TO>.ErrorWord.X0 (SystemFault))
Configuration	A configuration error has occurred. One or more configuration parameters are inconsistent or invalid. The technology object was incorrectly configured, or editable configuration data were incorrectly modified during runtime of the user program. (<TO>.ErrorWord.X1 (ConfigFault))
User program	An error occurred in the user program with a Motion Control instruction or its use. (<TO>.ErrorWord.X2 (UserFault))
Job rejected	A job cannot be executed. A Motion Control instruction cannot be executed because the necessary conditions are not met (e.g. axis assigned to the measuring input is not homed). (<TO>.ErrorWord.X3 (CommandNotAccepted))
I/O	An error occurred accessing a logical address. (<TO>.ErrorWord.X13 (PeripheralError))

Alarm display

For additional information and to acknowledge the error, go to the Inspector window by clicking on the "Alarm display" link.

Additional information

An option for the evaluation of the individual status bits can be found in the Evaluating StatusWord, ErrorWord and WarningWord (Page 359) section.

See also

StatusWord tag (measuring input) (Page 604)

ErrorWord tag (measuring input) (Page 605)

WarningWord tag (measuring input) (Page 606)

9.9 Technology object output cam

9.9.1 Status and error bits

Description

You use the "Technology object > Diagnostics > Status and error bits" diagnostic function in the TIA Portal to monitor the status and error messages for the technology object. The Diagnostics function is available in online operation.

The meaning of the status and error messages is described in the following tables. The associated technology object tag is given in parentheses.

Output cam status

The following table shows the possible states of the output cam:

Status	Description
Active	The technology object is in operation. (<TO>.StatusWord.X0 (Control))
Switched	The output cam is switched. (<TO>.CamOutput)
Inverted output cam output	The output cam output is inverted. (<TO>.StatusWord.X4 (OutputInverted))
Error	An error occurred at the technology object. Detailed information about the error is available in the "Error" area, and in the <TO>.ErrorDetail.Number and <TO>.ErrorDetail.Reaction tags of the technology object. (<TO>.StatusWord.X1 (Error))
Restart active	The technology object is being reinitialized. The tags of the technology data block are not updated with active restart. (<TO>.StatusWord.X2 (RestartActive))
Output cam output ready	The cam is synchronized with the output module and available for use. (<TO>.StatusWord.X5 (CommunicationOk))
Restart required	Data relevant for the restart has been changed. The changes are applied only after a restart of the technology object. (<TO>.StatusWord.X3 (OnlineStartValuesChanged))

Error

The following table shows the possible errors:

Error	Description
System	A system-internal error has occurred. (<TO>.ErrorWord.X0 (SystemFault))
Configuration	A configuration error has occurred. One or more configuration parameters are inconsistent or invalid. The technology object was incorrectly configured, or editable configuration data were incorrectly modified during runtime of the user program. (<TO>.ErrorWord.X1 (ConfigFault))
User program	An error occurred in the user program with a Motion Control instruction or its use. (<TO>.ErrorWord.X2 (UserFault))
Job rejected	A job cannot be executed. A Motion Control instruction cannot be executed because the necessary conditions are not met (e.g. axis assigned to the output cam is not homed). (<TO>.ErrorWord.X3 (CommandNotAccepted))
I/O	An error occurred accessing a logical address. (<TO>.ErrorWord.X13 (PeripheralError))

Alarm display

For additional information and to acknowledge the error, go to the Inspector window by clicking on the "Alarm display" link.

Additional information

An option for the evaluation of the individual status bits can be found in the Evaluating StatusWord, ErrorWord and WarningWord (Page 359) section.

See also

StatusWord tag (output cam) (Page 610)

ErrorWord tag (output cam) (Page 611)

WarningWord tag (output cam) (Page 612)

9.10 Cam track technology object

9.10.1 Status and error bits

Description

You use the "Technology object > Diagnostics > Status and error bits" diagnostic function in the TIA Portal to monitor the status and error messages for the technology object. The Diagnostics function is available in online operation.

The meaning of the status and error messages is described in the following tables. The associated technology object tag is given in parentheses.

Cam track status

The following table shows the possible states of the cam track:

Status	Description
Active	The technology object is in operation. (<TO>.StatusWord.X0 (Control))
Switched	A cam of cam track is switched. (<TO>.TrackOutput)
Inverted output cam output	The output cam output is inverted. (<TO>.StatusWord.X4 (OutputInverted))
Error	An error occurred at the technology object. Detailed information about the error is available in the "Error" area, and in the <TO>.ErrorDetail.Number and <TO>.ErrorDetail.Reaction tags of the technology object. (<TO>.StatusWord.X1 (Error))
Restart active	The technology object is being reinitialized. The tags of the technology data block are not updated with active restart. (<TO>.StatusWord.X2 (RestartActive))
Cam track output ready	The cam track is synchronized with the output module and available for use. (<TO>.StatusWord.X5 (CommunicationOk))
Restart required	Data relevant for the restart has been changed. The changes are applied only after a r estart of the technology object. (<TO>.StatusWord.X3 (OnlineStartValuesChanged))

Error

The following table shows the possible errors:

Error	Description
System	A system-internal error has occurred. (<TO>.ErrorWord.X0 (SystemFault))
Configuration	A configuration error has occurred. One or more configuration parameters are inconsistent or invalid. The technology object was incorrectly configured, or editable configuration data were incorrectly modified during runtime of the user program. (<TO>.ErrorWord.X1 (ConfigFault))
User program	An error occurred in the user program with a Motion Control instruction or its use. (<TO>.ErrorWord.X2 (UserFault))
Job rejected	A job cannot be executed. A Motion Control instruction cannot be executed because the necessary conditions are not met (e.g. axis assigned to the cam track is not homed). (<TO>.ErrorWord.X3 (CommandNotAccepted))
I/O	An error occurred accessing a logical address. (<TO>.ErrorWord.X13 (PeripheralError))

Alarm display

For additional information and to acknowledge the error, go to the Inspector window by clicking on the "Alarm display" link.

Additional information

An option for the evaluation of the individual status bits can be found in the Evaluating StatusWord, ErrorWord and WarningWord (Page 359) section.

See also

StatusWord tag (cam track) (Page 617)

ErrorWord tag (cam track) (Page 618)

WarningWord tag (cam track) (Page 619)

9.10.2 Cam track status

Description

You use the "Technology object > Diagnostics > Cam track status" diagnostics function in the TIA Portal to monitor the status of the cam track. The Diagnostics function is available in online operation.

"Validity and masking of the output cams" area

The individual cams of a cam track are shown in this area along with the status for the following properties:

Status	Description
Valid	Validity of the individual cams of the cam track (<TO>.Parameter.Cam[1 … 32].Existent)
Masked	Bit masking of the individual cams of the cam track (<TO>.Parameter.CamMasking)
Effective	Switched on output cam (bit-masked) (<TO>.SingleCamState)

"Positions" area

The following status values are displayed in this area:

Status	Description
Current position in the cam track	Position during cam track processing within a cam track cycle The distance to the current reference position of the current cam track (<TO>.MatchPosition) is displayed. (<TO>.TrackPosition)
Current cam track start	Reference position of the current cam track During cyclic processing of the cam track, the continued reference position of the current cam track is displayed. The unique detection and output of the position is only possible when the assigned technology object is in motion. (<TO>.MatchPosition)

Instructions 10

10.1 MC_Power V4

10.1.1 MC_Power: Enable, disable technology object V4

Description

With the Motion Control instruction "MC_Power", a technology object is enabled or disabled.

Applies to

- Synchronous axis
- Positioning axis
- Speed axis
- External encoder

Requirement

- The technology object has been configured correctly.
- Cyclic BUS communication is established between controller and encoder (<TO>.StatusSensor[n].CommunicationOK = TRUE).
- Cyclic BUS communication is established between controller and drive (<TO>.StatusDrive.CommunicationOK = TRUE).

Override response

- An "MC_Power" job cannot be aborted by any other Motion Control job.
- An "MC_Power" job with parameter "Enable"TRUE enables a technology object but does not thereby abort any other Motion Control instructions.
- Disabling the technology object (parameter "Enable" = FALSE) aborts all Motion Control jobs on the corresponding technology object in accordance with the selected "StopMode". This process cannot be canceled by the user.

Parameters

The following table shows the parameters of Motion Control instruction "MC_Power":

Parameters	Declaration	Data type	Default value	Description	
Axis	INPUT	TO_Axis	-	Technology object	
Enable	INPUT	BOOL	FALSE	TRUE	The technology object is enabled.
				FALSE	The technology object is disabled. All current jobs at the technology object are aborted in accordance with the configured "StopMode".
StartMode	INPUT	DINT	1	0	Enable positioning axis/synchronous axis not position-controlled
				1	Enable positioning axis/synchronous axis position-controlled
				The parameter initially takes effect when the positioning axis is enabled (Enable changes from FALSE to TRUE) and when the axis is enabled after acknowledgment of an interrupt that caused the axis to be disabled. This parameter is ignored when a speed axis or an external encoder is used.	
StopMode	INPUT	INT	0	Not applicable to the technology object external encoder If you disable a technology object with a negative edge at parameter "Enable", the axis decelerates in accordance with the selected "StopMode".	
				0	Emergency stop When the technology object is disabled, the axis brakes to a standstill without jerk limit, using the emergency stop deceleration configured in "Technology object > Configuration > Extended parameters > Emergency stop ramp". The enable is then canceled. (<TO>.DynamicDefaults.EmergencyDeceleration)
				1	Immediate stop When a technology object is disabled, the setpoint zero is output, and the enable is canceled. The axis is braked to a standstill according to the configuration in the drive.
				2	Stop with maximum dynamic values When the technology object is disabled, the axis is braked to a standstill using the maximum deceleration configured in "Technology object > Configuration > Extended parameters > Dynamic limits". The configured maximum jerk is hereby taken into account. The enable is then canceled. (<TO>.DynamicLimits.MaxDeceleration; <TO>.DynamicLimits.MaxJerk)

Parameters	Declaration	Data type	Default value	Description	
Status	OUTPUT	BOOL	FALSE	Technology object enable status	
				FALSE	Disabled • A positioning axis, synchronous axis or speed axis does not accept any motion control jobs. • Speed control and positioning control are not active. • The actual values of the technology object are not checked for validity.
				TRUE	Enabled • An enabled positioning axis, synchronous axis or speed axis accepts Motion Control jobs. • Speed control and positioning control are active. • The actual values of the technology object are valid.
Busy	OUTPUT	BOOL	FALSE	TRUE	Job is running.
Error	OUTPUT	BOOL	FALSE	TRUE	An error occurred in Motion Control instruction MC_Power. The cause of the error can be found in the "ErrorID" parameter.
ErrorID	OUTPUT	WORD	16#0000	Error ID (Page 652) for parameter "ErrorID"	

Enabling technology objects

To enable a technology object, set the "Enable" parameter to TRUE.

The following two cases are differentiated:

- Enable at a standstill
- Enable in motion of axis

Enable at a standstill

Depending on the "StartMode" parameter, the position is held (StartMode = 1) or the velocity setpoint zero is output (StartMode = 0). When the "Status" parameter shows the value TRUE, the technology object is enabled.

Enable in motion of axis

If StartMode = 1, the position at the time of the setting of the enable input is effective as set position for the position controller. The axis is braked to a standstill and adjusted to the set position depending on the maximum deceleration configured under "Technology object > Configuration > Extended parameters > Dynamic limits". If monitoring operation or dynamic limits are hereby exceeded, this leads to corresponding alarm reactions.

If StartMode = 0, the axis is braked as much as possible by the specification of the velocity setpoint zero. Monitoring operations and dynamic limits are not active in this case.

When the "Status" parameter shows the value TRUE, the technology object is enabled.

Note

Automatic enable after acknowledgment of a technology alarm

If the technology object is disabled due to a technology alarm, the technology object will be enabled again automatically after the cause has been eliminated and the alarm has been acknowledged. This requires the "Enable" parameter to have retained the value TRUE during this process.

Disabling technology objects

To disable a technology object, set the "Enable" parameter to FALSE.

If an axis is in motion, it is braked to a standstill according to the selected "StopMode".

When the "Busy" and "Status" parameters show the value FALSE, the disabling of the technology object is complete.

Drive connection by means of PROFIdrive

When a drive is connected using PROFIdrive, the setpoint, enable and drive status are transmitted via the PROFIdrive telegram.

- **Enable technology object and activate drive**

  With parameter "Enable" = TRUE, the technology object is enabled. The drive is enabled according to the PROFIdrive standard.

  When the <TO>.StatusDrive.InOperation tag shows the value TRUE, the drive is ready to execute setpoints. The "Status" parameter is set to the value TRUE.

- **Disable technology object and deactivate drive**

  With "Enable" = FALSE parameter, the "Status" parameter is set to the value FALSE, and the axis is braked according to the selected "StopMode". The drive is disabled according to the PROFIdrive standard.

Analog drive connection

The setpoint is output via an analog output. Optionally, you can configure an enabling signal via digital output (<TO>.Actor.Interface.EnableDriveOutput), and a readiness signal via digital input (<TO>.Actor.Interface.DriveReadyInput).

- **Enable technology object and activate drive**

  With parameter "Enable" = TRUE, the enable output ("Enable drive output") is set.

  When the drive returns the readiness signal via the ready input ("Drive ready input"), the "Status" parameter and the technology object's <TO>.StatusDrive.InOperation tag are set to TRUE, and the setpoint is switched to the analog output.

- **Disable technology object and deactivate drive**

  With parameter "Enable" = FALSE, the "Status" parameter is set to the value FALSE, and the axis is braked according to the selected "StopMode". When the setpoint zero is reached, the enable output is set to FALSE.

Additional information

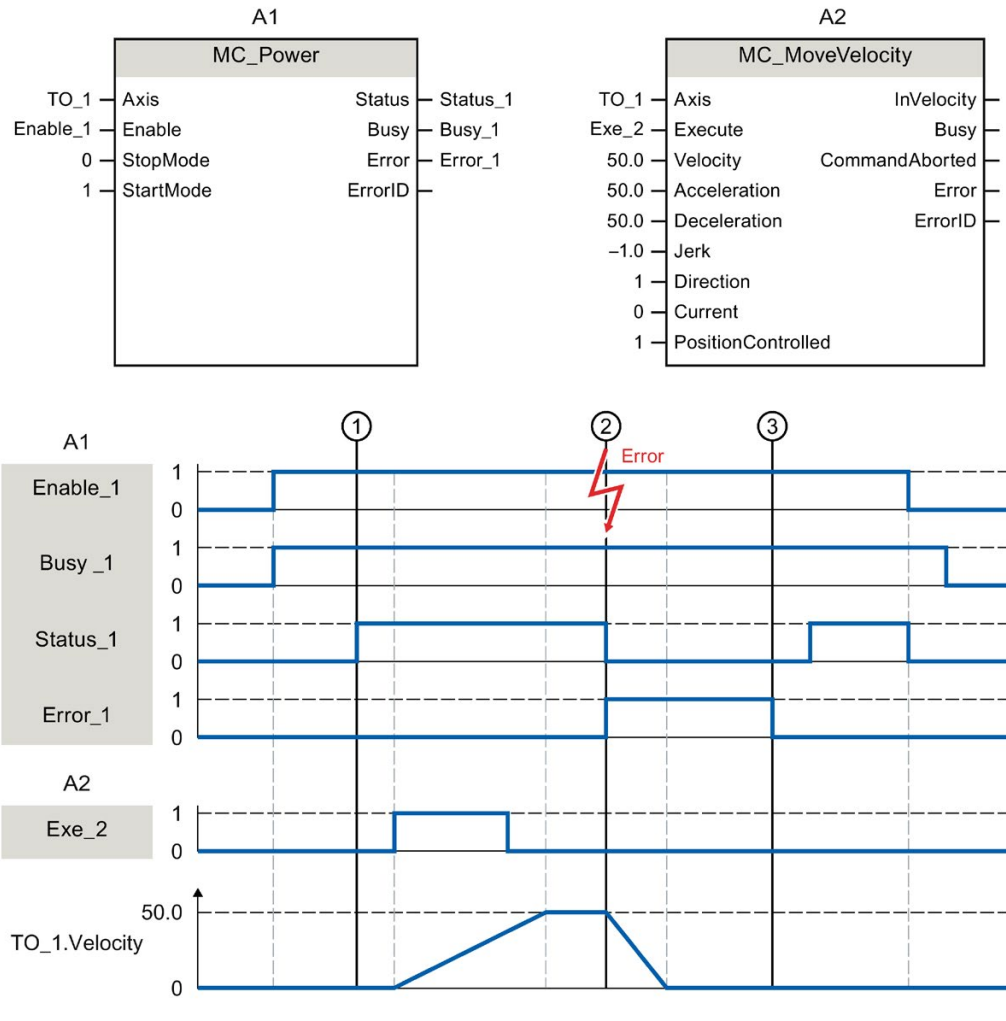
Additional information on enabling and disabling technology objects and drives can be found in the appendix, MC_Power Function Charts (Page 657).

See also

Error ID for Motion Control instructions (Page 652)

10.1.2 MC_Power: Function chart V4

Function chart: Enabling a technology object and example of alarm response



A technology object is enabled with "Enable_1= TRUE". The successful enable can be read from "Status_1" at time ①. The axis will then move with an "MC_MoveVelocity" job (A2). The velocity profile of the axis can be read from "TO_1.Velocity".

At time ② an error occurs in the technology object, which results in the disabling of the technology object (alarm response: remove enable). The axis is braked to a standstill according to the configuration in the drive. When the technology object is disabled, "Status_1" is reset. Since the axis was not disabled using "Enable_1" = FALSE, the selected "StopMode" does not apply. The cause of the error is corrected and the alarm is acknowledged at time ③.

Since "Enable_1" is still set, the technology object is enabled again. The successful enable can be read from "Status_1". Finally, the technology object is disabled with "Enable_1" = FALSE.

10.2 MC_Reset V4

10.2.1 MC_Reset: Acknowledge alarms, restart technology object V4

Description

With the Motion Control instruction "MC_Reset", you acknowledge all technology alarms that can be acknowledged in the user program. Acknowledgment also resets the "Error" and "Warning" bits in the technology data block.

With the Motion Control instruction "MC_Reset" with "Restart" = TRUE, you start reinitialization (restart) of technology objects. Upon restart of the technology object, the new configuration data are applied in the technology data block.

Applies to

- All technology objects

Requirement

- Positioning/synchronous axis, speed axis and external encoder technology objects:

  For a restart, the technology object must be disabled.

  ("MC_Power.Status" = FALSE and "MC_Power.Busy" = FALSE)

Override response

- Parameter "Restart" = FALSE:

  Processing of the "MC_Reset" instruction with parameter "Restart" = FALSE cannot be aborted by any other Motion Control job. The MC_Reset job does not abort any active motion control jobs.

- Parameter "Restart" = TRUE:

  Processing of the "MC_Reset" instruction with parameter "Restart" = TRUE cannot be aborted by any other Motion Control job.

Parameters

The following table shows the parameters of Motion Control instruction "MC_Reset":

Parameter	Declaration	Data type	Default value	Description	
Axis	INPUT	TO_Object	-	Technology object	
Execute	INPUT	BOOL	FALSE	TRUE	Start job with a positive edge
Restart	INPUT	BOOL	FALSE	TRUE	"Restart" Reinitialization of the technology object and acknowledgment of pending technology alarms. The technology object is reinitialized with the configured start values.
				FALSE	Acknowledgment of queued technology alarms.
Done	OUTPUT	BOOL	FALSE	TRUE	Error has been acknowledged. Restart has been executed.
Busy	OUTPUT	BOOL	FALSE	TRUE	Job is running.
CommandAborted	OUTPUT	BOOL	FALSE	TRUE	The job was aborted by another job during execution.
Error	OUTPUT	BOOL	FALSE	TRUE	An error occurred during execution of the job. The job is rejected. The cause of the error can be found in the "ErrorID" parameter.
ErrorID	OUTPUT	WORD	16#0000	Error ID (Page 652) for parameter "ErrorID"	

Acknowledging technology alarms

To acknowledge technology alarms, follow these steps:

1. Check the requirements indicated above.
2. Set the parameter "Restart" = FALSE.
3. Start the acknowledgment of the error with a positive edge at parameter "Execute".

When the "Done" parameter shows the value TRUE, the error has been acknowledged.

Note
Acknowledge with "Restart" = FALSE
If only the technology alarms are to be acknowledged, set "Restart"FALSE. The technology object cannot be used during a restart.

Restarting a technology object

To restart a technology object, follow these steps:

1. Check the requirements indicated above.
2. Set the parameter "Restart" = TRUE.
3. Perform the restart with a positive edge at parameter "Execute".

When the "Done" parameter shows the value TRUE, the restart of the technology object is complete.

Additional information regarding the restart can be found in the section "Restarting technology objects (Page 386)".

See also

Error ID for Motion Control instructions (Page 652)

10.3 MC_Home V4

10.3.1 MC_Home: Home technology object, set home position V4

Description

With the Motion Control instruction "MC_Home", you create the relationship between the position in the technology object and the mechanical position. The actual position value in the technology object is assigned to a homing mark at the same time. This homing mark represents a known mechanical position.

Homing is performed according to the mode selected with the "Mode" parameter and the configuration under "Technology object > Configuration > Extended parameters > Homing".

The "MC_Home.Mode" parameter for S7-1200 Motion Control and S7-1500 Motion Control has been standardized within the framework of technology version V2.0. This results in a new assignment of the parameter values for the "MC_Home.Mode" parameter. A comparison of the "MC_Home.Mode" parameter for technology versions V1.0 and ≥ V2.0 is available in section "Version overview (Page 179)".

The preset values under "Technology object > Configuration > Extended parameters > Dynamic default values" are used for the dynamic values Acceleration, Deceleration and Jerk.

Applies to

- Synchronous axis
- Positioning axis
- External encoder

The following table shows which modes are possible with each of the technology objects:

Operating mode	Positioning axis/ synchronous axis with incremental encoder	Positioning axis/ synchronous axis with absolute encoder	External incremental encoder	External absolute encoder
Active homing ("Mode" = 3, 5)	X	-	-	-
Passive homing ("Mode" = 2, 8, 10)	X	-	X	-
Set actual position ("Mode" = 0)	X	X	X	X
Relative shift of the actual position ("Mode" = 1)	X	X	X	X
Absolute encoder adjustment ("Mode" = 6, 7)	-	X	-	X

Requirement

- The technology object has been configured correctly.
- "Mode" = 2, 3, 5, 8, 10
  The technology object is enabled.
- "Mode" = 0, 1, 6, 7, 8
  The actual encoder values are valid (<TO>.StatusSensor[n].State = 2).
- "Mode" = 6, 7

  The axis is in position-controlled mode.

Override response

The override response for "MC_Home" jobs is described in section "Override response V4: Homing and motion jobs (Page 536)".

Parameters

The following table shows the parameters of Motion Control instruction "MC_Home":

Parameter	Declaration	Data type	Default value	Description	
Axis	INPUT	TO_Axis	-	Technology object	
Execute	INPUT	BOOL	FALSE	TRUE	Start job with a positive edge
Position	INPUT	LREAL	0.0	The specified value is used according to the selected "Mode".	
Mode	INPUT	INT	0	Operating mode	
				0	Direct homing (absolute) The current position of the technology object is set to the value of parameter "Position".
				1	Direct homing (relative) The current position of the technology object is shifted by the value of parameter "Position".
				2	Passive homing (without reset) Functions like "Mode" 8, with the difference that the "homed" status is **not** reset when the function is enabled.
				3	Active homing The TO positioning axis/synchronous axis performs a homing movement according to the configuration. After the completion of the motion, the axis is positioned at the value of the "Position" parameter.
				4	Reserved

Parameter	Declaration	Data type	Default value	Description	
				5	Active homing ("Position" parameter has no effect) The TO positioning axis/synchronous axis performs a homing movement according to the configuration. After completion of the motion, the axis is positioned at the home position configured under "Technology object > Configuration > Extended parameters > Homing > Active homing". (<TO>.Homing.HomePosition)
				6	Absolute encoder adjustment (relative) The current position is shifted by the value of parameter "Position". The calculated absolute value offset is stored retentively in the CPU. (<TO>.StatusSensor[n].AbsEncoderOffset)
				7	Absolute encoder adjustment (absolute) The current position is set to the value of parameter "Position". The calculated absolute value offset is stored retentively in the CPU. (<TO>.StatusSensor[n].AbsEncoderOffset)
				8	Passive homing When the homing mark is detected, the actual value is set to the value of the "Position" parameter.
				9	Abort passive homing An active job for passive homing is aborted.
				10	Passive homing ("Position" parameter has no effect) When the homing mark is detected, the actual value is set to the home position configured under "Technology object > Configuration > Extended parameters > Homing > Passive homing". (<TO>.Homing.HomePosition)
Reference-MarkPosition	OUTPUT	LREAL	0.0	Display of the position at which the technology object was homed (valid when "Done" = TRUE)	
Done	OUTPUT	BOOL	FALSE	TRUE	Job is completed.
Busy	OUTPUT	BOOL	FALSE	TRUE	Job is running.
Command Aborted	OUTPUT	BOOL	FALSE	TRUE	The job was aborted by another job during execution.
Error	OUTPUT	BOOL	FALSE	TRUE	An error occurred during execution of the job. The job is rejected. The cause of the error can be found in the "ErrorID" parameter.
ErrorID	OUTPUT	WORD	16#0000	Error ID (Page 652) for parameter "ErrorID"	

Resetting the "Homed" status

The "Homed" status of a technology object is reset under the following conditions (<TO>.StatusWord.X5 (HomingDone)):

- **Technology objects with incremental actual values:**
  - Starting an "MC_Home" job with "Mode" = 3, 5, 8, 10

    (After successful completion of the homing operation, the "Homed" status is reset.)
  - Error in the encoder system, or encoder failure
  - Restart of the technology object
  - After POWER OFF -> POWER ON of the CPU
  - Memory reset
  - Modification of the encoder configuration
- **Technology objects with absolute actual values:**
  - Error in sensor system/encoder failure
  - Replacement of the CPU
  - Modification of the encoder configuration
  - Restoration of the CPU factory settings
  - Transfer of a different project into the controller

Homing a technology object with "Mode" = 1..8, 10

To home a technology object, follow these steps:

1. Check the requirements indicated above.
2. Specify the desired homing function in the "Mode" parameter.
3. Initialize the necessary parameters with values, and start the homing operation with a positive edge at the "Execute" parameter.

When the "Done" parameter shows the value TRUE, the "MC_Home" job has been completed according to the selected "Mode". The "Homed" status of the technology object is indicated under "Technology object > Diagnostics > Status and error bits > Motion status > Homed" (<TO>.StatusWord.X5 (HomingDone)).

Abort of a passive homing with "Mode" = 9

With "Mode" = 9, the technology object is not homed. When an active "MC_Home" job for passive homing ("Mode" = 2, 8, 10) is overridden by another "MC_Home" job with "Mode" = 9, the running job is aborted with parameter "CommandAborted" = TRUE. The overriding job with "Mode" = 9 signals successful execution with parameter "Done" = TRUE.

Additional information

An option for the evaluation of the individual status bits can be found in the section "Evaluating StatusWord, ErrorWord and WarningWord (Page 359)".

See also

Override response V4: Homing and motion jobs (Page 536)

Error ID for Motion Control instructions (Page 652)

Homing (Page 78)

10.4 MC_Halt V4

10.4.1 MC_Halt: Pause axis V4

Description

With the Motion Control instruction "MC_Halt", you brake an axis until it comes to a standstill.

You define the dynamic behavior of the braking operation with parameters "Jerk" and "Deceleration".

Applies to

- Synchronous axis
- Positioning axis
- Speed axis

Requirement

- The technology object has been configured correctly.
- The technology object is enabled.

Override response

The override response for "MC_Halt" jobs is described in section "Override response V4: Homing and motion jobs (Page 536)".

Parameters

The following table shows the parameters of Motion Control instruction "MC_Halt":

Parameters	Declaration	Data type	Default value	Description	
Axis	INPUT	TO_SpeedAxis	-	Technology object	
Execute	INPUT	BOOL	FALSE	TRUE	Start job with a positive edge
Deceleration	INPUT	LREAL	-1.0	Deceleration	
				> 0.0	The specified value is used.
				= 0.0	Not permitted
				< 0.0	The deceleration configured in "Technology object > Configuration > Extended parameters > Dynamic defaults" is used. (<TO>.DynamicDefaults.Deceleration)
Jerk	INPUT	LREAL	-1.0	Jerk	
				> 0.0	Constant-acceleration velocity profile; the specified jerk is used
				= 0.0	Trapezoid velocity profile
				< 0.0	The jerk configured in "Technology object > Configuration > Extended parameters > Dynamic defaults" is used. (<TO>.DynamicDefaults.Jerk)

Parameters	Declaration	Data type	Default value	Description	
AbortAcceleration	INPUT	BOOL	FALSE	FALSE	The current acceleration at the start of the job is reduced using the configured jerk. Afterwards, the deceleration builds up
				TRUE	The acceleration is set to 0.0 at the start of the job, and the deceleration immediately builds up.
Done	OUTPUT	BOOL	FALSE	TRUE	Zero velocity reached
Busy	OUTPUT	BOOL	FALSE	TRUE	Job is running.
CommandAborted	OUTPUT	BOOL	FALSE	TRUE	The job was aborted by another job during execution.
Error	OUTPUT	BOOL	FALSE	TRUE	An error occurred during execution of the job. The job is rejected. The cause of the error can be found in the "ErrorID" parameter.
ErrorID	OUTPUT	WORD	16#0000	Error ID (Page 652) for parameter "ErrorID"	

Braking an axis with "MC_Halt"

Proceed as follows to decelerate an axis to a standstill:

1. Check the requirements indicated above.
2. Supply the parameters "Deceleration", "Jerk" and "AbortAcceleration" with the desired values.
3. Start the "MC_Halt" job with a positive edge at parameter "Execute".

The current motion state is indicated in "Busy", "Done" and "Error". The standstill of the axis is indicated under "Technology object > Diagnostics > Status and error bits > Motion status > Standstill" (<TO>.StatusWord.X7 (Standstill)).

Braking an axis with active force/torque limit

With active force/torque limiting the permitted torque may not be sufficient to move the calculated braking ramp. The "MC_Halt" command does not signal "Done" = TRUE.

To brake an axis with active force/torque limiting, use the Motion Control instruction "MC_MoveVelocity" with "MC_MoveVelocity.Velocity" = 0.0 and "MC_MoveVelocity.PositionControlled" = FALSE.

Additional information

An option for the evaluation of the individual status bits can be found in the Evaluating StatusWord, ErrorWord and WarningWord (Page 359) section.

See also

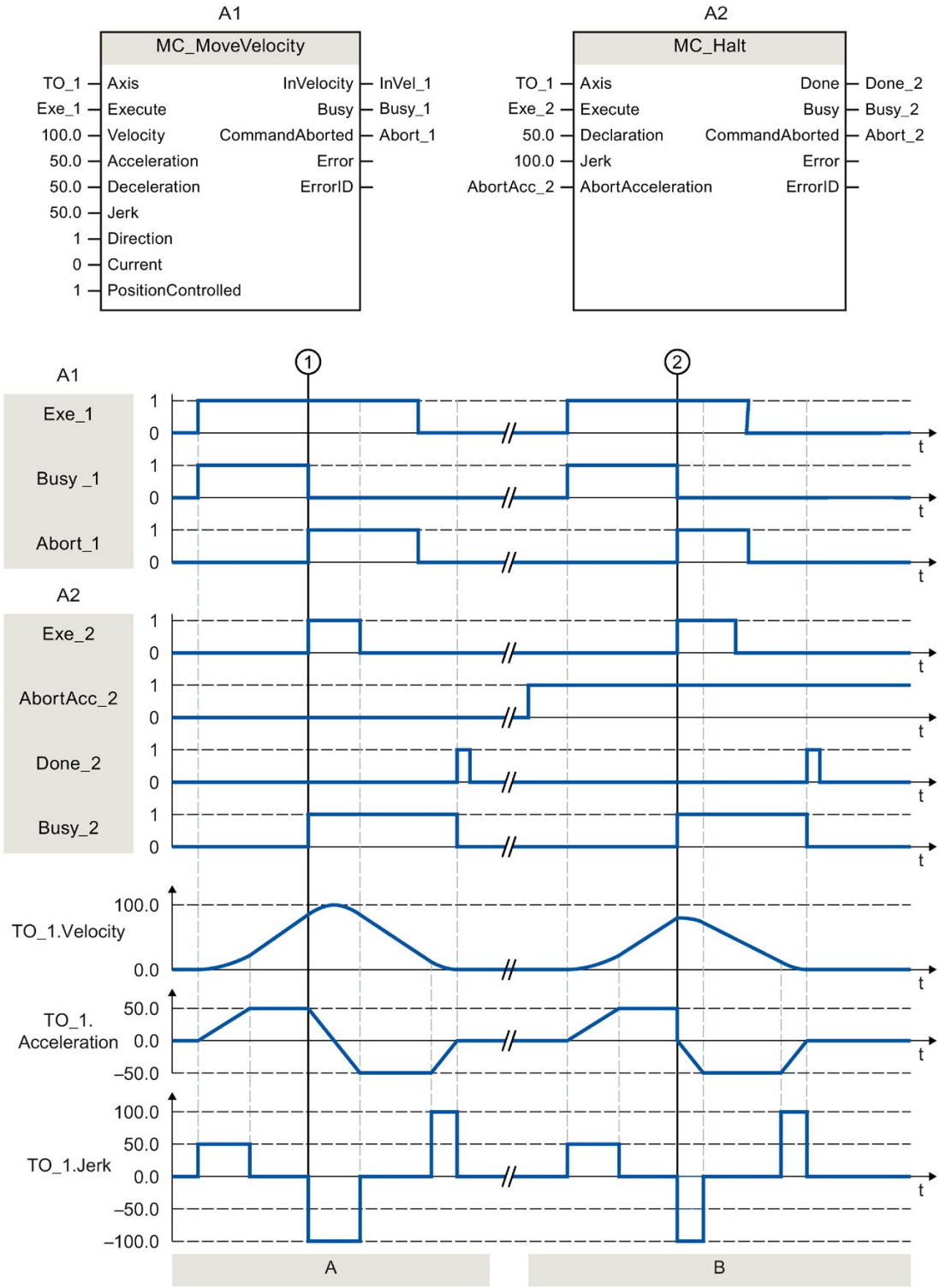
Override response V4: Homing and motion jobs (Page 536)

Error ID for Motion Control instructions (Page 652)

MC_MoveVelocity: Move axis at velocity/speed setpoint V4 (Page 453)

10.4.2 MC_Halt: Function chart V4

Function chart: Stopping an axis and the overriding job characteristics



Section A	An axis is moved with an "MC_MoveVelocity" job (A1). At time ①, the "MC_MoveVelocity" job is overridden by an "MC_Halt" job (A2). The job abort is signaled via "Abort_1". With "AbortAcc_2" = FALSE, the current acceleration is reduced with the specified jerk. Afterward, the deceleration builds up and the axis is braked to a standstill. The completion of the "MC_Halt" job is reported via "Done_2".
Section B	The axis is moved with an "MC_MoveVelocity" job (A1). At time ②, the "MC_MoveVelocity" job is overridden by an "MC_Halt" job (A2). The job abort is signaled via "Abort_1". With "AbortAcc_2" = TRUE, the current acceleration is set to zero immediately and the deceleration builds up. The axis is braked to a standstill. The completion of the "MC_Halt" job is reported via "Done_2".

10.5 MC_MoveAbsolute V4

10.5.1 MC_MoveAbsolute: Position axis absolutely V4

Description

With the Motion Control instruction "MC_MoveAbsolute", you can move an axis to an absolute position.

You define the dynamic behavior of the motion with parameters "Velocity", "Jerk", "Acceleration" and "Deceleration".

Applies to

- Synchronous axis
- Positioning axis

Requirement

- The technology object has been configured correctly.
- The technology object is enabled.
- The technology object is homed.

Override response

The override response for "MC_MoveAbsolute" jobs is described in section "Override response V4: Homing and motion jobs (Page 536)".

Parameters

The following table shows the parameters of Motion Control instruction "MC_MoveAbsolute":

Parameters	Declaration	Data type	Default value	Description	
Axis	INPUT	TO_PositioningAxis	-	Technology object	
Execute	INPUT	BOOL	FALSE	TRUE	Start job with a positive edge
Position	INPUT	LREAL	0.0	Absolute target position	
Velocity	INPUT	LREAL	-1.0	Velocity setpoint for the positioning	
				> 0.0	The specified value is used.
				= 0.0	Not permitted
				< 0.0	The velocity configured in "Technology object > Configuration > Extended parameters > Dynamic defaults" is used. (<TO>.DynamicDefaults.Velocity)
Acceleration	INPUT	LREAL	-1.0	Acceleration	
				> 0.0	The specified value is used.
				= 0.0	Not permitted
				< 0.0	The acceleration configured in "Technology object > Configuration > Extended parameters > Dynamic defaults" is used. (<TO>.DynamicDefaults.Acceleration)
Deceleration	INPUT	LREAL	-1.0	Deceleration	
				> 0.0	The specified value is used.
				= 0.0	Not permitted
				< 0.0	The deceleration configured in "Technology object > Configuration > Extended parameters > Dynamic defaults" is used. (<TO>.DynamicDefaults.Deceleration)
Jerk	INPUT	LREAL	-1.0	Jerk	
				> 0.0	Constant-acceleration velocity profile; the specified jerk is used
				= 0.0	Trapezoid velocity profile
				< 0.0	The jerk configured in "Technology object > Configuration > Extended parameters > Dynamic defaults" is used. (<TO>.DynamicDefaults.Jerk)
Direction	INPUT	INT	1	Motion direction of the axis Is only evaluated with "modulo" enabled. "Technology object > Configuration > Basic parameters > Enable modulo	
				1	Positive direction
				2	Negative direction
				3	Shortest distance

Parameters	Declaration	Data type	Default value	Description	
Done	OUTPUT	BOOL	FALSE	TRUE	Target position reached.
Busy	OUTPUT	BOOL	FALSE	TRUE	Job is running.
CommandAborted	OUTPUT	BOOL	FALSE	TRUE	The job was aborted by another job during execution.
Error	OUTPUT	BOOL	FALSE	TRUE	An error occurred during execution of the job. The job is rejected. The cause of the error can be found in the "ErrorID" parameter.
ErrorID	OUTPUT	WORD	16#0000	Error ID (Page 652) for parameter "ErrorID"	

Moving an axis to an absolute position

Proceed as follows to move an axis to an absolute position:

1. Check the requirements indicated above.
2. Specify the desired target position in the "Position" parameter.
3. Start the "MC_MoveAbsolute" job with a positive edge at parameter "Execute".

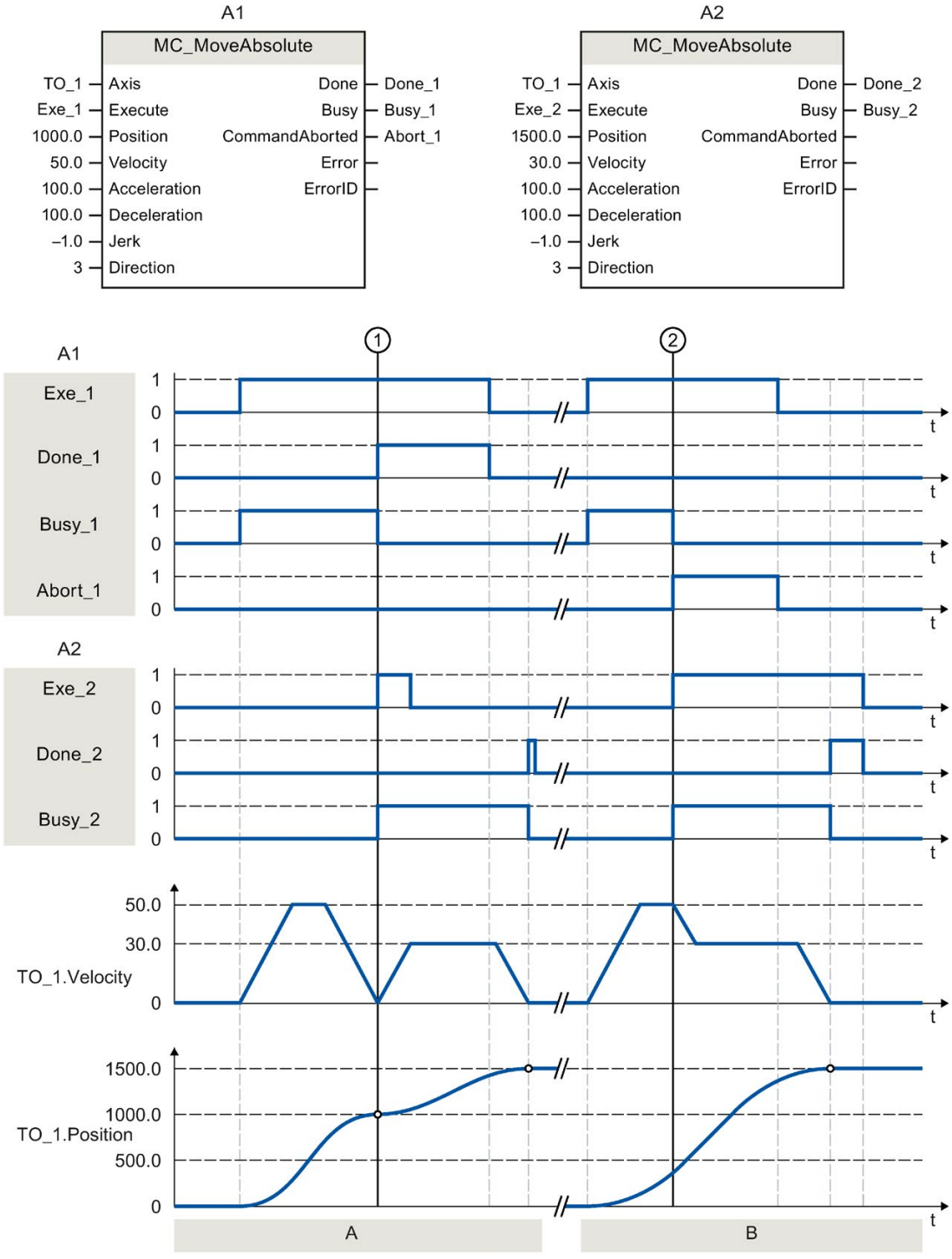
The current motion state is indicated in "Busy", "Done" and "Error".

See also

Override response V4: Homing and motion jobs (Page 536)
Error ID for Motion Control instructions (Page 652)

10.5.2 MC_MoveAbsolute: Function chart V4

Function chart: Absolute positioning of an axis, and the response to an overriding job



Section A	An axis is moved to absolute position 1000.0 with an "MC_MoveAbsolute" job (A1). When the axis reaches the target position, this is signaled at time ① via "Done_1". At this time ①, another "MC_MoveAbsolute" job (A2) with target position 1500.0 is started. When the axis reaches the target position 1500.0, this is signaled via "Done_2". Since "Exe_2" was previously reset, "Done_2" is applied only to one cycle.
Section B	An active "MC_MoveAbsolute" job (A1) is overridden at time ② by another "MC_MoveAbsolute" job (A2). The abort is signaled via "Abort_1". The axis is braked to the changed velocity and moved to the new target position 1500.0. When the new target position is reached, this is signaled via "Done_2".

10.6 MC_MoveRelative V4

10.6.1 MC_MoveRelative: Position axis relatively V4

Description

With the Motion Control instruction "MC_MoveRelative", you move an axis relative to its position when execution of the job began.

You define the dynamic behavior of the motion with parameters "Velocity", "Jerk", "Acceleration" and "Deceleration".

Applies to

- Synchronous axis
- Positioning axis

Requirement

- The technology object has been configured correctly.
- The technology object is enabled.

Override response

The override response for "MC_MoveRelative" jobs is described in section "Override response V4: Homing and motion jobs (Page 536)".

Parameters

The following table shows the parameters of Motion Control instruction "MC_MoveRelative":

Parameter	Declaration	Data type	Default value	Description	
Axis	INPUT	TO_PositioningAxis	-	Technology object	
Execute	INPUT	BOOL	FALSE	TRUE	Start job with a positive edge
Distance	INPUT	LREAL	0.0	Distance for the positioning process (negative or positive)	
Velocity	INPUT	LREAL	-1.0	Velocity setpoint for the positioning	
				> 0.0	The specified value is used.
				= 0.0	Not permitted
				< 0.0	The velocity configured in "Technology object > Configuration > Extended parameters > Dynamic defaults" is used. (<TO>.DynamicDefaults.Velocity)
Acceleration	INPUT	LREAL	-1.0	Acceleration	
				> 0.0	The specified value is used.
				= 0.0	Not permitted
				< 0.0	The acceleration configured in "Technology object > Configuration > Extended parameters > Dynamic defaults" is used. (<TO>.DynamicDefaults.Acceleration)
Deceleration	INPUT	LREAL	-1.0	Deceleration	
				> 0.0	The specified value is used.
				= 0.0	Not permitted
				< 0.0	The deceleration configured in "Technology object > Configuration > Extended parameters > Dynamic defaults" is used. (<TO>.DynamicDefaults.Deceleration)
Jerk	INPUT	LREAL	-1.0	Jerk	
				> 0.0	Constant-acceleration velocity profile; the specified jerk is used
				= 0.0	Trapezoid velocity profile
				< 0.0	The jerk configured in "Technology object > Configuration > Extended parameters > Dynamic defaults" is used. (<TO>.DynamicDefaults.Jerk)
Done	OUTPUT	BOOL	FALSE	TRUE	Target position reached
Busy	OUTPUT	BOOL	FALSE	TRUE	Job is running.
CommandAborted	OUTPUT	BOOL	FALSE	TRUE	The job was aborted by another job during execution.

Parameter	Declaration	Data type	Default value	Description	
Error	OUTPUT	BOOL	FALSE	TRUE	An error occurred during execution of the job. The job is rejected. The cause of the error can be found in the "ErrorID" parameter.
ErrorID	OUTPUT	WORD	16#0000	Error ID (Page 652) for parameter "ErrorID"	

Moving an axis relative to the starting position

Proceed as follows to move an axis relative to the starting position:

1. Check the requirements indicated above.
2. Specify distance to be moved in the "Distance" parameter.
3. Start the "MC_MoveRelative" job with a positive edge at parameter "Execute".

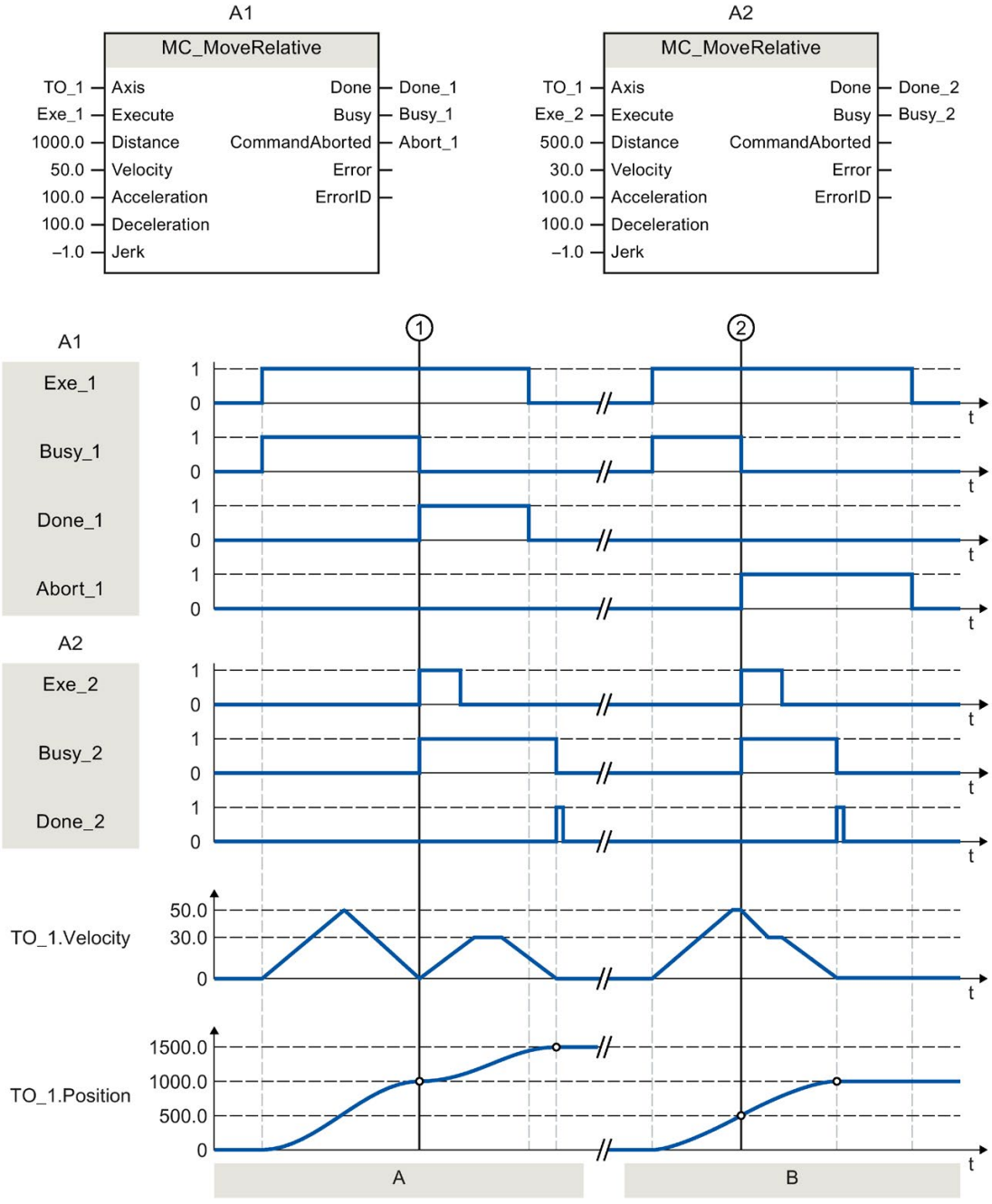
The current motion state is indicated in "Busy", "Done" and "Error".

See also

Override response V4: Homing and motion jobs (Page 536)
Error ID for Motion Control instructions (Page 652)

10.6.2 MC_MoveRelative: Function chart V4

Function chart: Relative positioning of an axis, and the overriding job characteristics



Section A	The axis is moved by an "MC_MoveRelative" job (A1) by the distance ("Distance") 1000.0 (the starting position here is 0.0). When the axis reaches the target position, this is signaled at time ① via "Done_1". At this time ①, another "MC_MoveRelative" job (A2) with distance 500.0 is started. When the new target position is reached, this is signaled via "Done_2". Since "Exe_2" was previously reset, "Done_2" is applied only to one cycle.
Section B	An active "MC_MoveRelative" job (A1) is overridden by another "MC_MoveRelative" job (A2). The abort is signaled at time ② via "Abort_1". The axis is then moved at the new velocity by the distance ("Distance") 500.0. When the new target position is reached, this is signaled via "Done_2".

10.7 MC_MoveVelocity V4

10.7.1 MC_MoveVelocity: Move axis at velocity/speed setpoint V4

Description

With the Motion Control instruction "MC_MoveVelocity", you move an axis at constant velocity/speed.

You define the dynamic behavior of the motion with parameters"Velocity", "Jerk", "Acceleration" and "Deceleration".

- Positioning axis/synchronous axis:

  A velocity is specified in the "Velocity" parameter.
- Speed axis:

  A speed is specified in the "Velocity" parameter.

Applies to

- Synchronous axis
- Positioning axis
- Speed axis

Requirement

- The technology object has been configured correctly.
- The technology object is enabled.

Override response

The override response for "MC_MoveVelocity" jobs is described in section Override response V4: Homing and motion jobs (Page 536).

Parameters

The following table shows the parameters of Motion Control instruction "MC_MoveVelocity":

Parameters	Declaration	Data type	Default value	Description	
Axis	INPUT	TO_SpeedAxis	-	Technology object	
Execute	INPUT	BOOL	FALSE	TRUE	Start job with a positive edge
Velocity	INPUT	LREAL	100.0	Velocity setpoint / speed setpoint for the motion ("Velocity" = 0.0 is permitted)	
Acceleration	INPUT	LREAL	-1.0	Acceleration	
				> 0.0	The specified value is used.
				= 0.0	Not permitted
				< 0.0	The acceleration configured in "Technology object > Configuration > Extended parameters > Dynamic defaults" is used. (<TO>.DynamicDefaults.Acceleration)
Deceleration	INPUT	LREAL	-1.0	Deceleration	
				> 0.0	The specified value is used.
				= 0.0	Not permitted
				< 0.0	The deceleration configured in "Technology object > Configuration > Extended parameters > Dynamic defaults" is used. (<TO>.DynamicDefaults.Deceleration)
Jerk	INPUT	LREAL	-1.0	Jerk	
				> 0.0	Constant-acceleration velocity profile; the specified jerk is used.
				= 0.0	Trapezoid velocity profile
				< 0.0	The jerk configured in "Technology object > Configuration > Extended parameters > Dynamic defaults" is used. (<TO>.DynamicDefaults.Jerk)
Direction	INPUT	INT	0	Direction of rotation of the axis	
				0	The sign of the velocity specified at the "Velocity" parameter defines the direction of rotation.
				1	Positive direction of rotation Value of "Velocity" is used.
				2	Negative direction of rotation Value of "Velocity" is used.
Current	INPUT	BOOL	FALSE	Maintain current velocity	
				FALSE	Deactivated The values of parameters "Velocity" and "Direction" are taken into account.

Parameters	Declaration	Data type	Default value	Description	
				TRUE	activated The values at the parameters "Velocity" and "Direction" are not taken into account. The current velocity and direction at function start are retained. When the axis resumes motion at the velocity that was current at function start, the "InVelocity" parameter returns the value TRUE.
PositionControlled	INPUT	BOOL	TRUE	FALSE	Non position-controlled operation
				TRUE	Position-controlled mode
				The parameter applies as long as the "MC_MoveVelocity" job is being executed. After this, the setting of the following job applies. This parameter is ignored when a speed axis is used.	
InVelocity	OUTPUT	BOOL	FALSE	TRUE	The velocity setpoint / speed setpoint was reached and will be maintained.
Busy	OUTPUT	BOOL	FALSE	TRUE	Job is running.
CommandAborted	OUTPUT	BOOL	FALSE	TRUE	The job was aborted by another job during execution.
Error	OUTPUT	BOOL	FALSE	TRUE	An error occurred during execution of the job. The cause of the error can be found in the "ErrorID" parameter.
ErrorID	OUTPUT	WORD	16#0000	Error ID (Page 652) for parameter "ErrorID"	

Behavior with velocity setpoint / speed setpoint zero ("Velocity" = 0.0)

An "MC_MoveVelocity" job with "Velocity" = 0.0 stops the axis with the configured deceleration. When the velocity setpoint / speed setpoint zero is reached, the parameter "InVelocity" will indicate the value TRUE.

Under "Technology object > Diagnostics > Status and error bits > Motion status", "constant velocity" and "standstill" will be displayed (<TO>.StatusWord.X12 (ConstantVelocity); <TO>.StatusWord.X7 (Standstill)).

The parameters "InVelocity" and "Busy" show the value TRUE until the "MC_MoveVelocity" job is overridden by another Motion Control job.

Moving an axis with constant velocity / speed

Proceed as follows to move an axis with constant velocity / speed:

1. Check the requirements indicated above.
2. At the parameter "Velocity", specify the velocity / speed, with which the axis should be moved.
3. Start the "MC_MoveVelocity" job with a positive edge at parameter "Execute".

The current motion state is indicated in "Busy", "InVelocity" and "Error".

If the "InVelocity" parameter shows the value TRUE, then the velocity setpoint / speed setpoint was reached. The axis continues moving at this constant velocity. The parameters "InVelocity" and "Busy" show the value TRUE until the "MC_MoveVelocity" job is overridden by another Motion Control job.

Note

Response to a change in the override

If the velocity / speed is influenced during constant motion by a change in the override (<TO>.Override.Velocity), the "InVelocity" parameter is reset during the acceleration or deceleration. When the newly calculated velocity / speed is reached ("Velocity" × "Override" %), then "InVelocity" is reset.

Additional information

An option for the evaluation of the individual status bits can be found in the section "Evaluating StatusWord, ErrorWord and WarningWord (Page 359)".

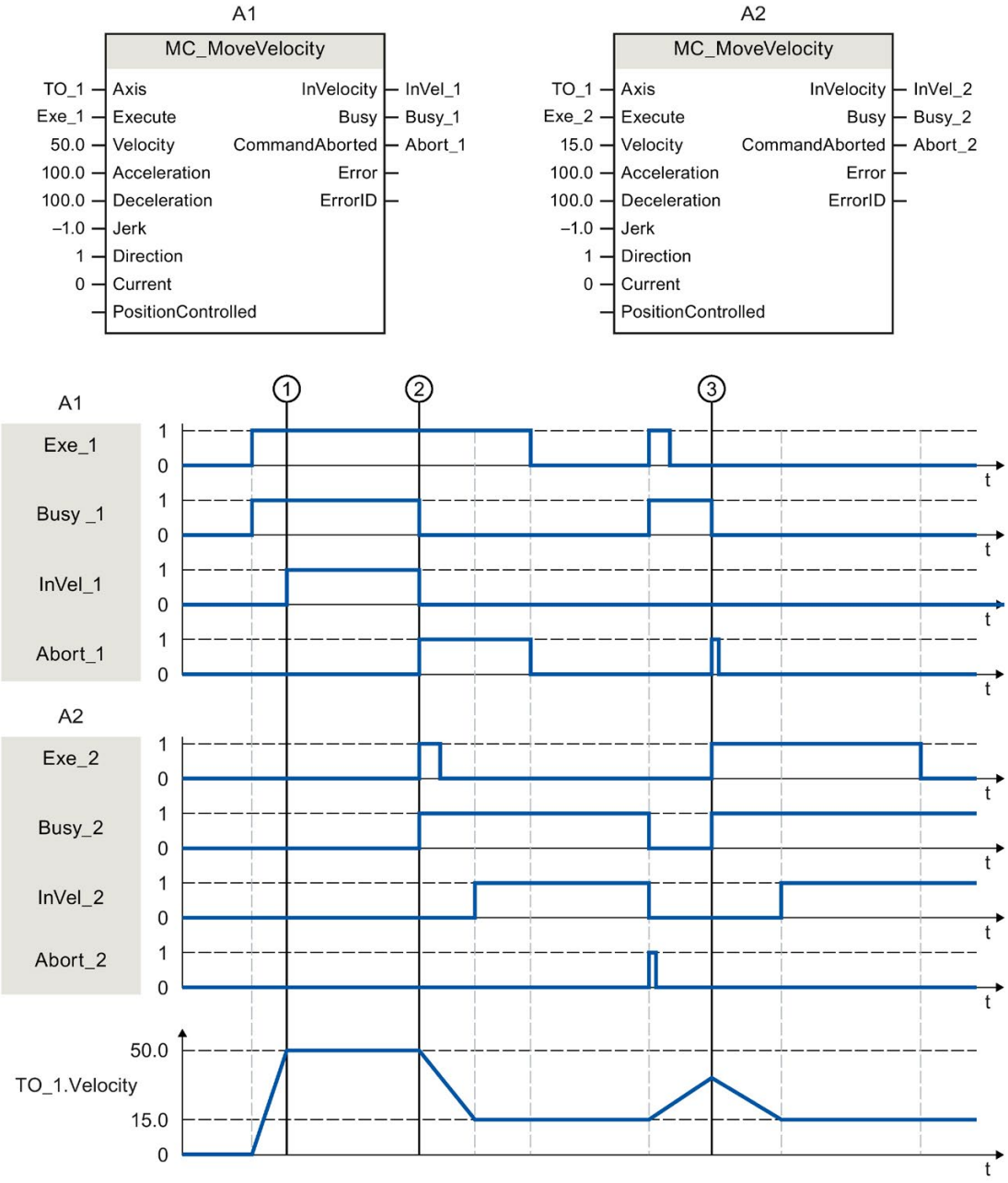
See also

Override response V4: Homing and motion jobs (Page 536)

Error ID for Motion Control instructions (Page 652)

10.7.2 MC_MoveVelocity: Function chart V4

Function chart: Moving an axis with velocity specification, and the response to an overriding job



An "MC_MoveVelocity" job (A1) initiated via "Exe_1" accelerates the axis and signals at time ① via "InVel_1" that the velocity setpoint 50.0 has been reached.

At time ②, the job is overridden by another "MC_MoveVelocity" job (A2). The abort is signaled via "Abort_1". When the new velocity setpoint 15.0 is reached, this is signaled via "InVel_2". The axis then continues moving at the constant velocity 15.0.

The running "MC_MoveVelocity" job (A2) is overridden by another "MC_MoveVelocity" job (A1). The abort is signaled via "Abort_2". The axis is accelerated to the new velocity setpoint 50.0. Before the velocity setpoint is reached, the current "MC_MoveVelocity" job (A1) is overridden at time ③ by another "MC_MoveVelocity" job A2). The abort is signaled via "Abort_1". When the new velocity setpoint 15.0 is reached, this is signaled via "InVel_2". The axis then continues moving at the constant velocity 15.0.

10.8 MC_MoveJog V4

10.8.1 MC_MoveJog: Move axis in jog mode V4

Description

With the Motion Control instruction "MC_MoveJog", you move an axis in jog mode.

You define the dynamic behavior of the motion with parameters "Velocity", "Jerk", "Acceleration" and "Deceleration".

- Positioning axis/synchronous axis:

  A velocity is specified in the "Velocity" parameter.
- Speed axis:

  A speed is specified in the "Velocity" parameter.

Applies to

- Synchronous axis
- Positioning axis
- Speed axis

Requirement

- The technology object has been configured correctly.
- The technology object is enabled.

Override response

The override response for "MC_MoveJog" jobs is described in section Override response V4: Homing and motion jobs (Page 536).

Parameters

The following table shows the parameters of Motion Control instruction "MC_MoveJog":

Parameter	Declaration	Data type	Default value	Description	
Axis	INPUT	TO_SpeedAxis	-	Technology object	
JogForward	INPUT	BOOL	FALSE	TRUE	As long as the parameter is TRUE, the axis moves in the positive direction at the velocity specified in parameter "Velocity".
JogBackward	INPUT	BOOL	FALSE	TRUE	As long as the parameter is TRUE, the axis moves in the negative direction at the velocity specified in parameter "Velocity".
Velocity	INPUT	LREAL	100.0	Velocity setpoint / speed setpoint for the motion	
				> 0.0	The specified value is used.
				< 0.0	The absolute value of the specified value is used.
				("Velocity" = 0.0 is permitted)	
Acceleration	INPUT	LREAL	-1.0	Acceleration	
				> 0.0	The specified value is used.
				= 0.0	Not permitted
				< 0.0	The acceleration configured in "Technology object > Configuration > Extended parameters > Dynamic defaults" is used. (<TO>.DynamicDefaults.Acceleration)
Deceleration	INPUT	LREAL	-1.0	Deceleration	
				> 0.0	The specified value is used.
				= 0.0	Not permitted
				< 0.0	The deceleration configured in "Technology object > Configuration > Extended parameters > Dynamic defaults" is used. (<TO>.DynamicDefaults.Deceleration)
Jerk	INPUT	LREAL	-1.0	Jerk	
				> 0.0	Constant-acceleration velocity profile; the specified jerk is used.
				= 0.0	Trapezoid velocity profile
				< 0.0	The jerk configured in "Technology object > Configuration > Extended parameters > Dynamic defaults" is used. (<TO>.DynamicDefaults.Jerk)
PositionControlled	INPUT	BOOL	TRUE	FALSE	Non position-controlled operation
				TRUE	Position-controlled mode
				The parameter applies as long as the "MC_MoveJog" job is being executed. After this, the setting of the following job applies. This parameter is ignored when a speed axis is used.	
InVelocity	OUTPUT	BOOL	FALSE	TRUE	The velocity setpoint / speed setpoint was reached and will be maintained.

Parameter	Declaration	Data type	Default value	Description	
Busy	OUTPUT	BOOL	FALSE	TRUE	Job is running.
CommandAborted	OUTPUT	BOOL	FALSE	TRUE	The job was aborted by another job during execution.
Error	OUTPUT	BOOL	FALSE	TRUE	An error occurred during execution of the job. The job is rejected. The cause of the error can be found in the "ErrorID" parameter.
ErrorID	OUTPUT	WORD	16#0000	Error ID (Page 652) for parameter "ErrorID"	

Behavior with zero setpoint velocity/speed ("Velocity" = 0.0)

An "MC_MoveJog" job with "Velocity" = 0.0 stops the axis with the configured deceleration. When the velocity setpoint / speed setpoint zero is reached, the parameter "InVelocity" will indicate the value TRUE.

Under "Technology object > Diagnostics > Status and error bits > Motion status", "constant velocity" and "standstill" will be displayed (<TO>.StatusWord.X12 (ConstantVelocity); <TO>.StatusWord.X7 (Standstill)).

Moving an axis in jog mode

Proceed as follows to move an axis in jog mode:

1. Check the requirements indicated above.
2. Move the axis in the positive direction with "JogForward", or in the negative direction with "JogBackward".

The current motion state is indicated in "Busy", "InVelocity" and "Error".

If both "JogForward" and "JogBackward" are set to TRUE, the axis is braked at the last valid deceleration. The error 16#8007 (incorrect direction specification) is output.

Note

Response to a change in the override

If the velocity/speed is influenced during constant motion by a change in the override (<TO>.Override.Velocity), the "InVelocity" parameter is reset during the acceleration or deceleration. When the newly calculated velocity is reached ("Velocity" × "Override" %), then "InVelocity" is set again.

Additional information

An option for the evaluation of the individual status bits can be found in the section "Evaluating StatusWord, ErrorWord and WarningWord" (Page 359).

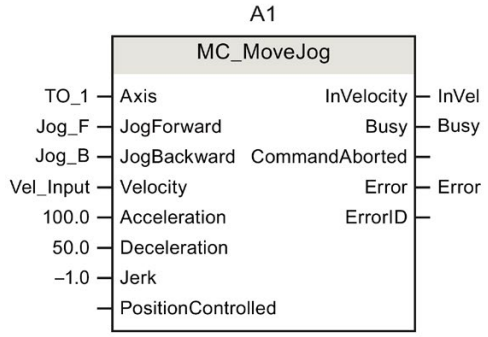
See also

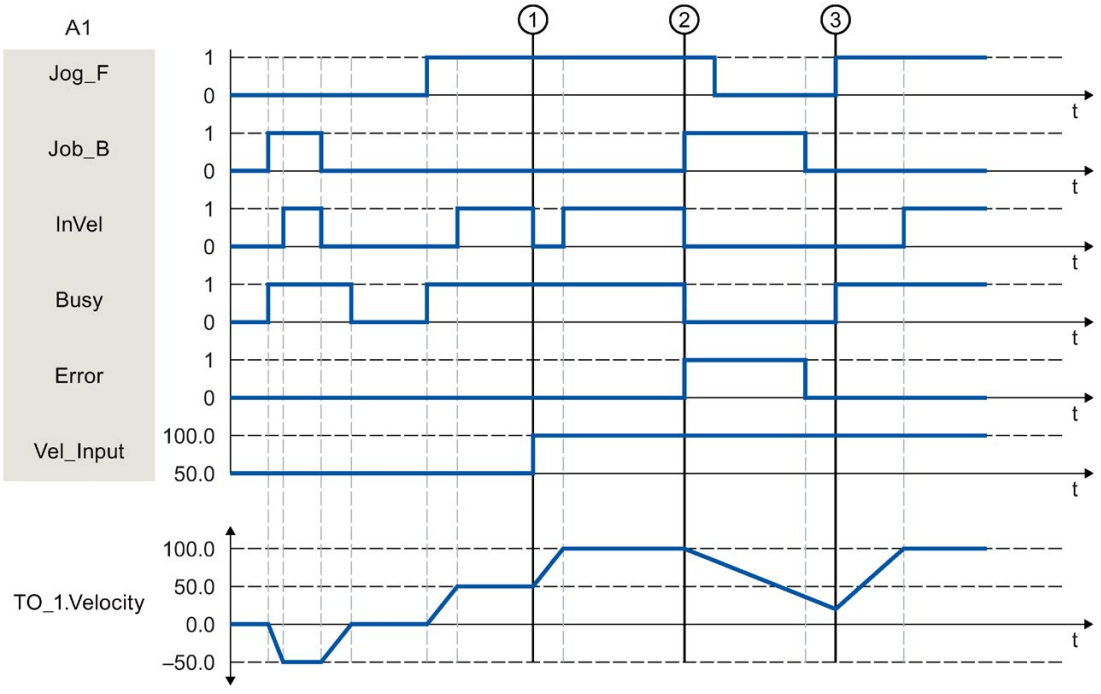
Override response V4: Homing and motion jobs (Page 536)

Error ID for Motion Control instructions (Page 652)

10.8.2 MC_MoveJog: Function chart V4

Function chart: Moving an axis in jog mode





The axis is moved in the negative direction in jog mode via "Jog_B". When the velocity setpoint -50.0 is reached, this is signaled via "InVel" = TRUE. After "Jog_B" is reset, the axis is braked and brought to a standstill. Then the axis is moved in the positive direction via "Jog_F". When the velocity setpoint 50.0 is reached, this is signaled via "InVel" = TRUE.

At time ①, if "Jog_F" is set, the velocity setpoint is changed to 100.0 by means of "Vel_Input". Alternatively, you can also change the velocity setpoint using the velocity override. "InVel" is reset. Axis is being accelerated. When the new velocity setpoint 100.0 is reached, this is signaled via "InVel" = TRUE.

If "Jog_F" is set, "Jog_B" is likewise set at time ②. If both "Jog_F" and "Jog_B" are set, then the axis is braked with the last applicable deceleration. An error is indicated via "Error", and the "ErrorID" of the error 16#8007 (incorrect direction specification) is output.

This error is resolved by resetting the two inputs "Jog_F" and "Jog_B".

During the braking ramp, "Jog_F" is set at time ③. The axis is accelerated to the last configured velocity. When the velocity setpoint 100.0 is reached, this is signaled via "InVel" = TRUE.

10.9 MC_MoveSuperimposed V4

10.9.1 MC_MoveSuperimposed: Position axes overlapping V4

Description

With the Motion Control instruction "MC_MoveSuperimposed", you start a relative positioning motion that is superimposed on a active basic motion.

You define the dynamic behavior of the motion with parameters "VelocityDiff", "Jerk", "Acceleration" and "Deceleration" . The dynamic values are added to the values of the basic motion. The duration of the basic motion is not extended by a superimposed motion.

The dynamics of the total axis motion is the sum of the dynamic values of the basic motion and the superimposed motion.

The behavior of the total motion depends on the type of basic motion:

- The basic motion is a single-axis motion:
  - The maximum dynamics of the superimposed motion is the difference between the current dynamic values of the basic motion and the dynamic limits.
  - The entire motion is limited to the configured dynamic limits.
- The basic motion is a synchronous motion:
  - The maximum dynamics of the superimposed motion is the difference between the current dynamic values of the basic motion and the dynamic limits.
  - The synchronous motion of the following axis is not limited to the dynamic limits of the following axis.
  - An "MC_MoveSuperimposed" job on a leading axis in synchronous operation affects the leading axis and the following axis.
  - An "MC_MoveSuperimposed" job on a following axis in synchronous operation only affects the following axis.

It is always the dynamics of the total motion that is displayed in the technology data block and in the TIA Portal.

Applies to

- Synchronous axis
- Positioning axis

Requirement

- The technology object has been configured correctly.
- The technology object is enabled.

Override response

The override response for "MC_MoveSuperimposed" jobs is described in section Override response V4: Homing and motion jobs (Page 536).

Parameters

The following table shows the parameters of Motion Control instruction "MC_MoveSuperimposed":

Parameters	Declaration	Data type	Default value	Description	
Axis	INPUT	TO_PositioningAxis	-	Axis technology object	
Execute	INPUT	BOOL	FALSE	TRUE	Start job with a positive edge
Distance	INPUT	LREAL	0.0	Additional distance for the overlapping positioning process (negative or positive)	
VelocityDiff	INPUT	LREAL	-1.0	Maximum velocity deviation compared to the active motion	
				> 0.0	The specified value is used.
				= 0.0	Not permitted
				< 0.0	The velocity configured in "Technology object > Configuration > Extended parameters > Dynamic defaults" is used. (<TO>.DynamicDefaults.Velocity)
Acceleration	INPUT	LREAL	-1.0	Acceleration	
				> 0.0	The specified value is used.
				= 0.0	Not permitted
				< 0.0	The acceleration configured in "Technology object > Configuration > Extended parameters > Dynamic defaults" is used. (<TO>.DynamicDefaults.Acceleration)
Deceleration	INPUT	LREAL	-1.0	Deceleration	
				> 0.0	The specified value is used.
				= 0.0	Not permitted
				< 0.0	The deceleration configured in "Technology object > Configuration > Extended parameters > Dynamic defaults" is used. (<TO>.DynamicDefaults.Deceleration)
Jerk	INPUT	LREAL	-1.0	Jerk	
				> 0.0	Constant-acceleration velocity profile; the specified jerk is used
				= 0.0	Trapezoid velocity profile
				< 0.0	The jerk configured in "Technology object > Configuration > Extended parameters > Dynamic defaults" is used. (<TO>.DynamicDefaults.Jerk)

Parameters	Declaration	Data type	Default value	Description	
Done	OUTPUT	BOOL	FALSE	TRUE	Superimposed positioning complete
Busy	OUTPUT	BOOL	FALSE	TRUE	Job is running.
CommandAborted	OUTPUT	BOOL	FALSE	TRUE	The job was aborted by another job during execution.
Error	OUTPUT	BOOL	FALSE	TRUE	An error occurred while processing the job. The job is rejected. The cause of the error can be found in the "ErrorID" parameter.
ErrorID	OUTPUT	WORD	0	Error ID (Page 652) for parameter "ErrorID"	

Starting superimposed positioning motion

To start a superimposed positioning motion with Motion Control instruction "MC_MoveSuperimposed", follow these steps:

1. Check the requirements indicated above.
2. Specify the additional distance to be moved in the "Distance" parameter.
3. Start the "MC_MoveSuperimposed" job with a positive edge at parameter "Execute".

The current motion state is indicated in "Busy", "Done" and "Error".

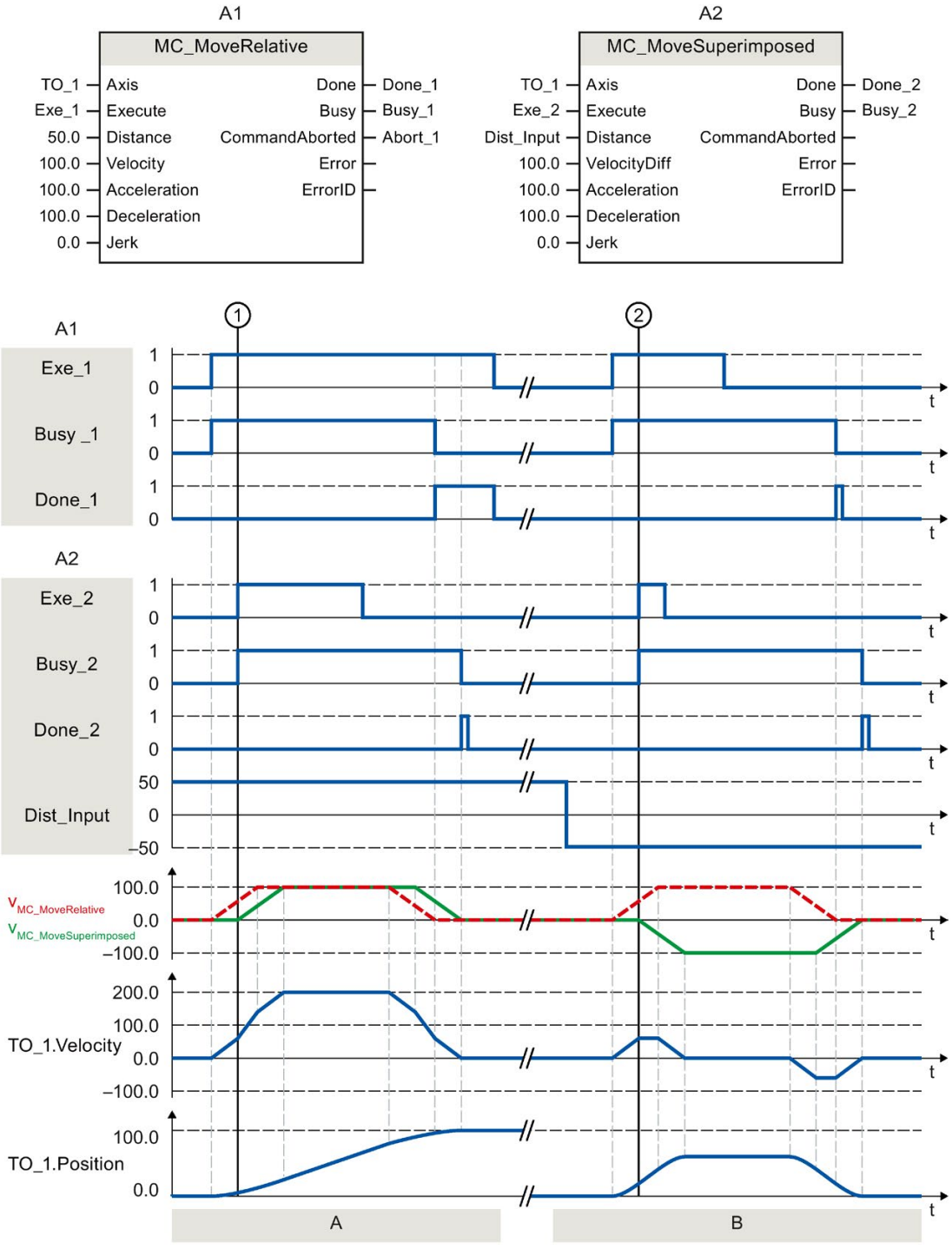
See also

Override response V4: Homing and motion jobs (Page 536)

Error ID for Motion Control instructions (Page 652)

10.9.2 MC_MoveSuperimposed: Function chart V4

Function chart: Positioning axes overlapping



Section A	Using "Exe_1", an "MC_MoveRelative" job with a distance of 50.0 is initiated. At time ①, using "Exe_2", an MC_MoveSuperimposed job with a distance of 50.0 is initiated. The axis is moved with the added dynamic values of both jobs by the distance 50 + 50 = 100.0. When the axis reaches the target position, this is signaled via "Done_2".
Section B	Using "Exe_1", an "MC_MoveRelative" job with a distance of 50.0 is initiated. At time ②, using "Exe_2", a MC_MoveSuperimposed job with a distance of -50.0 is initiated. The axis reverses and is moved with the added dynamic values of both jobs by the distance 50.0 - 50.0 = 0.0. When the axis reaches the target position, this is signaled via "Done_2".

10.10 MC_SetSensor V4

10.10.1 MC_SetSensor: Set alternative encoder as operationally active encoder V4

Description

With the Motion Control instruction "MC_SetSensor", you switch over the encoder for closed loop position control of the axis.

The actual value of the addressed encoder can be adapted without switchover using parameter "Mode" 2 and 3.

Applies to

- Synchronous axis
- Positioning axis

Requirement

- The technology object and the alternative encoder have been configured correctly.
- No restart command and no MC-Home job running.

Override response

- An "MC_SetSensor" job is not aborted by any other Motion Control job.
- A new "MC_SetSensor" job does not abort any active motion control jobs.

Parameters

The following table shows the parameters of Motion Control instruction "MC_SetSensor":

Parameters	Declaration	Data type	Default value	Description	
Axis	INPUT	TO_PositioningAxis	-	Technology object	
Execute	INPUT	BOOL	FALSE	TRUE	Start job with a positive edge
Sensor	INPUT	INT	1	Number of the new encoder (1 to 4).	
Mode	INPUT	DINT	0	The mode determines the position alignment between the old encoder and new encoder.	
				0	Switch over encoder and transfer current position to the new encoder With this encoder switchover, step changes in the positioning control are prevented. Bumpless switchover of the encoders is possible.
				1	Switch over encoder without aligning the actual position **Note** When closed loop position control is active, an additional difference of the two encoders acts as additional control deviation and can trigger a compensating motion.
				2	Transfer actual value The current actual value is transferred to the encoder specified in the "Sensor" parameter.
				3	Transfer actual value The actual position of the "Reference encoder" ("ReferenceSensor" parameter) is transferred to the encoder specified in the "Sensor" parameter.
ReferenceSensor	INPUT	INT	1	Number of the reference encoder (see parameter "Mode" = 3)	
Done	OUTPUT	BOOL	FALSE	TRUE	Encoder for closed loop position control of the axis was switched over.
Busy	OUTPUT	BOOL	FALSE	TRUE	Job is running.
CommandAborted	OUTPUT	BOOL	FALSE	TRUE	The job has been aborted.
Error	OUTPUT	BOOL	FALSE	TRUE	An error occurred during execution of the job. The job is rejected. The cause of the error can be found in the "ErrorID" parameter.
ErrorID	OUTPUT	WORD	16#0000	Error ID (Page 652) for parameter "ErrorID"	

Changing to absolute encoder

When you switch the encoder to an absolute encoder and transfer the actual value (Mode = 2, 3), the actual value is calculated with the value of the absolute encoder and the absolute value offset. When switching to a different encoder, calculation of the actual value is canceled. The absolute encoder once again returns the absolute value + absolute value offset (<TO>.StatusSensor[n].AbsEncoderOffset) without calculation by the "MC_SetSensor" job.

See also

Error ID for Motion Control instructions (Page 652)

Using multiple encoders (Page 49)

10.11 Measuring input, output cam, cam track

10.11.1 MC_MeasuringInput V4

10.11.1.1 MC_MeasuringInput: Start measuring once V4

Description

With the Motion Control instruction "MC_MeasuringInput", a one-time measuring is started.

With the one-time measuring, one or two edges can be detected with one measuring job. The position of the respective technology object axis or external encoder is assigned to the measuring event. The measurement result is indicated in the function block and in the technology data block and can be further processed in the user program. This completes the measuring job.

Another measuring job must be started again using "MC_MeasuringInput.Execute" = TRUE.

Applies to

- Measuring input

Requirement

- The technology object has been configured correctly.
- The encoder of the axis must have "valid" status (StatusSensor[1..4].State = valid). Otherwise, the measuring job is rejected in the function block with an error indication.
- Measuring using PROFIdrive is not possible during active or passive homing.

Override response

The override response for "MC_MeasuringInput" jobs is described in section Override response V4: Measuring input jobs (Page 538).

Parameters

The following table shows the parameters of Motion Control instruction "MC_MeasuringInput":

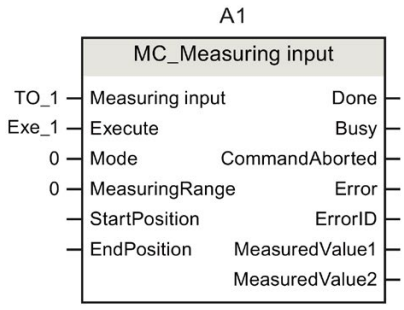
Parameters	Declaration	Data type	Default value	Description	
MeasuringInput	INPUT	TO_MeasuringInput	-	Technology object	
Execute	INPUT	BOOL	FALSE	TRUE	Start job with a positive edge
Mode	INPUT	DINT	0	Type of measurement	
				0	Measurement of next positive edge
				1	Measurement of next negative edge
				2	Measurement of next two edges
				3	Measurement of two edges, beginning with the positive edge • Rising edge = "MeasuredValue1" (measured value 1) • Falling edge = "MeasuredValue2" (measured value 2)
				4	Measurement of two edges, beginning with the negative edge • Falling edge = "MeasuredValue1" • Rising edge = "MeasuredValue2"
MeasuringRange	INPUT	BOOL	FALSE	Acquisition of measured values Observe the time-related boundary conditions (Page 142).	
				FALSE	Always acquire measured values
				TRUE	Acquire measured values only within the measuring range
StartPosition	INPUT	LREAL	0.0	Start position of the measuring range For an axis or external encoder with active modulo function, position data outside the modulo range is mirrored in the modulo range.	
EndPosition	INPUT	LREAL	0.0	End position of the measuring range For an axis or external encoder with active modulo function, position data outside the modulo range is mirrored in the modulo range.	
Done	OUTPUT	BOOL	FALSE	TRUE	The block has been completely processed. Measured values are valid.
Busy	OUTPUT	BOOL	FALSE	TRUE	Job is running.
CommandAborted	OUTPUT	BOOL	FALSE	TRUE	The measuring job has been aborted.
Error	OUTPUT	BOOL	FALSE	TRUE	An error occurred while processing the job. The cause of the error can be found in the "ErrorID" parameter.
ErrorID	OUTPUT	WORD	16#0000	Error ID (Page 652) for parameter "ErrorID"	
MeasuredValue1	OUTPUT	LREAL	0.0	First measured value	
MeasuredValue2	OUTPUT	LREAL	0.0	Second measured value (for measurement of two edges)	

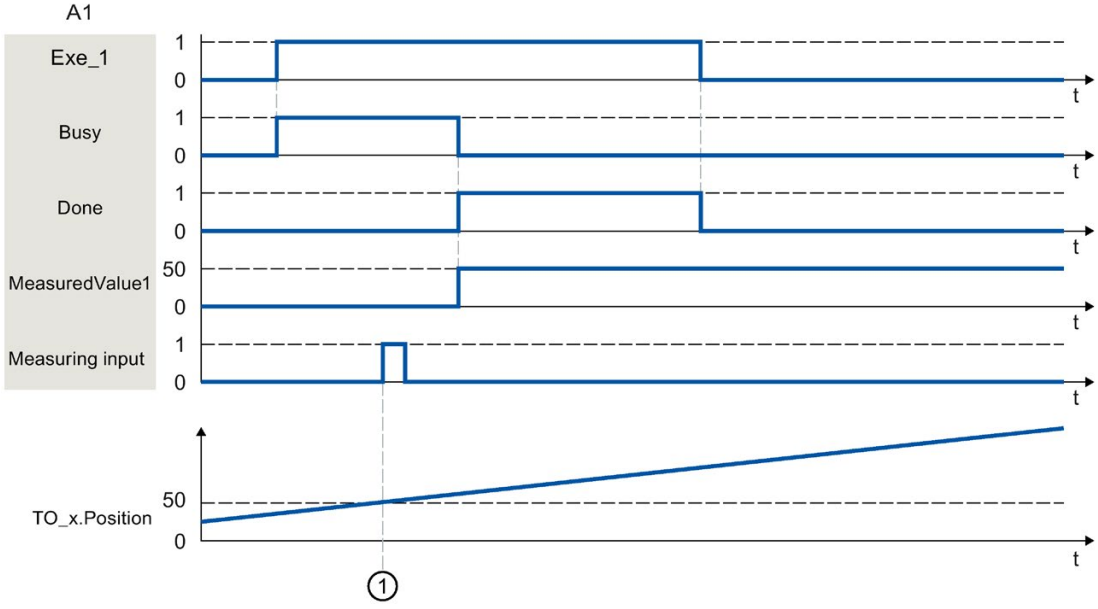
See also

Time-related boundary conditions (Page 142)
Error ID for Motion Control instructions (Page 652)
One-time measurement (Page 136)
Override response V4: Measuring input jobs (Page 538)

10.11.1.2 MC_MeasuringInput: Function chart V4

Function chart: Start measuring job once





A "MC_MeasuringInput" job with "Mode" = 0 initiated using "Execute" performs a measurement of the next positive edge. A successfully completed measurement is signaled with "Done" = TRUE. The determined measured value ① (in example: 50) is output using "MeasuredValue1".

10.11.2 MC_MeasuringInputCyclic V4

10.11.2.1 MC_MeasuringInputCyclic: Start cyclic measuring V4

Description

With the Motion Control instruction "MC_MeasuringInputCyclic", a cyclic measuring is started.

With cyclic measuring, up to two measuring events are detected by the system and the associated measuring positions displayed. The measurements are continued cyclically until they are ended per command.

Applies to

- Measuring input

Requirement

- The technology object has been configured correctly.
- Cyclic measuring is only possible when measuring using TM Timer DIDQ.
- The operationally active encoder of the axis must have "valid" status (StatusSensor[1..4].State = valid). Otherwise, the measuring job is rejected in the function block with an error indication.

Override response

The override response for "MC_MeasuringInputCyclic" jobs is described in section Override response V4: Measuring input jobs (Page 538).

Parameters

The following table shows the parameters of Motion Control instruction "MC_MeasuringInputCyclic":

Parameters	Declaration	Data type	Default value	Description	
MeasuringInput	INPUT	TO_Measuring-Input	-	Technology object	
Execute	INPUT	BOOL	FALSE	TRUE	Start job with a positive edge
Mode	INPUT	DINT	0	Type of measurement	
				0	Measurement of positive edges
				1	Measurement of negative edges
				2	Measurement of both edges

Parameters	Declaration	Data type	Default value	Description	
MeasuringRange	INPUT	BOOL	FALSE	Acquisition of measured values Observe the time-related boundary conditions (Page 142).	
				FALSE	Always acquire measured values
				TRUE	Acquire measured values only within the measuring range
StartPosition	INPUT	LREAL	0.0	Start position of the measuring range For an axis or external encoder with active modulo function, position data outside the modulo range is mirrored in the modulo range.	
EndPosition	INPUT	LREAL	0.0	End position of the measuring range For an axis or external encoder with active modulo function, position data outside the modulo range is mirrored in the modulo range.	
Busy	OUTPUT	BOOL	FALSE	TRUE	Job is running.
CommandAborted	OUTPUT	BOOL	FALSE	TRUE	The measuring job has been aborted.
Error	OUTPUT	BOOL	FALSE	TRUE	An error occurred while processing the job. The cause of the error can be found in the "ErrorID" parameter.
ErrorID	OUTPUT	WORD	16#0000	Error ID (Page 652) for parameter "ErrorID"	
MeasuredValue1	OUTPUT	LREAL		First measured value	
MeasuredValue2	OUTPUT	LREAL		Second measured value (when measuring multiple edges in one position control cycle)	
MeasuredValue1Counter	OUTPUT	UDINT	0	Count value for the first measured value	
MeasuredValue2Counter	OUTPUT	UDINT	0	Count value for the second measured value	
LostEdgeCounter1	OUTPUT	UDINT	0	Count value for the lost edges in the cycle clock of the first measured value acquisition	
LostEdgeCounter2	OUTPUT	UDINT	0	Count value for the lost edges in the cycle clock of the second measured value acquisition	

See also

Time-related boundary conditions (Page 142)

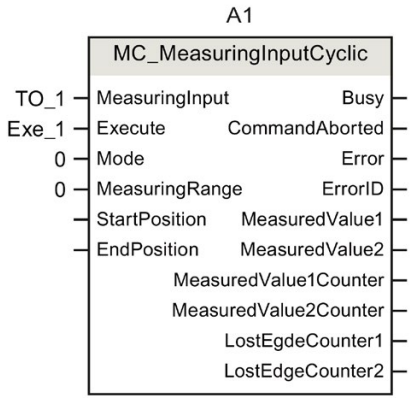
Error ID for Motion Control instructions (Page 652)

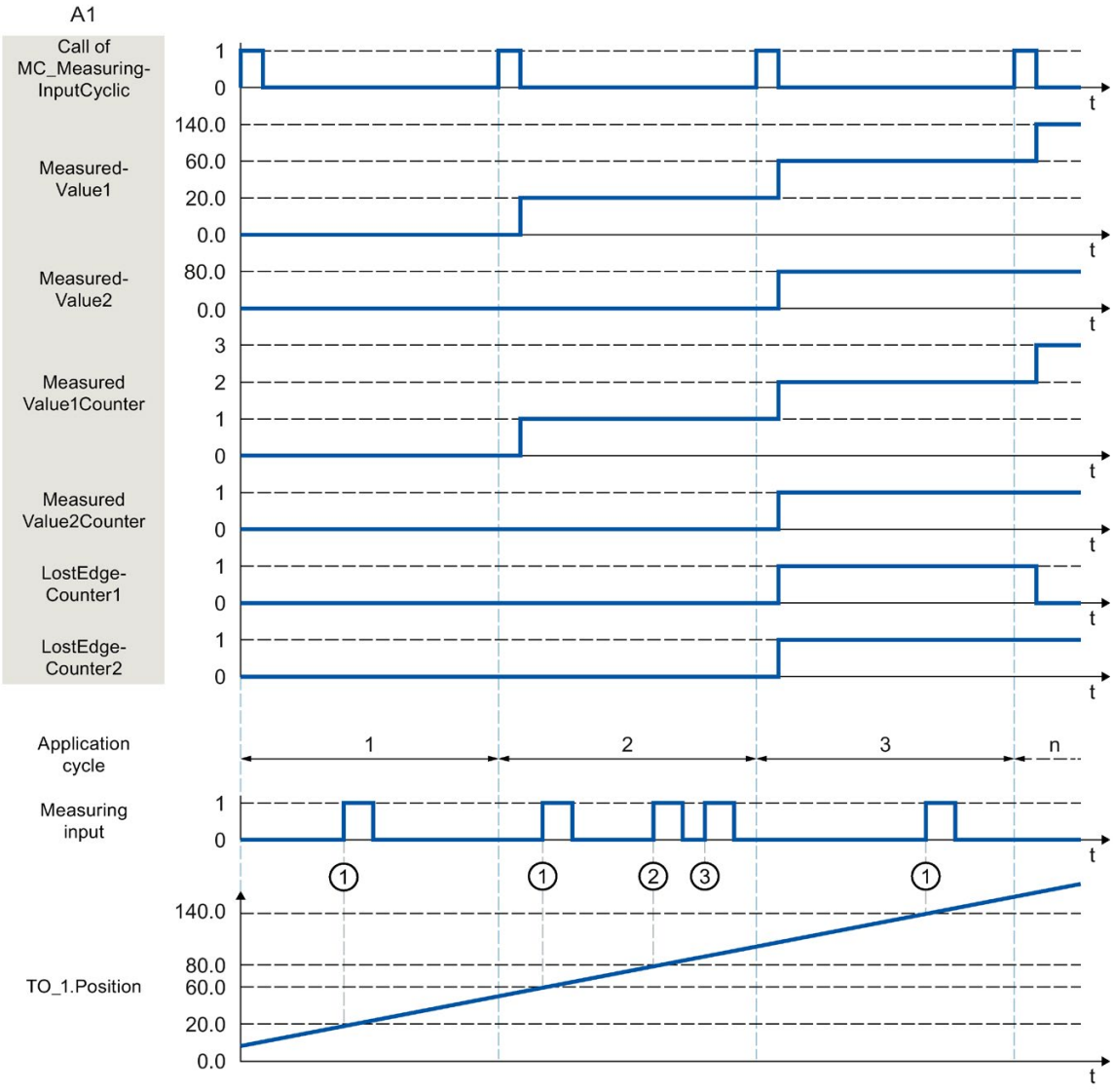
Cyclic measuring (Page 137)

Override response V4: Measuring input jobs (Page 538)

10.11.2.2 MC_MeasuringInputCyclic: Function chart V4

Function chart: Start cyclic measuring job





A "MC_MeasuringInputCyclic" command initiated using "Execute" (signal and start point not shown) (e.g. call in MC-PreServo [OB67]) with "Mode" = 0 and without specified measuring range "MeasuringRange" = FALSE performs a measurement of the positive edges. By calling the Motion Control instruction "MC_MeasuringInputCyclic" in MC-PreServo [OB67] or MC-PreServo [OB67], the measuring command as well as the measurement itself is called in the same application cycle.

The actual position determined at the time of the first positive edge ① in the position control cycle is output using "MeasuredValue1", and count tag "MeasuredValue1Counter" is incremented by "1".

The actual position determined at the time of the second positive edge ② in the position control cycle is output using "MeasuredValue2", and count tag "MeasuredValue2Counter" is incremented by "1".

If additional positive edges occur in the same position control cycle ③, these are recorded in LostEdgeCounter1 and LostEdgeCounter2.

10.11.3 MC_AbortMeasuringInput V4

10.11.3.1 MC_AbortMeasuringInput: Abort active measuring V4

Description

With the Motion Control instruction "MC_AbortMeasuringInput", an active one-time or cyclic measuring job is aborted.

Applies to

- Measuring input

Requirement

- The technology object has been configured correctly.

Override response

The override response for "MC_AbortMeasuringInput" jobs is described in section Override response V4: Measuring input jobs (Page 538).

Parameters

The following table shows the parameters of Motion Control instruction "MC_AbortMeasuringInput":

Parameters	Declaration	Data type	Default value	Description	
MeasuringInput	INPUT	TO_MeasuringInput	-	Technology object	
Execute	INPUT	BOOL	FALSE	TRUE	Start job with a positive edge
Done	OUTPUT	BOOL	0	The function block has been processed. The measuring job has been deactivated.	
Busy	OUTPUT	BOOL	FALSE	TRUE	Job is running.
CommandAborted	OUTPUT	BOOL	FALSE	TRUE	The job has been aborted.
Error	OUTPUT	BOOL	FALSE	TRUE	An error occurred while processing the job. The cause of the error can be found in the "ErrorID" parameter.
ErrorID	OUTPUT	WORD	16#0000	Error ID (Page 652) for parameter "ErrorID"	

See also

Error ID for Motion Control instructions (Page 652)

Override response V4: Measuring input jobs (Page 538)

Technology object measuring input (Page 133)

10.11.4 MC_OutputCam V4

10.11.4.1 MC_OutputCam: Activate/deactivate cam V4

Description

You use Motion Control instruction "MC_OutputCam" to activate the specified cam.

Depending on the cam type, the following input parameters are in effect:

- Distance output cam
  - "OnPosition"
  - "OffPosition"
- Time-based output cam
  - "OnPosition"
  - "Duration"

You define the operating mode and the effective direction of the cam with parameters "Mode" and "Direction".

When "MC_OutputCam.Enable" = TRUE, the input parameters are always read and take effect at the next position control cycle.

When a technological alarm occurs, the cam is processed again after error acknowledgment.

Applies to

- Output cam

Requirement

- The technology object has been configured correctly.
- The higher-level technology object must have a valid position.
- Setpoint output cams are not output for an axis in non-position-controlled operation.
- A setpoint output cam with the setting "MC_OutputCam.OnPosition" = 0 switches at position setpoint = 0.

Override response

The "MC_OutputCam" is canceled by:

- Disabling of the cam with "MC_OutputCam.Enable" = FALSE
- Only one instance of the "MC_OutputCam" function block can be active on an output cam in the user program. A second instance of the "MC_OutputCam" function block on a currently active output cam is rejected with an error.

Parameters

The following table shows the parameters of Motion Control instruction "MC_OutputCam":

Parameters	Declaration	Data type	Default value	Description	
OutputCam	INPUT	TO_OutputCam	-	Technology object	
Enable	INPUT	BOOL	FALSE	FALSE	Cam is disabled
				TRUE	Cam is being processed
OnPosition	INPUT	LREAL	0.0	Start position of the cam [unit of measurement of the interconnected technology object] For an axis or external encoder with active modulo function, position data outside the modulo range is mirrored in the modulo range.	
OffPosition	INPUT	LREAL	0.0	End position of the distance output cam [unit of measurement of the interconnected technology object] For an axis or external encoder with active modulo function, position data outside the modulo range is mirrored in the modulo range.	
Duration	INPUT	LREAL	0.0	Switch-on duration of the time-based output cam [unit of measurement: ms] The value for the switch-on duration of a time-based output cam must be greater than 0.0.	
Mode	INPUT	DINT	1	Operating mode	
				1	Standard Cam functionality (output not inverted)
				2	Cam functionality with inverted output
				3	Cam always ON (while "Enable" = TRUE)
Direction	INPUT	DINT	1	Activation direction of the cam	
				1	Positive direction
				2	Negative direction
				3	Both directions
CamOutput	OUTPUT	BOOL	-	Status display based on last call of Motion Control instruction "MC_OutputCam"	
Busy	OUTPUT	BOOL	FALSE	TRUE	Processing of the cam is active.
Error	OUTPUT	BOOL	FALSE	TRUE	An error occurred while processing the job. The cause of the error can be found in the "ErrorID" parameter.
ErrorID	OUTPUT	WORD	16#0000	Error ID (Page 652) for parameter "ErrorID"	

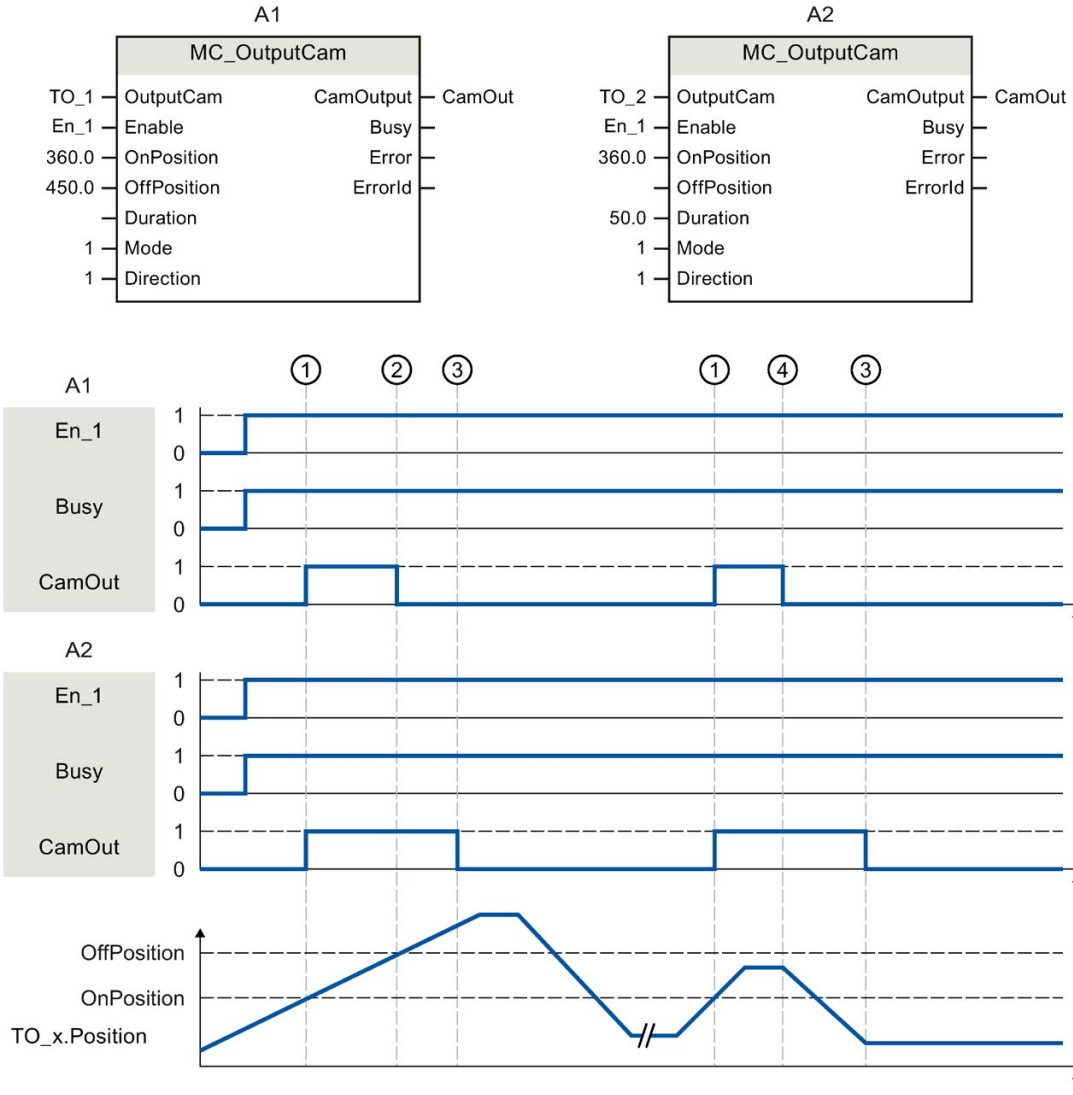
See also

Error ID for Motion Control instructions (Page 652)

Technology object output cam (Page 146)

10.11.4.2 MC_OutputCam: Function chart V4

Function chart: Activate the specified cam type



A1 Distance output cam
A2 Time-based output cam

A cam is activated with "Enable" = TRUE. The cam is output corresponding to the parameters.

The processing of the cam is indicated with "Busy" = TRUE.

When activation direction "Direction" = 1 (positive) is set, the cam behaves as follows, regardless of the cam type setting:

- The distance output cam switches on at "OnPosition" ① and switches off again at "OffPosition" ②. At a direction reversal the cam is switched off ④.
- The time-based output cam switches on at "OnPosition" ① and switches off again after expiration of the specified time "Duration" ③. A switched on time-based output cam remains active for the specified switch-on duration "Duration", even if overtravel of the start position occurs again in the reverse direction.

The switching state of the cam is output using "CamOutput".

With "Enable" = FALSE, the specified cam type is deactivated. "Busy" = FALSE shows that the cam is not being processed.

10.11.5 MC_CamTrack V4

10.11.5.1 MC_CamTrack: Activate/deactivate cam track V4

Description

With the Motion Control instruction "MC_CamTrack", the processing of a cam track is enabled.

Applies to

- Cam track

Requirement

- The technology object has been configured correctly.
- The higher-level technology object must have a valid position.
- Setpoint output cams are not output for an axis in non-position-controlled operation.

Override response

- The "MC_CamTrack" is aborted by the disabling of the cam track with "MC_CamTrack.Enable" = FALSE.
- Only one instance of the "MC_CamTrack" function block can be active on a cam track in the user program. A second instance of the "MC_CamTrack" function block on a currently active cam track is rejected with an error.
- The cam track is recalculated at a change of the parameters of the Motion Control instruction "MC_CamTrack" or in the technology data block. The cam track is processed in accordance with all parameter settings.

Parameters

The following table shows the parameters of Motion Control instruction "MC_CamTrack":

Parameters	Declaration	Data type	Default value	Description	
CamTrack	INPUT	TO_CamTrack	-	Technology object	
Enable	INPUT	BOOL	FALSE	TRUE	Cam track is processed
				FALSE	Cam track is disabled
Mode	INPUT	INT	1	0	When "Enable" = TRUE: Cam track processing is activated immediately Cam track data takes effect immediately Previously activated distance output cams are aborted if their track signal is not still set due to the changed cam track data. Previously activated time-based output cams are always aborted.
					When "Enable" = FALSE: Cam track processing is stopped immediately, distance output/time-based output cams are aborted immediately.
				1	When "Enable" = TRUE: Cam track processing is activated immediately/ with the next track cycle: • When a cam track is activated for the first time, the cam track processing begins immediately. • If the cam track processing is already active, the current cam track is output up to the end of the track cycle. The new cam track data then takes effect.
					When "Enable" = FALSE: Cam track processing is ended at the end of the cam track
				2	When "Enable" = TRUE: Cam track output is switched on immediately and remains switched on
					When "Enable" = FALSE: Cam track output is switched off immediately

Parameters	Declaration	Data type	Default value	Description	
InvertOutput	INPUT	BOOL	FALSE	Inverted output	
				TRUE	Track output is output inverted
				FALSE	Track output is output not inverted
TrackOutput	OUTPUT	BOOL	-	Indicates the switching state of the cam track.	
Busy	OUTPUT	BOOL	FALSE	TRUE	Processing of the cam track is active.
Error	OUTPUT	BOOL	FALSE	TRUE	An error occurred while processing the job. The cause of the error can be found in the "ErrorID" parameter.
ErrorID	OUTPUT	WORD	16#0000	Error ID (Page 652) for parameter "ErrorID"	

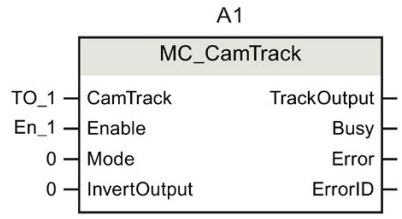
See also

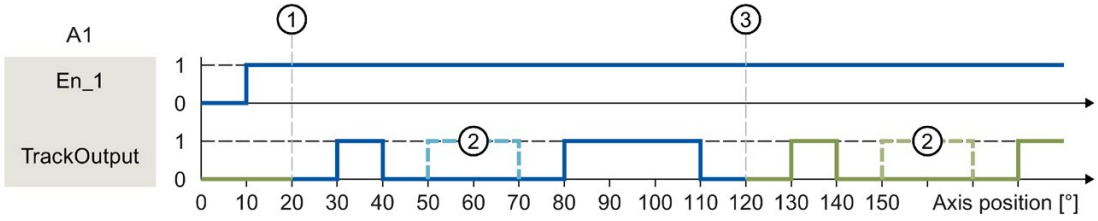
Error ID for Motion Control instructions (Page 652)

Cam track technology object (Page 161)

10.11.5.2 MC_CamTrack: Function chart V4

Function chart: Activate cam track





① Axis reference position
② Cam configured as invalid
③ Start of cyclically continued cam track

A cam track is activated with "Enable" = TRUE. The cam track is output in accordance with the parameters set in the technology data block.

Tag		Value	Description
<TO>Parameter.			
	CamTrackType	0	Specified cam type for the cam track is distance output cam
	ReferencePosition	20.0	Specified axis reference position for the cam track
	CamTrackLength	100.0	Specified length of the cam track
	CamTrack[1].Existent	TRUE	The first distance output cam of the cam track is specified as valid
	CamTrack[1].OnPosition	10.0	Start position for the first cam of the cam track
	CamTrack[1].OffPosition	20.0	End position for the first cam of the cam track
	CamTrack[2].Existent	FALSE	The second distance output cam of the cam track is specified as invalid
	CamTrack[2].OnPosition	30.0	Start position for the second cam of the cam track
	CamTrack[2].OffPosition	50.0	End position for the second cam of the cam track
	CamTrack[3].Existent	TRUE	The third distance output cam of the cam track is specified as valid
	CamTrack[3].OnPosition	60.0	Start position for the third cam of the cam track
	CamTrack[3].OffPosition	90.0	End position for the third cam of the cam track

10.12 Synchronous motion

10.12.1 MC_GearIn V4

10.12.1.1 MC_GearIn: Start gear synchronization V4

Description

With the Motion Control instruction "MC_GearIn", you start a gearing (Page 118) operation between a leading axis and a following axis.

You define the dynamic behavior of the following axis for synchronization with parameters "Jerk", "Acceleration" and "Deceleration".

The synchronization duration and distance are dependent on the following parameters:

- Start time of the "MC_GearIn" job
- Dynamics of the following axis at the start time
- Dynamic settings for synchronization
- Dynamics of the leading axis

You specify the gear ratio as the relationship between two integers (numerator/denominator) with the parameters "RatioNumerator" and "RatioDenominator".

The numerator of the gear ratio is specified as positive or negative. This yields the following behavior:

- **Positive gear ratio:**

  The leading and following axes move in the same direction.
- **Negative gear ratio**:

  The following axis moves in the opposite direction of the leading axis.

You can start synchronous operation when the leading axis is at a standstill or when it is in motion.

Applies to

- Synchronous axis

Requirement

- The technology objects of the leading axis and the following axis have been configured correctly.
- The leading axis is a positioning axis, synchronous axis, or external encoder.
- The following axis is a synchronous axis.
- The leading axis is specified as possible leading axis in the configuration of the following axis in "Technology object > Configuration > Leading value interconnections".
- The following axis is enabled.

Override response

The override response for "MC_GearIn" jobs is described in section Override response V4: Synchronous operation jobs (Page 537).

Disabling the following axis with "MC_Power.Enable" = FALSE aborts the synchronous operation in every status.

Disabling the leading axis with "MC_Power", in contrast, does not abort synchronous operation. The following axis follows the leading axis even during the braking ramp and after the leading axis is enabled again.

Parameters

The following table shows the parameters of Motion Control instruction "MC_GearIn":

Parameters	Declaration	Data type	Default value	Description	
Master	INPUT	TO_Axis	-	Leading axis technology object	
Slave	INPUT	TO_SynchronousAxis	-	Following axis technology object	
Execute	INPUT	BOOL	FALSE	TRUE	Start job with a positive edge
RatioNumerator	INPUT	DINT	1	Gear ratio numerator Permitted integer values: -2147483648 to 2147483648 (value 0 not permitted)	
RatioDenominator	INPUT	DINT	1	Gear ratio denominator Permitted integer values: 1 to 2147483648	
Acceleration	INPUT	LREAL	-1.0	Acceleration	
				> 0.0	The specified value is used.
				= 0.0	Not permitted
				< 0.0	The acceleration configured in "Technology object > Configuration > Extended parameters > Dynamic defaults" is used. (<TO>.DynamicDefaults.Acceleration)
Deceleration	INPUT	LREAL	-1.0	Deceleration	
				> 0.0	The specified value is used.
				= 0.0	Not permitted
				< 0.0	The deceleration configured in "Technology object > Configuration > Extended parameters > Dynamic defaults" is used. (<TO>.DynamicDefaults.Deceleration)
Jerk	INPUT	LREAL	-1.0	Jerk	
				> 0.0	Constant-acceleration velocity profile; the specified jerk is used
				= 0.0	Trapezoid velocity profile
				< 0.0	The jerk configured in "Technology object > Configuration > Extended parameters > Dynamic defaults" is used. (<TO>.DynamicDefaults.Jerk)

Parameters	Declaration	Data type	Default value	Description	
InGear	OUTPUT	BOOL	FALSE	TRUE	Synchronous operation reached The following axis is synchronized and moves synchronously to the leading axis.
Busy	OUTPUT	BOOL	FALSE	TRUE	Job is running.
CommandAborted	OUTPUT	BOOL	FALSE	TRUE	The job was aborted by another job during execution.
Error	OUTPUT	BOOL	FALSE	TRUE	An error occurred while processing the job. The job is rejected. The cause of the error can be found in the "ErrorID" parameter.
ErrorID	OUTPUT	WORD	0	Error ID (Page 652) for parameter "ErrorID"	

Starting synchronous operation

To start synchronous operation with the Motion Control instruction "MC_GearIn", follow these steps:

1. Check the requirements indicated above.
2. Specify the leading axis, the following axis and the gear ratio at the corresponding parameters.
3. Start the "MC_GearIn" job with a positive edge at parameter "Execute".

The following axis is synchronized to the leading value of the leading axis. If the "InGear" parameter shows the value TRUE, the following axis is synchronized and moves synchronously to the leading axis. The parameters "InGear" and "Busy" show the value TRUE until the "MC_GearIn" job is overridden by another Motion Control job.

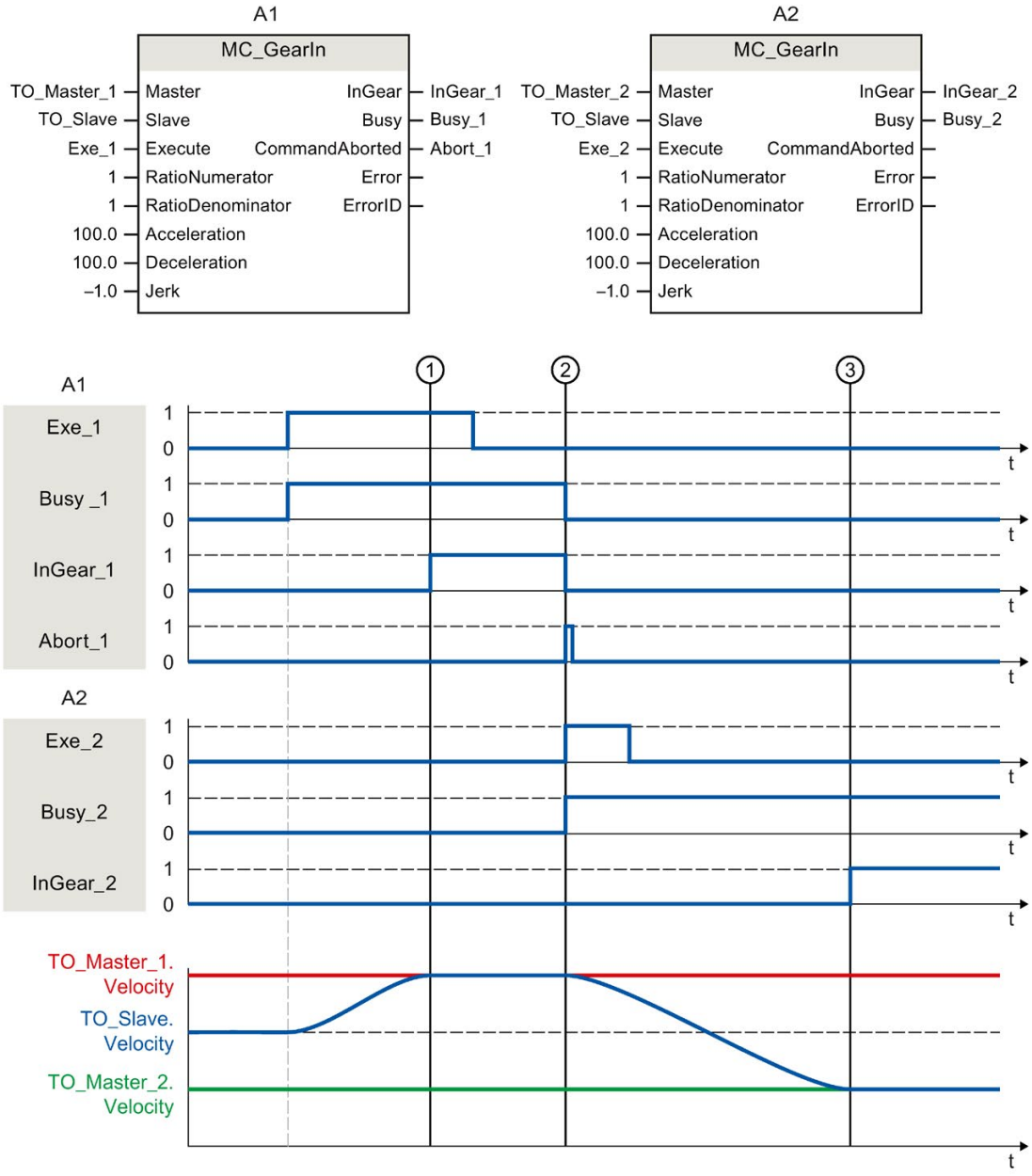
See also

Error ID for Motion Control instructions (Page 652)

Override response V4: Synchronous operation jobs (Page 537)

10.12.1.2 MC_GearIn: Function chart V4

Function chart: Synchronizing and switching the leading value



Using "Exe_1", an "MC_GearIn" job (A1) is initiated. The following axis (TO_Slave) is synchronized to the leading axis (TO_Master_1). "InGear_1" signals at time ① that the following axis is synchronized and moves synchronously to the leading axis.

At time ②, synchronous operation is overridden by another "MC_GearIn" job (A2). The abort is signaled via "Abort_1". The following axis is synchronized to the new leading axis (TO_Master_2). "InGear_2" signals at time ③ that the following axis is synchronized and moves synchronously to the leading axis.

10.12.2 MC_GearInPos V4

10.12.2.1 MC_GearInPos: Start gearing with specified synchronous positions V4

Description

With the Motion Control instruction "MC_GearInPos", you start a gearing (Page 120) operation between a leading axis and a following axis.

The synchronous operation is synchronized in advance of the specified synchronous position for the leading and following axis. The following types of synchronization (Page 127) are possible:

- **Synchronization using dynamic parameters**

  (SyncProfileReference = 0)

- **Synchronization using leading value distance**

  (SyncProfileReference = 1)

You specify the gear ratio as the relationship between two integers (numerator/denominator) with the parameters "RatioNumerator" and "RatioDenominator".

The numerator of the gear ratio is specified as positive or negative. This yields the following behavior:

- **Positive gear ratio:**

  The leading and following axes move in the same direction.

- **Negative gear ratio**:

  The following axis moves in the opposite direction of the leading axis.

You can start synchronous operation when the leading axis is at a standstill or when it is in motion.

Applies to

- Synchronous axis

Requirement

- The technology objects of the leading axis and the following axis have been configured correctly.
- The leading axis is a positioning axis, synchronous axis, or external encoder.
- The following axis is a synchronous axis.
- The leading axis is specified as possible leading axis in the configuration of the following axis in "Technology object > Configuration > Leading value interconnections".
- The following axis is enabled.
- When using the "MasterStartDistance", the leading axis must be at least the specified distance from the "MasterSyncPosition" when starting the job.

Override response

The override response for "MC_GearInPos" jobs is described in section Override response V4: Synchronous operation jobs (Page 537).

Disabling the following axis with "MC_Power.Enable" = FALSE aborts the synchronous operation in every status.

Disabling the leading axis with "MC_Power", in contrast, does not abort synchronous operation. The following axis follows the leading axis even during the braking ramp and after the leading axis is enabled again.

Parameters

The following table shows the parameters of Motion Control instruction "MC_GearInPos":

Parameters	Declaration	Data type	Default value	Description	
Master	INPUT	TO_Axis	-	Leading axis technology object	
Slave	INPUT	TO_SynchronousAxis	-	Following axis technology object	
Execute	INPUT	BOOL	FALSE	TRUE	Start job with a positive edge
RatioNumerator	INPUT	DINT	1	Gear ratio numerator Permitted integer values: -2147483647 to 2147483647 (value 0 not permitted)	
RatioDenominator	INPUT	DINT	1	Gear ratio denominator Permitted integer values: 1 to 2147483648	
MasterSyncPosition	INPUT	LREAL	0.0	Synchronous position of leading axis Position of the leading axis starting from which the leading and following axes move synchronously	
SlaveSyncPosition	INPUT	LREAL	0.0	Synchronous position of following axis Position of the following axis starting from which the leading and following axes move synchronously	
SyncProfileReference	INPUT	DINT	1	Type of synchronization	
				0	Synchronization using dynamic parameters
				1	Synchronization using leading value distance
MasterStartDistance	INPUT	LREAL	1.0	Leading value distance (with "SyncProfileReference" = 1)	
Velocity	INPUT	LREAL	-1.0	Velocity (with "SyncProfileReference" = 0)	
				> 0.0	The specified value is used.
				= 0.0	Not permitted
				< 0.0	The velocity configured in "Technology object > Configuration > Extended parameters > Dynamic defaults" is used. (<TO>.DynamicDefaults.Velocity)

Parameters	Declaration	Data type	Default value	Description	
Acceleration	INPUT	LREAL	-1.0	Acceleration (with "SyncProfileReference" = 0)	
				> 0.0	The specified value is used.
				= 0.0	Not permitted
				< 0.0	The acceleration configured in "Technology object > Configuration > Extended parameters > Dynamic defaults" is used. (<TO>.DynamicDefaults.Acceleration)
Deceleration	INPUT	LREAL	-1.0	Deceleration (with "SyncProfileReference" = 0)	
				> 0.0	The specified value is used.
				= 0.0	Not permitted
				< 0.0	The deceleration configured in "Technology object > Configuration > Extended parameters > Dynamic defaults" is used. (<TO>.DynamicDefaults.Deceleration)
Jerk	INPUT	LREAL	-1.0	Jerk (with "SyncProfileReference" = 0)	
				> 0.0	Constant-acceleration velocity profile; the specified jerk is used
				= 0.0	Trapezoid velocity profile
				< 0.0	The jerk configured in "Technology object > Configuration > Extended parameters > Dynamic defaults" is used. (<TO>.DynamicDefaults.Jerk)
SyncDirection	INPUT	DINT	3	Direction of synchronization (in effect for axes with activated Modulo setting)	
				1	Positive direction The following axis may only travel in positive direction during synchronization.
				2	Negative direction The following axis may only travel in negative direction during synchronization.
				3	Shortest distance Changes in direction are permitted for the following axis during synchronization.
StartSync	OUTPUT	BOOL	FALSE	TRUE	The following axis is synchronized to the leading axis.

Parameters	Declaration	Data type	Default value	Description	
InSync	OUTPUT	BOOL	FALSE	TRUE	Synchronous operation reached The following axis is synchronized and moves synchronously to the leading axis.
Busy	OUTPUT	BOOL	FALSE	TRUE	Job is running.
CommandAborted	OUTPUT	BOOL	FALSE	TRUE	The job was aborted by another job during execution.
Error	OUTPUT	BOOL	FALSE	TRUE	An error occurred while processing the job. The job is rejected. The cause of the error can be found in the "ErrorID" parameter.
ErrorID	OUTPUT	WORD	0	Error ID (Page 652) for parameter "ErrorID"	

Starting synchronous operation

To start synchronous operation with the Motion Control instruction "MC_GearInPos", follow these steps:

1. Check the requirements indicated above.
2. Specify the leading axis, the following axis, the gear ratio and the synchronous position with the corresponding parameters.
3. Start the "MC_GearInPos" job with a positive edge at parameter "Execute".

The following axis is synchronized to the leading value of the leading axis. If the "InSync" parameter shows the value TRUE, the following axis is synchronized and moves synchronously to the leading axis. The parameters "InSync" and "Busy" show the value TRUE until the "MC_GearInPos" job is overridden by another Motion Control job.

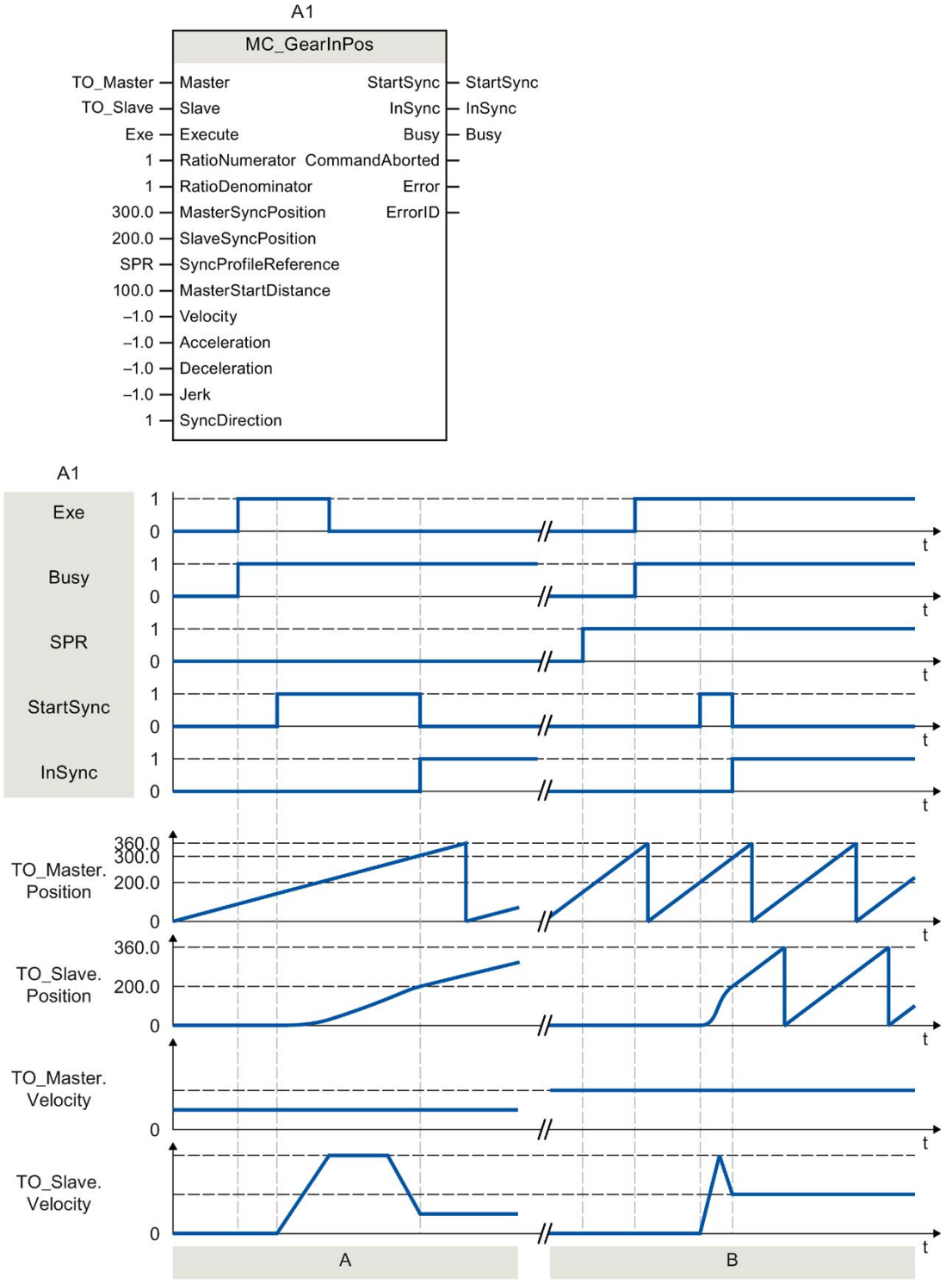
See also

Error ID for Motion Control instructions (Page 652)

Override response V4: Synchronous operation jobs (Page 537)

10.12.2.2 MC_GearInPos: Function chart V4

Function chart: Synchronization using dynamic parameters/leading value distance



Section A	Using "Exe", an "MC_GearInPos" job (A1) is initiated. The following axis (TO_Slave) is synchronized to the leading axis (TO_Master) by means of the specified dynamic parameters. The distance required for synchronization is calculated by the system. The start of the synchronization is displayed with StartSync. When the specified synchronous position is reached, "InSync" signals that the following axis is synchronized and moving synchronously to the leading axis.
Section B	Using "Exe", an "MC_GearInPos" job (A1) is initiated. The following axis (TO_Slave) is synchronized to the leading axis (TO_Master) by means of the specified leading value distance. The dynamics required for synchronization is calculated by the system. The start of the synchronization is displayed with StartSync. "InSync" signals that the following axis is synchronized and moving synchronously to the leading axis.

10.12.3 MC_PhasingAbsolute V4

10.12.3.1 MC_PhasingAbsolute: Absolute shift of leading value on the following axis V4

Description

With the Motion Control instruction "MC_PhasingAbsolute", you shift the leading value on a following axis during gearing with "MC_GearIn" and "MC_GearInPos" as an absolute shift. The position of the leading axis is not affected by this.

You define the dynamic response of the motion of the following axis with the parameters "Velocity", "Jerk", "Acceleration", and "Deceleration". The dynamic values are added to the values of the synchronous operation motion.

Applies to

- Synchronous axis

Requirement

- The technology objects of the leading axis and the following axis have been configured correctly.
- The leading axis is a positioning axis, synchronous axis, or external encoder.
- The following axis is a synchronous axis.
- The leading axis is specified as possible leading axis in the configuration of the following axis in "Technology object > Configuration > Leading value interconnections".
- The following axis is synchronized to the leading axis ("MC_GearIn.InGear" = TRUE or "MC_GearInPos.InSync" = TRUE) by means of the Motion Control instruction "MC_GearIn" or "MC_GearInPos".
- The following axis is enabled.

Override response

The override response for "MC_PhasingAbsolute" jobs is described in section Override response V4: Synchronous operation jobs (Page 537).

Disabling the leading axis with "MC_Power.Enable" = FALSE does not abort the leading value shift. The following axis follows the leading axis even during the braking ramp and after the leading axis is enabled again.

Parameters

The following table shows the parameters of Motion Control instruction "MC_PhasingAbsolute":

Parameters	Declaration	Data type	Default value	Description	
Master	INPUT	TO_Axis	-	Leading axis technology object	
Slave	INPUT	TO_SynchronousAxis	-	Following axis technology object	
Execute	INPUT	BOOL	FALSE	TRUE	Start job with a positive edge
PhaseShift	INPUT	LREAL	0.0	Absolute leading value shift	
Velocity	INPUT	LREAL	-1.0	Velocity of the following axis for leading value shift (added to synchronous operation motion)	
				> 0.0	The specified value is used.
				= 0.0	Not permitted
				< 0.0	The velocity configured in "Technology object > Configuration > Extended parameters > Dynamic defaults" is used. (<TO>.DynamicDefaults.Velocity)
Acceleration	INPUT	LREAL	-1.0	Acceleration of the following axis for leading value shift (added to synchronous operation motion)	
				> 0.0	The specified value is used.
				= 0.0	Not permitted
				< 0.0	The acceleration configured in "Technology object > Configuration > Extended parameters > Dynamic defaults" is used. (<TO>.DynamicDefaults.Acceleration)
Deceleration	INPUT	LREAL	-1.0	Deceleration of the following axis for leading value shift (added to synchronous operation motion)	
				> 0.0	The specified value is used.
				= 0.0	Not permitted
				< 0.0	The deceleration configured in "Technology object > Configuration > Extended parameters > Dynamic defaults" is used. (<TO>.DynamicDefaults.Deceleration)

Parameters	Declaration	Data type	Default value	Description	
Jerk	INPUT	LREAL	-1.0	Jerk of the following axis for leading value shift (added to synchronous operation motion)	
				> 0.0	Constant-acceleration velocity profile; the specified jerk is used
				= 0.0	Trapezoid velocity profile
				< 0.0	The jerk configured in "Technology object > Configuration > Extended parameters > Dynamic defaults" is used. (<TO>.DynamicDefaults.Jerk)
Done	OUTPUT	BOOL	FALSE	TRUE	Leading value shift is finished.
Busy	OUTPUT	BOOL	FALSE	TRUE	Job is running.
CommandAborted	OUTPUT	BOOL	FALSE	TRUE	The job was aborted by another job during execution.
Error	OUTPUT	BOOL	FALSE	TRUE	An error occurred while processing the job. The job is rejected. The cause of the error can be found in the "ErrorID" parameter.
ErrorID	OUTPUT	WORD	0	Error ID (Page 652) for parameter "ErrorID"	
AbsolutePhaseShift	OUTPUT	LREAL	0.0	As long as "Busy" = TRUE: Display of leading value shift completed up to now	

Start absolute leading value shift

To start an absolute leading value shift with the Motion Control instruction "MC_PhasingAbsolute", follow these steps:

1. Check the requirements indicated above.
2. Specify the absolute leading value shift in the "PhaseShift" parameter.
3. Start the "MC_PhasingAbsolute" job with a positive edge at parameter "Execute".

The current motion state is indicated in parameters "Busy", "AbsolutePhaseShift", "Done" and "Error".

See also

Error ID for Motion Control instructions (Page 652)

Override response V4: Synchronous operation jobs (Page 537)

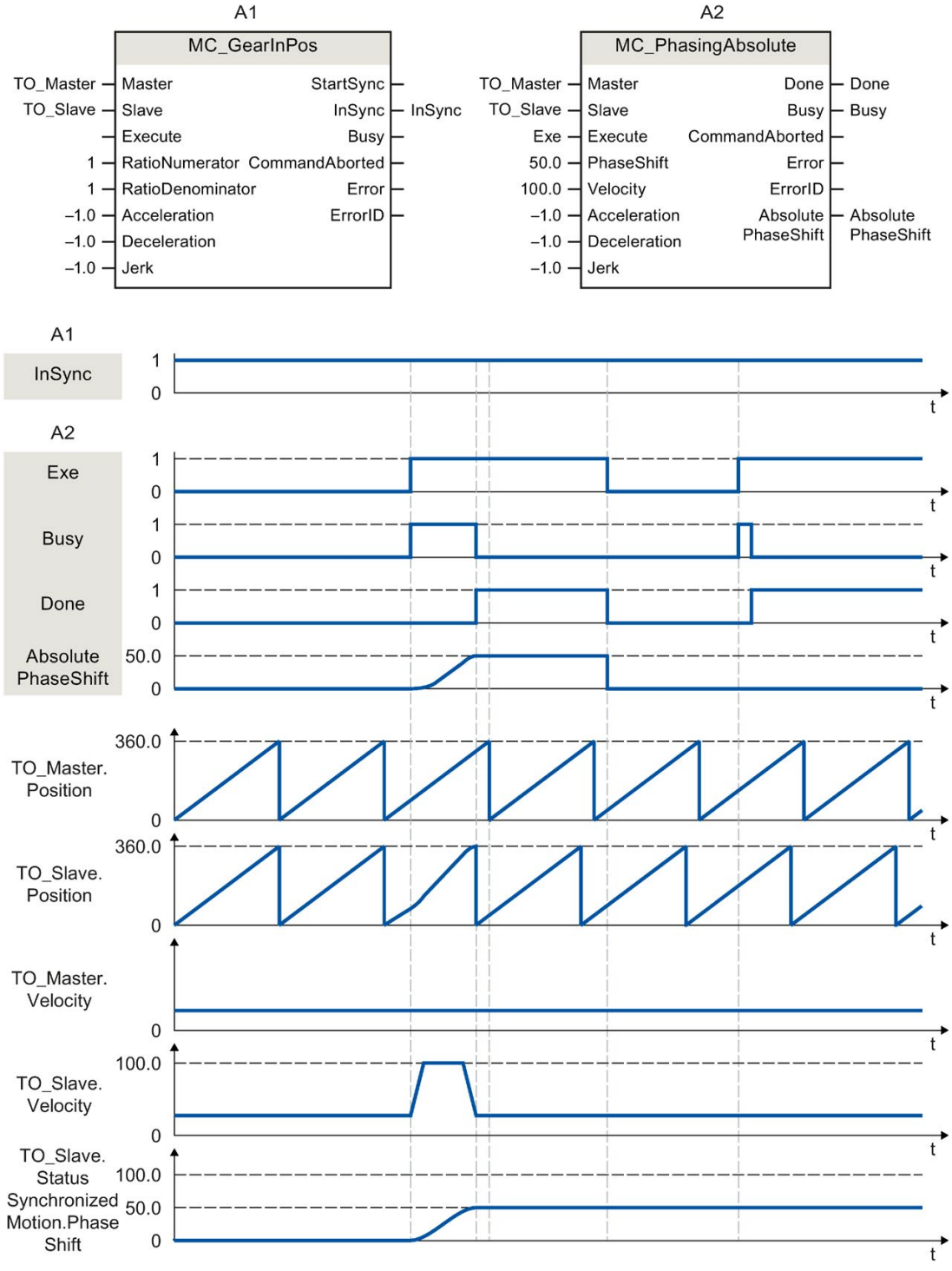
MC_GearIn V4 (Page 484)

MC_GearInPos V4 (Page 488)

Gearing with "MC_GearInPos" with specified synchronous positions (Page 120)

10.12.3.2 MC_PhasingAbsolute: Function chart V4

Function chart: Absolute shift of leading value



During an active gearing operation with "MC_GearInPos" (A1), a "MC_PhasingAbsolute" job (A2) is initiated using "Exe". The leading value shift is performed with the dynamics specified additively to the synchronous operation motion. "Done" indicates that the leading value was successfully shifted. The leading value shift 50.0 resulting from the job is indicated in "AbsolutePhaseShift". The absolute leading value shift 50.0 is indicated in the tag of the technology object <TO>.StatusSynchronizedMotion.PhaseShift. The motion of the leading axis is not affected.

After the leading value shift, the "MC_PhasingAbsolute" job (A2) is initiated again using "Exe". Because the leading value shift (<TO>.StatusSynchronizedMotion.PhaseShift) is already 50.0, the leading value is not shifted.

10.12.4 MC_PhasingRelative V4

10.12.4.1 MC_PhasingRelative: Relative shift of leading value on the following axis V4

Description

With the Motion Control instruction "MC_PhasingRelative", you shift the leading value on a following axis during gearing with "MC_GearIn" and "MC_GearInPos" relative to the existing leading value shift. The position of the leading axis is not affected by this.

You define the dynamic response of the motion of the following axis with the parameters "Velocity", "Jerk", "Acceleration", and "Deceleration" . The dynamic values are added to the values of the synchronous operation motion.

Applies to

- Synchronous axis

Requirement

- The technology objects of the leading axis and the following axis have been configured correctly.
- The leading axis is a positioning axis, synchronous axis, or external encoder.
- The following axis is a synchronous axis.
- The leading axis is specified as possible leading axis in the configuration of the following axis in "Technology object > Configuration > Leading value interconnections".
- The following axis is synchronized to the leading axis ("MC_GearIn.InGear" = TRUE or "MC_GearInPos.InSync" = TRUE) by means of the Motion Control instruction "MC_GearIn" or "MC_GearInPos".
- The following axis is enabled.

Override response

The override response for "MC_PhasingRelative" jobs is described in section Override response V4: Synchronous operation jobs (Page 537).

Disabling the leading axis with "MC_Power.Enable" = FALSE does not abort the leading value shift. The following axis follows the leading axis even during the braking ramp and after the leading axis is enabled again.

Parameters

The following table shows the parameters of Motion Control instruction "MC_PhasingRelative":

Parameters	Declaration	Data type	Default value	Description	
Master	INPUT	TO_Axis	-	Leading axis technology object	
Slave	INPUT	TO_SynchronousAxis	-	Following axis technology object	
Execute	INPUT	BOOL	FALSE	TRUE	Start job with a positive edge
PhaseShift	INPUT	LREAL	0.0	Relative leading value shift	
Velocity	INPUT	LREAL	-1.0	Velocity of the following axis for leading value shift (added to synchronous operation motion)	
				> 0.0	The specified value is used.
				= 0.0	Not permitted
				< 0.0	The velocity configured in "Technology object > Configuration > Extended parameters > Dynamic defaults" is used. (<TO>.DynamicDefaults.Velocity)
Acceleration	INPUT	LREAL	-1.0	Acceleration of the following axis for leading value shift (added to synchronous operation motion)	
				> 0.0	The specified value is used.
				= 0.0	Not permitted
				< 0.0	The acceleration configured in "Technology object > Configuration > Extended parameters > Dynamic defaults" is used. (<TO>.DynamicDefaults.Acceleration)
Deceleration	INPUT	LREAL	-1.0	Deceleration of the following axis for leading value shift (added to synchronous operation motion)	
				> 0.0	The specified value is used.
				= 0.0	Not permitted
				< 0.0	The deceleration configured in "Technology object > Configuration > Extended parameters > Dynamic defaults" is used. (<TO>.DynamicDefaults.Deceleration)

Parameters	Declaration	Data type	Default value	Description	
Jerk	INPUT	LREAL	-1.0	Jerk of the following axis for leading value shift (added to synchronous operation motion)	
				> 0.0	Constant-acceleration velocity profile; the specified jerk is used
				= 0.0	Trapezoid velocity profile
				< 0.0	The jerk configured in "Technology object > Configuration > Extended parameters > Dynamic defaults" is used. (<TO>.DynamicDefaults.Jerk)
Done	OUTPUT	BOOL	FALSE	TRUE	Leading value shift is finished.
Busy	OUTPUT	BOOL	FALSE	TRUE	Job is running.
CommandAborted	OUTPUT	BOOL	FALSE	TRUE	The job was aborted by another job during execution.
Error	OUTPUT	BOOL	FALSE	TRUE	An error occurred while processing the job. The job is rejected. The cause of the error can be found in the "ErrorID" parameter.
ErrorID	OUTPUT	WORD	0	Error ID (Page 652) for parameter "ErrorID"	
CoveredPhaseShift	OUTPUT	LREAL	0.0	As long as "Busy" = TRUE: Display of leading value shift completed up to now	

Start relative leading value shift

To start a relative leading value shift with the Motion Control instruction "MC_PhasingRelative", follow these steps:

1. Check the requirements indicated above.
2. Specify the relative leading value shift in the "PhaseShift" parameter.
3. Start the "MC_PhasingRelative" job with a positive edge at parameter "Execute".

The current motion state is indicated in parameters "Busy", "CoveredPhaseShift", "Done" and "Error".

See also

Error ID for Motion Control instructions (Page 652)

Override response V4: Synchronous operation jobs (Page 537)

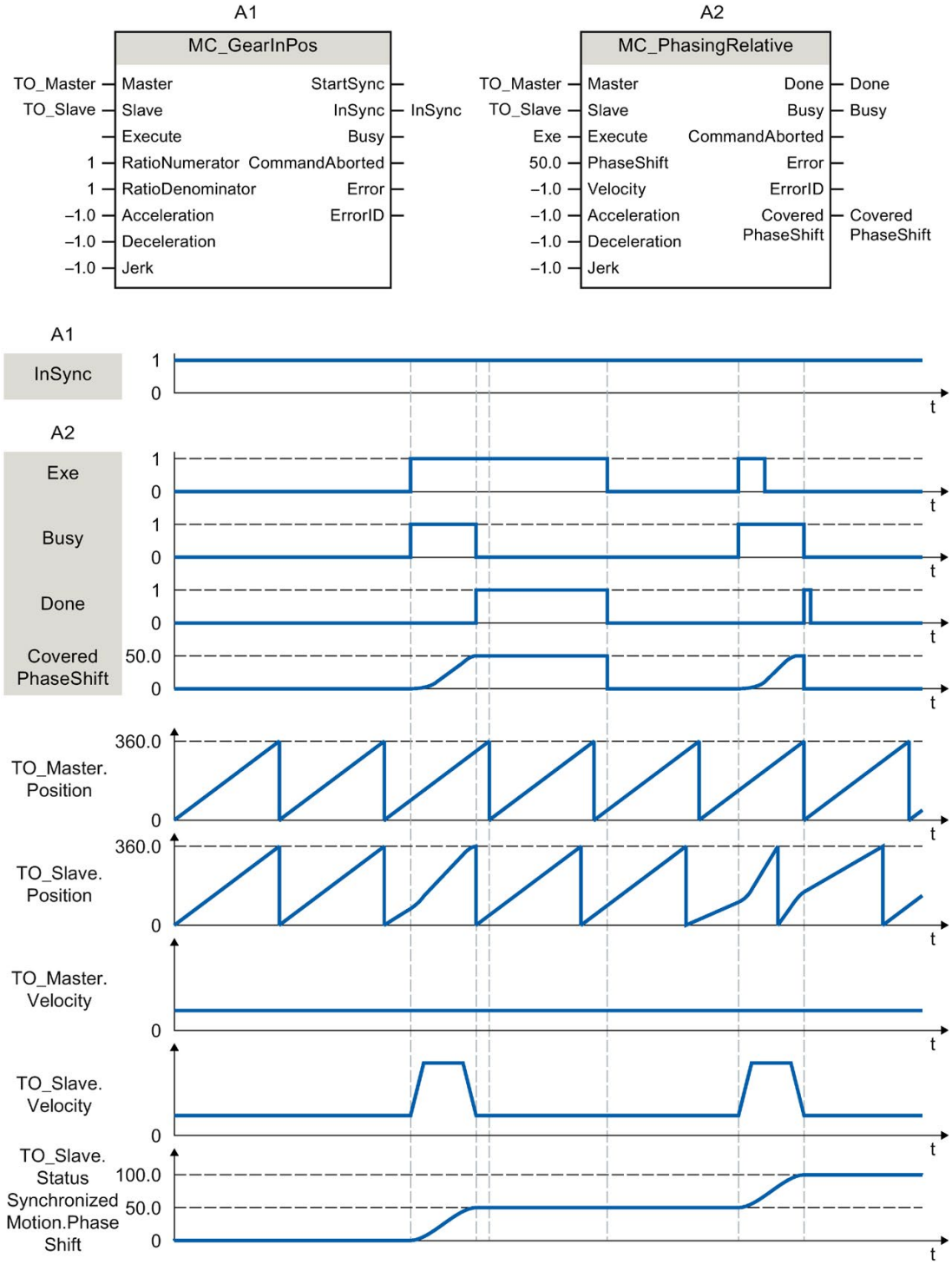
MC_GearIn V4 (Page 484)

MC_GearInPos V4 (Page 488)

Gearing with "MC_GearInPos" with specified synchronous positions (Page 120)

10.12.4.2 MC_PhasingRelative: Function chart V4

Function chart: Relative shift of leading value



During an active gearing operation with "MC_GearInPos" (A1), a "MC_PhasingRelative" job (A2) is initiated using "Exe". The leading value shift is performed with the dynamics specified additively to the synchronous operation motion. "Done" indicates that the leading value was successfully shifted. The leading value shift 50.0 resulting from the job is indicated in "CoveredPhaseShift". The absolute leading value shift 50.0 is indicated in the tag of the technology object <TO>.StatusSynchronizedMotion.PhaseShift. The motion of the leading axis is not affected.

After the leading value shift, the "MC_PhasingRelative" job (A2) is initiated again using "Exe". The leading value shift is performed again with the dynamics specified additively to the synchronous operation motion. "Done" indicates that the leading value was successfully shifted. The leading value shift 50.0 resulting from the job is indicated in "CoveredPhaseShift". The absolute leading value shift 100.0 is indicated in the tag of the technology object <TO>.StatusSynchronizedMotion.PhaseShift.

10.12.5 MC_CamIn V4

10.12.5.1 MC_CamIn: Start camming V4.

Description

With the Motion Control instruction "MC_CamIn", you start a camming (Page 122) operation between a leading axis and a following axis.

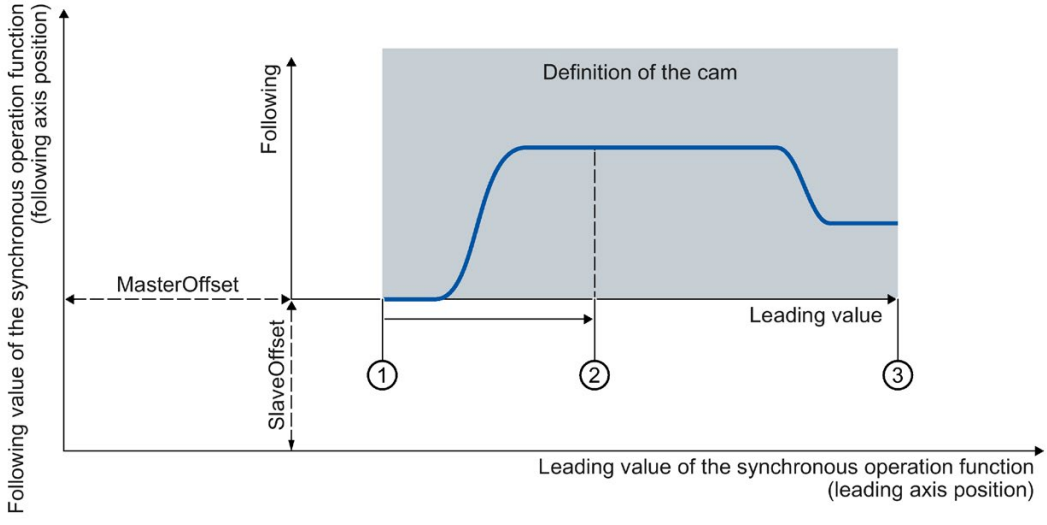
The synchronous operation is synchronized in advance of the specified synchronous position of the leading axis with "SyncProfileReference" = 0 or 1. The synchronous position of the leading axis starting from which the leading and following axes move synchronously results from the starting position of the cam and the "MasterSyncPosition" and "MasterOffset" parameters. The synchronous operation with "SyncProfileReference" = 2 leads to immediate synchronization. The exact synchronization point in the cam is specified using the "MasterSyncPosition" parameter. This setting is used mainly for synchronizing at a standstill.

The "MasterOffset" parameter is used to shift the leading values of the cam when "SyncProfileReference" = 0 or 1. You use this to specify the position of the cam in relation to the leading value of the synchronous operation function. As a result, you offset the curve defined as an absolute curve to the position range needed for the application.

With the "MasterSyncPosition" parameter, you specify the synchronization position in the cam relative to the starting position of the cam within the domain ("StartLeadingValue"). When the synchronization position is reached, the synchronization operation is complete. If the entire cam is to be run, specify the value 0.0 (default value) in "MasterSyncPosition".

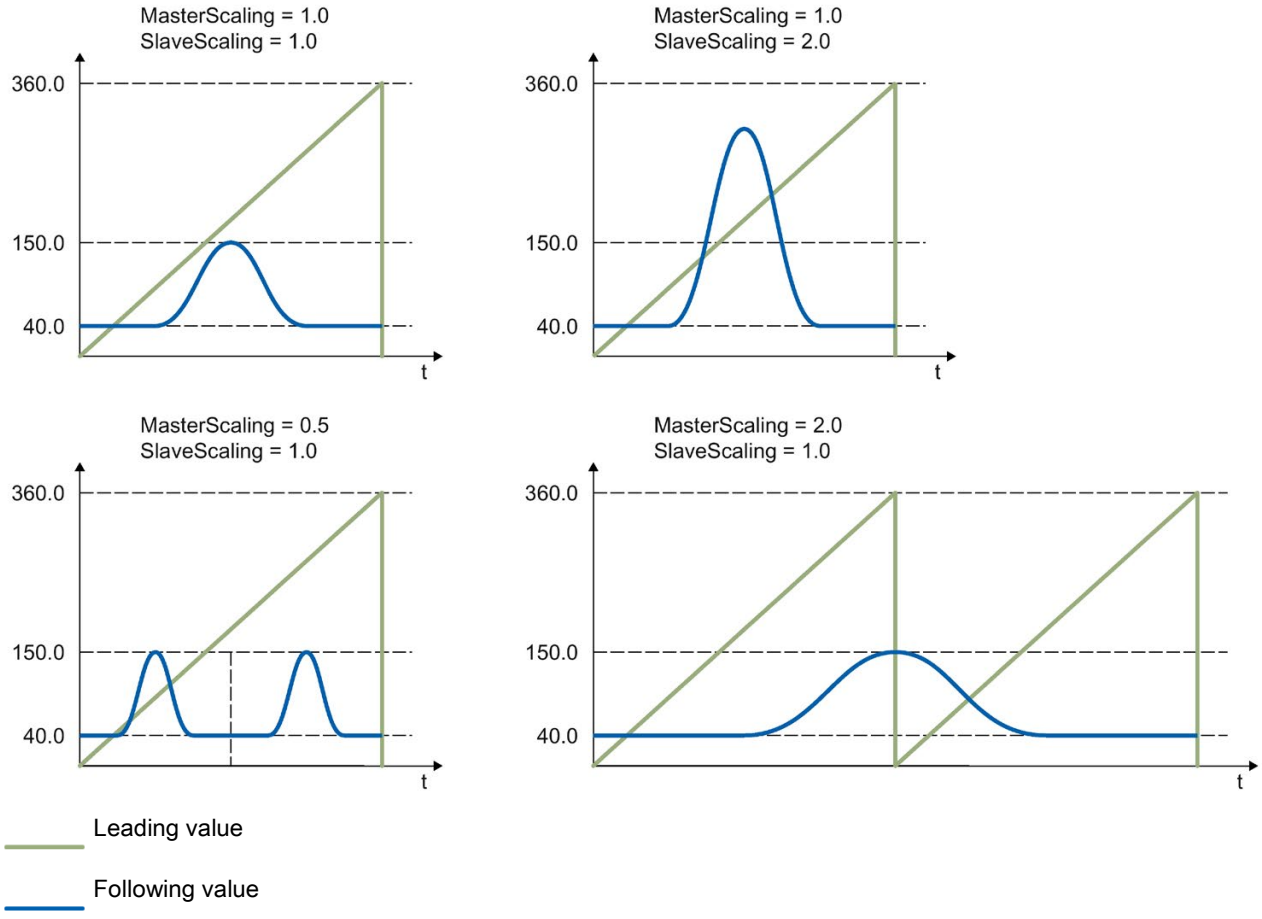
By default, the "MasterSyncPosition" parameter is set to 0.0, so that the synchronization process is completed with the start of the cam. By changing the Value of the "MasterSyncPosition", you can specifically move the synchronous position within the cam without changing the position of the cam.

The figure below shows the basic effect of the leading value and following value shift as well as the definition of the can for a "StartLeadingValue" > 0 and a "MasterSyncPosition" > 0:



① StartLeadingValue - First defined interpolation point/start of the first segment of the cam
② MasterSyncPosition - Completion of the synchronization operation
③ EndLeadingValue - Last defined interpolation point/end of the last segment of the cam

The figure below shows the basic effect of scaling the cam with the parameters "MasterScaling" and "SlaveScaling":



The following types of synchronization (Page 127) are possible:

- **Synchronization using dynamic parameters**

  (SyncProfileReference = 0)
- **Synchronization using leading value distance**

  (SyncProfileReference = 1)
- **Direct synchronous setting**

  (SyncProfileReference = 2)

You can start synchronous operation when the leading axis or following axis is at a standstill or when it is in motion.

Applies to

- Synchronous axis

Requirement

- The technology objects of the leading axis, following axis, and cam have been configured correctly.
- The leading axis is a positioning axis, synchronous axis, or external encoder.
- The following axis is a synchronous axis.
- The leading axis is specified as possible leading axis in the configuration of the following axis in "Technology object > Configuration > Leading value interconnections".
- The following axis is enabled.
- The cam is interpolated with "MC_InterpolateCam".
- When using the "MasterStartDistance", the leading axis must be at least the specified distance from the "MasterSyncPosition" when starting the job.

Override response

The override response for "MC_CamIn" jobs is described in section Override response V4: Synchronous operation jobs (Page 537).

Disabling the following axis with "MC_Power.Enable" = FALSE aborts the synchronous operation in every status.

Disabling the leading axis with "MC_Power", in contrast, does not abort synchronous operation. The following axis follows the leading axis even during the braking ramp and after the leading axis is enabled again.

Parameters

The following table shows the parameters of Motion Control instruction "MC_CamIn":

Parameter	Declaration	Data type	Default value	Description	
Master	INPUT	TO_Axis	-	Leading axis technology object	
Slave	INPUT	TO_Synchronous Axis	-	Following axis technology object	
Cam	INPUT	TO_Cam	-	Cam technology object	
Execute	INPUT	BOOL	FALSE	TRUE	Start job with a positive edge
MasterOffset	INPUT	LREAL	0.0	Offset of leading values of cam (with "SyncProfileReference" =0 or 1) The cam technology object is not changed.	
SlaveOffset	INPUT	LREAL	0.0	Offset of following values of cam (with "SyncProfileReference" =0 or 1) The cam technology object is not changed.	
MasterScaling	INPUT	LREAL	1.0	Scaling the leading values of the cam The cam technology object is not changed.	
SlaveScaling	INPUT	LREAL	1.0	Scaling the following values of the cam The cam technology object is not changed.	

Parameter	Declaration	Data type	Default value	Description	
MasterSyncPosition	INPUT	LREAL	0.0	Completion position of the synchronization operation relative to the starting position of the cam The value must be within the leading value range of the cam.	
SyncProfileReference	INPUT	DINT	1	Synchronization profile	
				0	Synchronization using dynamic parameters
				1	Synchronization using leading value distance
				2	Direct synchronous setting
MasterStartDistance	INPUT	LREAL	0.0	Leading value distance (distance of the leading axis during the synchronization process) (with "SyncProfileReference" = 1)	
Velocity	INPUT	LREAL	-1.0	Velocity (with "SyncProfileReference" = 0)	
				> 0.0	The specified value is used.
				= 0.0	Not permitted
				< 0.0	The velocity configured in "Technology object > Configuration > Extended parameters > Dynamic defaults" is used. (<TO>.DynamicDefaults.Velocity)
Acceleration	INPUT	LREAL	-1.0	Acceleration (with "SyncProfileReference" = 0)	
				> 0.0	The specified value is used.
				= 0.0	Not permitted
				< 0.0	The acceleration configured in "Technology object > Configuration > Extended parameters > Dynamic defaults" is used. (<TO>.DynamicDefaults.Acceleration)
Deceleration	INPUT	LREAL	-1.0	Deceleration (with "SyncProfileReference" = 0)	
				> 0.0	The specified value is used.
				= 0.0	Not permitted
				< 0.0	The deceleration configured in "Technology object > Configuration > Extended parameters > Dynamic defaults" is used. (<TO>.DynamicDefaults.Deceleration)
Jerk	INPUT	LREAL	-1.0	Jerk (with "SyncProfileReference" = 0)	
				> 0.0	Constant-acceleration velocity profile; the specified jerk is used

Parameter	Declaration	Data type	Default value	Description	
				= 0.0	Trapezoid velocity profile
				< 0.0	The jerk configured in "Technology object > Configuration > Extended parameters > Dynamic defaults" is used. (<TO>.DynamicDefaults.Jerk)
ApplicationMode	INPUT	DINT	0	Application of the cam	
				0	Once/not cyclic
				1	Cyclic (absolute application on the following value side)
				2	Cyclic appending (continuously appending on the following value side)
SyncDirection	INPUT	DINT	3	Direction of synchronization (in effect for axes with activated Modulo setting)	
				1	Positive direction The following axis may only travel in positive direction during synchronization.
				2	Negative direction The following axis may only travel in negative direction during synchronization.
				3	Shortest distance Changes in direction are permitted for the following axis during synchronization.
StartSync	OUTPUT	BOOL	FALSE	TRUE	The following axis is synchronized to the leading axis.
InSync	OUTPUT	BOOL	FALSE	TRUE	Synchronous operation reached The following axis is synchronized and moves synchronously to the leading axis.
Busy	OUTPUT	BOOL	FALSE	TRUE	Job is running.
CommandAborted	OUTPUT	BOOL	FALSE	TRUE	The job was aborted by another job during execution.
Error	OUTPUT	BOOL	FALSE	TRUE	An error occurred while processing the job. The job is rejected. The cause of the error can be found in the "ErrorID" parameter.
ErrorID	OUTPUT	WORD	0	Error ID (Page 652) for parameter "ErrorID"	
EndOfProfile	OUTPUT	BOOL	FALSE	TRUE	The end of the cam has been reached. Displayed for at least one call of "MC_CamIn" in the user program when the cam is used cyclically.

Starting synchronous operation

To start synchronous operation with the Motion Control instruction "MC_CamIn", follow these steps:

1. Check the requirements indicated above.
2. Specify the leading axis, the following axis, the utilized cam and the synchronous position in the corresponding parameters.
3. Start the "MC_CamIn" job with a positive edge at parameter "Execute".

The following axis is synchronized to the leading value of the leading axis. If the "InSync" parameter shows the value TRUE, the following axis is synchronized and moves synchronously to the leading axis. With cyclic application of the cam, "InSync" and "Busy" show the value TRUE until the "MC_CamIn" job is overridden by another Motion Control job. With non-cyclic application of the cam, "InSync" and "Busy" are set to the value FALSE when the parameter "EndOfProfile" is set to the value TRUE.

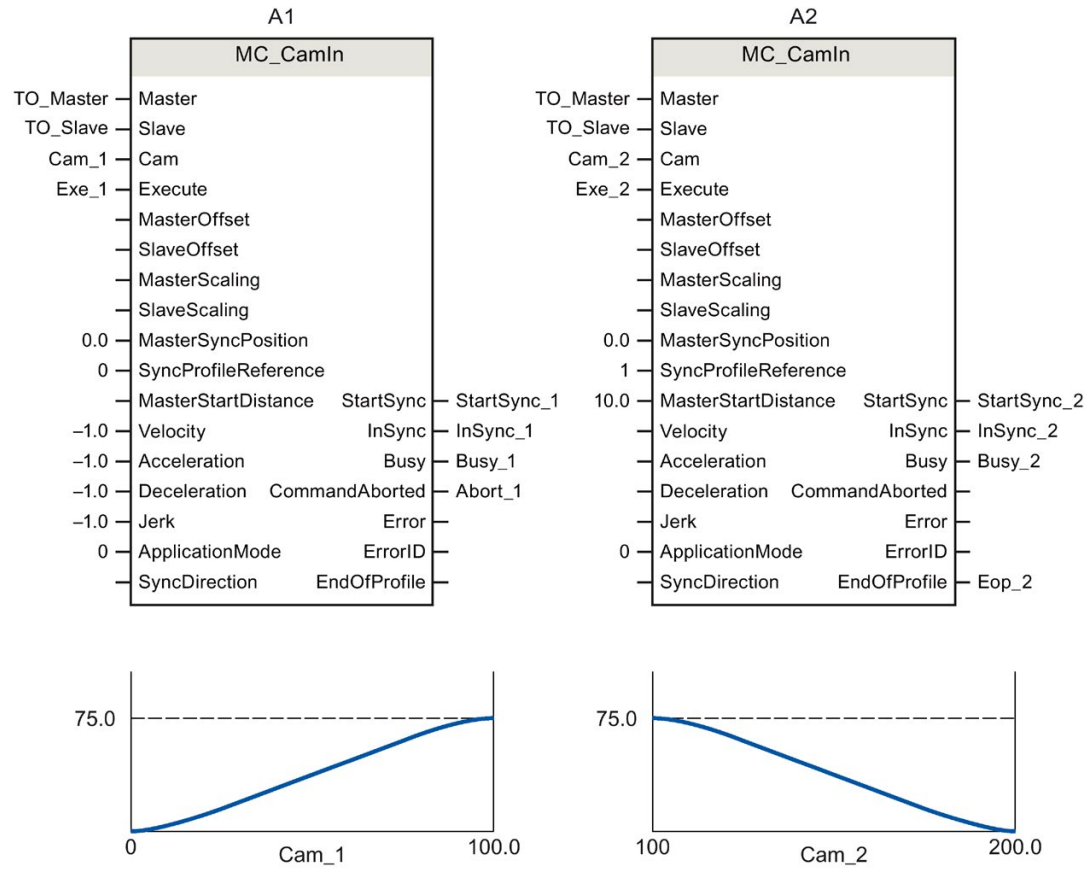
See also

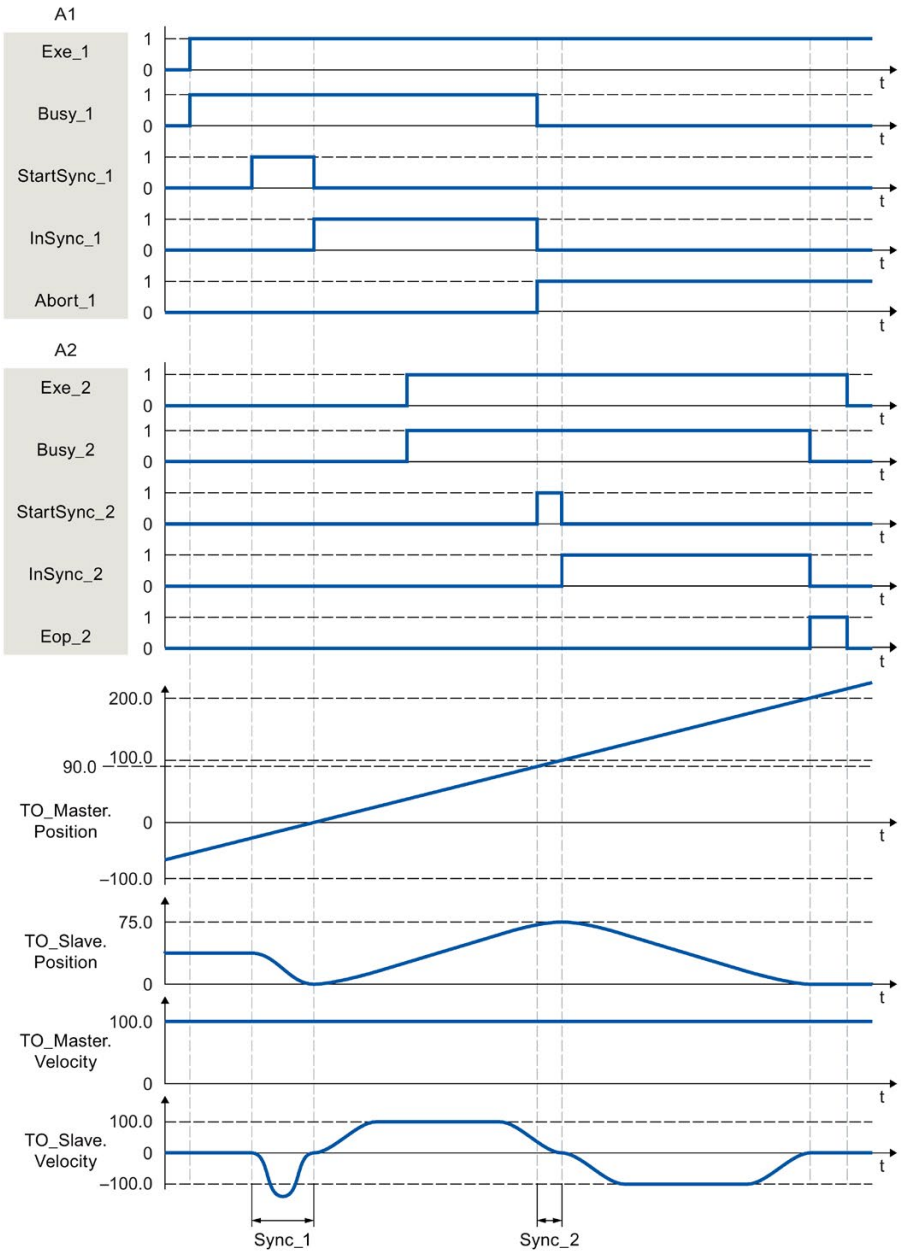
Error ID for Motion Control instructions (Page 652)

Override response V4: Synchronous operation jobs (Page 537)

10.12.5.2 MC_CamIn: Function chart V4

Function chart: Synchronizing and switching the cam





Using "Exe_1", an "MC_CamIn" job (A1) is initiated. The start of the synchronization is displayed with StartSync_1. The following axis (TO_Slave) is synchronized to the cam (Cam_1) within the range "Sync_1" by means of the specified dynamic parameters. "InSync_1" signals that the following axis is synchronized and moving synchronously to the leading axis.

The synchronous operation is overridden by another "MC_CamIn" job (A2). The abort is signaled via "Abort_1". The start of the synchronization is displayed with StartSync_2. The following axis is synchronized to the new cam (Cam_2) within the range "Sync_2" by means of the specified leading value distance. Within the range "Sync_2", the axis does not following the cam "Cam_1" The axis is moved with the dynamics calculated by the system to the synchronous position of A2. "InSync_2" signals that the following axis is synchronized and moving synchronously to the leading axis.

10.12.6 MC_SynchronizedMotionSimulation V4

10.12.6.1 MC_SynchronizedMotionSimulation: Simulate synchronous operation V4

Description

With the Motion Control instruction "MC_SynchronizedMotionSimulation", you simulate an active synchronous operation (Page 113) on a following axis. As a result, a synchronous operation remains active when the following axis is disabled with "MC_Power". The following axis does not have to be synchronized again after being enabled again.

With the start of a "MC_SynchronizedMotionSimulation" job, the velocity setpoint from the synchronous operation is set to zero. If an overlaid movement is active on the following axis at the start of the simulation, the setpoints of this overlaid movement will continue to be output.

Setpoints of motion jobs that are started during synchronous operation simulation are output to the drive.

If the position of the following axis at the end of the simulation differs from the position at the start of the simulation, this triggers a setpoint step-change.

Applies to

- Synchronous axis

Requirement

- The technology object has been configured correctly.
- The following axis is a synchronous axis.
- Synchronous operation is active on the technology object in status "Synchronous" (<TO>.StatusWord.X22 = TRUE).

Override response

An "MC_SynchronizedMotionSimulation" job is not aborted by any other Motion Control job. The simulated synchronous operation remains active even when the following axis is disabled with "MC_Power.Enable" = FALSE.

A restart of the technology object stops the simulation and aborts the synchronous operation.

A new "MC_SynchronizedMotionSimulation" job does not abort any other Motion Control jobs. With "MC_SynchronizedMotionSimulation.Enable" = TRUE, synchronous operation jobs are rejected.

Parameters

The following table shows the parameters of Motion Control instruction "MC_SynchronizedMotionSimulation":

Parameters	Declaration	Data type	Default value	Description	
Slave	INPUT	TO_SynchronousAxis	-	Following axis technology object	
Enable	INPUT	BOOL	FALSE	TRUE	Simulation of synchronous operation is started.
				FALSE	Simulation of the synchronous operation is stopped.
InSimulation	OUTPUT	BOOL	FALSE	TRUE	Synchronous operation is being simulated
Busy	OUTPUT	BOOL	FALSE	TRUE	Job is running.
Error	OUTPUT	BOOL	FALSE	TRUE	An error occurred while processing the job. The job is rejected. The cause of the error can be found in the "ErrorID" parameter.
ErrorID	OUTPUT	WORD	0	Error ID (Page 652) for parameter "ErrorID"	

Continuing synchronous operation when the following axis is disabled

In order not to stop synchronous operation with "MC_SynchronizedMotionSimulation" Motion Control instruction when the following axis is disabled, follow these steps:

1. Check the requirements indicated above.
2. Specify the following axis in the "Slave" parameter.
3. Bring the leading axis to a standstill (e.g. with "MC_Halt").
4. Start the simulation of the synchronous operation on the following axis with "MC_SynchronizedMotionSimulation.Enable" = TRUE.
5. When the "InSimulation" parameter shows the value TRUE, disable the following axis. The synchronous operation remains active in the simulation.
6. To reset synchronous operation again after the following axis is enabled, stop synchronous operation simulation with "MC_SynchronizedMotionSimulation.Enable" = FALSE.

   The synchronous operation simulation is stopped. The following axis follows the leading axis without re-synchronization.

See also

Error ID for Motion Control instructions (Page 652)

Synchronous axis technology object (Page 113)

10.13 Cam

10.13.1 MC_InterpolateCam V4

10.13.1.1 MC_InterpolateCam: Interpolate cam disc V4

Description

With the Motion Control instruction "MC_InterpolateCam", you interpolate a cam.

Following the interpolation (Page 176), the gaps between the defined interpolation points and segments of the cam are closed. The cam is interpolated from the minimum value of the definition range to the maximum value. After interpolation, an explicit value in the value range is assigned to each value in the definition range.

The interpolation method defines how missing ranges are interpolated. You specify the interpolation method in the configuration of the technology object (Page 284). The following interpolation methods are possible:

- Linear interpolation
- Interpolation with cubic splines
- Interpolation with Bézier splines

Applies to

- Cam

Requirement

- The technology object has been configured correctly.
- The cam is not currently being used, e.g. for camming.

Override response

- An "MC_InterpolateCam" job is not aborted by any other Motion Control job.
- A new "MC_InterpolateCam" job does not abort any active motion control jobs.

Parameters

The following table shows the parameters of Motion Control instruction "MC_InterpolateCam":

Parameters	Declaration	Data type	Default value	Description	
Cam	INPUT	TO_Cam	-	Cam technology object	
Execute	INPUT	BOOL	FALSE	TRUE	Start job with a positive edge
Done	OUTPUT	BOOL	FALSE	TRUE	The cam is interpolated.
Busy	OUTPUT	BOOL	FALSE	TRUE	Job is running.
Error	OUTPUT	BOOL	FALSE	TRUE	An error occurred while processing the job. The job is rejected. The cause of the error can be found in the "ErrorID" parameter.
ErrorID	OUTPUT	WORD	0	Error ID (Page 652) for parameter "ErrorID"	

Interpolating a cam disc

To interpolate a cam with the "MC_InterpolateCam" Motion Control instruction, follow these steps:

1. Check the requirements indicated above.
2. Specify the cam to be interpolated in the "Cam" parameter.
3. Start the "MC_InterpolateCam" job with a positive edge at parameter "Execute".

The cam is interpolated. When the "Done" parameter shows the value TRUE, the interpolation is finished.

See also

Error ID for Motion Control instructions (Page 652)

Cam technology object (Page 174)

10.13.2 MC_GetCamFollowingValue V4

10.13.2.1 MC_GetCamFollowingValue: Read out following value of a cam disc V4

Description

With the Motion Control instruction "MC_GetCamFollowingValue", you read the following value and the first and second derivative of the following value for a leading value from a cam.

Applies to

- Cam

Requirement

- The technology object has been configured correctly.
- The cam is interpolated.

Override response

- An "MC_GetCamFollowingValue" job is not aborted by any other Motion Control job.
- A new "MC_GetCamFollowingValue" job does not abort any active motion control jobs.

Parameters

The following table shows the parameters of Motion Control instruction "MC_GetCamFollowingValue":

Parameters	Declaration	Data type	Default value	Description	
Cam	INPUT	TO_Cam	-	Cam technology object	
Execute	INPUT	BOOL	FALSE	TRUE	Start job with a positive edge
LeadingValue	INPUT	LREAL	0.0	Leading value for which the following value is read	
Done	OUTPUT	BOOL	FALSE	TRUE	The following value was read.
Busy	OUTPUT	BOOL	FALSE	TRUE	Job is running.
Error	OUTPUT	BOOL	FALSE	TRUE	An error occurred while processing the job. The job is rejected. The cause of the error can be found in the "ErrorID" parameter.
ErrorID	OUTPUT	WORD	0	Error ID (Page 652) for parameter "ErrorID"	
Value	OUTPUT	LREAL	-	Read following value (position) (valid when "Done" = TRUE)	
FirstDerivative	OUTPUT	LREAL	-	First derivative of read following value (valid when "Done" = TRUE)	
SecondDerivative	OUTPUT	LREAL	-	Second derivative of read following value (valid when "Done" = TRUE)	

Reading a following value

To read a following value from a cam with the "MC_GetCamFollowingValue" Motion Control instruction, follow these steps:

1. Check the requirements indicated above.
2. Specify the cam and the leading value in the corresponding parameters.
3. Start the "MC_GetCamFollowingValue" job with a positive edge at parameter "Execute".

When the "Done" parameter shows the value TRUE, the following value has been read. The following value and the derivatives are output in the "Value", "FirstDerivative" and "SecondDerivative" parameters.

See also

Error ID for Motion Control instructions (Page 652)

10.13.3 MC_GetCamLeadingValue V4

10.13.3.1 MC_GetCamLeadingValue: Read out leading value of a cam disc V4 (S7-1500T)

Description

With the Motion Control instruction "MC_GetCamLeadingValue", you read the leading value that is defined for a following value from a cam.

Because the same following values can be defined for different leading values, an approximation of the leading value can specified in the "ApproachValue" parameter.

Applies to

- Cam

Requirement

- The technology object has been configured correctly.
- The cam is interpolated.

Override response

- An "MC_GetCamLeadingValue" job is not aborted by any other Motion Control job.
- A new "MC_GetCamLeadingValue" job does not abort any active motion control jobs.

Parameters

The following table shows the parameters of Motion Control instruction "MC_GetCamLeadingValue":

Parameter	Declaration	Data type	Default value	Description	
Cam	INPUT	TO_Cam	-	Cam technology object	
Execute	INPUT	BOOL	FALSE	TRUE	Start job with a positive edge
FollowingValue	INPUT	LREAL	0.0	Following value for which the leading value is read	
ApproachLeadingValue	INPUT	LREAL	0.0	Approximation value for the searched for leading value If the following value is used multiple times in the cam, it can be used to limit the searched leading value.	
Done	OUTPUT	BOOL	FALSE	TRUE	The leading value was read.
Busy	OUTPUT	BOOL	FALSE	TRUE	Job is running.
Error	OUTPUT	BOOL	FALSE	TRUE	An error occurred while processing the job. The job is rejected. The cause of the error can be found in the "ErrorID" parameter.
ErrorID	OUTPUT	WORD	0	Error ID (Page 652) for parameter "ErrorID"	
Value	OUTPUT	LREAL	-	Read leading value (position) (valid when "Done" = TRUE)	

Reading a leading value

To read a leading value from a cam with the "MC_GetCamLeadingValue" Motion Control instruction, follow these steps:

1. Check the requirements indicated above.
2. Specify the cam, the leading value, and the approximation value for the searched-for leading value in the corresponding parameters.
3. Start the "MC_GetCamLeadingValue" job with a positive edge at parameter "Execute".

When the "Done" parameter shows the value TRUE, the leading value has been determined. The calculation of the leading value can take several cycles. The leading value is output in the "Value" parameter.

See also

Error ID for Motion Control instructions (Page 652)

10.14 MotionIn

10.14.1 MC_MotionInVelocity V4

10.14.1.1 MC_MotionInVelocity: Specify motion setpoints V4

Description

With the Motion Control instruction "MC_MotionInVelocity", you specify cyclically applicable calculated motion setpoints for velocity and acceleration as a basic motion for the axis. No velocity profile is calculated for this, the values are directly active at the technology object. The dynamic limits are not in effect. The motion setting using MotionIn can be superimposed with an "MC_MoveSuperimposed" job (Page 462).

With the "Velocity" parameter, you specify the desired velocity and with "Acceleration" the desired acceleration. The setpoint acceleration only has an effect when the "MC_MotionInVelocity" job is overridden by another Motion Control job. The acceleration is set to the acceleration setpoint of the "MC_MotionInVelocity" job. If the acceleration setpoint is zero, zero is set when the acceleration is substituted.

Applies to

- Positioning axis
- Speed axis
- Synchronous axis

Requirement

- The technology object has been configured correctly.
- The technology object is enabled.

Override response

The override response for "MC_MotionInVelocity" jobs is described in section "Override response V4: Homing and motion jobs (Page 536)".

Parameters

The following table shows the parameters of Motion Control instruction "MC_MotionInVelocity":

Parameter	Declaration	Data type	Default value	Description	
Axis	INPUT	TO_SpeedAxis	-	Technology object	
Enable	INPUT	BOOL	FALSE	TRUE	Start job with a positive edge The specified setpoints are used as long as the parameter is set to "TRUE".
				FALSE	End of the job with negative edge If the parameter is set from TRUE to FALSE, the setpoints are set to 0.0.
Velocity	INPUT	LREAL	0.0	Velocity setpoint Observe the dynamic limits.	
Acceleration	INPUT	LREAL	0.0	Setpoint acceleration Observe the dynamic limits.	
PositionControlled	INPUT	BOOL	TRUE	TRUE	Position-controlled mode
				FALSE	Controlled running
Busy	OUTPUT	BOOL	FALSE	TRUE	The job is being processed.
CommandAborted	OUTPUT	BOOL	FALSE	TRUE	The job was aborted by another job during execution.
Error	OUTPUT	BOOL	FALSE	TRUE	An error occurred while processing the job. The job is rejected. The cause of the error can be found in the "ErrorID" parameter.
ErrorID	OUTPUT	WORD	16#0000	Error ID (Page 652) for parameter "ErrorID"	

See also

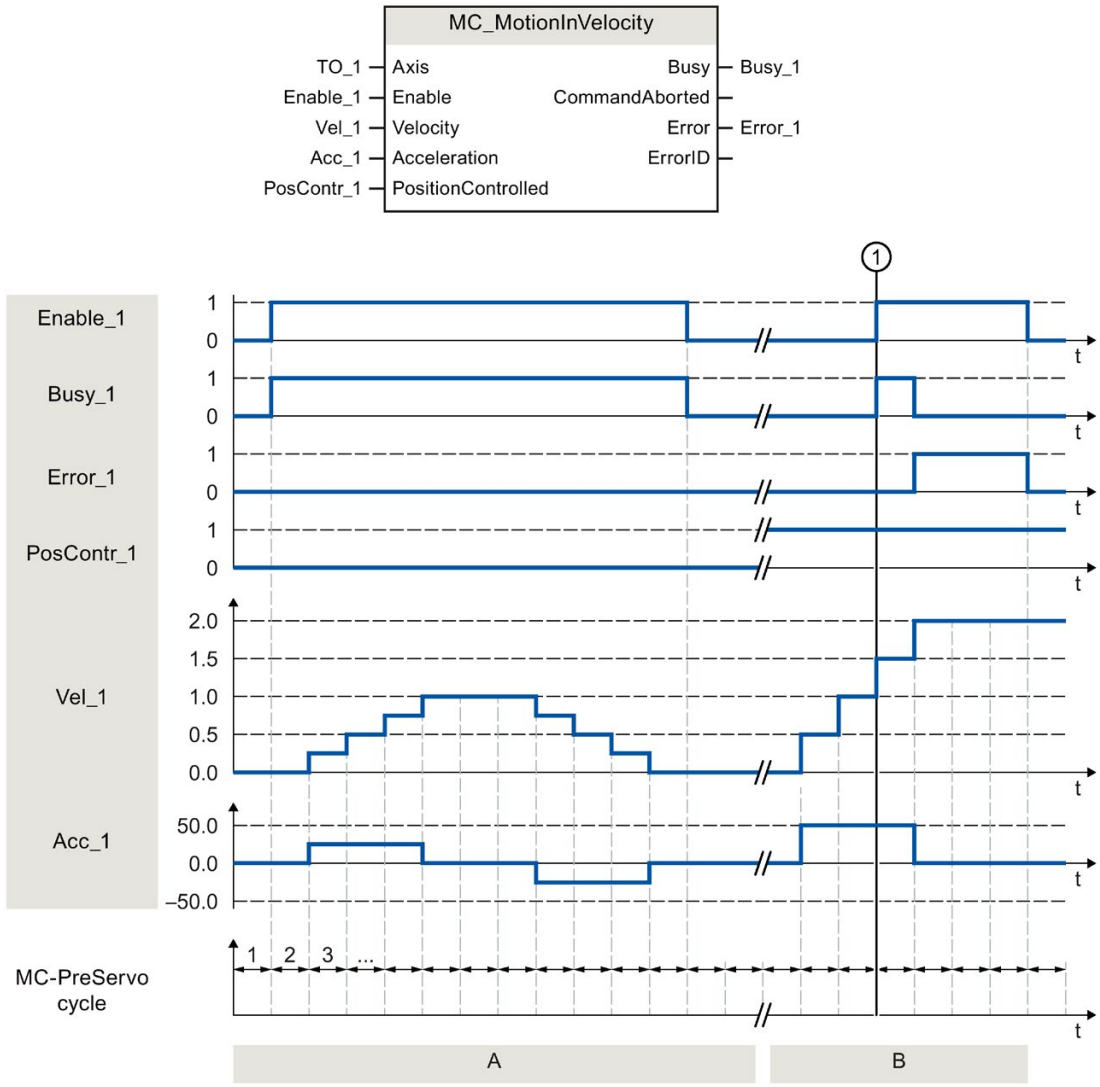
Error ID for Motion Control instructions (Page 652)

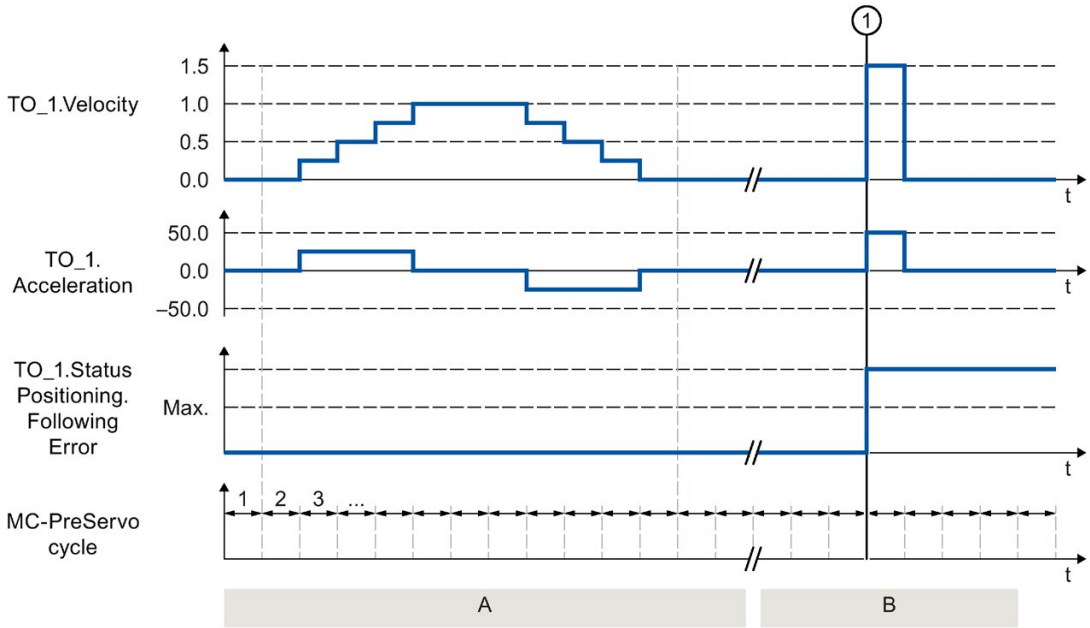
Override response V4: Homing and motion jobs (Page 536)

Motion specification via MotionIn (Page 71)

10.14.1.2 MC_MotionInVelocity: Function chart V4

Function chart: Specify motion setpoints





Section A	With "Enable_1 = TRUE" the technology object is specified cyclic in the MC-PreServo-clock velocity "Vel_1" and acceleration "Acc_1". These specifications are applied directly as setpoint velocity "TO_1.Velocity" and setpoint acceleration "TO_1.Acceleration", without hereby calculating a velocity profile. As the position monitoring "PosContr_1" is set to FALSE, no following error "TO_1.StatusPositioning.FollowingError" is determined.
Section B	The velocity and acceleration specifications are not active as long as "Enable_1" is set to FALSE. At time ①, "Enable_1" is set to TRUE. As the position monitoring "PosContr_1" is set to TRUE, a following error "TO_1.StatusPositioning.FollowingError" is determined. The velocity specification "Vel_1" and the acceleration default "Acc_1" cause a setpoint jump which exceeds the maximum permissible following error. With active position lag monitoring, the technology alarm 521 is output, and the technology object is disabled. With deactivated following error monitoring, the setpoint jump is executed with maximum dynamic.

10.14.2 MC_MotionInPosition V4

10.14.2.1 MC_MotionInPosition: Specify motion setpoints V4

Description

With the Motion Control instruction "MC_MotionInPosition", you specify the cyclic, applicable motion setpoints for position, velocity and acceleration as basic motion for the axis. No velocity profile is calculated for this, the values are directly active at the technology object. The dynamic limits are not in effect. The motion setting using MotionIn can be superimposed with an "MC_MoveSuperimposed" job (Page 462).

With the "Position" parameter, you specify the set position.

With the "Velocity" parameter, you specify the setpoint velocity. The setpoint velocity is used as a feedforward control value when velocity feedforward control is activated. If the "MotionInPosition" job is overridden by another Motion Control job, the setpoint velocity of the "MC_MotionInPosition" job is used for the velocity.

With the "Acceleration" parameter, you specify the setpoint acceleration. The setpoint acceleration only has an effect when the "MC_MotionInPosition" job is overridden by another Motion Control job. The acceleration is set to the acceleration setpoint of the "MC_MotionInPosition" job. If the acceleration setpoint is zero, zero is set when the acceleration is substituted.

Applies to

- Positioning axis
- Synchronous axis

Requirement

- The technology object has been configured correctly.
- The technology object is enabled.

Override response

The override response for "MC_MotionInPosition" jobs is described in section "Override response V4: Homing and motion jobs (Page 536)".

Parameters

The following table shows the parameters of Motion Control instruction "MC_MotionInPosition":

Parameter	Declaration	Data type	Default value	Description	
Axis	INPUT	TO_PositioningAxis	-	Technology object	
Enable	INPUT	BOOL	FALSE	TRUE	Start job with a positive edge The specified setpoints are used as long as the parameter is set to "TRUE".
				FALSE	End of the job with negative edge If the parameter is set from TRUE to FALSE, the setpoints are set to 0.0. The most recently specified value remains active for the position setpoint.
Position	INPUT	LREAL	0.0	Position setpoint	
Velocity	INPUT	LREAL	0.0	Velocity setpoint Observe the dynamic limits.	
Acceleration	INPUT	LREAL	0.0	Setpoint acceleration Observe the dynamic limits.	
Busy	OUTPUT	BOOL	FALSE	TRUE	The job is being processed.
CommandAborted	OUTPUT	BOOL	FALSE	TRUE	The job was aborted by another job during execution.
Error	OUTPUT	BOOL	FALSE	TRUE	An error occurred while processing the job. The job is rejected. The cause of the error can be found in the "ErrorID" parameter.
ErrorID	OUTPUT	WORD	16#0000	Error ID (Page 652) for the parameter "ErrorID"	

See also

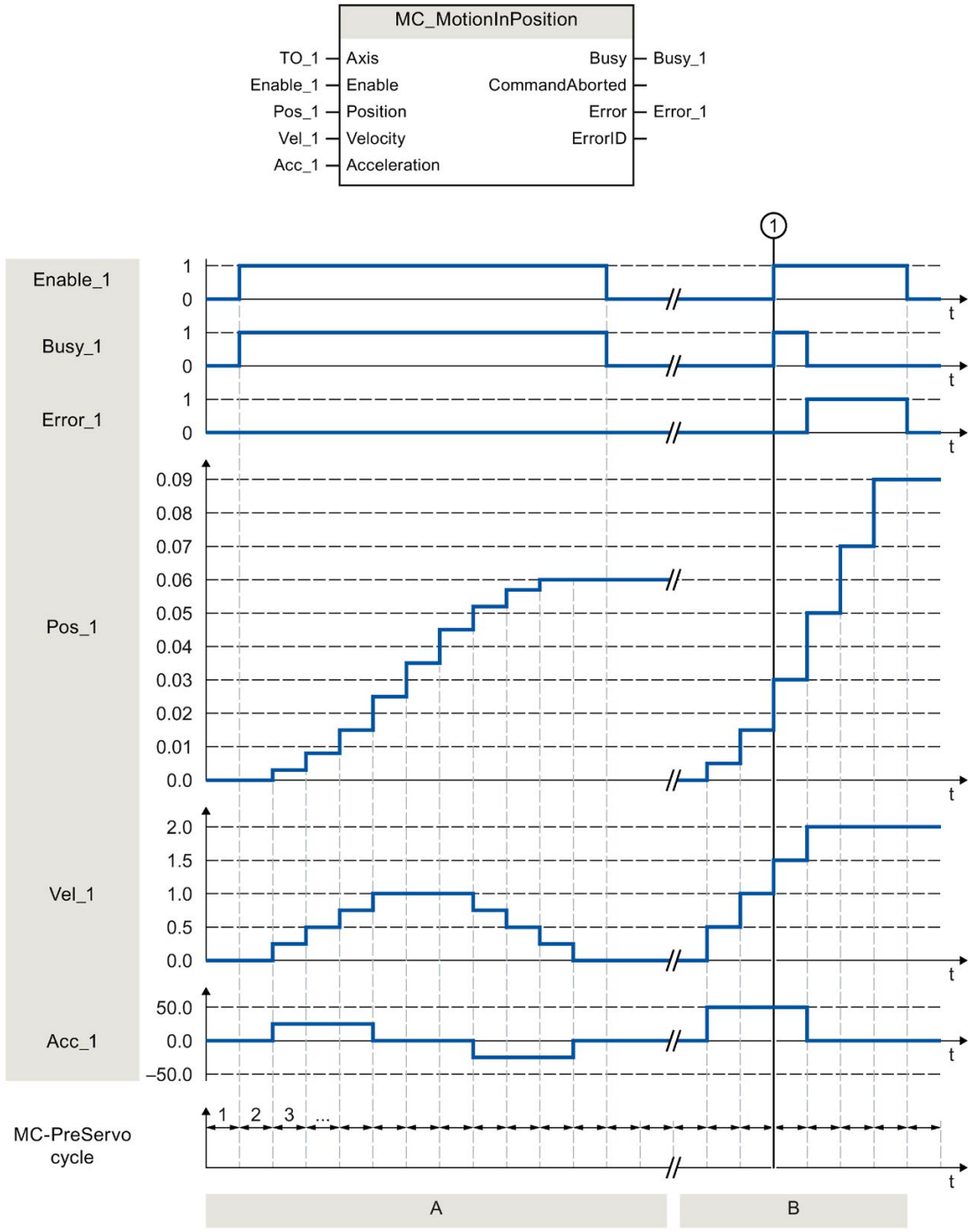
Error ID for Motion Control instructions (Page 652)

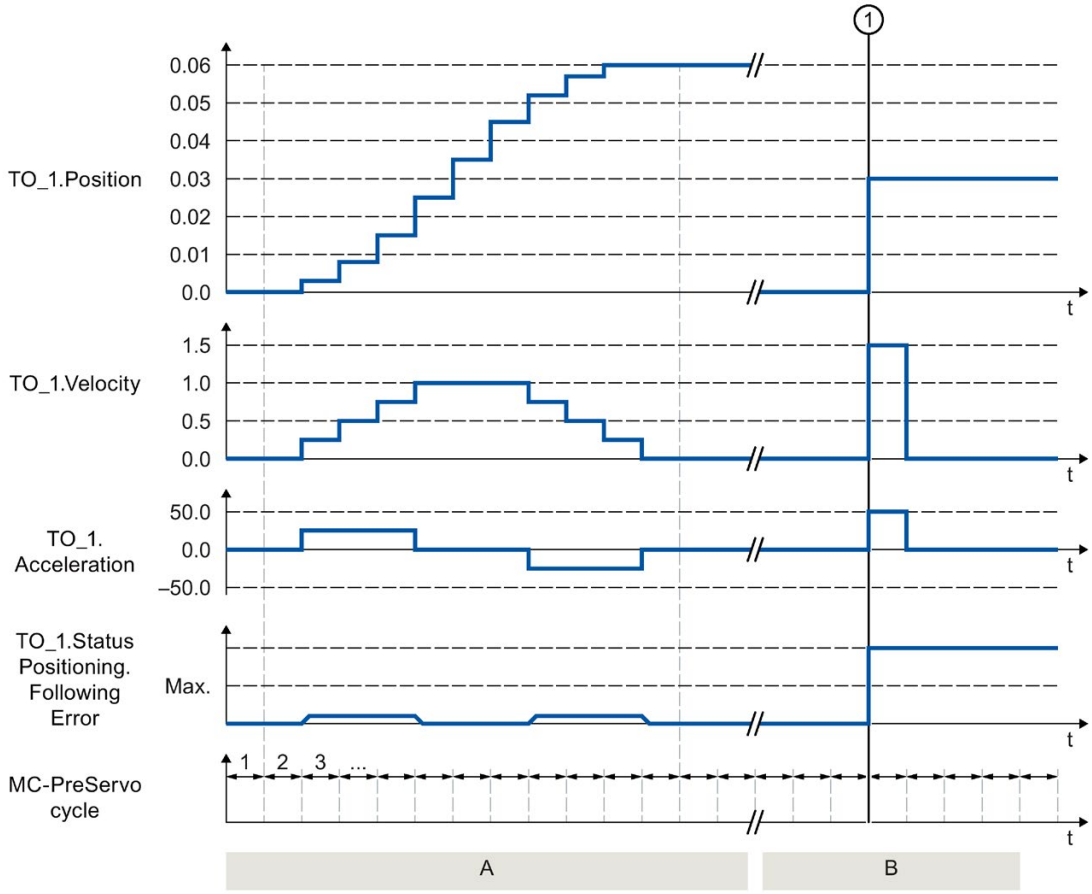
Override response V4: Homing and motion jobs (Page 536)

Motion specification via MotionIn (Page 71)

10.14.2.2 MC_MotionInPosition: Function chart V4

Function chart: Specify motion setpoints





Section A	With "Enable_1 = TRUE" the technology object is specified cyclic in the MC-PreServo-clock position "Pos_1", velocity "Vel_1" and acceleration "Acc_1". These specifications are applied directly as set position "TO_1.Position", setpoint velocity "TO_1.Velocity" and setpoint acceleration "TO_1.Acceleration", without hereby calculating a velocity profile.
Section B	The position, velocity and acceleration specifications are not active as long as "Enable_1" is set to FALSE. At time ①, "Enable_1" is set to TRUE. The default position setting "Pos_1" causes a setpoint jump which exceeds the maximum permissible following error. With active position lag monitoring, the technology alarm 521 is output, and the technology object is disabled. With deactivated following error monitoring, the setpoint jump is executed with maximum dynamic.

10.15 Torque data

10.15.1 MC_TorqueLimiting V4

10.15.1.1 MC_TorqueLimiting: Activate and deactivate force/torque limit / fixed stop detection V4

Description

With the Motion Control instruction "MC_TorqueLimiting", you activate and assign parameters for force/torque limiting and fixed stop detection. Together with a position-controlled motion job, a "Travel to fixed stop" can be realized with the fixed stop detection. In the axis configuration, you can configure whether the force/torque limiting is to relate to the drive side or the load side.

The functions of the Motion Control instruction "MC_TorqueLimiting" can be activated and deactivated before and during a motion job.

Force/torque limiting applies to

- Speed axis
- Positioning axis
- Synchronous axis

Requirements for force/torque limiting

- The technology object and the reference torque of the drive have been configured correctly.
- No enable-preventing errors are pending for the technology object (the technology object does not have to be enabled).
- The drive must support force/torque reduction. Only PROFIdrive drives with SIEMENS telegram 10x support force/torque limiting.
- Interconnection in the SINAMICS drive:
  - P1522 to a fixed value of 100%
  - P1523 to a fixed value of -100% (e.g. through interconnection to fixed value parameter P2902[i]).

Fixed stop detection applies to

- Positioning axis
- Synchronous axis

Requirement for fixed stop detection

- The fixed stop detection can only be applied to position-controlled axes. For fixed stop detection, the axis must be enabled as position-controlled axis; motion commands must be executed as position-controlled motion commands.
- The technology object has been configured correctly.
- When a drive and telegram that support force/torque limiting is used, the reference torque of the drive must be correctly configured for the technology object.
- No enable-preventing errors are pending for the technology object (the technology object does not have to be enabled).

Override response

- An "MC_TorqueLimiting" job cannot be aborted by any other Motion Control job.
- A new "MC_TorqueLimiting" job does not abort any active Motion Control jobs.
- If the high and low torque limiting is active via the "MC_TorqueRange" job, the "MC_TorqueLimiting" job is rejected with an error message and vice versa. The functions do not override one another.

Parameters

The following table shows the parameters of Motion Control instruction "MC_TorqueLimiting":

Parameter	Declaration	Data type	Default value	Description	
Axis	INPUT	TO_SpeedAxis	-	Technology object	
Enable	INPUT	BOOL	FALSE	TRUE	Activate function corresponding to input parameter Mode
Limit	INPUT	LREAL	-1.0	Value of force/torque limiting (in the configured unit of measurement) If drive and telegram do not support force/torque limiting, the specified value is irrelevant.	
				≥ 0	Use the value specified in the parameter ("0" value is permissible)
				< 0	Use the value configured in the "Torque limiting" configuration window. Tag Torque Limit: <TO>.TorqueLimiting.LimitDefaults.Torque Tag Force Limit: <TO>.TorqueLimiting.LimitDefaults.Force
Mode	INPUT	DINT	0	0	Force/torque limiting
				1	Fixed stop detection If drive and telegram support force/torque limiting, this is applied.
InClamping	OUTPUT	BOOL	FALSE	TRUE	Mode = 1: The drive is kept at the fixed stop (clamping), the axis position is within the positioning tolerance.

Parameter	Declaration	Data type	Default value	Description	
InLimitation	OUTPUT	BOOL	FALSE	TRUE	Mode = 0 and 1: Drive is operating at the force/torque limit.
Busy	OUTPUT	BOOL	FALSE	TRUE	Job is running.
Error	OUTPUT	BOOL	FALSE	TRUE	An error occurred while processing the job. The job is rejected. The cause of the error can be found in the "ErrorID" parameter.
ErrorID	OUTPUT	WORD	16#0000	Error ID (Page 652) for parameter "ErrorID"	

Changes to input parameters "Limit" and "Mode" are also transferred at the cyclic call of the Motion Control instruction when "Enable = TRUE".

See also

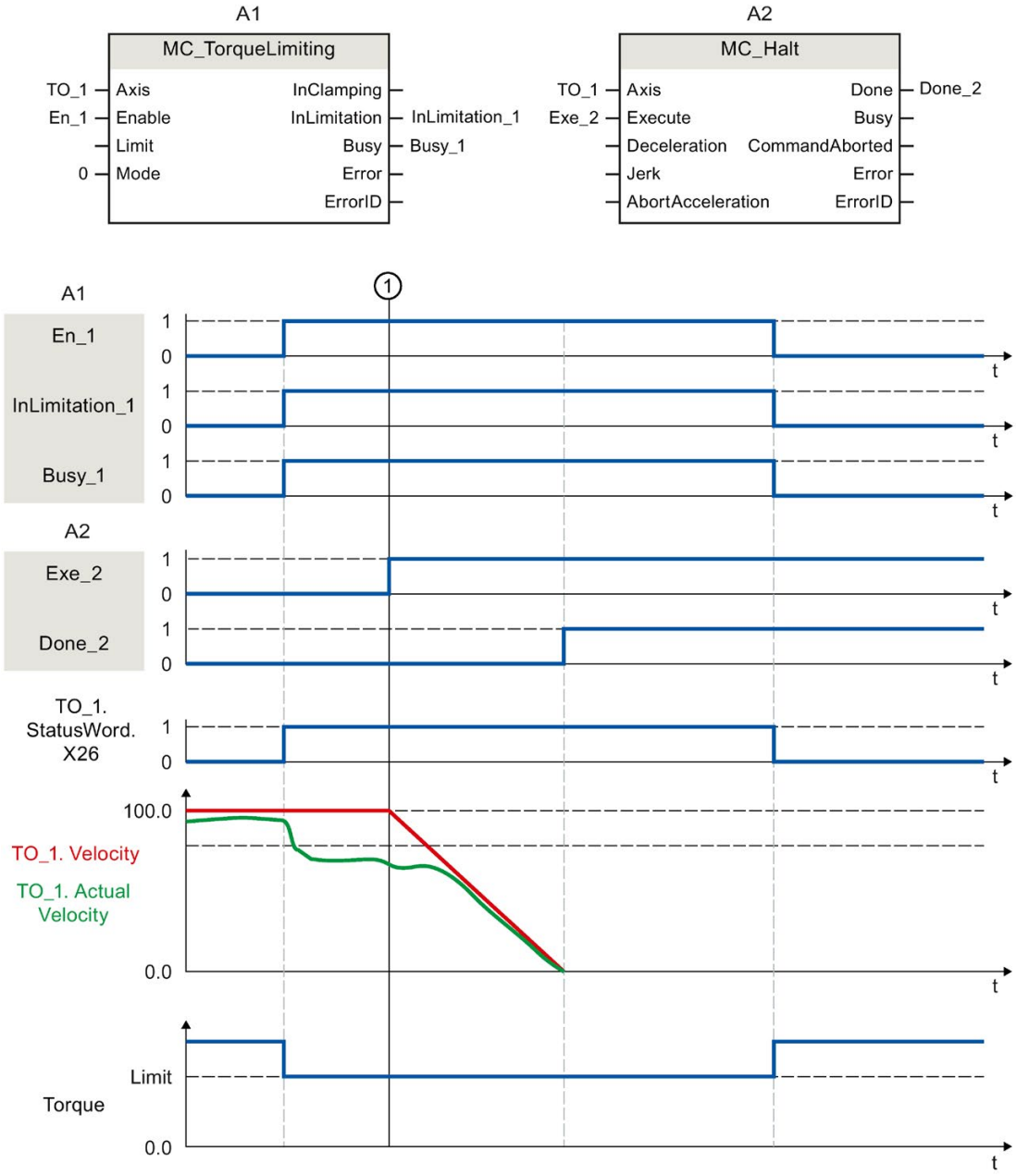
Error ID for Motion Control instructions (Page 652)

Fixed stop detection (Page 74)

Force/torque limiting (Page 73)

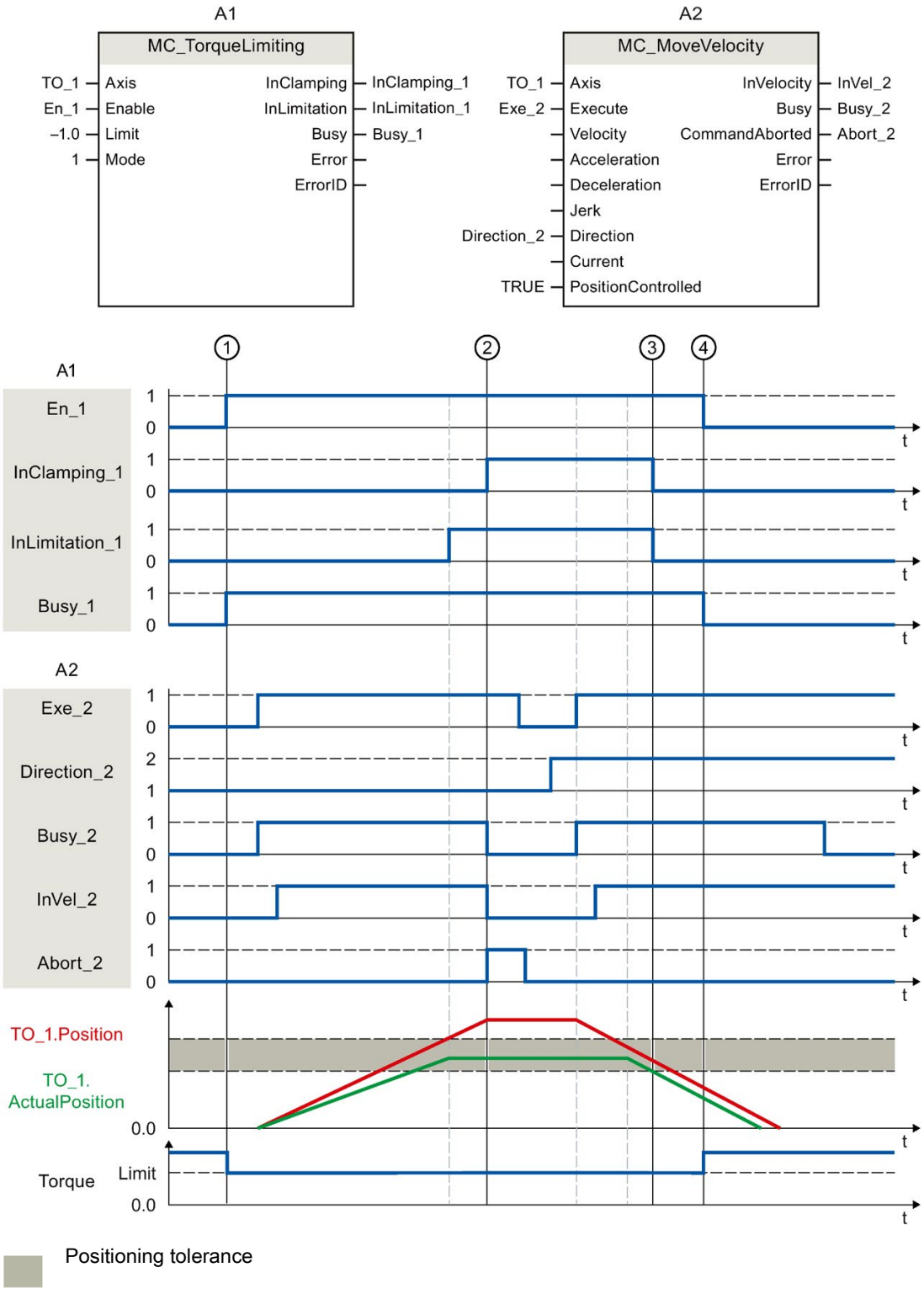
10.15.1.2 MC_TorqueLimiting: Function chart V4

Function chart: Stopping an axis when the torque limit is reached



At time ①, an "MC_Halt" job (A2) is executed on an axis with active torque limiting "MC_TorqueLimiting" (A1). Torque limiting is still active "MC_TorqueLimiting.Enable" = TRUE and any accumulated following error is retained and will be reduced with the time. When the actual velocity is "0.0" and the minimum dwell time in the standstill window has elapsed, the tag "MC_Halt.Done" shows = TRUE. When position monitoring is activated, reaching of the target position is also monitored.

Function chart: Torque limiting with fixed stop detection (mode = 1)



At time ①, a "MC_TorqueLimiting" job (A1) is initiated via "En_1". An "MC_MoveVelocity" job (A2) is executed on the axis with active torque limiting. The torque limiting is still active "MC_TorqueLimiting.Enable" = TRUE. When the following error limit ② is reached, the "MC_MoveVelocity" job is aborted with "Abort" = TRUE. The drive is kept at the fixed stop (clamping). The actual position of the axis is within the positioning tolerance. An "MC_MoveVelocity" job is once again called via the two tags "Execute" = TRUE and "Direction_2" = TRUE and the axis moves with constant velocity in the opposite direction. The clamping is hereby reduced when the positioning tolerance ③ is exited. At time ④, the torque limiting is cancelled.

10.15.2 MC_TorqueAdditive V4

10.15.2.1 MC_TorqueAdditive: Specify additive torque V4

Description

With the Motion Control instruction "MC_TorqueAdditive", you specify an additive torque for the drive to which the technology object is assigned. The torque data are transferred via the telegram 750.

With the "Value" parameter, you specify the additive setpoint torque. The specification of the additive torque setpoint is overriding. An additional torque may be positive or negative. If you invert the setpoint for the technology object, the value for the additive torque is also inverted and transferred inverted to the drive.

Applies to

- Positioning axis
- Speed axis
- Synchronous axis

Requirement

- The technology object has been configured correctly.
- The technology object is enabled.
- The drive is connected via PROFIdrive telegram.
- Telegram 750 is configured.

  Telegram 750 is available for SINAMICS drives V4.9 and higher.

Override response

- An "MC_TorqueAdditive" job is not aborted by any other Motion Control job.
- A new "MC_TorqueAdditive" job does not abort any active Motion Control jobs.

Parameters

The following table shows the parameters of Motion Control instruction "MC_TorqueAdditive":

Parameter	Declaration	Data type	Default value	Description	
Axis	INPUT	TO_SpeedAxis	-	Technology object	
Enable	INPUT	BOOL	FALSE	TRUE	The specified setpoint is used as long as the parameter is set to TRUE.
				FALSE	The additive torque transferred to the drive is zero.
Value	INPUT	LREAL	0.0	Additive setpoint torque Permissible values: -1.0E12 to 1.0E12	
Busy	OUTPUT	BOOL	FALSE	TRUE	The job is being processed.
Error	OUTPUT	BOOL	FALSE	TRUE	An error occurred while processing the job. The job is rejected. The cause of the error can be found in the "ErrorID" parameter.
ErrorID	OUTPUT	WORD	16#0000	Error ID (Page 652) for parameter "ErrorID"	

See also

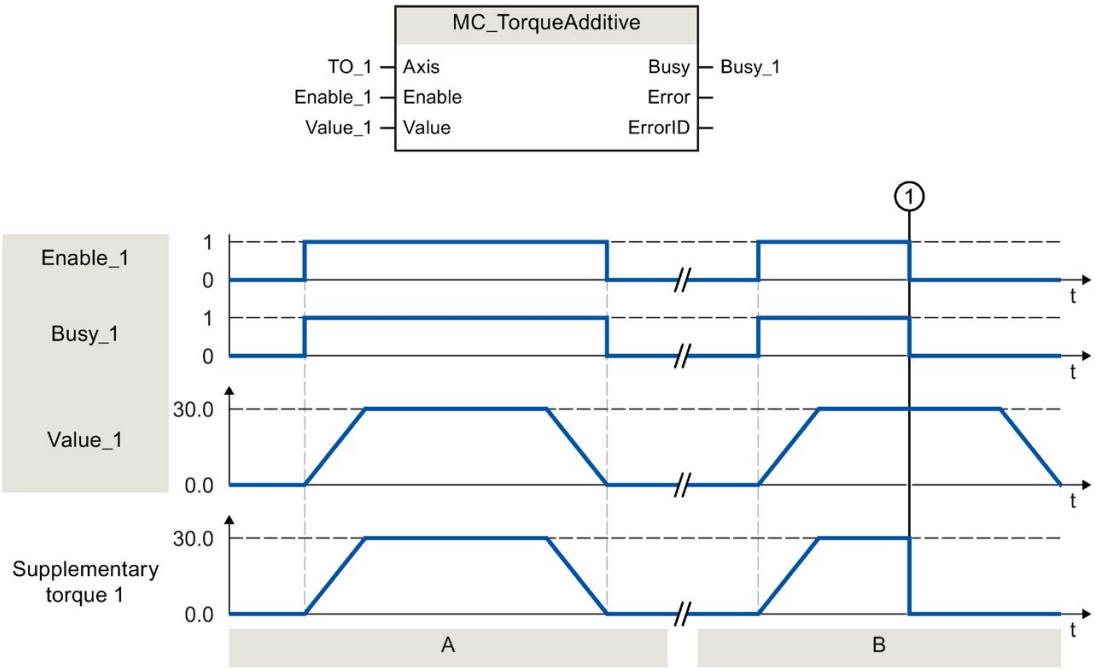
Error ID for Motion Control instructions (Page 652)

PROFIdrive telegrams (Page 40)

Additive setpoint torque (Page 76)

10.15.2.2 MC_TorqueAdditive: Function chart V4

Function chart: Activate/deactivate additive setpoint torque



Section A	With "Enable_1 = TRUE", an additive setpoint torque "Value_1" is specified for the drive assigned to the technology object. This setting is transferred to the drive parameter "p1511 - Supplementary torque 1" using telegram 750.
Section B	With "Enable_1 = TRUE", an additive setpoint torque "Value_1" is specified for the drive assigned to the technology object. This setting is transferred to the drive parameter "p1511 - Supplementary torque 1" using telegram 750. The additive setpoint torque is first built up. At time ①, "Enable_1" is already set to FALSE, before the additive setpoint torque is reduced again. The reduction of the torque setpoint is transmitted directly to the drive.

10.15.3 MC_TorqueRange V4

10.15.3.1 MC_TorqueRange: Set high and low torque limits V4

Description

With the Motion Control instruction "MC_TorqueRange", you can specify an upper and lower torque limit to the drive assigned to the technology object. The torque data are transferred via the telegram 750.

With the "UpperLimit" parameter you specify the upper torque limit and with "LowerLimit" the lower torque limit. The specification of the torque limits has smoothing effect on the movements. If you invert the setpoints for the technology object, the values for the high and low torque limit are also inverted and transferred inverted to the drive.

If the high and low torque limits are active, the following monitors and limits are disabled by default:

- Following error monitoring
- Time limitations for positioning and standstill monitoring

Monitoring remains in effect if you have selected the option "Leave position-related monitoring enabled" under "Technology object > Configuration > Extended parameters > Limits > Torque limit".

Applies to

- Positioning axis
- Speed axis
- Synchronous axis

Requirement

- The technology object has been configured correctly.
- The drive is connected via PROFIdrive telegram.
- Telegram 750 is configured.

  Telegram 750 is available for SINAMICS drives V4.9 and higher.

Override response

- An "MC_TorqueRange" job is not aborted by any other Motion Control job.
- A new "MC_TorqueRange" job does not abort any active Motion Control jobs.
- If the torque limiting is active via the "MC_TorqueLimiting" job, the "MC_TorqueRange" job is rejected with an error message and vice versa. The functions do not override one another.

Parameters

The following table shows the parameters of Motion Control instruction "MC_TorqueRange":

Parameter	Declaration	Data type	Default value	Description	
Axis	INPUT	TO_SpeedAxis	-	Technology object	
Enable	INPUT	BOOL	FALSE	TRUE	The specified values are used as long as the TRUE parameter is set.
				FALSE	No values for the high and low torque limit are transferred to the drive.
UpperLimit	INPUT	LREAL	1.0 E12	Upper torque limit (in the configured unit)	
				Permitted range of values: -1.0 E12 to 1.0 E12 The value of the parameter "UpperLimit" must not be greater than the value of the parameter "LowerLimit".	
LowerLimit	INPUT	LREAL	-1.0 E12	Lower torque limit (in the configured unit)	
				Permitted range of values: -1.0 E12 to 1.0 E12 The value of the parameter "LowerLimit" must not be less than the value of the parameter "UpperLimit".	
Busy	OUTPUT	BOOL	FALSE	TRUE	The job is being processed.
Error	OUTPUT	BOOL	FALSE	TRUE	An error occurred while processing the job. The job is rejected. The cause of the error can be found in the "ErrorID" parameter.
ErrorID	OUTPUT	WORD	16#0000	Error ID (Page 652) for parameter "ErrorID"	

See also

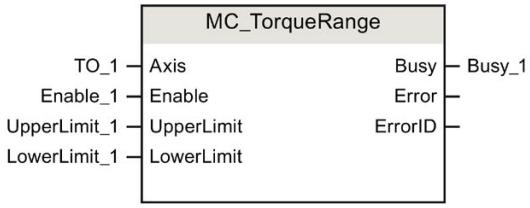
Error ID for Motion Control instructions (Page 652)

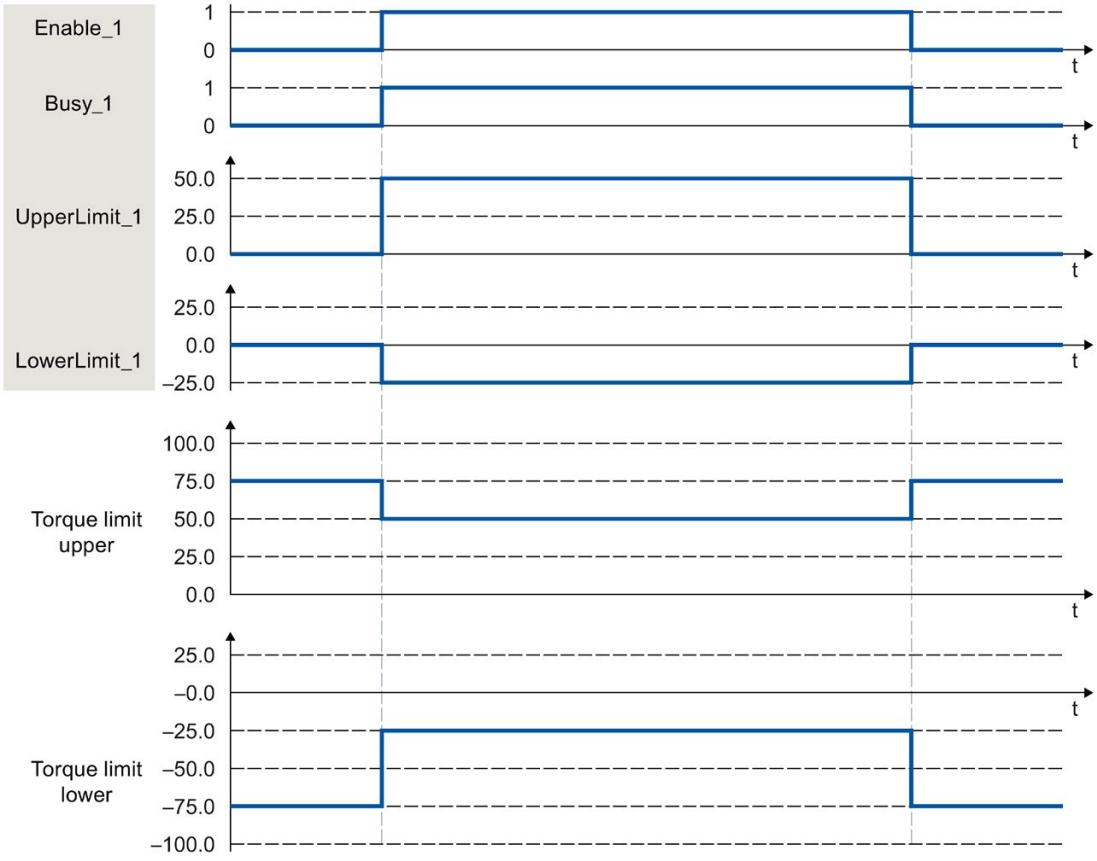
PROFIdrive telegrams (Page 40)

Permissible torque range (Page 76)

10.15.3.2 MC_TorqueRange: Function chart V4

Function chart: Set high and low torque limits





With "Enable_1 = TRUE" an upper torque limit "UpperLimit_1" and a lower torque limit "LowerLimit_1" are specified to the drive assigned to the technology object. These settings are transferred directly to the drive parameters "p1522 - Torque limit upper" and "p1523 - Torque limit lower" using telegram 750. If "Enable_1" is reset to FALSE, the upper and lower torque limits are no longer active.

10.16 Override response of Motion Control jobs V4

10.16.1 Override response V4: Homing and motion jobs

The following table shows how a new Motion Control job affects active homing and motion jobs:

⇒ Active job ⇓ New job	MC_Home "Mode" = 2, 8, 10	MC_Home ("Mode" = 3, 5)	MC_Halt MC_MoveAbsolute MC_MoveRelative MC_MoveVelocity MC_MoveJog	MC_MoveSuper-imposed	MC_MotionIn Velocity MC_MotionIn Position
MC_Home "Mode" = 3, 5	A	A	A	A	A
MC_Home "Mode" = 9	A	-	-	-	-
MC_Halt MC_MoveAbsolute MC_MoveRelative MC_MoveVelocity MC_MoveJog MC_MotionInVelocity MC_MotionInPosition	-	A	A	A	A
MC_MoveSuperimposed	-	-	-	A	-
MC_GearIn	-	A	A	A	-
MC_GearInPos pending[1)]	-	-	-	-	-
MC_GearInPos active[2)]	-	A	A	A	-
MC_CamIn pending[1)]	-	-	-	-	-
MC_CamIn active[2)]	-	A	A	A	-

A The running job is aborted with "CommandAborted" = TRUE.

- No effect. Running job continues to be executed.

1) "Busy" = TRUE, "StartSync" = FALSE, "InSync" = FALSE

2) "Busy" = TRUE, "StartSync" or "InSync" = TRUE

10.16.2 Override response V4: Synchronous operation jobs

The following table shows how a new Motion Control job affects the motion of the axis on active synchronous operation jobs:

⇒ Active job ⇓ New job	MC_GearIn	MC_GearInPos pending[1]	MC_GearInPos active[2]	MC_Phasing-Absolute MC_Phasing-Relative	MC_CamIn pending[1]	MC_CamIn active[2]
MC_Home "Mode" = 3, 5	A	-	-	-	-	-
MC_Halt	A	-	A	A	-	A
MC_MoveAbsolute MC_MoveRelative MC_MoveVelocity MC_MoveJog	A	-	A	A	-	A
MC_MotionInVelocity MC_MotionInPosition	A	A	A	-	A	A
MC_MoveSuperimposed	-	-	-	-	-	-
MC_GearIn	A	A	A	A	A	A
MC_GearInPos pending[1]	-	A	-	-	A	-
MC_GearInPos active[2]	A	A	A	A	A	A
MC_PhasingAbsolute MC_PhasingRelative	-	-	-	A	-	-
MC_CamIn pending[1]	-	A	-	-	A	-
MC_CamIn active[2]	A	A	A	A	A	A

A The running job is aborted with "CommandAborted" = TRUE.

- No effect. Running job continues to be executed.

1) A pending synchronous operation ("Busy" = TRUE, "StartSync" = FALSE, "InSync" = FALSE) does not cancel active commands. A pending synchronous operation job can only be overridden by a further synchronous operation job on the same following axis. Cancellation is possible with "MC_Power".

2) The status "Busy" = TRUE, "StartSync" or "InSync" = TRUE corresponds to active synchronous operation.

10.16.3 Override response V4: Measuring input jobs

The following table shows which new Motion Control jobs will override active measuring input jobs:

⇒ Active job ⇓ New job	MC_MeasuringInput	MC_MeasuringInputCyclic
MC_Home "Mode" = 2, 3, 5, 8, 9, 10	A	A
MC_Home "Mode" = 0, 1, 6, 7	-	-
MC_MeasuringInput MC_MeasuringInputCyclic MC_AbortMeasuringInput	A	A

A The running job is aborted with "CommandAborted" = TRUE.

- No effect. Running job continues to be executed.

Appendix A

A.1 Tags of the speed axis technology object

A.1.1 Legend

Tag	Name of the tag	
Data type	Data type of the tag	
Values	Value range of the tag - minimum value to maximum value If no specific value is shown, the value range limits of the relevant data type apply or the information under "Description".	
W	Effectiveness of changes in the technology data block	
	DIR	Direct: Values are changed directly and take effect at the start of the next MC-Servo [OB91].
	CAL	At call of Motion Control instruction: Values are changed directly and take effect at the start of the next MC-Servo [OB91] after the call of the corresponding Motion Control instruction in the user program.
	RES	Restart: Changes to the start value in the load memory are made using the extended instruction "WRIT_DBL" (write to DB in load memory). Changes will not take effect until after restart of the technology object.
	RON	Read only: The tag cannot and must not be changed during runtime of the user program.
Description	Description of the tag	

Access to the tags is with "<TO>.<tag name>". The placeholder <TO> represents the name of the technology object.

A.1.2 Actual values and setpoints (speed axis)

The following tags indicate the setpoint and actual values of the technology object.

Tags

Legend (Page 539)

Tag	Data type	Values	W	Description
Velocity	LREAL	-	RON	Velocity setpoint / speed setpoint
ActualSpeed	LREAL	-	RON	Actual speed of the motor (with analog setpoint = 0.0)
Acceleration	LREAL	-	RON	Setpoint acceleration

A.1.3 Variable simulation (speed axis)

The tag structure <TO>.Simulation.<tag name> contains the configuration of the simulation mode. In simulation mode, you can simulate axes without a real drive in the CPU.

Tags

Legend (Page 539)

Tag		Data type	Values	W	Description
Simulation.		STRUCT			
	Mode	UDINT	-	RES[1)]	Simulation mode 0: No simulation, normal operation 1: Simulation mode

1) Technology version V2.0: RON

A.1.4 VirtualAxis tag (speed axis)

The tag structure <TO>.VirtualAxis.<tag name> contains the configuration of the simulation mode. In simulation mode, you can simulate axes without a real drive in the CPU.

Tags

Legend (Page 539)

Tag		Data type	Values	W	Description
VirtualAxis.		STRUCT			
	Mode	UDINT	-	RON	Virtual axis 0: No virtual axis 1: Axis is always and exclusively operated as virtual axis

A.1.5 Actor tags (speed axis)

The tag structure <TO>.Actor.<tag name> contains the controller-side configuration of the drive.

Tags

Legend (Page 539)

Tag	Data type	Values	W	Description
Actor.	STRUCT			
Type	DINT	-	RON	Drive connection 0: Analog output 1: PROFIdrive telegram
InverseDirection	BOOL	-	RES	Inversion of the setpoint FALSE: no TRUE: Yes
DataAdaption	DINT	-	RES	Automatic transfer of the drive values reference speed, maximum speed and reference torque in the device 0: No automatic transfer, manual configuration of values 1: Automatic transfer of values configured in the drive to the configuration of the technology object
Efficiency	LREAL	0.0 to 1.0	RES	Efficiency of gear
Interface.	STRUCT			
AddressIn	VREF	0 to 65535	RON	Input address for the PROFIdrive telegram
AddressOut	VREF	0 to 65535	RON	Output address for the PROFIdrive telegram or the analog setpoint
EnableDriveOutput	BOOL	-	RES	"Enable output" for analog drives FALSE: disabled TRUE: Activated
EnableDriveOutputAddress	VREF	0 to 65535	RON	Address for the "Enable output" for analog setpoint
DriveReadyInput	BOOL	-	RES	"Ready input" for analog drives The analog drive signals its readiness to receive speed setpoints. FALSE: disabled TRUE: Activated
DriveReadyInputAddress	VREF	0 to 65535	RON	Address for the "Enable input" for analog setpoint
EnableTorqueData	BOOL	-	RES	Torque data FALSE: Deactivated TRUE: Activated
TorqueDataAddressIn	VREF	0 to 65535	RON	Input Address of the Telegram 750
TorqueDataAddress-Out	VREF	0 to 65535	RON	Output address of the telegram 750

Tag			Data type	Values	W	Description
	DriveParameter.					
		ReferenceSpeed	LREAL	0.0 to 1.0E12	RES	Reference value (100%) for the speed setpoint (N-set) of the drive The speed setpoint is transferred in the PROFIdrive telegram as a normalized value from -200% to 200% of the "ReferenceSpeed". For setpoint specification via an analog output, the analog output can be operated in the range from -117% to 117%, provided the drive permits this.
		MaxSpeed	LREAL	0.0 to 1.0E12	RES	Maximum value for the speed setpoint of the drive (N-set) (PROFIdrive: MaxSpeed ≤ 2 × ReferenceSpeed Analog setpoint: MaxSpeed ≤ 1.17 × ReferenceSpeed)
		ReferenceTorque	LREAL	0.0 to 1.0E12	RES	Reference torque of drive (p2003). Valid for standard motor setting.

A.1.6 Torque Limiting tag (speed axis)

The tag structure <TO>.TorqueLimiting.<tag name> contains the configuration of the torque limiting.

Tags

Legend (Page 539)

Tag			Data type	Values	W	Description
TorqueLimiting.			STRUCT			
	LimitBase		DINT	-	RES	Torque limiting 0: Motor side 1: Load side
	PositionBasedMonitorings		DINT	-	RES	Positioning and following error monitoring 0: Monitoring deactivated 1: Monitoring activated
	LimitDefaults.		STRUCT			
		Torque	LREAL	0.0 to 1.0E12	CAL	Limiting torque
		Force	LREAL	0.0 to 1.0E12	CAL	Limiting force

A.1.7 LoadGear tags (speed axis)

The tag structure <TO>.LoadGear.<tag name> contains the configuration of the load gear.

Tags

Legend (Page 539)

Tag		Data type	Value range	W	Description
LoadGear.		STRUCT			
	Numerator	UDINT	1 to 4294967295	RES	Load gear numerator
	Denominator	UDINT	1 to 4294967295	RES	Load gear denominator

A.1.8 Units tags (speed axis)

The tag structure <TO>.Units.<tag name> shows the set technological units.

Tags

Legend (Page 539)

Tag		Data type	Values	W	Description	
Units.		STRUCT				
	VelocityUnit	UDINT	-	RON	Unit for velocity	
					1082	1/s
					1083	1/min
					1528	1/h
	TimeUnit	UDINT	-	RON	Unit for time	
					1054	s
	TorqueUnit	UDINT	-	RON	Unit for torque	
					1126	Nm
					1128	kNm
					1529	lbf in (pound-force-inch)
					1530	lbf ft
					1531	ozf in (ounce-force-inch)
					1532	ozf ft
					1533	pdl in (poundal-inch)
					1534	pdl ft
	ForceUnit	UDINT	-	RON	Unit for force	
					1120	N
					1122	kN
					1094	lbf (pound-force)
					1093	ozf (ounce-force)
					1535	pdl (poundals)

A.1.9 DynamicLimits tags (speed axis)

The tag structure <TO>.DynamicLimits.<tag name> contains the configuration of the dynamic limits. During Motion Control, no dynamic values greater than the dynamic limits are permitted. If you have specified greater values in a Motion Control instruction, then motion is performed using the dynamic limits, and a warning is indicated (alarm 501 to 503 - Dynamic values were limited).

Tags

Legend (Page 539)

Tag		Data type	Values	W	Description
DynamicLimits.		STRUCT			
	MaxVelocity	LREAL	0.0 to 1.0E12	RES	Maximum permissible velocity of the axis
	MaxAcceleration	LREAL	0.0 to 1.0E12	DIR	Maximum permissible acceleration of the axis
	MaxDeceleration	LREAL	0.0 to 1.0E12	DIR	Maximum permissible deceleration of the axis
	MaxJerk	LREAL	0.0 to 1.0E12	DIR	Maximum permissible jerk on the axis

A.1.10 DynamicDefaults tags (speed axis)

The tag structure <TO>.DynamicDefaults.<tag name> contains the configuration of the dynamic defaults. These settings will be used when you specify a dynamic value less than 0.0 in a Motion Control instruction (exceptions: MC_MoveJog.Velocity, MC_MoveVelocity.Velocity). Changes to the default dynamic values will be applied at the next positive edge at the "Execute" parameter of a Motion Control instruction.

Tags

Legend (Page 539)

Tag		Data type	Values	W	Description
DynamicDefaults.		STRUCT			
	Velocity	LREAL	0.0 to 1.0E12	CAL	Default velocity
	Acceleration	LREAL	0.0 to 1.0E12	CAL	Default acceleration
	Deceleration	LREAL	0.0 to 1.0E12	CAL	Default deceleration
	Jerk	LREAL	0.0 to 1.0E12	CAL	Default jerk
	EmergencyDeceleration	LREAL	0.0 to 1.0E12	DIR	Emergency stop deceleration

A.1.11 Override tags (speed axis)

The tag structure <TO>.Override.<tag name> contains the configuration for the override parameters. The override parameters are used to apply a correction percentage to default values. An override change takes effect immediately, and is performed with the dynamic settings in effect in the Motion Control instruction.

Tags

Legend (Page 539)

Tag		Data type	Values	W	Description
Override.		STRUCT			
	Velocity	LREAL	0.0 to 200.0%	DIR	Velocity or speed override Percentage correction of the velocity/speed

A.1.12 StatusDrive tags (speed axis)

The tag structure <TO>.StatusDrive.<tag name> indicates the status of the drive.

Tags

Legend (Page 539)

Tag		Data type	Values	W	Description
StatusDrive.		STRUCT			
	InOperation	BOOL	-	RON	Operational status of the drive FALSE: Drive not ready. Setpoints will not be executed. TRUE: Drive ready. Setpoints can be executed.
	CommunicationOK	BOOL	-	RON	Cyclic BUS communication between controller and drive FALSE: Not established TRUE: Established
	Error	BOOL	-	RON	FALSE: No drive error TRUE: Drive error
	AdaptionState	DINT	-	RON	Status of automatic data transfer of drive parameters 0: "NOT_ADAPTED" (Data not transferred) 1: "IN_ADAPTION" (Data transfer in progress) 2: "ADAPTED" (Data transfer complete) 3: "NOT_APPLICABLE" (Data transfer not selected, not possible) 4: "ADAPTION_ERROR" (Error during data transfer)

A.1.13 StatusTorqueData tags (speed axis)

The tag structure <TO>.StatusTorqueData.<tag name> indicates the status of the torque.

Tags

Legend (Page 539)

Tag		Data type	Value range	W	Description
StatusTorqueData.		STRUCT			
	CommandAdditiveTorqueActive	DINT	-	RON	Additive torque setpoint function 0: Deactivated 1: Activated
	CommandTorqueRangeActive	DINT	-	RON	Torque range above high and low limit of the torque function 0: Deactivated 1: Activated
	ActualTorque	LREAL	-1.0E12 to 1.0E12	RON	Actual torque of the axis in the technological unit of the TO for torque

A.1.14 StatusMotionIn tags (speed axis)

The tag structure <TO>.StatusMotionIn.<tag name> indicates the motion status.

Tags

Legend (Page 539)

Tag		Data type	Value range	W	Description
StatusMotionIn.		STRUCT			
	FunctionState	DINT	-	RON	0: No MotionIn function active 1: MotionInVelocity active 2: MotionInPosition active

A.1.15 StatusWord tag (speed axis)

The <TO>.StatusWord tag contains the status information of the technology object.

Information on the evaluation of the individual bits (e.g. bit 0 "Enable") can be found in the section Evaluating StatusWord, ErrorWord and WarningWord (Page 359).

Tag

Legend (Page 539)

Tag	Data type	Values	W	Description
StatusWord	DWORD	-	RON	Status data of the technology object
Bit 0	-	-	-	"Enable" Enable status 0: Technology object disabled 1: Technology object enabled
Bit 1	-	-	-	"Error" 0: No error present 1: Error present
Bit 2	-	-	-	"RestartActive" 0: No "Restart" active 1: "Restart" active. The technology object is being reinitialized.
Bit 3	-	-	-	"OnlineStartValuesChanged" 0: "Restart" tags unchanged 1: Change to "Restart" tags. For the changes to be applied, the technology object must be reinitialized.
Bit 4	-	-	-	"ControlPanelActive" Axis control panel 0: Deactivated 1: Activated
Bit 5	-	-	-	Reserved
Bit 6	-	-	-	"Done" 0: Motion job is running, or Axis control panel enabled 1: No motion job is running and axis control panel disabled
Bit 7	-	-	-	Reserved
Bit 8	-	-	-	Reserved
Bit 9	-	-	-	"JogCommand" 0: No "MC_MoveJog" job running 1: "MC_MoveJog" job running
Bit 10	-	-	-	"VelocityCommand" 0: No "MC_MoveVelocity" job running 1: "MC_MoveVelocity" job running
Bit 11	-	-	-	Reserved
Bit 12	-	-	-	"ConstantVelocity" 0: Axis is accelerating or decelerating. 1: Velocity setpoint reached. The axis is traversing at this constant velocity or is at a standstill.

Tag	Data type	Values	W	Description
Bit 13	-	-	-	"Accelerating" 0: No acceleration process active 1: Acceleration process active
Bit 14	-	-	-	"Decelerating" 0: No deceleration process active 1: Deceleration process active
Bit 15... Bit 24	-	-	-	Reserved
Bit 25	-	-	-	"AxisSimulation" 0: No simulation 1: Simulation is active
Bit 26	-	-	-	"TorqueLimitingCommand" 0: No "MC_TorqueLimiting" job is running 1: "MC_TorqueLimiting" job is running
Bit 27	-	-	-	"InLimitation" 0: Drive is not operating at the torque limit 1: Drive is operating at the torque limit
Bit 28... Bit 31	-	-	-	Reserved

A.1.16 ErrorWord tag (speed axis)

The <TO>.ErrorWord tag indicates technology object errors (technology alarms).

Information on the evaluation of the individual bits (e.g. bit 3 "CommandNotAccepted") can be found in the Evaluating StatusWord, ErrorWord and WarningWord (Page 359) section.

Tag

Legend (Page 539)

Tag	Data type	Values	W	Description
ErrorWord	DWORD	-	RON	
Bit 0	-	-	-	"SystemFault" System error
Bit 1	-	-	-	"ConfigFault" Configuration error One or more configuration parameters are inconsistent or invalid.
Bit 2	-	-	-	"UserFault" Error in user program at a Motion Control instruction or its use
Bit 3	-	-	-	"CommandNotAccepted" Command cannot be executed. A Motion Control instruction cannot be executed because necessary requirements have not been met.
Bit 4	-	-	-	"DriveFault" Error in drive
Bit 5	-	-	-	Reserved
Bit 6	-	-	-	"DynamicError" Specified dynamic values are limited to permissible values.
Bit 7	-	-	-	"CommunicationFault" Communication error Missing or faulty communication.
Bit 8	-	-	-	Reserved
Bit 9	-	-	-	Reserved
Bit 10	-	-	-	Reserved
Bit 11	-	-	-	Reserved
Bit 12	-	-	-	Reserved
Bit 13	-	-	-	"PeripheralError" Error accessing a logical address
Bit 14	-	-	-	Reserved
Bit 15	-	-	-	"AdaptionError" Error during data transfer
Bit 16... Bit 31	-	-	-	Reserved

A.1.17 ErrorDetail tags (speed axis)

The tag structure <TO>.ErrorDetail.<tag name> contains the alarm number and the effective local alarm reaction for the technology alarm that is currently pending for the technology object.

You can find a list of the technology alarms and alarm reactions in the Technology alarms (Page 626) appendix.

Tags

Legend (Page 539)

Tag		Data type	Values	W	Description
ErrorDetail.		STRUCT			
	Number	UDINT	-	RON	Alarm number
	Reaction	DINT	0 to 5	RON	Effective alarm reaction 0: No reaction 1: Stop with current dynamic values 2: Stop with maximum dynamic values 3: Stop with emergency stop ramp 4: Remove enable 5: Track setpoints

A.1.18 WarningWord tag (speed axis)

The <TO>.WarningWord tag indicates pending warnings for the technology object.

Information on the evaluation of the individual bits (e.g. bit 13 "PeripheralWarning") can be found in the Evaluating StatusWord, ErrorWord and WarningWord (Page 359) section.

Tag

Legend (Page 539)

Tag	Data type	Values	W	Description
WarningWord	DWORD	-	RON	
Bit 0	-	-	-	"SystemWarning" A system-internal error has occurred.
Bit 1	-	-	-	"ConfigWarning" Configuration error One or several configuration parameters are adjusted internally.
Bit 2	-	-	-	"UserWarning" Error in user program at a Motion Control instruction or its use
Bit 3	-	-	-	"CommandNotAccepted" Command cannot be executed. A Motion Control instruction cannot be executed because necessary requirements have not been met.
Bit 4	-	-	-	"DriveWarning" Error in drive
Bit 5	-	-	-	Reserved
Bit 6	-	-	-	"DynamicWarning" Specified dynamic values are limited to permissible values.
Bit 7				"CommunicationWarning" Communication error Missing or faulty communication.
Bit 8... Bit 12				Reserved
Bit 13				"PeripheralWarning" Error accessing a logical address
Bit 14				Reserved
Bit 15				"AdaptionWarning" Error in automatic data transfer
Bit 16... Bit 31	-	-	-	Reserved

A.1.19 ControlPanel tags (speed axis)

The tag structure <TO>.ControlPanel.<tag name> contains no user-relevant data. This tag structure is internally used.

Tags

Legend (Page 539)

Tag				Data type	Values	W	Description
ControlPanel.				STRUCT			
	Input.			STRUCT			
		TimeOut		LREAL	100 to 60000	DIR	
		EsLifeSign		UDINT	-	DIR	
		Command.		ARRAY [1..2] OF STRUCT			
			ReqCounter	UDINT	-	DIR	-
			Type	UDINT	-	DIR	-
			Position	LREAL	-	DIR	-
			Velocity	LREAL	-	DIR	-
			Acceleration	LREAL	-	DIR	-
			Deceleration	LREAL	-	DIR	-
			Jerk	LREAL	-	DIR	-
			Param	LREAL	-	DIR	-
	Output.			STRUCT			
		RTLifeSign		UDINT	-	RON	
		Command.		ARRAY [1..2] OF STRUCT			
			AckCounter	UDINT	-	RON	-
			Error	BOOL	-	RON	-
			ErrorID	UDINT	-	RON	-
			Done	BOOL	-	RON	-
			Aborted	BOOL	-	RON	-

A.1.20 InternalToTrace tags (speed axis)

The tag structure <TO>.InternalToTrace.<tag name> contains no user-relevant data. This tag structure is internally used.

Tags

Legend (Page 539)

Tag		Data type	Values	W	Description
InternalToTrace.		ARRAY [1..4] OF STRUCT			
	Id	DINT	-	DIR	-
	Value	LREAL	-	DIR	-

A.2 Tags of the positioning axis/synchronous axis technology object

A.2.1 Legend

Tag	Name of the tag	
Data type	Data type of the tag	
Values	Value range of the tag - minimum value to maximum value (L - linear specification R - rotary specification) If no specific value is shown, the value range limits of the relevant data type apply or the information under "Description".	
W	Effectiveness of changes in the technology data block	
	DIR	Direct: Values are changed directly and take effect at the start of the next MC-Servo [OB91].
	CAL	At call of Motion Control instruction: Values are changed directly and take effect at the start of the next MC-Servo [OB91] after the call of the corresponding Motion Control instruction in the user program.
	RES	Restart: Changes to the start value in the load memory are made using the extended instruction "WRIT_DBL" (write to DB in load memory). Changes will not take effect until after restart of the technology object.
	RON	Read only: The tag cannot and must not be changed during runtime of the user program.
Description	Description of the tag	

Access to the tags is with "<TO>.<tag name>". The placeholder <TO> represents the name of the technology object.

A.2.2 Actual values and setpoints (positioning axis/synchronous axis)

The following tags indicate the setpoint and actual values of the technology object.

Tags

Legend (Page 554)

Tag	Data type	Values	W	Description
Position	LREAL	-	RON	Position setpoint
Velocity	LREAL	-	RON	Velocity setpoint / speed setpoint
ActualPosition	LREAL	-	RON	Actual position
ActualVelocity	LREAL	-	RON	Actual velocity
ActualSpeed	LREAL	-	RON	Actual speed of the motor (with analog setpoint = 0.0)
Acceleration	LREAL	-	RON	Setpoint acceleration
ActualAcceleration	LREAL	-	RON	Actual acceleration
OperativeSensor	UDINT	1 to 4	RON	Operative encoder

A.2.3 Simulation tag (positioning axis / synchronous axis)

The tag structure <TO>.Simulation.<tag name> contains the configuration of the simulation mode. In simulation mode, you can simulate axes without a real drive in the CPU.

Tags

Legend (Page 554)

Tag		Data type	Values	W	Description
Simulation.		STRUCT			
	Mode	UDINT	-	RES[1)]	Simulation mode 0: No simulation, normal operation 1: Simulation mode

1) Technology version V2.0: RON

A.2.4 VirtualAxis tag (positioning axis/synchronous axis)

The tag structure <TO>.VirtualAxis.<tag name> contains the configuration of the simulation mode. In simulation mode, you can simulate axes without a real drive in the CPU.

Tags

Legend (Page 554)

Tag		Data type	Values	W	Description
VirtualAxis.		STRUCT			
	Mode	UDINT	-	RON	Virtual axis 0: No virtual axis 1: Axis is always and exclusively operated as virtual axis

A.2.5 Actor tags (positioning axis/synchronous axis)

The tag structure <TO>.Actor.<tag name> contains the controller-side configuration of the drive.

Tags

Legend (Page 554)

Tag	Data type	Values	W	Description
Actor.	STRUCT			
Type	DINT	-	RON	Drive connection 0: Analog output 1: PROFIdrive telegram
InverseDirection	BOOL	-	RES	Inversion of the setpoint FALSE: no TRUE: Yes
DataAdaption	DINT	-	RES	Automatic transfer of the drive values reference speed, maximum speed and reference torque 0: No automatic transfer, manual configuration of values 1: Automatic transfer of values configured in the drive to the configuration of the technology object
Efficiency	LREAL	0.0 to 1.0	RES	Efficiency of mechanics (gear and leadscrew)
Interface.	STRUCT			
AddressIn	VREF	0 to 65535	RON	Input address for the PROFIdrive telegram
AddressOut	VREF	0 to 65535	RON	Output address for the PROFIdrive telegram or the analog setpoint
EnableDriveOutput	BOOL	-	RES	"Enable output" for analog drives FALSE: disabled TRUE: Activated
EnableDriveOutput-Address	VREF	0 to 65535	RON	Address for the "Enable output" for analog setpoint
DriveReadyInput	BOOL	-	RES	"Ready input" for analog drives The analog drive signals its readiness to receive speed setpoints. FALSE: disabled TRUE: Activated
DriveReadyInputAddress	VREF	0 to 65535	RON	Address for the "Enable input" for analog setpoint
EnableTorqueData	BOOL	-	RES	Torque data FALSE: Deactivated TRUE: Activated
TorqueDataAddressIn	VREF	0 to 65535	RON	Input address of the supplemental telegram
TorqueDataAddressOut	VREF	0 to 65535	RON	Output address of the supplemental telegram

Tag			Data type	Values	W	Description
	DriveParameter.					
		ReferenceSpeed	LREAL	0.0 to 1.0E12	RES	Reference value (100%) for the speed setpoint (N-set) of the drive The speed setpoint is transferred in the PROFIdrive telegram as a normalized value from -200% to 200% of the "ReferenceSpeed". For setpoint specification via an analog output, the analog output can be operated in the range from -117% to 117%, provided the drive permits this.
		MaxSpeed	LREAL	0.0 to 1.0E12	RES	Maximum value for the speed setpoint of the drive (N-set) (PROFIdrive: MaxSpeed ≤ 2 × ReferenceSpeed Analog setpoint: MaxSpeed ≤ 1.17 × ReferenceSpeed)
		ReferenceTorque	LREAL	0.0 to 1.0E12	RES	Reference value (100%) for the drive torque

See also

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A.2.6 TorqueLimiting tag (positioning axis/synchronous axis)

The tag structure <TO>.TorqueLimiting.<tag name> contains the configuration of the torque limiting.

Tags

Legend (Page 554)

Tag			Data type	Values	W	Description
TorqueLimiting.			STRUCT			
	LimitBase		DINT	-	RES	Torque limiting 0: Motor side 1: Load side
	PositionBasedMonitorings		DINT	-	RES	Positioning and following error monitoring 0: Monitoring deactivated 1: Monitoring activated
	LimitDefaults.		STRUCT			
		Torque	LREAL	0.0 to 1.0E12	CAL	Limiting torque
		Force	LREAL	0.0 to 1.0E12	CAL	Limiting force

A.2.7 Clamping tag (positioning axis/synchronous axis)

The tag structure <TO>.Clamping.<tag name> contains the configuration of the fixed stop detection.

Tags

Legend (Page 554)

Tag		Data type	Values	W	Description
Clamping.		STRUCT			
	FollowingErrorDeviation	LREAL	0.001 to 1.0E12	DIR	Value of the following error starting from which the fixed stop is detected.
	PositionTolerance	LREAL	0.001 to 1.0E12	DIR	Position tolerance for clamping monitoring

A.2.8 Sensor[n] tags (positioning axis/synchronous axis)

The tag structure <TO>.Sensor[n].<tag name> contains the controller-end configuration for the encoder, and the configuration for active and passive homing.

Tags

Legend (Page 554)

Tag			Data type	Values	W	Description
Sensor[n].			ARRAY [1..4] OF STRUCT			
	Existent		BOOL	-	RON	Displaying created encoders
	Type		DINT	-	RON	Encoder type 0: "INCREMENTAL" (incremental) 1: "ABSOLUTE" (absolute) 2: "CYCLIC_ABSOLUTE" (cyclic absolute)
	InverseDirection		BOOL	-	RES	Inversion of the actual value FALSE: no TRUE: Yes
	System		DINT	-	RES	Encoder system 0: "LINEAR" (linear encoder) 1: "ROTATORY" (rotary encoder)
	MountingMode		DINT	-	RES	Mounting type of encoder 0: On motor shaft 1: On load side 2: External measuring system
	DataAdaption		DINT	-	RES	Automatic transfer of the drive values reference speed, maximum speed and reference torque in the device 0: No automatic transfer, manual configuration of values 1: Automatic transfer of values configured in the drive to the configuration of the technology object
	Interface.					
		AddressIn	VREF	0 to 65535	RON	Input address for the PROFIdrive telegram
		AddressOut	VREF	0 to 65535	RON	Output address for the PROFIdrive telegram
		Number	UDINT	1 to 2	RON	Number of the encoder in the telegram
	Parameter.					
		Resolution	LREAL	1.0E-12 to 1.0E12	RES	Resolution of a linear encoder (offset between two encoder pulses)
		StepsPerRevolution	UDINT	1 to 8388608	RES	Increments per rotary encoder revolution
		FineResolutionXist1	UDINT	0 to 31	RES	Number of bits for fine resolution Gx_XIST1 (cyclic actual encoder value)
		FineResolutionXist2	UDINT	0 to 31	RES	Number of bits for fine resolution Gx_XIST2 (absolute value of encoder)

Tag			Data type	Values	W	Description
		Determinable-Revolutions	UDINT	0 to 8388608	RES	Number of differentiable encoder revolutions for a multi-turn absolute encoder (For a single-turn absolute encoder = 1; for an incremental encoder = 0)
		DistancePer-Revolution	LREAL	0.0 to 1.0E12	RES	Load distance per revolution of an externally mounted encoder
	ActiveHoming.		STRUCT			
		Mode	DINT	-	RES	Homing mode 0: Use zero mark via PROFIdrive telegram 1: Use zero mark via PROFIdrive telegram and reference cam 2: Use homing mark via digital input
		SideInput	BOOL	-	CAL	Side of the digital input for active homing: FALSE: Negative side TRUE: Positive side
		Direction	DINT	-	CAL	Homing direction / homing mark approach direction 0: Positive homing direction 1: Negative homing direction
		DigitalInputAddress	VREF	0 to 65535	RON	Address of digital input
		HomePositionOffset	LREAL	-1.0E12 to 1.0E12	CAL	Home position offset
		SwitchLevel	BOOL	-	RES	Signal level that is present at the digital input when homing mark is approached FALSE: Low level TRUE: High level
	PassiveHoming.		STRUCT			
		Mode	DINT	-	RES	Homing mode 0: Use zero mark via PROFIdrive telegram 1: Use zero mark via PROFIdrive telegram and reference cam 2: Use homing mark via digital input
		SideInput	BOOL	-	CAL	Side of digital input during passive homing: FALSE: Negative side TRUE: Positive side
		Direction	DINT	-	CAL	Homing direction / homing mark approach direction 0: Positive homing direction 1: Negative homing direction 2: Current homing direction
		DigitalInputAddress	VREF	0 to 65535	RON	Address of digital input
		SwitchLevel	BOOL	-	RES	Signal level that is present at the digital input when homing mark is approached FALSE: Low level TRUE: High level

See also

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A.2.9 Extrapolation tag (positioning axis/synchronous axis)

The tag structure <TO>.Extrapolation.<tag name> contains the configuration of the actual value extrapolation.

Tags

Legend (Page 554)

Tag			Data type	Values	W	Description
Extrapolation.			STRUCT			
	LeadingAxis-DependentTime		LREAL	-	RON	Extrapolation time component (caused by leading axis) Results from the following times: • Time of actual value acquisition for the leading axis • Ipo cycle • Time of actual position filter of leading axis (T1 + T2)
	FollowingAxis-DependentTime		LREAL	0.0 to 1.0E12	DIR	Extrapolation time component (caused by following axis) Results from the following times: • For a following axis with set velocity precontrol: – Communication cycle – Ipo cycle – Speed control loop substitute time for the following axis – Output time of the setpoint for the following axis • For a following axis without velocity precontrol: – Communication cycle – Ipo cycle – Position control loop equivalent time 1/Kv from <TO>.PositionControl.Kv) – Output time of the setpoint for the following axis
	PositionFilter.		STRUCT			
		T1	LREAL	0.0 to 1.0E12	DIR	Position filter time constant T1
		T2	LREAL	0.0 to 1.0E12	DIR	Position filter time constant T2
	VelocityFilter.		STRUCT			
		T1	LREAL	0.0 to 1.0E12	DIR	Velocity filter time constant T1
	VelocityTolerance.		STRUCT			
		Range	LREAL	0.0 to 1.0E12	DIR	Tolerance band width for velocity
	Hysteresis.		STRUCT			
		Value	LREAL	0.0 to 1.0E12	DIR	Hysteresis value

A.2.10 LoadGear tags (positioning axis/synchronous axis)

The tag structure <TO>.LoadGear.<tag name> contains the configuration for the load gear.

Tags

Legend (Page 554)

Tag		Data type	Value range	W	Description
LoadGear.		STRUCT			
	Numerator	UDINT	1 to 4294967295	RES	Load gear counter
	Denominator	UDINT	1 to 4294967295	RES	Load gear denominator

A.2.11 Properties tags (positioning axis/synchronous axis)

The tag structure <TO>.Properties.<tag name> contains the configuration of the type of axis or motion.

Tags

Legend (Page 554)

Tag		Data type	Value range	W	Description
Properties.		STRUCT			
	MotionType	DINT	-	RON	Indication of axis or motion type: 0: Linear axis or motion 1: Rotary axis or motion

A.2.12 Units tag (positioning axis/synchronous axis)

The tag structure <TO>.Units.<tag name> shows the set technological units.

Tags

Legend (Page 554)

Tag		Data type	Values	W	Description	
Units.		STRUCT				
	LengthUnit	UDINT	-	RON	Unit for position	
					1010	m
					1013	mm
					1011	km
					1014	µm
					1015	nm
					1019	in
					1018	ft
					1021	mi
					1004	rad
					1005	°
	VelocityUnit	UDINT	-	RON	Unit for velocity	
					1521	°/s
					1522	°/min
					1086	rad/s
					1523	rad/min
					1062	mm/s
					1061	m/s
					1524	mm/min
					1525	m/min
					1526	mm/h
					1063	m/h
					1527	km/min
					1064	km/h
					1066	in/s
					1069	in/min
					1067	ft/s
					1070	ft/min
					1075	mi/h
	TimeUnit	UDINT	-	RON	Unit for time	
					1054	S

Tag		Data type	Values	W	Description	
	TorqueUnit	UDINT	-	RON	Unit for torque	
					1126	Nm
					1128	kNm
					1529	lbf in (pound-force-inch)
					1530	lbf ft
					1531	ozf in (ounce-force-inch)
					1532	ozf ft
					1533	pdl in (poundal-inch)
					1534	pdl ft
	ForceUnit	UDINT	-	RON	Unit for force	
					1120	N
					1122	kN
					1094	lbf (pound-force)
					1093	ozf (ounce-force)
					1535	pdl (poundals)

A.2.13 Mechanics tags (positioning axis/synchronous axis)

The tag structure <TO>.Mechanics.<tag name> contains the configuration of the mechanics.

Tags

Legend (Page 554)

Tag		Data type	Value range	W	Description
Mechanics.		STRUCT			
	LeadScrew	LREAL	0.0 to 1.0E12	RES	Leadscrew pitch

A.2.14 Modulo tags (positioning axis/synchronous axis)

The tag structure <TO>.Modulo.<tag name> contains the configuration of the modulo function.

Tags

Legend (Page 554)

Tag		Data type	Values	W	Description
Modulo.		STRUCT			
	Enable	BOOL	-	RES	FALSE: Modulo conversion disabled TRUE: Modulo conversion enabled When modulo conversion is enabled, a check is made for modulo length > 0.0
	Length	LREAL	0.001 to 1.0E12	RES	Modulo length
	StartValue	LREAL	-1.0E12 to 1.0E12	RES	Modulo start value

See also

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A.2.15 DynamicLimits tags (positioning axis/synchronous axis)

The tag structure <TO>.DynamicLimits.<tag name> contains the configuration of the dynamic limits. During Motion Control, no dynamic values greater than the dynamic limits are permitted. If you have specified greater values in a Motion Control instruction, then motion is performed using the dynamic limits, and a warning is indicated (alarm 501 to 503 - Dynamic values were limited).

Tags

Legend (Page 554)

Tag		Data type	Values	W	Description
DynamicLimits.		STRUCT			
	MaxVelocity	LREAL	0.0 to 1.0E12	RES	Maximum permissible velocity of the axis
	Velocity	LREAL	0.0 to 1.0E12	DIR	Current maximum velocity of the axis
	MaxAcceleration	LREAL	0.0 to 1.0E12	DIR	Maximum permissible acceleration of the axis
	MaxDeceleration	LREAL	0.0 to 1.0E12	DIR	Maximum permissible deceleration of the axis
	MaxJerk	LREAL	0.0 to 1.0E12	DIR	Maximum permissible jerk on the axis

See also

Evaluating the technology data block (Page 356)

A.2.16 DynamicDefaults tags (positioning axis/synchronous axis)

The tag structure <TO>.DynamicDefaults.<tag name> contains the configuration of the dynamic defaults. These settings will be used when you specify a dynamic value less than 0.0 in a Motion Control instruction (exceptions: MC_MoveJog.Velocity, MC_MoveVelocity.Velocity). Changes to the default dynamic values will be applied at the next positive edge at the "Execute" parameter of a Motion Control instruction.

Tags

Legend (Page 554)

Tag		Data type	Values	W	Description
DynamicDefaults.		STRUCT			
	Velocity	LREAL	0.0 to 1.0E12	CAL	Default velocity
	Acceleration	LREAL	0.0 to 1.0E12	CAL	Default acceleration
	Deceleration	LREAL	0.0 to 1.0E12	CAL	Default deceleration
	Jerk	LREAL	0.0 to 1.0E12	CAL	Default jerk
	EmergencyDeceleration	LREAL	0.0 to 1.0E12	DIR	Emergency stop deceleration

See also

Evaluating the technology data block (Page 356)

A.2.17 PositionLimits_SW tags (positioning axis/synchronous axis)

The tag structure <TO>.PositionLimits_SW.<tag name> contains the configuration for position monitoring with software limit switches. Software limit switches are used to limit the operating range of a positioning axis.

Tags

Legend (Page 554)

Tag		Data type	Values	W	Description
PositionLimits_SW.		STRUCT			
	Active	BOOL	-	DIR	FALSE: Monitoring disabled TRUE: Monitoring enabled
	MinPosition	LREAL	-1.0E12 to 1.0E12	DIR	Position of negative software limit switches
	MaxPosition	LREAL	-1.0E12 to 1.0E12	DIR	Position of positive software limit switches ("MaxPosition" > "MinPosition")

See also

Evaluating the technology data block (Page 356)

A.2.18 PositionLimits_HW tags (positioning axis/synchronous axis)

The tag structure <TO>.PositionLimits_HW.<tag name> contains the configuration of position monitoring with hardware limit switches. Hardware limit switches are used to limit the traversing range of a positioning axis.

Tags

Legend (Page 554)

Tag		Data type	Values	W	Description
PositionLimits_HW.		STRUCT			
	Active	BOOL	-	RES	FALSE: Monitoring disabled TRUE: Monitoring enabled With "Active", both (negative and positive) hardware limit switches are activated or deactivated.
	MinSwitchLevel	BOOL	-	RES	Level selection for activation of the negative hardware limit switch: FALSE: Low level (Low active) TRUE: High level (High active)
	MinSwitchAddress	VREF	0 to 65535	RON	Address for the negative hardware limit switch
	MaxSwitchLevel	BOOL	-	RES	Level selection for enabling of the positive hardware limit switch: FALSE: Low level (Low active) TRUE: High level (High active)
	MaxSwitchAddress	VREF	0 to 65535	RON	Address for the positive hardware limit switch

See also

Evaluating the technology data block (Page 356)

A.2.19 Homing tags (positioning axis/synchronous axis)

The tag structure <TO>.Homing.<tag name> contains the configuration for homing the TO.

Tags

Legend (Page 554)

Tag		Data type	Values	W	Description
Homing.		STRUCT			
	AutoReversal	BOOL	-	RES	Reversal at the hardware limit switches FALSE: no TRUE: Yes
	ApproachDirection	BOOL	-	CAL	Direction of approach to the homing position switch FALSE: positive direction TRUE: Negative direction
	ApproachVelocity	LREAL	L: 0.0 to 10000.0 mm/s R: 0.0 to 360000.0°/s	CAL	Approach velocity Velocity during active homing at which the reference cam and home position are approached.
	ReferencingVelocity	LREAL	L: 0.0 to 1000.0 mm/s R: 0.0 to 36000.0°/s	CAL	Homing velocity Velocity during active homing at which the home position is approached.
	HomePosition	LREAL	-1.0E12 to 1.0E12	CAL	Home position

See also

Evaluating the technology data block (Page 356)

A.2.20 Override tags (positioning axis/synchronous axis)

The tag structure <TO>.Override.<tag name> contains the configuration for the override parameters. The override parameters are used to apply a correction percentage to default values. An override change takes effect immediately, and is performed with the dynamic settings in effect in the Motion Control instruction.

Tags

Legend (Page 554)

Tag		Data type	Values	W	Description
Override.		STRUCT			
	Velocity	LREAL	0.0 to 200.0%	DIR	Velocity or speed override Percentage correction of the velocity/speed

See also

Evaluating the technology data block (Page 356)

A.2.21 PositionControl tags (positioning axis/synchronous axis)

The tag structure <TO>.PositionControl.<tag name> contains the settings of closed loop position control.

Tags

Legend (Page 554)

Tag		Data type	Values	W	Description
PositionControl.		STRUCT			
	Kv	LREAL	0.0 to 2147480.0	DIR	Proportional gain of the closed loop position control ("Kv" > 0.0)
	Kpc	LREAL	0.0 to 150.0%	DIR	Velocity precontrol of the position control Recommended setting: • Isochronous drive connection via PROFIdrive: 100.0% • Non-isochronous drive connection via PROFIdrive: 0.0 to 100.0% • Analog drive connection: 0.0 to 100.0%
	EnableDSC	BOOL	-	RES	Dynamic Servo Control (DSC) FALSE: DSC disabled TRUE: DSC enabled DSC is only possible with one of the following PROFIdrive telegrams: • Standard telegram 5 or 6 • SIEMENS telegram 105 or 106
	SmoothingTimeBy-ChangeDifference	LREAL	0.0 to 1.0E+12	DIR	Manipulated variable ramp at step change of control deviation due to encoder switchover.
	InitialOperativeSensor	UDINT	-	RES	Active encoder after initialization of the axis. (encoder number 1 to 4) This encoder is used after startup of the CPU and after a restart of the technology object (Page 386). At an operating mode transition from STOP → RUN of the CPU (without restart of the technology object), the encoder that was also active before the STOP is still being used.

Tag			Data type	Values	W	Description
	ControlDifference-Quantization.		STRUCT			
		Mode	DINT	-	RES	Type of quantification Configuration of a quantization when a drive with stepper motor interface is connected 0: No quantification 1: Quantization corresponding to encoder resolution 2: Quantization to a direct value (configuration is performed using the parameter view (data structure))
		Value	LREAL	0.001 to 1.0E+12	RES	Value of quantification Configuration of a value for quantization to a direct value (<TO>.PositionControl.ControlDifferenceQuantization.Mode = 2) (configuration is performed using the parameter view (data structure))

See also

Evaluating the technology data block (Page 356)

A.2.22 DynamicAxisModel tags (positioning axis/synchronous axis)

The tag structure <TO>.DynamicAxisModel.<tag name> contains the settings of the balancing filter.

Tags

Legend (Page 554)

Tag		Data type	Values	W	Description
DynamicAxisModel.		STRUCT			
	VelocityTimeConstant	LREAL	0.0 to 1.0E12	DIR	Speed control loop substitute time [s]
	AdditionalPositionTi-meConstant	LREAL	0.0 to 1.0E12	DIR	Additive position control loop substitute time [s]

A.2.23 FollowingError tags (positioning axis/synchronous axis)

The tag structure <TO>.FollowingError.<tag name> contains the configuration for following error monitoring.

If the permissible following error is exceeded, then technology alarm 521 is output, and the technology object is disabled (alarm reaction: remove enable).

When the warning level is reached, a warning is output (technology alarm 522).

Tags

Legend (Page 554)

Tag		Data type	Values	W	Description
FollowingError.		STRUCT			
	EnableMonito-ring	BOOL	-	RES	FALSE: Following error monitoring disabled TRUE: Following error monitoring enabled
	MinValue	LREAL	L: 0.0 to 1.0E12 R: 0.001 to 1.0E12	DIR	Permissible following error at velocities below the value of "MinVelocity".
	MaxValue	LREAL	L: 0.0 to 1.0E12 R: 0.002 to 1.0E12	DIR	Maximum permissible following error, which may be reached at the maximum velocity.
	MinVelocity	LREAL	0.0 to 1.0E12	DIR	"MinValue" is permissible below this velocity and is held constant.
	WarningLevel	LREAL	0.0 to 100.0	DIR	Warning level: Percentage value relative to the valid maximum following error.

See also

Evaluating the technology data block (Page 356)

A.2.24 PositionMonitoring tags (positioning axis/synchronous axis)

The tag structure <TO>.PositioningMonitoring.<tag name> contains the configuration for position monitoring at the end of a positioning motion.

If the actual position value at the end of a positioning motion is reached within the tolerance time and remains in the positioning window for the minimum dwell time, then <TO>.StatusWord.X5 (Done) is set in the technology data block. This completes a Motion Control job.

If the tolerance time is exceeded, then technology alarm 541 "Positioning monitoring" with supplemental value 1: Display "Target range not reached".

If the minimum dwell time is not met, then technology alarm 541 "Positioning monitoring" with supplemental value 2: Display "Exit target range again".

Tags

Legend (Page 554)

Tag		Data type	Values	W	Description
PositioningMonitoring.		STRUCT			
	ToleranceTime	LREAL	0.0 to 1.0E12	DIR	Tolerance time Maximum permitted duration from reaching velocity setpoint zero, until entrance into the positioning window.
	MinDwellTime	LREAL	0.0 to 1.0E12	DIR	Minimum dwell time in the positioning window:
	Window	LREAL	0.0 to 1.0E12	DIR	Positioning window

See also

Evaluating the technology data block (Page 356)

A.2.25 StandstillSignal tags (positioning axis/synchronous axis)

The tag structure <TO>.StandstillSignal.<tag name> contains the configuration for the standstill signal.

If the actual velocity value is below the velocity threshold, and does not exceed it during the minimum dwell time, then the standstill signal <TO>.StatusWord.X7 (Standstill) is set.

Tags

Legend (Page 554)

Tag		Data type	Values	W	Description
StandstillSignal.		STRUCT			Configuration for the standstill signal
	VelocityThreshold	LREAL	0.0 to 1.0E12	DIR	Velocity threshold If velocity is below this threshold, then the minimum dwell time begins.
	MinDwellTime	LREAL	0.0 to 1.0E12	DIR	Minimum dwell time

See also

Evaluating the technology data block (Page 356)

A.2.26 StatusPositioning tags (positioning axis/synchronous axis)

The tag structure <TO>.StatusPositioning.<tag name> indicates the status of a positioning motion.

Tags

Legend (Page 554)

Tag		Data type	Values	W	Description
StatusPositioning.		STRUCT			
	Distance	LREAL	-1.0E12 to 1.0E12	RON	Distance to the target position
	TargetPosition	LREAL	-1.0E12 to 1.0E12	RON	Target position
	FollowingError	LREAL	-1.0E12 to 1.0E12	RON	Current following error
	SetpointExecutionTime	LREAL	-1.0E12 to 1.0E12	RON	Setpoint execution time of the axis (Results from T_{lpo}, T_{vtc} or 1/kv, T_{Send} and T_O of the axis)

See also

Evaluating the technology data block (Page 356)

A.2.27 StatusDrive tags (positioning axis/synchronous axis)

The tag structure <TO>.StatusDrive.<tag name> indicates the status of the drive.

Tags

Legend (Page 554)

Tag		Data type	Values	W	Description
StatusDrive.		STRUCT			
	InOperation	BOOL	-	RON	Operational status of the drive FALSE: Drive not ready. Setpoints will not be executed. TRUE: Drive ready. Setpoints can be executed.
	CommunicationOK	BOOL	-	RON	Cyclic BUS communication between controller and drive FALSE: Not established TRUE: Established
	Error	BOOL	-	RON	FALSE: No drive error TRUE: Drive error
	AdaptionState	DINT	-	RON	Status of automatic data transfer of drive parameters 0: "NOT_ADAPTED" (Data not transferred) 1: "IN_ADAPTION" (Data transfer in progress) 2: "ADAPTED" (Data transfer complete) 3: "NOT_APPLICABLE" (Data transfer not selected, not possible) 4: "ADAPTION_ERROR" (Error during data transfer)

See also

Evaluating the technology data block (Page 356)

A.2.28 StatusServo tags (positioning axis/synchronous axis)

The tag structure <TO>.StatusServo.<tag name> indicates the status for the balancing filter.

Tags

Legend (Page 554)

Tag		Data type	Values	W	Description
StatusServo.		STRUCT			
	BalancedPosition	LREAL	-	RON	Position after the balancing filter.
	ControlDifference	LREAL	-	RON	Control error

A.2.29 StatusSensor[n] tags (positioning axis/synchronous axis)

The tag structure <TO>.StatusSensor[n].<tag name> indicates the status of the measuring system.

Tags

Legend (Page 554)

Tag		Data type	Values	W	Description
StatusSensor[n].		ARRAY [1..4] OF STRUCT			
	State	DINT	-	RON	Status of actual encoder value 0: "NOT_VALID" (not valid) 1: "WAITING_FOR_VALID" (waiting for valid status) 2: "VALID" (valid)
	CommunicationOK	BOOL	-	RON	Cyclic BUS communication between controller and encoder FALSE: Not established TRUE: Established
	Error	BOOL	-	RON	FALSE: No error in the measuring system TRUE: Error in the measuring system.
	AbsEncoderOffset	LREAL	-	RON	Home point offset to the value of an absolute value encoder. The value will be retentively stored in the CPU.
	Control	BOOL	-	RON	FALSE: Encoder is not active TRUE: Encoder is active
	Position	LREAL	-	RON	Encoder position
	Velocity	LREAL	-	RON	Encoder velocity
	AdaptionState	DINT	-	RON	Status of automatic data transfer of encoder parameters 0: "NOT_ADAPTED" (Data not transferred) 1: "IN_ADAPTION" (Data transfer in progress) 2: "ADAPTED" (Data transfer complete) 3: "NOT_APPLICABLE" (Data transfer not selected, not possible) 4: "ADAPTION_ERROR" (Error during data transfer)

See also

Evaluating the technology data block (Page 356)

A.2.30 StatusExtrapolation tag (positioning axis/synchronous axis)

The tag structure <TO>.StatusExtrapolation.<tag name> indicates the status of the actual value extrapolation.

Tags

Legend (Page 554)

Tag		Data type	Values	W	Description
Extrapolation.		STRUCT			
	FilteredPosition	LREAL	-1.0E12 to 1.0E12	RON	Position after position filter
	FilteredVelocity	LREAL	-1.0E12 to 1.0E12	RON	Velocity according to tolerance band
	ExtrapolatedPosition	LREAL	-1.0E12 to 1.0E12	RON	Extrapolated position
	ExtrapolatedVelocity	LREAL	-1.0E12 to 1.0E12	RON	Extrapolated velocity

A.2.31 StatusSynchronizedMotion tags (synchronous axis)

The tag structure <TO>.StatusSynchronizedMotion.<tag name> indicates the status of the synchronous operation.

Tags

Legend (Page 554)

Tag			Data type	Value range	W	Description
StatusSynchronizedMotion.			STRUCT			
	FunctionState		DINT	-	RON	Indication of which synchronous operation function is active 0: No synchronous operation active 1: Gearing (MC_GearIn) 2: Gearing with specified synchronous positions (MC_GearInPos) 3: Camming (MC_CamIn)
	PhaseShift		LREAL	-1.0E12 to 1.0E12	RON	Current absolute leading value shift
	ActualMaster		DB_ANY	0 to 65535	RON	At the start of a "MC_GearIn" job, the number of the technology data block of the currently used leading axis is displayed. "ActualMaster" = 0 when synchronous operation is inactive
	ActualCam		DB_ANY	0 to 65535	RON	Cam that is currently being used for camming
	MasterOffset		LREAL	-1.0E12 to 1.0E12	RON	Current shift of the leading value range of the cam
	MasterScaling		LREAL	-1.0E12 to 1.0E12	RON	Current scaling of the leading value range of the cam
	SlaveOffset		LREAL	-1.0E12 to 1.0E12	RON	Current shift of the following value range of the cam
	SlaveScaling		LREAL	-1.0E12 to 1.0E12	RON	Current scaling of the following value range of the cam
	StatusWord.		STRUCT			
	Bit 0	MaxVelocity-Exceeded	BOOL	-	RON	Configured maximum velocity is exceeded during synchronous operation.
	Bit 1	Max-Acceleration-Exceeded	BOOL	-	RON	Configured maximum acceleration is exceeded during synchronous operation.
	Bit 2	Max-Deceleration-Exceeded	BOOL	-	RON	Configured maximum deceleration is exceeded during synchronous operation.
	Bit 3	InSimulation	BOOL	-	RON	FALSE: Synchronous operation not simulated TRUE: Synchronous operation is being simulated
	Bit 4... Bit 31	-	BOOL	-	RON	Reserved

See also

Synchronous axis technology object (Page 113)

A.2.32 StatusKinematicsMotion tag (positioning axis/synchronous axis)

The <TO>.StatusKinematicsMotion tag contains the status information of the technology object.

Information on the evaluation of the individual bits (e.g. bit 2 "MaxDecelerationExceeded") can be found in the Evaluating StatusWord, ErrorWord and WarningWord (Page 359) section.

Tag

Legend (Page 554)

Tag	Data type	Values	W	Description
Status-Kinemaics-Motion	DWORD	-	RON	Status data of the technology object
Bit 0	-	-	-	"MaxVelocityExceeded" 0: The TO Kinematics has a lower velocity setpoint calculated than the one configured on the axis 1: The TO Kinematics has a higher velocity setpoint calculated than the one configured on the axis.
Bit 1	-	-	-	"MaxAccelerationExceeded" 0: The TO Kinematics has a lower acceleration setpoint calculated as maxAcceleration of the axis. 1: The TO Kinematics has a higher acceleration setpoint calculated as maxAcceleration of the axis.
Bit 2	-	-	-	"MaxDecelerationExceeded" 0: The TO Kinematics has a lower delay setpoint calculated as maxDeceleration of the axis. 1: The TO Kinematics has a higher delay setpoint calculated as maxDeceleration of the axis.

A.2.33 StatusTorqueData tags (positioning axis/synchronous axis)

The tag structure <TO>.StatusTorqueData.<tag name> indicates the status of the torque data.

Tags

Legend (Page 554)

Tag		Data type	Value range	W	Description
StatusTorqueData.		STRUCT			
	CommandAdditiveTorque-Active	DINT	-	RON	Additive torque setpoint active function 0: No 1: Yes
	CommandTorqueRange-Active	DINT	-	RON	Torque limits B +, B- active function 0: No 1: Yes
	ActualTorque	LREAL	-1.0E12 to 1.0E12	RON	Actual torque of the axis

A.2.34 StatusMotionIn tags (positioning axis/synchronous axis)

The tag structure <TO>.StatusMotionIn.<tag name> indicates the status of the MotionIn function.

Tags

Legend (Page 554)

Tag		Data type	Value range	W	Description
StatusMotionIn.		STRUCT			
	FunctionState	DINT	-	RON	0: No MotionIn function active 1: MotionInVelocity active 2: MotionInPosition active

A.2.35 StatusWord tag (positioning axis/synchronous axis)

The <TO>.StatusWord tag contains the status information of the technology object.

Information on the evaluation of the individual bits (e.g. bit 5 "HomingDone") can be found in the Evaluating StatusWord, ErrorWord and WarningWord (Page 359) section.

Tag

Legend (Page 554)

Tag	Data type	Values	W	Description
Status-Word	DWORD	-	RON	Status information of the technology object
Bit 0	-	-	-	"Enable" Enable status 0: The technology object is disabled. 1: The technology object is enabled.
Bit 1	-	-	-	"Error" 0: No error present. 1: An error is present.
Bit 2	-	-	-	"RestartActive" 0: No "Restart" is active. 1: A "Restart" is active. The technology object is being reinitialized.
Bit 3	-	-	-	"OnlineStartValuesChanged" 0: The "Restart" tags are unchanged. 1: The "Restart" tags were changed. For the changes to be applied, the technology object must be reinitialized.
Bit 4	-	-	-	"ControlPanelActive" 0: The axis control panel is disabled. 1: The axis control panel is active.
Bit 5	-	-	-	"HomingDone" Homing status 0: The technology object is not homed. 1: The technology object is homed.
Bit 6	-	-	-	"Done" 0: A motion job is in progress or the axis control panel is activated. 1: No motion job is in progress and the axis control panel is deactivated.
Bit 7	-	-	-	"Standstill" Standstill signal 0: The axis is in motion. 1: The axis is at a standstill.
Bit 8	-	-	-	"PositioningCommand" 0: No positioning job is in progress. 1: A positioning job is running ("MC_MoveRelative", "MC_MoveAbsolute").

Tag	Data type	Values	W	Description
Bit 9	-	-	-	"JogCommand" 0: No "MC_MoveJog" job is running. 1: An "MC_MoveJog" job is running
Bit 10	-	-	-	"VelocityCommand" 0: No "MC_MoveVelocity" job is running. 1: An "MC_MoveVelocity" job is running
Bit 11	-	-	-	"HomingCommand" 0: No "MC_Home" job in progress. 1: An "MC_Home" job is being processed.
Bit 12	-	-	-	"ConstantVelocity" 0: The axis is accelerated or decelerated. 1: The setpoint velocity is reached. The axis is traversing at this constant velocity or is at a standstill.
Bit 13	-	-	-	"Accelerating" 0: No acceleration job is in progress. 1: An acceleration operation is active.
Bit 14	-	-	-	"Decelerating" 0: No deceleration process is running. 1: A deceleration operation is active.
Bit 15	-	-	-	"SWLimitMinActive" 0: No negative software limit switch was reached. 1: A negative software limit switch was reached or exceeded.
Bit 16	-	-	-	"SWLimitMaxActive" 0: No positive software limit switch was reached. 1: A positive software limit switch was reached or exceeded.
Bit 17	-	-	-	"HWLimitMinActive" 0: No negative hardware limit switch was reached. 1: A negative hardware limit switch was reached or exceeded.
Bit 18	-	-	-	"HWLimitMaxActive" 0: No positive hardware limit switch was reached. 1: A positive hardware limit switch was reached or exceeded.
Bit 19	-	-	-	Reserved
Bit 20	-	-	-	Reserved
Bit 21	-	-	-	Positioning axis technology object: Reserved Synchronous axis technology object: "Synchronizing" 0: The axis does not synchronize to a leading value. 1: The axis synchronizes to a leading value.

Tag	Data type	Values	W	Description
Bit 22	-	-	-	Positioning axis technology object: Reserved Synchronous axis technology object: "Synchronous" 0: The axis moves asynchronous to a leading value. 1: The axis moves synchronously to a leading value.
Bit 23	-	-	-	"SuperimposedMotionCommand" 0: No overlaid movement is active. 1: No overlaid movement is running.
Bit 24	-	-	-	Positioning axis technology object: Reserved Synchronous axis technology object: "PhasingCommand" 0: No Motion Control instruction for leading value shift is running. 1: A Motion Control instruction for leading value shift is active.
Bit 25	-	-	-	"AxisSimulation" 0: The simulation is not running. 1: The simulation is active.
Bit 26	-	-	-	"TorqueLimitingCommand" 0: No "MC_TorqueLimiting" job is running. 1: An "MC_TorqueLimiting" job is running
Bit 27	-	-	-	"InLimitation" 0: The drive does not operate at the torque limit. 1: The drive is operating at the torque limit.
Bit 28	-	-	-	"NonPositionControlled" 0: The axis is in position-controlled mode. 1: The axis is not in position-controlled mode.
Bit 29	-	-	-	"KinematicsMotionCommand" 0: The axis is not used for a kinematics job. 1: The axis is used for a kinematics job.
Bit 30	-	-	-	"InClamping" 0: The axis is not clamped at a fixed stop. 1: The axis is clamped at a fixed stop.
Bit 31	-	-	-	"MotionInCommand" 0: No MotionIn function is active. 1: The "MotionInVelocity" job is running. 2: The "MotionInPosition" job is running

See also

Evaluating the technology data block (Page 356)

A.2.36 ErrorWord tag (positioning axis/synchronous axis)

The <TO>.ErrorWord tag indicates technology object errors (technology alarms).

Information on the evaluation of the individual bits (e.g. bit 3 "CommandNotAccepted") can be found in the Evaluating StatusWord, ErrorWord and WarningWord (Page 359) section.

Tag

Legend (Page 554)

Tag	Data type	Values	W	Description
ErrorWord	DWORD	-	RON	
Bit 0	-	-	-	"SystemFault" A system-internal error has occurred.
Bit 1	-	-	-	"ConfigFault" Configuration error One or more configuration parameters are inconsistent or invalid.
Bit 2	-	-	-	"UserFault" Error in user program at a Motion Control instruction or its use
Bit 3	-	-	-	"CommandNotAccepted" Command cannot be executed. A Motion Control instruction cannot be executed because necessary requirements have not been met.
Bit 4	-	-	-	"DriveFault" Error in drive
Bit 5	-	-	-	"SensorFault" Error in encoder system
Bit 6	-	-	-	"DynamicError" Specified dynamic values are limited to permissible values.
Bit 7	-	-	-	"CommunicationFault" Communication error Missing or faulty communication.
Bit 8	-	-	-	"SWLimit" Software limit switch reached or overtraveled.
Bit 9	-	-	-	"HWLimit" Hardware limit switch reached or overtraveled.
Bit 10	-	-	-	"HomingError" Error during homing operation The homing cannot be completed.
Bit 11	-	-	-	"FollowingErrorFault" Following error limits exceeded
Bit 12	-	-	-	"PositioningFault" Positioning error
Bit 13	-	-	-	"PeripheralError" Error accessing a logical address

Tag	Data type	Values	W	Description
Bit 14	-	-	-	Positioning axis technology object: Reserved Synchronous axis technology object: "SynchronousError" Error during synchronous operation The leading axis specified for the Motion Control instruction "MC_GearIn" was not configured as a possible leading axis.
Bit 15	-	-	-	"AdaptionError" Error in automatic data transfer
Bit 16... Bit 31	-	-	-	Reserved

See also

Evaluating the technology data block (Page 356)

A.2.37 ErrorDetail tags (positioning axis/synchronous axis)

The tag structure <TO>.ErrorDetail.<tag name> contains the alarm number and the effective local alarm reaction for the technology alarm that is currently pending for the technology object.

You can find a list of the technology alarms and alarm reactions in the Technology alarms (Page 626) appendix.

Tags

Legend (Page 554)

Tag		Data type	Values	W	Description
ErrorDetail.		STRUCT			
	Number	UDINT	-	RON	Alarm number
	Reaction	DINT	0 to 5	RON	Effective alarm reaction 0: No reaction 1: Stop with current dynamic values 2: Stop with maximum dynamic values 3: Stop with emergency stop ramp 4: Remove enable 5: Track setpoints

See also

Evaluating the technology data block (Page 356)

Technology alarms (Page 403)

A.2.38 WarningWord tag (positioning axis/synchronous axis)

The <TO>.WarningWord tag indicates pending warnings for the technology object.

Information on the evaluation of the individual bits (e.g. bit 13 "PeripheralWarning") can be found in the Evaluating StatusWord, ErrorWord and WarningWord (Page 359) section.

Tag

Legend (Page 554)

Tag	Data type	Values	W	Description
WarningWord	DWORD	-	RON	
Bit 0	-	-	-	"SystemWarning" A system-internal error has occurred.
Bit 1	-	-	-	"ConfigWarning" Configuration error One or several configuration parameters are adjusted internally.
Bit 2	-	-	-	"UserWarning" Error in user program at a Motion Control instruction or its use
Bit 3	-	-	-	"CommandNotAccepted" Command cannot be executed. A Motion Control instruction cannot be executed because necessary requirements have not been met.
Bit 4	-	-	-	"DriveWarning" Error in drive
Bit 5	-	-	-	"SensorWarning" Error in encoder system
Bit 6	-	-	-	"DynamicError" Specified dynamic values are limited to permissible values.
Bit 7	-	-	-	"CommunicationWarning" Communication error Missing or faulty communication.
Bit 8	-	-	-	"SWLimitMin"
Bit 9	-	-	-	"SWLimitMax"
Bit 10	-	-	-	"HomingWarning" Error during homing operation The homing cannot be completed.
Bit 11	-	-	-	"FollowingErrorWarning" Warning limit of following error monitoring reached/exceeded
Bit 12	-	-	-	"PositioningWarning" Positioning error
Bit 13	-	-	-	"PeripheralWarning" Error accessing a logical address

Tag	Data type	Values	W	Description
Bit 14	-	-	-	Positioning axis technology object: Reserved Synchronous axis technology object: "SynchronousWarning" Error during synchronous operation The leading axis specified for the Motion Control instruction "MC_GearIn" was not configured as a possible leading axis.
Bit 15	-	-	-	"AdaptionWarning" Error in automatic data transfer
Bit 16... Bit 31	-	-	-	Reserved

See also

Evaluating the technology data block (Page 356)

A.2.39 ControlPanel tags (positioning axis/synchronous axis)

The tag structure <TO>.ControlPanel.<tag name> contains no user-relevant data. This tag structure is internally used.

See also

Evaluating the technology data block (Page 356)

A.2.40 InternalToTrace tags (positioning axis/synchronous axis)

The tag structure <TO>.InternalToTrace.<tag name> contains no user-relevant data. This tag structure is internally used.

See also

Evaluating the technology data block (Page 356)

A.3 Tags of the technology object external encoder

A.3.1 Legend

Tag	Name of the tag	
Data type	Data type of the tag	
Values	Value range of the tag - minimum value to maximum value If no specific value is shown, the value range limits of the relevant data type apply or the information under "Description".	
W	Effectiveness of changes in the technology data block	
	DIR	Direct: Values are changed directly and take effect at the start of the next MC-Servo [OB91].
	CAL	At call of Motion Control instruction: Values are changed directly and take effect at the start of the next MC-Servo [OB91] after the call of the corresponding Motion Control instruction in the user program.
	RES	Restart: Changes to the start value in the load memory are made using the extended instruction "WRIT_DBL" (write to DB in load memory). Changes will not take effect until after restart of the technology object.
	RON	Read only: The tag cannot and must not be changed during runtime of the user program.
Description	Description of the tag	

Access to the tags is with "<TO>.<tag name>". The placeholder <TO> represents the name of the technology object.

A.3.2 Actual values and setpoints (external encoder)

The following tags indicate the setpoint and actual values of the technology object.

Tags

Legend (Page 588)

Tag	Data type	Values	W	Description
ActualPosition	LREAL	-	RON	Actual position
ActualVelocity	LREAL	-	RON	Actual velocity
ActualAcceleration	LREAL	-	RON	Actual acceleration

A.3.3 Sensor tags (external encoder)

The tag structure <TO>.Sensor.<tag name> contains the controller-end configuration for the encoder, and the configuration for active and passive homing.

Tags

Legend (Page 588)

Tag			Data type	Values	W	Description
Sensor.			STRUCT			
	Type		DINT	-	RES	Encoder type 0: "INCREMENTAL" (incremental) 1: "ABSOLUTE" (absolute) 2: "CYCLIC_ABSOLUTE" (cyclic absolute)
	InverseDirection		BOOL	-	RES	Inversion of the actual value FALSE: no TRUE: Yes
	System		DINT	-	RES	Encoder system 0: "LINEAR" (linear encoder) 1: "ROTATORY" (rotary encoder)
	MountingMode		DINT	-	RES	Mounting type of encoder 0: On motor shaft 1: On load side 2: External measuring system
	DataAdaption		DINT	-	RES	Automatic transfer of the drive values reference speed, maximum speed and reference torque in the device 0: No automatic transfer, manual configuration of values 1: Automatic transfer of values configured in the drive to the configuration of the technology object
	Interface.					
		AddressIn	VREF	0 to 65535	RON	Input address for the PROFIdrive telegram
		AddressOut	VREF	0 to 65535	RON	Output address for the PROFIdrive telegram
		Number	UDINT	1 to 2	RON	Number of the encoder in the telegram
	Parameter.					
		Resolution	LREAL	-1.0E12 to 1.0E12	RES	Resolution of a linear encoder (offset between two encoder pulses)
		StepsPerRevolution	UDINT	1 to 8388608	RES	Increments per rotary encoder revolution
		FineResolutionXist1	UDINT	0 to 31	RES	Number of bits for fine resolution Gx_XIST1 (cyclic actual encoder value)
		FineResolutionXist2	UDINT	0 to 31	RES	Number of bits for fine resolution Gx_XIST2 (absolute value of encoder)
		Determinable-Revolutions	UDINT	0 to 8388608	RES	Number of differentiable encoder revolutions for a multi-turn absolute encoder (For a single-turn absolute encoder = 1; for an incremental encoder = 0)

Tag			Data type	Values	W	Description
		DistancePer-Revolution	LREAL	0.0 to 1.0E12	RES	Load distance per revolution of an externally mounted encoder
	PassiveHoming.		STRUCT			
		Mode	DINT	-	RES	Homing mode 0: Use zero mark via PROFIdrive telegram 1: Use zero mark via PROFIdrive telegram and reference cam 2: Use homing mark via digital input
		SideInput	BOOL	-	CAL	Side of digital input during passive homing: FALSE: Negative side TRUE: Positive side
		Direction	DINT	-	CAL	Homing direction / homing mark approach direction 0: Positive homing direction 1: Negative homing direction 2: Current homing direction
		DigitalInputAddress	VREF	0 to 65535	RES	Address of the digital input
		SwitchLevel	BOOL	-	RON	Signal level that is present at the digital input when homing mark is approached FALSE: Low level TRUE: High level

A.3.4 Extrapolation tag (external encoder)

The tag structure <TO>.Extrapolation.<tag name> contains the configuration of the actual value extrapolation.

Tags

Legend (Page 588)

Tag			Data type	Values	W	Description
Extrapolation.			STRUCT			
	LeadingAxis-DependentTime		LREAL	-	RON	Extrapolation time component (caused by leading axis) Results from the following times: • Time of actual value acquisition for the leading axis • Ipo cycle • Time of actual position filter of leading axis (T1 + T2)
	FollowingAxis-DependentTime		LREAL	0.001 to 1.0E12	DIR	Extrapolation time component (caused by following axis) Results from the following times: • For a following axis with set velocity precontrol: – Communication cycle – Ipo cycle – Speed control loop substitute time for the following axis – Output time of the setpoint for the following axis • For a following axis without velocity precontrol: – Communication cycle – Ipo cycle – Position control loop equivalent time (1/Kv from <TO>.PositionControl.Kv) – Output time of the setpoint for the following axis
	PositionFilter.		STRUCT			
		T1	LREAL	0.001 to 1.0E12	DIR	Position filter time constant T1
		T2	LREAL	0.001 to 1.0E12	DIR	Position filter time constant T2
	VelocityFilter.		STRUCT			
		T1	LREAL	0.001 to 1.0E12	DIR	Velocity filter time constant T1
	VelocityTolerance.		STRUCT			
		Range	LREAL	0.001 to 1.0E12	DIR	Tolerance band width for velocity
	Hysteresis.		STRUCT			
		Value	LREAL	0.001 to 1.0E12	DIR	Hysteresis value

A.3.5 LoadGear tags (external encoder)

The tag structure <TO>.LoadGear.<tag name> contains the configuration for the load gear.

Tags

Legend (Page 588)

Tag		Data type	Value range	W	Description
LoadGear.		STRUCT			
	Numerator	UDINT	1 to 4294967295	RES	Load gear counter
	Denominator	UDINT	1 to 4294967295	RES	Load gear denominator

A.3.6 Properties tags (external encoder)

The tag structure <TO>.Properties.<tag name> contains the configuration of the type of axis or motion.

Tags

Legend (Page 588)

Tag		Data type	Value range	W	Description
Properties.					
	MotionType	DINT	-	RON	Indication of axis or motion type: 0: Linear axis or motion 1: Rotary axis or motion

A.3.7 Units tag (external encoder)

The tag structure <TO>.Units.<tag name> shows the set technological units.

Tags

Legend (Page 588)

Tag		Data type	Values	W	Description	
Units.		STRUCT				
	LengthUnit	UDINT	-	RON	Unit for position	
					1010	m
					1013	mm
					1011	km
					1014	µm
					1015	nm
					1019	in
					1018	ft
					1021	mi
					1004	rad
					1005	°
	VelocityUnit	UDINT	-	RON	Unit for velocity	
					1521	°/s
					1522	°/min
					1086	rad/s
					1523	rad/min
					1062	mm/s
					1061	m/s
					1524	mm/min
					1525	m/min
					1526	mm/h
					1063	m/h
					1527	km/min
					1064	km/h
					1066	in/s
					1069	in/min
					1067	ft/s
					1070	ft/min
					1075	mi/h
	TimeUnit	UDINT	-	RON	Unit for time	
					1054	s

A.3.8 Mechanics tags (external encoder)

The tag structure <TO>.Mechanics.<tag name> contains the configuration of the mechanics.

Tags

Legend (Page 588)

Tag		Data type	Value range	W	Description
Mechanics.					
	LeadScrew	LREAL	0.0 to 1.0E12	RES	Leadscrew pitch

A.3.9 Modulo tags (external encoder)

The tag structure <TO>.Modulo.<tag name> contains the configuration of the modulo function.

Tags

Legend (Page 588)

Tag		Data type	Values	W	Description
Modulo.		STRUCT			
	Enable	BOOL	-	RES	FALSE: Modulo conversion disabled TRUE: Modulo conversion enabled When modulo conversion is enabled, a check is made for modulo length > 0.0
	Length	LREAL	0.001 to 1.0E12	RES	Modulo length
	StartValue	LREAL	-1.0E12 to 1.0E12	RES	Modulo start value

A.3.10 Homing tags (external encoder)

The tag structure <TO>.Homing.<tag name> contains the configuration for homing the TO.

Tags

Legend (Page 588)

Tag		Data type	Values	W	Description
Homing.		STRUCT			
	HomePosition	LREAL	-1.0E12 to 1.0E12	CAL	Home position

A.3.11 StatusSensor tags (external encoder)

The tag structure <TO>.StatusSensor.<tag name> indicates the status of the measuring system.

Tags

Legend (Page 588)

Tag		Data type	Values	W	Description
StatusSensor.		STRUCT			
	State	DINT	-	RON	Status of actual encoder value 0: "NOT_VALID" (not valid) 1: "WAITING_FOR_VALID" (waiting for valid status) 2: "VALID" (valid)
	CommunicationOK	BOOL	-	RON	Cyclic BUS communication between controller and encoder FALSE: Not established TRUE: Established
	Error	BOOL	-	RON	FALSE: No error in the measuring system TRUE: Error in the measuring system.
	AbsEncoderOffset	LREAL	-	RON	Home point offset to the value of an absolute value encoder. The value will be retentively stored in the CPU.
	Control	BOOL	-	RON	FALSE: Encoder is not active TRUE: Encoder is active
	Position	LREAL	-	RON	Encoder position
	Velocity	LREAL	-	RON	Encoder velocity
	AdaptionState	DINT	-	RON	Status of automatic data transfer of encoder parameters 0: "NOT_ADAPTED" (Data not transferred) 1: "IN_ADAPTION" (Data transfer in progress) 2: "ADAPTED" (Data transfer complete) 3: "NOT_APPLICABLE" (Data transfer not selected, not possible) 4: "ADAPTION_ERROR" (Error during data transfer)

A.3.12 StatusExtrapolation tag (external encoder)

The tag structure <TO>.StatusExtrapolation.<tag name> indicates the status of the actual value extrapolation.

Tags

Legend (Page 588)

Tag		Data type	Values	W	Description
Extrapolation.		STRUCT			
	FilteredPosition	LREAL	-1.0E12 to 1.0E12	RON	Position after position filter
	FilteredVelocity	LREAL	-1.0E12 to 1.0E12	RON	Velocity according to tolerance band
	ExtrapolatedPosition	LREAL	-1.0E12 to 1.0E12	RON	Extrapolated position
	ExtrapolatedVelocity	LREAL	-1.0E12 to 1.0E12	RON	Extrapolated velocity

A.3.13 StatusWord tag (external encoder)

The <TO>.StatusWord tag contains the status information of the technology object.

Information on the evaluation of the individual bits (e.g. bit 5 "HomingDone") can be found in the Evaluating StatusWord, ErrorWord and WarningWord (Page 359) section.

Tag

Legend (Page 588)

Tag	Data type	Values	W	Description
StatusWord	DWORD	-	RON	Status data of the technology object
Bit 0	-	-	-	"Enable" Enable status 0: Technology object disabled 1: Technology object enabled
Bit 1	-	-	-	"Error" 0: No error present 1: Error present
Bit 2	-	-	-	"RestartActive" 0: No "Restart" active 1: "Restart" active. The technology object is being reinitialized.
Bit 3	-	-	-	"OnlineStartValuesChanged" 0: "Restart" tags unchanged 1: Change to "Restart" tags. For the changes to be applied, the technology object must be reinitialized.
Bit 4	-	-	-	Reserved
Bit 5	-	-	-	"HomingDone" Homing status 0: Technology object not homed 1: Technology object homed
Bit 6	-	-	-	"Done" 0: Motion job is running, or Axis control panel enabled 1: No motion job is running and axis control panel disabled
Bit 7	-	-	-	Reserved
Bit 8	-		-	Reserved
Bit 9	-	-	-	Reserved
Bit 10	-	-	-	Reserved
Bit 11	-	-	-	"HomingCommand" 0: No "MC_Home" job is running 1: "MC_Home" job is running
Bit 12... Bit 31	-	-	-	Reserved

A.3.14 ErrorWord tag (external encoder)

The <TO>.ErrorWord tag indicates technology object errors (technology alarms).

Information on the evaluation of the individual bits (e.g. bit 3 "CommandNotAccepted") can be found in the Evaluating StatusWord, ErrorWord and WarningWord (Page 359) section.

Tag

Legend (Page 588)

Tag	Data type	Values	W	Description
ErrorWord	DWORD	-	RON	
Bit 0	-	-	-	"SystemFault" A system-internal error has occurred.
Bit 1	-	-	-	"ConfigFault" Configuration error One or more configuration parameters are inconsistent or invalid.
Bit 2	-	-	-	"UserFault" Error in user program at a Motion Control instruction or its use
Bit 3	-	-	-	"CommandNotAccepted" Command cannot be executed. A Motion Control instruction cannot be executed because necessary requirements have not been met.
Bit 4	-	-	-	Reserved
Bit 5	-	-	-	"SensorFault" Error in encoder system
Bit 6	-	-	-	Reserved
Bit 7	-	-	-	"CommunicationFault" Communication error Missing or faulty communication.
Bit 8	-	-	-	Reserved
Bit 9	-	-	-	Reserved
Bit 10	-	-	-	"HomingError" Error during homing operation The homing cannot be completed.
Bit 11	-	-	-	Reserved
Bit 12	-	-	-	Reserved
Bit 13	-	-	-	"PeripheralError" Error accessing a logical address
Bit 14... Bit 31	-	-	-	Reserved

A.3.15 ErrorDetail tags (external encoder)

The tag structure <TO>.ErrorDetail.<tag name> contains the alarm number and the effective local alarm reaction for the technology alarm that is currently pending for the technology object.

You can find a list of the technology alarms and alarm reactions in the Technology alarms (Page 626) appendix.

Tags

Legend (Page 588)

Tag		Data type	Values	W	Description
ErrorDetail.		STRUCT			
	Number	UDINT	-	RON	Alarm number
	Reaction	DINT	0, 10	RON	Effective alarm reaction 0: No reaction 10: Remove enable For the technology object external encoder, only alarm reactions 0 and 4 are possible.

A.3.16 WarningWord tag (external encoder)

The <TO>.WarningWord tag indicates pending warnings for the technology object.

Information on the evaluation of the individual bits (e.g. bit 13 "PeripheralWarning") can be found in the Evaluating StatusWord, ErrorWord and WarningWord (Page 359) section.

Tag

Legend (Page 588)

Tag	Data type	Values	W	Description
WarningWord	DWORD	-	RON	
Bit 0	-	-	-	"SystemWarning" A system-internal error has occurred.
Bit 1	-	-	-	"ConfigWarning" Configuration error One or several configuration parameters are adjusted internally.
Bit 2	-	-	-	"UserWarning" Error in user program at a Motion Control instruction or its use
Bit 3	-	-	-	"CommandNotAccepted" Command cannot be executed. A Motion Control instruction cannot be executed because necessary requirements have not been met.
Bit 4	-	-	-	Reserved
Bit 5	-	-	-	"SensorWarning" Error in encoder system
Bit 6	-	-	-	Reserved
Bit 7	-	-	-	"CommunicationWarning" Communication error Missing or faulty communication.
Bit 8	-	-	-	Reserved
Bit 9	-	-	-	Reserved
Bit 10	-	-	-	"HomingWarning" Error during homing operation The homing cannot be completed.
Bit 11	-	-	-	Reserved
Bit 12	-	-	-	Reserved
Bit 13	-	-	-	"PeripheralWarning" Error accessing a logical address
Bit 14... Bit 31	-	-	-	Reserved

A.3.17 InternalToTrace tags (external encoder)

The tag structure <TO>.InternalToTrace.<tag name> contains no application-relevant data. This tag structure is internally used.

Tags

Legend (Page 588)

Tag		Data type	Values	W	Description
InternalToTrace.		ARRAY [1..4] OF STRUCT			
	Id	DINT	-	DIR	-
	Value	LREAL	-	RON	-

A.4 Tags of the measuring input technology object

A.4.1 Legend

Tag	Name of the tag	
Data type	Data type of the tag	
Values	Value range of the tag - minimum value to maximum value If no specific value is shown, the value range limits of the relevant data type apply or the information under "Description".	
W	Effectiveness of changes in the technology data block	
	DIR	Direct: Values are changed directly and take effect at the start of the next MC-Servo [OB91].
	CAL	At call of Motion Control instruction: Values are changed directly and take effect at the start of the next MC-Servo [OB91] after the call of the corresponding Motion Control instruction in the user program.
	RES	Restart: Changes to the start value in the load memory are made using the extended instruction "WRIT_DBL" (write to DB in load memory). Changes will not take effect until after restart of the technology object.
	RON	Read only: The tag cannot and must not be changed during runtime of the user program.
Description	Description of the tag	

Access to the tags is with "<TO>.<tag name>". The placeholder <TO> represents the name of the technology object.

A.4.2 Display data (measuring input)

The <TO>.Status and <TO>.InputState tags show the status of the measuring input function and the input of the measuring input.

Tags

Legend (Page 600)

Tag	Data type	Values	W	Description
Status	DINT	-	RON	Measuring input function status 0: "INACTIVE" (measurement is not active) 1: "WAITING_FOR_TRIGGER" (measuring input is waiting for measuring event) 2: "TRIGGER_OCCURRED" (one or more measured values have been acquired) 3: "MEASURING_ERROR" (error during the measurement)
InputState	BOOL	-	RON	Measuring input input status FALSE: Input of measuring input not active TRUE: Input of measuring input active

A.4.3 Parameter tags (measuring input)

The tag structure <TO>.Parameter.<tag name> contains the configuration of the basic parameters of the measuring input technology object.

Tags

Legend (Page 600)

Tag		Data type	Values	W	Description
Parameter.		STRUCT			
	MeasuringInputType	DINT		RON	Measuring input type 0: "TIME_BASED" (measurement using time stamp) 1: "PROFIDRIVE" (measuring event using PROFIdrive telegram)
	PROFIdriveProbe-Number	UDINT	1, 2	RES	Number of the measuring input to be used for a measurement using PROFIdrive telegram
	MeasuringRange-ActivationTime	LREAL	0.0 to 1.0E12	RON	System share for activation time of measuring range
	MeasuringRangeAdditio-nalActivationTime	LREAL	0.0 to 1.0E12	RES	Additional activation time when using measuring range limits [ms]
	CorrectionTime	LREAL	0.0 to 1.0E12	RES	Correction time for the measurement result [ms]

A.4.4 Interface tags (measuring input)

The tag structure <TO>.Interface.<tag name> contains the configuration of the input properties for the technology object measuring input.

Tags

Legend (Page 600)

Tag		Data type	Values	W	Description
Interface.		STRUCT			
	Address	VREF	-	RON	I/O address for the digital measuring input

A.4.5 Units tags (measuring input)

The tag structure <TO>.Units.<tag name> shows the set technological units.

Tags

Legend (Page 600)

Tag		Data type	Values	W	Description	
Units.		STRUCT				
	LengthUnit	UDINT	-	RON	Unit for position	
					1010	m
					1013	mm
					1011	km
					1014	µm
					1015	nm
					1019	in
					1018	ft
					1021	mi
					1004	rad
					1005	°
	TimeUnit	UDINT	-	RON	Unit for time	
					1056	ms

A.4.6 MeasuredValues tags (measuring input)

The tag structure <TO>.MeasuredValues.<tag name> displays the measurement results.

Tags

Legend (Page 600)

Tag		Data type	Values	W	Description
MeasuredValues.		STRUCT			
	MeasuredValue1	LREAL	-1.0E12 to 1.0E12	RON	First measured value
	MeasuredValue2	LREAL	-1.0E12 to 1.0E12	RON	Second measured value
	Measured-Value1Counter	UDINT	0 to 2147483647	RON	Count value for the first measured value
	Measured-Value2Counter	UDINT	0 to 2147483647	RON	Count value for the second measured value
	LostEdgeCounter1	UDINT	0 to 7	RON	LEC for measured value 1 (zero in the case of one-time measurement)
	LostEdgeCounter2	UDINT	0 to 7	RON	LEC for measured value 2 (zero in the case of one-time measurement)

A.4.7 StatusWord tag (measuring input)

The <TO>.StatusWord tag contains the status information of the technology object.

Information on the evaluation of the individual bits (e.g. bit 2 "RestartActive") can be found in the Evaluating StatusWord, ErrorWord and WarningWord (Page 359) section.

Tags

Legend (Page 600)

Tag	Data type	Values	W	Description
StatusWord	DWORD	-	RON	Status information of the technology object
Bit 0	-	-	-	"Control" 0: Technology object not in operation 1: Technology object in operation
Bit 1	-	-	-	"Error" 0: No error present 1: Error present
Bit 2	-	-	-	"RestartActive" 0: No "Restart" active 1: "Restart" active. The technology object is being reinitialized.
Bit 3	-	-	-	"OnlineStartValuesChanged" 0: "Restart" tags unchanged 1: Change to "Restart" tags. For the changes to be applied, the technology object must be reinitialized.
Bit 4	-	-	-	Reserved
Bit 5	-	-	-	"CommunicationOK" Communication between measuring input and measuring module 0: Not established 1: Established
Bit 6... Bit 31	-	-	-	Reserved

A.4.8 ErrorWord tag (measuring input)

The <TO>.ErrorWord tag indicates technology object errors (technology alarms).

Information on the evaluation of the individual bits (e.g. bit 3 "CommandNotAccepted") can be found in the Evaluating StatusWord, ErrorWord and WarningWord (Page 359) section.

Tags

Legend (Page 600)

Tag	Data type	Values	W	Description
ErrorWord	DWORD	-	RON	
Bit 0	-	-	-	"SystemFault" A system-internal error has occurred.
Bit 1	-	-	-	"ConfigFault" Configuration error One or more configuration parameters are inconsistent or invalid.
Bit 2	-	-	-	"UserFault" Error in user program at a Motion Control instruction or its use
Bit 3	-	-	-	"CommandNotAccepted" Command cannot be executed. A Motion Control instruction cannot be executed because necessary requirements have not been met.
Bit 4... Bit 12	-	-	-	Reserved
Bit 13	-	-	-	"PeripheralError" Error accessing a logical address
Bit 14... Bit 31	-	-	-	Reserved

A.4.9 ErrorDetail tags (measuring input)

The tag structure <TO>.ErrorDetail.<tag name> contains the alarm number and the effective local alarm reaction for the technology alarm that is currently pending for the technology object.

You can find a list of the technology alarms and alarm reactions in the Technology alarms (Page 626) appendix.

Tags

Legend (Page 600)

Tag		Data type	Values	W	Description
ErrorDetail.		STRUCT			
	Number	UDINT	-	RON	Alarm number
	Reaction	DINT	0, 8	RON	Effective alarm reaction 0: No reaction 8: End measuring input processing

A.4.10 WarningWord tag (measuring input)

The <TO>.WarningWord tag indicates pending warnings for the technology object.

Information on the evaluation of the individual bits (e.g. bit 1 "ConfigWarning") can be found in the Evaluating StatusWord, ErrorWord and WarningWord (Page 359) section.

Tag

Legend (Page 600)

Tag	Data type	Values	W	Description
WarningWord	DWORD	-	RON	
Bit 0	-	-	-	"SystemWarning" A system-internal error has occurred.
Bit 1	-	-	-	"ConfigWarning" Configuration error One or several configuration parameters are adjusted internally.
Bit 2	-	-	-	"UserWarning" Error in user program at a Motion Control instruction or its use
Bit 3	-	-	-	"CommandNotAccepted" Command cannot be executed. A Motion Control instruction cannot be executed because necessary requirements have not been met.
Bit 4... Bit 12	-	-	-	Reserved
Bit 13				"PeripheralWarning" Error accessing a logical address
Bit 14... Bit 31	-	-	-	Reserved

A.5 Tags of the cam technology object

A.5.1 Legend

Tag	Name of the tag	
Data type	Data type of the tag	
Values	Value range of the tag - minimum value to maximum value If no specific value is shown, the value range limits of the relevant data type apply or the information under "Description".	
W	Effectiveness of changes in the technology data block	
	DIR	Direct: Values are changed directly and take effect at the start of the next MC-Servo [OB91].
	CAL	At call of Motion Control instruction: Values are changed directly and take effect at the start of the next MC-Servo [OB91] after the call of the corresponding Motion Control instruction in the user program.
	RES	Restart: Changes to the start value in the load memory are made using the extended instruction "WRIT_DBL" (write to DB in load memory). Changes will not take effect until after restart of the technology object.
	RON	Read only: The tag cannot and must not be changed during runtime of the user program.
Description	Description of the tag	

Access to the tags is with "<TO>.<tag name>". The placeholder <TO> represents the name of the technology object.

A.5.2 Display data (cam)

The <TO>.CamOutput tag indicates the switching state of the cam.

Tags

Legend (Page 607)

Tag	Data type	Values	W	Description
CamOutput	BOOL	-	RON	Switching state of output cam FALSE: not interconnected TRUE: Switched

A.5.3 Parameter tags (cam)

The tag structure <TO>.Parameter.<tag name> contains the configuration of the basic parameters of the output cam technology object.

Tags

Legend (Page 607)

Tag		Data type	Values	W	Description
Parameter.		STRUCT			
	OutputCamType	DINT	-	RES	Output cam type 0: Distance output cam 1: Time-based output cam
	PositionType	DINT	-	RES	Position reference 0: Position setpoint 1: Actual position
	OnCompensation	LREAL	0.0 to 1.0E12	DIR	Activation time Lead time for the switch-on edge
	OffCompensation	LREAL	0.0 to 1.0E12	DIR	Deactivation time Lead time for the switch-off edge
	Hysteresis	LREAL	0.0 to 1.0E12	DIR	Hysteresis value For output cams with reference to actual position, always enter a hysteresis value (> 0.0).

A.5.4 Interface tags (cam)

The tag structure <TO>.Interface.<tag name> contains the configuration of the output properties for the output cam technology object.

Tags

Legend (Page 607)

Tag		Data type	Values	W	Description
Interface.		STRUCT			
	EnableOutput	BOOL	-	RES	Activation of the output cam output FALSE: Output is deactivated TRUE: Output is activated
	Address	VREF	-	RON	I/O address of the output cam
	LogicOperation	DINT	-	RON	Logical operation of the output cam signals at the output 0: OR operation 1: AND operation

A.5.5 Units tags (cam)

The tag structure <TO>.Units.<tag name> shows the set technological units.

Tags

Legend (Page 607)

Tag		Data type	Values	W	Description	
Units.		STRUCT				
	LengthUnit	UDINT	-	RON	Unit for position	
					1010	m
					1013	mm
					1011	km
					1014	µm
					1015	nm
					1019	in
					1018	ft
					1021	mi
					1004	rad
					1005	°
	TimeUnit	UDINT	-	RON	Unit for time	
					1056	ms

A.5.6 StatusWord tag (output cam)

The <TO>.StatusWord tag contains the status information of the technology object.

Information on the evaluation of the individual bits (e.g. bit 2 "RestartActive") can be found in the Evaluating StatusWord, ErrorWord and WarningWord (Page 359) section.

Tags

Legend (Page 607)

Tag	Data type	Values	W	Description
StatusWord	DWORD	-	RON	Status information of the technology object
Bit 0	-	-	-	"Control" 0: Technology object not in operation 1: Technology object in operation
Bit 1	-	-	-	"Error" 0: No error present 1: Error present
Bit 2	-	-	-	"RestartActive" 0: No "Restart" active 1: "Restart" active. The technology object is being reinitialized.
Bit 3	-	-	-	"OnlineStartValuesChanged" 0: "Restart" tags unchanged 1: Change to "Restart" tags. For the changes to be applied, the technology object must be reinitialized.
Bit 4	-	-	-	"OutputInverted" 0: Output cam output not inverted 1: Output cam output inverted
Bit 5	-	-	-	"CommunicationOK" Communication between output cam and output module 0: Not established 1: Established
Bit 6... Bit 31	-	-	-	Reserved

A.5.7 ErrorWord tag (output cam)

The <TO>.ErrorWord tag indicates technology object errors (technology alarms).

Information on the evaluation of the individual bits (e.g. bit 3 "CommandNotAccepted") can be found in the Evaluating StatusWord, ErrorWord and WarningWord (Page 359) section.

Tags

Legend (Page 607)

Tag	Data type	Values	W	Description
ErrorWord	DWORD	-	RON	
Bit 0	-	-	-	"SystemFault" A system-internal error has occurred.
Bit 1	-	-	-	"ConfigFault" Configuration error One or more configuration parameters are inconsistent or invalid.
Bit 2	-	-	-	"UserFault" Error in user program at a Motion Control instruction or its use
Bit 3	-	-	-	"CommandNotAccepted" Command cannot be executed. A Motion Control instruction cannot be executed because necessary requirements have not been met.
Bit 4... Bit 12	-	-	-	Reserved
Bit 13	-	-	-	"PeripheralError" Error accessing a logical address
Bit 14... Bit 31	-	-	-	Reserved

A.5.8 ErrorDetail tags (cam)

The tag structure <TO>.ErrorDetail.<tag name> contains the alarm number and the effective local alarm reaction for the technology alarm that is currently pending for the technology object.

You can find a list of the technology alarms and alarm reactions in the Technology alarms (Page 626) appendix.

Tags

Legend (Page 607)

Tag		Data type	Values	W	Description
ErrorDetail.		STRUCT			
	Number	UDINT	-	RON	Alarm number
	Reaction	DINT	0, 6	RON	Effective alarm reaction 0: No reaction 6: Output cam processing is complete.

A.5.9 WarningWord tag (output cam)

The <TO>.WarningWord tag indicates pending warnings for the technology object.

Information on the evaluation of the individual bits (e.g. bit 1 "ConfigWarning") can be found in the Evaluating StatusWord, ErrorWord and WarningWord (Page 359) section.

Tag

Legend (Page 607)

Tag	Data type	Values	W	Description
WarningWord	DWORD	-	RON	
Bit 0	-	-	-	"SystemWarning" A system-internal error has occurred.
Bit 1	-	-	-	"ConfigWarning" Configuration error One or several configuration parameters are adjusted internally.
Bit 2	-	-	-	"UserWarning" Error in user program at a Motion Control instruction or its use
Bit 3	-	-	-	"CommandNotAccepted" Command cannot be executed. A Motion Control instruction cannot be executed because necessary requirements have not been met.
Bit 4... Bit 12	-	-	-	Reserved
Bit 13				"PeripheralWarning" Error accessing a logical address
Bit 14... Bit 31	-	-	-	Reserved

A.6 Tags of the cam track technology object

A.6.1 Legend

Tag	Name of the tag	
Data type	Data type of the tag	
Values	Value range of the tag - minimum value to maximum value If no specific value is shown, the value range limits of the relevant data type apply or the information under "Description".	
W	Effectiveness of changes in the technology data block	
	DIR	Direct: Values are changed directly and take effect at the start of the next MC-Servo [OB91].
	CAL	At call of Motion Control instruction: Values are changed directly and take effect at the start of the next MC-Servo [OB91] after the call of the corresponding Motion Control instruction in the user program.
	RES	Restart: Changes to the start value in the load memory are made using the extended instruction "WRIT_DBL" (write to DB in load memory). Changes will not take effect until after restart of the technology object.
	RON	Read only: The tag cannot and must not be changed during runtime of the user program.
Description	Description of the tag	

Access to the tags is with "<TO>.<tag name>". The placeholder <TO> represents the name of the technology object.

A.6.2 Display data (cam track)

The following tags indicate the status of the cam track:

Tags

Legend (Page 613)

Tag	Data type	Values	W	Description
Status	DINT	-	RON	0: "INACTIVE" (inactive) 1: "ACTIVE" (active) 2: "ACTIVE_WAITING_FOR_NEXT_CYCLE" (active and waiting for next track)
TrackOutput	BOOL	-	RON	FALSE: Cam track is not output. TRUE: Cam track is output.
SingleCamState	DWORD	16#0 to 16#FFFF_FFFF	RON	Switched on output cam (bit-masked) 0: Output cam is not switched on 1: Output cam is switched on
TrackPosition	LREAL	-1.0E12 to 1.0E12	RON	Display of the current position within the cam track
MatchPosition	LREAL	-1.0E12 to 1.0E12	RON	Reference position of the current cam track During cyclic processing of the cam track, the continued reference position of the current cam track is displayed. The unique detection and output of the position is only possible when the assigned technology object is in motion.

A.6.3 Parameter tags (cam track)

The tag structure <TO>.Parameter.<tag name> contains the configuration of the basic parameters of the cam track technology object.

Tags

Legend (Page 613)

Tag			Data type	Values	W	Description
Parameter.			STRUCT			
	CamTrackType		DINT	-	RES	Output cam type 0: Distance output cam 1: Time-based output cam
	PositionType		DINT	-	RES	Position reference 0: Position setpoint 1: Actual position
	ReferencePosition		LREAL	-1.0E12 to 1.0E12	DIR	Reference position
	CamTrackLength		LREAL	0.001 to 1.0E12	DIR	Track length
	CamMasking		DWORD	16#0 to 16#FFFF_FFFF	DIR	Bit masking of individual output cams
	OnCompensation		LREAL	0.0 to 1.0E12	DIR	Activation time Lead time for the switch-on edge
	OffCompensation		LREAL	0.0 to 1.0E12	DIR	Deactivation time Lead time for the switch-off edge
	Hysteresis		LREAL	0.0 to 1.0E12	DIR	Hysteresis value For output cams with reference to actual position, always enter a hysteresis value (> 0.0).
	Cam[1 … 32].		STRUCT			
		OnPosition	LREAL	0.0 to 1.0E12	CAL	Start position (distance and time-based output cams)
		Offposition	LREAL	0.0 to 1.0E12	CAL	End position (distance output cam)
		Duration	LREAL	0.001 to 1.0E12	CAL	Switch-on duration (time-based output cam)
		Existent	BOOL	-	CAL	FALSE: Output cam not used TRUE: Output cam is used

A.6.4 Interface tags (cam track)

The tag structure <TO>.Interface.<tag name> contains the configuration of the output properties for the cam track technology object.

Tags

Legend (Page 613)

Tag		Data type	Values	W	Description
Interface.		STRUCT			
	EnableOutput	BOOL	-	RES	Output cam output at the bit specified under "<TO>.Interface.Address" FALSE: No output TRUE: Output
	Address	VREF	-	RON	I/O address for digital cam output

A.6.5 Units tags (cam track)

The tag structure <TO>.Units.<tag name> shows the set technological units.

Tags

Legend (Page 613)

Tag		Data type	Values	W	Description	
Units.		STRUCT				
	LengthUnit	UDINT	-	RON	Unit for position	
					1010	m
					1013	mm
					1011	km
					1014	µm
					1015	nm
					1019	in
					1018	ft
					1021	mi
					1004	rad
					1005	°
	TimeUnit	UDINT	-	RON	Unit for time	
					1056	ms

A.6.6 StatusWord tag (cam track)

The <TO>.StatusWord tag contains the status information of the technology object.

Information on the evaluation of the individual bits (e.g. bit 2 "RestartActive") can be found in the Evaluating StatusWord, ErrorWord and WarningWord (Page 359) section.

Tags

Legend (Page 613)

Tag	Data type	Values	W	Description
Status tus-Word	DWORD	-	RON	Status information of the technology object
Bit 0	-	-	-	"Control" 0: Technology object not in operation 1: Technology object in operation
Bit 1	-	-	-	"Error" 0: No error present 1: Error present
Bit 2	-	-	-	"RestartActive" 0: No "Restart" active 1: "Restart" active. The technology object is being reinitialized.
Bit 3	-	-	-	"OnlineStartValuesChanged" 0: "Restart" tags unchanged 1: Change to "Restart" tags. For the changes to be applied, the technology object must be reinitialized.
Bit 4	-	-	-	"OutputInverted" 0: Output cam output not inverted 1: Output cam output inverted
Bit 5	-	-	-	"CommunicationOK" Communication between cam track and output module 0: Not established 1: Established
Bit 6... Bit 31	-	-	-	Reserved

A.6.7 ErrorWord tag (cam track)

The <TO>.ErrorWord tag indicates technology object errors (technology alarms).

Information on the evaluation of the individual bits (e.g. bit 3 "CommandNotAccepted") can be found in the Evaluating StatusWord, ErrorWord and WarningWord (Page 359) section.

Tags

Legend (Page 613)

Tag	Data type	Values	W	Description
ErrorWord	DWORD	-	RON	
Bit 0	-	-	-	"SystemFault" A system-internal error has occurred.
Bit 1	-	-	-	"ConfigFault" Configuration error One or more configuration parameters are inconsistent or invalid.
Bit 2	-	-	-	"UserFault" Error in user program at a Motion Control instruction or its use
Bit 3	-	-	-	"CommandNotAccepted" Command cannot be executed. A Motion Control instruction cannot be executed because necessary requirements have not been met.
Bit 4... Bit 12	-	-	-	Reserved
Bit 13	-	-	-	"PeripheralError" Error accessing a logical address
Bit 14... Bit 31	-	-	-	Reserved

A.6.8 ErrorDetail tags (cam track)

The tag structure <TO>.ErrorDetail.<tag name> contains the alarm number and the effective local alarm reaction for the technology alarm that is currently pending for the technology object.

You can find a list of the technology alarms and alarm reactions in the Technology alarms (Page 626) appendix.

Tags

Legend (Page 613)

Tag		Data type	Values	W	Description
ErrorDetail.		STRUCT			
	Number	UDINT	-	RON	Alarm number
	Reaction	DINT	0, 7	RON	Effective alarm reaction 0: No reaction 7: Cam track processing Is complete.

A.6.9 WarningWord tag (cam track)

The <TO>.WarningWord tag indicates pending warnings for the technology object.

Information on the evaluation of the individual bits (e.g. bit 1 "ConfigWarning") can be found in the Evaluating StatusWord, ErrorWord and WarningWord (Page 359) section.

Tag

Legend (Page 600)

Tag	Data type	Values	W	Description
WarningWord	DWORD	-	RON	
Bit 0	-	-	-	"SystemWarning" A system-internal error has occurred.
Bit 1	-	-	-	"ConfigWarning" Configuration error One or several configuration parameters are adjusted internally.
Bit 2	-	-	-	"UserWarning" Error in user program at a Motion Control instruction or its use
Bit 3	-	-	-	"CommandNotAccepted" Command cannot be executed. A Motion Control instruction cannot be executed because necessary requirements have not been met.
Bit 4... Bit 12	-	-	-	Reserved
Bit 13				"PeripheralWarning" Error accessing a logical address
Bit 14... Bit 31	-	-	-	Reserved

A.7 Tags of the cam technology object

A.7.1 Legend

Tag	Name of the tag	
Data type	Data type of the tag	
Values	Value range of the tag - minimum value to maximum value If no specific value is shown, the value range limits of the relevant data type apply or the information under "Description".	
W	Effectiveness of changes in the technology data block	
	DIR	Direct: Values are changed directly and take effect at the start of the next MC-Servo [OB91].
	CAL	At call of Motion Control instruction: Values are changed directly and take effect at the start of the next MC-Servo [OB91] after the call of the corresponding Motion Control instruction in the user program.
	RES	Restart: Changes to the start value in the load memory are made using the extended instruction "WRIT_DBL" (write to DB in load memory). Changes will not take effect until after restart of the technology object.
	RON	Read only: The tag cannot and must not be changed during runtime of the user program.
Description	Description of the tag	

Access to the tags is with "<TO>.<tag name>". The placeholder <TO> represents the name of the technology object.

A.7.2 Point tags (cam)

The tag structure <TO>.Point.<tag name> contains the defined points of the cam.

Tags

Legend (Page 620)

Tag		Data type	Values	W	Description
Point.		ARRAY[1..1000] OF STRUCT			
	x	LREAL	-1.0E12 to 1.0E12	CAL	Value of the point in the definition range
	y	LREAL	-1.0E12 to 1.0E12	CAL	Value of the point in the range of the function

A.7.3 ValidPoints tags (cam)

The tag structure <TO>.ValidPoint.<tag name> shows the validity of the defined points of the cam.

Tags

Legend (Page 620)

Tag		Data type	Values	W	Description
ValidPoint.		ARRAY[1..1000] OF BOOL			
	ValidPoint	BOOL	-	CAL	Indicates whether the defined point is valid. FALSE: Invalid TRUE: Valid

A.7.4 Segment tags (cam)

The tag structure <TO>.Segment.<tag name> contains the defined segments of the cam.

Tags

Legend (Page 620)

Tag		Data type	Values	W	Description
Segment.		ARRAY[1..50] OF STRUCT			
	xmin	LREAL	-1.0E12 to 1.0E12	CAL	Start coordinates of the segment
	xmax	LREAL	-1.0E12 to 1.0E12	CAL	End coordinates of the segment
	a0	LREAL	-1.0E12 to 1.0E12	CAL	Coefficient A0 for x^0 of the polynomial for the segment
	a1	LREAL	-1.0E12 to 1.0E12	CAL	Coefficient A1 for x^1 of the polynomial for the segment
	a2	LREAL	-1.0E12 to 1.0E12	CAL	Coefficient A2 for x^2 of the polynomial for the segment
	a3	LREAL	-1.0E12 to 1.0E12	CAL	Coefficient A3 for x^3 of the polynomial for the segment
	a4	LREAL	-1.0E12 to 1.0E12	CAL	Coefficient A4 for x^4 of the polynomial for the segment
	a5	LREAL	-1.0E12 to 1.0E12	CAL	Coefficient A5 for x^5 of the polynomial for the segment
	a6	LREAL	-1.0E12 to 1.0E12	CAL	Coefficient A6 for x^6 of the polynomial for the segment
	sineAmplitude	LREAL	-1.0E12 to 1.0E12	CAL	Amplitude of the sine element
	sinePeriod	LREAL	-1.0E12 to 1.0E12	CAL	Period length of the sine element [rad]
	sinePhase	LREAL	-1.0E12 to 1.0E12	CAL	Phase offset of the sine element [rad]

A.7.5 ValidSegments tags (cam)

The tag structure <TO>.ValidSegment.<tag name> shows the validity of the defined segments of the cam.

Tags

Legend (Page 620)

Tag		Data type	Values	W	Description
ValidSegment.		ARRAY[1..50] OF BOOL			
	ValidSegment	BOOL	-	CAL	Indicates whether the defined segment is valid. FALSE: Invalid TRUE: Valid

A.7.6 InterpolationSettings tags (cam)

The tag structure <TO>.InterpolationSettings.<tag name> contains the configuration for the interpolation of the cam.

Tags

Legend (Page 620)

Tag		Data type	Values	W	Description
InterpolationSettings.		STRUCT			
	InterpolationMode	DINT	-1.0E12 to 1.0E12	CAL	Interpolation type 0: linear 1: C splines 2: B splines
	BoundaryConditions	DINT	-1.0E12 to 1.0E12	CAL	Characteristics of the boundary points 0: No profile start or profile end conditions 1: First derivative equal at profile start and end

A.7.7 StatusCam tags (cam)

The tag structure <TO>.StatusCam.<tag name> indicates the status of the cam.

Tags

Legend (Page 620)

Tag		Data type	Values	W	Description
StatusCam.		STRUCT			
	StartLeadingValue	LREAL	-1.0E12 to 1.0E12	RON	Start value of the definition range of the cam
	EndLeadingValue	LREAL	-1.0E12 to 1.0E12	RON	End value of the definition range of the cam

A.7.8 StatusWord tag (cam)

The <TO>.StatusWord tag contains the status information of the technology object.

Information on the evaluation of the individual bits (e.g. bit 4 "CamDataChanged") can be found in the Evaluating StatusWord, ErrorWord and WarningWord (Page 359) section.

Tags

Legend (Page 620)

Tag	Data type	Values	W	Description
StatusWord	DWORD	-	RON	Status information of the technology object
Bit 0	-	-	-	"Control" Use status 0: Cam not in use 1: Cam in use
Bit 1	-	-	-	"Error" 0: No error present 1: Error present
Bit 2	-	-	-	"RestartActive" 0: No "Restart" active 1: "Restart" active The technology object is being reinitialized.
Bit 3	-	-	-	"OnlineStartValuesChanged" 0: "Restart" tags unchanged 1: Change to "Restart" tags. For the changes to be applied, the technology object must be reinitialized.
Bit 4	-	-	-	"CamDataChanged" 0: No change 1: The definition range of the cam has changed in the technology data block.
Bit 5	-	-	-	"Interpolated" 0: Cam is not interpolated 1: Cam is interpolated
Bit 6	-	-	-	"InInterpolation" 0: Cam not undergoing interpolation 1: Cam undergoing interpolation
Bit 7... Bit 31	-	-	-	Reserved

A.7.9 ErrorWord tag (cam)

The <TO>.ErrorWord tag indicates technology object errors (technology alarms).

Information on the evaluation of the individual bits (e.g. bit 3 "CommandNotAccepted") can be found in the Evaluating StatusWord, ErrorWord and WarningWord (Page 359) section.

Tags

Legend (Page 620)

Tag	Data type	Values	W	Description
ErrorWord	DWORD	-	RON	
Bit 0	-	-	-	"SystemFault" A system-internal error has occurred.
Bit 1	-	-	-	"ConfigFault" Configuration error One or more configuration parameters are inconsistent or invalid.
Bit 2	-	-	-	"UserFault" Error in user program at a Motion Control instruction or its use
Bit 3	-	-	-	"CommandNotAccepted" Command cannot be executed. A Motion Control instruction cannot be executed because necessary requirements have not been met.
Bit 4... Bit 31	-	-	-	Reserved

A.7.10 ErrorDetail tag (cam)

The tag structure <TO>.ErrorDetail.<tag name> contains the alarm number and the effective local alarm reaction for the technology alarm that is currently pending for the technology object.

You can find a list of the technology alarms and alarm reactions in the Technology alarms (Page 626) appendix.

Tags

Legend (Page 620)

Tag		Data type	Values	W	Description
ErrorDetail.		STRUCT			
	Number	UDINT	-	RON	Alarm number
	Reaction	DINT	0, 9	RON	Effective alarm reaction 0: No reaction 9: Terminate processing of the technology object

A.7.11 WarningWord tag (cam)

The <TO>.WarningWord tag indicates pending warnings for the technology object.

Information on the evaluation of the individual bits (e.g. bit 3 "CommandNotAccepted") can be found in the Evaluating StatusWord, ErrorWord and WarningWord (Page 359) section.

Tags

Legend (Page 620)

Tag	Data type	Values	W	Description
Warning-Word	DWORD	-	RON	
Bit 0	-	-	-	"SystemWarning" A system-internal error has occurred.
Bit 1	-	-	-	"ConfigWarning" Configuration error One or more configuration parameters are inconsistent or invalid.
Bit 2	-	-	-	"UserWarning" Error in user program at a Motion Control instruction or its use
Bit 3	-	-	-	"CommandNotAccepted" Command cannot be executed. A Motion Control instruction cannot be executed because necessary requirements have not been met.
Bit 4... Bit 31	-	-	-	Reserved

A.8 Technology alarms

A.8.1 Overview

The following table shows an overview of the technology alarms and the corresponding alarm reactions. When a technology alarm occurs, evaluate the entire indicated alarm text, in order to find the precise cause.

Legend

No.	Number of the technology alarm (corresponds to <TO>.ErrorDetail.Number)
Reaction	Effective alarm reaction (corresponds to <TO>.ErrorDetail.Reaction)
Error bit	Bit that is set in <TO>.ErrorWord when the technology alarm occurs A description of the bits can be found in the appendix (Page 584).
Warning bit	Bit that is set in <TO>.WarningWord when the technology alarm occurs A description of the bits can be found in the appendix (Page 586).
Restart	To acknowledge the technology alarm, the technology object must be reinitialized (Restart).
Diagnostic buffer	The alarm is entered in the diagnostics buffer.
Alarm text	Displayed alarm test (limited)

List of the technology alarms

No.	Reaction	Error bit	Warning bit	Restart	Diagnostic buffer	Alarm text
101	Remove enable	X1	-	X	X	Configuration error.
102	Remove enable	X15	-	X	X	Drive configuration adaptation error.
103	Remove enable	X15	-	X	X	Encoder configuration adaptation error.
104	Stop with maximum dynamic values	X1	-	-	-	SW limit switch specification error.
105	Remove enable	X1	-	X	X	Drive configuration error.
106	Remove enable	X1	-	-	X	Drive connection configuration error.
107	Remove enable	X1	-	X	X	Encoder configuration error.
108	Remove enable	X1	-	-	X	Encoder connection configuration error.
109	Remove enable	X1	-	X	-	Configuration error.
110	No reaction	-	X1	-	-	Configuration is adjusted internally.
111	No reaction	-	X15	-	X	TO and drive configuration inconsistent.
112	No reaction	-	X15	-	X	TO and encoder configuration inconsistent.
113	Remove enable	X2	-	X	-	Isochronous mode not possible.
201	Remove enable	X0	-	X	X	Internal error.
202	No reaction	X0	-	X	-	Internal configuration error.

No.	Reaction	Error bit	Warning bit	Restart	Diagnostic buffer	Alarm text
203	Remove enable	X0	-	X	-	Internal error.
204	Remove enable	X0	-	-	-	Commissioning error.
304	Stop with emergency stop ramp	X2	-	-	-	Velocity limit is zero.
305	Stop with emergency stop ramp	X2	-	-	-	• Acceleration limit is zero. • Deceleration limit is zero.
306	Stop with emergency stop ramp	X2	-	-	-	Jerk limit is zero.
307	Stop with maximum dynamic values	X2	-	-	X	• Negative numerical value range of the position reached. • Positive numerical value range of the position reached.
308	Remove enable	X2	-	-	X	• Negative numerical value range of the position exceeded. • Positive numerical value range of the position exceeded.
321	Stop with emergency stop ramp	X3	-	-	-	Axis not homed.
322	No reaction	-	X3	-	-	Restart not executed.
323	Remove enable	X3	-	-	-	MC_Home could not be performed.
341	Stop with maximum dynamic values	X10	-	-	-	Error in homing data.
342	Stop with emergency stop ramp	X10	-	-	-	Reference cam/encoder zero mark not found.
343	Remove enable	X1	-	-	-	Homing function not supported by device.
401	Remove enable	X13	-	-	X	Error accessing logical address.
411	Remove enable	X5	-	-	X	Faulty encoder at the logical address.
412	Remove enable	X5	-	-	-	Permitted actual value range exceeded.
421	Remove enable	X4	-	-	X	Faulty drive at the logical address.
431	Remove enable	X7	-	-	X	Faulty communication with device at logical address.
501	No reaction	-	X6	-	-	Programmed velocity is limited.
502	No reaction	-	X6	-	-	• Programmed acceleration is being limited. • Programmed deceleration is being limited.
503	No reaction	-	X6	-	-	Programmed jerk is limited.
504	No reaction	-	X6	-	-	Speed setpoint monitoring active.
511	No reaction	-	X6	-	-	Dynamic limits are violated by the kinematics motion.
521	Remove enable	X11	-	-	-	Following error.
522	No reaction	-	X11	-	-	Warning following error tolerance.

No.	Reaction	Error bit	Warning bit	Restart	Diagnostic buffer	Alarm text
531	Remove enable	X9	-	-	-	• Positive HW limit switch approached. • Negative HW limit switch approached. • Illegal free travel direction of active hardware limit switch. • HW limit switch polarity reversed, free travel not possible. • Both hardware limit switches active, retraction not possible.
533	Stop with maximum dynamic values	X8	-	-	-	• Negative SW limit switch approached. • Positive SW limit switch approached.
534	Remove enable	X8	-	-	-	• Negative SW limit switch is crossed. • Positive SW limit switch is crossed.
541	Remove enable	X12	-	-	-	Position monitoring error.
542	Remove enable	X2	-	-	-	Clamping monitoring error: Axis leaving clamping tolerance window.
550	Track setpoints	X4	-	-	-	Drive-autonomous motion is being executed.
551	No reaction	X2	X6	-	-	Maximum velocity cannot be reached with drive/axis parameters.
552	Remove enable	X15	-	-	-	Adaptation error of encoder during power-up.
601	Stop with maximum dynamic values	X14	-	-	-	Leading axis is not assigned or defective.
603	Remove enable	X14	-	-	-	Leading axis is not in position-controlled mode.
608	Stop with maximum dynamic values	X14	-	-	-	Error during synchronization.
611	Remove enable	X2	-	-	-	The cam specified in the MC_CamIn.Cam parameter has not been configured or is not available or is not interpolated.
612	Remove enable	X2	-	-	-	Specified cam has not been interpolated.
700	Remove enable	X2	-	-	-	Output cam limiting error.
701	Remove enable	X13	-	-	-	I/O output error.
702	Remove enable	X2	-	-	-	Position value valid.
703	Remove enable	X2	-	-	-	Cam track data faulty.
704	Remove enable	X2	-	-	-	Output cam data faulty.
750	Remove enable	X2	-	-	-	Measuring job not possible during homing of assigned axis.
752	Remove enable	X2	-	-	-	Validity range of measuring job not recognized.
753	Remove enable	X2	-	-	-	Only one measuring input can access an encoder at a time.
754	Remove enable	X2	-	-	-	Measuring input configuration in external device is not correct.
755	Remove enable	X13	-	-	-	Measuring job not possible.
758	No reaction	X2	-	-	-	A measuring edge was not evaluated.

See also

Technology alarms (Page 403)

A.8.2 Technology alarms 101-113

Technology alarm 101

Alarm reaction: Remove enable

Restart: Required

Alarm text	Remedy
Configuration error.	
Value in <tag> not allowed.	Adjust the specified value.
Faulty load gear factors.	Adjust the load gear factors in <TO>.LoadGear.Numerator and/or <TO>.LoadGear.Denominator .
At least one encoder required. Sensor[].existent	Configure at least one encoder.
Sensor[1] must be configured for DSC.	Configure Sensor[1]
Values in Sensor.Parameter.FineResolutionXist1 and P979 are not identical.	Set the identical fine resolution on the technology as on the drive.
Controller parameter incorrect.	Adjust the <TO>.PositionController.Kv value.
PROFIBUS parameter assignment is inconsistent; sum Ti and To greater than send clock.	Adjust the send clock in the hardware configuration.
Drive or drive telegram type or encoder not suitable for DSC.	Check whether the drive can be operated with DSC and adjust the drive telegram if required.
TimeOut parameter outside of limits.	Set the monitoring time of the axis control panel to a valid value.
Simulation.Mode parameter outside of limits.	Set the parameter to a valid value.
Telegram in Actor.Interface.AddressIn and AddressOut are not identical.	Set the identical drive telegram type for sending and receiving direction.
Illegal combination for referencing data incremental. encoder.	Check the active and passive homing settings.
Telegram in Sensor.Interface.AddressIn and AddressOut are not identical.	Set the identical encoder telegram type for sending and receiving direction.

Technology alarm 102

Alarm reaction: Remove enable

Restart: Required

Alarm text	Remedy
Drive configuration adaptation error.	
Drive is not assigned to a SINAMICS device.	The drive adaptation is only available for SINAMICS drives.
Drive is not interconnected directly to I/O area.	During configuration of the axis, the log addresses were set to a data block or bit memory, for example. The adaptation is only possible when the encoder has been directly interconnected to an I/O area.
Adaptation canceled due to insufficient resources.	Check whether your device supports acyclic data communication according to PROFIdrive.
Parameter does not exist, value unreadable or invalid.	
Maximum speed	
Maximum torque/force (P1520)	
Maximum torque/force (P1521)	
Torque resolution	
Rated speed	
Rated torque	
Motor type	

Technology alarm 103

Alarm reaction: Remove enable

Restart: Required

Alarm text	Remedy
Encoder configuration adaptation error.	
Encoder is not assigned to a SINAMICS device.	The encoder adaptation is only available for SINAMICS devices and external Siemens encoders.
Encoder is not interconnected directly to I/O area.	During configuration of the axis, the log addresses were set to a data block or bit memory address area, for example. The adaptation is only possible when the encoder has been directly interconnected to an I/O area.
Adaptation canceled due to insufficient resources.	Check whether your device supports acyclic data communication according to PROFIdrive.
Parameter does not exist, value unreadable or invalid.	
Encoder system	
Encoder resolution	
Encoder fine resolution Gx_XIST1	
Encoder fine resolution Gx_XIST2	
Encoder revolutions	

Technology alarm 104

Alarm reaction: Stop with maximum dynamic values

Restart: Not required

Alarm text	Remedy
SW limit switch specification error.	
Neg. SW limit switch greater than pos. SW limit switch.	Change the position of the software limit switches.

Technology alarm 105

Alarm reaction: Remove enable

Restart: Required

Alarm text	Remedy
Drive configuration error.	
HW Configuration.	• Connect a suitable device. • Check the device (I/Os). • Check the topology of the project. • Compare the device configuration and the configuration of the technology object. • Contact customer service.
The TO needs a smaller servo cycle clock.	
Error in internal communication.	• Check the project for consistency and download it to the controller again. • Contact customer service.
Address for drive data does not exist in project.	Check the project for consistency and download it to the controller again.

Technology alarm 106

Alarm reaction: Remove enable

Restart: Not required

Alarm text	Remedy
Drive connection configuration error.	
System has no communication with drive.	Internal system error. • Check the project for consistency and download it to the controller again. • Contact customer service.
Drive not initialized during ramp-up.	• Ensure that the communication between the controller and drive is established. To do this, evaluate <TO>.StatusDrive.CommunicationOK before enabling the axis. • To enable a technology object, the drive initialization must be complete. Trigger the job again later.

Technology alarm 107

Alarm reaction: Remove enable

Restart: Required

Alarm text	Remedy
Encoder configuration error.	
HW Configuration	• Connect a suitable device. • Check the device (I/Os). • Check the topology of the project. • Compare the device configuration and the configuration of the technology object. • Contact customer service.
The TO needs a smaller servo cycle clock.	
Error internal communication.	• Check the project for consistency and download it to the controller again. • Contact customer service.

Technology alarm 108

Alarm reaction: Remove enable

Restart: Not required

Alarm text	Remedy
Encoder connection configuration error.	
System without communication to encoder.	Internal system error. • Check the project for consistency and download it to the controller again. • Contact customer service.
Encoder not initialized during ramp-up.	• Ensure that the communication between the controller and encoder is established. To do this, evaluate <TO>.StatusSensor[1..4].CommunicationOK before enabling the axis and also check if the status of the encoder actual value is <TO>.StatusSensor[1..4].State = VALID (2). • To enable a technology object, the encoder initialization must be complete. Trigger the job again later.
Encoder data address missing in project.	Check the project for consistency and download it to the controller again.

Technology alarm 109

Alarm reaction: Remove enable

Restart: Required

Alarm text	Remedy
Configuration error.	
Neg. HW limit switch.	• Connect a suitable device. • Check the device (I/Os). • Check the topology of the project. • Compare the device configuration and the configuration of the technology object. • Contact customer service.
Pos. HW limit switch	
Reference cam "Active homing".	
Reference cam "Passive homing".	
Enable bit for the analog drive interface.	
DriveReady bit of the analog drive interface.	
Measurement sensing input is faulty.	
Output cam output faulty.	

Technology alarm 110

Alarm reaction: No reaction

Restart: Not required

Alarm text	Remedy
Configuration is adjusted internally.	
Actor.DriveParameter.MaxSpeed is limited.	• Correct the reference value in the drive and in the configuration of the technology object to <TO>.Actor.MaxSpeed /2. • With analog drive connection, correct the reference value in the drive and in the configuration of the technology object to <TO>.Actor.MaxSpeed /1.17. • The value can be set in the drive, for example, in p2000 = p1082.
PositioningMonitoring.ToleranceTime is limited.	Change the configuration data.
DynamicDefaults.EmergencyDeceleration is limited.	
DriveParameter.ReferenceTorque is too low.	

Technology alarm 111

Alarm reaction: No reaction

Restart: Not required

Alarm text	Remedy
TO and drive configuration inconsistent.	
Different telegram.	Match the telegram configuration for the technology object with the telegram configuration in the drive. (P922 in drive)
Incompatible torque resolution.	Adjust the high torque resolution for the drive.
Master application cycle and servo cycle clock not the same.	Adjust the cycle of the master application in the device configuration for the PROFIBUS slave.
Servo cycle clock and drive cycle clock not equal.	
Linear motor configured.	Set round-frame motor (P300) in the drive.

Technology alarm 112

Alarm reaction: No reaction

Restart: Not required

Alarm text	Remedy
TO and encoder configuration inconsistent.	
Different telegram type.	Match the telegram configuration for the technology object with the telegram configuration in the drive. (P922 in drive)
Encoder is not an absolute encoder.	Configure the encoder for the technology object as an incremental encoder.
Master application cycle and servo cycle clock not the same.	Adjust the cycle of the master application in the device configuration for the PROFIBUS slave.
Servo cycle clock and drive cycle clock not equal.	

Technology alarm 113

Alarm reaction: Remove enable

Restart: Required

Alarm text	Remedy
Isochronous mode not possible.	• The configured output for the cam or cam track technology object or the input for the technology object measuring input cannot be used in isochronous mode. Configure the I/O in the device configuration as isochronous I/O. • Make sure that the organization block MC_Servo [OB91] is called synchronously with the bus system.

A.8.3 Technology alarms 201-204

Technology alarm 201

Alarm reaction: Remove enable

Restart: Required

Alarm text	Solution
Internal error.	Contact customer service.

Technology alarm 202

Alarm reaction: No reaction

Restart: Required

Alarm text	Solution
Internal configuration error.	Contact customer service.

Technology alarm 203

Alarm reaction: Remove enable

Restart: Required

Alarm text	Solution
Internal error.	Contact customer service.

Technology alarm 204

Alarm reaction: Remove enable

Restart: Not required

Alarm text	Solution
Commissioning error.	
Connection to the TIA Portal interrupted.	Check the connection properties.

A.8.4 Technology alarms 304-343

Technology alarm 304

Alarm reaction: Stop with emergency stop ramp

Restart: Not required

Alarm text	Remedy
Velocity limit is zero.	Enter a non-zero value for the maximum velocity (DynamicLimits.MaxVelocity) in the dynamic limits.

Technology alarm 305

Alarm reaction: Stop with emergency stop ramp

Restart: Not required

Alarm text	Remedy
Acceleration/deceleration limit is zero.	
Acceleration	Enter a non-zero value for the maximum acceleration (DynamicLimits.MaxAcceleration) in the dynamic limits.
Deceleration	Enter a non-zero value for the maximum deceleration (DynamicLimits.MaxDeceleration) in the dynamic limits.

Technology alarm 306

Alarm reaction: Stop with emergency stop ramp

Restart: Not required

Alarm text	Remedy
Jerk limit is zero.	Enter a non-zero value for the maximum jerk (DynamicLimits.MaxJerk) in the dynamic limits.

Technology alarm 307

Alarm reaction: Stop with maximum dynamic values

Restart: Not required

Alarm text	Remedy
Negative/positive numerical value range of the position reached.	
Negative	Enable the "Modulo" setting for the technology object.
Positive	

Technology alarm 308

Alarm reaction: Remove enable

Restart: Not required

Alarm text	Remedy
Negative/positive numerical value range of the position exceeded.	
Negative	Enable the "Modulo" setting for the technology object.
Positive	

Technology alarm 321

Alarm reaction: Stop with emergency stop ramp

Restart: Not required

Alarm text	Remedy
Axis not homed.	To perform an absolute positioning motion, you must home the technology object.

Technology alarm 322

Alarm reaction: No reaction

Restart: Not required

Alarm text	Remedy
Restart not executed.	
The technology object is not ready for restart.	Download the project again.
The condition for restart of the technology object is not satisfied.	Disable the technology object.

Technology alarm 323

Alarm reaction: Remove enable

Restart: Not required

Alarm text	Remedy
MC_Home could not be performed.	• Enable the "Modulo" setting for the technology object. • Adjust the position value for use of the Motion Control instruction "MC_Home".

Technology alarm 341

Alarm reaction: Stop with maximum dynamic values

Restart: Not required

Alarm text	Remedy
Error in homing data.	
Approach velocity is zero.	Check the configuration for homing (Homing.ApproachVelocity).
Homing velocity is zero.	Check the configuration for homing (Homing.ReferencingVelocity).

Technology alarm 342

Alarm reaction: Stop with emergency stop ramp

Restart: Not required

Alarm text	Remedy
Reference cam/encoder zero mark not found.	The reference cam configured for homing was not found in the traversing range of the axis.

Technology alarm 343

Alarm reaction: Remove enable

Restart: Not required

Alarm text	Remedy
Homing function not supported by device.	Configure a reference switch input for the pulse generator output used in the properties of the C-CPU. ("Pulse generators (PTO/PWM) > PTO[n]/PWN[n] > Hardware inputs/outputs") When homing across a zero mark, the CPU transfers the reference switch input as zero mark.

A.8.5 Technology alarms 401-431

Technology alarm 401

Alarm reaction: Remove enable

Restart: Not required

Alarm text	Solution
Error accessing logical address.	
Invalid address.	• Connect a suitable device. • Check the device (I/Os). • Check the topology of the project. • Compare the device configuration and the configuration of the technology object. • Contact customer service.
Input address is invalid.	
Output address is invalid.	

Technology alarm 411

Alarm reaction: Remove enable

Restart: Not required

Alarm text	Solution
Faulty encoder at the logical address.	
Alarm message from encoder.	Check the function, connections and I/Os of the encoder.
HW error encoder.	
Encoder dirty.	
Read error encoder absolute value.	Compare the encoder type in the drive or encoder parameter P979 with the configuration data of the technology object.
Zero mark monitoring encoder.	Encoder signals error in zero mark monitoring (fault code 0x0002 in Gx_XIST2, see PROFIdrive profile).
Encoder in Parking state.	• Search for the cause of the error in the connected drive or encoder. • Check whether the alarm was possibly triggered by a commissioning action involving the drive or encoder.

Technology alarm 412

Alarm reaction: Remove enable

Restart: Not required

Alarm text	Remedy
Permitted actual value range exceeded.	
Positive.	Home the axis/encoder in a valid actual value range.
Negative.	
Modulo length.	Adjust the modulo length to the utilized encoder.

Technology alarm 421

Alarm reaction: Remove enable

Restart: Not required

Alarm text	Solution
Faulty encoder at the logical address.	
Alarm message from drive.	• Check the functions and connections of the drive. • Enable and acknowledge safety function in the drive.
No drive control required.	
Drive has shut down.	
Drive enable not possible.	

Technology alarm 431

Alarm reaction: Remove enable

Restart: Not required

Alarm text	Solution
Faulty communication with device at logical address.	
Drive failed.	Check the function, connections and I/Os of the drive .
Signs of life of drive faulty.	• Check the function, connections and I/Os of the drive . • Compare the clock parameters in the device configuration (PROFIBUS line, slave OM for drive or encoder) and the execution system. Tmapc and servo must be set to the same cycle time. (Incorrect parameter assignment is indicated by reason 0x0080.) • If you call the application cycle of the MC-Servo [OB91] reduced to the send clock of a PROFINET IO system and the technology alarm 431 (Signs of life of drive faulty) is repeatedly shown, increase the update time of the send clock.
Encoder failed.	Check the function, connections and I/Os of the encoder.
Signs of life of encoder faulty.	• Check the function, connections and I/Os of the encoder. • Compare the clock parameters in the device configuration (PROFIBUS line, slave OM for drive or encoder) and the execution system. Tmapc and servo must be set to the same cycle time.

A.8.6 Technology alarms 501-552

Technology alarm 501

Alarm reaction: No reaction

Restart: Not required

Alarm text	Remedy
Programmed velocity is limited.	• Check the value for the velocity of the Motion Control instruction. • Check the configuration of the dynamic limits.

Technology alarm 502

Alarm reaction: No reaction

Restart: Not required

Alarm text	Remedy
Programmed acceleration/deceleration is being limited.	
Acceleration	• Check the value for the acceleration of the Motion Control instruction. • Check the configuration of the dynamic limits.
Deceleration	• Check the value for the deceleration of the Motion Control instruction. • Check the configuration of the dynamic limits.

Technology alarm 503

Alarm reaction: No reaction

Restart: Not required

Alarm text	Remedy
Programmed jerk is limited.	• Check the value for the jerk of the Motion Control instruction. • Check the configuration of the dynamic limits.

Technology alarm 504

Alarm reaction: No reaction

Restart: Not required

Alarm text	Solution
Speed setpoint monitoring active.	• Check the mechanical configuration. • Check the encoder connection. • Check the configuration of the speed setpoint interface. • Check the configuration of the control loop. • Check the value for the maximum velocity DynamicLimits.MaxVelocity.

Technology alarm 511

Alarm reaction: No reaction

Restart: Not required

Alarm text	Remedy
Dynamic limits are violated by the kinematics motion.	
Velocity	Reduce the velocity of the kinematics motion.
Acceleration	Reduce the acceleration of the kinematics motion.
Deceleration	Reduce the deceleration of the kinematics motion.

Technology alarm 521

Alarm reaction: Remove enable

Restart: Not required

Alarm text	Solution
Following error.	• Check the configuration of the control loop. • Check the direction signal of the encoder. • Check the configuration of the following error monitoring.

Technology alarm 522

Alarm reaction: No reaction

Restart: Not required

Alarm text	Solution
Warning following error tolerance.	• Check the configuration of the control loop. • Check the direction signal of the encoder. • Check the configuration of the following error monitoring.

Technology alarm 531

Alarm reaction: Remove enable

Restart: Not required

Alarm text	Solution
Pos. HW limit switch reached.	Acknowledge the alarm. After the acknowledgment, motions in the negative direction are allowed.
Neg. HW limit switch reached.	Acknowledge the alarm. After the acknowledgment, motions in the positive direction are allowed.
Illegal free travel direction of active hardware limit switch.	The programmed direction of movement is disabled due to the active hardware limit switch. Retract the axis in the opposite direction.
HW limit switch polarity reversed, free travel not possible.	• Check the mechanical configuration of the hardware limit switch. • Check the limit switches. • The error can be acknowledged by switching the controller off and on or using "MC_Reset" with "Restart" = TRUE.
Both hardware limit switches active, retraction not possible.	

Technology alarm 533

Alarm reaction: Stop with maximum dynamic values

Restart: Not required

Alarm text	Solution
Negative/positive SW limit switch approached.	
Negative	The software limit switch was reached from an active motion. Move the axis away from the software limit switch in the positive direction.
Positive	The software limit switch was reached from an active motion. Move the axis away from the software limit switch in the negative direction.

Technology alarm 534

Alarm reaction: Remove enable

Restart: Not required

Alarm text	Solution
Negative/positive SW limit switch is crossed.	
Negative	The SW limit switch was crossed. Acknowledge the alarm. After the acknowledgment, motions in the positive direction are allowed.
Positive	The SW limit switch was crossed. Acknowledge the alarm. After the acknowledgment, motions in the negative direction are allowed.

Technology alarm 541

Alarm reaction: Remove enable

Restart: Not required

Alarm text	Solution
Position monitoring error.	
Target range not reached.	The target range was not reached within the tolerance time. • Check the configuration of the position monitoring. • Check the configuration of the control loop.
Exit target range again.	The target range was exited within the minimum dwell time. • Check the configuration of the position monitoring. • Check the configuration of the control loop.

Technology alarm 542

Alarm reaction: Remove enable

Restart: Not required

Alarm text	Solution
Clamping monitoring error: Axis leaving clamping tolerance window.	The axis has executed a motion greater than the permissible tolerance at the fixed stop. Check whether the fixed stop has broken away.

Technology alarm 550

Alarm reaction: Track setpoints

Restart: Not required

Alarm text	Solution
Drive-autonomous motion is being executed.	The drive is performing a motion that was not specified by the technology object. Check whether there is an active safety function in the drive.

Technology alarm 551

Alarm reaction: No reaction

Restart: Not required

Alarm text	Solution
Maximum velocity cannot be reached with drive/axis parameters.	The configured maximum velocity cannot be reached with the configured mechanics of the axis. Check the configuration of the mechanics and the set reference speed.

Technology alarm 552

Alarm reaction: Remove enable

Restart: Not required

Alarm text		Solution
Adaptation error of encoder during power-up.		
	Encoder is not assigned to a SINAMICS device.	• The operationally active encoder could not be adapted. However, there are other encoders that can be used. Use the encoder switch (MC_SetSensor). • The encoder set as the operationally active encoder could not be adapted. • Specify a different sensor for the initialization of the technology object.
	Encoder is not interconnected directly to I/O area.	During configuration of the axis, the log addresses were set to a data block area or bit memory area. The adaptation is only possible when the encoder has been directly interconnected to an I/O area.
	Adaptation canceled due to insufficient resources.	Check whether your device supports acyclic data communication according to PROFIdrive.
	Parameter does not exist, value unreadable or invalid.	
	Encoder system	
	Encoder resolution	
	Encoder fine resolution	
	Encoder revolutions	

A.8.7 Technology alarms 601-618

Technology alarm 601

Alarm reaction: Stop with maximum dynamic values

Restart: Not required

Alarm text	Solution
Leading axis is not assigned or defective.	Configure the possible leading value axes for the following axis under Configuration > Leading value interconnections.

Technology alarm 603

Alarm reaction: No reaction

Restart: Not required

Alarm text	Solution
Leading axis is not in position-controlled mode.	The following axis must be operated in position-controlled mode for synchronous operation functionality.

Technology alarm 608

Alarm reaction: Stop with maximum dynamic values

Restart: Not required

Alarm text	Solution
Error during synchronization.	Prevent a reversing leading value motion during the synchronization operation.

Technology alarm 611

Alarm reaction: Remove enable

Restart: Not required

Alarm text	Solution
The cam specified in the MC_CamIn.Cam parameter has not been configured or is not available.	Configure and interpolate the cam. Restart the job.

Technology alarm 612

Alarm reaction: Remove enable

Restart: Not required

Alarm text	Solution
Specified cam has not been interpolated.	Interpolate the cam used for camming with the Motion Control instruction "MC_InterpolateCam".

A.8.8 Technology alarms 700-758

Technology alarm 700

Alarm reaction: Remove enable

Restart: Not required

Alarm text	Remedy
Output cam limiting error.	
Cam position: OnPosition	The position for the OnPosition could not be calculated. Invalid positions (e.g. OnPosition > OffPosition) were calculated due to lead times. The output cam cannot be switched due to the axis dynamics and compensation times.
Cam position: OffPosition	The position for the OffPosition could not be calculated. Invalid positions (e.g. OffPosition < OnPosition) were calculated due to lead times. The output cam cannot be switched due to the axis dynamics and compensation times.

Technology alarm 701

Alarm reaction: Remove enable

Restart: Not required

Alarm text	Remedy
I/O output error.	The digital output for the output cam or cam track technology object cannot be addressed. Download the device configuration again.

Technology alarm 702

Alarm reaction: Remove enable

Restart: Not required

Alarm text	Remedy
Position value valid.	• A Motion Control job "MC_Reset" is being executed on the axis. Wait until the "Restart" of the technology object is complete. • The encoder values are invalid due to an encoder error. Check the encoder and adjust the configuration if necessary.

Technology alarm 703

Alarm reaction: Remove enable

Restart: Not required

Alarm text	Remedy
Output cam data faulty.	
Output cam: Output cam number	Check the configuration of the relevant output cam in the cam track and adjust the values if necessary. Examples of a correct configuration: • <TO>.Parameter.Cam[].OnPosition < <TO>.Parameter.Cam[].OffPosition • <TO>.Parameter.Cam[].Duration > <TO>.Parameter.OffCompensation - <TO>.Parameter.OnCompensation

Technology alarm 704

Alarm reaction: Remove enable

Restart: Not required

Alarm text	Remedy
Output cam data faulty.	Check the configuration of the output cam and adjust the values if necessary. Examples of a correct configuration: • MC_OutputCam.OnPosition < MC_OutputCam.OffPosition • MC_OutputCam.Duration > <TO>.Parameter.OffCompensation - <TO>.Parameter.OnCompensation

Technology alarm 750

Alarm reaction: Remove enable

Restart: Not required

Alarm text	Remedy
Measuring job not possible during homing of assigned axis.	Do not use the motion instructions "MC_Home" and "MC_MeasuringInput" simultaneously.

Technology alarm 752

Alarm reaction: No reaction

Restart: Not required

Alarm text	Remedy
Validity range of measuring job not recognized.	The measuring range specified in Motion Control instruction "MC_MeasuringInput" was not recognized. Adjust the measuring range.

Technology alarm 753

Alarm reaction: Remove enable

Restart: Not required

Alarm text	Remedy
Only one measuring input can access an encoder at a time.	Use only one Motion Control instruction "MC_MeasurinInput" for an encoder.

Technology alarm 754

Alarm reaction: Remove enable

Restart: Not required

Alarm text	Remedy
Measuring input configuration in external device is not correct.	Check the configuration of the measuring inputs on the external device.

Technology alarm 755

Alarm reaction: Remove enable

Restart: Not required

Alarm text	Remedy
Measuring job not possible.	
Device has reported an error.	The measurement was aborted with error. Check the measuring input functionality in the utilized device
Cyclic measuring is not possible with telegram 39x.	• Use the Motion Control instruction "MC_MeasuringInput" for starting a one-time measurement. • Cyclic measuring is only possible when measuring using TM Timer DIDQ. Change the configuration of the measuring input type to "TM Timer DIDQ".

Technology alarm 758

Alarm reaction: None

Restart: Not required

Alarm text	Remedy
A measuring edge was not evaluated.	An edge was already detected at the input of the measuring input even though the module was not yet ready. The measured value is provided at the next edge.

A.9 Error ID for Motion Control instructions

Errors in Motion Control instructions are signaled using the parameters "Error" and "ErrorID".

Under the following conditions, "Error" = TRUE and "ErrorID" = 16#8xxx are indicated for the Motion Control instruction:

- Illegal status of the technology object, which prevents the execution of the job.
- Illegal parameter assignment of the Motion Control instruction, which prevents the execution of the job.
- As a result of the alarm reaction for a technology object error.

The following tables list all "ErrorIDs" that can be indicated for Motion Control instructions. Besides the cause of the error, remedies for eliminating the error are also listed:

16#0000 - 16#800F

ErrorID	Description	Remedy
16#0000	No error	-
16#8001	A technology alarm (technology object error) occurred while processing the Motion Control instruction.	In the technology data block, an error message is output at the "ErrorDetail.Number" tag. You can find a list of the technology alarms and alarm reactions in the Technology alarms (Page 626) appendix.
16#8002	Illegal specification of the technology object	• Check the specification of the technology object for the "Axis", "Master", "SlaveOutputCamCamTrack-MeasuringInput" or "Cam" parameter. • You can use a kinematics technology object only for the "AxesGroup" parameter. • For MC_MeasuringInputCyclic: Specify a valid measuring input type for parameter "MeasuringInputType".
16#8003	Illegal velocity specification	Specify a permissible value for the velocity for parameter "Velocity".
16#8004	Illegal acceleration specification	Specify a permissible value for the acceleration for parameter "Acceleration".
16#8005	Illegal deceleration specification	Specify a permissible value for the deceleration for parameter "Deceleration".
16#8006	Illegal jerk specification	Specify a permissible value for the jerk for parameter "Jerk".
16#8007	Illegal direction specification	Specify a permissible value for the rotation direction for parameter "Direction" or "SyncDirection".
	Invalid entry Both the "JogForward" and "JogBackward" parameters are set to TRUE at the same time. The axis is braked at the last valid deceleration.	Reset both the "JogForward" parameter and the "JogBackward" parameter.
16#8008	Invalid distance specification	Set a valid distance value at parameter "Distance".
16#8009	Invalid position specification	Set a valid position value at parameter "Position".
16#800A	Illegal operating mode	Specify a permissible operating mode for parameter "Mode".

ErrorID	Description	Remedy
16#800B	Illegal stop mode specifications	Specify a permissible value for the stop mode at the "StopMode" parameter.
16#800C	Only one instance of the instruction per technology object is allowed.	The instruction is called at multiple points in the user program with identical value for parameter "Axis", "Master", "Slave" or "Cam". Ensure that only one instruction with the value for parameter "Axis", "Master", "Slave" or "Cam" is called.
16#800D	The job is not permitted in the current state. "Restart" is executed.	While a "Restart" is being performed, the technology object cannot perform any jobs. Wait until the "Restart" of the technology object is complete.
16#800E	If the technology object is enabled, a "Restart" is not possible.	Before a "Restart", deactivate the technology object with "MC_Power.Enable"FALSE.
16#800F	The job cannot be executed because the technology object is locked.	Enable the technology object with "MC_Power.Enable" = TRUE. Restart the job.

16#8010 - 16#802F

ErrorID	Description	Remedy
16#8010	Invalid homing mode for incremental encoder	Absolute value adjustment is not possible with an incremental encoder ("Mode" = 6, 7). Start a homing process for an incremental encoder using parameter "Mode" = 0, 1, 2, 3, 5, 8, 10.
16#8011	Invalid homing mode for absolute encoder	Passive and active homing ("Mode" = 2, 3, 5, 8, 10) are not possible for an absolute value encoder. Start a homing process for an absolute encoder using parameter "Mode" = 0, 1, 6, 7.
16#8012	The job cannot be executed because the axis control panel is active.	Return master control to your user program. Restart the job.
16#8013	The online connection between the CPU and the TIA Portal is down.	Check the online connection to the CPU.
16#8014	No internal job memory available.	The maximum possible number of Motion Control job has been reached. Reduce the number of jobs to be executed (parameter "Execute" = FALSE).
16#8015	Error acknowledgment with "MC_Reset" is not possible. Error in the configuration of the technology object.	Check the configuration of the technology object.
16#8016	The actual values are not valid.	To execute a "MC_Home" or positioning job, the actual values must be valid. Check the status of the actual values. The technology object tag "<TO>.StatusSensor[n].State" must show the value 2 (valid).
16#8017	Illegal value for gear ratio numerator	Specify a permissible value for the gear ratio numerator for parameter "RatioNumerator". Permitted integer values: -2147483648 to 2147483648 (value 0 not permitted)

ErrorID	Description	Remedy
16#8018	Illegal value for gear ratio denominator	Specify a permissible value for the gear ratio denominator for parameter "RatioDenominator". Permitted integer values: 1 to 2147483648
16#8019	Job cannot be executed. The specified following axis is the original leading value for the synchronous operation chain.	Recursive interconnections are not possible. A leading axis cannot be interconnected as a following axis to its own leading value. Specify a permissible following axis for parameter "Slave".
16#8021	Illegal value for shift of the leading value range	Specify a permissible value for the shift of the leading value range for parameter "MasterOffset".
16#8022	Illegal value for shift of the following value range	Specify a permissible value for the shift of the leading value range for parameter "SlaveOffset".
16#8023	Illegal value for scaling of the leading value range	Specify a permissible value for the scaling of the leading value range for parameter "MasterScaling".
16#8024	Illegal value for scaling of the following value range	Specify a permissible value for the scaling of the following value range for parameter "SlaveScaling".
16#8026	Illegal value for leading value distance	Specify a permissible value for the leading value distance for parameter "MasterStartDistance".
16#8027	Illegal value for use of cam	Specify a permissible value for cyclic/acyclic use of the cam for parameter "ApplicationMode".

16#8030 - 16#807F

ErrorID	Description	Remedy
16#8034	Illegal value for synchronous position of the leading axis	Specify a permissible value for the synchronous position of the leading axis for parameter "MasterSyncPosition".
16#8035	Illegal value for synchronous position of the following axis	Specify a permissible value for the synchronous position of the following axis for parameter "SlaveSyncPosition".
16#8036	Illegal value for type of synchronization	Specify a permissible value for the type of synchronization for parameter "SyncProfileReference".
16#8040	Illegal value for start position of output cam	Specify a permissible value for the start position of the output cam for parameter "OnPosition".
16#8041	Illegal value for end position of distance output cam	Specify a permissible value for the end position of the distance output cam for parameter "OffPosition".
16#8042	Illegal value for switch-on duration of time-based output cam	Specify a permissible value for the switch-on duration of the time-based output cam for parameter "Duration".
16#8043	Illegal value for force/torque limiting	Specify a value within the permissible range at the "Limit" parameter. Permitted integer values: -2147483648 to 2147483648
16#8044	The axis is not configured for torque reduction.	Select drive telegram 102, 103, 105 or 106
16#8045	The job cannot be executed because a job for traveling to fixed stop is active.	Switchover to non-position-controlled mode is not possible during active travel to fixed stop.
16#8046	The "MC_TorqueLimiting" job cannot be deactivated in the "InClamping" state.	Retract the axis and deactivate "MC_TorqueLimiting".
16#8047	The motion results in a fixed stop.	Only motions away from the fixed stop are permitted.

ErrorID	Description	Remedy
16#804A	Illegal value for additive torque setpoint	Specify a permissible value for the additive torque setpoint at the "Value" parameter.
16#804B	Illegal value for torque high limit	Specify a permissible value for the high limit of the torque at the "UpperLimit" parameter.
16#804C	Illegal value for torque low limit	Specify a permissible value for the low limit of the torque at the "LowerLimit" parameter.
16#804D	The value of the high limit of the torque is less than or equal to the value of the low limit of the torque.	Adapt the values of the "UpperLimit" and "LowerLimit" parameters so that the high limit of the torque is greater than the value of the low limit of the torque.
16#804E	The job cannot be executed because the "MC_TorqueLimiting" job is active.	Stop the force / torque limit or fixed stop detection. Restart the "MC_TorqueRange" job.
	The job cannot be executed because a "MC_TorqueRange" job is active.	Exit the setting of the high and low torque limits. Restart the "MC_TorqueLimiting" job.
16#804F	The axis is not configured for additional torque values.	Use supplemental telegram 750.
16#8050	Illegal encoder number	Specify a permissible number of the new encoder (1 to 4) for parameter "MC_SetSensor.Sensor".
16#8051	Illegal number of the reference encoder	Specify a permissible number of the reference encoder for parameter "MC_SetSensor.ReferenceSensor".
16#8062	Illegal approach value	Specify a permissible approach value for the searched for leading value for parameter "ApproachLeadingValue".
16#8063	A valid mapping to the definition range (leading values) does not exist for the specified following value.	Specify a permissible following value for parameter "FollowingValue".
16#8064	A valid mapping to the range of the function (following values) does not exist for the specified leading value.	Specify a permissible leading value for parameter "LeadingValue".
16#8070	Illegal value for leading value shift	Specify a permissible value for the leading value shift for parameter "PhaseShift".
16#8071	The job cannot be executed because the axis is not in position-controlled mode.	Activate position-controlled mode.
16#8074	The job cannot be executed because the "MC_Home" job is active.	During active or passive homing, an encoder switchover is rejected. Wait until the "MC_Home" job is complete. Restart the job.
16#8075	The job cannot be executed because no synchronization operation is active on the axis.	Switch on the synchronous operation function. Restart the job.
16#8076	The job cannot be executed because synchronization is being simulated at the specified axis.	End the simulation of the synchronous operation. Restart the job.

16#80A0 - 16#8FFF

ErrorID	Description	Remedy
16#80A1	The order cannot be executed because a synchronous operation job is active.	A "MC_Home" job on a following axis is not executed when a "MC_CamIn" or "MC_GearInPos" job is active. Exit the synchronous operation job. Restart the job.
16#80A2	The measuring range is invalid with the configured modulo axis settings.	Check and adjust the measuring input and adjust the measuring range positions, if necessary.
16#80A3	The measuring input job via PROFIdrive telegram could not be started because a homing job is active.	Simultaneous execution of a homing job and a measuring input job via PROFIdrive telegram is not possible. Wait until the homing job has ended. Restart the measuring job via PROFIdrive telegram.
16#80A5	Illegal value for start position of measuring range	Specify a permissible value for the start position of the measuring range for parameter "MC_MeasuringInput.StartPosition" or MC_MeasuringInputCyclic.StartPosition.
16#80A6	Illegal value for end position of measuring range	Specify a permissible value for the end position of the measuring range for parameter "MC_MeasuringInput.EndPosition" or MC_MeasuringInputCyclic.EndPosition.
16#80A7	A measurement is performed when measuring with the measuring range, but the calculated position is outside the specified measuring range. The measured value is discarded.	Check and adjust the measuring input and adjust the measuring range positions, if necessary.
16#80A8	The job cannot be executed because camming is active on the axis.	The Motion Control instructions "MC_PhasingRelative" and "MC_PhasingAbsolute" can only be applied to active gearing with "MC_GearIn" or "MC_GearInPos" ("MC_GearIn.InGear" = TRUE or "MC_GearInPos.InSync" = TRUE).
16#80A9	The job cannot be executed because the following axis is synchronized ("MC_GearInPos.StartSync" = TRUE) or a kinematics motion is active.	The Motion Control instructions "MC_PhasingRelative" and "MC_PhasingAbsolute" can only be applied to active gearing with "MC_GearIn" or "MC_GearInPos" ("MC_GearIn.InGear" = TRUE or "MC_GearInPos.InSync" = TRUE).
16#80AA	The cam contains no points or segments and cannot be interpolated.	Fill the cam with points/segments. Restart the job.
16#80AB	The cam is currently being used and cannot be interpolated.	End the current use of the cam. Restart the job.
16#80AC	The cam contains incorrect points or segments and cannot be interpolated. (for example, the cam contains only one point.)	Fill the cam with permissible points/segments. Restart the job.
16#80AD	The specified synchronous position is outside the definition range of the cam.	Specify a permissible synchronous position for parameter "MasterSyncPosition". Restart the job.
16#80AE	The job cannot be executed because a kinematic motion is active.	End the current kinematic motion. Restart the job.
16#8FFF	Unspecified error	Contact your local Siemens representative or support center. You can find your contact at Industry Automation and Drive Technologies at: http://www.siemens.com/automation/partner (http://www.siemens.com/automation/partner)

See also

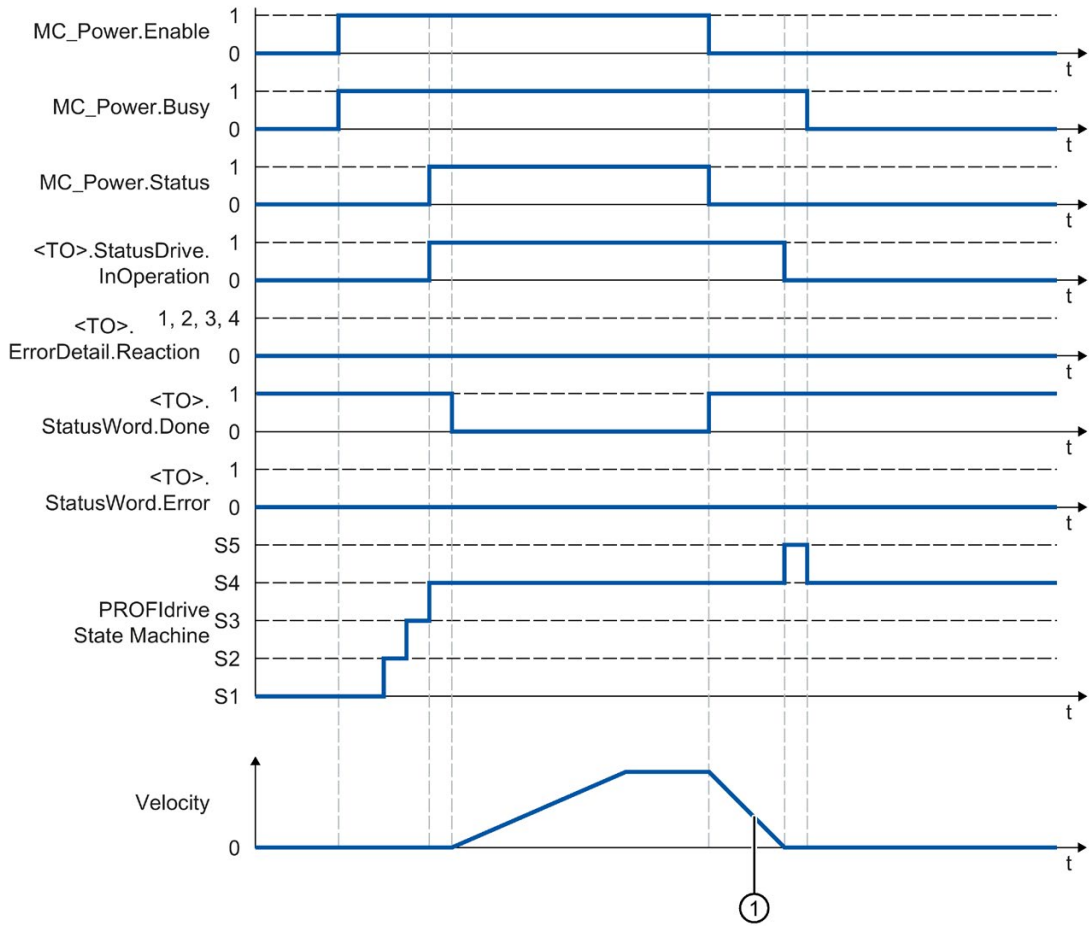
Errors in Motion Control instructions (Page 407)

A.10 MC_Power function chart

A.10.1 Drive connection via PROFIdrive

A.10.1.1 StopMode 0, 2

Function chart: Enabling a technology object and disabling with "StopMode" = 0, 2



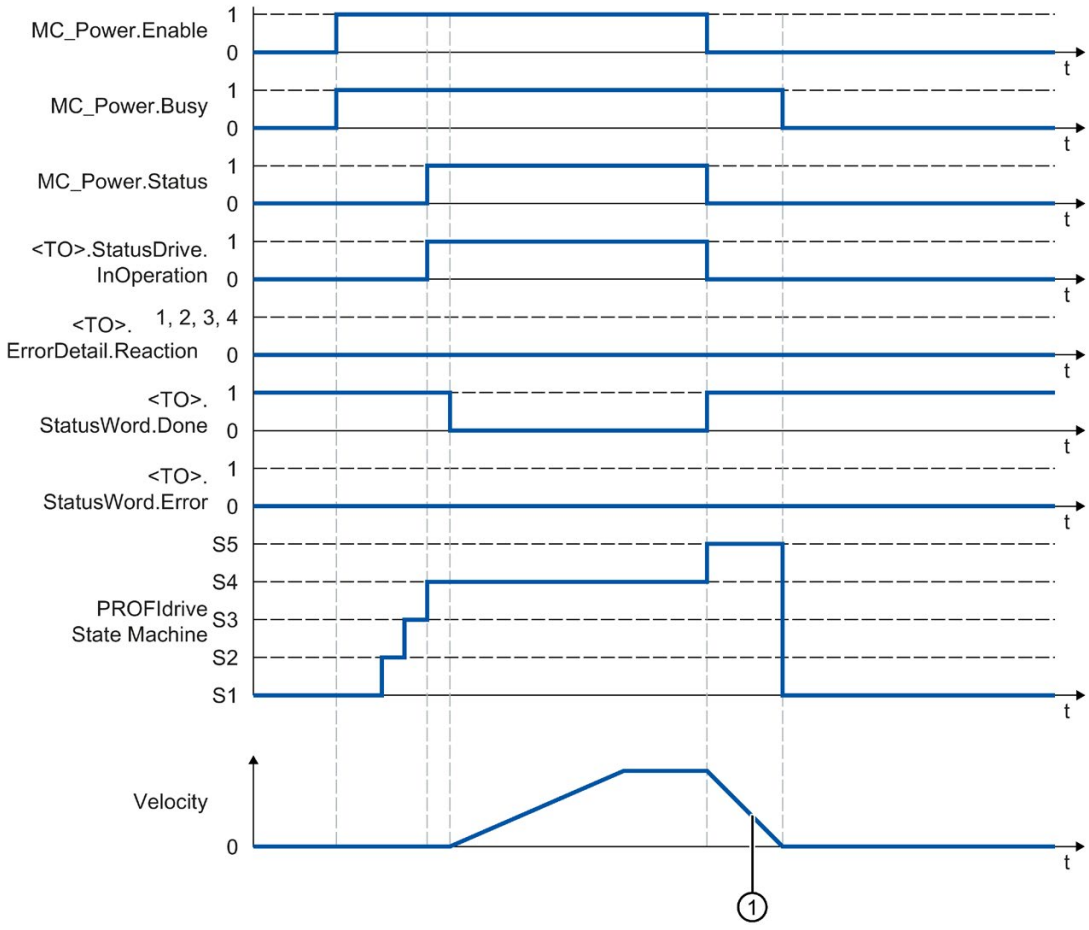
①
- "StopMode" = 0

  The axis is braked with the configured emergency stop deceleration.
- "StopMode" = 2

  The axis decelerates with the configured maximum deceleration.

A.10.1.2 StopMode 1

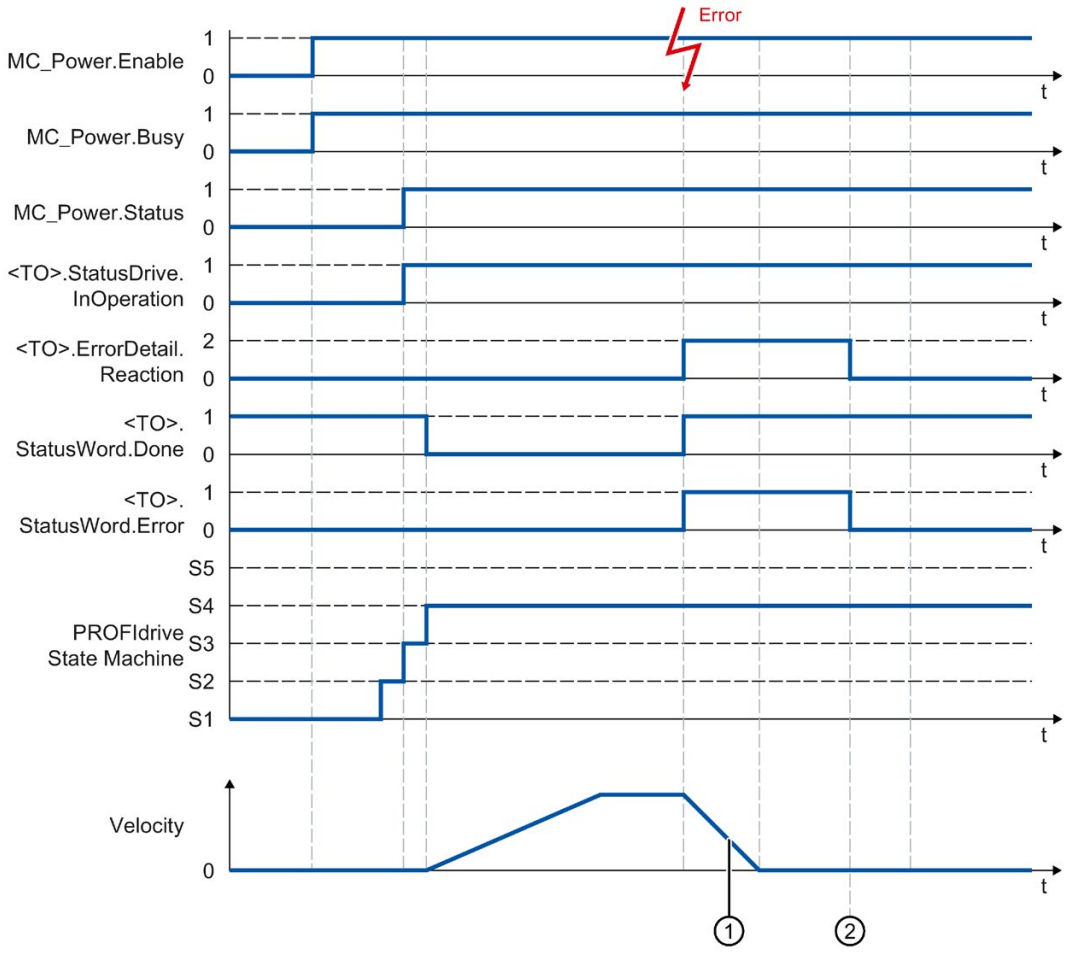
Function chart: Enabling a technology object and disabling with "StopMode" = 1



① The deceleration ramp depends on the configuration in the drive.

A.10.1.3 Alarm reactions with braking ramp via the technology object

Function chart: Enabling a technology object and occurrence of a technology alarm with braking ramp via the technology object



① The axis is braked based on the alarm reaction:

- Stop with current dynamic values (<TO>.ErrorDetail.Reaction = 1)

  The axis is braked with the deceleration in the Motion Control instruction.
- Stop with maximum dynamic values (<TO>.ErrorDetail.Reaction = 2)

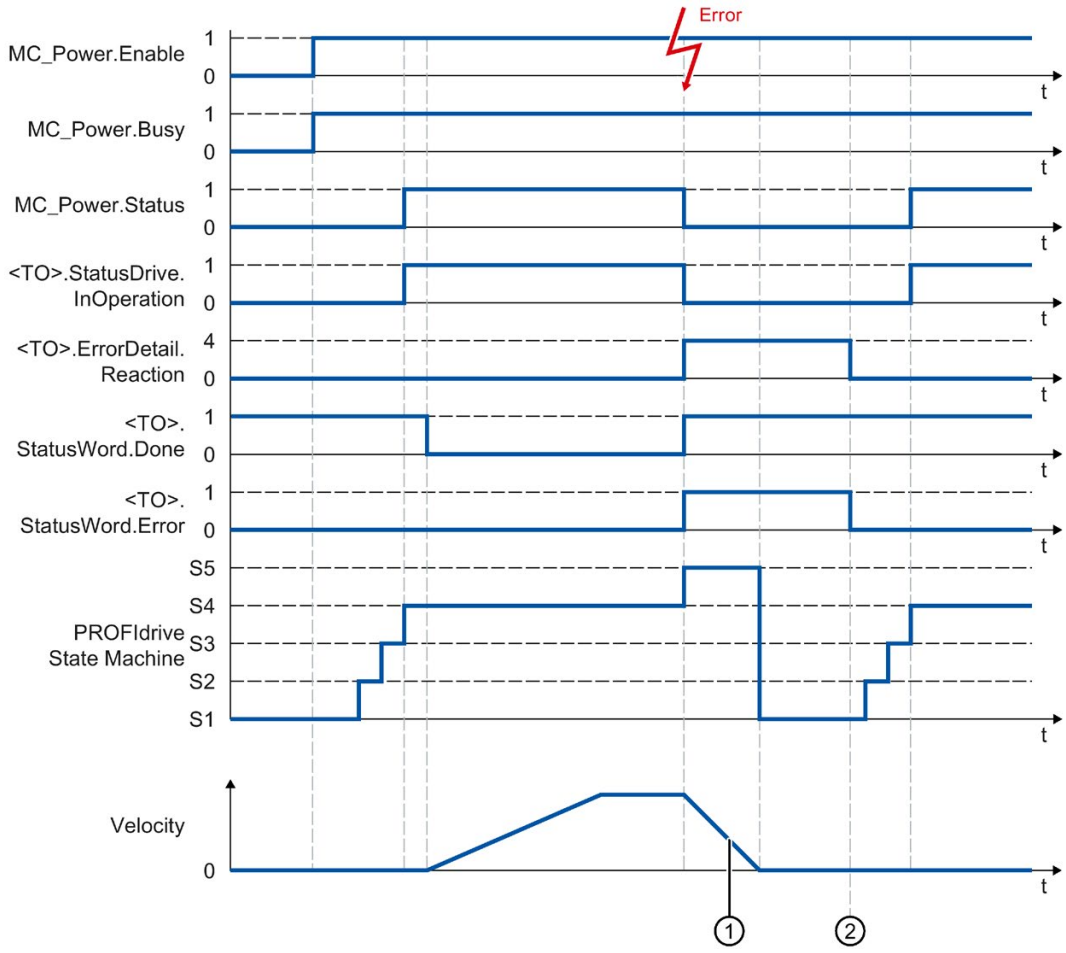
  The axis decelerates with the configured maximum deceleration.
- Stop with emergency stop ramp (<TO>.ErrorDetail.Reaction = 3)

  The axis is braked with the configured emergency stop deceleration.

② The technology alarm is acknowledged.

A.10.1.4 Alarm response "Remove enable"

Function chart: Enabling a technology object and occurrence of a technology alarm with alarm reaction "Remove enable"

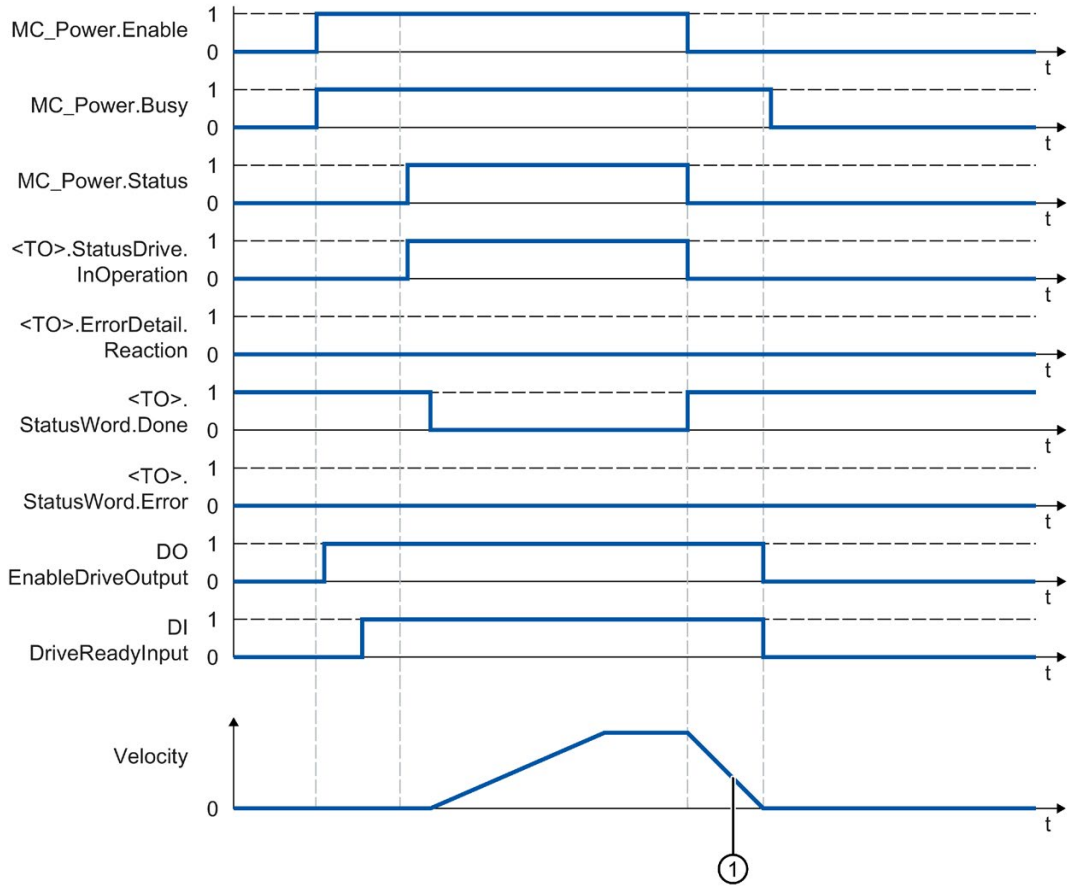


① The deceleration ramp depends on the configuration in the drive.
② The technology alarm is acknowledged at time ②.

A.10.2 Analog drive connection

A.10.2.1 StopMode 0, 2

Function chart: Enabling a technology object and disabling with "StopMode" = 0, 2



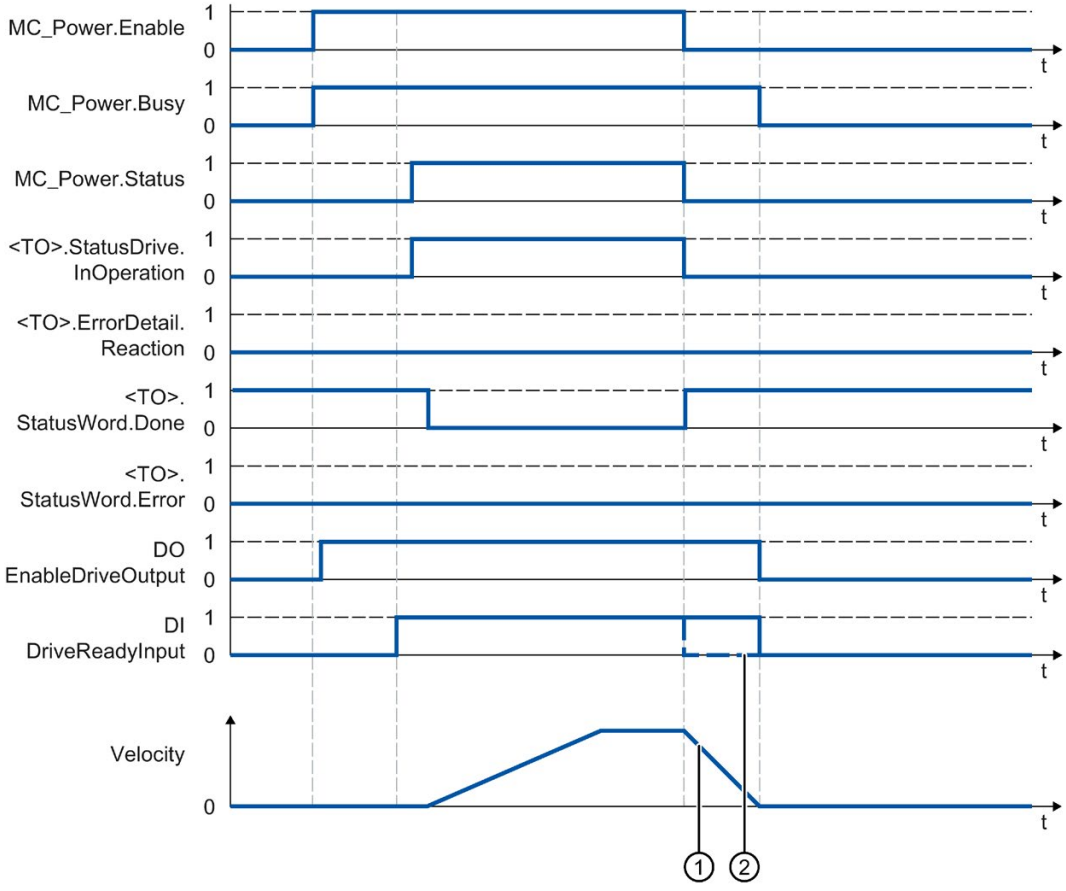
①
- "StopMode" = 0

  The axis is braked with the configured emergency stop deceleration.
- "StopMode" = 2

  The axis decelerates with the configured maximum deceleration.

A.10.2.2 StopMode 1

Function chart: Enabling a technology object and disabling with "StopMode" = 1

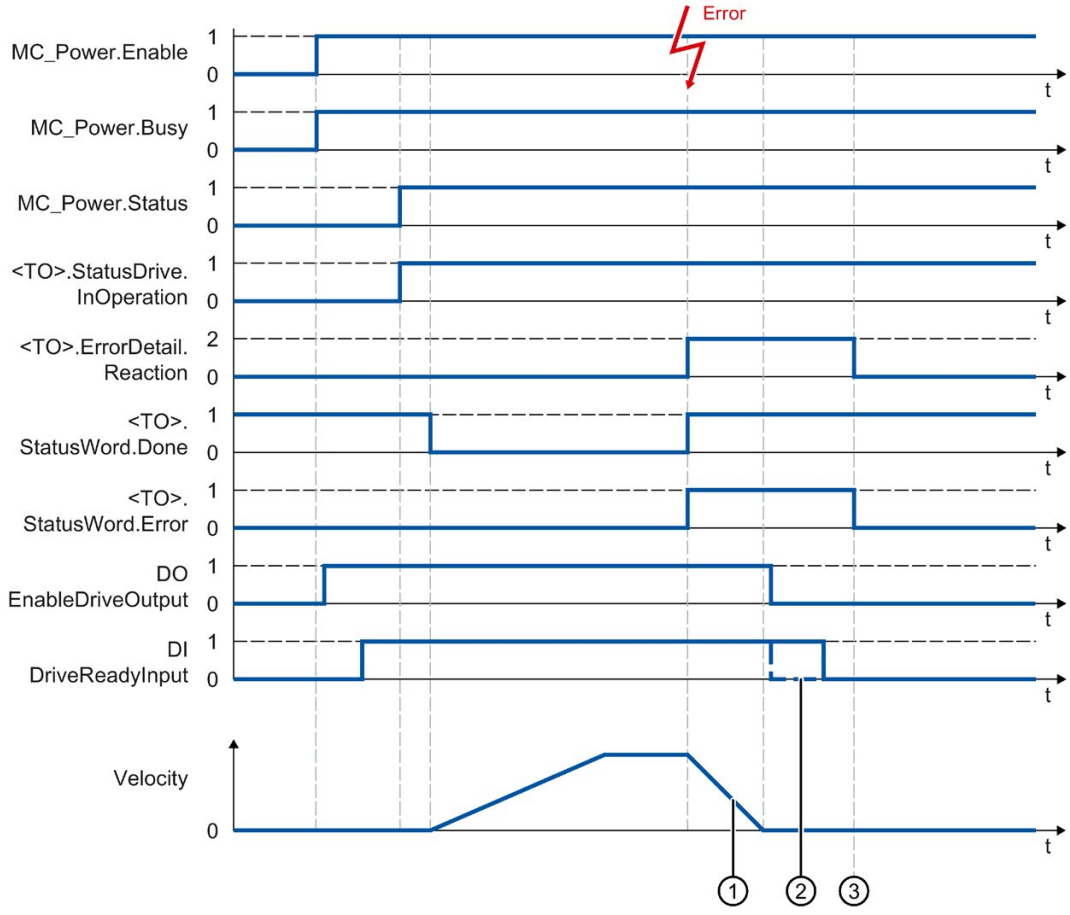


① The deceleration ramp depends on the configuration in the drive.

② The behavior of the ready signal of the drive "DI DriveReadyInput" is manufacturer-specific.

A.10.2.3 Alarm reactions with braking ramp via the technology object

Function chart: Enabling a technology object and occurrence of a technology alarm with braking ramp via the technology object



① The axis is braked based on the alarm reaction:

- Stop with current dynamic values (<TO>.ErrorDetail.Reaction = 1)

  The axis is braked with the deceleration in the Motion Control instruction.
- Stop with maximum dynamic values (<TO>.ErrorDetail.Reaction = 2)

  The axis decelerates with the configured maximum deceleration.
- Stop with emergency stop ramp (<TO>.ErrorDetail.Reaction = 3)

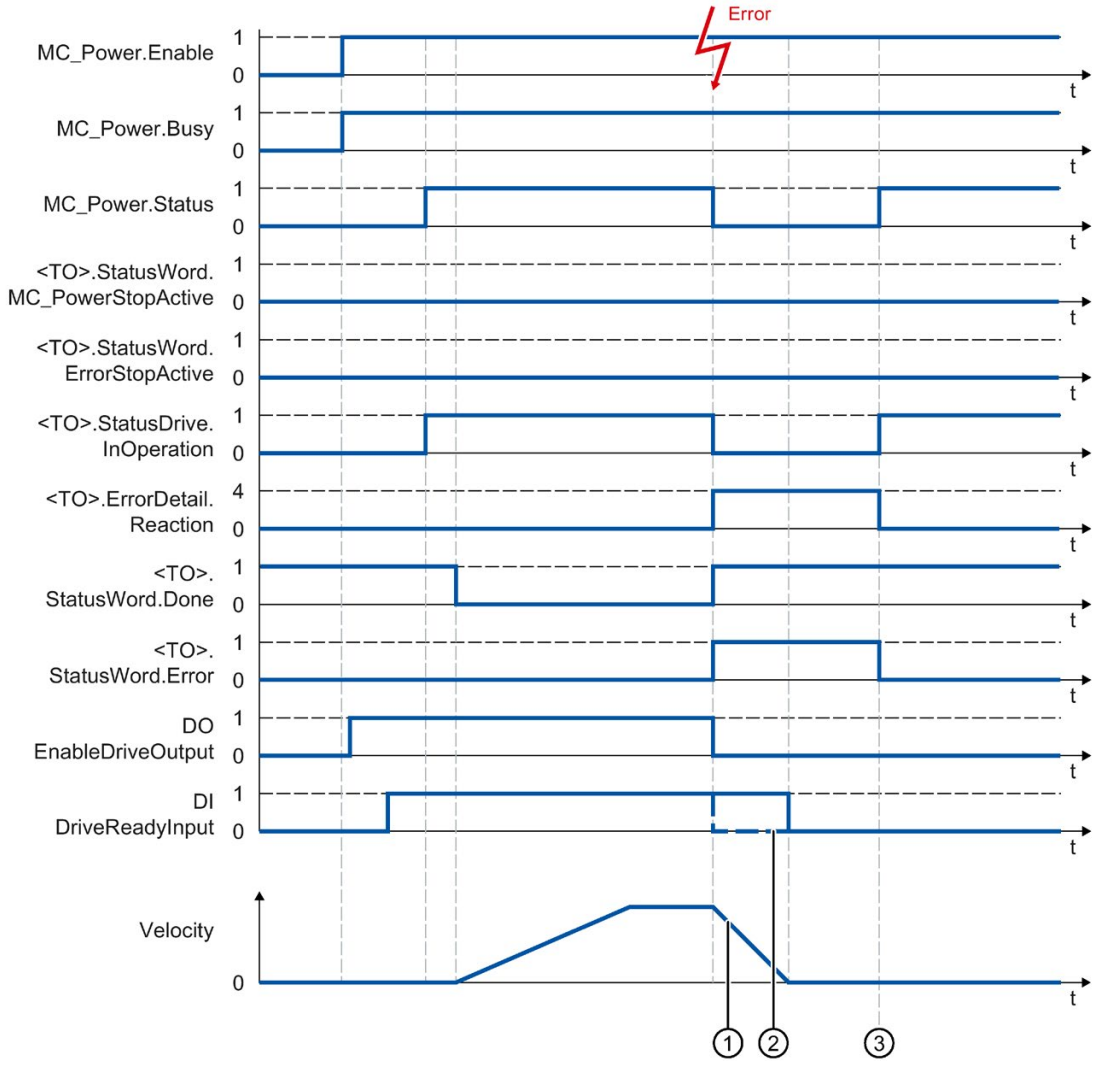
  The axis is braked with the configured emergency stop deceleration.

② The behavior of the ready signal of the drive "DI DriveReadyInput" is manufacturer-specific.

③ The technology alarm is acknowledged at time ③.

A.10.2.4 Alarm response "Remove enable"

Function chart: Enabling a technology object and occurrence of a technology alarm with alarm reaction "Remove enable"



① The deceleration ramp depends on the configuration in the drive.
② The behavior of the ready signal of the drive "DI DriveReadyInput" is manufacturer-specific.
③ The technology alarm is acknowledged at time ③.

A.11 SINAMICS drives

A.11.1 Compatibility list

An overview of drives that can be interconnected with an S7-1500 CPU is available at:

https://support.industry.siemens.com/cs/document/109750431
(https://support.industry.siemens.com/cs/ww/en/view/109750431)

A.11.2 Homing SINAMICS drives with external zero marks

For SINAMICS drives with external zero marks, synchronization during homing must always occur on the left side of the external zero mark's signal. That is to say, with a positive direction of travel synchronization is done on a positive edge, and with a negative direction of travel synchronization is done on a negative edge.

By inverting the signal, synchronization can also be done on the right sight of the signal of the external zero mark. The inversion can be configured in the drive using SINAMICS parameter P490.

Homing to an encoder zero mark or an external zero mark is configured in SINAMICS parameter P495.

A.12 Data types

Data type for use with technology as of V4.0

The table below contains the data types for reference to the respective technology object:

Data type	Structure
TO_SpeedAxis	Speed axis
TO_PositioningAxis	Positioning axis
TO_SynchronousAxis	Synchronous axis
TO_Encoder	External encoder
TO_OutputCam	Output cam
TO_CamTrack	Cam track
TO_MeasuringInput	Measuring input
TO_Cam	Cam (S7-1500T)
TO_Kinematics	Kinematics (S7-1500T)
PD_TELx	Telegram no. "x"
PD_STW1_611Umode	Control word 1 (STW1)
PD_STW2_611Umode	Control word 2 (STW2)
PD_ZSW1_611Umode	Status word 1 (ZSW1)
PD_ZSW2_611Umode	Status word 2 (ZSW2)

See also

PROFIdrive telegrams (Page 40)

Glossary

Absolute synchronous operation

Function corresponds to the Motion Control instruction MC_GearInPos or MC_CamIn.

Absolute value encoder

Position encoder which outputs the position in the form of a digital numerical value. This numerical value is unique within the entire measuring range of the absolute value encoder.

Axis control panel

The axis control panel allows you to move the axis in manual mode, optimize the axis settings, and test the operation of the axis in your system.

Axis type

The axis type differs depending on the unit of measurement according to which the axis is positioned.

Depending on the execution of the mechanics, an axis is implemented as a linear axis or rotary axis:

- For linear axes, the position of the axis is specified as a linear measure, e.g. millimeters (mm).
- For rotary axes, the position of the axis is specified as an angular measure, e.g. degrees (°).

Communication processor (CP)

Module for expanded communications tasks covering special applications, for example in the area of security.

Communications module (CM)

Module for communications tasks which is used as an interface expansion of the CPU (for example PROFIBUS) or provides additional communications options (e.g. PtP) in an automation system.

Drive

The combination of motor (electric or hydraulic), actuator (converter, valve), control system, measuring system and supply (infeed, accumulator).

Dynamic Servo Control (DSC)

In drives that support DSC, you can optionally use the position controller in the drive. The position controller in the drive is usually implemented with a rapid speed-control cycle. This improves the control performance for digitally coupled drives.

Following error

The following error is the difference between the position setpoint and the actual position value. The transmission times of the setpoint to the drive, and of the actual position value to the controller, are taken into account in the calculation of the following error.

GSD file

As a Generic Station Description, this file contains all properties of a PROFINET or PROFIBUS device that are necessary for its configuration.

Hardware limit switch

Mechanical limit position switch that limits the maximum permissible traversing range of the axis.

Homing

With homing, you create the relationship between the position in the technology object and the mechanical position of the axis. The position value in the technology object is assigned to a homing mark at the same time. This homing mark represents a known mechanical position.

Incremental encoder

Position encoder which outputs the position change incrementally in the form of a digital numerical value.

Kv factor

Gain factor of the position controller

Master value

Input value for synchronous operation

Motion Control instruction

Use the Motion Control instructions to start Motion Control jobs at technology objects in your user program and thus execute the desired functionality at the technology objects. You track the status of running jobs with the output parameters of the Motion Control instructions.

Override

Percentage correction of the velocity/speed

Processing cycle clock

The processing of a technology object in the servo cycle clock.

PROFIdrive

PROFIdrive is a profile specified by the PNO (PROFIBUS user organization) for PROFIBUS DP and PROFINET IO for speed- and position-controlled drives.

PROFIdrive frame

Frame for communication according to PROFIdrive.

Proximity switch

Position switch which is activated with the moving part without mechanical contact.

Relative gearing

Function corresponds to the Motion Control instruction MC_GearIn.

Restart

The technology object is reinitialized with the current configuration parameters.

Safe Stop 1 (SS1)

The Safe Stop 1 (SS1) safety function brings a drive to standstill quickly and safely via an internal rapid stop ramp. Safe Torque Off (STO) is activated after standstill. STO ensures that no more torque generating energy acts on a drive. This prevents unintended startup of the drive.

You can use the SS1 safety function when a fast stop of the drive with a subsequent transition to STO is required. SS1 is used, for example, to quickly stop high inertia loads or to brake drives quickly and safely at high speeds

Safe Stop 2 (SS2)

The Safe Stop 2 (SS2) safety function brings a drive to standstill quickly and safely via an internal rapid stop ramp. After standstill is reached, the standstill position is monitored on the drive side. The drive can deliver full torque to maintain the standstill.

SS2, for example, is used for processing machines and machine tools.

Safe Torque Off (STO)

The Safe Torque Off (STO) safety function is the most commonly used and most basic drive-internal safety function. STO ensures that no more torque generating energy acts on a drive. This prevents unintended startup of the drive. The pulses of the drive are eliminated. The drive is reliably torque-free. This state is monitored internally in the drive.

You can use STO when the drive comes to a standstill in a sufficiently short time on its own due to the load torque or due to friction. Other areas of use are where "coasting" of the drive has no relevance for safety.

Software limit switch

A programmable position which limits the traversing range of an axis.

Synchronization

The phase of the following axis to reach synchronous movement.

Synchronous operation

Defined synchronous movement after synchronization of a following axis to a leading axis.

Technology alarm

If an error occurs at a technology object (e.g. approaching a hardware limit switch), a technology alarm is triggered and indicated.

The impact of a technology alarm on the technology object is specified by the alarm reaction (e.g. remove enable). The alarm reaction is specified by the system.

Technology data block

The technology data block represents the technology object and contains all configuration data, setpoint and actual values, and status information of the technology object.

Technology module (TM)

Module for technological tasks, e.g. counting, measuring and positioning.

Zero mark

Position reference for the movement of rotary and linear incremental encoders. The zero mark of an incremental encoder is used as a homing mark, for example.

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