SIEMENS

Edition 11/2022

FUNCTION MANUAL

SIMATIC

S7-1500

S7-1500/S7-1500T Axis functions V7.0 as of STEP 7 V18

support.industry.siemens.com

SIEMENS

SIMATIC

S7-1500
S7-1500/S7-1500T Axis functions V7.0 as of STEP 7 V18

Function Manual

S7-1500/S7-1500T Motion Control

11/2022

A5E37577655-AE

Legal information

Warning notice system

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

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.

NOTICE
indicates that property damage can result if proper precautions are not taken.

If more than one degree of danger is present, the warning notice representing the highest degree of danger will be used. A notice warning of injury to persons with a safety alert symbol may also include a warning relating to property damage.

Qualified Personnel

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.

Proper use of Siemens products

Note the following:

WARNING
Siemens products may only be used for the applications described in the catalog and in the relevant technical documentation. If products and components from other manufacturers are used, these must be recommended or approved by Siemens. Proper transport, storage, installation, assembly, commissioning, operation and maintenance are required to ensure that the products operate safely and without any problems. The permissible ambient conditions must be complied with. The information in the relevant documentation must be observed.

Trademarks

All names identified by ® are registered trademarks of Siemens AG. The remaining trademarks in this publication may be trademarks whose use by third parties for their own purposes could violate the rights of the owner.

Disclaimer of Liability

We have reviewed the contents of this publication to ensure consistency with the hardware and software described. Since variance cannot be precluded entirely, we cannot guarantee full consistency. However, the information in this publication is reviewed regularly and any necessary corrections are included in subsequent editions.

Siemens AG
Digital Industries
Postfach 48 48
90026 NÜRNBERG
GERMANY

A5E37577655-AE
Ⓟ 10/2022 Subject to change

Table of contents

1 Introduction (S7-1500, S7-1500T)

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.

Industry Mall

The Industry Mall is the catalog and ordering system of Siemens AG for automation and drive solutions on the basis of Totally Integrated Automation (TIA) and Totally Integrated Power (TIP).

You can find catalogs for all automation and drive products on the Internet (https://mall.industry.siemens.com).

1.1 S7-1500 Motion Control Documentation Guide (S7-1500, S7-1500T)

Product information

Please also note the supplementary information on the Motion Control documentation:

- Product information on the S7-1500/1500T Motion Control documentation
  https://support.industry.siemens.com/cs/ww/en/view/109794046
  (https://support.industry.siemens.com/cs/ww/en/view/109794046)

Documentation

The documentation of the Motion Control functions is divided into the following documents:

- S7-1500/S7-1500T Motion Control Overview
  https://support.industry.siemens.com/cs/ww/en/view/109812056
  (https://support.industry.siemens.com/cs/ww/en/view/109812056)
  This document describes the innovations in the technology versions, functions that are used for all technology objects, and the process response of Motion Control applications.
- S7-1500/S7-1500T Motion Control alarms and error IDs
  https://support.industry.siemens.com/cs/ww/en/view/109812061
  (https://support.industry.siemens.com/cs/ww/en/view/109812061)
  This document describes the technology alarms of the technology objects and the error identifications of the Motion Control instructions.
- S7-1500/S7-1500T Axis functions
  https://support.industry.siemens.com/cs/ww/en/view/109812057
  (https://support.industry.siemens.com/cs/ww/en/view/109812057)
  This document describes the drive and encoder connection and functions for single-axis movements.
- S7-1500/S7-1500T Synchronous operation functions
  https://support.industry.siemens.com/cs/ww/en/view/109812059
  (https://support.industry.siemens.com/cs/ww/en/view/109812059)
  This document describes gearing, velocity synchronous operation and camming as well as cross-PLC synchronous operation.
- S7-1500/S7-1500T Measuring input and cam functions
  https://support.industry.siemens.com/cs/ww/en/view/109812060
  (https://support.industry.siemens.com/cs/ww/en/view/109812060)
  This document describes the detection of the actual position via a measuring input and the output of switching signals via output cam or cam track.
- S7-1500/S7-1500T Kinematics functions
  https://support.industry.siemens.com/cs/ww/en/view/109812058
  (https://support.industry.siemens.com/cs/ww/en/view/109812058)
  This document describes the control of kinematics with up to 6 interpolating axes.

See also

Topic page "SIMATIC Technology - Motion Control: Overview and Important Links"
https://support.industry.siemens.com/cs/ww/en/view/109751049
(https://support.industry.siemens.com/cs/ww/en/view/109751049)

1.2 Function Manuals documentation guide (S7-1500, S7-1500T)

1.2.1 Information classes Function Manuals (S7-1500, S7-1500T)

The documentation for the SIMATIC S7-1500 automation system, for the 1513/1516pro-2 PN, SIMATIC Drive Controller CPUs based on SIMATIC S7-1500 and the SIMATIC ET 200MP, ET 200SP, ET 200AL and ET 200eco PN distributed I/O systems is arranged into three areas.
This arrangement enables you to access the specific content you require.
You can download the documentation free of charge from the Internet (https://support.industry.siemens.com/cs/ww/en/view/109742705).

Basic information

The system manuals and Getting Started describe in detail the configuration, installation, wiring and commissioning of the SIMATIC S7-1500, SIMATIC Drive Controller, ET 200MP, ET 200SP, ET 200AL and ET 200eco PN systems. Use the corresponding operating instructions for 1513/1516pro-2 PN CPUs.
The STEP 7 online help supports you in the configuration and programming.
Examples:

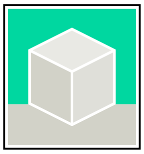
- Getting Started S7-1500
- System manuals
- Operating instructions ET 200pro and 1516pro-2 PN CPU
- Online help TIA Portal

Device information

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

- Equipment manuals for CPUs
- Equipment manuals for interface modules
- Equipment manuals for digital modules
- Equipment manuals for analog modules
- Equipment manuals for communication modules
- Equipment manuals for technology modules
- Equipment manuals for power supply modules
- Equipment manuals for BaseUnits

General information



The function manuals contain detailed descriptions on general topics relating to the SIMATIC Drive Controller and the S7-1500 automation system.
Examples:

- Function Manual Diagnostics
- Function Manual Communication
- Function Manuals Motion Control
- Function Manual Web Server
- Function Manual Cycle and Response Times
- PROFINET Function Manual
- PROFIBUS Function Manual

Product Information

Changes and supplements to the manuals are documented in a Product Information. The Product Information takes precedence over the device and system manuals.
You will find the latest Product Information on the Internet:

- S7-1500/ET 200MP (https://support.industry.siemens.com/cs/de/en/view/68052815)
- SIMATIC Drive Controller (https://support.industry.siemens.com/cs/de/en/view/109772684/en)
- Motion Control (https://support.industry.siemens.com/cs/de/en/view/109794046/en)
- ET 200SP (https://support.industry.siemens.com/cs/de/en/view/73021864)
- ET 200eco PN (https://support.industry.siemens.com/cs/ww/en/view/109765611)

Manual Collections

The Manual Collections contain the complete documentation of the systems put together in one file.
You will find the Manual Collections on the Internet:

- S7-1500/ET 200MP/SIMATIC Drive Controller (https://support.industry.siemens.com/cs/ww/en/view/86140384)
- ET 200SP (https://support.industry.siemens.com/cs/ww/en/view/84133942)
- ET 200AL (https://support.industry.siemens.com/cs/ww/en/view/95242965)
- ET 200eco PN (https://support.industry.siemens.com/cs/ww/en/view/109781058)

1.2.2 Basic tools (S7-1500, S7-1500T)

The tools described below support you in all steps: from planning, over commissioning, all the way to analysis of your system.

TIA Selection Tool

The TIA Selection Tool tool supports you in the selection, configuration, and ordering of devices for Totally Integrated Automation (TIA).
As successor of the SIMATIC Selection Tools , it assembles the configuration editors for automation technology already familiar into a single 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.
(https://support.industry.siemens.com/cs/ww/en/view/109767888)

SIMATIC Automation Tool

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

The SIMATIC Automation Tool offers a wide range of functions:

- Scanning of a PROFINET/Ethernet system network and identification of all connected CPUs
- Assignment of addresses (IP, subnet, Gateway) and device name (PROFINET device) to a CPU
- Transfer of the date and the programming device/PC time converted to UTC time to the module
- Program download to CPU
- RUN/STOP mode switchover
- CPU localization through LED flashing
- Reading out of CPU error information
- Reading the CPU diagnostic buffer
- Reset to factory settings
- Firmware update of the CPU and connected modules

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

PRONETA

SIEMENS PRONETA (PROFINET network analysis) is a commissioning and diagnostic tool for PROFINET networks. PRONETA Basic has two core functions:

- The "Network analysis" offers a quick overview of the PROFINET topology. It is possible to make simple parameter changes (for example, to the names and IP addresses of the devices). In addition, a quick and convenient comparison of the real configuration with a reference system is also possible.
- The "IO test" is a simple and rapid test of the wiring and the module configuration of a plant, including documentation of the test results.

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

SIEMENS PRONETA Professional is a licensed product that offers you additional functions. It offers you simple asset management in PROFINET networks and supports operators of automation systems in automatic data collection/acquisition of the components used through various functions:

- The user interface (API) offers an access point to the automation cell to automate the scan functions using MQTT or a command line.
- With PROFIenergy diagnostics, you can quickly detect the current pause mode or the readiness for operation of devices that support PROFIenergy and change these as needed.
- The data record wizard supports PROFINET developers in reading and writing acyclic PROFINET data records quickly and easily without PLC and engineering.

You can find SIEMENS PRONETA Professional on the Internet. (https://www.siemens.com/proneta-professional)

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 the optimal use of resources

You can find SINETPLAN on the Internet (https://new.siemens.com/global/en/products/automation/industrial-communication/profinet/sinetplan.html).

1.2.3 SIMATIC Technical Documentation (S7-1500, S7-1500T)

Additional SIMATIC documents will complete your information. You can find these documents and their use at the following links and QR codes.

The Industry Online Support gives you the option to get information on all topics. Application examples support you in solving your automation tasks.

Overview of the SIMATIC Technical Documentation

Here you will find an overview of the SIMATIC documentation available in Siemens Industry Online Support:

Industry Online Support International (https://support.industry.siemens.com/cs/ww/en/view/109742705)

Watch this short video to find out where you can find the overview directly in Siemens Industry Online Support and how to use Siemens Industry Online Support on your mobile device:

Quick introduction to the technical documentation of automation products per video (https://support.industry.siemens.com/cs/us/en/view/109780491)

YouTube video: Siemens Automation Products - Technical Documentation at a Glance (https://youtu.be/TwLSxxRQQsA)

mySupport

With "mySupport" you can get the most out of your Industry Online Support.

Registration	You must register once to use the full functionality of "mySupport". After registration, you can create filters, favorites and tabs in your personal workspace.
Support requests	Your data is already filled out in support requests, and you can get an overview of your current requests at any time.
Documentation	In the Documentation area you can build your personal library.
Favorites	You can use the "Add to mySupport favorites" to flag especially interesting or frequently needed content. Under "Favorites", you will find a list of your flagged entries.
Recently viewed articles	The most recently viewed pages in mySupport are available under "Recently viewed articles".
CAx data	The CAx data area gives you access to the latest product data for your CAx or CAe system. You configure your own download package with a few clicks: • 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" on the Internet. (https://support.industry.siemens.com/My/ww/en)

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 can find the application examples on the Internet. (https://support.industry.siemens.com/cs/ww/en/ps/ae)

Safety instructions (S7-1500, S7-1500T) 2

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 visit (https://www.siemens.com/cert).

3 New features V7.0 (S7-1500, S7-1500T)

Technology version V7.0 contains the following new features:

Drive and encoder connection

- When connecting a drive via data block, you can configure the communication times T_i, T_o, and T_{DC} for calculating the following error.

Motion control and dynamic limits

- The "MC_MotionInSuperimposed" instruction is available. With this instruction you can assign the axis cyclic applicative motion setpoints for additional distance, velocity and acceleration in addition to the basic motion.
- The "MC_HaltSuperimposed" instruction is available. This instruction decelerates a superimposed motion on the axis generated with the instructions "MC_MoveSuperimposed", "MC_MotionInSuperimposed", or "MC_HaltSuperimposed" to zero velocity.

Traversing range limitation

- Extension SW limit switch:
  - You can additionally configure "Stop at SW limit switch with programmable dynamics".
  - When overtraveling the SW limit switches, emergency stop and retention of the axis enable is possible.
- Extension HW limit switch:
  - When configuring the positioning axis and synchronous axis, the HW limit switches can be configured as "traversable" as before, and now as "non-traversable".
  - When approaching a HW limit switch that cannot be overtraveled, you can configure the alarm response.

Homing

- The "MC_SaveAbsoluteEncoderData" instruction is available. Use this instruction to save the absolute adjustment data for CPU device replacement on the SIMATIC Memory Card.
- With the "MC_Home" instruction, the new incremental encoder adjustment homing type "MC_Home.Mode" = 13 is available. The axis does not perform a compensating motion and the offset of the position is not applied at all encoders of the axis. This makes it easier to readjust individual encoders.
- Active and passive homing of absolute encoders with "MC_Home" is available.

- The homing status of the "<TO>.StatusSensor[1..4].Adjusted" encoders is displayed.
- The S7-1500T CPU supports absolute adjustment/incremental adjustment of non-operational encoders. This means that the respective encoder no longer has to be enabled for homing.

Configuring a control loop

- For axes in a synchronous system, the dynamic filter enables dynamic adaptation of axes with higher dynamic responses to the axis with the lowest dynamic response.

Position monitoring

- The parameter assignment of the additional delay time for following error calculation when the dynamic filter is active is available.

"MC_Power.StopMode" = 3

- The "MC_Power" instruction supports "StopMode" = 3 (coast down).

4 Overview of functions (S7-1500, S7-1500T)

4.1 Speed-controlled axis technology object (S7-1500, S7-1500T)

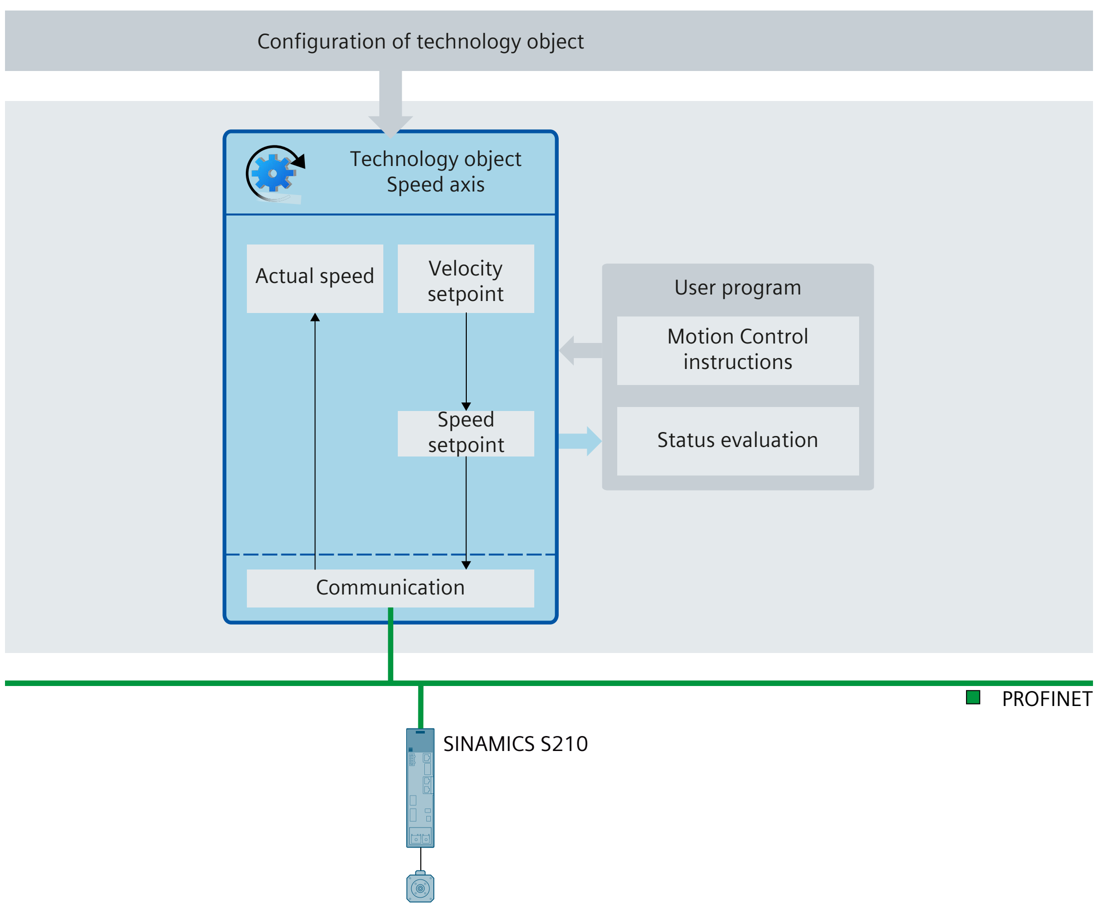
The speed axis technology object calculates speed setpoints, taking into account the dynamic settings, and outputs them to the drive. All motions of the speed axis take place as speed-controlled motions. An existing load gear is taken into account on the system side.

+You can find an overview of the supported instructions of the speed axis technology object in the section "Motion Control instructions for axis control (Page 29)".

A drive is assigned to each speed axis, e.g. via a PROFIdrive telegram.

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:

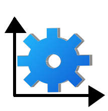


Configuration

The following configurations are available in the speed axis technology object:

- Basic parameters
  - Units of measure (Page 33)
  - Virtual axis (Page 36)
  - Axis in simulation (Page 36)
- Hardware interface
  - Connecting PROFIdrive drives (Page 49)
  - Transfer drive parameters automatically (Page 61)
  - Connecting stepper motors (Page 63)
  - Connecting drives with analog setpoint interface (Page 63)
  - Connecting force/torque data via SIEMENS additional telegram 750 (Page 65)
- Mechanics
  - Configuring the mechanics of the speed axis (Page 75)
  - Configuring the load gear (Page 85)
- Dynamic default values (Page 98)
- Emergency stop (Page 102)
- Limits
  - Dynamic limits (Page 98)
  - Torque limits (Page 102)

4.2 Positioning axis technology object (S7-1500, S7-1500T)



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.

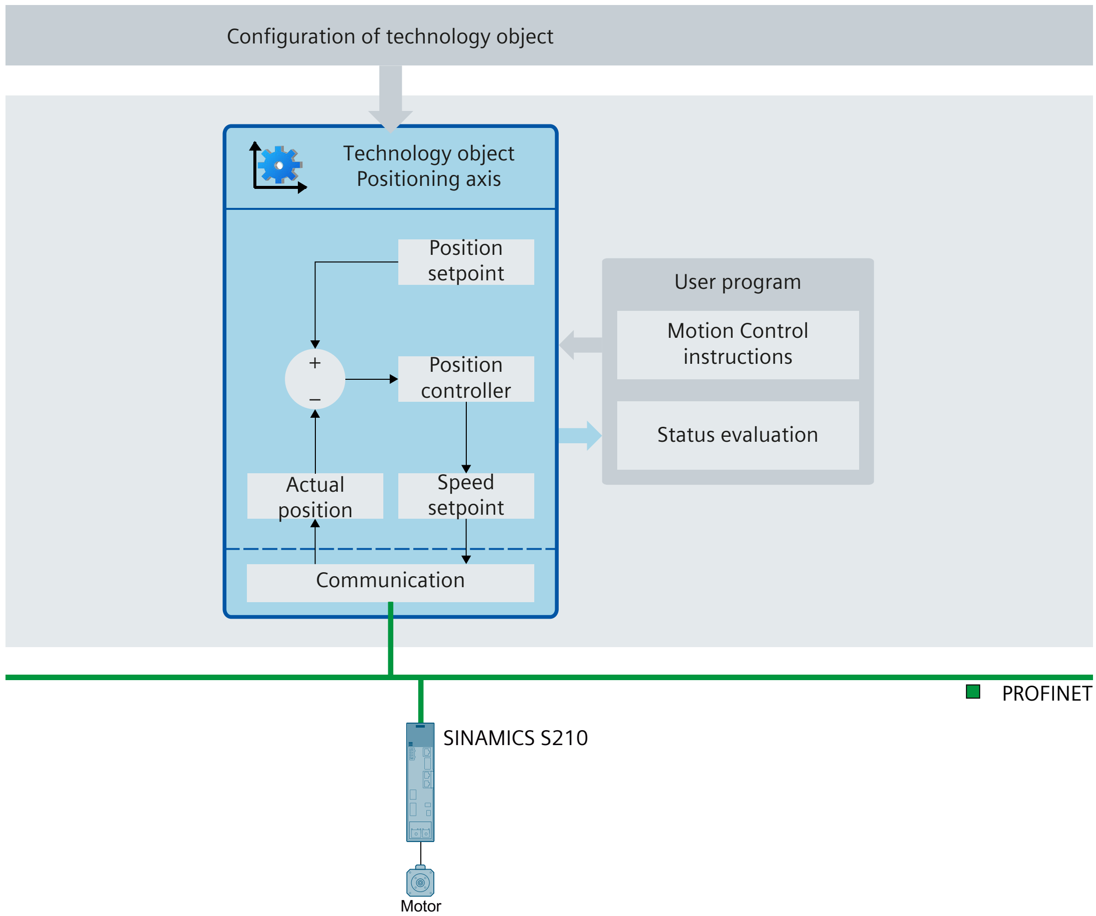
You can find an overview of the supported instructions of the positioning axis technology object in the section "Motion Control - Instructions for axis control (Page 29)".

Each positioning axis is assigned a drive, e.g. via a PROFIdrive telegram, and an encoder, via 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.

Depending on the design of the mechanics, a positioning axis can be configured as a linear or rotary axis.

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



Configuration

The following configurations are available in the positioning axis technology object:

- Basic parameters
  - Axis or encoder type (Page 32)
  - Units of measure (Page 33)
  - Modulo setting (Page 34)
  - Virtual axis (Page 36)
  - Axis in simulation (Page 36)
- Hardware interface
  - Connecting PROFIdrive drives (Page 49)
  - Connecting encoders via PROFIdrive (Page 54)
  - Transferring drive and encoder parameters automatically (Page 61)
  - Connecting stepper motors (Page 63)
  - Connecting drives with analog setpoint interface (Page 63)
  - Connecting force/torque data via SIEMENS additional telegram 750 (Page 65)

- Mechanics
  - Configuring drive and encoder direction for positioning axis/synchronous axis (Page 83)
  - Configuring the load gear (Page 85)
  - Configuring the leadscrew pitch (Page 85)
  - Backlash compensation (Page 86)
- Dynamic default values (Page 93)
- Emergency stop (Page 102)
- Limits
  - Position limits (Page 116)
  - Dynamic limits (Page 93)
  - Torque limits (Page 102)
  - Fixed stop detection (Page 104)
- Homing
  - Active homing (Page 133)
  - Passive homing (Page 142)
- Position monitoring functions
  - Position monitoring (Page 157)
  - Following error (Page 159)
  - Standstill signal (Page 160)
- Control loop
  - Configuring position controller in the PLC (Page 166)
  - Configuring position controller for drives with DSC (Page 165)
  - Configuring a dynamic filter (Page 167)
  - Switching the position control off and on (Page 169)

The following configurations of the positioning axis technology object are specific to synchronous operation:

- Leading value settings
  - Configuring provision of the leading value
  - Configuring the delay time
- Actual value extrapolation

You can find a description of the configuration parameters in the "S7-1500/S7-1500T synchronous operation functions" documentation (Page 12).

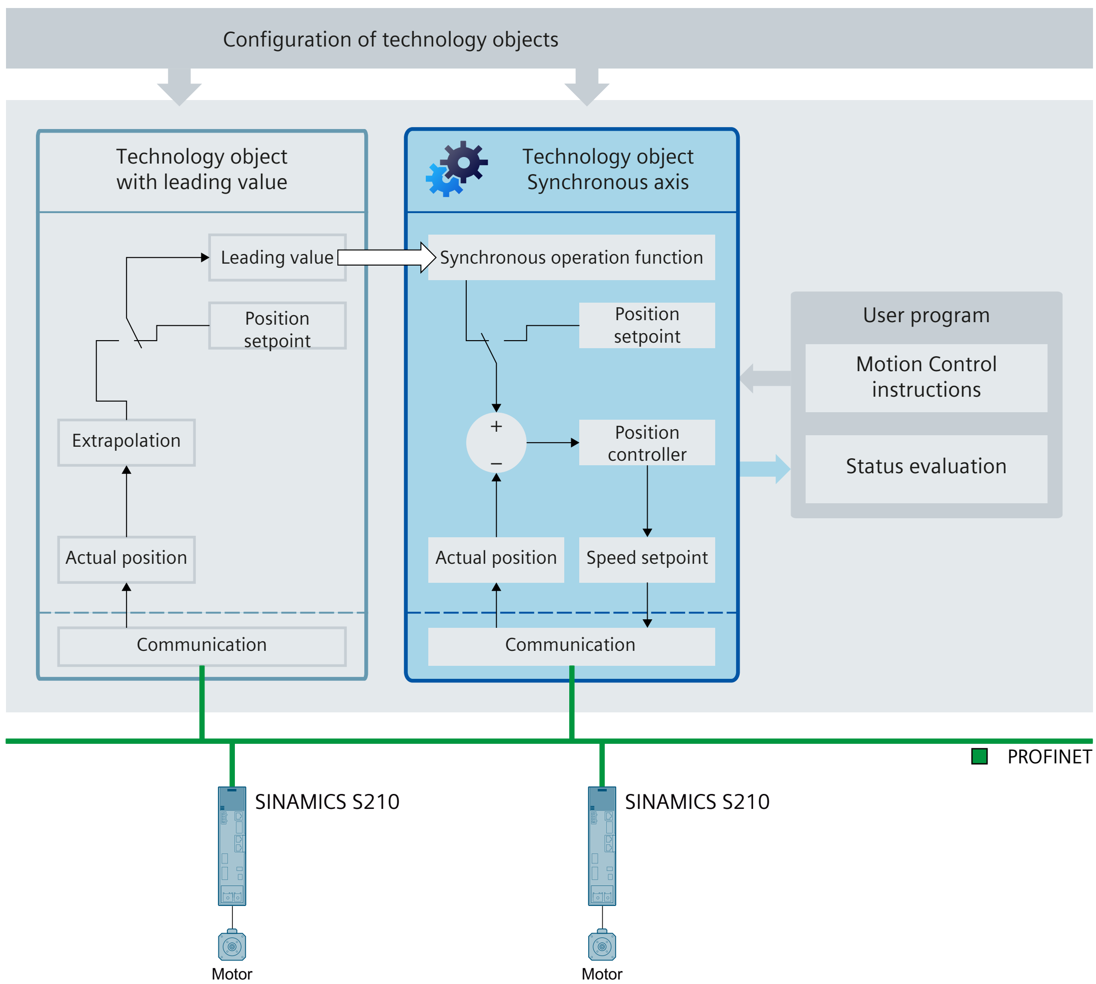
4.3 Synchronous axis technology object (S7-1500, S7-1500T)

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 supported instructions of the synchronous axis technology object in the section "Motion control instructions for axis control (Page 29)".

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



Configuration

The following non-isochronous specific configurations correspond to the positioning axis technology object:

- Basic parameters
  - Axis or encoder type (Page 32)
  - Units of measure (Page 33)
  - Modulo setting (Page 34)
  - Virtual axis (Page 36)
  - Axis in simulation (Page 36)
- Hardware interface
  - Connecting PROFIdrive drives (Page 49)
  - Connecting encoders via PROFIdrive (Page 54)
  - Transferring drive and encoder parameters automatically (Page 61)
  - Connecting stepper motors (Page 63)
  - Connecting drives with analog setpoint interface (Page 63)
  - Connecting force/torque data via SIEMENS additional telegram 750 (Page 65)
- Mechanics
  - Configuring drive and encoder direction for positioning axis/synchronous axis (Page 83)
  - Configuring the load gear (Page 85)
  - Configuring the leadscrew pitch (Page 85)
  - Configuring backlash compensation (Page 86)
- Dynamic default values (Page 93)
- Emergency stop (Page 102)
- Limits
  - Position limits (Page 116)
  - Dynamic limits (Page 93)
  - Torque limits (Page 102)
  - Fixed stop detection (Page 104)
- Homing
  - Active homing (Page 133)
  - Passive homing (Page 142)
- Position monitoring functions
  - Position monitoring (Page 157)
  - Following error (Page 159)
  - Standstill signal (Page 160)
- Control loop
  - Configuring position controller in the PLC (Page 166)
  - Configuring position controller for drives with DSC (Page 165)
  - Configuring a dynamic filter (Page 167)
  - Switching the position control off and on (Page 169)

You can find a description of the configuration parameters in the "S7-1500/S7-1500T Axis functions" documentation (Page 12).

The following configurations of the synchronous axis technology object are specific to synchronous operation:

- Leading value interconnections
- Leading value settings
  - Configuring provision of the leading value
  - Configuring the delay time
- Actual value extrapolation

You can find a description of the configuration parameters in the "S7-1500/S7-1500T synchronous operation functions" documentation (Page 12).

4.4 External encoder technology object (S7-1500, S7-1500T)

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

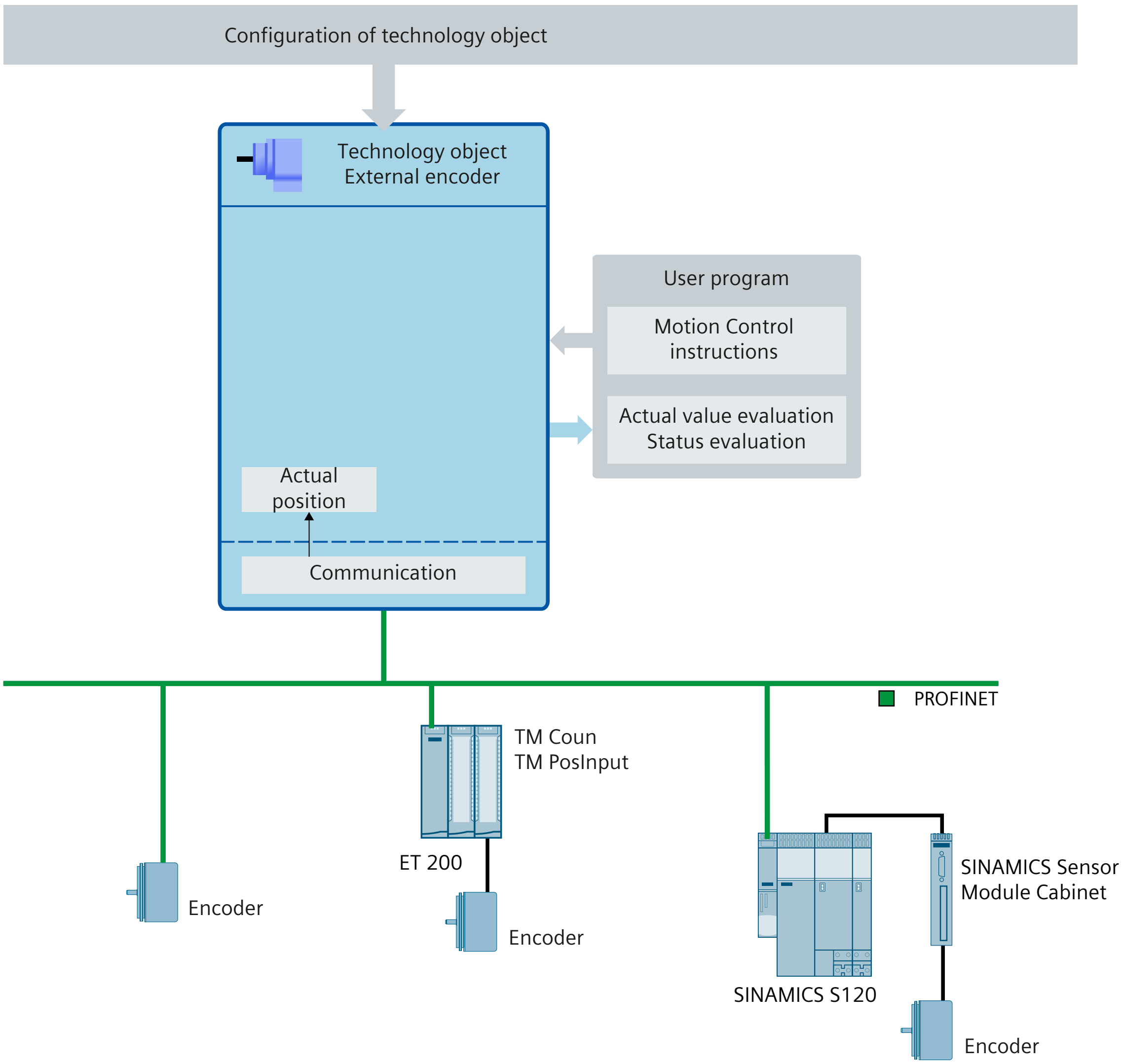
The actual position detected by the external encoder can be used for the following functions, for example:

- 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)

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.

You can find an overview of the supported instructions of the positioning axis technology object in the section "Motion Control - Instructions for axis control (Page 29)".

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



Configuration

The following configurations are available in the technology object external encoder:

- Basic parameters
  - Configure the type of an external encoder (Page 33)
  - Units of measure (Page 33)
  - Modulo setting (Page 34)
- Hardware interface
  - Connecting encoders via PROFIdrive (Page 54)

- Mechanics
  - Configuring the mechanics of the external encoder (Page 81)
  - Configuring the load gear (Page 85)
  - Configuring the leadscrew pitch (Page 85)
- Homing
  - Passive homing (Page 142)

The following configurations of the external encoder technology object are specific to synchronous operation:

- Leading value settings
  - Configuring provision of the leading value
  - Configuring the delay time
- Actual value extrapolation

You can find a description of the configuration parameters in the "S7-1500/S7-1500T synchronous operation functions" documentation (Page 12).

4.5 Motion control instructions for axis control (S7-1500, S7-1500T)

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

The following table shows the motion control instructions that are supported by the technology objects:

Motion control instruction	Validity		Technology object		
	S7-1500	S7-1500T	Speed axis (Page 21)	Positioning axis (Page 22) Synchronous axis (Page 24)	External encoder (Page 27)
"MC_Power" Enable, disable technology object	✓	✓	✓	✓	-
"MC_Reset" Acknowledge alarms, restart techno-logy object	✓	✓	✓	✓	✓
"MC_Home" Home technology object, set home position	✓	✓	-	✓	✓
"MC_Halt" Pause axis	✓	✓	✓	✓	-
"MC_MoveAbsolute" Position axis absolutely	✓	✓	-	✓	-
"MC_MoveRelative" Position axis relatively	✓	✓	-	✓	-
"MC_MoveVelocity" Move axes with velocity/speed setpoint	✓	✓	✓	✓	-
"MC_MoveJog" Move axis in jog mode	✓	✓	✓	✓	-

Motion control instruction	Validity		Technology object		
	S7-1500	S7-1500T	Speed axis (Page 21)	Positioning axis (Page 22) Synchronous axis (Page 24)	External encoder (Page 27)
"MC_MoveSuperimposed" Positioning axis overlapping	✓	✓	-	✓	-
"MC_HaltSuperimposed" Pause superimposed motions on the axis.	✓	✓	-	✓	-
"MC_SetSensor" Switch alternative encoder to operative encoder	-	✓	-	✓	-
"MC_Stop" Stop axis and prevent new motion jobs	✓	✓	✓	✓	-
"MC_SetAxisSTW" Control bits of control word 1 and control word 2	✓	✓	✓	✓	-
"MC_WriteParameter" Write parameter	✓	✓	✓	✓	✓
"MC_SaveAbsoluteEncoderData" Save absolute adjustment for device replacement	✓	✓	-	✓	✓
"MC_MotionInVelocity" Specify motion setpoints	-	✓	✓	✓	-
"MC_MotionInPosition" Specify motion setpoints	-	✓	-	✓	-
"MC_MotionInSuperimposed" Specify superimposed motion setpoints	-	✓	-	✓	-
"MC_TorqueAdditive" Specify additive torque	✓	✓	✓	✓	-
"MC_TorqueRange" Set high and low torque limit	✓	✓	✓	✓	-
"MC_TorqueLimiting" Activate/deactivate force/torque limiting / fixed stop detection	✓	✓	✓	✓	-

4.6 Extended functions of the technology CPU (S7-1500T)

In addition to the functionality of the S7-1500 CPU, the S7-1500T CPU provides additional functions:

Additional functions	Description
Multiple encoders for positioning axis/synchronous axis (Page 58)	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.

Additional functions	Description
"MotionIn" function (Page 111)	With the "MC_MotionInVelocity", "MC_MotionInPosition", and "MC_MotionInSuperimposed" motion control instructions, you can specify cyclically applicable calculated motion setpoints as the basic motion for the axis. No velocity profile is calculated for this, the values are directly active at the technology object.

4.7 Functions in STEP 7 (S7-1500, S7-1500T)

The following table shows the functions supported by technology objects in STEP 7:

Functions in the TIA Portal	Technology object		
	Speed axis (Page 21)	**Positioning axis** (Page 22) **Synchronous axis** (Page 24)	**External encoder** (Page 27)
"Axis control panel" Move and home axes using the TIA Portal	✓	✓	-
"Optimization" Optimization of closed loop position control	-	✓	-

Axis functions (S7-1500, S7-1500T) 5

5.1 Configuring basic parameters (S7-1500, S7-1500T)

5.1.1 Configure axis type (S7-1500, S7-1500T)

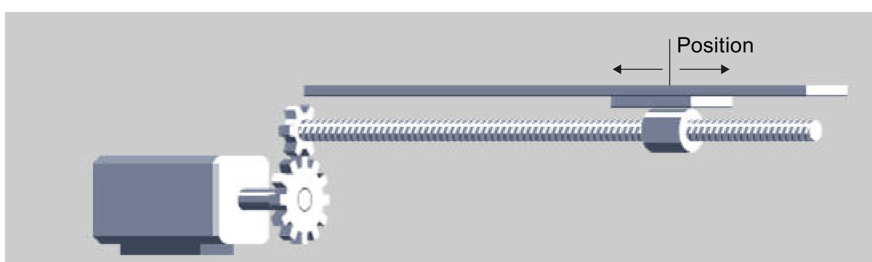
Axes can be configured with different axis types:

- Speed axes are always rotary axes.
- You configure positioning axes and synchronous axes either as rotary or linear axes, depending on the mechanics.

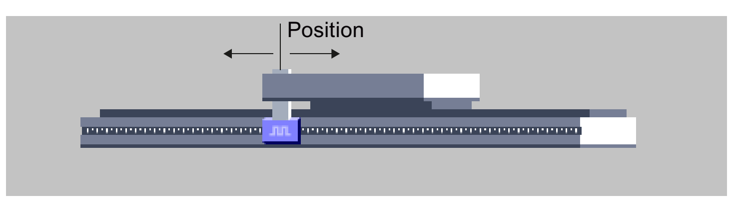
Configure axis type

In the "Axis type" area, select the type that matches the mechanics for your axis.

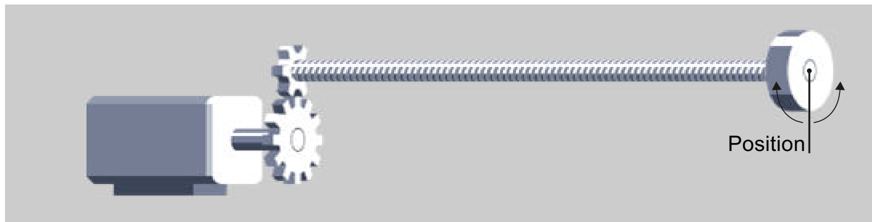
- **Linear axis**
  You can configure the linear axis either with a standard motor or with a linear motor.
  For linear axes, the position of the axis is specified as a linear measure, e.g. millimeters (mm).
  - Linear axis with standard motor



  - Linear axis with linear motor



- **Rotary axis**
  The rotary axis is always configured with a standard motor.
  For rotary axes, the position of the axis is specified as an angular measure, e.g. degrees (°).



Note the following if you apply the drive values automatically from the Startdrive.
If the drive in the Startdrive is configured as a linear motor, you have to adapt the configuration of the axis type. Change the axis type to "Linear" or attach a standard motor as drive.
Connecting PROFIdrive drives (Page 49)
Transferring drive and encoder parameters automatically (Page 61)

5.1.2 Configure the type of an external encoder (S7-1500, S7-1500T)

For the "External encoder" technology object, you can configure whether the encoder accepts linear or rotary motions.
Select the appropriate type for your encoder in the "External encoder type" area.

- Linear
- Rotary

5.1.3 Units of measure (S7-1500, S7-1500T)

Select the units of measure available for the technology object from the drop-down lists.
Setting or changing the measurement units affects the display of the 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.
When measurement units are changed, the values of individual parameters in the technology object lie outside the minimum value or maximum value due to the LREAL format. Adapt the values or change the measurement units back.
The set units are displayed in the "<TO>.Units" tag structure of the technology object. The tag structure is described under the tags of the respective technology object.

Speed

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

Position and velocity

The table below shows the supported measurement units 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/s^2 measurement unit.

The jerk is set accordingly as the position/s^3 measurement unit.

Force and torque

The table below shows the supported measurement units 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

Time

The measurement unit 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

Position values with higher resolution

If you select the check box "Use position values with higher resolution" in the configuration of the positioning axis, synchronous axis, external encoder and kinematics technology objects, six decimal places are available in the selected unit, instead of the standard three. Due to the LREAL format, the representable position and angle range in [mm] and [°] is limited to +/- 1.0E09.

The following values are reduced by a factor of 1000 for position values with a higher resolution:

- Displayable position range
- Displayable angular range
- Mechanical gear ratio
- Numerical traversing range with regard to long-term stability
- Dynamic values for velocity, acceleration and deceleration

5.1.4 Modulo setting (S7-1500, S7-1500T)

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. The long-term accuracy (Page 128) can also be adhered to with modular axes up to the maximum travel time.

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°.

The modulo cycle counters for the position setpoint and the actual position on the positioning axis, synchronous axis and external encoder technology objects indicate the number of modulo revolutions.

Modulo cycle counter

If the "Modulo" setting is activated, the modulo cycle counter is activated for the positioning axis, synchronous axis, and external encoder technology objects. The modulo cycle counter is displayed at the technology object for the position setpoint and the actual position. The modulo cycle counter counts the modulo revolutions and thus the number of modulo runs at the technology object.

The tag <TO>.ModuloCycle indicates the number of modulo cycles of the setpoint.

The tag <TO>.ActualModuloCycle indicates the number of modulo cycles of the actual value.

The counter values of the modulo cycles change during switch on, restart and homing.

The following applies to an incremental encoder:

<table>
<tr><th>Action</th><th>Description</th></tr>
<tr><td>Switching on the CPU</td><td>The modulo cycle counter is set to 0.</td></tr>
<tr><td>Reset with "Restart" = TRUE</td><td>The modulo cycle counter is set to 0.</td></tr>
<tr><td>Active and passive homing with "Mode" = 2, 3, 5, 8, 10</td><td>• If the home position is in the range "Modulo start value ≤ Home position ≤ (Modulo Start value + Modulo length / 2)", the modulo cycle counter is set to 0.
• If the home position is in the range "(Modulo start value + Modulo length / 2) < Home position < (Modulo start value + Modulo length)" the modulo cycle is set to -1.</td></tr>
<tr><td>Direct homing absolute with "Mode"= 0, 11</td><td rowspan="2">The modulo value is the shortest distance between the current and new position. Depending of the distance, the modulo cycle counter can remain the same, increase by 1 or decrease by 1.</td></tr>
<tr><td>Direct homing absolute with "Mode"= 1, 12</td></tr>
</table>

The following applies to an absolute encoder:

<table>
<tr><th>Action</th><th>Description</th></tr>
<tr><td>Switching on the CPU</td><td>The modulo cycle counter changes according to the determined modulo length from the absolute value of the encoder and the absolute value offset of an absolute value encoder adjustment, if an absolute value encoder adjustment has taken place.</td></tr>
<tr><td>Reset with "Restart" = TRUE</td><td>The modulo cycle counter remains unchanged.</td></tr>
<tr><td>Absolute encoder adjustment with "Mode" = 7</td><td>The modulo cycle counter is set to 0.</td></tr>
<tr><td>Absolute encoder adjustment with "Mode" = 6</td><td rowspan="2">The modulo value is the shortest distance between the current and new position. Depending of the distance, the modulo cycle counter can remain the same, increase by 1 or decrease by 1.</td></tr>
<tr><td>Direct homing absolute with "Mode" = 0, 11</td></tr>
</table>

Action	Description
Direct homing absolute with "Mode"= 1, 12	The modulo value is the shortest distance between the current and new position. Depending of the distance, the modulo cycle counter can remain the same, increase by 1 or decrease by 1.

Enable and configure 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).

5.1.5 Virtual axis (S7-1500, S7-1500T)

S7-1500 Motion Control offers the possibility to configure an axis as a virtual axis. A virtual axis behaves like a real axis, but has no drive or encoder connection. The setpoints are only processed within the controller. A real drive is never controlled in this situation.

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).

If you have configured an absolute encoder at the virtual axis, you must home the virtual axis after switching on the CPU.

The further behavior of a virtual axis is identical to the behavior of an axis in simulation (Page 36).

5.1.6 Axis in simulation (S7-1500, S7-1500T)

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 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 measuring 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_TorqueLimiting	The specified torque is not output to the drive.

5.1.7 Actual value calculation for virtual axis or axis in simulation (S7-1500, S7-1500T)

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:

Calculation	
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 for one axis in simulation	$T_t = T_{ipo} + T_{servo} + 1/Kv + T_{addPtc}$

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

Switching between real and simulated axis in the user program

5.2 Drive and encoder connection (S7-1500, S7-1500T)

Number of drives and encoders per technology object

The following table shows the number of drives and encoders for the various technology objects.

Technology object	Number of drives (actuators)	Number of encoders (sensors)
Speed axis	1	0
Positioning axis, synchronous axis	1	1 (S7-1500) 1 to 4 (S7-1500T)
External encoder	0	1

Supported drive types

You can connect the following drives:

- Drive with an analog setpoint interface
- Drives with PROFIdrive telegram (PROFINET IO or PROFIBUS DP), e.g.
  - SINAMICS
  - SIMATIC MICRO-DRIVE
  - Technology modules
  - Drives from other manufacturers

Encoder connection options

The following connection options are available for an encoder:

- Connection to the drive
- Encoder on the technology module, e.g. TM Count 1x24V
- PROFIdrive encoder directly on the PROFIBUS DP/PROFINET IO

The actual encoder value is transmitted exclusively via PROFIdrive telegram.

Drive configuration process

Complete the following steps to add and configure a drive.

- Adding a drive unit (Page 39)
  - SINAMICS Startdrive
  - GSD file
  - SIMATIC technology module
- Configuration of the PROFIdrive telegram for PROFIdrive drives (Page 45)

- Configure communication between drive and CPU in the device configuration
  - Configure PROFINET IO network (Page 41)
  - Configure PROFIBUS DP network (Page 43)
- Configure data exchange between technology object and PROFIdrive drive
  - Connect PROFIdrive drive directly (Page 49)
  - Connect PROFIdrive drive via data block (Page 49)
  - Configure drive parameters manually (Page 53)
  - Transfer drive parameters automatically (Page 61)
- Configure data exchange between technology object and drive with analog setpoint interface (Page 63)
- Connect stepper motors (Page 63)

If you want to use a torque pre-control, change the torque limits in the drive from the user program, or evaluate the current actual torque value, you have to connect the additional telegram 750 to the technology object.

- Connecting force/torque data via SIEMENS additional telegram 750 (Page 65)

Encoder configuration process

Add the encoder in the device configuration.

- Add encoder in the device configuration
  - PROFINET-IO encoder
  - Profibus-DP encoder
  - Technology module

Configuring the data exchange between technology object and encoder.

- Connect ProfiDrive encoder directly (Page 54)
- Connect ProfiDrive encoder via data block (Page 55)
- Transfer encoder parameters automatically (Page 61)
- Configure encoder parameters manually (Page 56)

Configure the encoder type (Page 55).

5.2.1 Adding and configuring drives (S7-1500, S7-1500T)

Siemens offers numerous drive systems for various applications.

Depending on the drive, the parameter assignment and implementation in the TIA Portal are different. The application examples provide step-by-step descriptions of how to add and configure the drives.

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 more information on connecting via Startdrive, refer to:

- Getting Started SINAMICS S120 in the Startdrive
  Getting Started SINAMICS S120
  (https://support.industry.siemens.com/cs/ww/en/view/109747452)
- Application example "Configuring an S120 with Startdrive":
  Application example SINAMICS S120
  (https://support.industry.siemens.com/cs/ww/en/view/109743270)
- Application example "Configuring an S210 with Startdrive":
  Application example SINAMICS S210
  (https://support.industry.siemens.com/cs/ww/en/view/109750431)

Using the GSD file

You can add and configure the SINAMICS S210 using a GSD file.
Application example SINAMICS S210
(https://support.industry.siemens.com/cs/ww/en/view/109750431)

Using SINAMICS V90 PN

To add and configure a SINAMICS V90 PN drive in the TIA Portal, you need the Hardware Support Package HSP 0185 (SINAMICS V90 PN).

- Getting Started SINAMICS V90 PN on S7-1500 motion control:
  Getting Started SINAMICS V90 PN
  (https://support.industry.siemens.com/cs/ww/en/view/109739497)
- Configure SINAMICS V90 PN with web server
  Application example SINAMICS V90 PN
  (https://support.industry.siemens.com/cs/ww/en/view/109739053)

Using SIMATIC MICRO-DRIVE PDC

To add and configure a SIMATIC MICRO-DRIVE PDC in the TIA Portal, you need the Hardware Support Package HSP 198.
Application example SIMATIC MICRO-DRIVE PDC
(https://support.industry.siemens.com/cs/ww/us/view/109770395)

Using ET 200SP F - TM ServoDrive

To add and configure a ET 200SP F-TM ServoDrive in the TIA Portal, you need the Hardware Support Package HSP 0311.
Application example ET 200SP F - TM ServoDrive
(https://support.industry.siemens.com/cs/ww/en/view/109780201)

Drives compatibility list

In the Siemens Industry Online Support you can find an overview of the drives you can connect with a S7-1500 CPU.
Compatibility list (https://support.industry.siemens.com/cs/ww/en/view/109750431)

5.2.1.1 Adding and configuring a PROFINET-IO drive (S7-1500, S7-1500T)

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.

Requirement

- 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 > 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 CPU.
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 "Configuring PROFIdrive telegrams (Page 45)".
Repeat step 6, if you want to add another drive and another standard telegram.

Interconnect the port of the CPU with the port of the drive

1. Open the topology view in the device configuration.
2. Interconnect the port of the drive with the port of the CPU as in the real setup.
   To plan your PROFINET topology, please note the PROFINET installation guideline of the PROFIBUS user organization (https:\\www.profibus.com).

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 [X150] > Advanced options > Isochronous mode".
3. Select the "Isochronous mode" check box in this tab.

In the detailed overview, the check box for the telegram must also be selected for isochronous mode.

Configure the CPU as the sync master and set isochronous mode

1. Select the device view of the CPU.
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).

Configuring the drive as a sync slave

1. Select the device view of the drive unit
2. In the Properties window, select the tab "PROFINET interface [X150] > Advanced options > Real-time settings > Synchronization"
3. Select the RT class: "IRT"

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.

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. An "PROFINET IO system" must be selected in the "Source of the send clock" 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 errors occur 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 selected for the "Process image".

5.2.1.2 Adding and configuring a PROFIBUS DP drive (S7-1500, S7-1500T)

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.

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 CPU.
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 "Configuring PROFIdrive telegrams (Page 45)".
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.

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".

5.2.2 Configuring PROFIdrive telegrams (S7-1500, S7-1500T)

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 the page of the PROFIBUS user organization under "Download" > "Profiles":
https://www.profibus.com (https:\\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.

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 (Measuring via SINAMICS (central probe))	391, 392, 393
Measuring input at axis module	Corresponds to measuring via PROFIdrive

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[5)], status word ZSW1 • Speed setpoint 16 bit (NSET), actual speed value 16 bit (NACT)
2	• Controls word STW1[5)] and STW2[5)], status words ZSW1 and ZSW2 • Speed setpoint 32 bit (NSET), actual speed value 32 bit (NACT)

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)

5) STW1 and STW2: Bits not used by the technology object can be controlled via the user program with the Motion Control instruction "MC_SetAxisSTW".

Telegram	Brief description
3	• Controls word STW1[5] and STW2[5], 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	• Controls word STW1[5] and STW2[5], 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)
5	• Controls word STW1[5] and STW2[5], 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) – Kv factor gain position control (KPC)
6	• Controls word STW1[5] and STW2[5], 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) – Kv factor gain position control (KPC)
Siemens telegrams (with torque limiting)	
102	• Controls word STW1[5] and STW2[5], 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	• Controls word STW1[5] and STW2[5], 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	• Controls word STW1[5] and STW2[5], 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) – Kv factor gain position control (KPC) • Torque limiting

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)

5) STW1 and STW2: Bits not used by the technology object can be controlled via the user program with the Motion Control instruction "MC_SetAxisSTW".

Telegram	Brief description
106	• Controls word STW1[5)] and STW2[5)], 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) – Kv factor gain position control (KPC) • 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
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)

5) STW1 and STW2: Bits not used by the technology object can be controlled via the user program with the Motion Control instruction "MC_SetAxisSTW".

The following table shows PROFIdrive telegrams that are not supported but are modified by the MC servo:

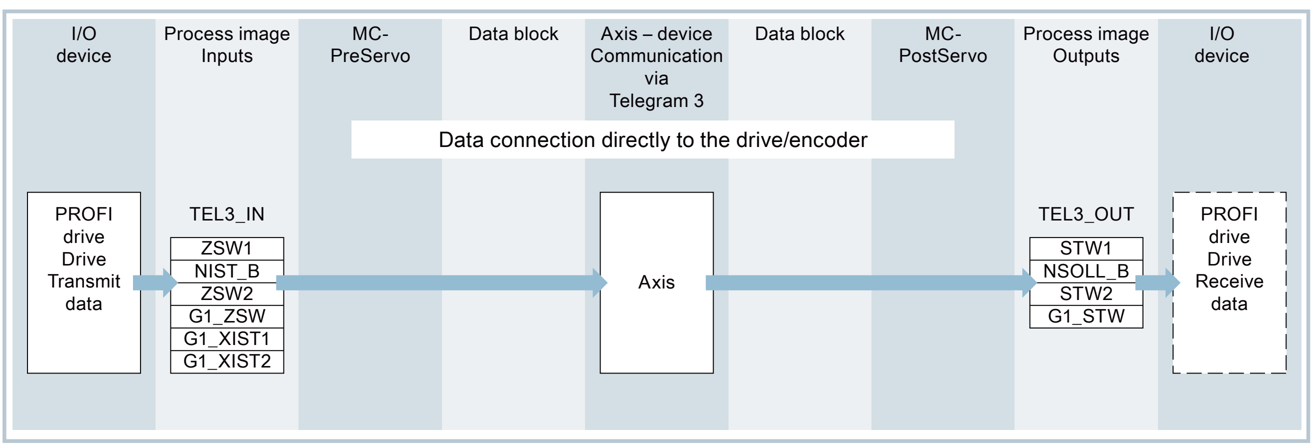
Telegram	Brief description
SIEMENS telegrams	
390	Control word CU_STW1, status word CU_ZSW1
394	Control word CU_STW1, status word CU_ZSW1
395	Control word CU_STW1, status word CU_ZSW1

The exact content of the telegrams can be found in the "SINAMICS S120/S150 (https://support.industry.siemens.com/cs/ww/en/view/109763271)" list manual

5.2.3 Connecting PROFIdrive drives (S7-1500, S7-1500T)

5.2.3.1 Connecting PROFIdrive drive directly (S7-1500, S7-1500T)

In the "Drive" field, select an already configured PROFIdrive drive/slot. A suitable PROFIdrive telegram must be configured so that a drive is displayed.



When you have selected a drive, you can use the "Device configuration" button to navigate directly to the device view of the PROFIdrive, e.g. in Startdrive. Use the "Drive configuration" button to navigate to the parameter assignment of the PROFIdrive drive in Startdrive.

NOTE

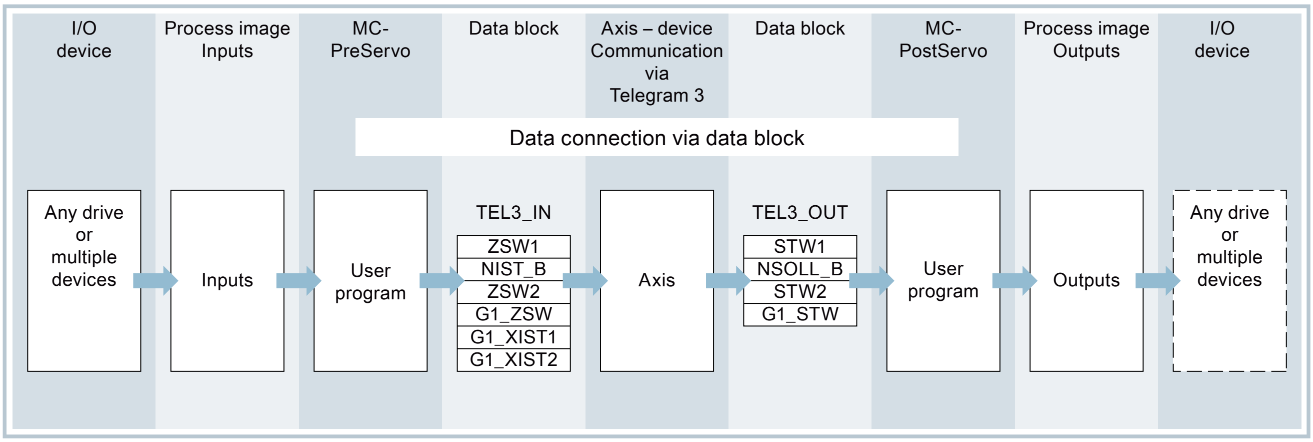
Option "Show all modules"

If a PROFIdrive drive that has already been configured is not available for selection, use the option "Show all modules" to display all reachable modules.

When you select the option "Show all modules", only the address range for each of the displayed modules is checked. If the address range of the module is large enough for the selected PROFIdrive telegram, you can select the module. For this reason, make sure that you select a PROFIdrive drive.

5.2.3.2 Connecting a PROFIdrive drive via data block (S7-1500, S7-1500T)

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 process-related telegram contents, a data interface can be connected via a data block before and after the 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.

5.2.3.3 Connect drive/encoder via data block (S7-1500, S7-1500T)

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. Create a new tag on "Add" in the block editor.
6. For the new tag, enter "PD_TELx" completely in the "Data type" column. The "x" stands for the telegram number. Example: "PD_TEL3" for standard telegram 3
   You have created a tag structure of the type "PD_TELx". 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 technology object. For example, the input area contains the actual values of the drive and the output area contains the setpoints for the drive.

   For the data connection via a data block, "Input" and "Output" must always be in of the "PD_TELx" tag structure. Do not use standalone tag structures for "Input" and "Output", such as "PD_TEL3_IN".

   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. Select the entry "Data block" from the "Data block" drop-down list.
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.

NOTE

As of TIA Portal V17, you can connect tag structures of the "PD TELx" data type that are defined in arrays (Array [0..x] of "PD_TELx"), PLC data types or structures within a data block.

Programming MC-PreServo and MC-PostServo

- Edit the tag structure for the input area "Input" in the MC-PreServo.
- Edit the tag structure for the output area "Output" in the 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 on the Internet (https://support.industry.siemens.com/cs/ww/en/view/109741575).

Configuration of the communication times T_i, T_o, T_{DC}

When calculating the following error, the transmission times of the setpoint to the drive and of the actual position value to the controller are deducted. The transmission times result from the following communication times:

- T_i: Time to import process values
- T_o: Time to export process values
- T_{DC}: Send clock of the PROFINET interface or PROFIBUS send clock

The following error is calculated from the delayed position setpoint by the communication times $T_i + T_o + T_{DC}$ and the cycle time of the MC Servo T_{Servo} minus the actual position in the controller.

Unlike with direct drive or encoder connection, the communication times are not automatically adapted by the technology object with the connection via data block; by default, the communication times are preset to 0.0 s. For the correct calculation of the real following error "<TO>.StatusPositioning.FollowingError" and the system deviation at the position controller "<TO>.StatusServo.ControlDifference", you configure the communication times T_i, T_o, T_{DC} manually.

You can find a description of the communication times in the PROFINET with STEP 7 function manual on the Internet (https://support.industry.siemens.com/cs/ww/en/view/49948856).

Procedure

1. Read the T_i, T_o, and T_{DC} (send clock) from the device configuration of the drive or encoder. You can find the values in the menu "PROFINET interface > Advanced settings > Isochronous mode".
2. Define the read times as variables of the data type "LREAL" in a data block.

NOTE

Enter the time in seconds (s) in the data block. In the device configuration, times are entered in milliseconds (ms). A time Ti of 0.125 ms corresponds to 0.000125 s.

3. Call the "MC_WriteParameter" instruction with the following parameter assignment for "MC_WriteParameter.ParameterNumber". For the input parameter "Value", assign the defined tag for T_i with the corresponding time.

Communication time	MC_WriteParameter.ParameterNumber
T_i	1010
T_o	1011
T_{DC}	1012

4. Assign the associated technology object at the "Axis" input parameter.
5. Start the job with a positive edge at the "Execute" input parameter.
   The output parameter "Done" signals that the change has been applied.
   Bit 3 of the tag "<TO>.StatusWord" (OnlineStartValueChanged) indicates that a restart of the technology object is required to effectively apply the values.
6. Repeat steps 3. to 5. for the communication times T_o and T_{DC}.
7. To apply the change of the communication times, restart the technology object with the instruction "MC_Reset" with "Restart" = TRUE.

Result

The communication times for T_i, T_o and T_{DC} are not taken into account by the technology object when calculating the following error.

NOTE

When you connect the technology object directly to the drive, the technology object automatically adapts the communication times. Do not configure the communication times via the user program in this case.

The communication times are retained with a "RUN → STOP → RUN" transition of the CPU or in case of another restart of the technology object.

Note that the communication times are reset to 0.0 s in the following cases:

- Download of the technology object
- POWER OFF → POWER ON
- Memory reset

In this case, configure the communication times again.

5.2.3.4 Configuring drive parameters manually (S7-1500, S7-1500T)

If the connected drive does not allow the drive parameters to be applied automatically, configure the drive parameters manually. You can find the configured values in the manufacturer's information or in the drive commissioning tool.

Transferring drive and encoder parameters automatically (Page 61)

Standard motor

- **Reference speed**Configure the reference speed of the drive in this field according to the manufacturer's specifications. 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**In this field, configure the reference torque of the drive according to its configuration.
  The reference torque is required for the force/torque reduction, which is supported with telegram 10x.

Linear motor

- **Reference velocity**Configure the reference velocity of the drive in accordance with the manufacturer's specifications in this field. The specification of the drive velocity is a percentage of the reference velocity in the range -200% to 200%.
- **Maximum velocity**Configure the maximum velocity of the drive in this field.
- **Reference force**In this field, configure the reference force of the drive according to its configuration.
  The reference force is required for the force/torque reduction, which is supported with telegram 10x.

5.2.4 Connecting encoders via PROFIdrive (S7-1500, S7-1500T)

When using a PROFIdrive drive telegram with encoder data for the positioning axis or synchronous axis technology object, e.g. telegram 3, the encoder from the PROFIdrive telegram is automatically connected as the first encoder.
With telegram 6 or 106, the first two encoders are automatically connected (only S7-1500T).

You must connect the encoder separately to the drive in the following applications:

- Drive and encoder data in two separate PROFIdrive telegrams (drive connection via PROFIdrive telegram 1 and encoder connection via PROFIdrive telegram 81/83)
- Connection to the technology object external encoder
- Connection as a second, third or fourth encoder on the positioning axis or synchronous axis technology object (S7-1500T)
- Connection as the first encoder, instead of the automatically connected encoder from the PROFIdrive drive telegram.

5.2.4.1 Connecting the encoder directly (S7-1500, S7-1500T)

In the "Encoder field", select an already configured encoder or its PROFIdrive telegram.

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. During central operation in the CPU isochrone mode is possible as of firmware version 2.8.1.

You can identify the technology modules suitable for position detection for Motion Control in the documentation for the technology module and the catalog data.

With the compact CPUs (e.g. CPU 1512C-1 PN) you can use the high-speed counters (HSC) for position detection.

PROFIdrive encoder on PROFINET/PROFIBUS (PROFIdrive)

In the "PROFIdrive encoder" field, select a configured encoder on PROFINET/PROFIBUS. When you have selected an encoder, you can configure the encoder 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.

NOTE

Option "Show all modules"

If a PROFIdrive that has already been configured is not available for selection, use the option "Show all modules" to display all reachable modules.

When you select the option "Show all modules", only the address range for each of the displayed modules is checked. If the address range of the module is large enough for the selected PROFIdrive telegram, you can select the module. For this reason, make sure that you select a PROFIdrive encoder.

5.2.4.2 Connect encoder via data block (S7-1500, S7-1500T)

If you have selected "Data block" under the data connection, select in the "Data block" field a previously created data block which contains a tag structure of the data type "PD_TELx" ("x" stands for the telegram number to be used).

The procedure is described in the section "Connecting a PROFIdrive drive via data block (Page 49)".

5.2.4.3 Configuring the encoder type (S7-1500, S7-1500T)

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 cyclic absolute (measuring range < traversing range of axis)

Configuration of the encoder type

Make the setting of the encoder type depending on the encoder used and the measuring range of the encoder. The following table contains the selection criteria.

Encoder type	Actual value type	Explanation	Selection
Incremental	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.	Select this encoder type when using an incremental encoder.
Absolute	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.	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 crossing 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.	An absolute encoder is used and the measuring range of the encoder is smaller than the traversing range of the axis. If you cannot ensure that there is no encoder zero crossing in the traversing range, use the "Cyclic absolute" setting.
Cyclic absolute		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.	An absolute encoder is used and the measuring range of the encoder is smaller than the traversing range of the axis. Recommended settings for absolute actual values: The "Cyclic absolute" encoder type is recommended. With this setting, the position of the zero crossing of the encoder is automatically taken into consideration by the technology object.

5.2.4.4 Configuring encoder parameters manually (S7-1500, S7-1500T)

If the connected encoder does not allow the encoder parameters to be applied automatically, configure the encoder parameters manually. You can find the configured values in the manufacturer's information or in the drive commissioning tool.

Transferring drive and encoder parameters automatically (Page 61)

Encoder parameters for a rotary measuring system

Parameters	Drive parameters in SINAMICS	Encoder type		
		Increment-al	Absolute	Cyclic absolute
Increments per revolution	p979[2] encoder 1 p979[12] encoder 2	x	x	x
Number of revolutions	p979 [5] encoder 1 p979[15] encoder 2	-	x	x
Bits for fine resolution in the incremental actual value (Gx_XIST1)	p979[3] encoder 1 p979[13] encoder 2	x	x	x
Bits for fine resolution in the absolute actual value (Gx_XIST2)	p979[4] encoder 1 p979[14] encoder 2	-	x	x
Encoder reference speed	p2000	x	x	x

Encoder parameters for linear measuring system

Parameters	Drive parameters in SINAMICS	Encoder type		
		Increment-al	Absolute	Cyclic absolute
Distance between two increments	p979[2] encoder 1 p979[12] encoder 2	x	x	x
Bits for fine resolution in the incremental actual value (Gx_XIST1)	p979[3] encoder 1 p979[13] encoder 2	x	x	x
Bits for fine resolution in the absolute actual value (Gx_XIST2)	p979[4] encoder 1 p979[14] encoder 2	-	x	x
Encoder reference velocity	p2000	x	x	x

Evaluation of incremental actual value Gx_XIST1 with absolute encoders

In its default setting "<TO>.Sensor[1..4].Parameter.BehaviorGx_XIST1" = 1, the technology object assumes that the incremental actual value "Gx_XIST1" in the PROFIdrive telegram is supplied as an incremental counter value with a data width of 32 bits by the encoder or by the encoder module. In the "Gx_XIST1", this corresponds to a value between 0 and 4.294.967.295 (32 bits). The technology object expects overflow at these limits.

If "Gx_XIST1" is transmitted in the PROFIdrive telegram with a data width of less than 32 bits, configure "<TO>.Sensor[1..4].Parameter.BehaviorGx_XIST1" with 0. In this configuration, the technology object does not expect an incremental counter value with 32 bits, but evaluates only the data width according to the parameter assignment of the encoder at the technology object in "Gx_XIST1". The overflow in "Gx_XIST1" is also expected based on this parameter assignment. You can diagnose whether the data width of the incremental counter value is less than 32 bits with a trace of "Gx_XIST1" from the PROFIdrive telegram. If "Gx_XIST1" overflows back to 0 before it reaches 4,294,967,295, then the data width is less.

5.2.4.5 Using multiple encoders (S7-1500T)

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, for example:

- 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. To use Dynamic Servo Control (DSC), you must configure the motor encoder of the drive as the first encoder on the axis. The motor encoder is always the first encoder in the telegram.
- 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 to be used or each measuring system 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 retains 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.

"Mode" = 2 and 3 can be used to prepare a switchover.

Position adjustment mode

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 actual position to the encoder to be switched ("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.

5.2.4.6 Calculate actual velocity from actual speed NIST_B from PROFIdrive telegram (S7-1500, S7-1500T)

If you use an encoder with a low resolution, configure the following calculation methods:

- For positioning axis and synchronous axis technology objects: Calculate actual velocity from actual speed "NIST_B" from telegram
- For technology object external encoder: Calculate actual velocity from actual speed "NIST_B" of encoder telegram 83

For encoders with low resolution, the calculation of the actual velocity from the actual speed "NIST_B" in the PROFIdrive telegram is more precise than the standard calculation from the change in the actual position in the servo cycle.

Encoder resolution	Recommended configuration	Explanation
High	<TO>.Sensor[1..4].ActualVelocityMode = 0	Calculation of the actual velocity from the differentiation of the actual position
Low	<TO>.Sensor[1..4].ActualVelocityMode = 1	Calculation of the actual velocity from the actual speed "NIST_B" from the PROFIdrive telegram

The calculation of the actual velocity is relevant for the following Motion Control functions:

- Actual value extrapolation for actual value coupling in synchronous operation (S7-1500T)
- Output cam with output cam reference "Actual value"
- Transition from follow-up mode to position-controlled mode
- Calculation of the emergency stop ramp
- Standstill detection

NOTE

The calculation method of the actual velocity has no influence on the position control and the motion control of the technology object.

WARNING

Use of drive telegrams with two encoders

The standard telegrams 4 and 6 and the Siemens telegram 106 support up to two encoders.

Note that the actual speed "NIST_B" is only transferred for encoder 1 in the drive telegram.

If you have connected the second encoder of the telegram for encoder 2 in the technology object and for this encoder "Calculate actual velocity from actual speed NIST_B from PROFIdrive telegram" (<TO>.Sensor.Sensor (2).ActualVelocityMode = PROFIDRIVE_NIST), then the first encoder of the telegram returns the actual speed and the second encoder of the telegram returns the actual position.

If you calculate actual velocity from actual speed "NIST_B" of encoder telegram 83, you must configure the following reference values:

- With rotary measuring system: Encoder reference speed "<TO>.Sensor[1..4].Parameter.ReferenceSpeed"
- With linear measuring system: Encoder reference velocity "<TO>.Sensor[1..4].Parameter.ReferenceVelocity"

When calculating the actual velocity from the actual speed "NIST_B" from drive telegrams, the reference value from the tag "<TO>.Actor.DriveParameter.ReferenceSpeed" or "<TO>.Actor.DriveParameter.ReferenceVelocity" is automatically used. You do not need to configure any additional reference values in "<TO>.Sensor[1..4]".

5.2.5 Transferring drive and encoder parameters automatically (S7-1500, S7-1500T)

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 during runtime (online)

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

- SINAMICS drives (see "compatibility list (https://support.industry.siemens.com/cs/ww/en/view/109750431)")
- Certified PROFINET encoder as of encoder profile 4.1

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 with the value of the tags "<TO>.StatusDrive.AdaptionState" = 2 and "<TO>.StatusSensor[1..4].AdaptionState" = 2 of the technology object.

Automatic transfer of parameters during configuration (offline)

If you have completed the drive configuration, e.g. with SINAMICS Startdrive, you can transfer the drive or encoder parameters offline in the technology object. The parameters are automatically transferred to the CPU before the download.

Parameters

The settings for automatic transfer can be found 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			

Setting in the TIA Portal	Controller tag in the technology data block	Drive parameter	Automatic transfer
Telegram number	Telegram input address <TO>.Actor.Interface.AddressIn Telegram output address <TO>.Actor.Interface.AddressOut	Telegram number P922	-
Motor type	<TO>.Actor.MotorType 0 Standard motor 1 Linear motor	Servo drive with "Linear motor" bit r108.12	✓
Reference speed in [rpm] (standard motor)	<TO>.Actor.DriveParameter.ReferenceSpeed	(SINAMICS drives: P2000)	✓
Maximum speed of motor in [1/min] (standard motor)	<TO>.Actor.DriveParameter.MaxSpeed	(SINAMICS drives: P1082)	✓
Reference torque in [NM] (standard motor)	<TO>.Actor.DriveParameter.ReferenceTorque	(SINAMICS drives: P2003)	✓
Reference velocity in [m/min] (linear motor)	<TO>.Actor.LinearMotorDriveParameter.ReferenceVelocity	(SINAMICS drives: P2000)	✓
Maximum velocity in [m/min) (linear motor)	<TO>.Actor.LinearMotorDriveParameter.MaxVelocity	(SINAMICS drives: P1082)	✓
Reference force in [N] (linear motor)	<TO>.Actor.LinearMotorDriveParameter.ReferenceForce	(SINAMICS drives: P2003)	✓
Encoder			
Telegram	<TO>.Sensor[1..4].Interface.AddressIn <TO>.Sensor[1..4].Interface.AddressOut	P922	-
Encoder type	<TO>.Sensor[1..4].Type 0 Incremental 1 Absolute 2 Cyclic absolute	P979[5] Encoder 1 P979[15] Encoder 2	-
Measuring system	<TO>.Sensor[1..4].System 0 Linear 1 Rotary	P979[1] Bit0 Encoder 1 P979[11] Bit0 Encoder 2	✓
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[1..4].Parameter.Resolution	P979[2] Encoder 1 P979[12] Encoder 2	✓
Increments per revolution (rotary encoder)	<TO>.Sensor[1..4].Parameter.StepsPerRevolution	P979[2] Encoder 1 P979[12] Encoder 2	✓
Number of bits for fine resolution XIST1 (cyclic actual encoder value, linear or rotary encoder)	<TO>.Sensor[1..4].Parameter.FineResolutionXist1	P979[3] Encoder 1 P979[13] Encoder 2	✓
Number of bits for fine resolution XIST2 (absolute encoder value, linear or rotary encoder)	<TO>.Sensor[1..4].Parameter.FineResolutionXist2	P979[4] Encoder 1 P979[14] Encoder 2	✓

Setting in the TIA Portal	Controller tag in the technology data block	Drive parameter	Automatic transfer
Distinguishable encoder revolutions (rotary absolute encoder)	<TO>.Sensor[1..4].Parameter.DeterminableRevolutions	P979[5] Encoder 1 P979[15] Encoder 2	✓
Encoder reference speed (rotary measuring system)	<TO>.Sensor[1..4].Parameter.ReferenceSpeed	P2000	✓
Encoder reference velocity (linear measuring system)	<TO>.Sensor[1..4].Parameter.ReferenceVelocity	P2000	✓

5.2.6 Connecting stepper motors (S7-1500, S7-1500T)

Drives with a stepper motor interface are connected using telegram 3 and with the help of PTO (Pulse Train Output) pulse generators.
Use the following modules to control the stepper motors:

- TM PTO 2x24V / TM PTO 4
- SIMATIC MICRO-Drive F-TM StepDrive S

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 motor in standstill 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.

5.2.7 Connecting drives with analog setpoint interface (S7-1500, S7-1500T)

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 CPU.

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.

Activate 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.

Reference speed with analog setpoint interface

The reference speed of the drive is the speed with which the drive spins when there is an output of 100% at the analog output. The reference speed must be configured in the drive, and transferred into 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 overridden by approximately 17%. This means that an analog output can be operated in the range from -117% to 117%, insofar as the drive permits this.

Reference velocity with analog setpoint interface

With a linear motor, the reference velocity is the velocity at which the drive moves with an output of 100% at the analog output. The reference velocity must be configured for the drive and transferred to 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 overridden by approximately 17%. This means that an analog output can be operated in the range from -117% to 117%, insofar as the drive permits this.

5.2.8 Connecting force/torque data via SIEMENS additional telegram 750 (S7-1500, S7-1500T)

With the connection of the Siemens additional telegram 750 you can use the following functions:

- Specification of an additive setpoint torque (torque precontrol) with MC_TorqueAdditive
- Setting the upper and lower torque limit with MC_TorqueRange
- Reading out the actual torque value with <DB>.StatusTorqueData.ActualTorque or ActualForce

---

NOTE

Force data for linear motors

When using a linear motor, force data is transferred via SIEMENS additional telegram 750 instead of torque data.

Activation of the additional data in the technology object

If you want to configure the data connection of the torque data, select the "Torque data" check box in TO_Axis > Configuration > Hardware interface > Drive data exchange with the drive > Additional 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 of the additional telegram in the technology object

If you select the entry "Additional telegram" in the "Data connection" drop-down list, you can edit the "Additional telegram" drop-down list.

- 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 supplemental telegrams with this function.

Connect additional telegram via data block

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_TEL750" data type.

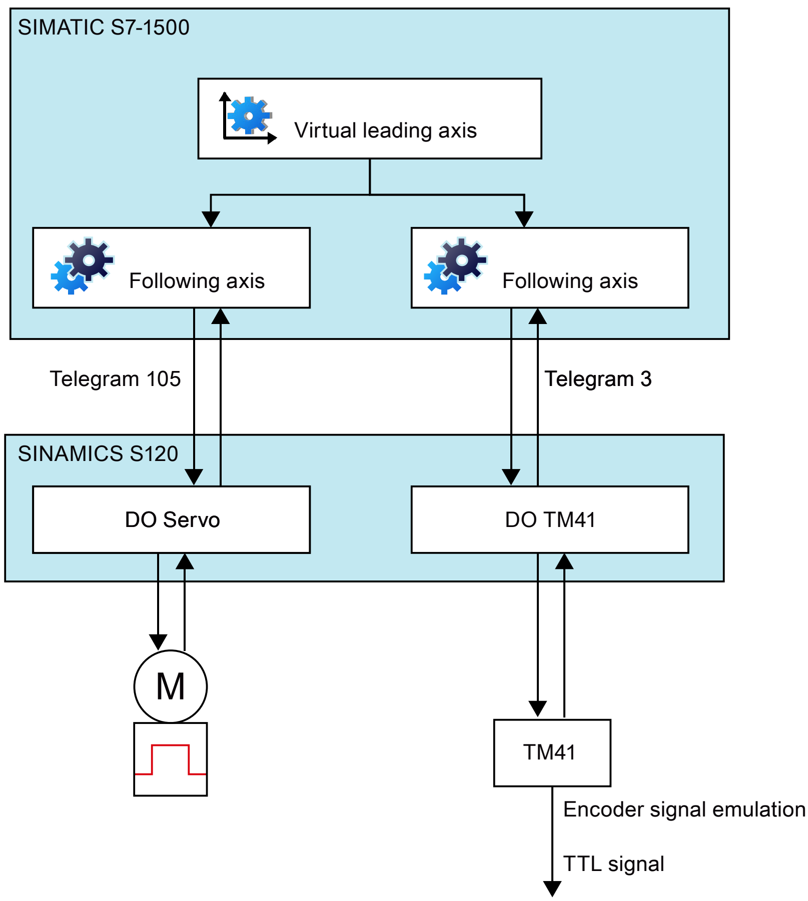
In the "Data block" field, select the data block which you want to use to integrate the torque data.

5.2.9 Encoder signal output via TM41 (S7-1500, S7-1500T)

With the TM41 you can emulate the axis position (a leading value) as encoder signal output. The output angle signal behaves like the signal of an incremental encoder. This means that you can, for example, provide a leading value as an encoder signal for an external control.

The TM41 is connected to a TO Axis via standard telegram 3. The TO can be used as an axis at the Motion FBs in the user program.

In the following figure, a real servo axis operated with DSC is controlled by a virtual axis on the SIMATIC S7-1500 and an axis with signal output is controlled via a TM41 module. The position of the servo axis is output via an encoder signal at the TM41 through the synchronous operation coupling of the two following axes. The encoder signals can be evaluated by other controllers.



Requirements for the drive

- The TM41 can only be connected to SINAMICS S120 drives.
- The value [0] must be configured in the drive for the "Selection of operating mode" (p4400).

Restrictions

Please note the following restrictions for operation of the TM41 at the technology object.

- No active homing
- No measuring via digital drive
- Backlash compensation must be deactivated.
- Following error monitoring must be deactivated.
- Position monitoring must be deactivated.
- Standstill monitoring must be deactivated.
- Hardware limit position monitoring must be deactivated.

Necessary position controller setting

- Precontrol = 100%
- Speed control loop substitute time = 0.000

Automatic transfer of parameters

Recommendation: For the TM41, the automatic transfer of parameters should always be executed online.

Proceed as follows for automatic transfer offline:

1. Commission the TM41 online.
2. Upload the drive parameters to the TIA Portal project so that the parameters in the Startdrive project are consistent with the online parameters in the drive.

Transferring drive and encoder parameters automatically (Page 61)

5.2.10 Tags: Drive and encoder connection (S7-1500, S7-1500T)

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

Drive telegram	
Tag	**Description**
<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
<TO>.Actor.LinearMotorDriveParameter.ReferenceVelocity	Reference value (100%) for the velocity setpoint of a liner motor
<TO>.Actor.LinearMotorDriveParameter.MaxVelocity	Maximum value for the velocity setpoint of a linear motor

Drive telegram	
Tag	**Description**
<TO>.Actor.LinearMotorDriveParameter.ReferenceForce	Reference force for the force of a linear motor, which is transmitted as percentage value

Encoder telegram	
Tag	**Description**
<TO>.Sensor[1..4].Interface.AddressIn	Input address for the PROFIdrive telegram
<TO>.Sensor[1..4].Interface.AddressOut	Output address for the PROFIdrive telegram
<TO>.Sensor[1..4].System	Encoder system linear or rotary
<TO>.Sensor[1..4].Type	Encoder type, incremental, absolute or cyclic absolute
<TO>.Sensor[1..4].Parameter.Resolution	Resolution for linear encoder Space between two lines
<TO>.Sensor[1..4].Parameter.StepsPerRevolution	Steps per revolution for rotary encoder
<TO>.Sensor[1..4].Parameter.DeterminableRevolutions	Number of differentiable encoder revolutions for a multi-turn absolute encoder
<TO>.Sensor[1..4].Parameter.ReferenceSpeed	Reference speed for the actual speed (NSET_B), which is transmitted as percentage value
<TO>.Sensor[1..4].Parameter.ReferenceVelocity	Reference velocity for the actual speed (NSET_B), which is transmitted as percentage value

Fine resolution	
Tag	**Description**
<TO>.Sensor[1..4].Parameter.FineResolutionXist1	Number of bits for fine resolution XIST1 (cyclic actual encoder value)
<TO>.Sensor[1..4].Parameter.FineResolutionXist2	Number of bits for fine resolution XIST2 (absolute value of encoder)

Simulation mode		
Tag	**Description**	
<TO>.Simulation.Mode	Simulation mode	
	0	No simulation, normal operation
	1	Simulation mode

5.3 Safety functions in the drive (S7-1500, S7-1500T)

In addition to programming the motion sequences, you must also reduce the risks of the machine through safety functions to ensure machine safety. The SINAMICS drive system provides integrated safety functions, hereinafter referred to as "Safety Integrated Functions".

The "Safety Integrated Functions" of the SINAMICS drive system available can be subdivided into the following functions:

- Safe stopping process
- Safe brake control
- Safe monitoring of motion
- Safe monitoring of position

More information on the "Safety Integrated Functions" in SINAMICS drives is available in the "SINAMICS S120 Safety Integrated" function manual (https://support.industry.siemens.com/cs/ww/en/view/109771806).

Interaction between the technology object and the SINAMICS "Safety Integrated Functions"

The "Safety Integrated Functions" of the SINAMICS drive system are monitoring functions for fail-safe monitoring of the drive motion. The motion of the drives is controlled via technology objects and the programmed motion control jobs in the user program of the SIMATIC S7-1500.

When using the "Safety Integrated Functions", you must evaluate the status information of the SINAMICS "Safety Integrated Functions" and program your user program depending on this status information. You can implement an interaction between the SINAMICS "Safety Integrated Functions" and the motion control in the SIMATIC S7-1500.

The technology object does not contain any information on the states of the SINAMICS "Safety Integrated Functions". Evaluate the current status of the "Safety Integrated Functions" in the drive using one of the following options.

- "Safety Info Channel" (SIC)
- Status words of the PROFIsafe telegram (read access)

If you do not use a PROFIsafe telegram, create a telegram for the SIC.

Safety Info Channel

The "Safety Info Channel" is mapped in the telegrams 700 and 701.

Status word	Status information	Telegram 700	Telegram 701
S_ZSW1B	• Safe stopping process • Safe monitoring of motion	x	x
S_ZSW2B	Safe monitoring of position	-	x
S_ZSW3B	Status information on the brake test	-	x
S_V_LIMIT_B	• Necessary velocity setpoint limiting due to the selected SINAMICS "Safety Integrated Functions". • When selecting a "Safety Integrated Function" for safe shutdown or the "Safety Integrated Function" SDI, the necessary status word S_V_LIMIT_B takes on the value 0.	x	x

The free "LDrvSafe" library contains function blocks and a description for easy evaluation of the "Safety Info Channel" in your user program.
LDrvSafe (https://support.industry.siemens.com/cs/ww/en/view/109485794)

PROFIsafe telegram

When you control the SINAMICS "Safety Integrated Functions" via PROFIsafe, you have read access from the standard user program to the PROFIsafe status words.

With this information you can react with a Motion Control Instruction suitable for your machine when a "Safety Integrated Function" is triggered in the user program.

5.3.1 Safe stopping process (S7-1500, S7-1500T)

SINAMICS "Safety Integrated Functions" with drive-autonomous stop reaction

The "Safety Integrated Function" STO triggers a drive-autonomous stop reaction and the drive coasts down (OFF2). The technology object signals the technology alarm 421 (alarm response: remove enable).

The following "Safety Integrated Functions" trigger a drive-autonomous stop reaction and the drive decelerates at the OFF3 ramp.

- SS1
- SS2

The result is that the drive performs a motion that was not specified by the technology object. The technology object signals the technology alarm 550 (alarm response: follow up setpoints). Have the technology object enabled ("MC_Power.Enable" = TRUE) so that the drive-autonomous braking process is not interrupted.

Example - Pressing an emergency stop control device

Example:

After pressing the emergency stop button, all drives of the machine must be brought to a standstill as quickly as possible. Standstill drives must not accelerate unintentionally.

Solution:

To this end, the "Safety Integrated Function" SS1 is selected in the SINAMICS drive system and each selected drive is independently braked electrically until it is at standstill.

Enabling the technology object after a drive-autonomous stop reaction:

To enable the technology object again after triggering a drive-autonomous stop reaction, follow these steps:

1. Verify in the "Safety Info Channel" SIC, whether STO, SS1 or SS2 was triggered.
2. Eliminate the cause of the triggered "Safety-Integrated Function", for example, by unlocking the emergency stop button.
3. Safely acknowledge the pending safety messages in the drive.
4. Wait until STO, SS1 and SS2 are no longer active.
5. Acknowledge the technology alarms 421 and 550 with an "MC_Reset" job.

Drive-autonomous stop reaction with coupled axes

> **NOTICE**
>
> **Machine damage caused by loss of synchronous operation coupling after drive-autonomous stop reaction**
>
> For axes coupled by synchronous operation, a drive-autonomous stop reaction causes each axis to decelerate individually along its own OFF3 ramp. This means that the axes are no longer coupled after SS1 or SS2. This can damage the mechanical components or the workpiece.
>
> If permitted by the risk assessment, use the following "Safety Integrated Functions":
>
> - SS1E instead of SS1
> - SS2E or SOS instead of SS2

When triggering SS1E, no drive-autonomous deceleration is started but a safe delay time is started instead. Motion control still takes place within the safe delay time from the user program of the SIMATIC S7-1500. You must set the axis group to a standstill within the delay time. To do so, stop the leading axis of the synchronous operation, for example, with an "MC_Halt" job to safely stop the entire axis group within the safe delay time. When the safe delay time expires, STO automatically takes effect.
The same behavior applies to SS2E and SOS.

5.3.2 Safe brake control (S7-1500, S7-1500T)

The drive-based function "Safe Brake Test" (SBT) is a diagnostic function and checks the required holding torque of a brake (operating or holding brake). After starting the brake test, the drive purposely generates a torque against the applied brake.
The brake test in combination with technology objects is usually controlled via the "Safety Control Channel".
The free "LDrvSafe" library provides you with function blocks and a description for easy control of the "Safety Control Channel" and to use the safe brake test.
LDrvSafe (https://support.industry.siemens.com/cs/ww/en/view/109485794)

5.3.3 Safe monitoring of motion (S7-1500, S7-1500T)

When you select the motion monitoring "Safety Integrated Functions" of the SINAMICS drive system, you must limit the speed and/or the acceleration of the axis to maintain the availability of the machine.
You have the following options to limit the velocity and the acceleration.

- Adapting the dynamic limits at the technology object
  - <TO>.DynamicLimits.Velocity
  - <TO>.DynamicLimits.Acceleration
- Limiting the dynamic parameters at the Motion Control instructions
- Limiting the velocity through the override "<TO>.Velocity.Override"

SLS

In SINAMICS, the necessary setpoint speed limiting is configured as follows:

S_V_LIMIT_B (r9733) = Selected SLS limit value (p9531) * evaluation factor (p9533
The setpoint speed limiting "S_V_LIMIT_B" is specified on the motor side in SINAMICS and calculated from the SLS limit value configured on the load side.

Parameter	Limit value	Unit
S_V_LIMIT_B (r9733)	Motor-side limit value	• Standard motor: 1/min • Linear motor: m/min
SLS limit value (p9531)	Load side limit value taking into account the mechanical parameters in SINAMICS	• Safety rotary axis: 1/min • Safety linear axis: mm/min

To recognize the necessary setpoint speed limiting after selection of SLS, evaluate the tag "S_V_LIMIT_B" from the "Safety Info Channel". "S_V_LIMIT_B" is transmitted in the SIC normalized via the parameter p2000. The parameter p2000 is saved in the tag "<TO>.Actor.DriveParameter.ReferenceSpeed" of the technology object.
To convert "S_V_LIMIT_B" into the maximum velocity setpoint (v_{max}) of the technology object, use the following formula for the following units of measurement.

- Linear axis with standard motor:

$$v_{max}\left[\frac{mm}{s}\right] = \frac{\text{S\_V\_LIMIT\_B}}{\text{16\#40000000}} \cdot \text{<TO>.Actor.DriveParameter.ReferenceSpeed}\left[\frac{1}{min}\right] \cdot \frac{1}{60}\left[\frac{min}{s}\right]$$

$$\cdot\ \text{<TO>.Mechanics.LeadScrew}\ [mm] \cdot \frac{\text{<TO>.LoadGear.Denominator}}{\text{<TO>.LoadGear.Numerator}}$$

- Linear axis with linear motor:

$$v_{max}\left[\frac{mm}{s}\right] = \frac{\text{S\_V\_LIMIT\_B}}{\text{16\#40000000}} \cdot \text{<TO>.Actor.DriveParameter.ReferenceSpeed}\left[\frac{m}{min}\right]$$

$$\cdot \frac{1000}{1}\left[\frac{mm}{m}\right] \cdot \frac{1}{60}\left[\frac{min}{s}\right]$$

- Rotary axis with standard motor:

$$v_{max}\left[\frac{^\circ}{s}\right] = \frac{\text{S\_V\_LIMIT\_B}}{\text{16\#40000000}} \cdot \text{<TO>.Actor.DriveParameter.ReferenceSpeed}\left[\frac{1}{min}\right] \cdot \frac{1}{60}\left[\frac{min}{s}\right]$$

$$\cdot\ 360[^\circ] \cdot \frac{\text{<TO>.LoadGear.Denominator}}{\text{<TO>.LoadGear.Numerator}}$$

Alternatively, especially when using fewer SLS levels, you can define the necessary setpoint speed limiting yourself and save it permanently in a data block. See the procedure for SLA as a reference.

Example - Opening a protective door in setup mode

Example:

The machine operator must be able to enter the danger zone of a machine after the protective door has been opened and slowly move a horizontal conveyor in it with an acknowledgment button. The actual velocity of 250 mm/s must not be exceeded in this process.

The horizontal conveyor is implemented using the following technology:

- Technology object Positioning axis as linear axis in the SIMATIC S7-1500
- Safety linear axis axes with standard motor in SINAMICS

Solution:

Select the "Safety Integrated Function" SLS with the limit value 15000 mm/min (is equivalent to 250 mm/s) in SINAMICS. If the actual velocity (intentionally or unintentionally) exceeds the limit value of 250 mm/s, a drive-autonomous, user-defined stop reaction, such as SS1, is triggered.

1. In SINAMICS, you make the following parameter assignment for the drive:
   - SLS limit value Level 1 (p9531) = 15000 mm/min = 250 mm/s
   - Evaluation factor (p9533) = 80%

   Result: The parameter assignment results in the following value for the setpoint speed limiting: 250 mm/s * 0.8 = 200 mm/s

   In this example, this means that the velocity setpoint of the horizontal conveyor is 200 mm/s before the "Safety Integrated Function" SLS Level 1 with the actual speed limit value of 250 mm/s is active.
2. Evaluate the setpoint speed limiting from "S_V_LIMIT_B" in the SIC and convert the standardized value into the velocity value with the configured unit of measurement of the technology object.

   Alternatively, especially when using fewer SLS levels, you can save the setpoint speed limiting of 200 mm/s directly in a data block.
3. Evaluate "S_ZSW1B.Bit6" from SIC (SLS selected) cyclically in the user program. If SLS is selected ("S_ZSW1B.Bit6" = TRUE), execute step 4.
4. Specify the setpoint speed limiting of 200 mm/s as dynamic limitation "<TO>.DynamicLimits.Velocity" at the technology object and limit the setpoint velocity "Velocity" at the Motion Control instructions of the technology object. Alternatively, you can also reduce the setpoint velocity via the override "<TO>.Velocity.Override".

SLA

For SLA, the necessary setpoint speed limiting is not calculated by the drive system but must be calculated by the user instead. In this case, you must calculate the necessary setpoint speed limiting yourself and save it in the SIMATIC S7-1500, for example, in a data block. When selecting SLA, you limit the acceleration to this specific value.

SDI

You can recognize a corresponding direction of rotation limitation via the signals SDI negative/SDI positive. If the axis is currently moving in the direction that is no longer permissible after the delay time has expired, you stop or change the motion direction of the axis before the drive performs a drive-autonomous stop reaction.

5.3.4 Safe monitoring of position (S7-1500, S7-1500T)

When you select the position monitoring "Safety Integrated Functions" of the SINAMICS drive system, you must limit the position area of the axis to maintain the availability of the machine.

To recognize the permissible position area after selecting SLP, you calculate and save it in the SIMATIC S7-1500, for example, in a data block. When selecting SLP, you limit the setpoint positions of the technology object at the Motion Control instructions to this position area.

5.3.5 Overview of safety-oriented functions (S7-1500, S7-1500T)

Below you will find a description of the drive response and which corresponding user reactions you have to program in the SIMATIC user program.

Function	SIC STW	SIC Bit	Drive response		Recommended reaction in the user program
Safe stopping process					
STO	S_ZSW1-B	0	1	Drive switches off immediately (OFF2).	"MC_Power" can remain enabled (waiting).
			0	STO not active	None
SS1	S_ZSW1-B	1	1	Drive decelerates autonomously along the OFF3 ramp and then switches off (OFF2).	"MC_Power" remains enabled until STO
			0	SS1 not active	None
SS1E	S_ZSW1-B	1	1	Drive switches off after delay time has expired (OFF2).	Stop axis before delay time elapses, e.g. with "MC_Halt", and then switch off the drive with "MC_Power.Enable" = FALSE
			0	SS1E not active	None
SS2	S_ZSW1-B	2	1	Drive decelerates along OFF3 ramp and then monitors the standstill.	"MC_Power" remains enabled
			0	SS2 not active	None
SS2E	S_ZSW3-B	11	1	Drive monitors the standstill after delay time has expired.	Stop axis before delay time elapses with "MC_Halt" and hold drive in control with "MC_Power.Enable" = TRUE
			0	SS2E not active	None
SOS	S_ZSW1-B	3	1	Drive monitors the standstill after delay time has expired	Stop axis before delay time elapses with "MC_Stop" and hold drive in control with "MC_Power.Enable" = TRUE
			0	SOS not active	None
Safe brake control					
SBC	-	-	Drive switches off immediately (OFF2) and safely controls the outputs for the brake.		None
SBT	S_ZSW_-3	0..15	Drive is brought to a standstill and remains in control. Then, a drive-autonomous torque is generated against the applied brake.		Stop axis before selecting SBT, e.g. with "MC_Halt" and hold drive in control with "MC_Power.Enable" = TRUE
Safe monitoring of motion					
SLS	S_ZSW1-B	4	1	Drive monitors a maximum permissible velocity.	Limit the axis velocity
			0	SLS not active	None
		6	1	After expiration of a delay time, drive monitors a maximum permissible velocity.	Limit axis velocity within the delay time
			0	SLS deselected	None

Function	SIC STW	SIC Bit	Drive response		Recommended reaction in the user program
SSM	-	-	Drive transfers signal to the F-CPU whether the current velocity is below a defined velocity.		Reach positive velocity of the axis within the delay time and maintain or stop axis with "MC_Halt".
SDI	S_ZSW1-B	12	1	After expiration of a delay time, drive monitors the positive motion direction.	Reach positive velocity of the axis within the delay time and maintain or stop axis with "MC_Halt"
			0	SDI positive deselected	None
		13	1	After expiration of a delay time, drive monitors the negative motion direction.	Reach negative velocity of the axis within the delay time and maintain or stop axis with "MC_Halt"
			0	SDI negative deselected	None
Safe monitoring of position					
SLP	S_ZSW2-B	4	1	SLP area 2 selected	None
			0	SLP area 2 selected	None
		7	1	After expiration of delay time, drive monitors adherence to a defined position area.	Maintain position area of the axis according to the selected SLP area
			0	SLP not selected or no user approval	None
SP	-	-	Drive transfers actual position to the F-CPU.		None
SCA	-	-	Drive transfers safe cam information to the F-CPU.		None

5.4 Mechanics (S7-1500, S7-1500T)

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

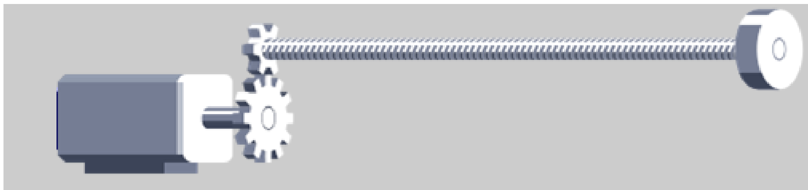
Examples of units of angle: °, rad

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

5.4.1 Configuring the mechanics of the speed axis (S7-1500, S7-1500T)

In the mechanics of the speed axis technology object, you configure how the load side is connected mechanically to the drive.

Configuring the mechanics of a speed axis technology object is necessary for the correct display and processing of the technology object speed.



Configure the following parameters:

- Invert drive direction
- Load gear (Page 85)

Inverting the drive direction of the speed axis

By default, the technology object controls the drive with positive speed if the axis is to be moved in the positive direction. Invert the drive direction if the axis travels in positive direction at negative speed due to the mechanical design.

To invert the drive direction of the speed axis, follow these steps:

1. In the configuration of the technology object, navigate to "Extended parameters > Mechanics > Drive mechanism"
2. Select the "Invert drive direction" check box.

5.4.2 Configuring the mechanics of the positioning axis/synchronous axis (S7-1500, S7-1500T)

Configuring the mechanics of an axis technology object is necessary for the correct display and processing of the technology object position. The options for configuring the mechanics depend on the following configurations:

- "Axis type" under "Basic parameters"
- "Encoder mounting type" under "Extended parameters > Mechanics > Encoder"
- "Measuring system" under "Hardware interface > Data exchange with encoder > Encoder data"

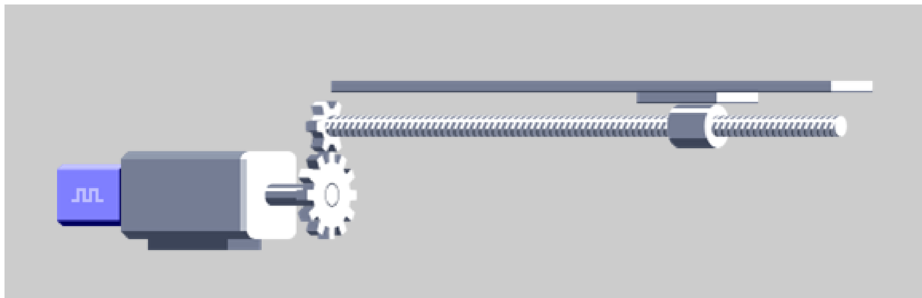
Select encoder (S7-1500T)

With an S7-1500T, you can configure the mechanics of a positioning axis/synchronous axis for up to four encoders.

Select the encoder to be configured from the drop-down list under "Settings for". You can configure the encoders independently of each other.

"Linear" axis type with standard motor, encoder mounting type encoder on motor shaft

The encoder is connected to the motor shaft in a mechanically fixed manner. Motor and encoder form a unit.

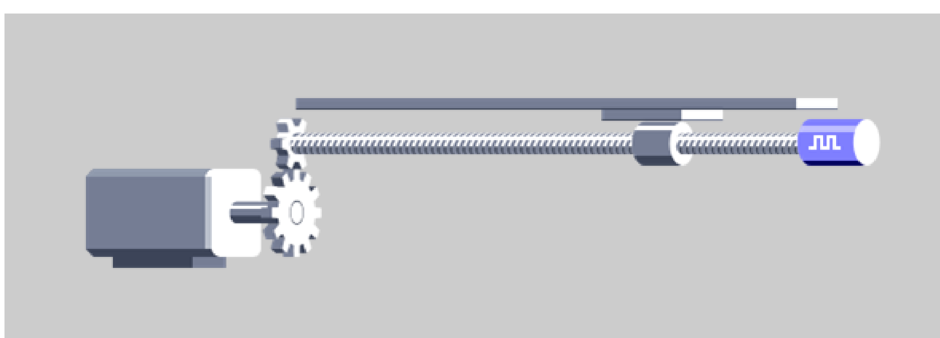


To configure the mechanics for this constellation of axis type and encoder mounting type, follow these steps:

1. Check that the axis type is configured as linear and "Standard motor" under Basic parameters.
2. Under "Extended parameters > Mechanics > Encoder", select the "On motor shaft" encoder mounting type.
3. Configure the following parameters:
   – Drive and encoder direction for positioning axis/synchronous axis (Page 83)
   – Backlash compensation (Page 86)
   – Load gear (Page 85)
   – Leadscrew pitch (Page 85)

Linear axis type with standard motor, encoder mounting type encoder on load side, measuring system rotary

The encoder is mechanically connected to the load side of the gear.



To configure the mechanics for this constellation of axis type and encoder mounting type, follow these steps:

1. Check that the axis type is configured as linear and standard motor under Basic parameters.
2. Under "Extended parameters > Mechanics > Encoder", select the "On load side" encoder mounting type.
3. Configure the following parameters:
   – Drive and encoder direction for positioning axis/synchronous axis (Page 83)
   – Load gear (Page 85)
   – Leadscrew pitch (Page 85)

Linear axis type with standard motor, encoder mounting type on load side, measuring system linear

The encoder is mechanically connected to the load side of the gear.

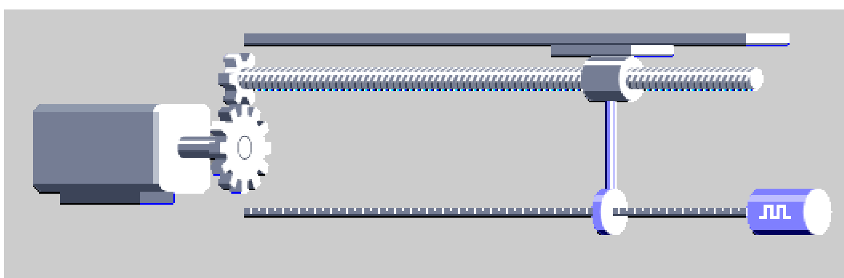


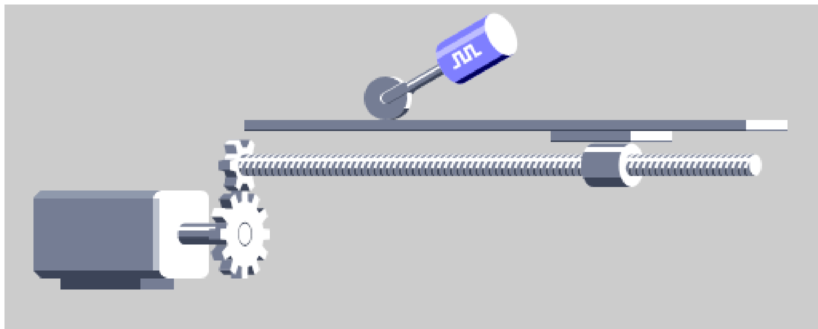
Figure 5-1 Encoder mounting type load side linear axis, measuring system linear

To configure the mechanics for this constellation of axis type and encoder mounting type, follow these steps:

1. Check that the axis type is configured as linear and standard motor under Basic parameters.
2. Under "Extended parameters > Mechanics > Encoder", select the "On load side" encoder mounting type.
3. Configure the following parameters:
   – Drive and encoder direction for positioning axis/synchronous axis (Page 83)
   – Load gear (Page 85)
   – Leadscrew pitch (Page 85)

Linear axis type with standard motor, encoder mounting type external measuring system

An external measuring system provides the position values of the linear load motion.

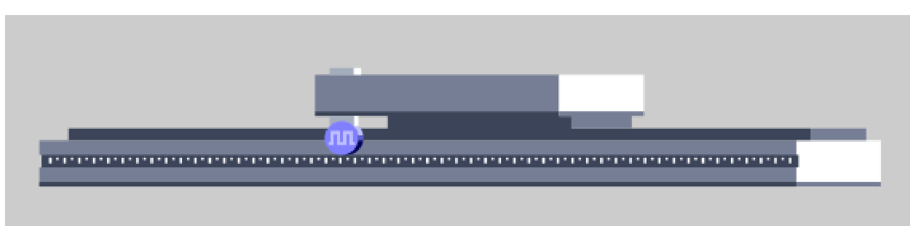


To configure the mechanics for this constellation of axis type and encoder mounting type, follow these steps:

1. Check that the axis type is configured as linear and standard motor under Basic parameters.
2. Under "Extended parameters > Mechanics > Encoder", select the "External measuring system" encoder mounting type.
3. Configure the linear load travel per encoder revolution under "Distance per encoder revolution".
4. Configure the following parameters:
   – Drive and encoder direction for positioning axis/synchronous axis (Page 83)
   – Load gear (Page 85)
   – Leadscrew pitch (Page 85)

Linear axis type with linear motor, encoder mounting type external measuring system, measuring system rotary

An external measuring system provides the position values of the linear load motion.

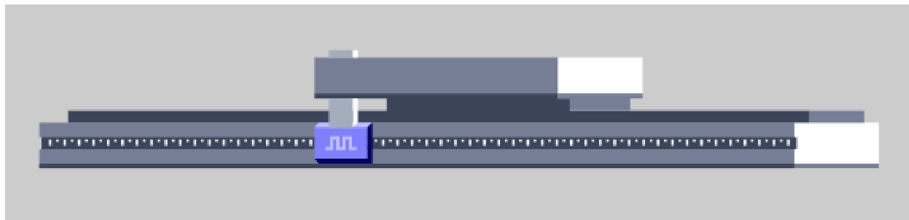


To configure the mechanics for this constellation of axis type and encoder mounting type, follow these steps:

1. Check that the axis type is configured as linear and linear motor under Basic parameters.
   With this constellation, "External measuring system" is automatically set permanently as encoder mounting type under "Extended parameters > Mechanics > Encoder".
2. Configure the linear load travel per encoder revolution under "Distance per encoder revolution".
3. Configure the following parameters:
   – Drive and encoder direction for positioning axis/synchronous axis (Page 83)

Linear axis type with linear motor, encoder mounting type encoder on motor shaft, measuring system linear

An external measuring system provides the position values of the linear load motion.

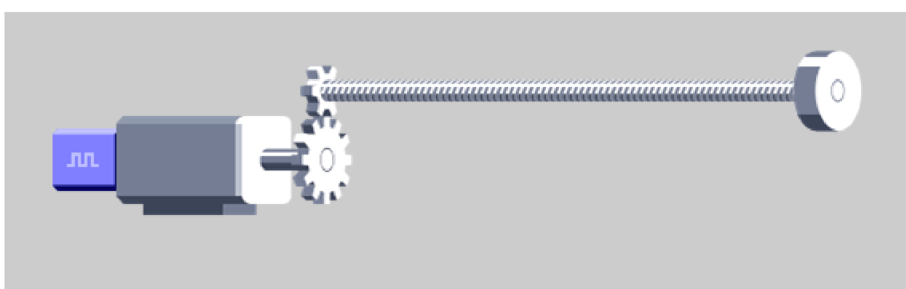


To configure the mechanics for this constellation of axis type and encoder mounting type, follow these steps:

1. Check that the axis type is configured as linear and linear motor under Basic parameters.
   With this constellation, "On motor shaft" is automatically set permanently as encoder mounting type under "Extended parameters > Mechanics > Encoder".
2. Configure the following parameters:
   – Drive and encoder direction for positioning axis/synchronous axis (Page 83)

Rotary axis type with standard motor, encoder mounting type encoder on motor shaft

The encoder is connected to the motor shaft in a mechanically fixed manner. Motor and encoder form a unit.

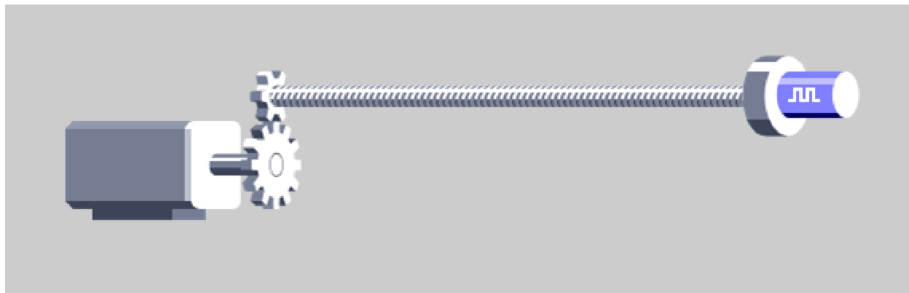


To configure the mechanics for this constellation of axis type and encoder mounting type, follow these steps:

1. Check that the axis type is configured as rotary and standard motor under Basic parameters.
2. Under "Extended parameters > Mechanics > Encoder", select the "On motor shaft" encoder mounting type.
3. Configure the following parameters:
   – Drive and encoder direction for positioning axis/synchronous axis (Page 83)
   – Backlash compensation (Page 86)
   – Load gear (Page 85)

Rotary axis type with standard motor, encoder mounting type encoder on load side

The encoder is mechanically connected to the load side of the gear.

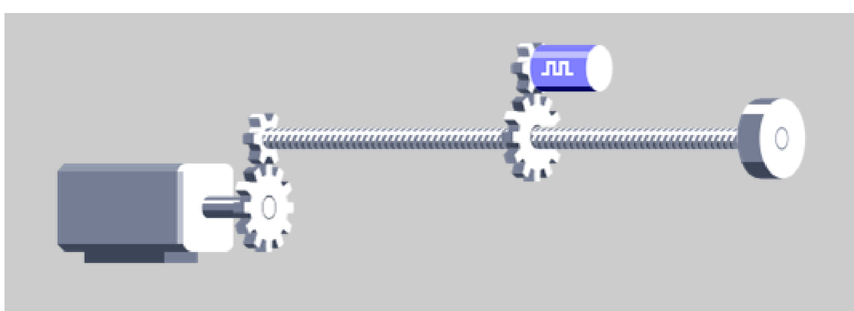


To configure the mechanics for this constellation of axis type and encoder mounting type, follow these steps:

1. Check that the axis type is configured as rotary and standard motor under Basic parameters.
2. Under "Extended parameters > Mechanics > Encoder", select the "On load side" encoder mounting type.
3. Configure the following parameters:
   – Drive and encoder direction for positioning axis/synchronous axis (Page 83)
   – Load gear (Page 85)

Rotary axis type with standard motor, encoder mounting type external measuring system

An external measuring system provides the position values of the rotary load motion.



To configure the mechanics for this constellation of axis type and encoder mounting type, follow these steps:

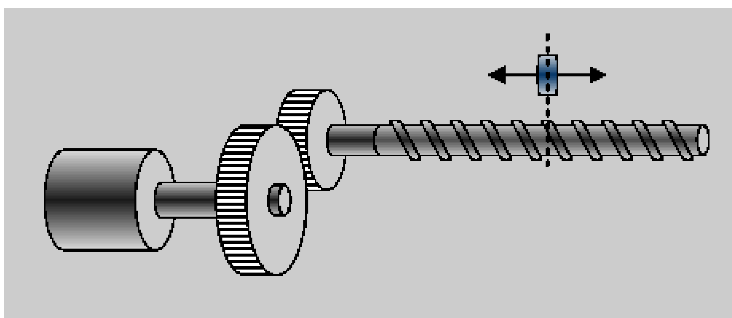
1. Check that the axis type is configured as rotary and standard motor under Basic parameters.
2. Under "Extended parameters > Mechanics > Encoder", select the "External measuring system" encoder mounting type.
3. Configure the rotary load travel per encoder revolution under "Distance per encoder revolution".
4. Configure the following parameters:
   – Drive and encoder direction for positioning axis/synchronous axis (Page 83)
   – Load gear (Page 85)

5.4.3 Configuring the mechanics of the external encoder (S7-1500, S7-1500T)

In the mechanics of the external encoder technology object, you configure how the external encoder is connected mechanically to an axis.
Configuring the mechanics of an external encoder technology object is necessary for the correct display and processing of the technology object position. The options for configuring the mechanics depend on the following configurations:

- "External encoder type" under "Basic parameters"
- "Measuring system" under "Hardware interface > Data exchange with encoder > Encoder data"

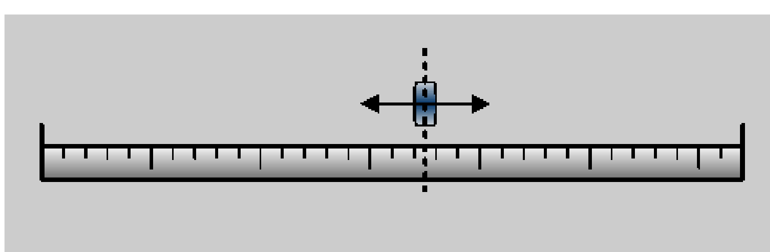
Linear type, measuring system rotary



Configure the following parameters:

- Invert encoder direction
- Load gear (Page 85)
- Leadscrew pitch (Page 85)

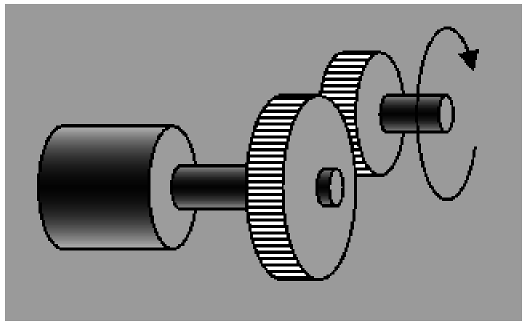
Linear type, measuring system linear



Configure the following parameters:

- Invert encoder direction
- In the "Distance between increments" field, configure the distance between the increments of the linear encoder.

Rotary type



Configure the following parameters:

- Invert encoder direction
- Load gear (Page 85)

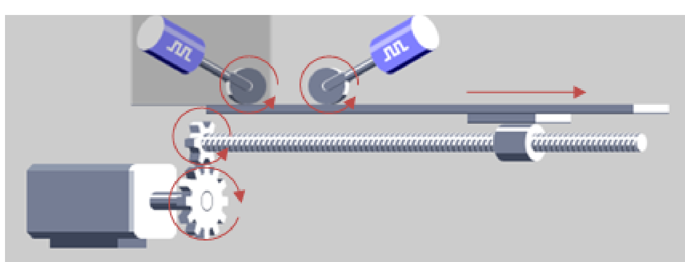
Inverting the encoder direction for external encoder

To invert the encoder direction for an external encoder, follow these steps:

1. In the configuration of the technology object, navigate to "Extended parameters > Mechanics > Encoder"
2. Select the "Invert encoder direction" check box.

Example: Inverting the encoder direction for an external encoder

In the following example, an external encoder with two different installation directions is shown. If the encoder rotates in the counter-clockwise direction or counts in the negative direction when the axis travels in the positive direction, you need to invert the encoder direction.



To check the direction of rotation, you can monitor the "Gx_XIst1" value from the PROFIdrive telegram in a trace.

Rotate the encoder shaft as it rotates when the axis travels in the positive direction:

- Value "Gx_XIst1" decreases: The encoder counts in the negative direction. Invert the encoder direction.
- Value "Gx_XIst1" increases: The encoder counts in the positive direction, no inversion necessary.

5.4.4 Configuring drive and encoder direction for positioning axis/synchronous axis (S7-1500, S7-1500T)

For the speed axis and positioning axis/synchronous axis technology objects, you can invert the drive and encoder direction.

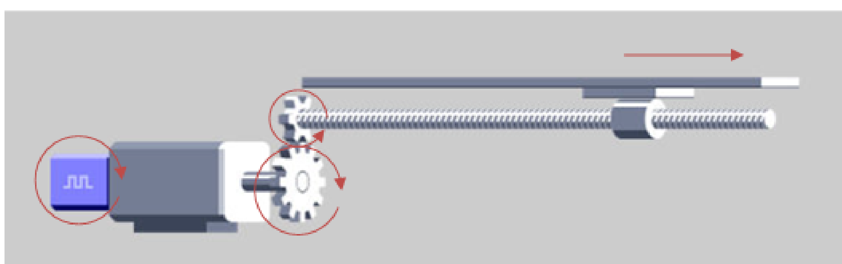
Configuring drive and encoder direction on a positioning axis

By default, the technology object controls the drive with positive speed if the axis is to be moved in the positive direction. Invert the drive direction if the axis travels in positive direction at negative speed due to the mechanical design.

By default, an increasing actual encoder value is evaluated as positive direction of movement of the axis. Invert the encoder direction if the actual encoder value decreases when the axis travels in the positive direction.

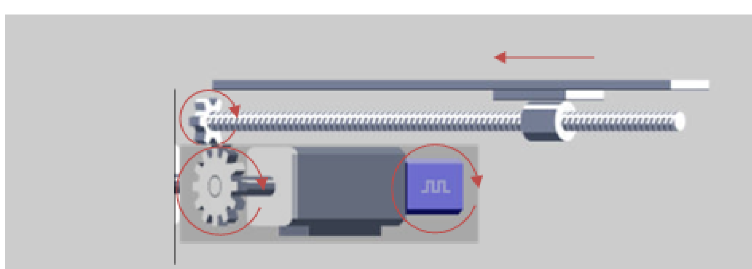
With SINAMICS drives, the direction of the drive and the direction of the motor encoder are identical by default. If the axis travels in the positive direction at positive speeds, you do not need to invert either the drive direction or the encoder direction.

In the following figure, the drive direction, encoder direction and the real mechanical direction of movement are positive. This arrangement does not require inversion.



Invert the drive direction and the encoder direction if the axis travels in the mechanically negative direction with positive motor speed and increasing encoder increments.

An example of this is the linear axis in the following figure, which travels in the negative direction with positive speed.



Through the inversion of the drive direction and the encoder direction, the motor travels with negative speed in the case of positively specified velocity, which results in movement in the correct direction. You also need to invert the encoder direction, because the motor encoder direction corresponds to the drive direction.

Invert drive direction

To invert the drive direction, follow these steps:

1. In the configuration of the technology object, navigate to "Extended parameters > Mechanics > Drive mechanism"
2. Select the "Invert drive direction" check box.

Invert encoder direction

To invert the encoder direction, follow these steps:

1. In the configuration of the technology object, navigate to "Extended parameters > Mechanics > Encoder"
2. Select the "Invert encoder direction" check box.

5.4.5 Configuring the load gear (S7-1500, S7-1500T)

If you use a load gear between motor shaft and load side, you need to configure the load gear at the technology object.
The gear ratio of the load gear is specified as the ratio between motor revolutions and load revolutions.
You can configure the load gear for the following technology objects:

- Speed axis
- Positioning axis/synchronous axis
- External encoder

Procedure

To configure the load gear, follow these steps:

1. In the configuration of the technology object, navigate to "Extended parameters > Mechanics > Drive mechanism > Load gear"
2. In the "Number of motor revolutions" configuration field, configure the integer number of motor revolutions.
3. In the "Number of load revolutions" configuration field, configure the integer number of load revolutions.

5.4.6 Configuring the leadscrew pitch (S7-1500, S7-1500T)

The leadscrew pitch indicates the distance by which the load is moved when the leadscrew makes one revolution.
You can configure the leadscrew pitch for the following technology objects:

- Positioning axis/synchronous axis
- External encoder

Example

Movement of the load [mm] = Leadscrew pitch * number of motor revolutions * (load gear denominator / load gear numerator)
Load gear denominator = 2

Load gear numerator = 1
Leadscrew pitch = 10 mm / load revolution
Motor revolutions = 50
1000 mm = 10 [mm/rot] * 50 [rot] * 2

Procedure

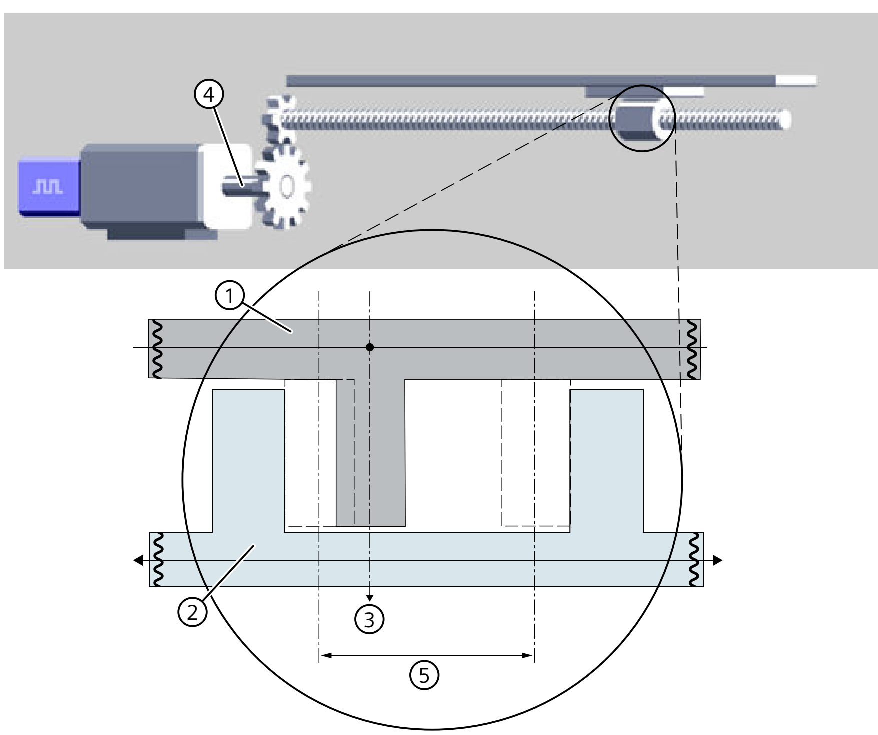
To configure the leadscrew pitch, follow these steps:

1. In the configuration of the technology object, navigate to "Extended parameters > Mechanics > Drive mechanism > Position parameters"
2. Enter the leadscrew pitch for the technology object in unit of measurement for position of the technology object per revolution in the "Leadscrew pitch" configuration field.

5.4.7 Backlash compensation (S7-1500, S7-1500T)

What is the backlash?

Backlash (also called play, mechanical play) is the distance or the angle that a motor must travel through when the direction of rotation reverses until the axis actually moves in the other direction.
The backlash of an axis is made up of the backlash of the gearbox and spindle.
The following figure shows the backlash on the spindle of a linear axis.



① Load side
② Drive side
③ Axis position
④ Motor position
⑤ Size of backlashes

An encoder with mounting type "on motor shaft" records the motor position. The technology object calculates the axis position from the motor position, taking the mechanics (gear unit, leadscrew pitch) into account.

If there is a backlash on the axis, then this backlash is traversed during a reversing motion at the reversal point. While the backlash is being traversed, the real mechanical position of axis does not change, but the motor position changes. Without backlash compensation, the technology object calculates a faulty axis position from the motor position, which means that the axis is not moved to the correct axis position during a reversing motion job.

Backlash compensation

If you enable backlash compensation for the motor encoder, the backlash is taken into account when calculating the axis position. The axis is always moved to the correct axis position even with a reversing motion job.

Setpoint operation

The setpoint mode is the standard mode of the axis in which motion jobs are accepted and executed.

When the direction of the position setpoint is reversed, the technology object automatically compensates for the backlash. When the motion job starts with a direction reversal, the actual position value of the technology object is adapted. The following settings are relevant for calculating the actual position value:

- Size of backlashes
- Velocity of backlash compensation

The resulting following error is compensated by the position controller and the backlash is traversed. The traversing of the backlash is therefore also dependent on the position controller gain (kv factor).

Follow-up mode

In follow-up mode the setpoint is followed up to the actual value. Actual position and actual velocity are updated. This means that it is possible to track when the axis is moved by external influence. Motion jobs are not executed.

Backlash compensation is required in follow-up mode if an axis is moved on the load side with a direction reversal. The same compensation model is used in follow-up mode as in setpoint mode. After the direction reversal of the actual encoder value has been recognized, the actual position value of the technology object is only coupled when the complete size of backlashes has been traversed.

Requirements

- Technology objects (V6.0 or higher)
  - Positioning axis
  - Synchronous axis
- Encoder mounting type: On motor shaft
  Backlash compensation is not relevant for a load-side encoder and external measuring systems. A load-side encoder records the axis position directly. After a direction reversal, the backlash on the load-side encoder is traversed using the position control.

NOTE

Excessive velocity if the backlash is too large

Do not set the backlashes larger than as the real existing backlashes. With direction reversal, note that the actual position value is adapted according to the set velocity of backlash compensation and the size of backlashes. A higher velocity of backlash compensation shortens the compensation time. The resulting control difference is output via the position controller.

Enable backlash compensation

To activate backlash compensation for an axis, proceed as follows:

1. In the configuration of the Axis technology object, navigate to "Extended parameters"> "Mechanics".
2. Select the "Enable backlash compensation" check box.

In case of axes with multiple encoders, you must activate backlash compensation for each encoder individually.

Backlash compensation settings

In the configuration of the technology object, set the following values for backlash compensation:

- Size of backlashes
- Velocity of backlash compensation. At 0.0, the actual value is modified in a servo cycle.
- Absolute homing direction (relevant for absolute encoders)

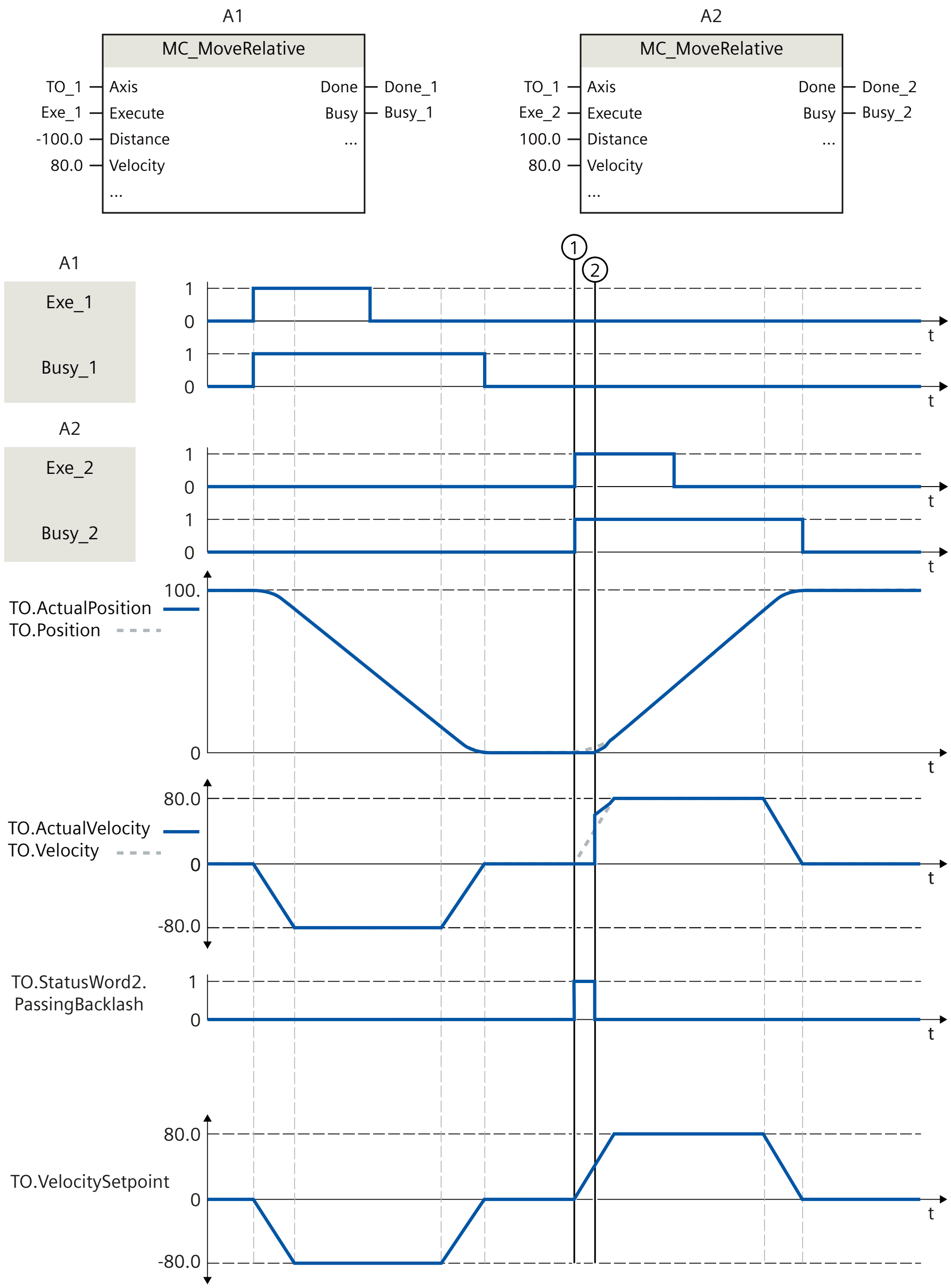
You have the option of changing the settings for the backlash compensation directly during runtime without restarting the technology object. Change the value of the tags in the technology object "<TO>.Sensor[1..4].Backlash".

After changing the settings for backlash compensation, you have to home the axis again.

You can find more detailed information on the tags of the technology objects in the section "Appendix (Page 346)".

Backlash compensation function chart

The function chart shows how the backlash compensation affects the movement of an axis when the direction changes.



① The reversing motion job "MC_MoveRelative" is triggered. The actual motor value is modified by the backlash and the axis traverses the backlash via the position controller.

The "<TO>.StatusWord2.PassingBacklash" bit is set.

② The backlash is run through completely.

The "<TO>.StatusWord2.PassingBacklash" bit is reset.

② The axis position "<TO>.ActualPosition" is adjusted to the position setpoint "<TO>.Position" via the position control.

Homing when backlash compensation is enabled

Incremental encoder

- Direct homing "MC_Home" with "Mode" = 0.1
  Always move the axis in the same direction before or during direct homing. If you move the axis in another direction during direct homing, then the axis position is incorrect by the amount of the backlash.
- Passive and active homing "MC_Home" with "Mode" = 2,3,5,8,10
  Always move the axis in the same direction to the home position. Select either "positive" or "negative" as homing direction.

NOTE

Before reaching the homing mark, the backlash must have traversed completely in the homing direction.

Absolute encoder

- "MC_Home" absolute encoder adjustment with "Mode" = 6.7
  So that the actual encoder value can be clearly assigned to an axis position for an absolute encoder, the position of the backlash must also be taken into account when setting the absolute value offset during absolute encoder adjustment. The position of the backlash results from the direction of travel of the axis during or before the absolute encoder adjustment. Configure the direction of travel of axis using the "Absolute homing direction" parameter. After the controller is switched on again, the axis traverses the backlash if the first traversing motion is in the opposite direction to the absolute homing direction.
  If the absolute encoder adjustment has already been carried out, the axis position will only be displayed correctly after the controller has been switched off and on again if the position of the backlash at the time of switch-on corresponds to the position of the backlash of the axis position when the absolute encoder offset was set. Otherwise the axis position can deviate from the axis position displayed up to a maximum of the size of the backlash. The controller records the actual encoder value at the switch-on time, but cannot infer the position of the backlash without traversing the axis. After the axis has been traversed for the first time by at least the size of backlashes, the technology object again shows the real mechanical position.

Reversal of direction for non-homed axes

The backlash compensation when the direction is reversed is independent of the "Homed" status. In the first motion of the non-homed axis, the backlash compensation is not active. After the axis has completely passed through the backlash in one direction, the backlash compensation becomes active when the axis travels in the opposite direction.

What do you need to note in axes with multiple encoders?

- If the effective encoder is a load-side encoder, then the backlash is implicitly controlled via the position control.
- The position of the motor encoder is followed up accordingly during operation with the load-side encoder as an effective encoder and the backlash is taken into account.
- Switch from a load-side encoder to the motor encoder with "MC_SetSensor" with "Mode" = 0:
  - The backlash must be completely run through once in order that you can set the position of the motor encoder to the same as that of the encoder on the load side.
  - The homing status of the axis is maintained. A new homing is not required on the motor encoder.
- Switch the motor encoder to a load-side encoder with "MC_SetSensor" with "Mode" = 0:
  - The backlash must be completely run through once in order that you can match the position of the load-side encoder to the position of the motor encoder.

How large is the backlash?

The following basic options are available to determine the size of backlashes:

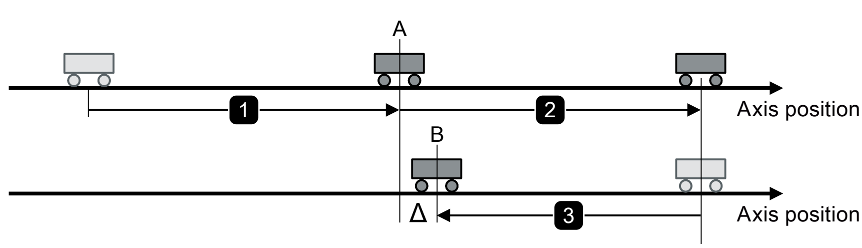
- Read the backlash from the data sheet, e.g. for a ball screw
- Measuring backlash

Example: Measuring the size of backlashes on a linear axis

Using a linear axis as example, the following section describes how you can determine the size of backlashes by measuring.

Requirements: Backlash compensation is not enabled.

1. Traverse the axis to an axis position A. Mark the axis position and write down the corresponding actual value from the technology object (<TO>.ActualPosition).
2. Continue to move the axis in the same direction at least around the expected size of backlashes.
3. Traverse the axis to the noted actual value from 1. or by the traveled distance from 2. Because of the backlash, the axis is now at of axis position B.
4. Measure the position difference of the axis positions Δ = A - B.



   You have measured the backlash.

5. Activate backlash compensation and enter the measured size of backlashes.

See also

Homing when backlash compensation is enabled (Page 153)

5.4.8 Tags: Mechanics (S7-1500, S7-1500T)

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

Type of motion		
Tag	**Description**	
<TO>.Properties.MotionType	Indication of linear or rotary motion	
	0	Linear motion
	1	Rotary motion

Load gear	
Tag	**Description**
<TO>.LoadGear.Numerator	Load gear numerator
<TO>.LoadGear.Denominator	Load gear denominator

Leadscrew pitch	
Tag	**Description**
<TO>.Mechanics.LeadScrew	Leadscrew pitch
<TO>.Actor.Efficiency	Efficiency of leadscrew pitch

Encoder mounting type	
Tag	**Description**
<TO>.Sensor[1..4].MountingMode	Encoder mounting type
<TO>.Sensor[1..4].Parameter.DistancePerRevolution	Load distance per encoder revolution with an externally mounted encoder

Inversion	
Tag	**Description**
<TO>.Actor.InverseDirection	Setpoint inversion
<TO>.Sensor[1..4].InverseDirection	Actual value inversion

Modulo	
Tag	**Description**
<TO>.Modulo.Enable	Enable modulo
<TO>.Modulo.Length	Modulo length
<TO>.Modulo.StartValue	Modulo start value

Backlash compensation	
Tag	**Description**
<TO>.Sensor[1..4].Backlash.Enable	Enable backlash compensation
<TO>.Sensor[1..4].Backlash.Size	Size of backlashes[1]
<TO>.Sensor[1..4].Backlash.Velocity	Velocity for traversing of backlashes At 0.0, the backlash is traversed in a servo cycle. (only with positioning axis and synchronous axis)
<TO>.Sensor[1..4].Backlash.DirectionAbsoluteHoming	Direction of movement during or before absolute encoder adjustment

[1] If you enable/disable backlash compensation or change the size of backlashes during runtime, you must home the axis again.

5.5 Motion control and limits for dynamics (S7-1500, S7-1500T)

Motion control of the axis occurs by means of velocity profiles (Page 98). 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.

The configurable emergency stop deceleration (Page 102) is triggered by the Motion Control instructions "MC_Power" and "MC_Stop" or by a technology alarm.

The jerk limit reduces the mechanical load during a change in acceleration or deceleration. The result is a "smoothed" velocity profile.

Configuring dynamic defaults at the technology object

You can configure dynamic defaults for motion jobs for the axis technology object. You define values as dynamic defaults that can be used for motion jobs in most situations.

Configure the following dynamic defaults under "Extended parameters > Dynamic default":

- Velocity (<TO>.DynamicDefaults.Velocity)
  In the "Velocity" field, you configure the default value for the velocity of the axis.
- Acceleration (<TO>.DynamicDefaults.Acceleration)
  You configure the default value for acceleration in the "Ramp-up time" or "Acceleration" fields.
  Relationship between ramp-up time and acceleration:

$$\text{Ramp-up time} = \frac{\text{Velocity}}{\text{Acceleration}}$$

NOTE

A change in the velocity influences the acceleration value of the axis. The ramp-up time remains.

- Deceleration (<TO>.DynamicDefaults.Deceleration)
  You configure the default value for deceleration in the "Ramp-down time" or "Deceleration" fields.
  Relationship between ramp-down time and deceleration:

  $$\text{Ramp-down time} = \frac{\text{Velocity}}{\text{Deceleration}}$$

  NOTE

  A change in the velocity influences the deceleration value of the axis. The ramp-down time remains.

- Jerk of the axis (<TO>.DynamicDefaults.Jerk)
  - You configure the jerk for the acceleration and deceleration ramp in the "Jerk" box. The value "0" means that jerk limiting is deactivated.
  - You configure the smoothing time for the acceleration ramp in the "Smoothing time" field.

  NOTE

  The jerk value is identical for the acceleration and deceleration ramps. 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.

  In case of a fault, the axis decelerates with the configured emergency stop deceleration. A configured jerk limit is not taken into account for this.

  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.

The default values for acceleration and deceleration also act on the traversing motions of active homing.

Parameterizing dynamic values in Motion Control instruction

At the Motion Control instructions, you configure the dynamic values for a motion job at the parameters "Velocity", "Acceleration", "Deceleration" or "Jerk". You make the parameter assignment for each parameter individually.

Using dynamic defaults for a motion job

To use a dynamic default for a motion job, set a value of less than 0 at the parameter (default: -1.0).

The following table shows which dynamic defaults you can use with which Motion Control instruction.

Motion Control instruction	<TO>.DynamicDefaults.Velocity	<TO>.DynamicDefaults.Acceleration	<TO>.DynamicDefaults.Deceleration	<TO>.DynamicDefaults.Jerk
MC_MoveAbsolute	✓	✓	✓	✓
MC_MoveRelative	✓	✓	✓	✓
MC_MoveVelocity	-	✓	✓	✓
MC_MoveJog	-	✓	✓	✓
MC_MoveSuperimposed	✓[1)]	✓	✓	✓
MC_Halt	-	-	✓	✓
MC_HaltSuperimposed	-	-	✓	✓
MC_STOP."Mode" = 3	-	-	✓	✓

1) At the parameter MC_Superimposed.VelocityDiff

Parameterizing individual dynamic values for a motion job

To use an individual dynamic value for a motion job, set a value that is greater than 0 at the parameter.

Limiting the dynamics

Maximum values for velocity, acceleration, deceleration and jerk result from the properties of the drive and the mechanics.

Configure the following dynamic limits under "Extended parameters > Limits > Dynamic limits":

- Maximum velocity (<TO>.DynamicLimits.MaxVelocity)
  Configure the maximum permitted velocity of the axis in the "Maximum velocity" field.

- Maximum acceleration (<TO>.DynamicLimits.MaxAcceleration)
  Configure the maximum permitted acceleration in the "Ramp-up time" or "Maximum acceleration" fields.
  Relationship between ramp-up time and maximum acceleration:

$$\text{Ramp-up time} = \frac{\text{Maximum velocity}}{\text{Maximum acceleration}}$$

NOTE

A change in the maximum velocity influences the acceleration value of the axis. The ramp-up time remains.

- Maximum deceleration (<TO>.DynamicLimits.MaxDeceleration)
  Configure the maximum permitted deceleration in the "Ramp-down time" or "Maximum deceleration" fields.
  Relationship between ramp-down time and maximum deceleration:

$$\text{Ramp-down time} = \frac{\text{Maximum velocity}}{\text{Maximum deceleration}}$$

NOTE

The "maximum deceleration" for active homing with change of direction at the hardware limit switch must be set sufficiently high to brake the axis before it reaches the mechanical endstop.

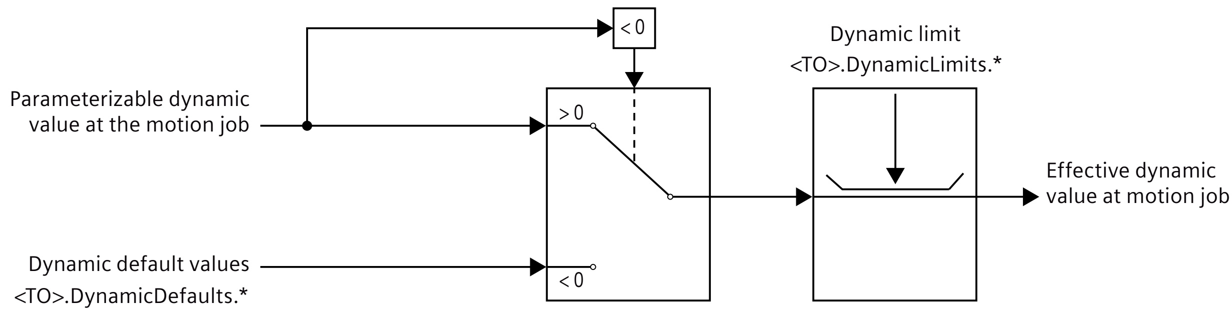
A change in the velocity influences the deceleration value of the axis. The ramp-down time remains.

- Jerk (<TO>.DynamicLimits.MaxJerk)
  You configure the jerk for the dynamic limits in the "Smoothing time" and "Jerk" fields. The same rules apply for the configuration as for the dynamic default of the jerk.

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.

Interaction of dynamic defaults and dynamic limits

The following overview shows how the dynamic value for a motion job is formed from the dynamic defaults and the dynamic limits.



Examples

The following table shows examples for the formation of the dynamic value for the velocity at a job of the instruction MC_MoveAbsolute.

	Configured dynamic default <TO>.DynamicDe-faults.Velocity	Parameterized value at the motion job MC_MoveAbsolute.Velocity	Dynamic limit <TO>.DynamicLim-its.MaxVelocity	Dynamic value at the motion job
Example 1	2000.0	-1.0	4000.0	2000.0
Example 2	2000.0	-1.0	500.0	500.0
Example 3	2000.0	3000.0	4000.0	3000.0
Example 4	2000.0	6000.0	4000.0	4000.0

5.5.1 Dynamic defaults for modulo axes (S7-1500, S7-1500T)

Maximum permissible velocity of the modulo axis

Note the maximum permissible velocity for modulo axes.

- Modulo axis is not configured as a possible leading value for a TO following axis:

$$\text{Maximum permissible velocity} = \frac{\text{Modulo length}}{T_{\text{Servo}}}$$

  If the maximum permissible velocity is exceeded, alarm 412 is output and the axis is blocked.
- Modulo axis is configured as a possible leading value for a TO following axis:

$$\text{Maximum permissible velocity} = \frac{\text{Modulo length}}{2 \cdot T_{\text{Servo}}}$$

  When the limit is active, alarm 501 is output.

5.5.2 Velocity profile (S7-1500, S7-1500T)

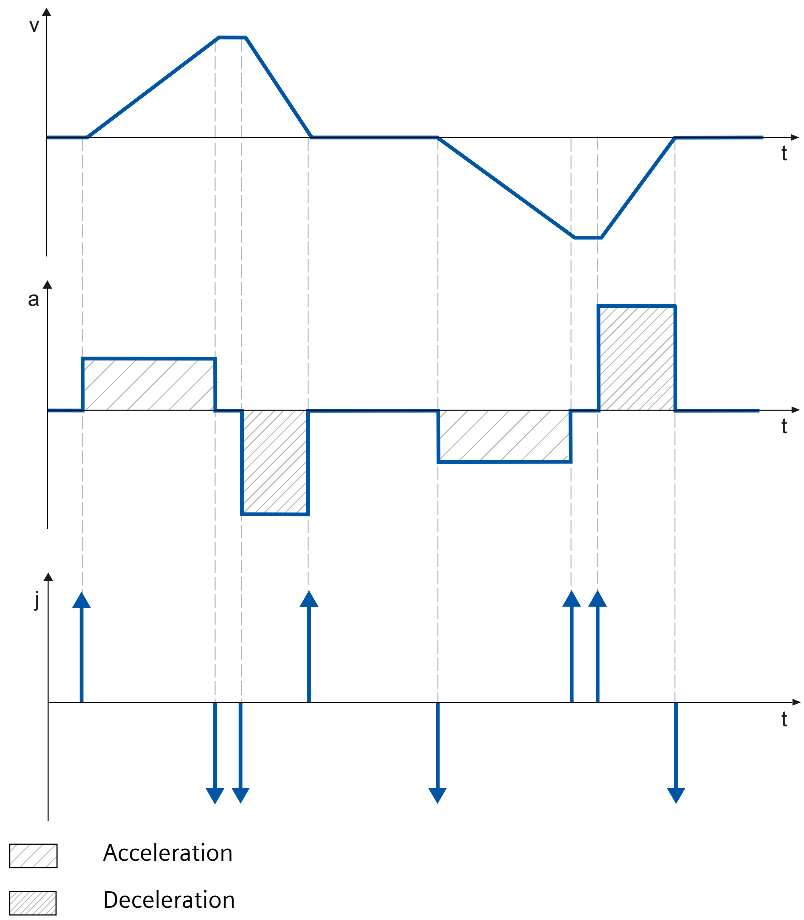
Velocity profiles with or without jerk limitation are supported for motion control of the axis.

The dynamic values for the motion are specified in the Motion Control job. Alternatively, the values of the dynamics defaults 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.

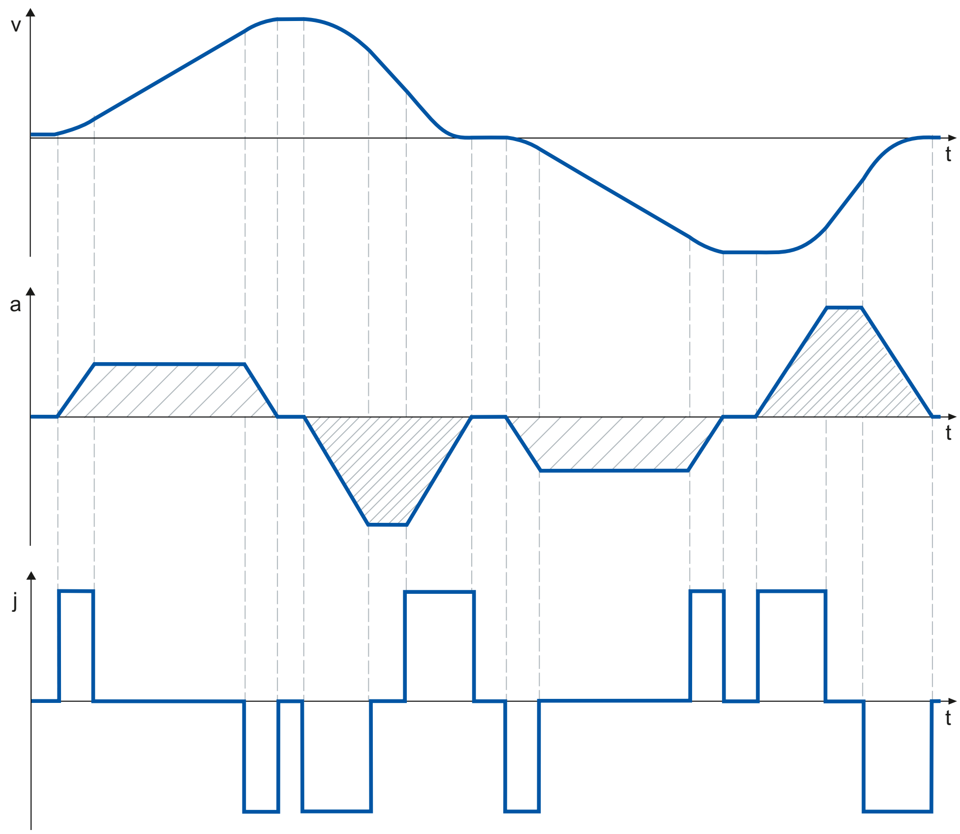
Velocity profile without jerk limitation

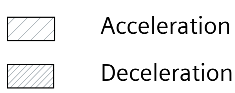
The following figure shows velocity, acceleration and jerk:



Velocity profile with jerk limitation

The following figure shows velocity, acceleration and jerk:



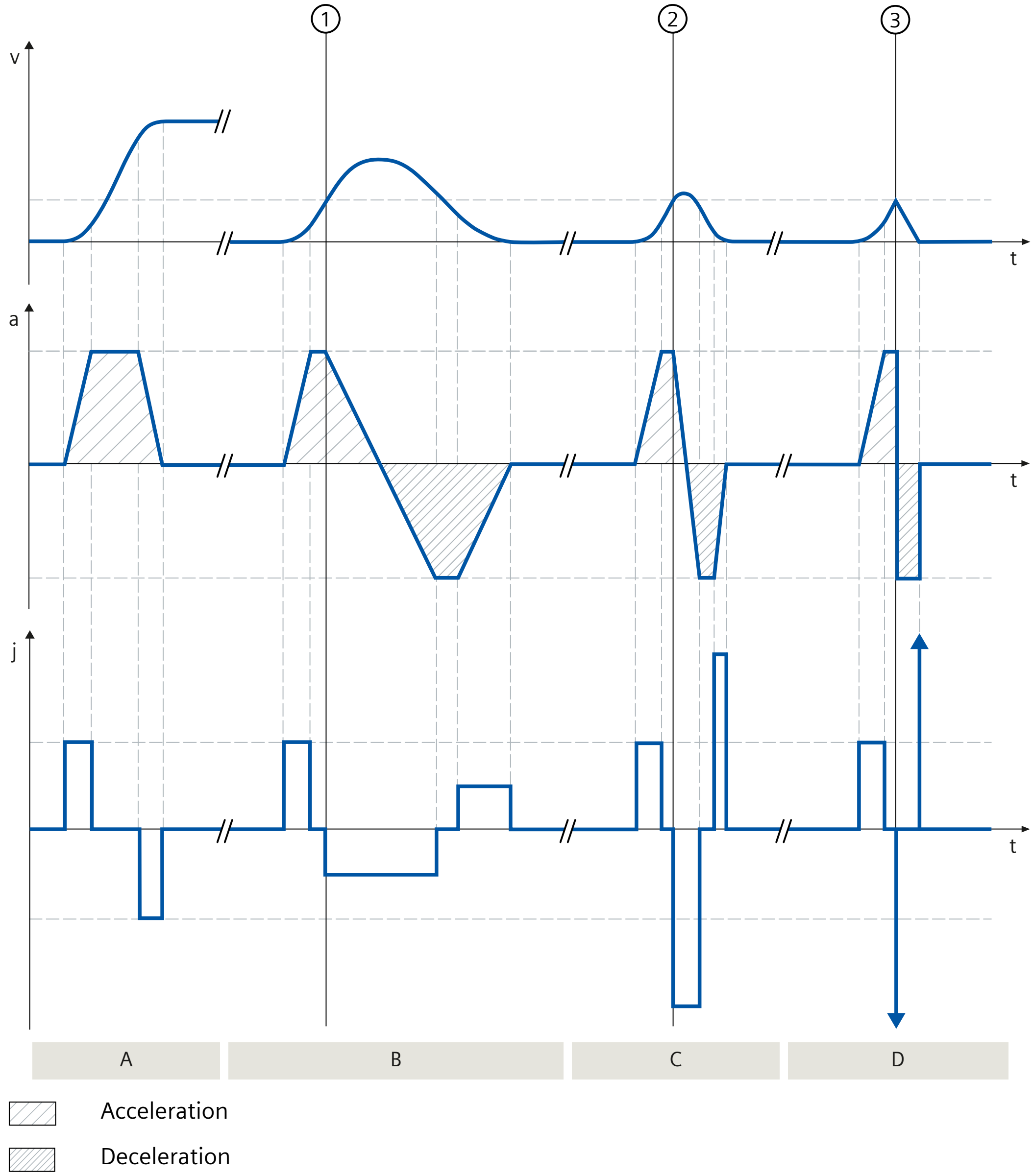


A velocity profile with jerk limitation is employed for a continuous acceleration and deceleration sequence. The jerk can be specified.

5.5.3 Override response with and without jerk limitation (S7-1500, S7-1500T)

When overriding the active job through a new jerk-limited motion, the current acceleration or deceleration is transitioned to the new acceleration/deceleration via the jerk. For overriding motions without jerk limitation, the acceleration/deceleration of the overriding job is effective immediately.

The following figure shows velocity, acceleration and jerk:



Section A

An "MC_MoveVelocity" job A1 is active.
In the following sections B, C and D, the job A1 is overridden by an additional "MC_MoveVelocity" job A2, A3, and A4 with "Velocity" = 0 each but with different jerk values.

Section B

At time 1, the active job A1 is overridden by a job A2 with low jerk. The acceleration is slowly transitioned via the jerk into the deceleration of the overriding job.

Section C

At time 2, the active job A1 is overridden by a job A3 with high jerk. The acceleration is quickly transitioned via the jerk into the deceleration of the overriding job.

Section D

At time ③, the active job A1 is overridden by a job A4 without jerk limitation. The deceleration of the overriding job is effective immediately.

5.5.4 Emergency stop deceleration (S7-1500, S7-1500T)

When stopping with the emergency stop ramp, the axis is braked from the current actual position and actual velocity to a standstill without a jerk limitation, using the configured emergency deceleration.

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

- In case of an emergency stop ramp that has been enabled via the Motion Control instruction "MC_Power" or "MC_Stop".
- 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".

Configuring emergency stop deceleration

Under "Extended parameters > Emergency stop", you configure the deceleration value for emergency stop in the "Emergency stop deceleration" or "Emergency stop ramp-down time" fields.

The following equation shows the relationship between emergency stop ramp-down time and emergency stop deceleration.

$$\text{Emergency stop ramp-down time} = \frac{\text{Maximum velocity}}{\text{Emergency stop deceleration}}$$

The configuration of the emergency stop deceleration is related to the configured maximum velocity of the axis. When 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.

5.5.5 Torque limits (S7-1500, S7-1500T)

5.5.5.1 Force/torque limiting (S7-1500, S7-1500T)

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. You can use, for example, a telegram 10x.

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".

You can specify the limiting values in the configured measurement unit for force or torque. The measurement units are defined in the "Basic parameters" configuration window.

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

- **"Linear" axis type**
  - Torque limiting active on motor side
  - Force limit active on load side
- **"Rotary" axis type**
  - Torque limiting 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

With the rotary motor, a load-side force limit you have defined is converted by the technology into a 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 efficiency of the gear and leadscrew is crucial, you can set them in the "<TO>.Actor.Efficiency" tag.

With the linear motor, you specify the load-side force limit directly. The efficiency is not taken into account.

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 it 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.

To deactivate the monitoring of the following error and the positioning monitoring during force/torque limiting, select the "Disable position-related monitoring" option. If you want to activate the position-related monitoring, select the option "Leave position-related monitoring enabled".

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 limit.

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" or "MC_Stop", the set position and the velocity setpoint are applied. Torque limiting still remains active and any accumulated following error is reduced. The axis is in 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 deceleration without any jerk limitation and brought to a standstill. The axis is then disabled when at a standstill.

Configuring force/torque limiting

You can configure the force/torque limit in the configuration of the positioning axis/synchronous axis technology object under "Extended parameters > Limits > Torque limiting".

Follow these steps:

1. In the "Effective" drop-down list, select whether the limit value is to be in effect "on load side" or "on motor side".
   If you have configured a linear motor, this setting has no effect.
2. Enter a default value in the specified measurement unit for "Torque limiting" or "Force limit".
   The default value is in effect when the torque limiting or force limit is specified using the 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 applies to the following axis configuration:
   – "Standard motor", axis type "linear" and limiting value effective "on load side".
     If the efficiency of the gear and leadscrew is crucial, you can set them in the "<TO>.Actor.Efficiency" tag.
   – "Linear motor"

Interconnection in the SINAMICS drive

The following interconnection is required 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])
- P1544 Torque/force reduction analysis during travel to fixed stop to 100% (default)
- P2194 Threshold value for the parameter "InLimitation" of < 100% (default 90%)

See also

Fixed stop detection (Page 104)

5.5.5.2 Fixed stop detection (S7-1500, S7-1500T)

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 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 canceled 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 telegram 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 break or push-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.

Configuring fixed stop detection

You configure the fixed stop detection in the configuration of the Positioning axis/synchronous axis technology object under "Extended parameters > Limits > Fixed stop detection".

- For "Following error", you configure the value of the following error starting from which the fixed stop detection is to take effect.

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.

- For "Positioning tolerance", you 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.

See also

Force/torque limiting (Page 102)

MC_TorqueLimiting: Activate/deactivate force/torque limit / fixed stop detection V7 (Page 273-274)

5.5.5.3 Additive setpoint torque/additive setpoint force (S7-1500, S7-1500T)

The Motion Control instruction "MC_TorqueAdditive" allows you to apply an additional torque/an additional force 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 are necessary for setting the additive setpoint torque/additive setpoint force:

- SINAMICS drive (see "compatibility list (https://support.industry.siemens.com/cs/ww/en/view/109750431)")
- SIEMENS supplementary telegram 750 for transmitting the torque data to the drive

The additive torque/additive setpoint force can be either positive or negative. The value specified in the instruction is a technological value, not a percentage. You set the unit of measure at the axis (default values: Nm, N).

See also

MC_TorqueAdditive: Specify additive torque V7 (Page 267-268)

5.5.5.4 Permissible torque range/force range (S7-1500, S7-1500T)

The Motion Control instruction "MC_TorqueRange" allows you to set torque limits/force 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 (https://support.industry.siemens.com/cs/ww/en/view/109750431)")
- 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. You set the unit of measure at the axis (default values torque: Nm/force: N). 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 limit V7 (Page 270)

5.5.6 Superimposed motions (S7-1500, S7-1500T)

With the motion control instructions "MC_MoveSuperimposed" and "MC_MotionInSuperimposed" you can start motions on the axis that additionally superimpose a position-controlled basic motion.

Use the motion control instruction "MC_HaltSuperimposed" to stop a superimposed motion on the axis independently of the basic motion.

You can superimpose the following motion control instructions with the "MC_MoveSuperimposed", "MC_MotionInSuperimposed", and "MC_HaltSuperimposed" motion control instructions:

- Single axis motion
  - MC_MoveAbsolute
  - MC_MoveRelative
  - MC_MoveVelocity
  - MC_MoveJog
- Synchronous operation
  - MC_GearIn
  - MC_GearInPos
  - MC_GearInVelocity
  - MC_CamIn
- MotionIn motion
  - MC_MotionInVelocity
  - MC_MotionInPosition

A kinematics motion is not permitted as a basic motion. If a kinematics motion is active, then the execution of a "MC_MoveSuperimposed" job or a "MC_MotionInSuperimposed" job is aborted with "Error" and the associated "ErrorID".

Superimposing a basic motion with a relative positioning motion

With the motion control instruction "MC_MoveSuperimposed (Page 235)" you can start a relative positioning motion by the "Distance" distance to superimpose a running basic motion.

The dynamic behavior during superimposed motion is defined with the parameters "VelocityDiff", "Jerk", "Acceleration", and "Deceleration". The basic motion is not affected by the superimposed motion.

The dynamic response of the total axis motion is the sum of the dynamic values of the basic motion and the superimposed motion.

The behavior of the overall motion depends on the type of basic motion:

- If the basic motion is a single-axis motion:
  - The maximum dynamic response 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.
- If the basic motion is a synchronous operation:
  - The synchronous operation 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 thus indirectly the following axis.
  - An "MC_MoveSuperimposed" job on a following axis in synchronous operation only affects the following axis.

NOTE

Setting synchronous operation with superimposed motions in simulation

If superimposed movements by the motion control instructions "MC_MoveSuperimposed", "MC_MotionInSuperimposed" or "MC_HaltSuperimposed" are or were active on the following axis, do not set a synchronous operation in simulation. This is because after you end the simulation, the following axis follows the leading axis without the position shifted by the superimposed motion. This can cause a setpoint jump of the position on the following axis.

If you are using synchronous operation, use the motion control instructions "MC_OffsetAbsolute" or "MC_OffsetRelative" to move the following axis position.

- If the basic motion is a MotionIn motion:
  - The dynamic response of the basic motion is not limited.
  - The maximum dynamic response of the superimposed motion is the difference between the current dynamic values of the basic motion and the dynamic limits.

The dynamic response of the overall motion is always displayed in the technology data block and in the diagnostics of the TIA Portal.

Starting superimposed positioning motion with "MC_MoveSuperimposed"

To start a superimposed positioning motion with the motion control instruction "MC_MoveSuperimposed", follow these steps:

1. Specify the additional distance to be moved in the "Distance" parameter.
2. Start the "MC_MoveSuperimposed" job with a positive edge at the "Execute" parameter.
   The "MC_MoveSuperimposed" job is executed with the set dynamic responses and superimposed on the basic motion.
   The processing status of the job is displayed at the "Busy", "Done", and "Error" parameters.

Superimposing basic motion with MotionIn motion specification

You can specify the cyclic, applicable motion setpoints for additional distance, velocity and acceleration, in addition to the basic motion for the axis with the motion control instruction "MC_MotionInSuperimposed (Page 263-264)". In this case no velocity profile is calculated and the values are directly active at the technology object.

The additional distance "Distance" is added to the set position of the basic motion. The summation of the two values corresponds to the set position of the axis.

The summation of the velocity setpoint "VelocityDiff" of the superimposed motion and the velocity setpoint of the basic motion are used as the precontroller value for the velocity precontrol.

The superimposed acceleration "AccelerationDiff" is only required for overriding the superimposed or overall motion.

The behavior of the overall motion depends on the type of basic motion:

- If the basic motion is a single-axis motion:
  - The dynamic responses of the superimposed and overall motions are not limited.
  - Only the basic motion is limited to the configured dynamic limits.
  - If the basic motion is completed then a job with "MC_MotionInSuperimposed" continues to be executed.
- If the basic motion is a synchronous operation:
  - The synchronous operation of the following axis is not limited to the dynamic limits of the following axis.
  - An "MC_MotionInSuperimposed" job on a leading axis in synchronous operation affects the leading axis and thus indirectly the following axis.
  - An "MC_MotionInSuperimposed" job on a following axis in synchronous operation only affects the following axis.

NOTE

Setting synchronous operation with superimposed motions in simulation

If superimposed movements by the motion control instructions "MC_MoveSuperimposed", "MC_MotionInSuperimposed" or "MC_HaltSuperimposed" are or were active on the following axis, do not set a synchronous operation in simulation. This is because after you end the simulation, the following axis follows the leading axis without the position shifted by the superimposed motion. This can cause a setpoint jump of the position on the following axis.

If you are using synchronous operation, use the motion control instructions "MC_OffsetAbsolute" or "MC_OffsetRelative" to move the following axis position.

- If the basic motion is a MotionIn motion:
  - The dynamic response of the superimposed motion and the dynamic response of the overall motion are not limited.
  - The dynamic response of the basic motion is not limited.
- No basic motion is active at the axis:
  - A job with "MC_MotionInSuperimposed" is also possible if no basic motion is active.

The dynamic response of the overall motion is always displayed in the technology data block and in the diagnostics of the TIA Portal.

Starting superimposed motion with "MC_MotionInSuperimposed"

To start a superimposed positioning motion with motion control instruction "MC_MotionInSuperimposed", follow these steps:

1. Specify the superimposed motion setpoints at the "Distance", "VelocityDiff", and "AccelerationDiff" parameters.
2. Start the "MC_MotionInSuperimposed" job with a positive edge at the "Enable" parameter.
   The "MC_MotionInSuperimposed" job is executed with the dynamic response specified at the "Distance" and "VelocityDiff" parameters and superimposed on the basic motion.
   The processing status of the job is displayed at the "Busy" and "Error" parameters.

Stopping superimposed motion independently of the basic motion

The motion control instruction "MC_HaltSuperimposed (Page 239)" stops a superimposed motion created with the instructions "MC_MoveSuperimposed", "MC_MotionInSuperimposed", or "MC_HaltSuperimposed".

With the "Jerk", "Deceleration" and "AbortAcceleration" parameters you can determine the dynamic behavior when stopping the superimposed motion.

The motion control instruction "MC_HaltSuperimposed" has no effect on the basic motion of the axis.

If no superimposed motion with "MC_MoveSuperimposed" or "MC_MotionInSuperimposed" is active, then the "MC_HaltSuperimposed" job is aborted immediately without effect. (MC_HaltSuperimposed.Done = true; MC_HaltSuperimposed.Busy = false)

Overriding of superimposed motions

The instructions of the superimposed motions are overridden according to the behavior described in the section "Override response V7: Homing and motion jobs (Page 279)". As a rule, the current dynamic responses are approximated to the new motion.

Status indicators of superimposed motions

The "<TO>.StatusWord.X23 (MoveSuperimposedCommand)" tag is set when the "MC_MoveSuperimposed" job is active.

The "<TO>.StatusWord2.X6 (MotionInSuperimposedCommand)" tag is set when the "MC_MotionInSuperimposed" job is active.

The "<TO>.StatusWord2.X7 (HaltSuperimposedCommand)" tag is set when the "MC_HaltSuperimposed" job is active.

The "<TO>.StatusPositioning.SuperimposedDistance" tag shows the distance traversed with the "MC_MoveSuperimposed", "MC_MotionInSuperimposed", and "MC_HaltSuperimposed" instructions. The value is reset when the basic motion and superimposed motion are completed or aborted.

5.5.7 Motion specification via "MotionIn" (S7-1500T)

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", "MC_MotionInPosition", and "MC_MotionInSuperimposed" 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. You are responsible for the accuracy or your information.

The setpoints are typically adapted in the processing cycle of the technology object. Call the "MotionIn" instruction in the MC-PreInterpolator [OB68]. The setpoints will be effective directly at the axis in the next application cycle [OB91].

WARNING

Unexpected axis motions

When using the motion specification via the motion control instructions "MC_MotionInVelocity", "MC_MotionInPosition", and "MC_MotionInSuperimposed", the axis can perform unexpected motions.

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

Before operation with the motion control instructions "MC_MotionInVelocity", "MC_MotionInPosition", and "MC_MotionInSuperimposed", set up the following precautionary measures:

- 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.

"MC_MotionInVelocity"

Use the "MC_MotionInVelocity (Page 255)" 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 acceleration value is zero.

"MC_MotionInPosition"

Use the "MC_MotionInPosition (Page 259)" instruction to specify the position, velocity and acceleration of the motion. This instruction is used for velocity, positioning and synchronous axes.

To execute the instruction, you must at least specify the position and velocity. The acceleration is needed for the overriding of running motions. By default, the acceleration value 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.

"MC_MotionInSuperimposed"

With the "MC_MotionInSuperimposed (Page 279)" instruction you can specify the additional distance, and the velocity and the acceleration of a superimposed motion of the axis. This instruction is used for velocity, positioning and synchronous axes.

To execute the instruction, you must at least specify the position and velocity. The acceleration is needed for the overriding of running motions. By default, the acceleration value 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.

Overriding with "MotionIn" instructions

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

Stopping the "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 sectionOverride response V7: Homing and motion jobs (Page 279). As a rule, the current dynamic responses are approximated to the new motion.

  NOTE

  Deviating dynamic settings

  When overriding the active job with a new jerk-limited motion, the current acceleration or deceleration is transferred to the new acceleration/deceleration via the jerk. Depending on the dynamic settings, this may take several application cycles. When the new acceleration or deceleration deviates significantly from the acceleration/deceleration at the time of the override, the transition profile can result in an unexpected axis motion.

  If such transitions cannot be excluded during acceleration/deceleration, adjust the dynamic settings of your jobs. For example, add a motion that is not jerk-limited with a direct transition to the new acceleration/deceleration. As an alternative, use high jerk values.

  For MotionIn jobs, the specification of the acceleration is only relevant for overriding the job. When the currently active acceleration is not to be reduced via the jerk, enter the value "0.0" at the "Acceleration" parameter of the MotionIn job.

- Setting 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 are not effective. Only limits set on the drive side are in effect.

MotionIn status indicators

The tag "<TO>.StatusMotionIn.FunctionState" = 1 indicates that an "MC_MotionInVelocity" job is active.

The tag "<TO>.StatusMotionIn.FunctionState" = 2 indicates that an "MC_MotionInPosition" job is active.

The tag "<TO>.StatusWord.X31 (MotionInCommand)" is set when a MotionIn job is active.

The "<TO>.StatusWord2.X6 (MotionInSuperimposedCommand)" tag is set when the "MC_MotionInSuperimposed" job is active.

The "<TO>.StatusMotionIn.StatusWord.X0 (MaxVelocityExcceeded)" tag indicates that the configured maximum velocity has been exceeded during a MotionIn job.

The "<TO>.StatusPositioning.SuperimposedDistance" tag shows the distance traversed with the "MC_MoveSuperimposed", "MC_MotionInSuperimposed", and "MC_HaltSuperimposed" instructions. This value is reset when the basic motion and the superimposed motion are completed or aborted.

See also

MC_MotionInSuperimposed: Specifying superimposed motion setpoints V7 (Page 263-264)

5.5.8 Tags: Motion control and limits for dynamics (S7-1500, S7-1500T)

The following technology object tags are relevant for motion control:

Status	
Tag	**Description**
<TO>.StatusWord	Status indicator for an active motion
<TO>.Position	Set position
<TO>.Velocity	Velocity setpoint/speed setpoint
<TO>.VelocitySetpoint	Specified 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>.StatusPositioning.Superimposed-Distance	Distance traveled with the instructions "MC_MoveSuperimposed", "MC_MotionInSuperimposed", and "MC_HaltSuperimposed". The value is reset when the base motion and the superim-posed motion are completed.
<TO>.StatusMotionIn.FunctionState	Status of the "MotionIn" function 0 — No "MotionIn" function active 1 — "MC_MotionInVelocity" active 2 — "MC_MotionInPosition" active
<TO>.StatusMotionIn.StatusWord.X0 (MaxVelocityExceeded)	The configured maximum velocity is exceeded during a MotionIn movement.
<TO>.StatusSynchronizedMotion.Status-Word.X0 (MaxVelocityExceeded)	The tag is set to the value "TRUE" when the maximum velocity configured for the following axis is exceeded during syn-chronous operation.
<TO>.StatusSynchronizedMotion.Status-Word.X1 (MaxAccelerationExceeded)	The tag is set to the value "TRUE" when the maximum acceler-ation configured for the following axis is exceeded during synchronous operation.
<TO>.StatusSynchronizedMotion.Status-Word.X2 (MaxDecelerationExceeded)	The tag is set to the value "TRUE" when the maximum decel-eration configured for the following axis is exceeded during synchronous operation.
<TO>.StatusWord.X23 (MoveSuperim-posedCommand)	An "MC_MoveSuperimposed" job is running.
<TO>.StatusWord.X31 (MotionInCom-mand)	A "MotionIn" job is active.
<TO>.StatusWord2.X6 (MotionInSuper-imposedCommand)	An "MC_MotionInSuperimposed" job is running.
<TO>.StatusWord2.X7 (HaltSuperim-posedCommand)	An "MC_HaltSuperimposed" job is running.

Override	
Tag	**Description**
<TO>.Override.Velocity	Velocity or speed override

Dynamic limit values	
Tag	**Description**
<TO>.DynamicLimits.MaxVelocity	Dynamic limitation for maximum velocity (mechanical)
<TO>.DynamicLimits.Velocity	Dynamic limitation for maximum velocity (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

Dynamic response defaults	
Tag	**Description**
<TO>.DynamicDefaults.Velocity	Default velocity
<TO>.DynamicDefaults.Acceleration	Default acceleration
<TO>.DynamicDefaults.Deceleration	Default deceleration
<TO>.DynamicDefaults.Jerk	Default jerk
<TO>.DynamicDefaults.EmergencyDeceleration	Emergency deceleration

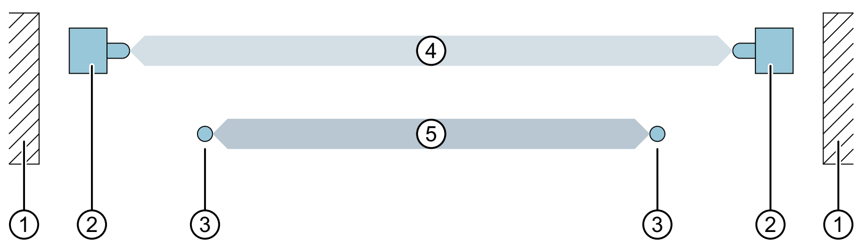
Torque limiting		
Tag	**Description**	
<TO>.TorqueLimiting.LimitDefaults.Torque	Limiting torque	
<TO>.TorqueLimiting.LimitDefaults.Force	Limiting force	
<TO>.TorqueLimiting.LimitBase	Torque limiting, motor or load side	
	0	Motor side
	1	Load side
<TO>.TorqueLimiting.PositionBasedMonitorings	Positioning and following error monitoring	
	0	Deactivated
	1	Enabled
<TO>.StatusTorqueData.CommandAdditiveTorqueActive	Additive setpoint torque/additive force function	
	0	Deactivated
	1	Enabled
<TO>.StatusTorqueData.CommandTorqueRangeActive	Torque limits/force limits function	
	0	Deactivated
	1	Enabled
<TO>.StatusTorqueData.ActualTorque	Actual torque of the axis (for standard motor)	
<TO>.StatusTorqueData.ActualForce	Actual force of axis (for linear motor)	

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

5.6 Traversing range limitation (S7-1500, S7-1500T)

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 switch (HW limit switch)

③ Software limit switch (SW limit switch)

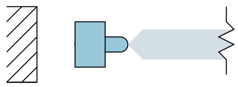
④ Maximum traversing range

⑤ Operating range

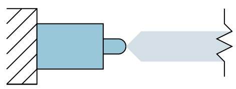
Types of HW limit switches

The positioning axis/synchronous axis technology object supports the following types of HW limit switches.

- Switch traversable: Axis can move beyond HW limit switch. The HW limit switch is enabled when it is approached. When it is overtraveled, the HW limit switch is disabled once again.



- Switch non-traversable: HW limit switch covers the entire range all the way to the mechanical endstop. The HW limit switch is enabled when it is approached and stays enabled up to the mechanical endstop.



5.6.1 Behavior when approaching and retracting a HW limit switch (S7-1500, S7-1500T)

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

Select the mounting 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.

When approaching a traversable hardware limit switch, technology alarm 531 is output. The axis is disabled and stopped with the configured braking ramp.

When approaching a non-traversable hardware limit switch, technology alarm 531 is output and the configured alarm response is executed.

Using the hardware limit switches as reversing output cams during active homing

When hardware limit switches are used as reversing output cams during homing, monitoring of the hardware limit switches has no effect during active homing.

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

When planning the distance between hardware limit switch and mechanical endstop during active homing, take into account the dynamic default of the deceleration and the approach velocity.

Direction reversal at the hardware limit switch (reversing cam) (Page 140)

Retracting the axis with a traversable HW limit switch

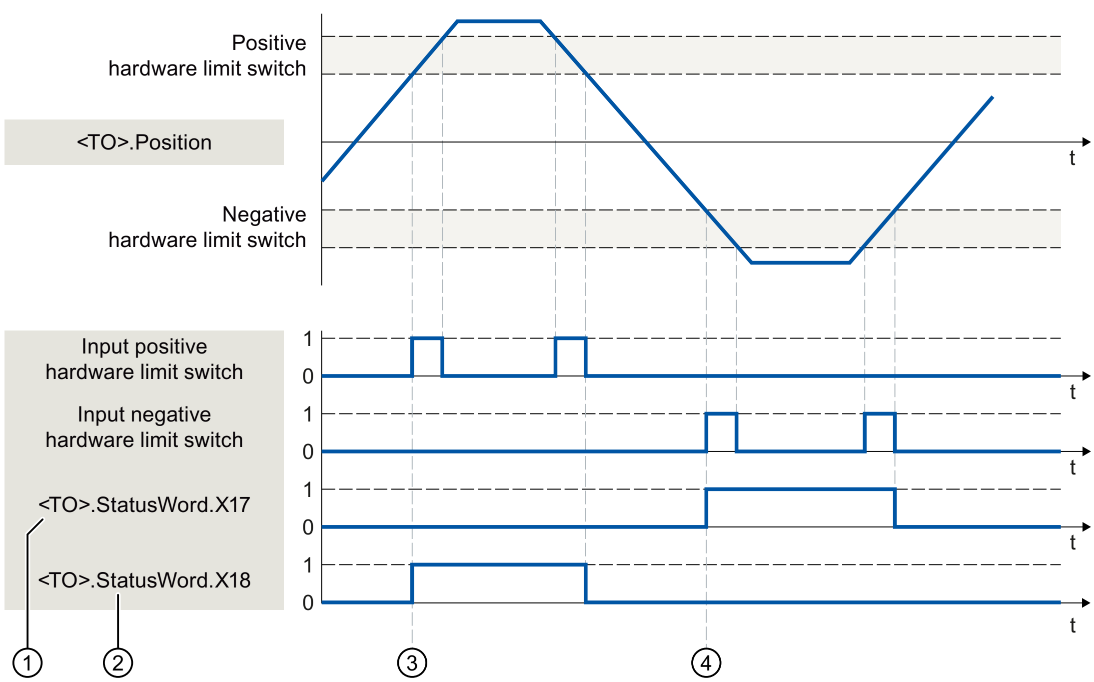
In case of a traversable HW limit switch, the position of the axis when the hardware limit switch is detected is stored internally on the CPU. The status of the reached hardware limit switch is reset only after the hardware limit switch is left and the axis is once again in the maximum traversing range.

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 with "MC_Reset". A restart is not required.
2. Move the axis in the retraction direction until the hardware limit switch is exited.
   - Negative HW limit switch: For retracting, move in the direction of higher position values.
   - Positive HW limit switch: For retracting, move in the direction of lower position values.

   Afterwards, the axis must be within the maximum traversing range.
   If you move the axis opposite the retraction direction before the hardware limit switch is left, the monitoring is 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.

NOTE

Retracting after technology alarm 531 with polarity reversed hardware limit switch or both hardware limit switches active:

To enable retracting, you can temporarily disable the hardware limit switch using the Motion Control instruction MC_WriteParameter (Page 252) via the parameter "PositionLimits_HW.Active" =FALSE.

Retracting the axis with a non-traversable HW limit switch

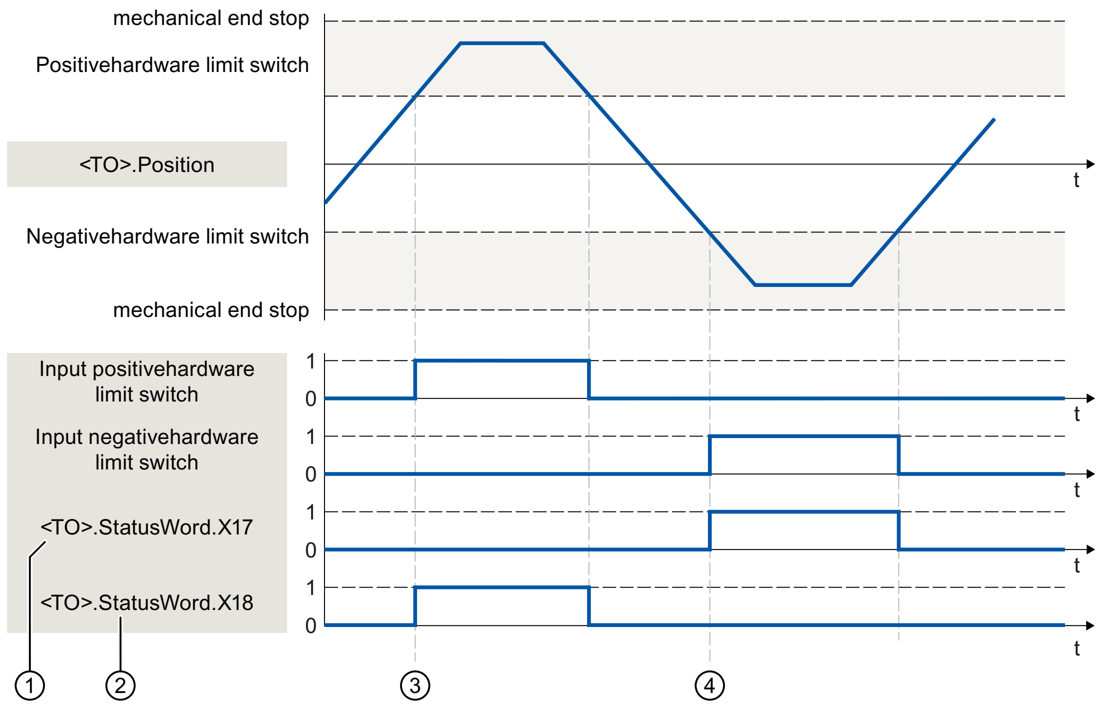
In case of a non-traversable HW limit switch, the position of the axis when the hardware limit switch is approached is not stored.

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 with "MC_Reset". A restart is not required.
2. Move the axis in the retraction direction until the hardware limit switch is exited.
   - Negative HW limit switch: For retracting, move in the direction of higher position values.
   - Positive HW limit switch: For retracting, move in the direction of lower position values.

   The status of the approached HW limit switch is reset as soon as the configured level at the digital input of the HW limit switch is no longer present.
   If you move the axis opposite the retraction direction before the hardware limit switch is left, the monitoring is 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 When the **positive** hardware limit switch is detected, the status <TO>.StatusWord.X18 (HWLimitMaxActive) for the positive HW limit switch is set. The status is reset as soon as the configured level at the digital input of the HW limit switch is no longer present.

④ When the **negative** hardware limit switch is detected, the status <TO>.StatusWord.X17 (HWLimitMinActive) for the negative HW limit switch is set. The status is reset as soon as the configured level at the digital input of the HW limit switch is no longer present.

NOTE

Retracting after technology alarm 531 with polarity reversed hardware limit switch or both hardware limit switches active:

To enable retracting, you can temporarily disable the hardware limit switch using the Motion Control instruction MC_WriteParameter (Page 252) via the parameter "PositionLimits_HW.Active" =FALSE.

Deactivating the hardware limit switch

For example, to enable homing at the fixed stop, you can temporarily disable the hardware limit switch using the Motion Control instruction "MC_WriteParameter (Page 252)" via the parameter "PositionLimits_HW.Active" = FALSE.

See also

MC_WriteParameter: Write parameter V7 (Page 252)

Direct homing (Page 148)

5.6.2 Configuring HW limit switches (S7-1500, S7-1500T)

Configuring HW limit switches

To configure the HW limit switches for the positioning axis/synchronous axis technology object, follow these steps:

1. In the configuration, navigate to "Extended parameters > Limits > Position limits > HW limit switches".
2. Click on the "Enable HW limit switch" check box.
   The function of the negative and positive hardware limit switch is active.
3. Select the type of HW limit switch from the "Type of hardware limit switch" drop-down list:
   - Switch traversable
   - Switch non-traversable
4. If you have selected "Switch non-traversable", configure the alarm response of technology alarm 531 at "Reaction":
   - Keep emergency stop and axis enable: When approaching the HW limit switch, the axis brakes to a standstill with the emergency stop deceleration without jerk limitation. The axis remains enabled.
   - Disable axis: When approaching the HW limit switch, the axis is stopped with the braking ramp configured in the drive.
5. For "Input negative HW limit switch", select the PLC tag of the digital input for the negative hardware limit switch.
   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.

NOTE

Only use hardware limit switches that remain permanently switched after the approach. This switching state may only be canceled after the return to the permitted traversing range.

The digital inputs of the hardware limit switches are evaluated by default in cyclic data exchange. If the hardware limit switches are to be evaluated in the position control cycle clock of the drive, select the entry "MC-Servo" for "Organization block" and "PIP OB Servo" for "Process image" in the settings of the input module under "I/O addresses".

⚠ CAUTION

Filter times of the digital inputs

Pay attention to the filter times of the digital inputs when placing hardware limit switches.

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.

6. For "Input positive HW limit switch", select the PLC tag of the digital input for the positive hardware limit switch.
   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.
7. In the "Level selection negative HW limit switch" drop-down list, select the triggering signal level for the negative HW limit switch.
   – High level: Input signal is "TRUE" when the hardware limit switch is approached.
   – Low level: Input signal is "FALSE" when the hardware limit switch is approached.
8. For "Level selection positive HW limit switch", select the triggering signal level for the positive HW limit switch from the drop-down list.

Interconnecting inputs for HW limit switches with Boolean tags

Instead of using digital inputs, you can also use Boolean tags to control the HW limit switches. For this, create a data block with the tags without the "Optimized block access" attribute.
Specify the addresses of these Boolean tags in the technology object data block.

Defining a data block for switching the HW limit switches

Proceed as follows to define the Boolean variables as HW limit switches:

1. Create a data block without the "Optimized block access" attribute, e.g. "HWLimitSwitches".
2. Define the following variables in the data block:

Name	Data type	Offset	Start value	Comment
UserData	DWord	0.0	16#0	Random data
HwLimitNeg	Bool	4.0	0	Variable for negative HW limit switch
HwLimitPos	Bool	4.1	0	Variable for positive HW limit switch

3. Use the "HwLimitPos" and "HwLimitNeg" tags in the user program to switch the HW limit switches.

Interconnecting the addresses of the Boolean tags in the technology object

To connect the HW limit switch to the address, follow these steps:

1. Open the Parameter view of the technology object.
2. Change the navigation structure to data structure.
3. Open the "PositionLimits_HW" structure.
4. Enter the values for the tags:

Name	Data type	Start value	Comment
MinSwitchAddressRid	DWord	33554433	RID for data type Boolean
MinSwitchAddressArea	Byte	132	DB memory area
MinSwitchAddressDbNumber	UInt	n	n = number of DB "HWLimitSwitches"
MinSwitchAddressOffset	UDint	32	Example in DB "HWLimitSwitches": Offset Boolean tag ("HwLimitNeg") = 4.0 Offset = (4 bytes x 8 bits/byte) + 0 bits = 32 bits
MaxSwitchAddressRid	DWord	33554433	RID for data type Boolean
MaxSwitchAddressArea	Byte	132	DB memory area
MaxSwitchAddressDbNumber	UInt	n	n = number of DB "HWLimitSwitches"
MaxSwitchAddressOffset	UDint	33	Example in DB "HWLimitSwitches" Offset Boolean tag ("HwLimitPos") = 4.1 Offset = (4 bytes x 8 bits/byte) + 1 bit = 33 bits

Result: The addresses of the HW limit switches are configured.

Writing addresses of the Boolean tags in the user program

To connect the HW limit switch to the address during runtime, follow these steps:

1. Create a data block with the "Optimized block access" attribute, e.g. "HWPositionLimitsAdress".
2. Define the following variables in the data block:

Name	Data type	Start value	Comment
MinSwitchAddressRid	DWord	16#0200_0001	RID for data type Boolean
MinSwitchAddressArea	Byte	16#84	DB memory area
MinSwitchAddressDbNumber	UInt	n	n = number of DB "HWLimitSwitches"
MinSwitchAddressOffset	UDint	32	Example in DB "HWLimitSwitches": Offset Boolean tag ("HwLimitNeg") = 4.0 Offset = (4 bytes x 8 bits/byte) + 0 bits = 32 bits
MaxSwitchAddressRid	DWord	16#0200_0001	RID for data type Boolean

Name	Data type	Start value	Comment
MaxSwitchAddressArea	Byte	16#84	DB memory area
MaxSwitchAddressDbNumber	UInt	n	n = number of DB "HWLimitSwitches"
MaxSwitchAddressOffset	UDint	33	Example in DB "HWLimitSwitches" Offset Boolean tag ("HwLimitPos") = 4.1 Offset = (4 bytes x 8 bits/byte) + 1 bit = 33 bits

3. Write the start values from the data block to the load memory of the "<TO>.PositionLimits_HW.MaxSwitchAddress" and "<TO>.PositionLimits_HW.MinSwitchAddress" tags with the "WRIT_DBL" instruction.
   You can find more information on changing restart-relevant data in the technology object in section "Changing restart-relevant data" of function manual "S7-1500/S7-1500T Motion Control Overview".
   Example of the tag "<TO>.PositionLimits_HW.MinSwitchAddress.RID":
   ```
   tempRetVal := WRIT_DBL
   (REQ := execute,
   SRCBLK := "HWPositionLimitsAdress".MinSwitchAddressRid,
   BUSY => busy,
   DSTBLK => <TO>.PositionLimits_HW.MinSwitchAddress.RID);
   ```
4. Perform a restart of the technology object.

Result: The Boolean variable is used as the input for the HW limit switch.

See also

MC_WriteParameter: Write parameter V7 (Page 252)

S7-1500 Motion Control Documentation Guide (Page 12)

5.6.3 Behavior when reaching the SW limit switch (S7-1500, S7-1500T)

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.

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.

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.

Approaching the software limit switches

When the software limit switch is approached, technology alarm 533 is output.

You can configure the alarm response for approaching the SW limit switches.

The technology object remains enabled.

Overrun of the software limit switches

If the software limit switches are overshot, technology alarm 534 is output.

You can configure the alarm response for crossing the SW limit switches.

Modulo function is enabled

When the modulo function is 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.

5.6.4 Retracting the SW limit switch (S7-1500, S7-1500T)

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 into the permitted operating range.
   – Negative SW limit switch: For retracting, move in the direction of positive position values.
   – Positive SW limit switch: For retracting, move in the direction of negative position values.

   If the axis is outside the valid traversing range, e.g. due to homing, the current position is the effective SW limit switch. As soon as the axis has been moved back into the valid traversing range, the configured SW limit switch takes effect.

   If you overtravel the effective SW limit switch in the opposite retraction direction, technology alarm 533 or 534 is issued.

5.6.5 Configuring SW limit switches (S7-1500, S7-1500T)

To configure the HW limit switches for the positioning axis/synchronous axis technology object, follow these steps:

1. In the configuration, navigate to "Extended parameters > Limits > Position limits".
2. Click the check box "Enable SW limit switches".
   The function of the negative and positive SW limit switch is active.

   NOTE

   Activated software limit switches act only on a homed axis.

   ---

3. For "Position negative SW limit switch", configure the position of the SW limit switch with the smaller position value.
4. For "Position positive SW limit switch", configure the position of the SW limit switch with the higher position value.

5. For "Reaction when a SW limit switch is reached", configure the alarm response of the technology alarm 533.
   – Stop with maximum dynamic values: Axis stops when the SW limit switch is approached with maximum dynamic values
   – Stop with current dynamic values: Axis stops when the SW limit switch is approached with the programmed dynamic values of the active job.

   NOTE

   If the axis approaches the software limit switch as a following axis in synchronous operation or as a kinematics axis during a kinematic movement, the axis is stopped with maximum dynamic values regardless of the selected setting.

   The technology object remains enabled.
6. For "Reaction when a SW limit switch is exceeded", configure the alarm response of the technology alarm 534:
   – Keep emergency stop and axis enable: When the software limit switch is overtraveled, the axis brakes to a standstill with the emergency stop deceleration without jerk limitation. The axis remains enabled.
   – Disable axis: Axis is disabled when the SW limit switch is overtraveled and braked with the braking ramp configured in the drive.

5.6.6 Tags: Traversing range limitation (S7-1500, S7-1500T)

Software limit switches

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

Status indicators	
Tag	**Description**
<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, indicating that a software limit switch has been violated.

Control bits	
Tag	**Description**
<TO>.PositionLimits_SW.Active	Enables/disables the monitoring of the software limit switches.

Position values	
Tag	**Description**
<TO>.PositionLimits_SW.MinPosition	Position of the negative software limit switch
<TO>.PositionLimits_SW.MaxPosition	Position of the positive software limit switch

Position values		
Tag	**Description**	
<TO>.PositionLimits_SW.LimitReached-Behavior	Alarm response when a software limit switch is approached with a single axis job	
	0	Stop axis with maximum dynamics
	1	Stop axis with the programmed dynamic parameters
<TO>.PositionLimits_SW.LimitExceeded-Behavior	Alarm response when overrunning a software limit switch	
	0	Disable axis
	1	Brake the axis with the configured emergency stop deceleration without any jerk limitation and bring it to a standstill.

Hardware limit switches

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

Status indicators	
Tag	**Description**
<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 reached.

Control bits	
Tag	**Description**
<TO>.PositionLimits_HW.Active	Enables/disables the monitoring of the hardware limit switches.

Parameters		
Tag	**Description**	
<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	Address for the negative hardware limit switch	
<TO>.PositionLimits_HW.MaxSwitch-Level	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	Address for the positive hardware limit switch	

Parameters		
Tag	**Description**	
<TO>.PositionLimits_HW.Mode	Type of HW limit switch	
	0	The HW limit switches are non-traversable.
	1	The HW limit switches are mechanically traversable.
<TO>.PositionLimits_HW.ApproachBehavior	Alarm response when approaching a HW limit switch	
	0	Disable axis
	1	Keep emergency stop and axis enable

5.6.7 Long-term accuracy (S7-1500, S7-1500T)

Long-term accuracy means that the technological set and actual position can always be determined uniquely.

The maximum technological position depends on the selected unit of measure and the maximum display of 9.0E12 mm. At higher resolution the maximum display is reduced to 9.0E9 mm.

The maximum travel time in which the technological position is accurate without rounding error depends on the maximum position and the velocity. The maximum travel time applies likewise to axes with and without modulo setting.

You can use the following equation to estimate when the limit of long-term accuracy is reached:

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

Example of the maximum traversing time

Maximum position = 9.0E12 mm

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

$$\text{Travel time} = \frac{\text{9.0E12 mm}}{\text{2.0E4 mm/min}} = \text{4.5E8 min} \quad \triangleq \text{856 years}$$

Unit of measure	Maximum travel time
nm, µm, mm, m, km, in, ft, mi, rad, °	4.5E8 min ≙ 856 years
mm[1)], °[1)]	4.5E5 min ≙ 0.856 years

[1)] Position values with higher resolution or six decimal places. The maximum position is reduced to 9.0E9 mm and thus also the travel time.

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

Measures to maintain long-term accuracy

To reset the travel time, carry out the following measures before the maximum travel time has expired or before reaching the maximum position:

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

See also

Units of measure (Page 33)

5.7 Homing (S7-1500, S7-1500T)

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.

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 (passive homing) or a direct position assignment.

You select the homing type via the "Mode" parameter of the "MC_Home (Page 209)" instruction.

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.

  Active homing has an effect on the operative encoder.

  When active homing starts, current traversing movements are aborted.

  During active homing with absolute encoder, an absolute value offset is retentively saved beyond the switching on/off of the controller.

  Active homing (Page 133)
- **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 has an effect on the operative encoder.

  Passive homing is also called homing on the fly.

  Passive homing (Page 142)

- **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.
  Direct homing (Page 148)
- **Set position setpoint**
  The set position of the technology object is set or offset directly to the value specified in "MC_Home". The following error remains.
  Set setpoint position (Page 150)
- **Absolute encoder adjustment**
  The supplied absolute value is assigned to the associated mechanical axis position by means of the absolute encoder adjustment. You carry out the absolute encoder adjustment once. The absolute value offset is retentively saved beyond the switching on/off of the controller.
  Absolute value adjustment (Page 150)
- **Incremental encoder adjustment**
  With the homing job, the actual position is set directly to the value specified in "MC_Home".
  Incremental encoder adjustment (Page 153)

Homing mode for active and passive homing

Various homing modes are available for the positioning axis/synchronous axis and external encoder technology objects.

Homing mode	Application	Description of the process
Reference cam and zero mark via PROFIdrive telegram.	Homing should take place on the zero mark, but the zero mark is present several times in the traversing range of the axis. High homing accuracy	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.
Use zero mark via PROFIdrive telegram	The encoder zero mark is only available once in the entire traversing range of the axis. An external zero mark is available in the traversing range of the axis. High homing accuracy	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.
Digital input	Can be used without a zero mark. Hardware limit switch can be used as a digital input. Lower homing accuracy than when homing via zero marks. A low homing velocity increases the accuracy.	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

Homing mode	Application	Description of the process
		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.

Supported encoders and technology objects

The following table shows which homing types are possible with the respective technology objects:

Mode	Positioning axis/synchronous axis with incremental encoder	Positioning axis/synchronous axis with absolute encoder	External encoder incremental	External encoder absolute
Active homing ("Mode" = 3, 5)	✓	✓	-	-
Passive homing ("Mode" = 2, 8, 10)	✓	✓	✓	✓
Set actual position ("Mode" = 0) Relative offset to the actual position ("Mode" = 1)	✓	✓	✓	✓
Set position setpoint (direct absolute) ("Mode" = 11) Relative offset of the position setpoint ("Mode" = 12)	✓	✓	✓	✓
Absolute encoder adjustment ("Mode" = 6, 7)	-	✓	-	✓
Incremental encoder adjustment ("Mode" = 13)	✓	-	✓	-

Start homing job

To start the homing job, activate the Motion Control instruction "MC_Home".

Homing status

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

The "<TO>.StatusWord.X11 (HomingCommand)" tag of the technology object indicates that a homing job is active.

The "<TO>.ErrorWord.X10 (HomingFault)" tag of the technology object indicates an error during homing.
The "<TO>.StatusSensor[1..4].Adjusted" tag shows whether the encoder is homed with one of the following homing types:

- Active homing
- Passive homing
- Absolute encoder adjustment
- Incremental encoder adjustment

NOTE

Once the tag "<TO>.StatusSensor[1..4].Adjusted" is set for an absolute encoder, it remains set until you download new settings for the encoder.

Home the axis again when replacing the absolute encoder.

After homing with the homing types Direct homing ("Mode" = 0, 1) and set position setpoint ("Mode" = 11,12) is completed, the "<TO>.StatusWord.X5 (HomingDone)" tag of the axis or external encoder technology object is set, but not the "<TO>.StatusSensor[1..4].Adjusted" tag of the encoder.

See also

Homing SINAMICS drives with external zero marks (Page 153)

5.7.1 Terms for active and passive homing (S7-1500, S7-1500T)

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 telegram. 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.
With active homing, the homing mark position corresponds to the home position minus home position offset.
With passive homing, the homing mark position corresponds to the home position.

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.

Approach velocity

With active homing, the technology object approaches the reference cam/digital input at the approach velocity.
A home position offset is also retracted at the approach velocity.

Homing velocity

With active homing, the technology object approaches the homing mark at homing velocity.

5.7.2 Active homing (S7-1500, S7-1500T)

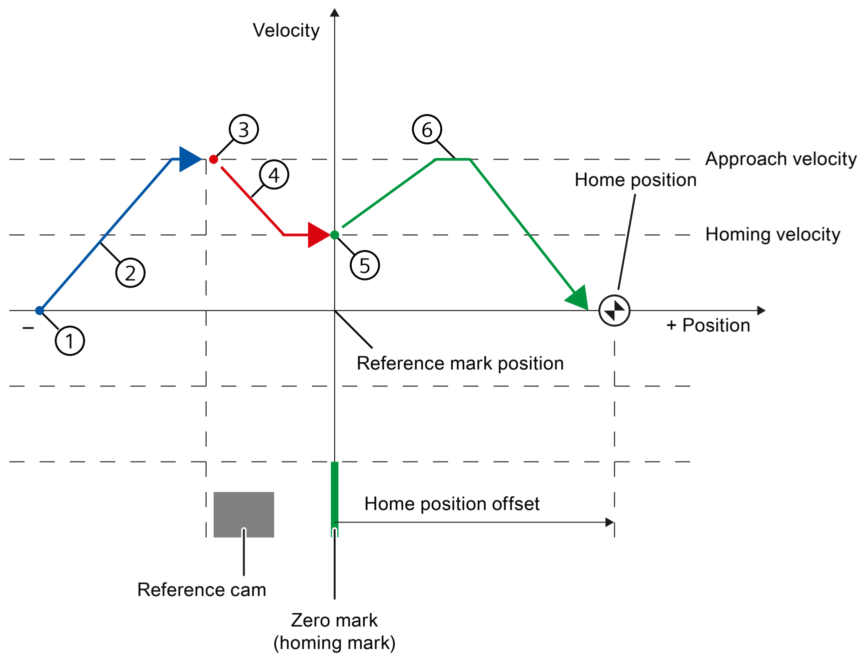
5.7.2.1 Active homing with homing output cam and zero mark (S7-1500, S7-1500T)

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 reference cam and zero mark
- Approach in the positive direction
- Homing in the positive direction
- Positive home position offset



Motion sequence

①	Start of active homing via the Motion Control instruction "MC_Home"
②	Approach to the reference cam in approach direction with approach velocity
③	Enable detection of the reference cam and homing mark detection
④	Approach to the homing mark with homing velocity
⑤	Detection of the homing mark
⑥	Approach to the home position with approach velocity.

NOTE

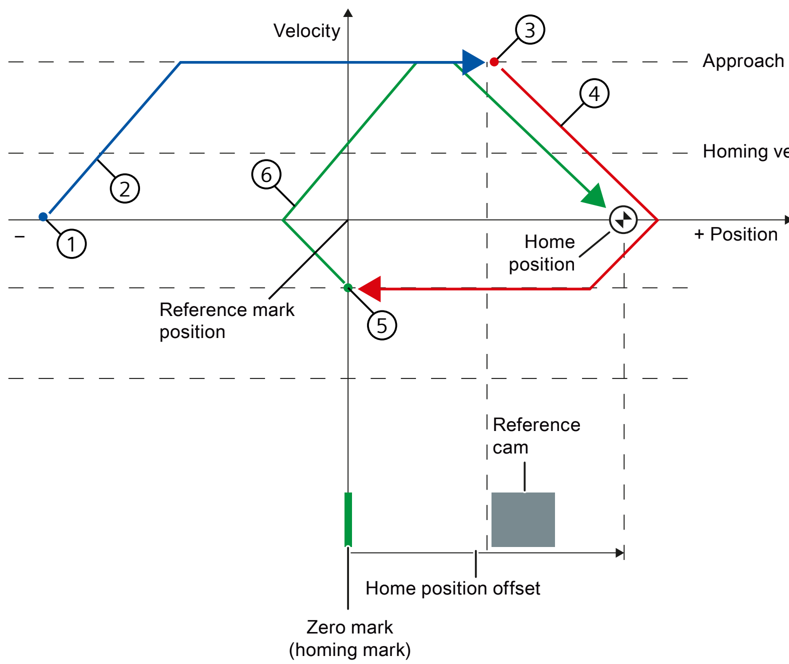
If the velocity cannot be reduced to the homing velocity between detection of the reference cam and the zero mark, homing is performed at the velocity present when the zero mark is crossed.

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



Motion sequence

① Start of active homing via the Motion Control instruction "MC_Home"

② Approach to the reference cam in approach direction with approach velocity

③ Enable detection of the reference cam and homing mark detection

④ Approach to the homing mark with homing velocity

⑤ Detection of the homing mark

⑥ Approach to the home position with approach velocity.

Requirements

- Digital input as PLC tag
- The technology object has been enabled.

Procedure

To make the technology object active with reference cam and zero mark homing, follow these steps:

1. In the project tree, in the configuration of the technology object, navigate to "Extended parameters > Homing > Active homing".
2. In the "Select the homing mode" field, select the "Use reference cam and zero mark via PROFIdrive telegram" option.

3. For "Digital input homing mark/cam", select the PLC tag of the digital input.
4. Select the appropriate signal level for the digital input under "Level selection".
5. In the "Approach direction" field, select the direction in which the reference cam is approached:
   – Positive: Approach direction in direction of positive position values
   – Negative: Approach direction in direction of negative position values
6. In the "Homing direction" field, select the direction in which the zero mark is approached for homing:
   – Positive: Homing direction in the direction of positive position values
   – Negative: Homing direction in the direction of negative position values
7. Under "Approach velocity", set the velocity with which the "reference cam" is approached. Any configured home position offset is traversed at the same velocity.
8. Under "Homing velocity", set the velocity with which the zero mark is approached for homing.
9. If the home position is different from the homing mark position, enter a corresponding home position offset under "Home position offset". The axis approaches the home position at approach velocity.
10. Configure the "Home position". The home position configured here is in effect when the Motion Control instruction "MC_Home" is executed with "Mode" = 5.
11. To home the technology object with the home position configured in the technology object, call the "MC_Home" instruction with "Mode" = 5.
    – When the homing mark is recognized, the position is set to:
      Position = value in tag "<TO>.Homing.HomePosition" minus
      "<TO>.Sensor[1..4].ActiveHoming.HomePositionOffset"
    – The "Homed" status of the technology object is set to TRUE.
    – The axis moves to the position that is specified in the "<TO>.Homing.HomePosition" tag.
    – The "Done" parameter in "MC_Home" is set to TRUE after moving to the home position.
12. To home the technology object and specify the home position directly on the homing job, call the "MC_Home" instruction with "Mode" = 3 and "Position" = <Home position>.
    – When the homing mark is recognized, the position is set to:
      Position = value in parameter "Position" minus
      "<TO>.Sensor[1..4].ActiveHoming.HomePositionOffset"
    – The "Homed" status of the technology object is set to TRUE.
    – The axis moves to the position that is specified in the "Position" parameter.
    – The "Done" parameter in "MC_Home" is set to TRUE after moving to the home position.

See also

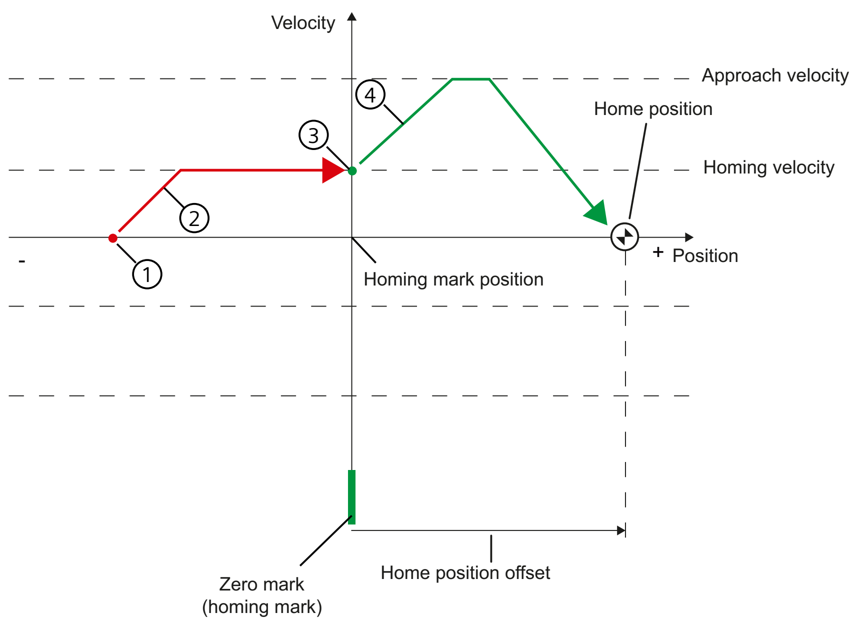
Homing SINAMICS drives with external zero marks (Page 153)

5.7.2.2 Active homing with zero mark (S7-1500, S7-1500T)

Example of homing motion

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

① Start of active homing via the "MC_Home" Motion Control instruction
② Approach to the homing mark in the homing direction with homing velocity
③ Detection of the homing mark
④ Approach to the home position with approach velocity.

Requirement

- The technology object has been enabled.

Procedure

To home the technology object actively with zero mark, follow these steps:

1. In the project tree, in the configuration of the technology object, navigate to "Extended parameters > Homing > Active homing".
2. In the "Select the homing mode" field, select the "Use zero mark via PROFIdrive telegram" option.

3. In the "Approach direction" field, select the direction in which the zero mark is approached:
   – Positive: Homing direction in the direction of positive position values
   – Negative: Homing direction in direction of negative position values
4. Under "Approach velocity", set the velocity with which any set home position offset is retracted.
5. Under "Homing velocity", set the velocity with which the homing mark is approached.
6. If the home position is different from the homing mark position, enter a corresponding home position offset under "Home position offset". The axis approaches the home position at approach velocity.
7. For "Home position", configure the absolute home position 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.
8. To home the technology object with the home position configured in the technology object, call the "MC_Home" instruction with "Mode" = 5.
   – When the homing mark is recognized, the position is set to:
     Position = value in tag "<TO>.Homing.HomePosition" minus
     "<TO>.Sensor[1..4].ActiveHoming.HomePositionOffset"
   – The "Homed" status of the technology object is set to TRUE.
   – The axis moves to the position that is specified in the "<TO>.Homing.HomePosition" tag.
   – The "Done" parameter in "MC_Home" is set to TRUE after moving to the home position.
9. To home the technology object and specify the home position directly on the homing job, call the "MC_Home" instruction with "Mode" = 3 and "Position" = <Home position>.
   – When the homing mark is recognized, the position is set to:
     Position = value in parameter "Position" minus
     "<TO>.Sensor[1..4].ActiveHoming.HomePositionOffset"
   – The "Homed" status of the technology object is set to TRUE.
   – The axis moves to the position that is specified in the "Position" parameter.
   – The "Done" parameter in "MC_Home" is set to TRUE after moving to the home position.

See also

Homing SINAMICS drives with external zero marks (Page 153)

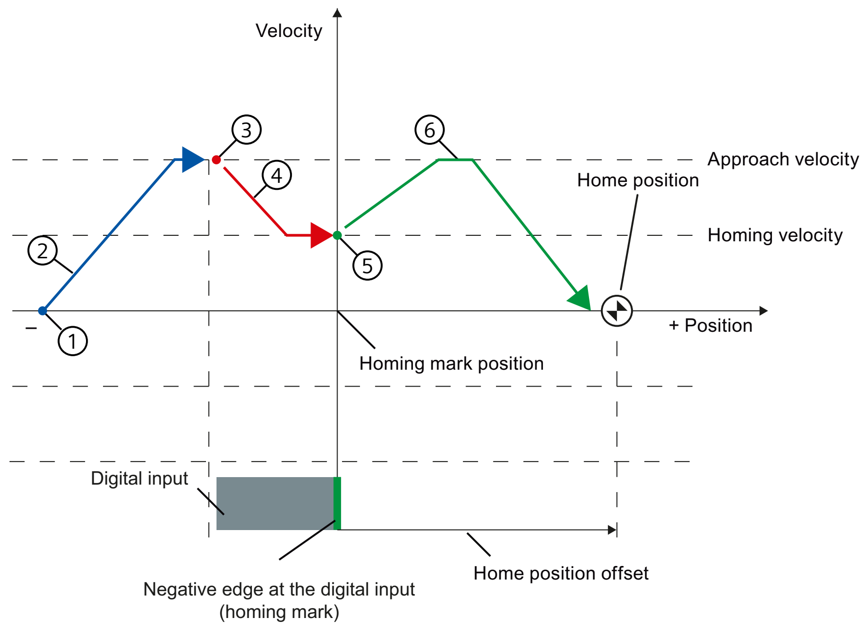
5.7.2.3 Active homing with digital input (S7-1500, S7-1500T)

Example of homing motion

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

① Start of active homing via the "MC_Home" Motion Control instruction

② Move on the positive edge at the digital input in the approach direction with approach velocity

③ Detection of the positive edge at the digital input

④ Approach to the homing mark in the homing direction with the homing velocity

⑤ Detection of the homing mark

⑥ Approach to the home position with approach velocity.

NOTE

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

Requirement

- Digital input as PLC tag
- The technology object has been enabled.

Procedure

To home the technology object actively with a digital input, follow these steps:

1. In the project tree, in the configuration of the technology object, navigate to "Extended parameters > Homing > Active homing".
2. In the "Select the homing mode" field, select the "Use homing mark via digital input" option.

3. For "Digital input homing mark/cam", select the PLC tag of the digital input.
4. Select the appropriate signal level for the digital input under "Level selection".
5. In the "Approach direction" field, select the direction in which the digital input is approached:
   – Positive: Approach direction in direction of positive position values
   – Negative: Approach direction in direction of negative position values
6. In the "Homing direction" field, select the direction in which the homing mark of the digital input is approached for homing:
   – Positive: Homing direction in the direction of positive position values
   – Negative: Homing direction in the direction of negative position values
7. In the "Homing mark" field, select which side of the digital input is to be used as the homing mark.
   – Positive side
   – Negative side
8. Under "Approach velocity", set the velocity with which the "digital input" is approached. Any configured home position offset is traversed at the same velocity.
9. Under "Homing velocity", set the velocity with which the homing mark is approached.
10. If the home position is different from the homing mark position, enter a corresponding home position offset under "Home position offset". The axis approaches the home position at approach velocity.
11. For "Home position", configure the absolute home position 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.
12. To home the technology object with the home position configured in the technology object, call the "MC_Home" instruction with "Mode" = 5.
   – When the homing mark is recognized, the position is set to:
     Position = value in tag "<TO>.Homing.HomePosition" minus
     "<TO>.Sensor[1..4].ActiveHoming.HomePositionOffset"
   – The "Homed" status of the technology object is set to TRUE.
   – The axis moves to the position that is specified in the "<TO>.Homing.HomePosition" tag.
   – The "Done" parameter in "MC_Home" is set to TRUE after moving to the home position.
13. To home the technology object and specify the home position directly on the homing job, call the "MC_Home" instruction with "Mode" = 3 and "Position" = <Home position>.
   – When the homing mark is recognized, the position is set to:
     Position = value in parameter "Position" minus
     "<TO>.Sensor[1..4].ActiveHoming.HomePositionOffset"
   – The "Homed" status of the technology object is set to TRUE.
   – The axis moves to the position that is specified in the "Position" parameter.
   – The "Done" parameter in "MC_Home" is set to TRUE after moving to the home position.

5.7.2.4 Direction reversal at the hardware limit switch (reversing cam) (S7-1500, S7-1500T)

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 deceleration does not hereby 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 default acceleration/deceleration. • Increase the distance between the hardware limit switch and the mechanical endstop.

5.7.2.5 Active homing to a hardware limit switch (S7-1500, S7-1500T)

If only hardware limit switches are available on the axis and no separate digital inputs are available as homing marks, then you can home the axis to the hardware limit switches.

NOTICE
Avoid moving to a mechanical end stop Take one of the following measures to ensure that the machine does not hit a mechanical stop when homing is active with the hardware limit switch as the homing mark: • Keep the approach velocity low. • Increase the configured acceleration/deceleration. • Increase the distance between the hardware limit switch and the mechanical end stop. • Select a home position offset in direction of the traversing range of the axis against the mechanical stop.

Procedure

To use the signal of the hardware limit switch as a homing mark, follow these steps:

1. In the project tree, in the configuration of the technology object, navigate to "Extended parameters > Homing > Active homing".
2. In the "Select the homing mode" field, select the "Use homing mark via digital input" option.
3. For "Digital input homing mark/cam", select the PLC tag of the hardware limit switch, e.g. "HwLimitPos".
4. Select the appropriate signal level for the digital input under "Level selection".
5. In the "Approach direction" field, select the direction in which the digital input is approached:
   – Positive: Approach direction in direction of positive position values
   – Negative: Approach direction in direction of negative position values

6. In the "Homing direction" field, select the direction in which the homing mark of the digital input is approached for homing:
   – Positive: Homing direction in the direction of positive position values
   – Negative: Homing direction in the direction of negative position values
7. In the "Homing mark" field, select which side of the digital input is to be used as the homing mark. The following recommendation applies to hardware limit switches in order not to traverse the axis unnecessarily far in the direction of the mechanical stop.
   – Positive side of the negative hardware limit switch
   – Negative side of the positive hardware limit switch
8. Under "Approach velocity", set the velocity with which the hardware limit switch is approached. Any configured home position offset is traversed at the same velocity.
9. Under "Homing velocity", set the velocity with which the homing mark is approached.
10. If the home position is different from the homing mark position, enter a corresponding home position offset under "Home position offset". The axis approaches the home position with the approach velocity. When homing to the hardware limit switch, the following settings are recommended in order to move to the home position in the direction of the traversing range or against the mechanical stop.
    – Negative hardware limit switch: Home position offset ≥ 0
    – Positive hardware limit switch: Home position offset ≤ 0
11. For "Home position", configure the absolute home position 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.
12. Disable the existing hardware limit switch with the Motion Control instruction "MC_WriteParameter".
13. To start active homing, call the "MC_Home" instruction in the user program.
    – To home the technology object with the home position configured in the technology object, call the "MC_Home" instruction with "Mode" = 5.
    – To home the technology object with the home position at the parameter "Position" home position, call the "MC_Home" instruction with "Mode" = 3.
14. Move the axis back to the working area between the hardware limit switches.
15. Activate existing hardware limit switches with the "MC_WriteParameter" Motion Control instruction.

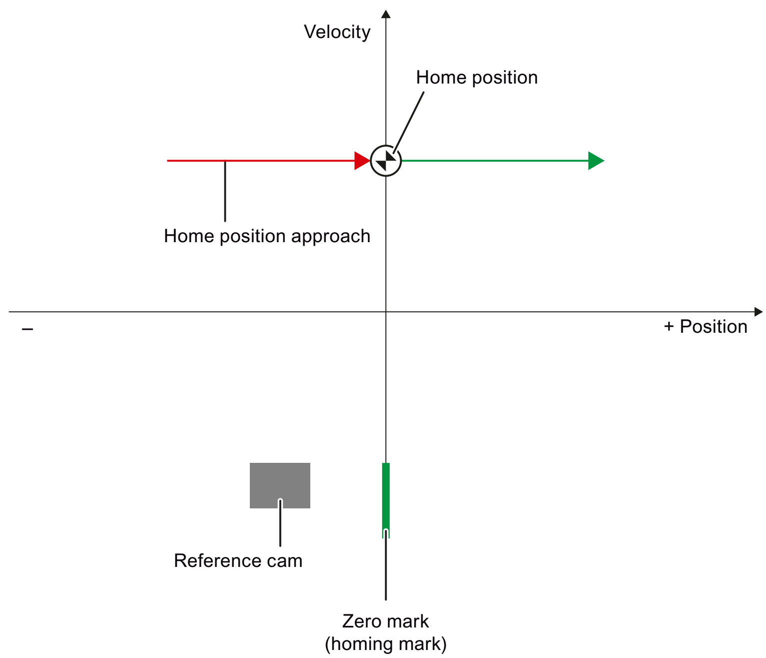
5.7.3 Passive homing (S7-1500, S7-1500T)

5.7.3.1 Passive homing with homing output cam and zero mark (S7-1500, S7-1500T)

Example of homing motion

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

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



Motion sequence

① Activation of passive homing using the Motion Control instruction "MC_Home"

② Motion due to a Motion Control job from the user.
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 output cam

④ Departure from the reference output cam
The departure from the reference cam enables the detection of the homing mark.

⑤ Detection of the homing mark

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.

Requirements

- Digital input as PLC tag
- The technology object has been enabled.

Procedure

To home the technology object passively with reference cam and zero mark, follow these steps:

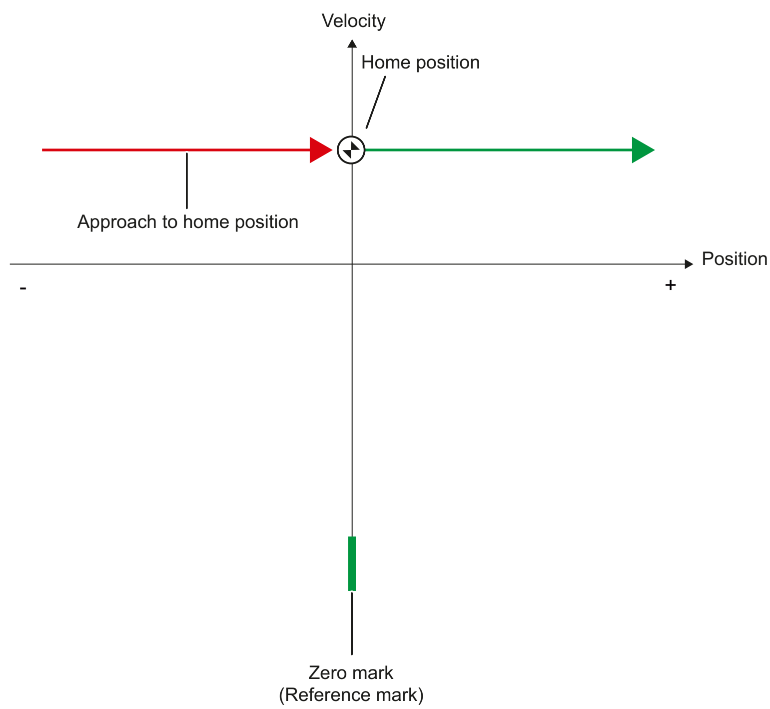
1. In the project tree, in the configuration of the technology object, navigate to "Extended parameters > Homing > Passive homing".
2. In the "Select the homing mode" field, select the "Use reference cam and zero mark via PROFIdrive telegram" option.
3. For "Digital input homing mark/cam", select the PLC tag of the digital input.
4. Select the appropriate signal level for the digital input under "Level selection".
5. In the "Homing direction" field, select the direction in which the next zero mark is to be approached for homing.
   – Positive: The axis moves in the direction of positive position values.
   – Negative: The axis moves in the direction of negative position values.
   – Current: The currently effective approach direction is used for homing.
6. For "Home position", configure the absolute home position 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.
7. To home the technology object with the home position configured in the technology object, call the "MC_Home" instruction with "Mode" = 10.
8. To home the technology object and specify the home position directly on the homing job, call the "MC_Home" instruction with "Mode" = 8 or "Mode" = 2 (without resetting the "homed" status).
9. Traverse the axis in the configured homing direction.
   – The detection of the zero mark/homing mark is enabled after the reference cam has been traversed.
   – When the homing mark is detected, the position of the axis or encoder is set depending on the mode:
     "Mode" = 10: Position = value in tag "<TO>.Homing.HomePosition"
     "Mode" = 8 or "Mode" = 2: Position = value in parameter "Position"
   – The axis is homed as soon as the zero mark/homing mark is reached or detected.

5.7.3.2 Passive homing with zero mark (S7-1500, S7-1500T)

Example of homing motion

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

① Activation of passive homing using the Motion Control instruction "MC_Home"

② Motion due to a Motion Control job from the user
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 homing mark

Requirement

- Technology object is enabled.

Procedure

To home the technology object passively with zero mark, follow these steps:

1. In the project tree, in the configuration of the technology object, navigate to "Extended parameters > Homing > Passive homing".
2. In the "Select the homing mode" field, select the "Use zero mark via PROFIdrive telegram" option.

3. In the "Homing direction" field, select the direction in which the next zero mark is to be approached for homing.
   – Positive: The axis moves in the direction of positive position values.
   – Negative: The axis moves in the direction of negative position values.
   – Current: The currently effective approach direction is used for homing.
4. For "Home position", configure the absolute home position 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.
5. To home the technology object with the home position configured in the technology object, call the "MC_Home" instruction with "Mode" = 10.
6. To home the technology object and specify the home position directly on the homing job, call the "MC_Home" instruction with "Mode" = 8 or "Mode" = 2 (without resetting the "homed" status).
7. Traverse the axis in the configured homing direction.
   – The detection of the zero mark/homing mark is enabled after the reference cam has been traversed.
   – When the homing mark is detected, the position of the axis or encoder is set depending on the mode:
     "Mode" = 10: Position = value in tag "<TO>.Homing.HomePosition"
     "Mode" = 8 or "Mode" = 2: Position = value in parameter "Position"
   – The axis is homed as soon as the zero mark/homing mark is reached or detected.

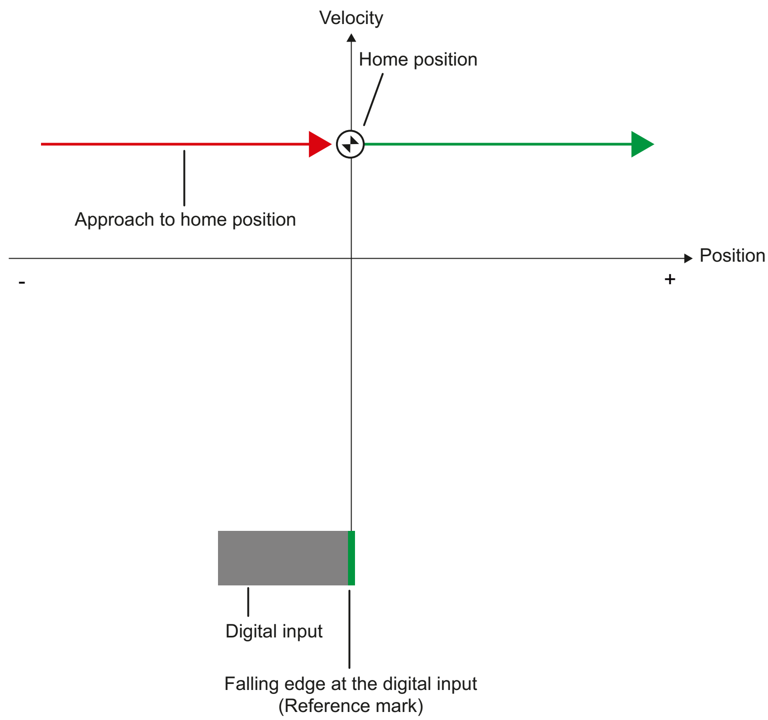
5.7.3.3 Passive homing with digital input (S7-1500, S7-1500T)

Example of homing motion

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

① Activation of passive homing using the Motion Control instruction "MC_Home"

② Motion due to a Motion Control job from the user
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 homing mark
In the example, the negative edge of the switch at the digital input represents the homing mark.

Requirements

- Digital input as PLC tag
- The technology object has been enabled.

Procedure

To home the technology object passively with digital input, follow these steps:

1. In the project tree, in the configuration of the technology object, navigate to "Extended parameters > Homing > Passive homing".
2. In the "Select the homing mode" field, select the "Use homing mark via digital input" option.
3. For "Digital input homing mark/cam", select the PLC tag of the digital input.
4. Select the appropriate signal level for the digital input under "Level selection".

5. In the "Homing direction" field, select the direction in which the next zero mark is to be approached for homing.
   – Positive: The axis moves in the direction of positive position values.
   – Negative: The axis moves in the direction of negative position values.
   – Current: The currently effective approach direction is used for homing.
6. In the "Homing mark" field, select which side of the digital input is to be used as the homing mark.
   – Positive side
   – Negative side
7. For "Home position", configure the absolute home position 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.
8. To home the technology object with the home position configured in the technology object, call the "MC_Home" instruction with "Mode" = 10.
9. To home the technology object and specify the home position directly on the homing job, call the "MC_Home" instruction with "Mode" = 8 or "Mode" = 2 (without resetting the "homed" status).
10. Traverse the axis in the configured homing direction.
   – The detection of the zero mark/homing mark is enabled after the reference cam has been traversed.
   – When the homing mark is detected, the position of the axis or encoder is set depending on the mode:
     "Mode" = 10: Position = value in tag "<TO>.Homing.HomePosition"
     "Mode" = 8 or "Mode" = 2: Position = value in parameter "Position"
   – The axis is homed as soon as the zero mark/homing mark is reached or detected.

5.7.3.4 Cancel passive homing (S7-1500, S7-1500T)

Requirements

- A job for passive homing with the instruction "MC_Home" ("Mode" = 2, 8, 10) was started.
- The technology object has not yet been homed.

Procedure

To cancel an active job for passive homing, follow these steps:

- Call the "MC_Home" instruction with "Mode" = 9.
  – When the 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 canceled with the parameter "CommandAborted" = TRUE.
  – The overriding job with "Mode" = 9 signals successful execution with parameter "Done" = TRUE.

5.7.4 Direct homing (S7-1500, S7-1500T)

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".

Requirement

- The technology object is in position-controlled mode.

Procedure

Set actual position absolutely

To set the actual position absolutely, proceed as follows:

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

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

Set actual position relatively

To set the actual position relatively, proceed as follows:

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

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

Direct homing at fixed stop

For direct homing at fixed stop, all motions must be programmed in the user program. Change the configuration data directly in the user program. The fixed stop is used as homing mark.

NOTICE
Too fast manual traversing to the fixed stop Too fast a manual traversing of the axis can lead to machine damage. Move the axis manually with low speed/velocity. Configure a suitable torque limit.

To set the position at the fixed stop absolutely or relatively, proceed as follows:

1. Activate a suitable fixed stop detection with the Motion Control instruction "MC_TorqueLimiting".
2. Deactivate the existing hardware limit switch with the Motion Control instruction "MC_WriteParameter".
3. Move the axis to the fixed stop using a suitable motion job. For example, use the Motion Control instructions "MC_MoveRelative" or "MC_MoveJog".
4. After the axis has reached the fixed stop, execute a direct homing using the Motion Control instruction "MC_Home".
5. Move the axis back to the working area between the hardware limit switches.

6. Activate the hardware limit switch with the Motion Control instruction "MC_WriteParameter".
7. Deactivate the fixed stop detection using the Motion Control instruction "MC_TorqueLimiting".

NOTE

In the case of an axis with several encoders, the offset of the position at the sensors of all encoders is also applied with a position correction with the parameter "Mode" = 0. This prevents the sensors from diverging.

See also

MC_TorqueLimiting V7 (Page 273)

MC_WriteParameter V7 (Page 252)

MC_MoveJog V7 (Page 230)

MC_MoveRelative V7 (Page 221)

MC_Home V7 (Page 209)

5.7.5 Set setpoint position (S7-1500, S7-1500T)

You can set the position setpoint of the axis or the encoder as absolute or relative.

Requirement

- Encoder values are valid (<TO>.StatusSensor[1..4].State = 2)

Procedure

Set position setpoint absolutely

To set the position setpoint absolutely, follow these steps:

1. In the "MC_Home" Motion Control instruction, enter the absolute position setpoint in the "Position" parameter.
2. Call the "MC_Home" Motion Control instruction with parameter "Mode" = 11.

The set position of the technology object is set to the value of the "Position" parameter. The following error remains.

Set position setpoint relatively

To set the position setpoint relatively, follow these steps:

1. In the "MC_Home" Motion Control instruction, enter the relative position setpoint in the "Position" parameter.
2. Call the "MC_Home" Motion Control instruction with parameter "Mode" = 12.

The set position of the technology object is shifted by the value of the "Position" parameter. The following error remains.

5.7.6 Absolute value adjustment (S7-1500, S7-1500T)

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

You can set the actual position of the axis or the encoder as absolute or relative.

Requirements

- The technology object is in position-controlled mode.
- The actual encoder values are valid ("<TO>.Statussensor[1..4].State" = 2).

Absolute specification of position

To perform absolute encoder adjustment with absolute specification of position, call the Motion Control instruction "MC_Home" with the parameters "Mode" = 7 and "Position" = absolute position setpoint.

To adjust the operative encoder, enter "Sensor" = 0 at the parameter.

To adjust a non-operative encoder, enter the number of the encoder at the "Sensor" parameter. (S7-1500T)

The current position is set to the value of parameter "Position".

The absolute encoder offset is retentively saved in the "<TO>.StatusSensor[1..4].AbsEncoderOffset" tag.

Relative specification of position

To perform absolute encoder adjustment with relative specification of position, call the Motion Control instruction "MC_Home" with the parameters "Mode" = 6 and "Position" = value by which the current position is to be shifted.

To adjust the operative encoder, enter "Sensor" = 0 at the parameter.

To adjust a non-operative encoder, enter the number of the encoder at the "Sensor" parameter. (S7-1500T)

The current position is shifted by the value of parameter "Position".

The absolute encoder offset is retentively saved in the "<TO>.StatusSensor[1..4].AbsEncoderOffset" tag.

Restoring the position after switching on the CPU

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 crossing 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, the actual value in the controller is no longer in accord with the mechanical axis position.

Resetting the absolute value offset of an encoder

To reset an absolute value offset stored retentively in the CPU, follow these steps:

1. Change the encoder type to incremental.
2. Load the technology object to the CPU.
   The retentively stored absolute value offset is deleted.
3. Change the encoder type back to absolute encoder.
4. Load the technology object to the CPU.

Specify the position of the axis again.

Save absolute encoder adjustment for device replacement on SIMATIC Memory Card

With this "MC_SaveAbsoluteEncoderData" Motion Control instruction you can save the absolute encoder adjustment data on the SIMATIC Memory Card for all technology objects with "Absolute" or "Cyclic absolute" encoder type. The data is saved on the SIMATIC Memory Card in the "UserFiles" folder as "AbsEncoderData.dat". To transfer the data of the absolute encoder adjustment into the new SIMATIC CPU when replacing the device, insert the SIMATIC Memory Card into the new SIMATIC CPU.

Alternatively, you can copy the "AbsEncoderData.dat" file into the "UserFiles" folder of another SIMATIC Memory Card and use this SIMATIC Memory Card.

You can also copy the "AbsEncoderData.dat" file in the web server of the CPU. Note that the "UserFiles" folder is write-protected on the "Filebrowser" web page. The "AbsEncoderData.dat" file must be downloaded as a user file. The assignment to the "UserFiles" folder takes place automatically.

The following requirements must be met in the loaded project of the new CPU so that you can use the data saved with "MC_SaveAbsoluteEncoderData" when replacing a device:

- Identical encoder configuration
- Identical names of technology objects
- Identical numbers of technology object data blocks

The new CPU must not contain any valid absolute encoder adjustment values. You can remove the absolute encoder adjustment values, for example, by performing a reset to factory settings without the "Format memory card" option.

If the requirements are met in the loaded project and the new CPU, the absolute encoder adjustment data saved on the SIMATIC Memory Card is transferred during startup of the CPU when replacing the device. No new absolute encoder adjustment is then necessary.

After the device replacement and the transfer of the backed-up data from the SIMATIC Memory Card to the CPU, the backup on the SIMATIC Memory Card is renamed automatically ("AbsEncoderData.bak") and is not used further. "The data backup for the absolute encoder adjustment was successfully restored" is entered in the diagnostic buffer.

MC_SaveAbsoluteEncoderData V7 (Page 254)

5.7.7 Incremental encoder adjustment (S7-1500, S7-1500T)

With the incremental encoder adjustment, you can set the absolute position of an incremental encoder with "Mode" = 13 at "MC_Home".

If the selected encoder is the operative encoder, the setpoint is automatically adjusted to the calibrated actual value during homing. The axis does not perform a compensating motion. After homing, the actual value of the axis is equal to the actual value of the encoder.

In the case of an axis with several encoders: Unlike with "Mode" = 0, the position offset is not applied at all encoders with a position correction with the parameter "Mode" = 13. This means the actual position values can deviate between the encoders. When switching the encoder with MC_SetSensor with Mode=1 (without synchronizing the actual position) and active position control, an additional difference of the two encoders acts as additional control deviation and can trigger a compensating motion.

During incremental encoder adjustment, the position of the incremental encoder is not saved retentively in the CPU. The values are lost after POWER-OFF.

Requirements

- Incremental encoder
- Technology object enabled and position-controlled or technology object disabled
- No active alarms

Procedure

For incremental encoder adjustment, call the Motion Control instruction "MC_Home" with the parameters "Mode" = 13 and "Position" = absolute position setpoint.

To adjust the operative encoder, enter "0" at the parameter "Sensor".

To adjust a non-operative encoder, enter the number of the encoder at the parameter "Sensor". (S7-1500T)

The current position is set to the value of parameter "Position".

5.7.8 Homing SINAMICS drives with external zero marks (S7-1500, S7-1500T)

For SINAMICS drives with external zero mark, 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 set on the drive with SINAMICS parameter p490.

Homing to an encoder zero mark or an external zero mark is set in SINAMICS parameter p495.

5.7.9 Homing when backlash compensation is enabled (S7-1500, S7-1500T)

Active and passive homing "MC_Home" with "Mode" = 2,3,5,8,10

Always move the axis in the same direction to the home position. Select either "positive" or "negative" as homing direction.

NOTE

Before reaching the homing mark, the backlash must have traversed completely in the homing direction.

Direct homing "MC_HOME" with "Mode" = 0.1

Always move the axis in the same direction before or during direct homing. If you move the axis in another direction during direct homing, then the axis position around the backlash is invalidated.

Absolute encoder adjustment "MC_Home" with "Mode" = 6.7

In order that the actual encoder value can be clearly assigned to an axis position for an absolute encoder, the position of the backlash must also be taken into account when setting the absolute value offset for the absolute encoder adjustment. The position of the backlash results from the direction of travel of the axis during or before the absolute encoder adjustment. Configure the direction of travel of axis using the "Absolute homing direction" parameter. After the controller is switched on again, the axis traverses the backlash if the first traversing motion is in the opposite direction to the absolute homing direction.

If the absolute encoder adjustment has already been carried out, the axis position will only be displayed correctly after the controller has been switched off and on again if the position of the backlash at the time of switch-on corresponds to the position of the backlash in relation to the axis position when the absolute encoder offset was set. Otherwise the axis position can deviate from the axis position displayed up to a maximum of the size of the backlash. The controller records the actual encoder value at the switch-on time, but cannot infer the position of the backlash without traversing the axis. After the axis has been traversed for the first time by at least the size of backlashes, the technology object again shows the real mechanical position.

Incremental encoder adjustment "MC_Home" with "Mode" = 13

((tbd V18))

See also

Backlash compensation (Page 86)

5.7.10 Resetting the "Homed" status (S7-1500, S7-1500T)

Incremental encoder

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

- Error in sensor system/encoder failure
- Starting an "MC_Home" job with "Mode" = 3, 5, 8, 10
  (As soon the homing mark has been approached, the status "Homed" is set to "TRUE".)
- 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

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

Absolute encoder

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

- Replacement of the CPU
- Changing the encoder type to incremental encoder
- 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 encoder adjustment.

5.7.11 Tags: Homing (S7-1500, S7-1500T)

The following technology object tags are relevant for homing:

Status indicators	
Tag	**Description**
<TO>.StatusWord.X11 (HomingCommand)	Homing job running
<TO>.StatusWord.X5 (HomingDone)	Technology object homed
<TO>.ErrorWord.X10 (HomingFault)	Error occurred during homing
<TO>.StatusSensor[1..4].Adjusted	Encoder homed

NOTE

Evaluation of the bits in "StatusWord", "ErrorWord" and "WarningWord"

Note the information in section "Evaluating StatusWord, ErrorWord and WarningWord" of the "S7-1500/S7-1500T Motion Control overview" documentation (Page 12).

Approach to reference output cam	
Tag	**Description**
<TO>.Homing.ApproachDirection	Start direction or approach direction for the approach to the reference output cam
<TO>.Homing.ApproachVelocity	Velocity for the approach to the reference output cam

Approach to the homing mark	
Tag	**Description**
<TO>.Sensor[1..4].ActiveHoming.Direction	Homing direction
<TO>.Homing.ReferencingVelocity	Velocity for the approach to the homing mark

Approach to home position	
Tag	**Description**
<TO>.Homing.ApproachVelocity	Velocity for the move to homing point

Positions	
Tag	**Description**
<TO>.Homing.AutoReversal	Reversal at the hardware limit switches
<TO>.Homing.HomePosition	Home position
<TO>.StatusSensor[1..4].AbsEncoderOffset	Calculated offset after the absolute encoder adjustment

Parameters for active homing	
Tag	**Description**
<TO>.Sensor[1..4].ActiveHoming.Mode	Homing mode

Parameters for active homing	
Tag	**Description**
<TO>.Sensor[1..4].ActiveHoming.SideInput	Side of the digital input
<TO>.Sensor[1..4].ActiveHoming.Direction	Homing direction or approach direction
<TO>.Sensor[1..4].ActiveHoming.DigitalInputAddress	Address of digital input
<TO>.Sensor[1..4].ActiveHoming.HomePositionOffset	Offset of the homing mark from the home position

Parameters for passive homing	
Tag	**Description**
<TO>.Sensor[1..4].PassiveHoming.Mode	Homing mode
<TO>.Sensor[1..4].PassiveHoming.SideInput	Side of the digital input
<TO>.Sensor[1..4].PassiveHoming.Direction	Homing direction or approach direction
<TO>.Sensor[1..4].PassiveHoming.DigitalInputAddress	Address of digital input

5.8 Position monitoring functions (S7-1500, S7-1500T)

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

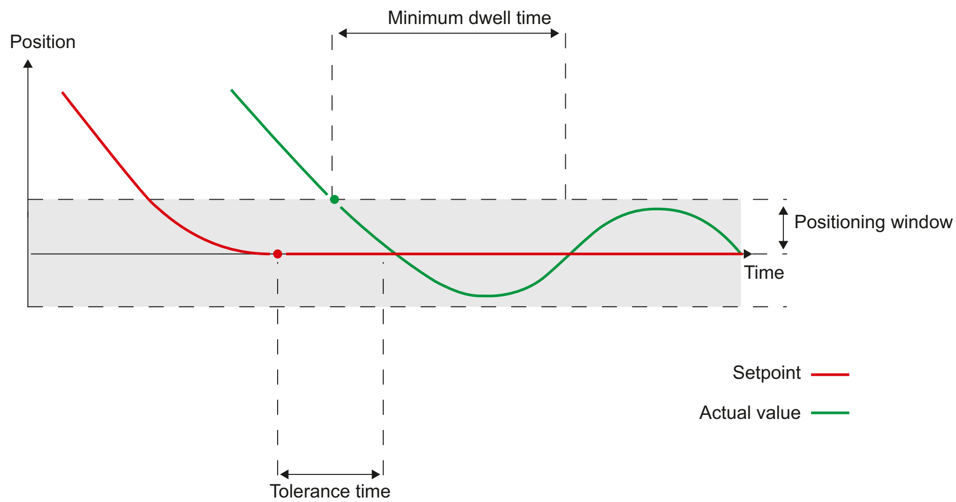
- Positioning monitoring (Page 157)
  The actual position value must reach a positioning window within a specified time, and remain in this positioning window for a minimum dwell time.
- Following error monitoring (Page 159)
  The following error is monitored based on a velocity-dependent following error limit. The permissible maximum following error depends on the velocity setpoint.
- Standstill signal (Page 160)
  When the actual velocity reaches the standstill window and remains there for the minimum dwell time, the standstill of the axis is indicated.

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

5.8.1 Positioning monitoring (S7-1500, S7-1500T)

Position 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 the setpoint reaching the target position
- By position-controlled stopping during motion by the Motion Control instruction "MC_Halt" or "MC_Stop"

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.

Configure positioning monitoring

You can find the positioning monitoring in the configuration of the positioning axis/synchronous axis under "Extended parameters > Position monitoring > Position monitoring".

Follow these steps:

1. In the "Positioning window" field, configure the size of the positioning window. If the axis is located within this window, the position is considered to be "reached".
2. In the "Tolerance time" field, configure the time within which the position value must reach the positioning window.
3. In the "Minimum dwell time" field, configure the time for which the current position value must be in the positioning window for at least the "minimum dwell time".
   Recommended setting: To avoid longer pauses, set values between 0 ms and 20 ms for dynamic positioning tasks.

5.8.2 Following error monitoring (S7-1500, S7-1500T)

The following error is the difference between the setpoint and actual position based on the connection of the axis at the drive. The leading behavior of the axis is contained in the following error. The size of the following error depends on the velocity. The following error also contains a portion that arises from the disturbance variables.

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

When calculating the following error, the transmission times of the setpoint to the drive and of the actual position value to the controller are deducted. The transmission times of the setpoints from the controller to the drive and the actual position values from the drive to the controller are therefore not part of the following error. The value of the following error is thus not the same as the difference between the position setpoint available in the controller minus the existing actual position.

The following error is thus calculated from the delayed position setpoint by $T_i + T_o + T_{DC} + T_{Servo}$ minus the actual position in the controller.

The calculation of the following error is valid for the following conditions:

- Position control with and without DSC
- Configuration with and without precontrol of the position control loop
- Configuration of the drive coupling via a PROFIdrive telegram or via an analog output

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.

Enabling and configuring following error monitoring

You can find the following error monitoring in the configuration of the positioning axis/synchronous axis under "Extended parameters > Position monitoring > Following error".

Select the "Enable following error monitoring" check box.

To configure the following error monitoring, follow these steps:

1. In the "Following error" field, configure the permissible following error for low velocities (without dynamic adaptation of the following error) in the unit of measure for position of the axis.
2. In the "Maximum following error" field, enter the maximum permissible following error in the unit of measure for position of the axis.
3. In the "Start of dynamic adjustment" field, enter in the unit of measure for velocity of the axis the velocity from which the following error is to be adjusted dynamically. Starting from this velocity, the following error up to the maximum velocity will be adjusted to the maximum following error.
4. In the "Warning level" field, enter the percentage of the permitted following error as of which a warning is output.

   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, the technology alarm 522 "Warning following error tolerance" is output. This is a warning and contains no alarm response.

Parameter assignment of the following error calculation with active dynamic filter

The following error is calculated from the delayed interpolated position setpoint by T_i, T_o, T_{DC} and T_{Servo} minus the current actual position value. The deceleration of the position setpoint by the dynamic filter in the technology object or through additional filters in the drive is not taken into account when calculating the following error. The calculated following error is therefore greater in reference to the position setpoint before the dynamic filter.

For correct calculation of the following error, configure an additional delay time <TO>.FollowingError.AdditionalSetpointDelayTime that delays the position setpoint when calculating the following error.

5.8.3 Standstill signal (S7-1500, S7-1500T)

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

Configuring stationary state detection

You can find the stationary state detection in the configuration of the positioning axis/synchronous axis under "Extended parameters > Position monitoring > Standstill signal".

Follow these steps:

1. In the "Standstill window" field, configure the size of the standstill window in the measurement unit for the axis velocity.
   To avoid repeated toggling of the "<TO>.Statusword.X7 (Standstill)" bit, a hysteresis acts internally when the standstill window is exited. To exit the standstill window again, the actual velocity must be slightly higher than configured for "Standstill window".
2. In the "Minimum dwell time in standstill window" field, configure the duration in seconds for which the velocity of the axis must remain in the standstill window for stationary state detection.

5.8.4 Tags: Position monitoring functions (S7-1500, S7-1500T)

Standstill signal

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

Status indicators	
Tag	**Description**
<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 value "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 set-point is therefore equal to zero.
<TO>.ErrorWord.X12 (PositioningFault)	A positioning error has occurred.

Positions and times	
Tag	**Description**
<TO>.PositioningMonitoring.Tolerance-Time	Maximum permissible time until positioning window is reached The time is started with the end of the setpoint interpolation.
<TO>.PositioningMonitoring.MinDwell-Time	Minimum dwell time in position window
<TO>.PositioningMonitoring.Window	Positioning window

Standstill signal	
Tag	**Description**
<TO>.StandstillSignal.VelocityThreshold	Velocity threshold for the standstill signal
<TO>.StandstillSignal.MinDwellTime	Minimum dwell time below the velocity threshold

Following error monitoring

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

Status indicators	
Tag	**Description**
<TO>.StatusPositioning.FollowingError	Current following error
<TO>.ErrorWord.X11 (FollowingError-Fault)	Status indication, that the following error is too large
<TO>.WarningWord.X11 (FollowingEr-rorWarning)	Status indication, that the following error warning limit has been reached

Control bits	
Tag	**Description**
<TO>.FollowingError.EnableMonitoring	Enable/disable following error monitoring

Timers	
Tag	**Description**
<TO>.FollowingError.AdditionalSetpoint-DelayTime	Time constant for additional deceleration of position setpoint to calculate the following error in the time unit of the axis

Limits	
Tag	**Description**
<TO>.FollowingError.MinVelocity	Lower velocity setpoint for the characteristic curve of the maximum following error
<TO>.FollowingError.MinValue	Permissible following error below the "<TO>.FollowingEr-ror.MinVelocity"
<TO>.FollowingError.MaxValue	Maximum permissible following error at maximum axis velo-city
<TO>.FollowingError.WarningLevel	Warning limit as a percentage value relative to the maximum permissible following error (velocity-dependent in accordance with the characteristic curve)

5.9 Configuring a control loop (S7-1500, S7-1500T)

Together with the controller in the drive, the technology object forms a cascade control system. The innermost control cascade is the current control, the next cascade is the speed

control. Both are located in the drive. The position controller is the outermost cascade and is in the technology object.
The position controller of the positioning axis/synchronous axis is a closed-loop P controller with or without velocity precontrol. Use the servo gain factor to set the gain of the proportional-action controller.
When position control is enabled, encoder systems, actual value calculation, controllers and monitors are active.
If position control is inactive, encoder systems, actual value calculation and monitoring are active on the actual value side.

Position controller configuration

Configure the position controller of the positioning axis/synchronous axis technology object:

- Control methods
  - Position control in the drive with Dynamic Servo Control (DSC) (Page 163)
  - Position control in the PLC (Page 164)
- Where does the position controller get its values?
  - Configuring position controller in the PLC (Page 166)
  - Configuring position controller for drives with DSC (Page 165)
- Setpoint filter
  - Configuring a dynamic filter (Page 167)

Optimize the position controller during commissioning.

- Optimize position controller (Page 181)

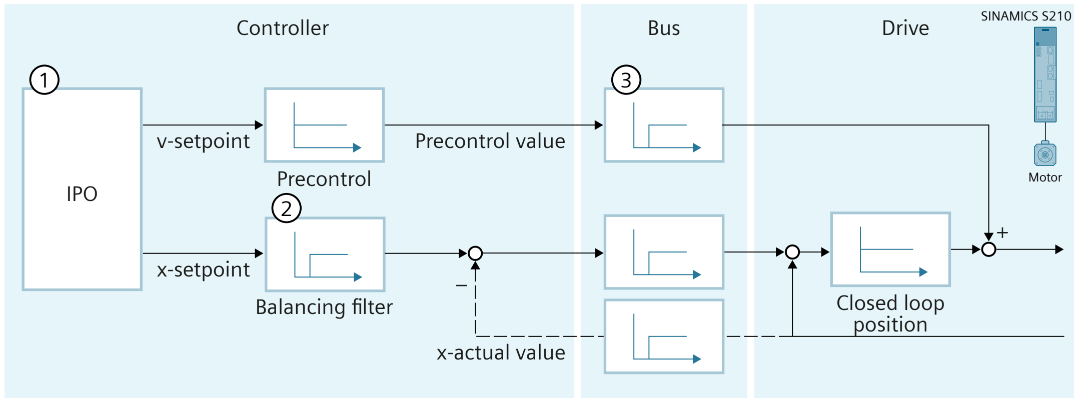
Additional information

For more information about axis control and controller optimization, refer to Siemens Industry Online Support in the FAQ entry 109779884 (https://support.industry.siemens.com/cs/ww/en/view/109779884).

5.9.1 Position control in the drive with Dynamic Servo Control (DSC) (S7-1500, S7-1500T)

In drives that support Dynamic Servo Control (DSC), you can use the position controller in the drive. If you use telegrams that support DSC, DSC, and thus the position controller in the drive, is automatically activated.
The position controller is usually executed in the drive in the cycle clock of the speed control loop. In this way, you can set higher position controller gain (Kv factor) and increase the dynamic response for reference variable sequence and disturbance variable correction for highly dynamic drives.
When used with a SINAMICS drive, DSC is the standard case, since the faster control cycle in the drive (e.g. 125 μs) leads to even better control quality.

The following figure shows the effective control structure **with** DSC and with precontrol:



① Interpolator with motion control

② Internal consideration of speed control loop substitute time

③ Communication between controller and drive

Requirements

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 configured on the drive:
  - Standard telegram 5 or 6
  - SIEMENS telegram 105 or 106

Procedure

To configure position control in the drive with DSC for a positioning axis/synchronous axis, follow these steps:

1. In the configuration of the technology object, navigate to "Extended parameters > Control loop > Dynamic Servo Control (DSC)".
2. Select the "Position control in the drive (DSC enabled)" option.
3. Apply the values from the drive.
   Configuring position controller for drives with DSC (Page 165)

Signal flow diagrams

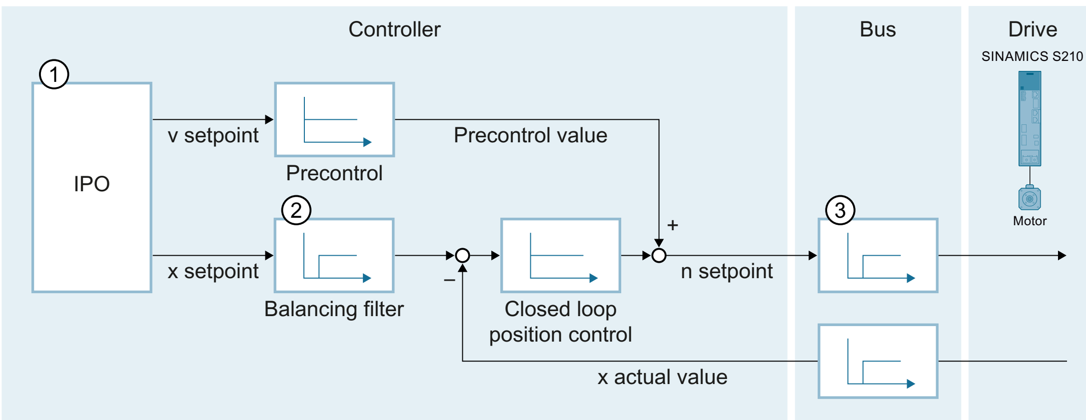
For more information about the control structure in the form of signal flow diagrams for the positioning axis/synchronous axis technology object, refer to the appendix (Page 356).

5.9.2 Position control in the PLC (S7-1500, S7-1500T)

The position controller is executed in the Motion Control application cycle, for example, 4 ms in the MC-Servo [OB91].

With position control in the CPU, the drive can be connected either isochronously or non-isochronously. If the drive supports isochronous mode, you can also connect it isochronously. You can find a description on how to connect a drive isochronously in section "Adding and configuring drives (Page 39)".

The following figure shows the effective control structure in position control in the controller:



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

Procedure

To configure position control in the CPU for a positioning axis/synchronous axis, follow these steps:

1. In the configuration of the technology object, navigate to "Extended parameters > Control loop > Dynamic Servo Control (DSC)".
2. Select the "Position control in the PLC" option.
3. Under "Position control", configure the values for precontrol, speed control loop substitute time and gain (Kv factor).
   Configuring position controller in the PLC (Page 166)

Signal flow diagrams

For more information about the control structure in the form of signal flow diagrams for the positioning axis/synchronous axis technology object, refer to the appendix (Page 356).

5.9.3 Configuring position controller for drives with DSC (S7-1500, S7-1500T)

You configure automatic adoption of the values for the positioning axis/synchronous axis in the configuration under "Extended parameters > Control loop > Position control".

A description of how to adapt the adopted values for the position controller to your axis is provided in section "Optimize position controller (Page 181)".

Automatic transfer from drive

If you have configured and optimized the assigned drive with SINAMICS Startdrive you can then apply the values for the Kv factor and the speed control loop substitute time from the drive.

Requirements:

- A drive is linked to the technology object.
- Dynamic Servo Control (DSC) is enabled.

Drive optimized

The display only applies if you have optimized the assigned drive with One Button Tuning (OBT).

- Display is green: Drive is optimized
- Display is gray: Drive is not optimized

Optimizing values on the drive

The green arrow takes you to the configuration of the drive in Startdrive. Optimize the drive there.

Taking values from the drive

When you click on this button you transfer the values from the drive to the technology object.

- Gain (Kv factor): The technology object adopts 50% of the value from the drive.
- Speed control loop substitute time: The technology object adopts the value from the drive.

	SINAMICS Startdrive offline	SINAMICS Startdrive online
Monitoring off	Offline values of the drive are applied. The values are transferred as start value to the technology object.	Online values of the drive are applied. The values are transferred as start value to the technology object.
Monitoring on	Offline values of the drive are applied. The values are transferred as actual values to the technology object.	Online values of the drive are applied. The values are transferred as actual values to the technology object.

5.9.4 Configuring position controller in the PLC (S7-1500, S7-1500T)

You configure the values for the position controller for the positioning axis/synchronous axis in the configuration under "Extended parameters > Control loop > Position control".

The basics on configuration values are explained below.

A description of how to set the suitable values for the position controller to your axis during commissioning is provided in section "Optimize position controller (Page 181)".

You need to optimize the speed controller separately on the drive.

Precontrol

Configure the percentage velocity precontrol in this field.

The velocity precontrol can be used to minimize the velocity-based following error during position control. As a result, faster positioning may be achieved because the reference variable acts faster.

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

With digital drive coupling, the velocity precontrol should be at 100%.

Speed control loop substitute time

In this field, configure the speed control loop substitute time (T_{vtc}).

The speed control loop substitute time is included in the balancing filter.

The balancing filter is a simplified model of the closed speed control loop. The balancing filter is used to prevent the position controller from overriding the speed manipulated variable during the acceleration and deceleration phases. To accomplish this, the position setpoint of the position controller is delayed by the speed control loop substitute time in relation to the speed precontrol.

Note the following regarding the configuration of the speed control loop substitute time:

- If you do not use any speed precontrol (0%), the configuration of the speed control loop substitute time is not relevant.
- If you use speed precontrol (>0%) and set the speed control loop substitute time to 0.0 s (default value), the axis will overshoot. To find the right setting, optimize the position controller.

Gain (Kv factor)

In this field, you configure 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 real axis (high stiffness), the higher the Kv factor can be configured. This reduces the following error, and a higher dynamic repsonse is achieved.

5.9.5 Configuring a dynamic filter (S7-1500, S7-1500T)

Applies to

- Positioning axis
- Synchronous axis

Use

Axes that act mostly independent of one another are usually optimized independent of one another. If necessary for the interaction in the overall system, a dynamic adjustment may be useful after optimizing the individual axes.

The axes involved in a machine often have different mechanics. When optimizing speed and position controllers of the individual axes, the axes will have different dynamics. Configure the dynamic filter to adapt the dynamic response of axes to one another.

For axes in a synchronous operation assembly with different speed control loop substitute times, we recommend a dynamic adjustment using the dynamic filter. You can precisely synchronize the real traversing movements between the leading axis and the following axis or two following axes because the same following error occurs in the axes involved.

For kinematics with different speed control loop substitute times T_{vtc} of the kinematics axes, a dynamic adaptation is required to travel the interpolated path motion with a high contour accuracy.

Description

The dynamic filter is a parameterizable PT2 setpoint filter with the time constants T_1, T_2 and an additional parameterizable dead time T_t. You use the filter to adjust axes with higher dynamic to the axis with the lowest dynamic. The dynamic filter is individually parameterizable for each positioning axis and synchronous axis.

The dynamic filter is disabled at the axis by default. To activate the dynamic filter at an axis, enable the dynamic filter in the configuration of the technology object and configure at least one of the timers T_1, T_2 or T_t to greater than 0.0.

T_t [1)]	T_1	T_2	Active dynamic filter
0.0	0.0	0.0	Dynamic filter not active (default)
>0.0	0.0	0.0	Exact setpoint delay via dead time
0.0	>0.0	0.0	PT1 setpoint filter without additional dead time
>0.0	>0.0	0.0	PT1 setpoint filter with additional dead time
0.0	0.0	>0.0	PT1 setpoint filter without additional dead time
>0.0	0.0	>0.0	PT1 setpoint filter with additional dead time
0.0	>0.0	>0.0	PT2 setpoint filter without additional dead time
>0.0	>0.0	>0.0	PT2 setpoint filter with additional dead time

1) The dead time Tt is internally limited to sixteen times the value from the application cycle of the MC_Servo. No alarm is output at higher values.

The dynamic filter is effective for position control with and without DSC. The dynamic filter delays the calculated position and velocity setpoints of the interpolator.

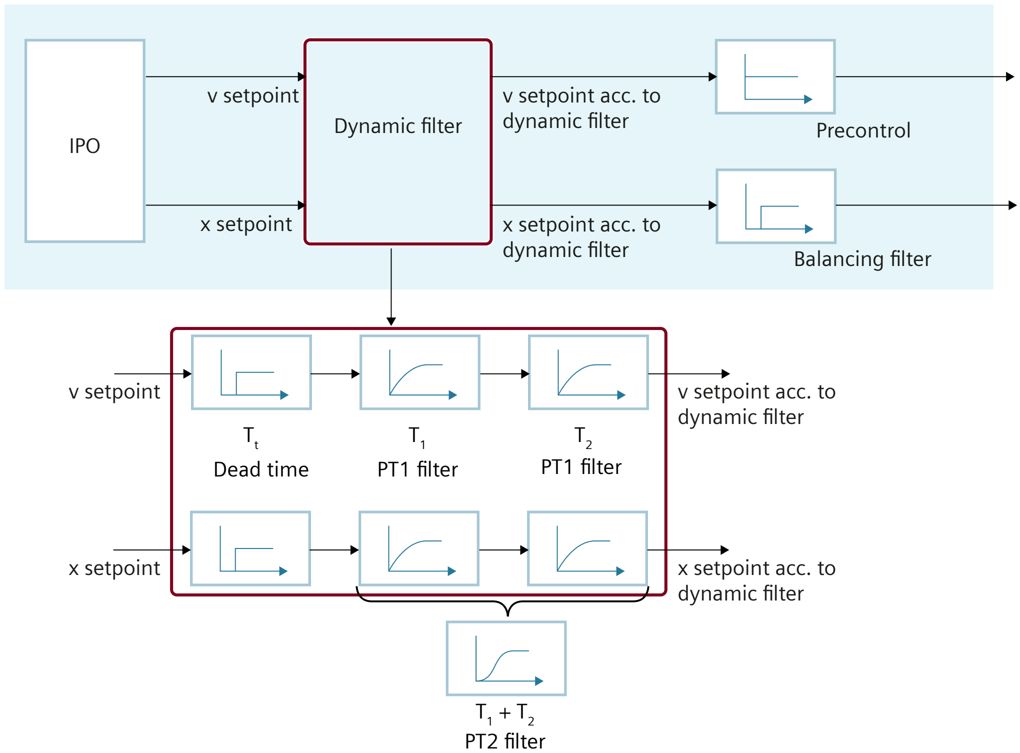
The series connection of two PT1 filters creates a PT2 filter. PT1/PT2 filters act as a low pass. This smooths the interpolated position and velocity setpoints. For the damping filter D of PT2 filter, D >= 1. The PT2 filter cannot vibrate.

The damping degree D is calculated using the following equation.

$$D = \frac{T_1 + T_2}{2 \cdot (T_1 \cdot T_2)^{\frac{1}{2}}}$$

The angular frequency ω is calculated using the following equation.

$$\omega = \frac{1}{(T_1 \cdot T_2)^{\frac{1}{2}}}$$



Procedure

1. First, optimize all axes.
2. Determine the speed control loop substitute times T_{vtc} (<TO>.DynamicAxisModel.VelocityTimeConstant) of all axes.
   Example:
   Axis 1: $T_{vtc} = 0.004$ s
   Axis 2: $T_{vtc} = 0.006$ s
   Axis 1 is the more dynamic axis. The difference is 0.002 s.
3. Enable the dynamic filter in the configuration of axis 1.
4. Configure the effective time constant of the dynamic filter (sum of the time constants T_1, T_2, T_t) at axis 1 to 0.002 s. Depending on the preferred filter behavior, set one of the following variants for parameter assignment of the dynamic filter. In the configuration of the technology object, you will see a graphic representation of the step response.
   - PT1: $T_1 = 0.002$ s
   - PT2: $T_1 = 0.001$ s, $T_2 = 0.001$ s
   - Exact setpoint delay without smoothing: $T_t = 0.002$ s
5. Parameterize the delay time of the dynamic filter for calculating the following error at axis 1. <TO>.FollowingError.AdditionalSetpointDelayTime = 0.002 s
   Following error monitoring (Page 159)

5.9.6 Switching the position control off and on (S7-1500, S7-1500T)

The position control of an axis can be switched off and on again with the following Motion Control instructions in the non-position-controlled mode:

- MC_Power
- MC_MoveVelocity
- MC_MoveJog
- MC_MotionInVelocity

The non-position-controlled mode is indicated in the tag of the technology object "<TO>.StatusWord.X28 (NonPositionControlled)" = TRUE.

MC_Power

The axis is enabled without position control with "MC_Power.Enable" = TRUE and the parameter "StartMode" = 0. The position control remains switched off until a different Motion Control instruction changes the status of the 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.

MC_MotionInVelocity and MC_MotionInPosition

A "MC_MotionInVelocity" job with "PositionControlled" = FALSE forces non-position-controlled operation.

A "MC_MotionInVelocity" job with "PositionControlled" = TRUE forces position-controlled operation.

The selected mode remains in effect after the job is completed.

A "MC_MotionInPosition" job forces position-controlled operation.

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_MotionInPosition
- MC_GearIn
- MC_GearInPos (S7-1500T)
- MC_CamIn (S7-1500T)

The position control remains active after completing the corresponding jobs.
The Motion Control instructions "MC_Halt" and "MC_Stop" are executed in position-controlled and also in non-position-controlled operation. The status of the position control is not changed by "MC_Halt"/"MC_Stop".
A torque limiting activated with "MC_TorqueLimiting" is in effect even with non-position-controlled operation.

5.9.7 Tags: Closed-loop control (S7-1500, S7-1500T)

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

<table>
<tr><th colspan="3">Parameters</th></tr>
<tr><th>Tag</th><th colspan="2">Description</th></tr>
<tr><td><TO>.PositionControl.Kv</td><td colspan="2">Proportional gain of the closed loop position control</td></tr>
<tr><td><TO>.PositionControl.Kpc</td><td colspan="2">Velocity precontrol of the positioning system (in %)</td></tr>
<tr><td><TO>.PositionControl.EnableDSC</td><td colspan="2">Enable DSC</td></tr>
<tr><td><TO>.DynamicAxisModel.VelocityTime-Constant</td><td colspan="2">Speed control loop substitute time [s]</td></tr>
<tr><td rowspan="5"><TO>.PositionControl.ControlDifference-Quantization.Mode</td><td colspan="2">Type of quantification
Configuration of a quantization when a drive with stepper motor interface is connected</td></tr>
<tr><td>0</td><td>No quantification</td></tr>
<tr><td>1</td><td>Quantization corresponding to encoder resolution</td></tr>
<tr><td>2</td><td>Quantization to a direct value (value input in "<TO>.PositionControl.ControlDifferenceQuantiza-tion.Value")</td></tr>
<tr><td colspan="2">Configuration is performed using the parameter view (data structure).</td></tr>
<tr><td><TO>.PositionControl.ControlDifference-Quantization.Value</td><td colspan="2">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).</td></tr>
</table>

The following technology object tags are relevant for the dynamic filter:

<table>
<tr><th colspan="3">Parameters</th></tr>
<tr><th>Tag</th><th colspan="2">Description</th></tr>
<tr><td rowspan="3"><TO>.SetpointFilter.DynamicFilter.Mode</td><td colspan="2">Dynamic filter mode</td></tr>
<tr><td>0</td><td>Dynamic filter not active</td></tr>
<tr><td>1</td><td>PT1/PT2 filter + dead time</td></tr>
<tr><td><TO>.SetpointFilter.DynamicFilter.T1</td><td colspan="2">First time constant of the PT2 filter in time unit of the axis</td></tr>
</table>

Parameters	
Tag	**Description**
<TO>.SetpointFilter.DynamicFilter.T2	Second time constant of the PT2 filter in time unit of the axis
<TO>.SetpointFilter.DynamicFilter.Tt	Additional dead time of the dynamic filter in time unit of the axis
<TO>.StatusServo.PositionAfterDynamic-Filter	Position setpoint after the dynamic filter

Commissioning (S7-1500, S7-1500T) 6

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" (https://support.industry.siemens.com/cs/ww/en/view/59191792) system manual.

6.1 Commissioning guidelines (S7-1500, S7-1500T)

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 > Settings of the control loop > Control loop"
Activate precontrol	Set the precontrol to 100 %.	"Technology object > Configuration > Extended parameters > Settings of the control loop > 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"

Step	Action to be performed	Supported by TIA Portal
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.	"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 and take over master control (Page 175). 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 (Page 179) at low velocity in the positive direction. ⇒ The drive must move. The actual position value must increase (positive direction). • Disable (Page 186) 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. In case of deviations, correct the parameters assigned for mechanics under "Technology object > Extended parameters > Mechanics". • For absolute encoders, check the absolute encoder adjustment. To do this, move the axis to the start of the traversing range and switch the system off. After the restart, check the actual encoder values for correctness. Repeat this step likewise at the traversing range end. If there are deviations, correct the following: – Settings for fine resolution under "Technology object > Data exchange with encoder" – Zero-crossing position of the encoder The position of the zero crossing can be changed by rotating the encoder in the dismantled state. With programmable encoders, the zero crossing can be adjusted by parameter assignment. The zero crossing must be outside the traversing range.	• "Technology object > Diagnostics > PROFIdrive telegram" • "Technology object > Commissioning > Axis control panel"
Specify dynamic parameters	For each traversing motion of the axis, enter the dynamic parameters (Page 180) in the axis control panel.	

Step	Action to be performed	Supported by TIA Portal
Checking the reference speed	Traverse the axis in jog mode (Page 179) 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"
Homing axis	If necessary, you can home (Page 178) the axis or set the home position.	
Optimize position controller	Use the Optimization (Page 181) 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
Commissioning additional technology objects	To commission additional technology objects, perform the corresponding steps again.	See above.

6.2 Take over master control and enable axis (S7-1500, S7-1500T)

You traverse individual axes during commissioning. A user program is not required.

With the axis control panel, you assume master control for a technology object and control the motions of the axis.

The axis control panel is located in the project tree of the speed axis, positioning axis and synchronous axis technology objects under "Technology object > Commissioning".

With optimization, you take over the master control and optimize the gain and the speed control loop substitute time of the position controller.

You optimize the positioning axis and synchronous axis technology objects under "Technology object > Commissioning".

WARNING

Unexpected axis motions

During commissioning, the axis can execute unexpected motions (e.g. due to erroneous configuration of the drive or the technology object). Any synchronized following axis is moved as well when moving a leading axis with the axis control panel or during optimization.

Therefore, perform the following precautionary measures before operation with the axis control panel or during 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.

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 commissioning for the technology object is not used by another instance of the TIA Portal.

Procedure

Follow these steps to control the axis:

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.

Setting the sign-of-life monitoring time

Monitoring time	Effect
Too low	Master control is frequently returned due to violation of the monitoring time and the axis stops with maximum deceleration because the communication time between the TIA Portal and CPU is longer than the configured monitoring time.
Appropriate	Monitoring time is not exceeded and the axis is stopped in time when the online connection is lost or sign of life monitoring is exceeded. Recommendation: 1000 ms to 2000 ms
Too high	Axis continues moving with the last setpoints of the axis control panel even though the connection between TIA Portal and CPU is interrupted or the communication time between TIA Portal and CPU is too long. The axis is not stopped in time because the monitoring time is still running.

Result

An online connection to the CPU is established, the axis control panel or optimization takes over master control of the technology object, and the technology object is enabled.

Behavior while the axis control panel or optimization has the master control

The axis can only be traversed with the axis control panel or the optimization. Access to the axis is blocked by another instance of the TIA Portal.

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).

Changes to the axis configuration will not become effective until the master control is taken over again.

In the following situations, the axis control panel or optimization will retain the master control and the axis keeps moving:

- The axis control panel/optimization is embedded in the TIA Portal, and you switch to a different window, for example, to the trace. Use the Split editor space option to use the axis control panel and the trace at the same time.

In the following situations, the axis control panel or optimization will retain the master control but stops the axis with maximum deceleration.

- The axis control panel or optimization is replaced in the TIA Portal, and you switch to a different window within the TIA Portal, for example, to the project tree. You change to a window outside of the TIA Portal.
- The "Stop" button is hidden by another dialog window or is no longer visible due to scrolling.

In the following situations, the axis is stopped with maximum deceleration and the axis control panel/optimization returns the master control to the user program.

- The online connection to the CPU fails and the time for sign of life monitoring has elapsed. The error message "ErrorID" = 16#8013 is displayed.
  Adapt the time for the sign-of-life monitoring in the warning.
- The online connection to the CPU is impaired by a communication load that is too high. The following message is entered in the alarm display log: "Commissioning error. Sign-of-life failure between controller and TIA Portal". Adapt the time for the sign-of-life monitoring in the warning.
- A dialog box (e.g. Save as) covers the axis control panel or optimization.

6.3 Homing with the axis control panel (S7-1500, S7-1500T)

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.

"Homing" mode corresponds to active homing with "Mode" = 3. The positioning axis/synchronous axis technology object performs a homing movement according to the configuration of the active homing (Page 133).

The "Set home position" operating mode in the axis control panel corresponds to direct homing (absolute) with "Mode" = 0.

For more detailed information on homing, refer to the section "Homing (Page 129)".

NOTE

Axis with absolute encoder

The absolute encoder adjustment is not available in the axis control panel. Perform the absolute encoder adjustment with the Motion Control instruction "MC_Home" with "Mode" = 6 or 7.

Actively homing the axis

Requirement

- The axis is enabled in the axis control panel.
- The parameters for active homing (Page 133) must be configured.

Procedure

1. Under "Operating mode", select "Homing" from the drop-down list.
2. Enter the home position in the Position text box.
3. Enter the setpoints for acceleration, deceleration and jerk.
4. Click the "Start" button. Homing movement is started.

Result

The axis executes the homing movement configured under "Active homing".

Setting the home position of an axis

Requirement

- The axis is enabled in the axis control panel.

Procedure

1. Under "Operating mode", select "Set home position" from the drop-down list.
2. Enter the position to which the axis is to be homed.
3. Click the "Start" button.

Result

The entered position is set as the actual position and the axis status is set to "Homed".

6.4 Traversing the axis with the axis control panel (S7-1500, S7-1500T)

Requirement

- The axis is enabled in the axis control panel.
- The setpoints for acceleration, deceleration and jerk have been entered in the control area.
- The axis is homed (position axis absolutely).

Jogging the axis

In "Jog" operating mode in the axis control panel, the motion commands are made by jogging.

1. Under "Operating mode", select "Jog" from the drop-down list.
2. To move the axis in the positive direction, keep the "Forward" button pressed.
3. To move the axis in the negative direction, keep the "Backward" button pressed.

Specify the velocity/speed in the axis control panel

For the "Velocity/speed setpoint" operating mode, 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".

1. Select the "Velocity/speed setpoint" entry in the "Operating mode" drop-down list.
2. Enter the velocity/speed setpoint in the "Velocity setpoint" text box.
3. To move the axis in the positive direction, click the "Forward" button.
4. To move the axis in the negative direction, click the "Backward" button.
5. Click the "Stop" button to stop the axis.

Position axis relatively

The positioning is executed as a controlled, relative traversing motion by the specified distance and the dynamic parameters assigned under "Control".

1. In the "Operating mode" drop-down list, select the entry "Relative positioning".
2. Specify the distance by which the axis is to be moved. A negative distance can be specified; it reverses the traversing direction. By clicking the "Forward" button, the axis travels in negative direction and vice versa.
3. Specify the dynamic parameters for the traversing motion.
4. To move the axis by the specified distance, click the "Forward" button. To move the axis by the specified distance in the opposite direction, click the "Backward" button.
5. Click the "Stop" button to stop the traversing motion.

Position axis absolutely

The positioning is executed as a controlled, absolute traversing motion by the specified distance and the dynamic parameters assigned under "Control".

1. In the "Operating mode" drop-down list, select "Absolute positioning".
2. Enter the target position.
3. Specify the dynamic parameters for the traversing motion.
4. Axes without modulo setting: To move the axis to the specified target position, click the "Start" button.
   Axes with modulo setting: To position the axis within the modulo range, click the "Forward" or "Backward" button. The axis is positioned within the modulo range. Position settings outside the modulo range are recalculated to the modulo range accordingly.
5. Click the "Stop" button to stop the traversing motion.

6.5 Specify the dynamics in the axis control panel (S7-1500, S7-1500T)

In the operating modes of the axis control panel, you can specify the dynamics for traversing the axis.

Configure the dynamic limits before you use the axis control panel so that the specified dynamic values from the axis control panel are limited and the default setting of the dynamic values takes place accordingly.

During the first commissioning, you should traverse the axis at low dynamics. Reduce the dynamic values to less than the default setting. Increase the dynamic values gradually when traversing of the axis meets your expectations.

Next, adapt the dynamic default and the dynamic limits in the configuration of the technology object. The dynamic values from the axis control panel are not automatically applied to the configuration of the technology object.

A velocity override or speed override set for the technology object is effective when operating the axis control panel.

Default setting of the dynamics values

The default setting of the dynamic values is as follows when calling the axis control panel:

Dynamic value	Default value
Velocity/ Velocity setpoint	Velocity or speed at which the axis is traversed when "Homing" operating mode is not selected. Default setting: 10% of the configured value in "Technology objects > Configuration > Extended parameters > Limits > Dynamics limits".
Acceleration	Acceleration with which the axis is traversed. Default setting: 10% of the configured value in "Technology objects > Configuration > Extended parameters > Limits > Dynamics limits".
Deceleration	Deceleration with which the axis is traversed. Default setting: 100% of the configured value in "Technology objects > Configuration > Extended parameters > Limits > Dynamic limits".
Jerk	Jerk with which the axis is traversed. Default setting: 100% of the configured value in "Technology objects > Configuration > Extended parameters > Limits > Dynamic limits".

6.6 Optimize position controller (S7-1500, S7-1500T)

The following section describes how to optimize the position controller of a drive with the axis control panel.
How you proceed depends on the assigned drive:

- SINAMICS drive with DSC configured with Startdrive
- SINAMICS drive with DSC configured without Startdrive
- Drive without DSC

Requirement

- 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.
- The axis has been enabled for commissioning.

Procedure for SINAMICS drives with DSC configured with Startdrive

To optimize the position controller, follow these steps:

1. Configure values for the distance, duration, and dynamics of a test step in the "Measurement configuration" area.
2. Click the green arrow at "Optimize values in drive".
   You go to the optimization of the drive in the Startdrive.
3. Optimize the controller automatically in Startdrive using One Button Tuning (OBT).

4. Navigate back to the optimization of the axis.
   The "Drive optimized" display is green.
5. Click the "Apply values from drive" button.
   The following valus are applied:
   – Gain (Kv factor): The technology object adopts 50% of the value from the drive (r5276).
   – Speed control loop substitute time: The technology object adopts the value from the drive (r5277).

   The online values of the drive are applied when they are connected to the drive online in SINAMICS Startdrive. The offline values of the drive are applied when they are not connected to the drive online in SINAMICS Startdrive.
6. Click the "Forward" or "Backward" button to start a test step for the optimization in positive or negative direction.
   A setpoint is output according to the specified distance for the specified duration. The axis moves by the specified distance. A trace recording of the motion (setpoint and actual values) is created automatically in the "Trace" area.
7. Evaluate the trace recording.
8. If you are not yet satisfied with the optimization result, continue to adjust the gain (KV).
9. Apply the optimized parameters in the project.

Procedure for SINAMICS drives with DSC configured without Startdrive

Requirements: You have carried out a One Button Tuning (OBT) controller optimization in the configuration of the drive. If you use an alternative method for controller optimization in drive, then proceed as with the other drives.

To optimize the position controller, follow these steps:

1. If necessary, configure values for the distance, duration, and dynamics of a test step in the "Measurement configuration" area.
2. Configure the following values as actual values in the "Optimize position controller" area:
   – Gain (Kv factor): Apply 50% of the value from the parameter r5276 of the drive in the technology object.
     Please note: Kv(TO)=0.5*16.66666*Kv(r5276)
   – Speed control loop substitute time: Apply the value from the parameters r5277 of the drive in the technology object.
     Please note: vtc(TO)=0.001*vtc(r5277)
3. Click the "Forward" or "Backward" button to start a test step for the optimization in positive or negative direction.
   A setpoint is output according to the specified distance for the specified duration. The axis moves by the specified distance. A trace recording of the motion (setpoint and actual values) is created automatically in the "Trace" area.
4. Evaluate the trace recording.
5. If you are not yet satisfied with the optimization result, continue to adjust the gain (KV).
6. Apply the optimized parameters in the project.

Procedure for other drives

You use the procedure described here for the following drives:

- SINAMICS drives with DSC that are not optimized with OBT
- SINAMICS drives without DSC
- Third-party drives

To optimize the position controller, follow these steps:

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. In the "Axis" area, click the "Enable" button to enable the technology object.
3. Configure values for the distance and dynamics of a test step in the "Measurement configuration" area. Select a sufficiently long measurement duration to record the entire measurement with the trace. If the measurement duration is too short, you will see a warning when entering the value.
4. Configure the following values as actual values in the "Optimize position controller" area:
   – Precontrol: 0.0
   – Speed control loop substitute time: 0.0
   – Gain (Kv factor): 10.0
5. Click the "Forward" or "Backward" button to start a test step for the optimization in positive or negative direction.
   To traverse the specified distance, a trapezoid velocity profile is used. The velocity profile is calculated from the specified dynamic parameters and the distance. A trace recording of the motion (setpoint and actual values) is created automatically in the "Trace" area.

   NOTE

   Check whether the current or torque limitation is active in the drive. To get a meaningful trace recording, both limitations should not be active during optimization. To do this, record the tag <TO>.StatusTorqueData.ActualTorque when using telegram 750 or check the limitations directly in the drive.

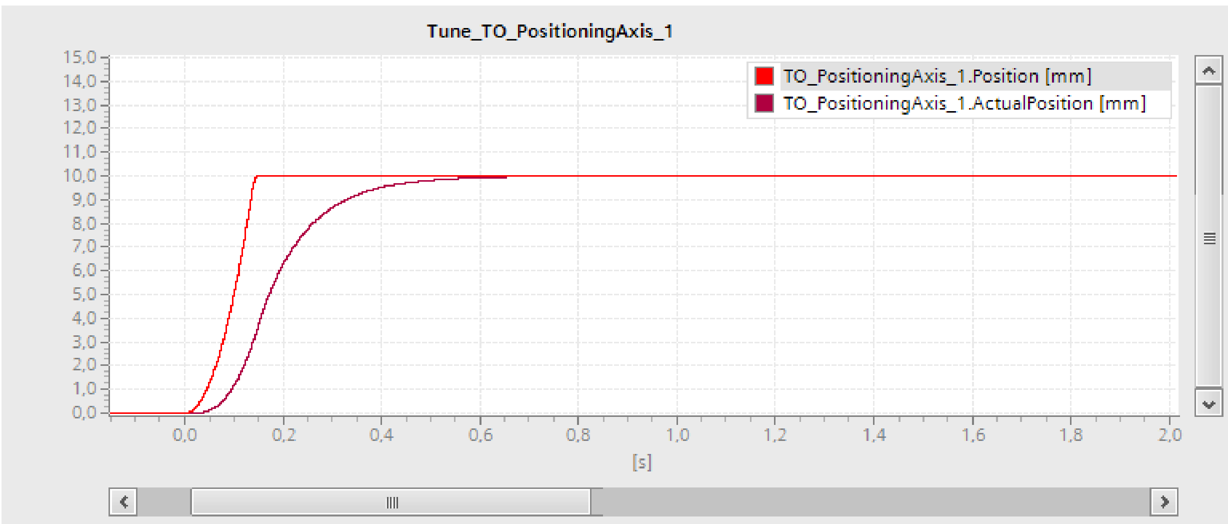
6. Evaluate the trace recording.
7. If required, increase in "measurement configuration" the values you use for "acceleration" and "deceleration".
8. Configure the following values as actual values in the "Optimize position controller" area:
   – Precontrol: 100.0
   – Speed control loop substitute time: 0.0
   – Gain (Kv factor): 90 % of the determined value
9. Adjust the speed control loop equivalent time until no more overshoots occur.
10. Apply the optimized parameter values as start values in the project.

Evaluating trace recordings

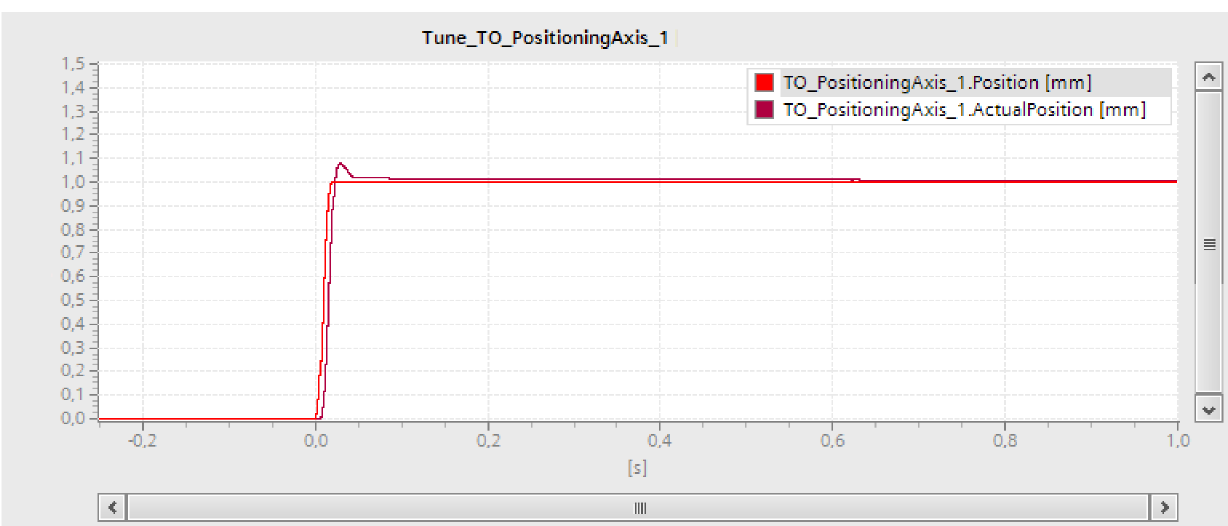
The trace recordings are not saved. Note the following properties of the curve:

- 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).

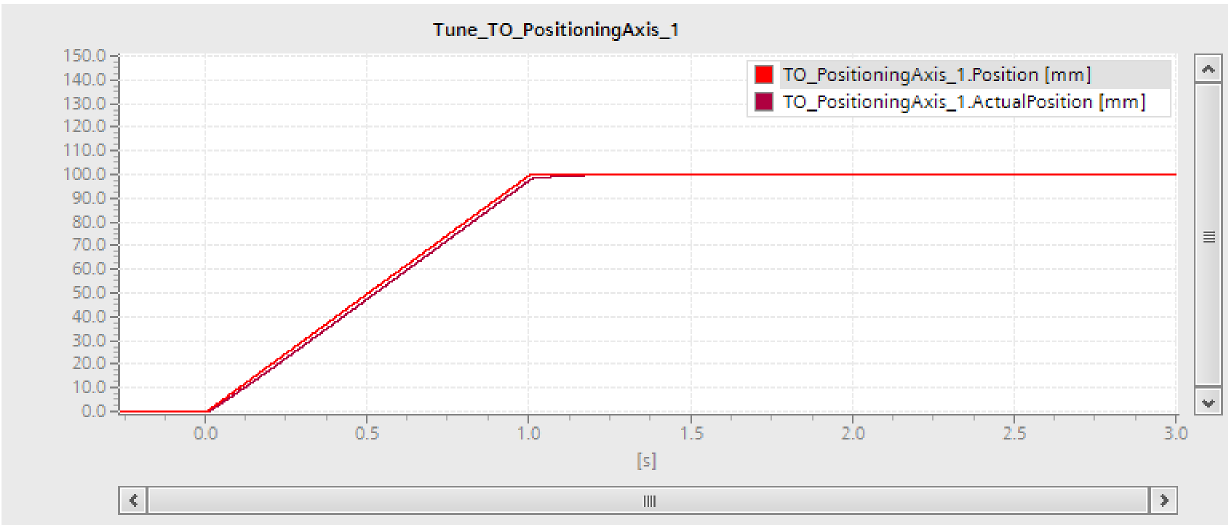
The following trace recording shows a curve with a long settling time:



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:



Adjust gain (Kv factor)

Proceed as follows to adapt the gain (Kv factor):

1. Increase the value with each test step, e.g. by 5%. If there is no major change in the control behavior, then select larger steps.
2. Click the "Forward" or "Backward" button to start another test step for optimization in the positive or negative direction.
3. Evaluate the trace recording.
4. Repeat steps 1-3 unit until no more overshoots occurs.

Adjust 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 the velocity variable being overridden by the position controller 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. Proceed as follows to adapt the speed control loop equivalent time:

1. Increase the value with each test step, e.g. by 1 ms.
2. On "Forward" or "Backward", perform another test step.
3. Evaluate the trace recording.
4. Repeat steps 1-3 unit until no more overshoots occurs.

Transferring the optimized parameter values of the position controller to the project

To transfer the optimized 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. This means the value is applied to the configuration of the technology object in the project.
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.

Additional information

For more information about axis control and axis optimization, refer to Siemens Industry Online Support in the FAQ entry 109779884 (https://support.industry.siemens.com/cs/ww/en/view/109779884).

6.7 Disable axis and hand over master control (S7-1500, S7-1500T)

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 equivalent time in your configuration using the "Project start value" value.

Requirement

- The axis is enabled in the axis control panel/optimization.
- The enabled technology object accepts Motion Control jobs.
- Speed control and position control are active.
- The actual values of the technology object are valid.

Procedure

Follow these steps to disable the axis and hand over the master control using the axis control panel or optimization:

1. To disable the technology object, click the "Disable" button in the "Axis" area.
2. To return master control to your user program, click the "Deactivate" button in the "Master control" area.

Diagnostics (S7-1500, S7-1500T) 7

The description of Motion Control diagnostics is limited to the diagnostics view of the technology objects in TIA Portal, the technology alarms and the error detections on Motion Control instructions.

The following descriptions can be found in the "S7-1500/S7-1500T Motion Control alarms and error IDs" documentation (Page 12):

- Diagnostics concept
- Technology alarms
- Error IDs in Motion Control instructions

A comprehensive description of the system diagnostics of the S7-1500 CPU can be found in the "Diagnostics" function manual (https://support.industry.siemens.com/cs/ww/en/view/59192926).

7.1 Speed-controlled axis technology object (S7-1500, S7-1500T)

7.1.1 Status and error bits (S7-1500, S7-1500T)

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))

Status	Description
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)	There is no active motion job at 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 limit active	At least the threshold value (default 90%) of the preset force/torque limitation acts on the axis. (<TO>.StatusWord.X27 (InLimitation))
Active stop job	The axis is stopped and disabled by Motion Control instruction "MC_Stop". (<TO>.StatusWord2.X0 (StopCommand))

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	A job cannot be executed. A Motion Control instruction cannot be executed because the necessary conditions have not been met. (<TO>.WarningWord.X3 (CommandNotAccepted))
Dynamic limitation	The dynamic values are limited to the dynamic limits. (<TO>.WarningWord.X6 (DynamicWarning))

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 was 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 more information and to acknowledge the error, go to the Inspector window by clicking on the "Alarm display" link.

More information

An option for evaluating the individual status bits can be found in the section "Evaluating StatusWord, ErrorWord and WarningWord" of the "S7-1500/S7-1500T Motion Control overview" (Page 12) documentation.

See also

"StatusWord" tag (speed axis) (Page 294)
"ErrorWord" tag (speed axis) (Page 295)
"WarningWord" tag (speed axis) (Page 297)

7.1.2 Motion status (S7-1500, S7-1500T)

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)

7.1.3 PROFIdrive telegram (S7-1500, S7-1500T)

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)

7.2 Positioning axis technology object (S7-1500, S7-1500T)

7.2.1 Status and error bits (S7-1500, S7-1500T)

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))

Status	Description
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[1].State)
Encoder values valid (S7-1500T)	The actual encoder values of encoder 1, encoder 2, encoder 3 or encoder 4 are valid. (<TO>.StatusSensor[1..4].State)
Active encoder (S7-1500T)	The encoder in effect operationally is encoder 1, encoder 2, encoder 3 or encoder 4. (<TO>.OperativeSensor)
Encoder values homed	Encoder is homed with one of the following homing types: • Active homing • Passive homing • Absolute encoder adjustment • Incremental encoder adjustment (<TO>.StatusSensor[1].Adjusted)
Encoder homed (S7-1500T)	Encoder 1, encoder 2, encoder 3 or encoder 4 is homed with one of the following homing types: • Active homing • Passive homing • Absolute encoder adjustment • Incremental encoder adjustment (<TO>.StatusSensor[1..4].Adjusted)
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 has been approached. (<TO>.StatusWord.X15 (SWLimitMinActive))
Positive SW limit switch approached.	The positive software limit switch has been approached. (<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 job 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 limit active	At least the threshold value (default 90%) of the preset force/torque limitation acts on the axis. (<TO>.StatusWord.X27 (InLimitation))
Active stop job	The axis is stopped and disabled by Motion Control instruction "MC_Stop". (<TO>.StatusWord2.X0 (StopCommand))

Status	Description
Superimposed motion	The motion of the axis is superimposed by at least one overlapping Motion Control instruction. (OR logic operation) (<TO>.StatusWord.X23 (MoveSuperimposedCommand)) (<TO>.StatusWord2.X6 (MotionInSuperimposedCommand)) (<TO>.StatusWord2.X7 (HaltSuperimposedCommand))

Warnings

The following table shows the possible warnings:

Warning	Description
Configuration	One or more configuration parameters are being internally adapted tempor-arily. (<TO>.WarningWord.X1 (ConfigWarning))
Job rejected	Job cannot be executed. You cannot execute a Motion Control instruction because necessary require-ments are not fulfilled. (<TO>.WarningWord.X3 (CommandNotAccepted))
Dynamic limitation	The dynamic values are limited to the dynamic limits. (<TO>.WarningWord.X6 (DynamicWarning))

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 was 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>.StatusSensor[1].Error)
Encoder (S7-1500T)	An error has occurred in the encoder system of encoder 1, encoder 2, encoder 3 or encoder 4. (<TO>.StatusSensor[1..4].Error)
Data exchange	Communication with a connected device is faulty. (<TO>.ErrorWord.X7 (CommunicationFault))

Error	Description
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 require-ments 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))
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))

Alarm display

For more information and to acknowledge the error, go to the Inspector window by clicking on the "Alarm display" link.

More information

An option for evaluating the individual status bits can be found in the section "Evaluating StatusWord, ErrorWord and WarningWord" of the "S7-1500/S7-1500T Motion Control overview" (Page 12) documentation.

See also

"StatusWord" tag (positioning axis) (Page 326)

"ErrorWord" tag (positioning axis) (Page 328)

"WarningWord" tag (positioning axis) (Page 330)

7.2.2 Motion status (S7-1500, S7-1500T)

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.MaxJerk)

7.2.3 PROFIdrive telegram (S7-1500, S7-1500T)

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

in the areas "Encoder" for CPU S7-1500 or "Encoder 1" to "Encoder 4" for CPU S7-1500T, the following parameters from the PROFIdrive telegram are displayed by 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)

7.3 Technology object external encoder (S7-1500, S7-1500T)

7.3.1 Status and error bits (S7-1500, S7-1500T)

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))

Status	Description
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)
Encoder values homed	Encoder is homed with one of the following homing types: • Active homing • Passive homing • Absolute encoder adjustment • Incremental encoder adjustment (<TO>.StatusSensor[n].Adjusted)
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)	There is no active Motion Control job 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 was 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))

Error	Description
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 more information and to acknowledge the error, go to the Inspector window by clicking on the "Alarm display" link.

More information

An option for evaluating the individual status bits can be found in the section "Evaluating StatusWord, ErrorWord and WarningWord" of the "S7-1500/S7-1500T Motion Control overview" (Page 12) documentation.

See also

"StatusWord" tag (external encoder) (Page 341)

"ErrorWord" tag (external encoder) (Page 342)

"WarningWord" tag (external encoder) (Page 344)

7.3.2 Motion status (S7-1500, S7-1500T)

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)

7.3.3 PROFIdrive telegram (S7-1500, S7-1500T)

The "Technology object > Diagnostics > PROFIdrive telegram" diagnostic function is used in the TIA Portal to monitor the PROFIdrive telegram of the encoder. The display of the diagnostics function is available in technology object online mode.

"Encoder" area

This area displays the following parameters contained in the PROFIdrive telegram 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)

Instructions (S7-1500, S7-1500T) 8

8.1 MC_Power V7 (S7-1500, S7-1500T)

8.1.1 MC_Power: Enable, disable technology object V7 (S7-1500, S7-1500T)

Description

With the Motion Control instruction "MC_Power", a technology object is enabled or disabled and, if necessary, a configured drive is switched on or off.

NOTE

Multi-instance DBs

If you use multi-instances of the MC_Power instruction, create the multi-instances in a separate function block. This allows you to download program blocks from other sections of your user program without switching off the axes, including in RUN mode.

Applies to

- Speed axis
- Positioning axis
- Synchronous axis
- External encoder

Requirements

- The technology object has been configured correctly.
- The readiness of the drive is assumed for enabling the technology object. When using the SIEMENS telegram 10x, you can evaluate the bit "DriveReady" from the signal word "MELDW" of the receiving telegram "PD_TEL10x_IN".
- Cyclic bus communication is established between controller and encoder ("<TO>.StatusSensor[1..4].CommunicationOK" = TRUE).
- Cyclic bus communication is established between controller and drive ("<TO>.StatusDrive.CommunicationOK" = TRUE).
- The status of the active encoder is valid ("<TO>.StatusSensor[1..4].State" = 2).
- The optional data adaption (Page 61) has been completed ("<TO>.StatusDrive.AdaptionState" = 2 and "<TO>.StatusSensor[1..4].AdaptionState" = 2).

The requirements that must be met before a technology object can be released via "MC_Power" can be found in the Siemens Industry Online Support in the FAQ entry 109750297 (https://support.industry.siemens.com/cs/ww/en/view/109750297).

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 the Motion Control instruction "MC_Power":

<table>
<tr><th>Parameter</th><th>Declaration</th><th>Data type</th><th>Default value</th><th colspan="2">Description</th></tr>
<tr><td>Axis</td><td>INPUT</td><td>TO_SpeedAxis
TO_PositioningAxis
TO_SynchronousAxis
TO_ExternalEncoder</td><td>-</td><td colspan="2">Technology object</td></tr>
<tr><td rowspan="2">Enable</td><td rowspan="2">INPUT</td><td rowspan="2">BOOL</td><td rowspan="2">FALSE</td><td>TRUE</td><td>The technology object is enabled.</td></tr>
<tr><td>FALSE</td><td>The technology object is disabled.
All current jobs at the technology object are aborted in accordance with the configured "StopMode".</td></tr>
<tr><td rowspan="3">StartMode</td><td rowspan="3">INPUT</td><td rowspan="3">DINT</td><td rowspan="3">1</td><td>0</td><td>Enable positioning axis/synchronous axis not position-controlled</td></tr>
<tr><td>1</td><td>Enable positioning axis/synchronous axis position-controlled</td></tr>
<tr><td colspan="2">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.</td></tr>
<tr><td rowspan="2">StopMode</td><td rowspan="2">INPUT</td><td rowspan="2">INT</td><td rowspan="2">0</td><td colspan="2">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".</td></tr>
<tr><td>0</td><td>Emergency stop
When the technology object is disabled, the axis is braked to a standstill without jerk limit, using the emergency stop deceleration configured in "Technology object > Configuration > Extended parameters > Emergency stop". The drive is then switched off and the technology object is locked.
(<TO>.DynamicDefaults.EmergencyDeceleration)</td></tr>
</table>

Parameter	Declaration	Data type	Default value	Description	
StopMode	INPUT	INT	0	1	Immediate stop When a technology object is disabled, the setpoint zero is output. The axis is braked to a standstill according to the configuration in the drive. The drive is then switched off and the technology object is locked.
				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 drive is then switched off and the technology object is locked. (<TO>.DynamicLimits.MaxDeceleration; <TO>.DynamicLimits.MaxJerk)
				3	Coasting down When the technology object is disabled, the drive is de-energized (pulse suppression) and switches to the closing lockout state. The drive then coasts to a stop. If you are using a drive with an analog setpoint interface, the enable output is disabled and the analog output signal is set to 0.0. **Note** Using drives with motor holding brake With pulse suppression, the drive gives the command to close the motor holding brake immediately and independently of the motor speed. If you do not want the brake to close, make sure to keep the brake open with the FB "LAxisCtrl_BrakeControl". "LAxisCtrl" library (https://support.industry.siemens.com/cs/ww/en/view/109749348)
Status	OUTPUT	BOOL	FALSE	Technology object enable status	
				FALSE	Disabled • The technology object 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.

Parameter	Declaration	Data type	Default value	Description	
Status	OUTPUT	BOOL	FALSE	TRUE	Enabled • The enabled technology object 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	The job is being processed.
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 for parameter "ErrorID" You can find more detailed information in the "Error IDs" section of the "S7-1500/S7-1500T Motion Control alarms and error IDs" documentation (Page 12).	

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 takes effect as the position setpoint 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 responses.

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.

Enabling axes with noisy encoder signals

When the "Enable" input is set, the extrapolated actual position is applied as the position setpoint. For extrapolation, the current actual velocity and the timers $T_i + T_{ipo} + T_{servo}$ are taken into account.

Noisy encoder signals cause the detection of an actual velocity despite standstill of the axis. For encoders with low resolution, this detected actual velocity is greater than for encoders with high resolution. High actual velocities result in significant jumps of the position setpoint when enabling the axis.

To output the velocity setpoint zero when enabling the axis in "StartMode" = 1 and prevent jumps of the position setpoint and braking of the axis with maximum deceleration, set <TO>.PositionControl.VelocityModePowerOn = 1. Monitoring operations and dynamic limits are not active in this case.

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 and, if necessary, a configured drive switched off.

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 "Enable" = TRUE parameter, 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 the "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 "Enable" = TRUE parameter, 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 the "Enable" = FALSE parameter, 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".

More information

You can find more detailed information on enabling and disabling technology objects and drives in the section ""MC_Power" function diagrams (Page 346)".

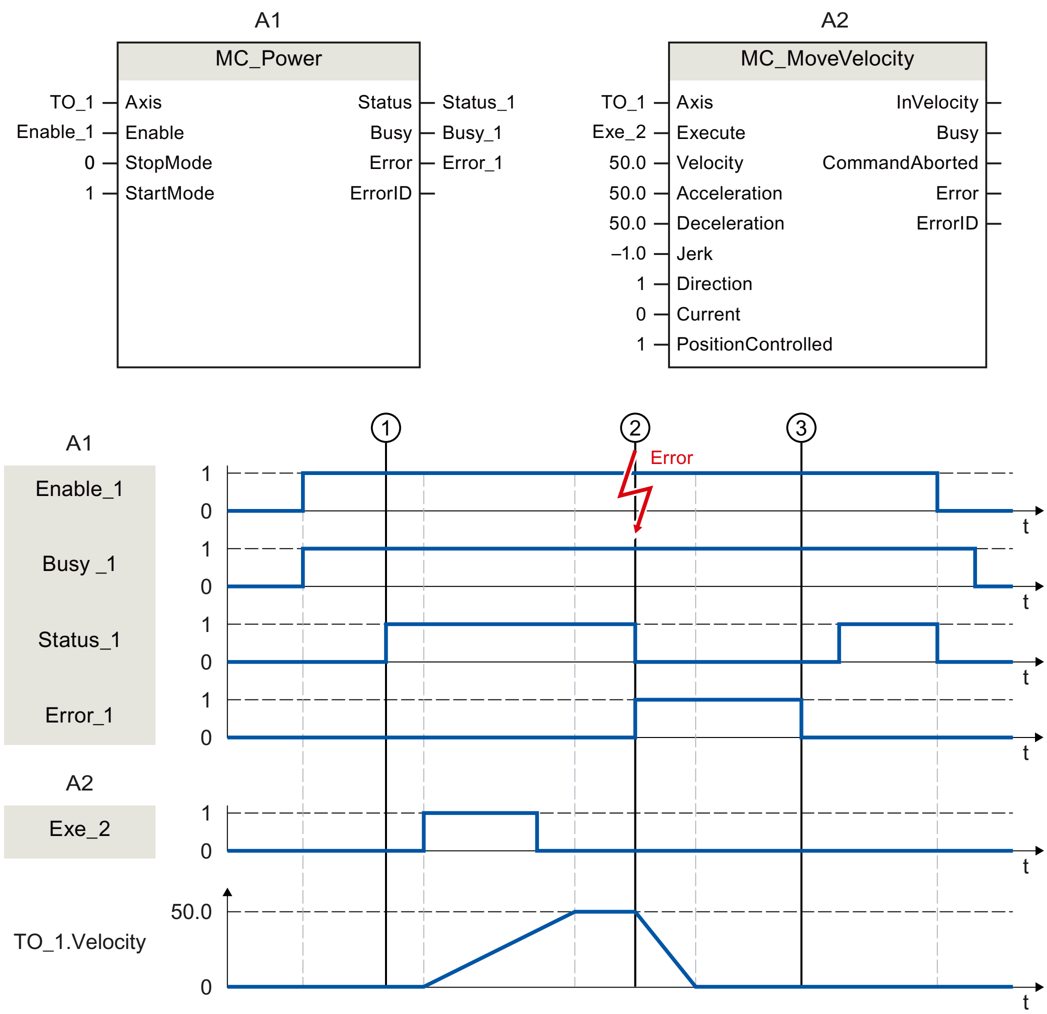
See also

Transferring drive and encoder parameters automatically (Page 61)

Emergency stop deceleration (Page 102)

8.1.2 MC_Power: Function chart V7 (S7-1500, S7-1500T)

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.

8.2 MC_Reset V7 (S7-1500, S7-1500T)

8.2.1 MC_Reset: Acknowledge alarms, restart technology object V7 (S7-1500, S7-1500T)

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 object data block. An acknowledgment of alarms in the drive is also possible without a pending error at the technology object.
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 object data block.

Applies to

- All technology objects

Requirement

- The technology objects speed axis, positioning axis, synchronous axis and external encoder.
  For a restart, the technology object must be disabled.
  ("MC_Power.Status" = FALSE and "MC_Power.Busy" = FALSE)
- Cyclic BUS communication is established between controller and encoder ("<TO>.StatusSensor[1..4].CommunicationOK" = TRUE).
- Cyclic BUS communication is established between controller and drive ("<TO>.StatusDrive.CommunicationOK" = TRUE).

Override response

- An "MC_Reset" job cannot be aborted by any other Motion Control job.
- A "MC_Reset" job with "Restart" = TRUE cancels all running Motion Control jobs.

Parameters

The following table shows the parameters of the Motion Control instruction "MC_Reset":

Parameter	Declaration	Data type	Default value	Description	
Axis	INPUT	TO_SpeedAxis TO_PositioningAxis TO_SynchronousAxis TO_ExternalEncoder TO_LeadingAxisProxy (S7-1500T) TO_OutputCam TO_CamTrack TO_MeasuringInput TO_Cam (S7-1500T) TO_Cam_10k (S7-1500T) TO_Kinematics (S7-1500T)	-	Technology object	
Execute	INPUT	BOOL	FALSE	TRUE	Start job with a positive edge
Restart	INPUT	BOOL	FALSE	TRUE	Reinitialization of the technology object and acknowledgment of pending technology alarms. The technology object is being reinitialized with the configured start values.
				FALSE	Acknowledgment of queued technology alarms
Done	OUTPUT	BOOL	FALSE	TRUE	Technology alarms have been acknowledged. The restart has been executed.
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 for parameter "ErrorID" You can find more detailed information in the "Error IDs" section of the "S7-1500/S7-1500T Motion Control alarms and error IDs" documentation (Page 12).	

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.

If you acknowledge multiple pending alarms, the pending alarms are displayed once more briefly in the "ErrorDetail.Number" tag without being signaled again. Check whether all alarms have been acknowledged after a restart with "MC_Reset.Done" = TRUE has been completely processed.

NOTE

Acknowledge technology alarms with "Restart" = FALSE

To acknowledge only the technology alarms, set "Restart" = FALSE. The technology object cannot be used during a restart. All technology alarms on axes and encoders are acknowledged, even if they are not enabled or not effective.

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.

You can find more information on restarting in the "Restarting technology objects" section of the "S7-1500/S7-1500T Motion Control overview" documentation (Page 12).

8.3 MC_Home V7 (S7-1500, S7-1500T)

8.3.1 MC_Home: Home technology object, set home position V7 (S7-1500, S7-1500T)

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.

With active homing, the default values under "Technology object > Configuration > Extended parameters > Dynamic default values" are used for the dynamic values acceleration, deceleration and jerk.

Applies to

- Positioning axis
- Synchronous axis
- External encoder

Requirement

- The technology object has been configured correctly.
- "Mode" = 2, 3, 5, 8, 10
  The technology object is enabled.
- "Mode" = 6, 7, 8, 11, 12, 13
  The encoder actual values are valid (<TO>.StatusSensor[1..4].State = 2).
- "Mode" = 0, 1, 6, 7
  The axis is in position-controlled mode.

Override response

The override response for "MC_Home" jobs is described in section "Override response V7: Homing and motion jobs (Page 279)".

Parameters

The following table shows the parameters of the Motion Control instruction "MC_Home":

Parameter	Declaration	Data type	Default value	Description	
Axis	INPUT	TO_PositioningAxis TO_SynchronousAxis TO_ExternalEncoder	-	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	Type of homing See table below	
Sensor	INPUT	DINT	0	S7-1500: Not relevant	
				S7-1500T: Selection of the absolute encoder ("Mode" = 6, 7) or incremental encoder ("Mode" = 13) to be calibrated	
				0	Operative encoder
				1..4	Encoder 1..4 (S7-1500T)
ReferenceMarkPosition	OUTPUT	LREAL	0.0	Display of the position at which the technology object was homed. With active homing, the homing mark position corresponds to the home position minus home position offset. With passive homing, the homing mark position corresponds to the home position. (valid when "Done" = TRUE)	
Done	OUTPUT	BOOL	FALSE	TRUE	Job is completed.
Busy	OUTPUT	BOOL	FALSE	TRUE	The job is being processed.

Parameter	Declaration	Data type	Default value	Description	
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 for parameter "ErrorID" You can find more detailed information in the "Error IDs" section of the "S7-1500/S7-1500T Motion Control alarms and error IDs" documentation (Page 12).	

More information

An option for evaluating the individual status bits can be found in the section "Evaluating StatusWord, ErrorWord and WarningWord" of the "S7-1500/S7-1500T Motion Control overview" (Page 12) documentation.

"Mode" parameter

Value	Description
0	Direct homing (absolute) The current position of the technology object is set to the value of parameter "Position". **Note** In the case of an axis with several encoders, the offset of the position at the sensors of all encoders is also applied with a position correction with the "Mode" parameter = 0. This prevents the sensors from diverging.
1	Direct homing (relative) The current position of the technology object is shifted by the value of parameter "Position". **Note** In the case of an axis with several encoders, the offset of the position at the sensors of all encoders is also applied with a position correction with the "Mode" parameter = 1. This prevents the sensors from diverging.
2	Passive homing (without reset) Function same as "Mode" = 8 with the difference that the "homed" status is **not** reset when the function is enabled.
3	Active homing The positioning axis/synchronous axis technology object 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
5	Active homing ("Position" parameter has no effect) The positioning axis/synchronous axis technology object 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)

Value	Description
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[1..4].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[1..4].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)
11	Set setpoint position (absolute) The set position of the technology object is set to the value of the "Position" parameter. The following error remains.
12	Shift the setpoint position (relative) The set position of the technology object is shifted by the value of the "Position" parameter. The following error remains.
13	Incremental encoder adjustment The current position is set to the value of parameter "Position".

See also

Homing (Page 129)

8.4 MC_Halt V7 (S7-1500, S7-1500T)

8.4.1 MC_Halt: Pause axis V7 (S7-1500, S7-1500T)

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

- Speed axis
- Positioning axis
- Synchronous axis

Requirement

- The technology object has been configured correctly.
- The technology object has been enabled.

Override response

The override response for "MC_Halt" jobs is described in section "Override response V7: Homing and motion jobs (Page 279)".

Parameters

The following table shows the parameters of the Motion Control instruction "MC_Halt":

Parameters	Declaration	Data type	Default value	Description	
Axis	INPUT	TO_SpeedAxis TO_PositioningAxis TO_SynchronousAxis	-	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 default values" 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 default values" is used. (<TO>.DynamicDefaults.Jerk)
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	Velocity zero has been reached.
Busy	OUTPUT	BOOL	FALSE	TRUE	The job is being processed.

Parameters	Declara-tion	Data type	Default value	Description	
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 for parameter "ErrorID" You can find more detailed information in the "Error IDs" section of the "S7-1500/S7-1500T Motion Control alarms and error IDs" documentation (Page 12).	

Braking an axis with "MC_Halt"

Proceed as follows to decelerate an axis to a standstill:

1. Check the requirements indicated above.
2. Set the necessary values for the parameters "Deceleration", "Jerk" and "AbortAcceleration".
3. Start the "MC_Halt" job with a positive edge at parameter "Execute".
   The current motion state is indicated in parameters "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

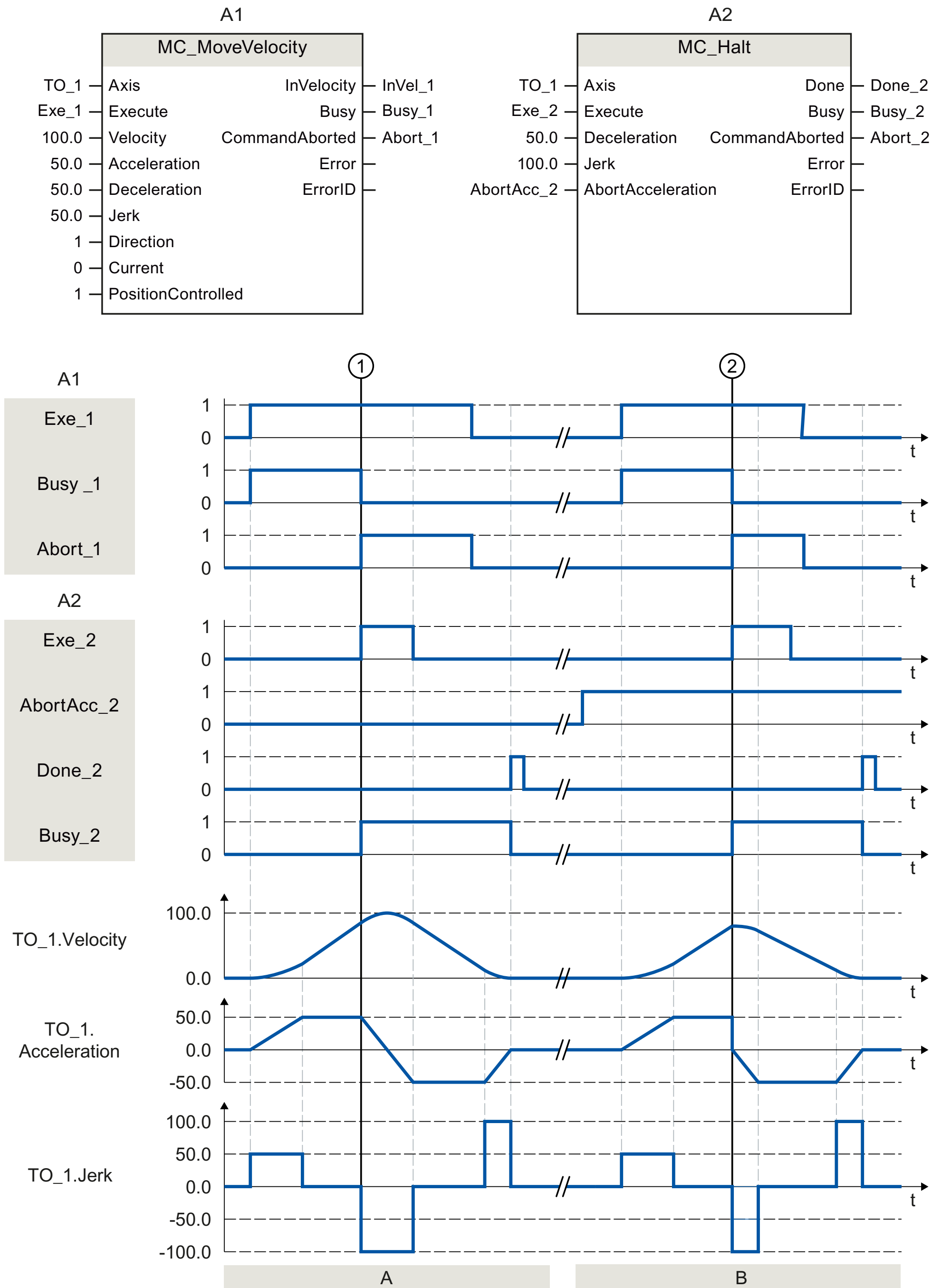
To brake an axis with active force/torque limiting, use the Motion Control instruction "MC_Stop" with "Emergency stop" mode ("Mode" = 0).

More information

Information on the evaluation of the individual bits can be found in the "Evaluating StatusWord, ErrorWord and WarningWord" section of the "S7-1500/S7-1500T Motion Control Overview" documentation (Page 12).

8.4.2 MC_Halt: Function chart V7 (S7-1500, S7-1500T)

Function chart: Pausing 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".

8.5 MC_MoveAbsolute V7 (S7-1500, S7-1500T)

8.5.1 MC_MoveAbsolute: Position axis absolutely V7 (S7-1500, S7-1500T)

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

- Positioning axis
- Synchronous axis

Requirement

- The technology object has been configured correctly.
- The technology object has been enabled.
- The technology object is homed.

Override response

The override response for "MC_MoveAbsolute" jobs is described in section "Override response V7: Homing and motion jobs (Page 279)".

NOTE

Deviating dynamic settings

When overriding the active job with a new jerk-limited motion, the current acceleration or deceleration is transferred to the new acceleration/deceleration via the jerk. Depending on the dynamic settings, this may take several application cycles. When the new acceleration or deceleration deviates significantly from the acceleration/deceleration at the time of the override, the transition profile can result in an unexpected motion of the axis.

If such transitions cannot be excluded during acceleration/deceleration, adjust the dynamic settings of your jobs. For example, add a motion that is not jerk-limited with a direct transition to the new acceleration/deceleration. As an alternative, use high jerk values.

Parameters

The following table shows the parameters of the Motion Control instruction "MC_MoveAbsolute":

Parameters	Declaration	Data type	Default value	Description	
Axis	INPUT	TO_PositioningAxis TO_SynchronousAxis	-	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 default values" 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 default values" is used. (<TO>.DynamicDefaults.Acceleration)

Parameters	Declaration	Data type	Default value	Description	
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 default values" is used. (<TO>.DynamicDefaults.Deceleration)
Jerk	INPUT	LREAL	-1.0	Jerk	
				> 0.0	Constant acceleration velocity profile The specified value is used.
				= 0.0	Trapezoid velocity profile
				< 0.0	The jerk configured in "Technology object > Configuration > Extended parameters > Dynamic default values" is used. (<TO>.DynamicDefaults.Jerk)
Direction	INPUT	INT	1	Motion direction of the axis This parameter is only evaluated when the modulo function is enabled. "Technology object > Configuration > Basic parameters > Enable modulo"	
				1	Positive direction
				2	Negative direction
				3	Shortest distance
Done	OUTPUT	BOOL	FALSE	TRUE	The target position has been reached. The minimum dwell time has expired (<TO>.PositioningMonitoring.MinDwellTime).
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 for parameter "ErrorID" You can find more detailed information in the "Error IDs" section of the "S7-1500/S7-1500T Motion Control alarms and error IDs" documentation (Page 12).	

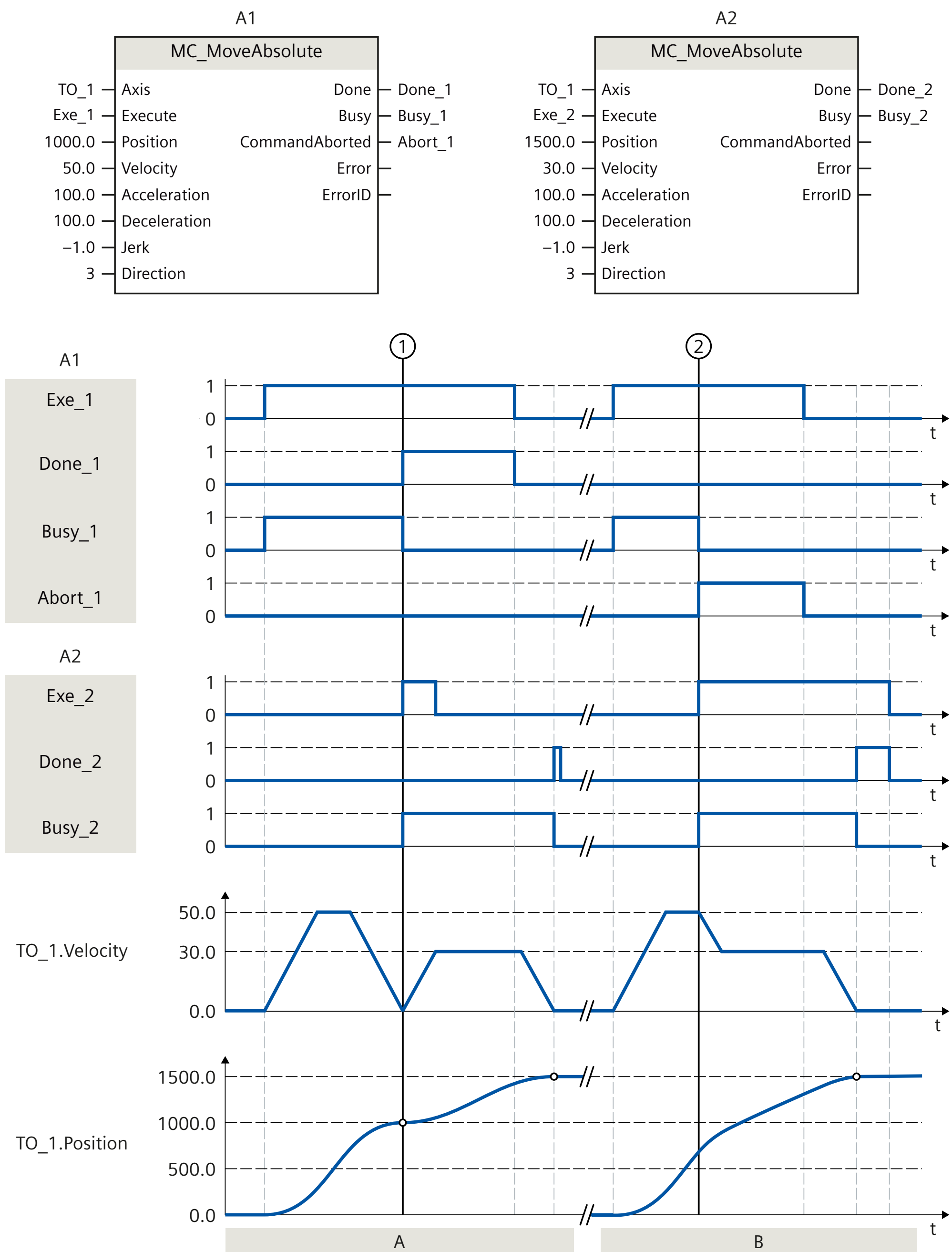
Moving an axis to an absolute position

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 parameters "Busy", "Done" and "Error".

8.5.2 MC_MoveAbsolute: Function chart V7 (S7-1500, S7-1500T)

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".

8.6 MC_MoveRelative V7 (S7-1500, S7-1500T)

8.6.1 MC_MoveRelative: Position axis relatively V7 (S7-1500, S7-1500T)

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

- Positioning axis
- Synchronous axis

Requirement

- The technology object has been configured correctly.
- The technology object has been enabled.

Override response

The override response for "MC_MoveRelative" jobs is described in section "Override response V7: Homing and motion jobs (Page 279)".

NOTE

Deviating dynamic settings

When overriding the active job with a new jerk-limited motion, the current acceleration or deceleration is transferred to the new acceleration/deceleration via the jerk. Depending on the dynamic settings, this may take several application cycles. When the new acceleration or deceleration deviates significantly from the acceleration/deceleration at the time of the override, the transition profile can result in an unexpected motion of the axis.

If such transitions cannot be excluded during acceleration/deceleration, adjust the dynamic settings of your jobs. For example, add a motion that is not jerk-limited with a direct transition to the new acceleration/deceleration. As an alternative, use high jerk values.

Parameters

The following table shows the parameters of the Motion Control instruction "MC_MoveRelative":

Parameter	Declaration	Data type	Default value	Description	
Axis	INPUT	TO_PositioningAxis TO_SynchronousAxis	-	Technology object	
Execute	INPUT	BOOL	FALSE	TRUE	Start job with a positive edge
Distance	INPUT	LREAL	0.0	Distance for the positioning process[1)] (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 default values" 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 default values" is used. (<TO>.DynamicDefaults.Acceleration)

1) If you have set "nm" as the unit of measurement for an axis, enter a value with magnitude greater than or equal to 1000.0 at the "MC_MoveRelative.Distance" parameter. If the amount of the value of "MC_MoveRelative.Distance" is less than 1000.0, the axis will not move during a motion task.

Parameter	Declaration	Data type	Default value	Description	
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 default values" is used. (<TO>.DynamicDefaults.Deceleration)
Jerk	INPUT	LREAL	-1.0	Jerk	
				> 0.0	Constant acceleration velocity profile The specified value is used.
				= 0.0	Trapezoid velocity profile
				< 0.0	The jerk configured in "Technology object > Configuration > Extended parameters > Dynamic default values" is used. (<TO>.DynamicDefaults.Jerk)
Done	OUTPUT	BOOL	FALSE	TRUE	The target position has been reached. The minimum dwell time has expired (<TO>.PositioningMonitoring.MinDwellTime).
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 for parameter "ErrorID" You can find more detailed information in the "Error IDs" section of the "S7-1500/S7-1500T Motion Control alarms and error IDs" documentation (Page 12).	

[1] If you have set "nm" as the unit of measurement for an axis, enter a value with magnitude greater than or equal to 1000.0 at the "MC_MoveRelative.Distance" parameter. If the amount of the value of "MC_MoveRelative.Distance" is less than 1000.0, the axis will not move during a motion task.

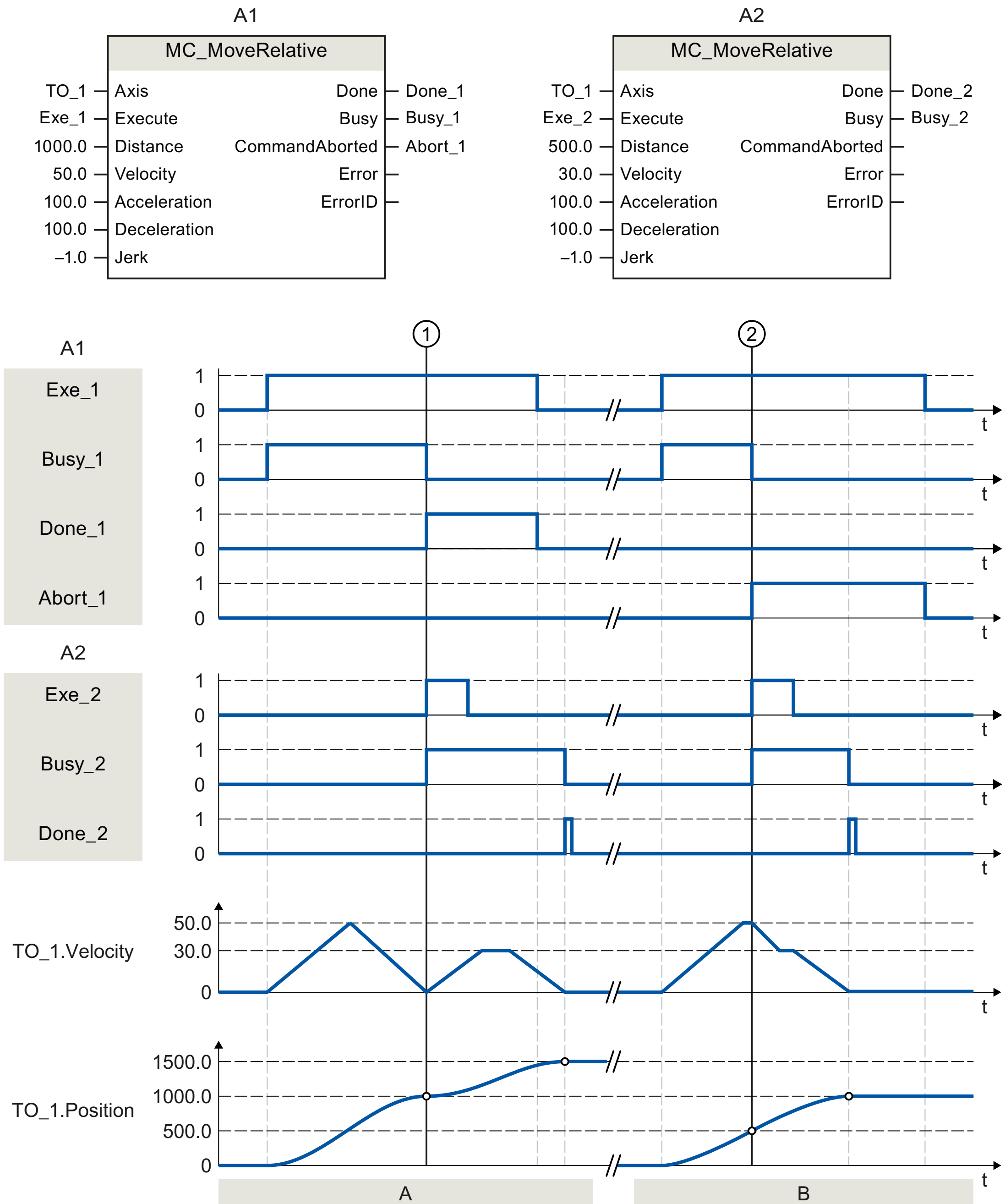
Moving an axis relative to the start position

Proceed as follows to move an axis relative to the start 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 parameters "Busy", "Done" and "Error".

8.6.2 MC_MoveRelative: Function chart V7 (S7-1500, S7-1500T)

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".

8.7 MC_MoveVelocity V7 (S7-1500, S7-1500T)

8.7.1 MC_MoveVelocity: Move axis with velocity/speed setpoint V7 (S7-1500, S7-1500T)

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

- Speed axis
- Positioning axis
- Synchronous axis

Requirement

- The technology object has been configured correctly.
- The technology object has been enabled.

Override response

The override response for "MC_MoveVelocity" jobs is described in section "Override response V7: Homing and motion jobs (Page 279)".

NOTE

Deviating dynamic settings

When overriding the active job with a new jerk-limited motion, the current acceleration or deceleration is transferred to the new acceleration/deceleration via the jerk. Depending on the dynamic settings, this may take several application cycles. When the new acceleration or deceleration deviates significantly from the acceleration/deceleration at the time of the override, the transition profile can result in an unexpected motion of the axis.

If such transitions cannot be excluded during acceleration/deceleration, adjust the dynamic settings of your jobs. For example, add a motion that is not jerk-limited with a direct transition to the new acceleration/deceleration. As an alternative, use high jerk values.

Parameters

The following table shows the parameters of the Motion Control instruction "MC_MoveVelocity":

Parameters	Declaration	Data type	Default value	Description	
Axis	INPUT	TO_SpeedAxis TO_PositioningAxis TO_SynchronousAxis	-	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 default values" 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 default values" is used. (<TO>.DynamicDefaults.Deceleration)

Parameters	Declaration	Data type	Default value	Description	
Jerk	INPUT	LREAL	-1.0	Jerk	
				> 0.0	Constant acceleration velocity profile The specified value is used.
				= 0.0	Trapezoid velocity profile
				< 0.0	The jerk configured in "Technology object > Configuration > Extended parameters > Dynamic default values" 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 The value of "Velocity" is used.
				2	Negative direction of rotation The value of "Velocity" is used.
Current	INPUT	BOOL	FALSE	Maintain current velocity	
				FALSE	Disabled The values of parameters "Velocity" and "Direction" are taken into account.
				TRUE	Enabled 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 has been reached. A velocity setpoint/speed setpoint is output.
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 cause of the error can be found in the "ErrorID" parameter.

Parameters	Declara-tion	Data type	Default value	Description
ErrorID	OUTPUT	WORD	16#0000	Error ID for parameter "ErrorID" You can find more detailed information in the "Error IDs" section of the "S7-1500/S7-1500T Motion Control alarms and error IDs" documentation (Page 12).

Behavior with setpoint velocity/speed 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 "Velocity" parameter, 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 parameters "Busy", "InVelocity" and "Error".
   If the "InVelocity" parameter shows the value "TRUE", the velocity/speed setpoint has been 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

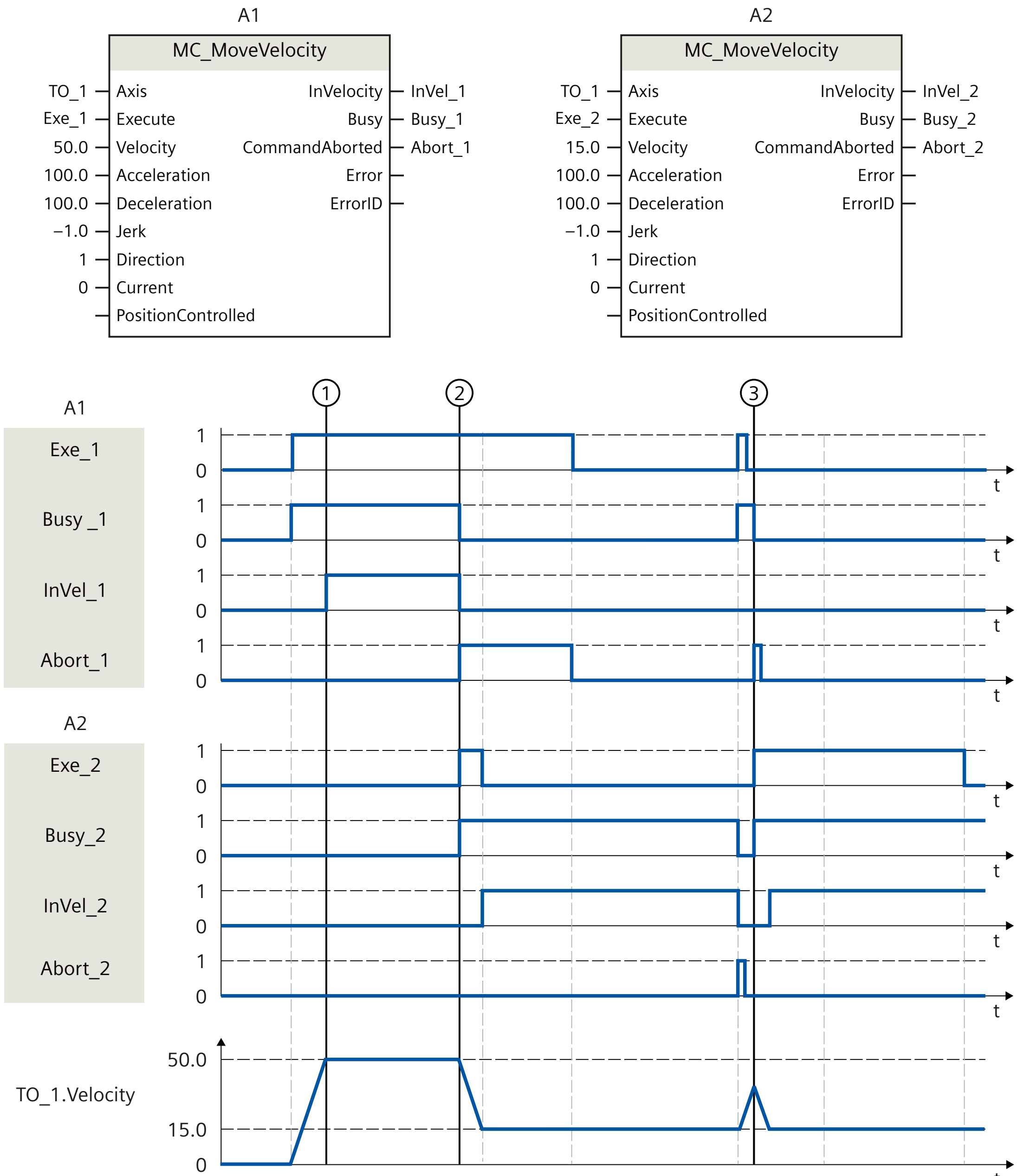
If the velocity/speed is influenced during constant motion by a change in the override (<TO>.Override.Velocity), the "InVelocity" parameter is reset during the acceleration or deceleration. When the newly calculated velocity/speed is reached ("Velocity" × "Override" %), then "InVelocity" is set again.

More information

An option for evaluating the individual status bits can be found in the section "Evaluating StatusWord, ErrorWord and WarningWord" of the "S7-1500/S7-1500T Motion Control overview" (Page 12) documentation.

8.7.2 MC_MoveVelocity: Function chart V7 (S7-1500, S7-1500T)

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.

8.8 MC_MoveJog V7 (S7-1500, S7-1500T)

8.8.1 MC_MoveJog: Move axis in jog mode V7 (S7-1500, S7-1500T)

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

- Speed axis
- Positioning axis
- Synchronous axis

Requirement

- The technology object has been configured correctly.
- The technology object has been enabled.

Override response

The override response for "MC_MoveJog" jobs is described in section "Override response V7: Homing and motion jobs (Page 279)".

NOTE

Deviating dynamic settings

When overriding the active job with a new jerk-limited motion, the current acceleration or deceleration is transferred to the new acceleration/deceleration via the jerk. Depending on the dynamic settings, this may take several application cycles. When the new acceleration or deceleration deviates significantly from the acceleration/deceleration at the time of the override, the transition profile can result in an unexpected motion of the axis.

If such transitions cannot be excluded during acceleration/deceleration, adjust the dynamic settings of your jobs. For example, add a motion that is not jerk-limited with a direct transition to the new acceleration/deceleration. As an alternative, use high jerk values.

Parameters

The following table shows the parameters of the Motion Control instruction "MC_MoveJog":

Parameter	Declaration	Data type	Default value	Description	
Axis	INPUT	TO_SpeedAxis TO_PositioningAxis TO_SynchronousAxis	-	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.
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 default values" is used. (<TO>.DynamicDefaults.Acceleration)

Parameter	Declaration	Data type	Default value	Description	
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 default values" is used. (<TO>.DynamicDefaults.Deceleration)
Jerk	INPUT	LREAL	-1.0	Jerk	
				> 0.0	Constant acceleration velocity profile The specified value is used.
				= 0.0	Trapezoid velocity profile
				< 0.0	The jerk configured in "Technology object > Configuration > Extended parameters > Dynamic default values" 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 has been reached. A velocity setpoint/speed setpoint is output.
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 for parameter "ErrorID" You can find more detailed information in the "Error IDs" section of the "S7-1500/S7-1500T Motion Control alarms and error IDs" documentation (Page 12).	

Behavior with setpoint velocity/speed zero ("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 parameters "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

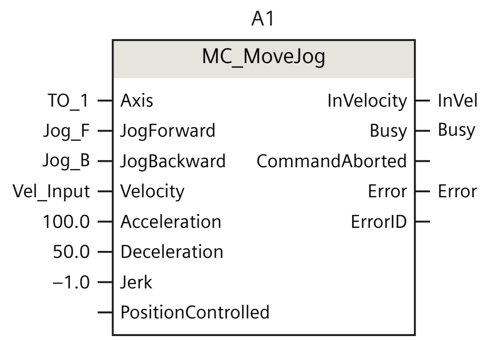
If the velocity/speed is influenced during constant motion by a change in the override (<TO>.Override.Velocity), the "InVelocity" parameter is reset during the acceleration or deceleration. When the newly calculated velocity is reached ("Velocity" × "Override" %), then "InVelocity" is set again.

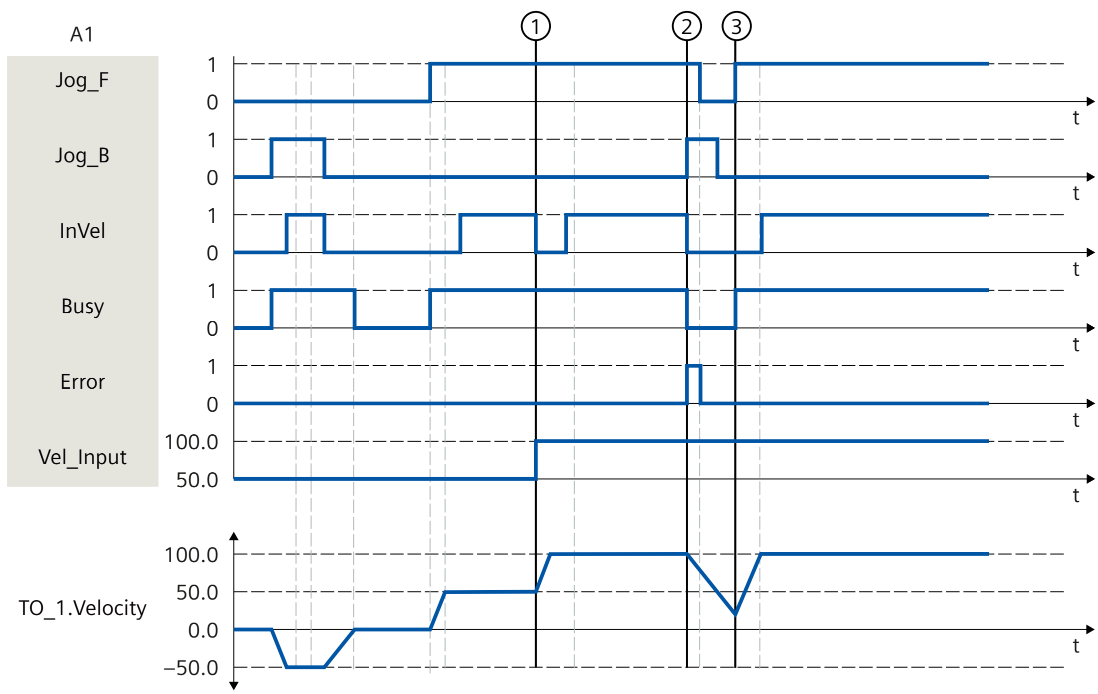
More information

An option for evaluating the individual status bits can be found in the section "Evaluating StatusWord, ErrorWord and WarningWord" of the "S7-1500/S7-1500T Motion Control overview" (Page 12) documentation.

8.8.2 MC_MoveJog: Function chart V7 (S7-1500, S7-1500T)

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 the 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.

8.9 MC_MoveSuperimposed V7 (S7-1500, S7-1500T)

8.9.1 MC_MoveSuperimposed: Position axis overlapping V7 (S7-1500, S7-1500T)

Description

With the Motion Control instruction "MC_MoveSuperimposed", you can start a relative positioning motion which is superimposed on a running basic motion.

Applies to

- Positioning axis
- Synchronous axis

Requirement

- The technology object has been configured correctly.
- The technology object has been enabled.

Override response

The override response for "MC_MoveSuperimposed" jobs is described in section "Override response V7: Homing and motion jobs (Page 279)".

NOTE

Deviating dynamic settings

When overriding the active job with a new jerk-limited motion, the current acceleration or deceleration is transferred to the new acceleration/deceleration via the jerk. Depending on the dynamic settings, this may take several application cycles. When the new acceleration or deceleration deviates significantly from the acceleration/deceleration at the time of the override, the transition profile can result in an unexpected motion of the axis.

If such transitions cannot be excluded during acceleration/deceleration, adjust the dynamic settings of your jobs. For example, add a motion that is not jerk-limited with a direct transition to the new acceleration/deceleration. As an alternative, use high jerk values.

Parameters

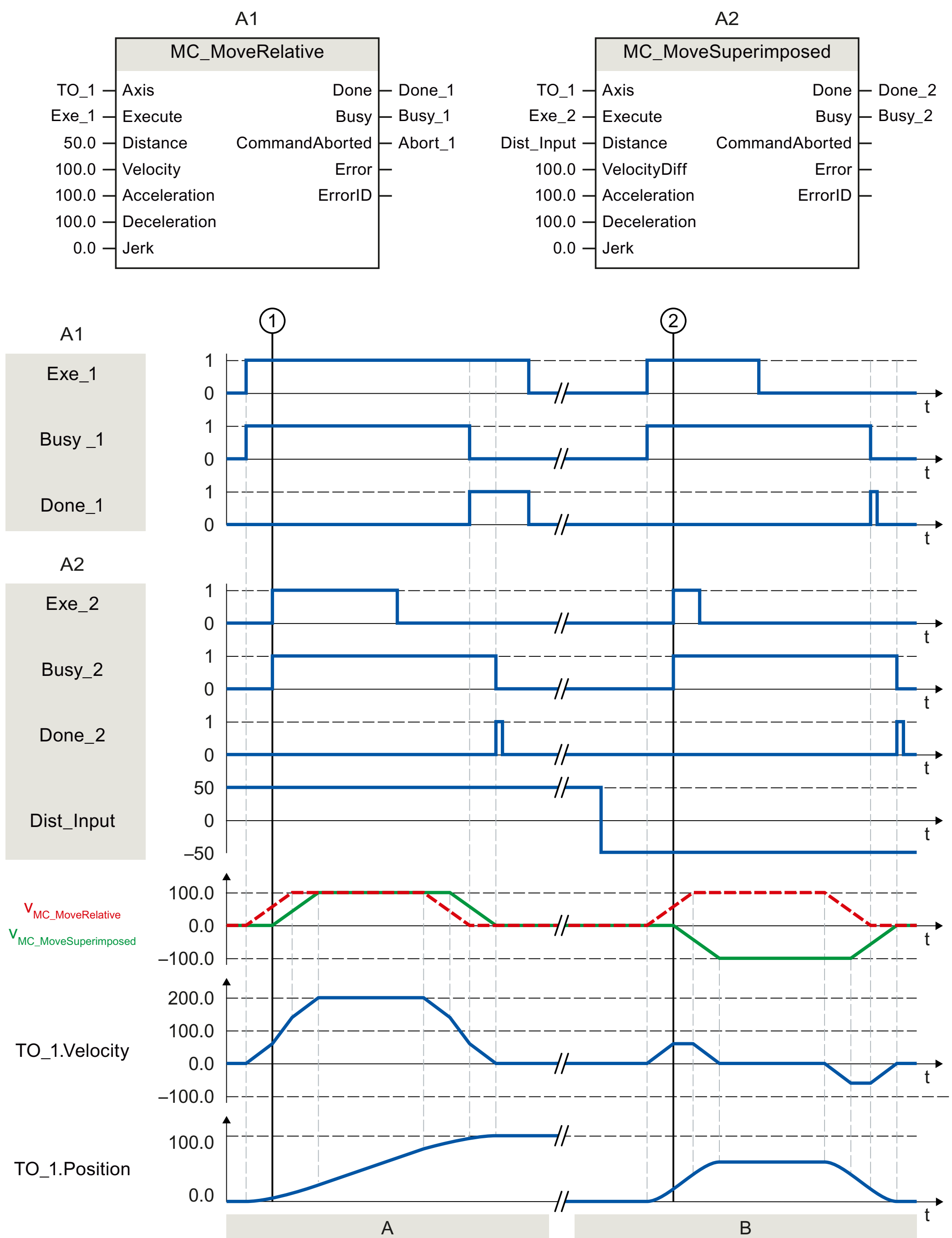
The following table shows the parameters of the Motion Control instruction "MC_MoveSuperimposed":

Parameters	Declara-tion	Data type	Default value	Description	
Axis	INPUT	TO_PositioningAxis TO_SynchronousAxis	-	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 operation (negative or positive)	
VelocityDiff	INPUT	LREAL	-1.0	Maximum velocity deviation compared to the act-ive motion	
				> 0.0	The specified value is used.
				= 0.0	Not permitted
				< 0.0	The velocity configured in "Technology object > Configuration > Extended para-meters > Dynamic default values" 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 "Techno-logy object > Configuration > Extended parameters > Dynamic default values" 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 "Techno-logy object > Configuration > Extended parameters > Dynamic default values" is used. (<TO>.DynamicDefaults.Deceleration)
Jerk	INPUT	LREAL	-1.0	Jerk	
				> 0.0	Constant acceleration velocity profile The specified value is used.
				= 0.0	Trapezoid velocity profile
				< 0.0	The jerk configured in "Technology object > Configuration > Extended parameters > Dynamic default values" is used. (<TO>.DynamicDefaults.Jerk)
Done	OUTPUT	BOOL	FALSE	TRUE	Superimposed positioning complete
Busy	OUTPUT	BOOL	FALSE	TRUE	The job is being processed.

Parameters	Declaration	Data type	Default value	Description	
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 for parameter "ErrorID" You can find more detailed information in the "Error IDs" section of the "S7-1500/S7-1500T Motion Control alarms and error IDs" documentation (Page 12).	

8.9.2 MC_MoveSuperimposed: Function chart V7 (S7-1500, S7-1500T)

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".

8.10 MC_StopSuperimposed V7 (S7-1500, S7-1500T)

8.10.1 MC_HaltSuperimposed: Pause superimposed motions on axis V7 (S7-1500, S7-1500T)

Description

Use the Motion Control instruction "MC_HaltSuperimposed" to decelerate a superimposed motion created with the "MC_MoveSuperimposed", "MC_MotionInSuperimposed", or "MC_HaltSuperimposed" instructions on the axis to zero velocity. This instruction has no effect on the basic motion of the axis.

Applies to

- Positioning axis
- Synchronous axis

Requirement

- The technology object has been configured correctly.
- The technology object has been enabled.

Override response

The override response for "MC_HaltSuperimposed" jobs is described in section "Override response V7: Homing and motion jobs (Page 279)".

Parameters

The following table shows the parameters of the Motion Control instruction "MC_HaltSuperimposed":

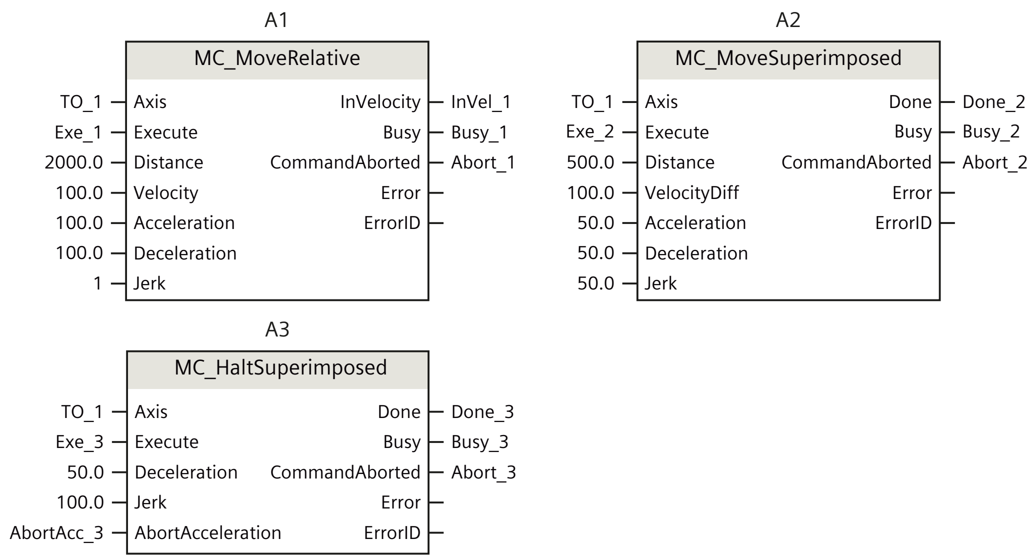
Parameters	Declaration	Data type	Default value	Description	
Axis	INPUT	TO_PositioningAxis TO_SynchronousAxis	-	Technology object	
Execute	INPUT	BOOL	FALSE	TRUE	Start job with a positive edge
Deceleration	INPUT	LREAL	-1.0	Deceleration of the superimposed motion	
				> 0.0	The specified value is used.
				= 0.0	Not permitted
				< 0.0	The deceleration configured in "Technology object > Configuration > Extended parameters > Dynamic default values" is used. (<TO>.DynamicDefaults.Deceleration)
Jerk	INPUT	LREAL	-1.0	Jerk of the superimposed motion	
				> 0.0	Constant-acceleration velocity profile of the superimposed motion; the specified jerk is used
				= 0.0	Trapezoidal velocity profile of the superimposed motion
				< 0.0	The jerk configured in "Technology object > Configuration > Extended parameters > Dynamic default values" is used. (<TO>.DynamicDefaults.Jerk)
AbortAcceleration	INPUT	BOOL	FALSE	FALSE	The current acceleration of the superimposed motion at the start of the job is reduced using the configured jerk. Afterwards, the deceleration builds up.
				TRUE	The acceleration of the superimposed motion is set to 0.0 at the start of the job; the deceleration builds up immediately.
Done	OUTPUT	BOOL	FALSE	TRUE	The execution of the job is completed. The superimposed motion is stopped.
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 for parameter "ErrorID" You can find more detailed information in the "Error IDs" section of the "S7-1500/S7-1500T Motion Control alarms and error IDs" documentation (Page 12).	

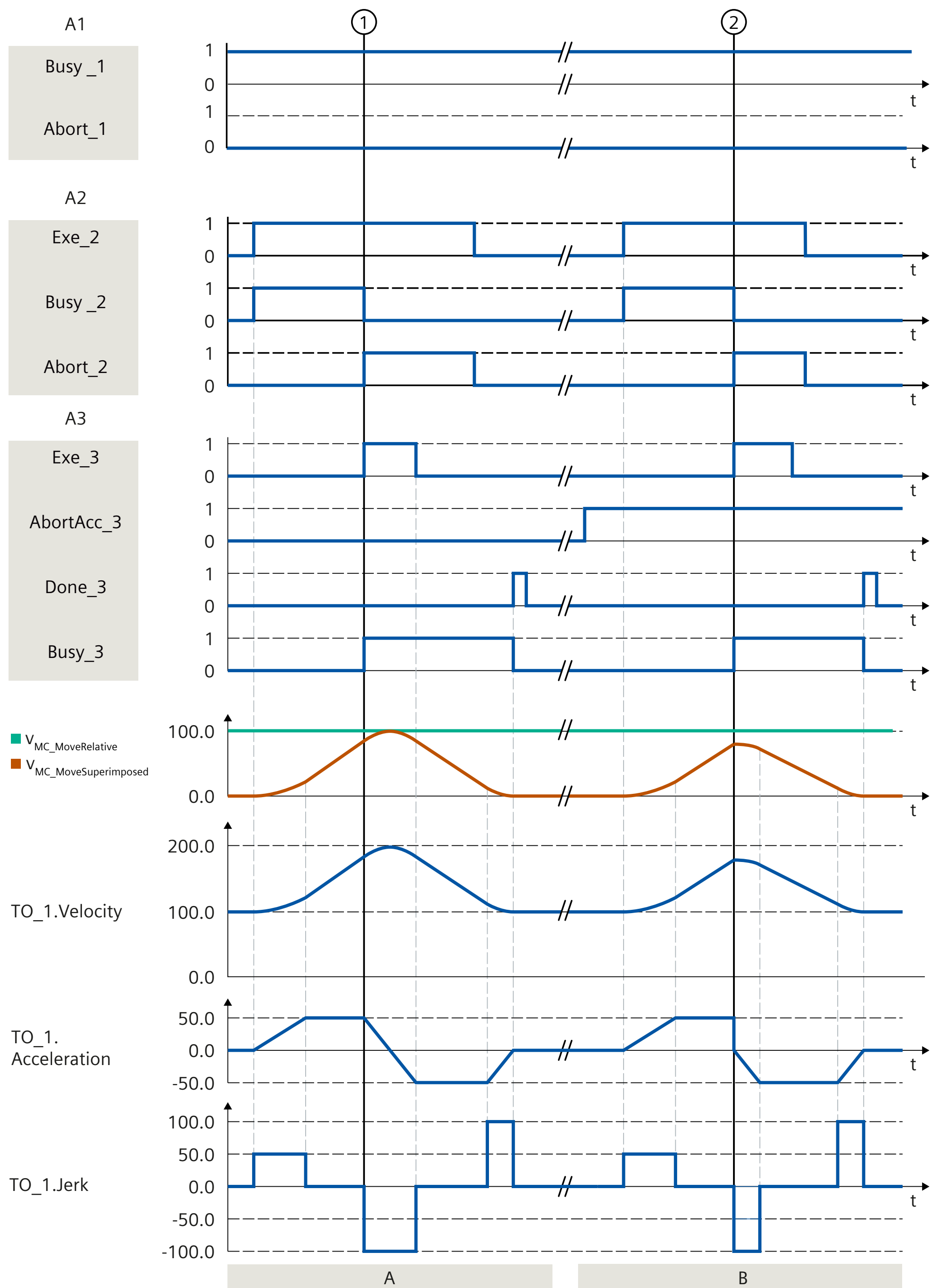
See also

Superimposed motions (Page 107)

8.10.2 MC_HaltSuperimposed: Function chart V7 (S7-1500, S7-1500T)

Function chart: Pause superimposed motions on the axis





Section A

The axis is moved with an "MC_MoveRelative" job (A1) as the basic motion.

Via "Exe_2", a "MC_MoveSuperimposed" job (A2) is triggered as a superimposed motion. The <TO>.StatusWord.X23 bit is set. At time ①, the "MC_MoveSuperimposed" job is overridden by an "MC_HaltSuperimposed" job (A3). The job abort is signaled via "Abort_2". The <TO>.StatusWord2.X7 bit is set and the <TO>.StatusWord.X23 bit is reset. With "AbortAcc_3" = FALSE, the current acceleration is reduced with the specified jerk. After that, the deceleration is built up and the superimposed motion is decelerated to velocity = 0. The completion of the "MC_HaltSuperimposed" job is reported via "Done_3". The <TO>.StatusWord2.X7 bit is reset.

Section B

The axis is moved with an "MC_MoveRelative" job (A1) as the basic motion.

Via "Exe_2", a "MC_MoveSuperimposed" job (A2) is triggered as a superimposed motion. The <TO>.StatusWord.X23 bit is set. At time ②, the "MC_MoveSuperimposed" job is overridden by an "MC_HaltSuperimposed" job (A3). The job abort is signaled via "Abort_2". The <TO>.StatusWord2.X7 bit is set and the <TO>.StatusWord.X23 bit is reset. With "AbortAcc_3" = TRUE, the current acceleration is set to zero immediately and the deceleration builds up. The superimposed motion is decelerated to velocity = 0. The completion of the "MC_HaltSuperimposed" job is reported via "Done_3". The <TO>.StatusWord2.X7 bit is reset.

8.11 MC_SetSensor V7 (S7-1500T)

8.11.1 MC_SetSensor: Switch alternative encoder to operative encoder V7 (S7-1500T)

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

- Positioning axis
- Synchronous 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 the Motion Control instruction "MC_SetSensor":

Parameters	Declaration	Data type	Default value	Description	
Axis	INPUT	TO_PositioningAxis TO_SynchronousAxis	-	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 actual 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 actual position 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	The job is being processed.
CommandAborted	OUTPUT	BOOL	FALSE	TRUE	The job has been aborted.
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 for parameter "ErrorID" You can find more detailed information in the "Error IDs" section of the "S7-1500/S7-1500T Motion Control alarms and error IDs" documentation (Page 12).	

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[1..4].AbsEncoderOffset) without calculation by the "MC_SetSensor" job.

8.12 MC_Stop V7 (S7-1500, S7-1500T)

8.12.1 MC_Stop: Stop axis and prevent new motion jobs V7 (S7-1500, S7-1500T)

Description

With the "MC_Stop" Motion Control instruction, you stop all movements of an axis and prevent new motion jobs for the technology object. The axis brakes to a standstill and remains switched on.

The standstill position is derived from the stop ramp. Three modes, which you define with the "Mode" parameter, are available for this purpose:

- "Mode" = 0: The dynamic response of the braking operation is determined by the configured emergency stop ramp.
- "Mode" = 2: The dynamic response of the braking operation is determined by the maximum dynamic values of the technology object.
- "Mode" = 3: The dynamic response of the braking operation is determined with parameters "Jerk" and "Decelaration" of the "MC_Stop" job.

Applies to

- Speed axis
- Positioning axis
- Synchronous axis

Requirements

- The technology object has been configured correctly.
- The technology object has been enabled.

Override response

- An "MC_Stop" job is not triggered by other movements.
- An "MC_Stop" job is aborted by an "MC_Power" job with "Enable" = FALSE.
- An "MC_Stop" job does not abort any synchronous operation function in simulation.
- An "MC_Stop" job is aborted by another "MC_Stop" job with a stop response that is the same or higher.
  Significance of stop responses (descending): "Mode" = 0 > "Mode" = 2 > "Mode" = 3

You can find more detailed information on the override response of an "MC_Stop" job in the section "Override response of Motion Control jobs V7 (Page 279)".

Override behavior between alarm responses and MC_Stop

"MC_Stop" jobs and alarm responses with "Stop" or "Remove enable" can override each other. An alarm response or a configured stop mode with higher significance overrides.

"MC_Stop" jobs are rejected or overridden by alarm responses with higher significance with "CommandAborted" = TRUE. Unlike other Motion Control instructions, "Error" = TRUE and "ErrorID" = 16#8001 is not output.

Alarm responses with stop can by overridden by "MC_Stop" jobs with higher significance.

The following table represents the significance of Stop mode at "MC_Stop" job and the alarm responses:

Stop mode	MC_Stop.Mode	<TO>.ErrorDetail.Reaction	Significance
Remove enable	-	4	4
Emergency stop	0	3	3
Stop with maximum dynamic values	2	2	2
Stop with current dynamic values/stop with specified dynamic response	3	2	1

Example 1

An alarm with "<TO>.ErrorDetail.Reaction" = 2 occurs. While the alarm is active, an "MC_Stop" job with "Mode" = 0 is sent.

Result: The stop with maximum dynamic values that was caused by the alarm is overridden by the emergency stop of the "MC_Stop" job. After the axis has been braked to a velocity of 0 by an emergency stop, the "MC_Stop" order outputs "Done" = TRUE.

Example 2

An MC_Stop job with Mode = 3 is active. During the active job, an alarm occurs with the alarm response "<TO>.ErrorDetail.Reaction" = 2.

Result: The stop of the "MC_Stop" job with specified dynamics is overridden by the alarm response with a stop with maximum dynamics. The "MC_Stop" job displays "CommandAborted" = TRUE.

NOTE

Check the configuration of the dynamic limits and the emergency stop. Because an emergency stop has a higher significance, configure the emergency stop delay higher or equal to the dynamic limits. In this way, you make sure that an overriding emergency stop does not reduce the dynamics of a stop with current or maximum dynamic values.

Parameters

The following table shows the parameters of the Motion Control instruction "MC_Stop":

Parameter	Declaration	Data type	Default value	Description	
Axis	INPUT	TO_SpeedAxis TO_PositioningAxis TO_SynchronousAxis	-	Technology object	
Execute	INPUT	BOOL	FALSE	TRUE	The motion is stopped and new motion jobs are prevented.
				FALSE	Motion jobs can be executed again.
Mode	INPUT	DINT	0	Mode for dynamic behavior	
				0	Emergency stop The technology object is braked to a standstill without jerk limit, using the emergency stop deceleration configured in "Technology object > Configuration > Extended parameters > Emergency stop". (<TO>.DynamicDefaults.EmergencyDeceleration)
				1	Not permitted
				2	Stop with maximum dynamic values The technology object is braked to a standstill using the maximum deceleration configured in "Technology object > Configuration > Extended parameters > Dynamics limits". The configured maximum jerk is hereby taken into account. (<TO>.DynamicLimits.MaxDeceleration, <TO>.DynamicLimits.MaxJerk)
				3	Stop with specified dynamic response The technology object is stopped with the specified values at the parameters "Deceleration" and "Jerk".

Parameter	Declaration	Data type	Default value	Description	
Deceleration	INPUT	LREAL	-1.0	When "Mode" = 3: Deceleration for the braking ramp	
				> 0.0	The specified value is used.
				= 0.0	Not permitted
				< 0.0	The deceleration configured in "Technology object > Configuration > Extended parameters > Dynamic default values" is used. (<TO>.DynamicDefaults.Deceleration)
Jerk	INPUT	LREAL	-1.0	When "Mode" = 3: Jerk for the braking ramp	
				> 0.0	The specified value is used.
				= 0.0	No jerk limitation
				< 0.0	The jerk configured in "Technology object > Configuration > Extended parameters > Dynamic default values" is used. (<TO>.DynamicDefaults.Jerk)
AbortAcceleration	INPUT	BOOL	FALSE	TRUE	Acceleration is set to 0.0. The configured deceleration is built up immediately.
				FALSE	The acceleration is reduced using the configured jerk. The configured deceleration then builds up.
Done	OUTPUT	BOOL	FALSE	TRUE	Standstill is reached.
Busy	OUTPUT	BOOL	FALSE	TRUE	The job is being processed.
CommandAborted	OUTPUT	BOOL	FALSE	TRUE	The job was aborted during execution either by "MC_Power" with "Enable" = FALSE, another "MC_Stop" job or an alarm response.
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 for parameter "ErrorID" You can find more detailed information in the "Error IDs" section of the "S7-1500/S7-1500T Motion Control alarms and error IDs" documentation (Page 12).	

Braking an axis with "MC_Stop"

Proceed as follows to decelerate an axis to a standstill:

1. Check the requirements indicated above.
2. Set the necessary values for the parameters "Mode", "Deceleration", "Jerk" and "AbortAcceleration".
3. Start the "MC_Stop" job with a positive edge at parameter "Execute".
   The current motion state is indicated in parameters "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)).
   As long as "Execute" = TRUE, the technology object cannot execute motion jobs.

Braking an axis with active force/torque limiting

Use the "Emergency stop" mode ("Mode" = 0) to brake an axis with active force/torque limitation.

More information

Information on the evaluation of the individual bits can be found in the "Evaluating StatusWord, ErrorWord and WarningWord" section of the "S7-1500/S7-1500T Motion Control Overview" documentation (Page 12).

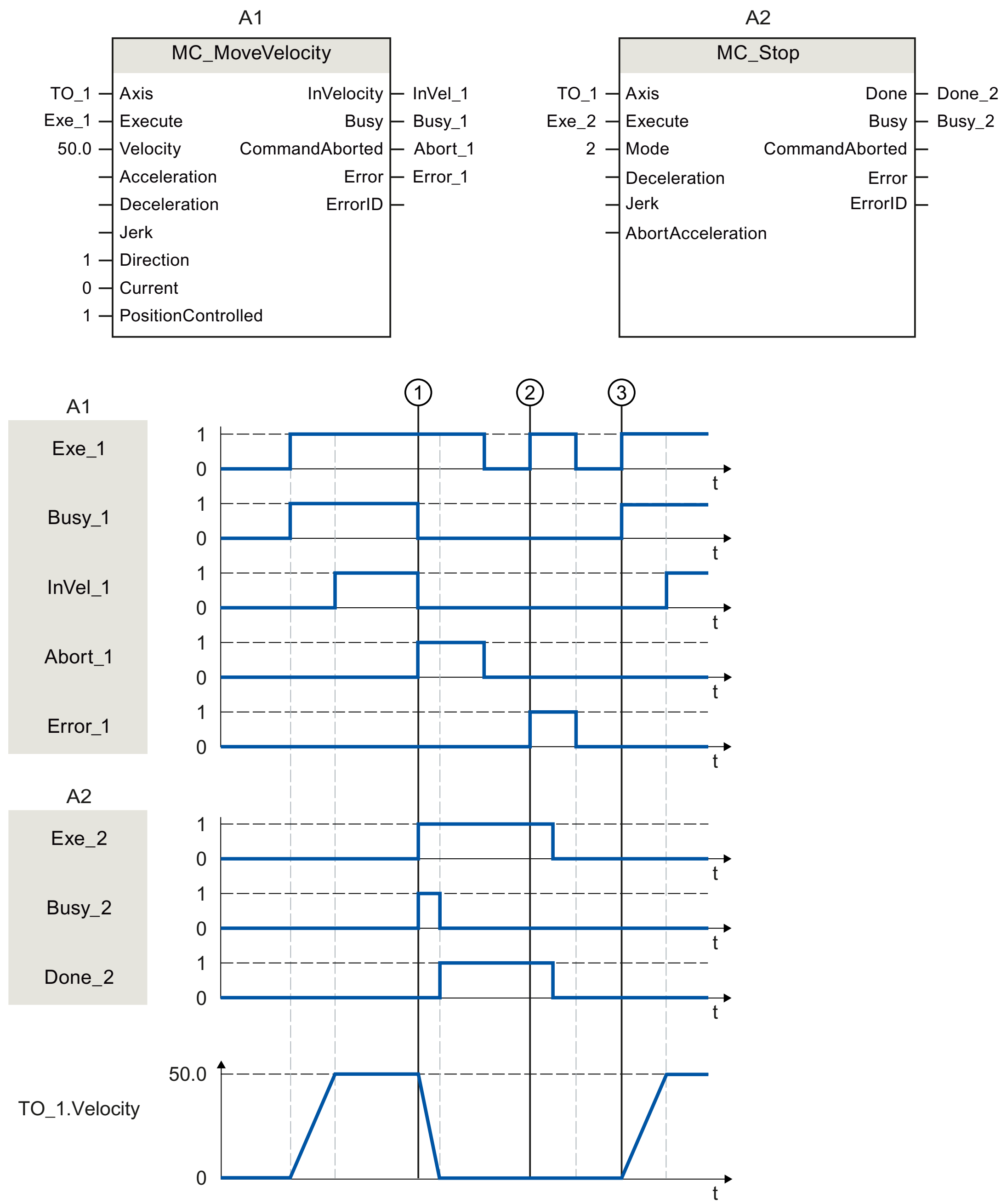
See also

Override response V7: Homing and motion jobs (Page 279)

Emergency stop deceleration (Page 102)

8.12.2 MC_Stop: Function chart V7 (S7-1500, S7-1500T)

Function chart: Braking an axis and the overriding job characteristics



An axis is moved with an "MC_MoveVelocity" job (A1). At time ①, the "MC_MoveVelocity" job is overridden by an "MC_Stop" job (A2). The job abort is signaled via "Abort_1". Afterwards, the configured deceleration builds up and the axis is braked to a standstill. While the axis is braking, "Busy_2" = TRUE. The completion of the "MC_Stop" job is reported via "Done_2".

At time ②, with an active "MC_Stop" job (A1), an "MC_MoveVelocity" job (A2) is executed. Because the axis is disabled by an "MC_Stop" job, the "MC_MoveVelocity" job is rejected. The error is signaled by "Error_1". "Exe_2" is then reset to "FALSE".

At time ③, the axis is moved by an "MC_MoveVelocity" job (A1) with positive edge.

8.13 MC_SetAxisSTW V7 (S7-1500, S7-1500T)

8.13.1 MC_SetAxisSTW: Control bits of control word 1 and 2 V7 (S7-1500, S7-1500T)

Description

With the Motion Control instruction "MC_SetAxisSTW", you control selected bits in control word 1 (STW1) and control word 2 (STW2) of the PROFIdrive telegram. This provides the possibility of directly controlling bits not used by the technology object. The bits to be controlled are specified via the parameters "STW1" and "STW2". The controlled bits remain effective until an "MC_SetAxisSTW" job is reset, the technology object is restarted or the CPU transitions from "RUN" to "STOP".

The following bits can be controlled in STW1:

- 8
- 9
- 11 to 15

Bits 0 to 11 can be controlled in STW2.

For the meaning of the bits to be controlled, refer to the "SINAMICS S120/S150" list manual (https://support.industry.siemens.com/cs/ww/en/view/109763271).

Applies to

- Speed axis
- Positioning axis
- Synchronous axis

Requirement

- The technology object has been configured correctly.
- The technology object is interconnected with a drive telegram.
- The technology object is not in simulation.
- A permissible bit masking is set.

Override response

- A new "MC_SetAxisSTW" job does not abort any active Motion Control jobs.
- An "MC_SetAxisSTW" job is only aborted by another "MC_SetAxisSTW" job.

Parameters

The following table shows the parameters of the Motion Control instruction "MC_SetAxisSTW":

Parameter	Declaration	Data type	Default value	Description	
Axis	INPUT	TO_SpeedAxis TO_PositioningAxis TO_SynchronousAxis	-	Technology object	
Execute	INPUT	BOOL	FALSE	TRUE	Start job with a positive edge
STW1	INPUT	WORD	16#0000	Set bits for STW1	
STW1BitMask	INPUT	WORD	16#0000	Bit masking for STW1	
STW2	INPUT	WORD	16#0000	Set bits for STW2	
STW2BitMask	INPUT	WORD	16#0000	Bit masking for STW2	
Done	OUTPUT	BOOL	FALSE	TRUE	The job is completed.
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 for parameter "ErrorID" You can find more detailed information in the "Error IDs" section of the "S7-1500/S7-1500T Motion Control alarms and error IDs" documentation (Page 12).	

See also

Override response V7: Homing and motion jobs (Page 279)

8.14 MC_WriteParameter V7 (S7-1500, S7-1500T)

8.14.1 MC_WriteParameter: Write parameter V7 (S7-1500, S7-1500T)

Description

With the Motion Control instruction "MC_WriteParameter", you can change selected parameters of the technology objects in runtime. The changes take effect directly or after a restart, depending on the corresponding parameter.

With a "RUN → STOP → RUN" transition of the CPU, the parameter value is retained. The changed parameter value is reset to the start value in the event of a POWER OFF or memory reset.

For parameters that are effective immediately, the changed parameter value is reset to the start value when the technology object is restarted. For parameters that become effective as the result of a restart, the parameter values are retained in the case of another restart.

Applies to

- Speed axis
- Positioning axis
- Synchronous axis
- External encoder

Requirement

- The technology object has been configured correctly.

Parameters

The following table shows the parameters of the Motion Control instruction "MC_WriteParameter":

Parameter	Declaration	Data type	Default value	Description	
Axis	INPUT	TO_SpeedAxis TO_PositioningAxis TO_SynchronousAxis TO_ExternalEncoder	-	Technology object	
Execute	INPUT	BOOL	FALSE	TRUE	Start job with a positive edge
ParameterNumber	INPUT	DINT	0	Index of the parameter to be changed	
Value	INPUT	Variant (BOOL, INT, DINT, UDINT, LREAL)	-	Variant pointer to the value to be written (source address)	
Done	OUTPUT	BOOL	FALSE	TRUE	Job is completed.
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 during processing. The job is rejected. The cause of the error can be found in the "ErrorID" parameter.
ErrorID	OUTPUT	WORD	16#0000	Error ID for parameter "ErrorID" You can find more detailed information in the "Error IDs" section of the "S7-1500/S7-1500T Motion Control alarms and error IDs" documentation (Page 12).	

Modifiable parameters

The following table shows the parameters that can be changed with the Motion Control instruction "MC_WriteParameter":

Tag	Index	Technology object	Data type	Description	Effectiveness
PositionLimits_HW.Active	1000	Positioning axis Synchronous axis	BOOL	Enabling/disabling hardware limit switch The negative and the positive hardware limit switches (Page 148) are activated or deactivated with this parameter, FALSE: HW limit switch deactivated TRUE: HW limit switch activated	Direct
T_i	1010	Speed axis Positioning axis Synchronous axis External encoder	LREAL	Communication time T_i (read in process values)	After restart
T_o	1011	Speed axis Positioning axis Synchronous axis External encoder	LREAL	Communication time T_o (output process values)	After restart
T_{Pn}/T_{DP}	1012	Speed axis Positioning axis Synchronous axis External encoder	LREAL	PROFINET send clock or PROFIBUS send clock	After restart

See also

Override response V7: Homing and motion jobs (Page 279)

Direct homing (Page 148)

Tags of the positioning axis technology object (Page 299)

Tags of the speed axis technology object (Page 286)

Tags of the technology object external encoder (Page 331)

8.15 MC_SaveAbsoluteEncoderData V7 (S7-1500, S7-1500T)

8.15.1 MC_SaveAbsoluteEncoderData: Saving absolute adjustment for device replacement V7 (S7-1500, S7-1500T)

Description

With the Motion Control instruction "MC_SaveAbsoluteEncoderData" you can save the adjustment of an absolute encoder for the device replacement.

Requirement

Sufficient storage space is available on the SIMATIC Memory Card.

Parameters

The following table shows the parameters of the Motion Control instruction "MC_SaveAbsoluteEncoderData":

Parameter	Declaration	Data type	Default value	Description	
Execute	INPUT	BOOL	FALSE	TRUE	Start job with a positive edge
Done	OUTPUT	BOOL	FALSE	TRUE	The absolute encoder adjustment for all technology objects of the CPU with an absolute encoder is saved for device replacement.
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	0	Error ID for parameter "ErrorID" You can find more detailed information in the "Error IDs" section of the "S7-1500/S7-1500T Motion Control alarms and error IDs" documentation (Page 12).	

8.16 MotionIn (S7-1500T)

8.16.1 MC_MotionInVelocity V7 (S7-1500T)

8.16.1.1 MC_MotionInVelocity: Specify motion setpoints V7 (S7-1500T)

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 effective.

With the "Velocity" parameter, you can specify the velocity setpoint and with "Acceleration" the acceleration setpoint. The velocity setpoint and acceleration setpoint are effective when the parameter "Enable" = TRUE and at least one value is specified for the "Velocity" parameter.

Applies to

- Speed axis
- Positioning axis
- Synchronous axis

Requirement

- The technology object has been configured correctly.
- The technology object has been enabled.

Override response

The override response for "MC_MotionInVelocity" jobs is described in section "Override response V7: Homing and motion jobs (Page 279)".

NOTE

Deviating dynamic settings

When overriding the active job with a new jerk-limited motion, the current acceleration or deceleration is transferred to the new acceleration/deceleration via the jerk. Depending on the dynamic settings, this may take several application cycles. When the new acceleration or deceleration deviates significantly from the acceleration/deceleration at the time of the override, the transition profile can result in an unexpected motion of the axis.

If such transitions cannot be excluded during acceleration/deceleration, adjust the dynamic settings of your jobs. For example, add a motion that is not jerk-limited with a direct transition to the new acceleration/deceleration. As an alternative, use high jerk values.

For MotionIn jobs, the specification of the acceleration is only relevant for overriding the job. When the currently active acceleration is not to be slowed down via the jerk, enter the value "0.0" at the "Acceleration" parameter of the MotionIn job.

Parameters

The following table shows the parameters of the Motion Control instruction "MC_MotionInVelocity":

Parameter	Declaration	Data type	Default value	Description	
Axis	INPUT	TO_SpeedAxis TO_PositioningAxis TO_SynchronousAxis	-	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.

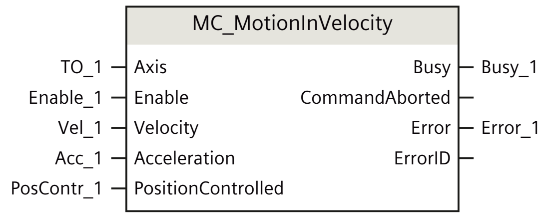
Parameter	Declaration	Data type	Default value	Description	
CommandAborted	OUTPUT	BOOL	FALSE	TRUE	The job was aborted by another job during execution.
Error	OUTPUT	BOOL	FALSE	TRUE	An error occurred while processing the job. The job is rejected. The cause of the error can be found in the "ErrorID" parameter.
ErrorID	OUTPUT	WORD	16#0000	Error ID for parameter "ErrorID" You can find more detailed information in the "Error IDs" section of the "S7-1500/S7-1500T Motion Control alarms and error IDs" documentation (Page 12).	

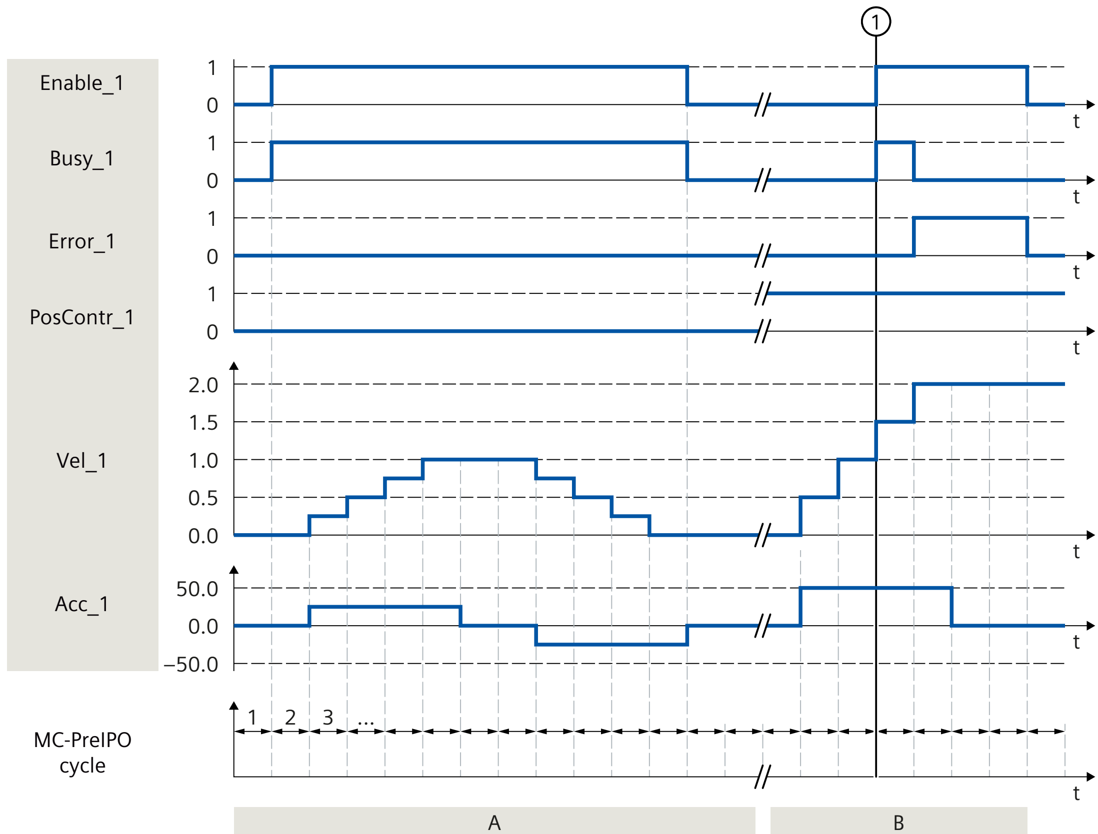
See also

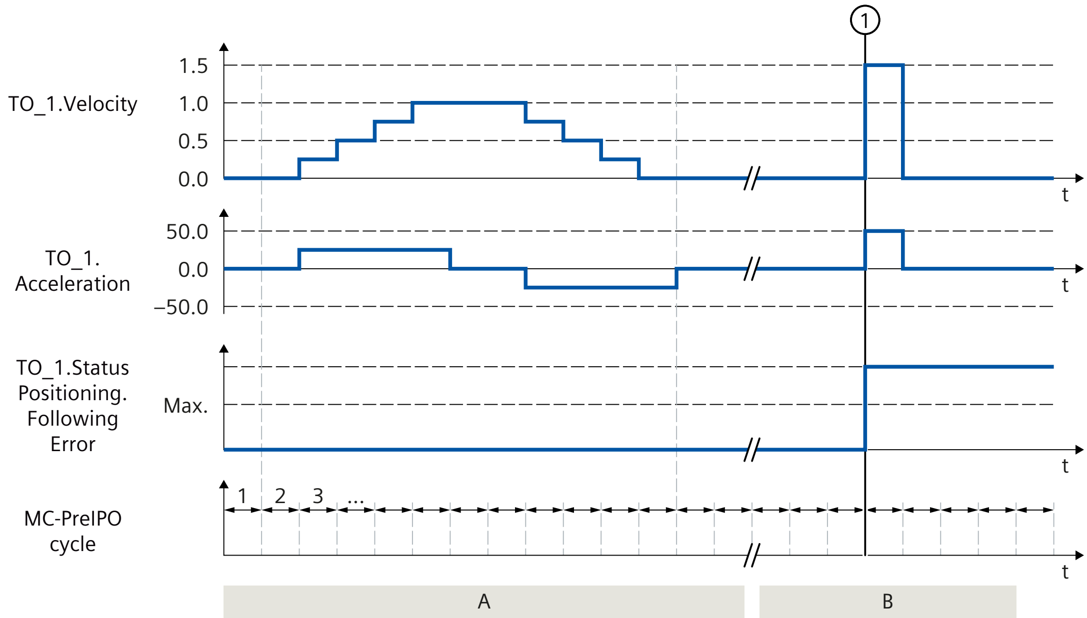
Motion specification via "MotionIn" (Page 111)

8.16.1.2 MC_MotionInVelocity: Function chart V7 (S7-1500T)

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 effective 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.

8.16.2 MC_MotionInPosition V7 (S7-1500T)

8.16.2.1 MC_MotionInPosition: Specify motion setpoints V7 (S7-1500T)

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 effective.

With the "Position" parameter, you can specify the set position. With the "Velocity" parameter, you can specify the velocity setpoint. With the "Acceleration" parameter, you can specify the setpoint acceleration.
The velocity setpoint is used as the precontroller value when velocity feedforward control is activated. The set position, velocity setpoint and acceleration setpoint are effective when the parameter "Enable" = TRUE and at least the values for the "Position" and "Velocity" parameters are specified.

Applies to

- Positioning axis
- Synchronous axis

Requirement

- The technology object has been configured correctly.
- The technology object has been enabled.

Override response

The override response for "MC_MotionInPosition" jobs is described in section "Override response V7: Homing and motion jobs (Page 279)".

NOTE

Deviating dynamic settings

When overriding the active job with a new jerk-limited motion, the current acceleration or deceleration is transferred to the new acceleration/deceleration via the jerk. Depending on the dynamic settings, this may take several application cycles. When the new acceleration or deceleration deviates significantly from the acceleration/deceleration at the time of the override, the transition profile can result in an unexpected motion of the axis.

If such transitions cannot be excluded during acceleration/deceleration, adjust the dynamic settings of your jobs. For example, add a motion that is not jerk-limited with a direct transition to the new acceleration/deceleration. As an alternative, use high jerk values.

For MotionIn jobs, the specification of the acceleration is only relevant for overriding the job. When the currently active acceleration is not to be slowed down via the jerk, enter the value "0.0" at the "Acceleration" parameter of the MotionIn job.

Parameters

The following table shows the parameters of the Motion Control instruction "MC_MotionInPosition":

Parameter	Declara-tion	Data type	Default value	Description
Axis	INPUT	TO_PositioningAxis TO_SynchronousAxis	-	Technology object

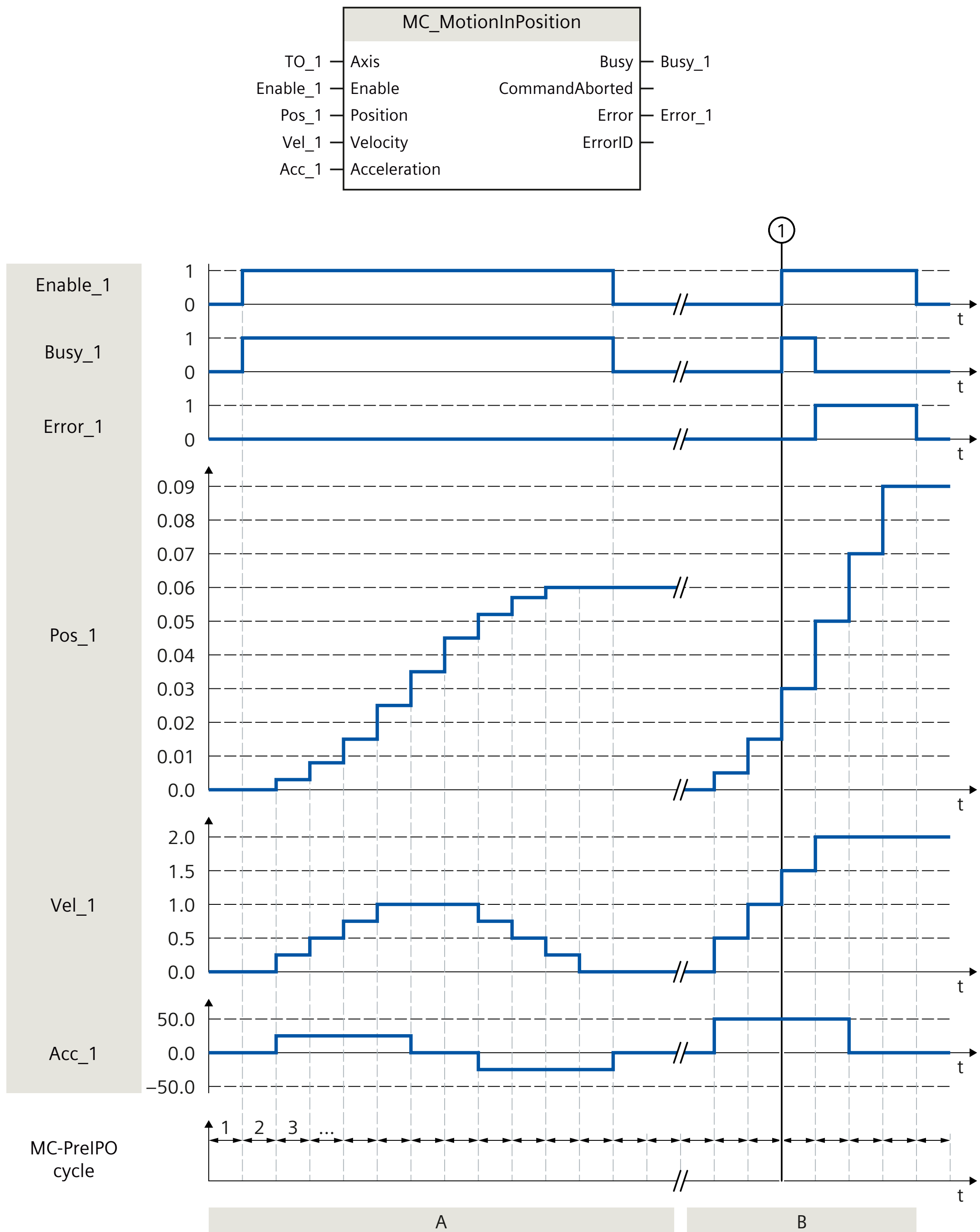
Parameter	Declaration	Data type	Default value	Description	
Enable	INPUT	BOOL	FALSE	TRUE	Start job with a positive edge The specified setpoints are used as long as the parameter is set to "TRUE".
				FALSE	End of the job with negative edge If the parameter is set from "TRUE" to "FALSE", the setpoints are set to 0.0. The most recently specified value remains active for the set position.
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 for the parameter "ErrorID" You can find more detailed information in the "Error IDs" section of the "S7-1500/S7-1500T Motion Control alarms and error IDs" documentation (Page 12).	

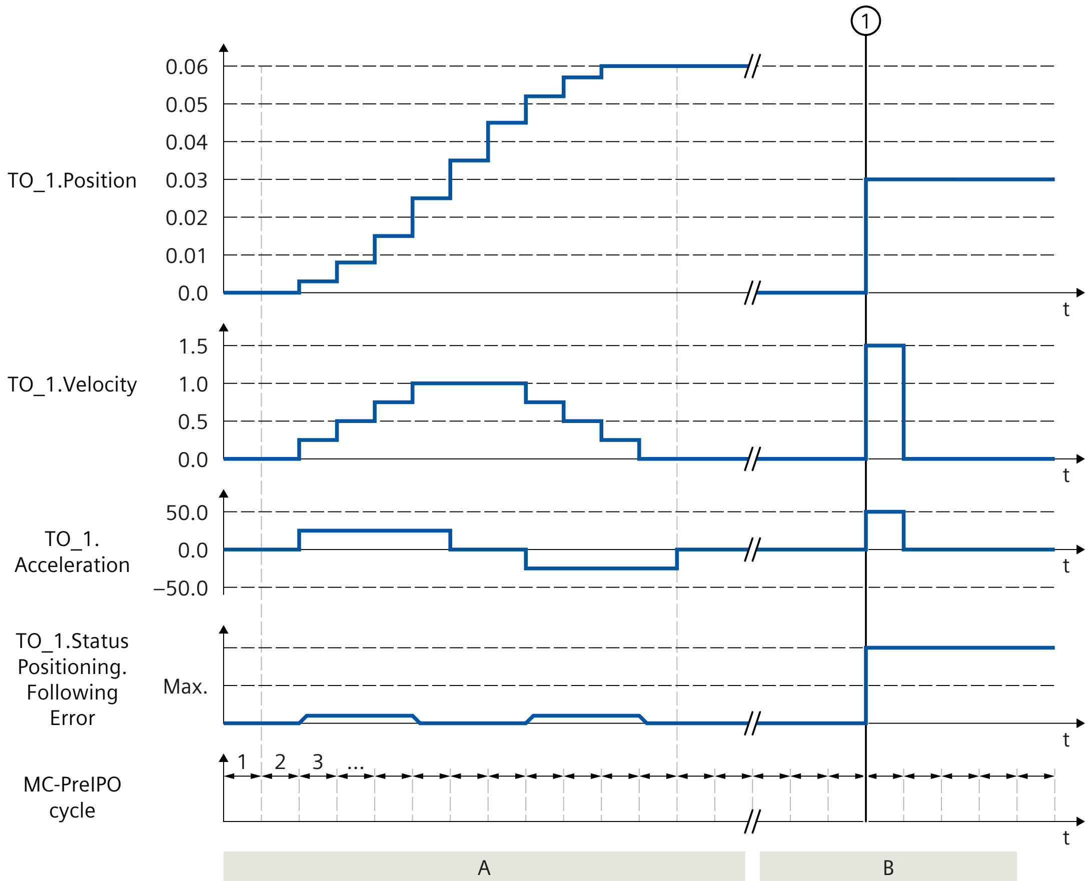
See also

Motion specification via "MotionIn" (Page 111)

8.16.2.2 MC_MotionInPosition: Function chart V7 (S7-1500T)

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.

8.16.3 MC_MotionInSuperimposed V7 (S7-1500T)

8.16.3.1 MC_MotionInSuperimposed: Specifying superimposed motion setpoints V7 (S7-1500T)

Description

With the Motion Control instruction "MC_MotionInSuperimposed", you specify the cyclic, applicable motion setpoints for position, velocity and acceleration in addition to the 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 effective.

Applies to

- Positioning axis
- Synchronous axis

Requirement

- The technology object has been configured correctly.
- The technology object has been enabled.

Override response

The override response for "MC_MotionInSuperimposed" jobs is described in section "Override response V7: Homing and motion jobs (Page 279)".

NOTE

Deviating dynamic settings

When overriding the active job with a new jerk-limited motion, the current acceleration or deceleration is transferred to the new acceleration/deceleration via the jerk. Depending on the dynamic settings, this may take several application cycles. When the new acceleration or deceleration deviates significantly from the acceleration/deceleration at the time of the override, the transition profile can result in an unexpected motion of the axis.

If such transitions cannot be excluded during acceleration/deceleration, adjust the dynamic settings of your jobs. For example, add a motion that is not jerk-limited with a direct transition to the new acceleration/deceleration. As an alternative, use high jerk values.

Parameters

The following table shows the parameters of the Motion Control instruction "MC_MotionInSuperimposed":

Parameter	Declaration	Data type	Default value	Description	
Axis	INPUT	TO_PositioningAxis TO_SynchronousAxis	-	Axis 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 set position.
Distance	INPUT	LREAL	0.0	Additional distance of the superimposed motion (negative or positive)	
VelocityDiff	INPUT	LREAL	0.0	Velocity setpoint of the superimposed motion (velocity difference) Observe the dynamic limits of the axis.	
AccelerationDiff	INPUT	LREAL	0.0	Setpoint acceleration of the superimposed motion (acceleration difference)[1)] Observe the dynamic limits of the axis.	
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	0	Error ID for parameter "ErrorID" You can find more detailed information in the "Error IDs" section of the "S7-1500/S7-1500T Motion Control alarms and error IDs" documentation (Page 12).	

1) The superimposed acceleration "AccelerationDiff" is only required for overriding the superimposed or entire motion. When braking the superimposed motion with a "MC_HaltSuperImposed" job with "AbortAcceleration" = FALSE, the specified acceleration is reduced via the jerk.

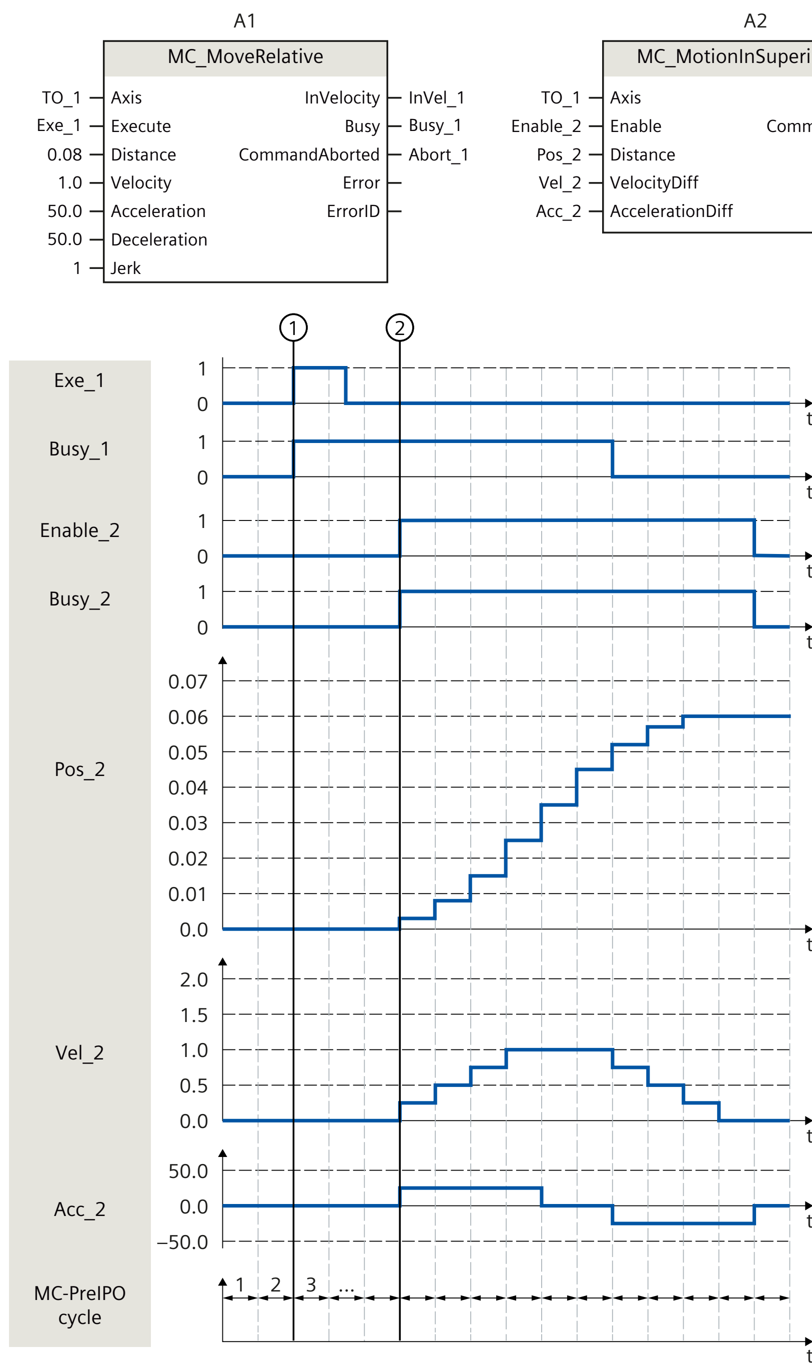
See also

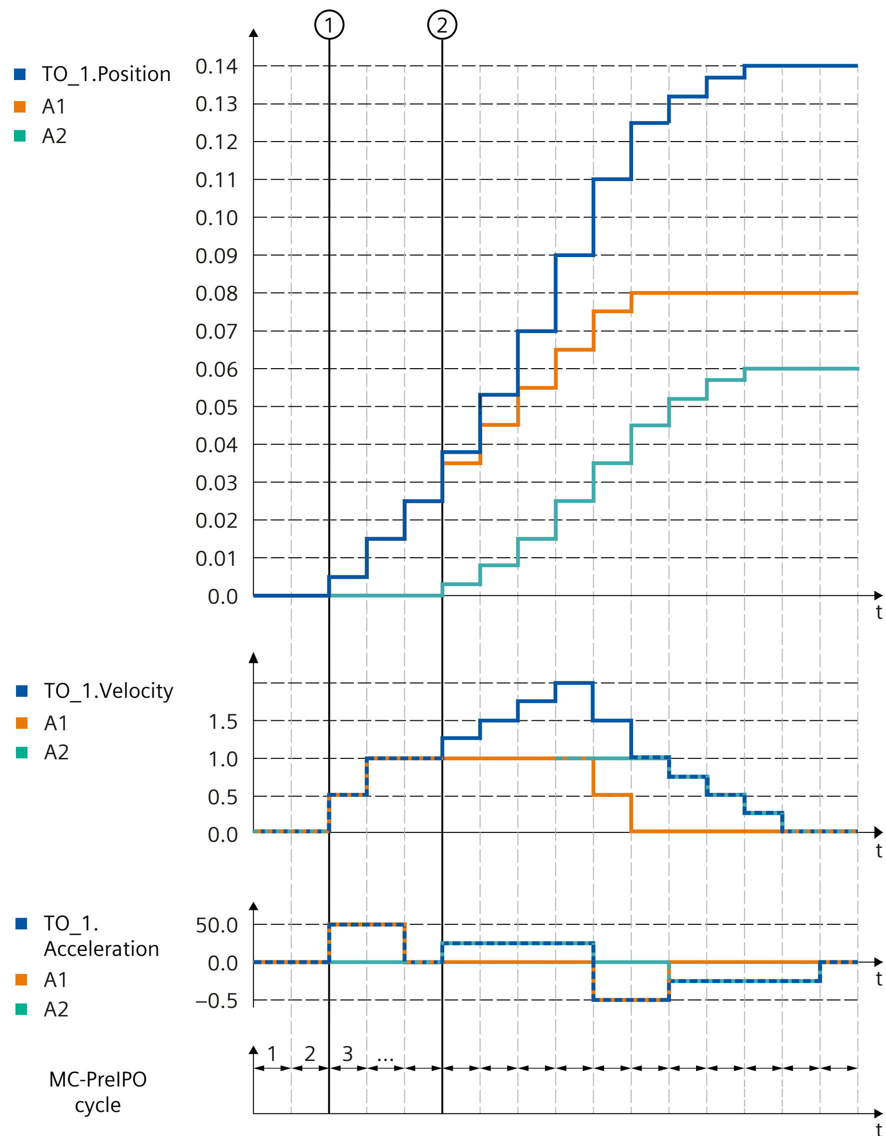
Motion specification via "MotionIn" (Page 111)

Superimposed motions (Page 107)

8.16.3.2 MC_MotionInSuperimposed: Function chart V7 (S7-1500T)

Function chart: Specifying superimposed motion setpoints





①
A "Exe_1" job is triggered via "MC_MoveRelative" with the distance 0.08 as the basic motion.
②
The "MC_MotionInSuperimposed" job is triggered. With the positive edge at "Enable_2", the setpoints "Pos_2", "Vel_2", and "Acc_2" become valid and superimpose the basic motion.

8.17 Torque data (S7-1500, S7-1500T)

8.17.1 MC_TorqueAdditive V7 (S7-1500, S7-1500T)

8.17.1.1 MC_TorqueAdditive: Specify additive torque V7 (S7-1500, S7-1500T)

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 a linear motor, use the "MC_TorqueAdditive" instruction to specify an additive force.

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

- Speed axis
- Positioning axis
- Synchronous axis

Requirement

- The technology object has been configured correctly.
- The technology object has been 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 the Motion Control instruction "MC_TorqueAdditive":

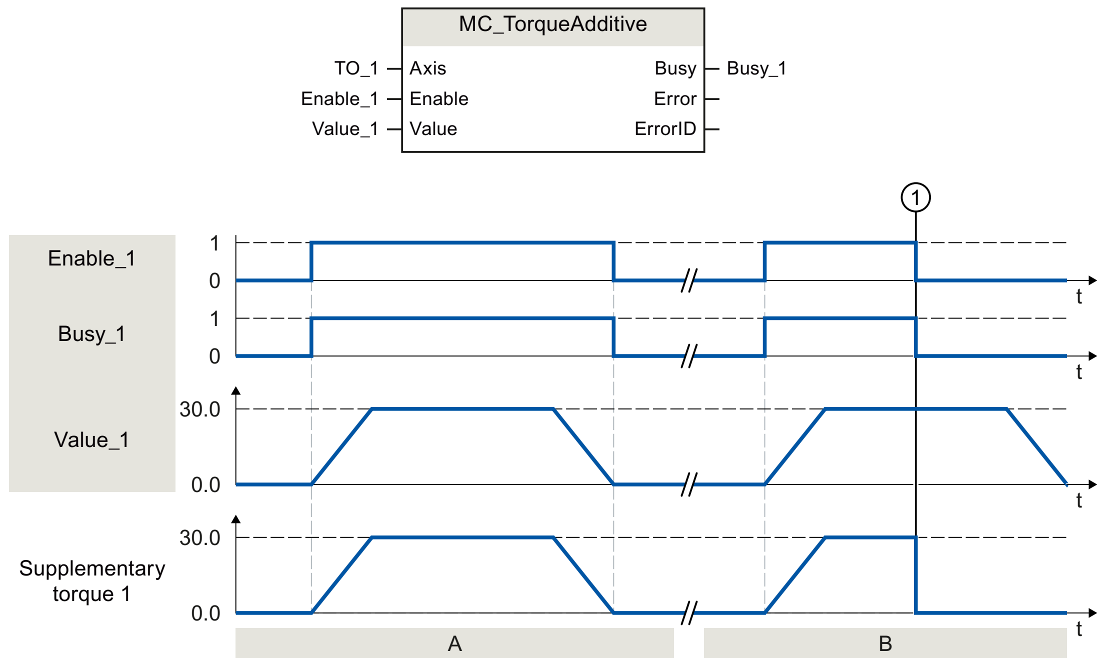
Parameter	Declaration	Data type	Default value	Description	
Axis	INPUT	TO_SpeedAxis TO_PositioningAxis TO_SynchronousAxis	-	Technology object	
Enable	INPUT	BOOL	FALSE	TRUE	The specified setpoint is used as long as the parameter is set to TRUE.
				FALSE	The additive torque transferred to the drive is zero.
Value	INPUT	LREAL	0.0	With standard motor: Additive setpoint torque With linear motor: Additive setpoint force 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 for parameter "ErrorID" You can find more detailed information in the "Error IDs" section of the "S7-1500/S7-1500T Motion Control alarms and error IDs" documentation (Page 12).	

See also

Additive setpoint torque/additive setpoint force (Page 106)

8.17.1.2 MC_TorqueAdditive: Function chart V7 (S7-1500, S7-1500T)

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 specification 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 specification 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.

8.17.2 MC_TorqueRange V7 (S7-1500, S7-1500T)

8.17.2.1 MC_TorqueRange: Set high and low torque limit V7 (S7-1500, S7-1500T)

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 a linear motor, use the "MC_TorqueRange" instruction to specify an upper and lower force limit.

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

- Speed axis
- Positioning 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 the Motion Control instruction "MC_TorqueRange":

Parameter	Declaration	Data type	Default value	Description	
Axis	INPUT	TO_SpeedAxis TO_PositioningAxis TO_SynchronousAxis	-	Technology object	
Enable	INPUT	BOOL	FALSE	TRUE	The specified values are used as long as the TRUE parameter is set.

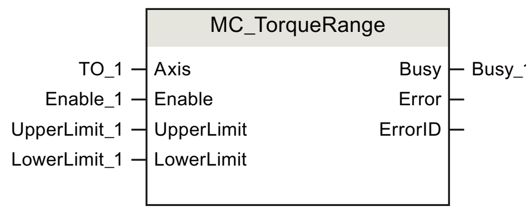
Parameter	Declara-tion	Data type	Default value	Description	
Enable	INPUT	BOOL	FALSE	FALSE	No values for the high and low torque limit are transferred to the drive.
UpperLimit	INPUT	LREAL	1.0 E12	With standard motor: Upper torque limit (in the configured unit) With linear motor: Upper force limit (in the configured unit) Permitted value range: -1.0 E12 to 1.0 E12 The value of the parameter "UpperLimit" must be greater than the value of the parameter "LowerLimit".	
LowerLimit	INPUT	LREAL	-1.0 E12	With standard motor: Lower torque limit (in the configured unit) With linear motor: Lower force limit (in the configured unit) Permitted value range: -1.0 E12 to 1.0 E12 The value of the parameter "LowerLimit" must 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 for parameter "ErrorID" You can find more detailed information in the "Error IDs" section of the "S7-1500/S7-1500T Motion Control alarms and error IDs" documentation (Page 12).	

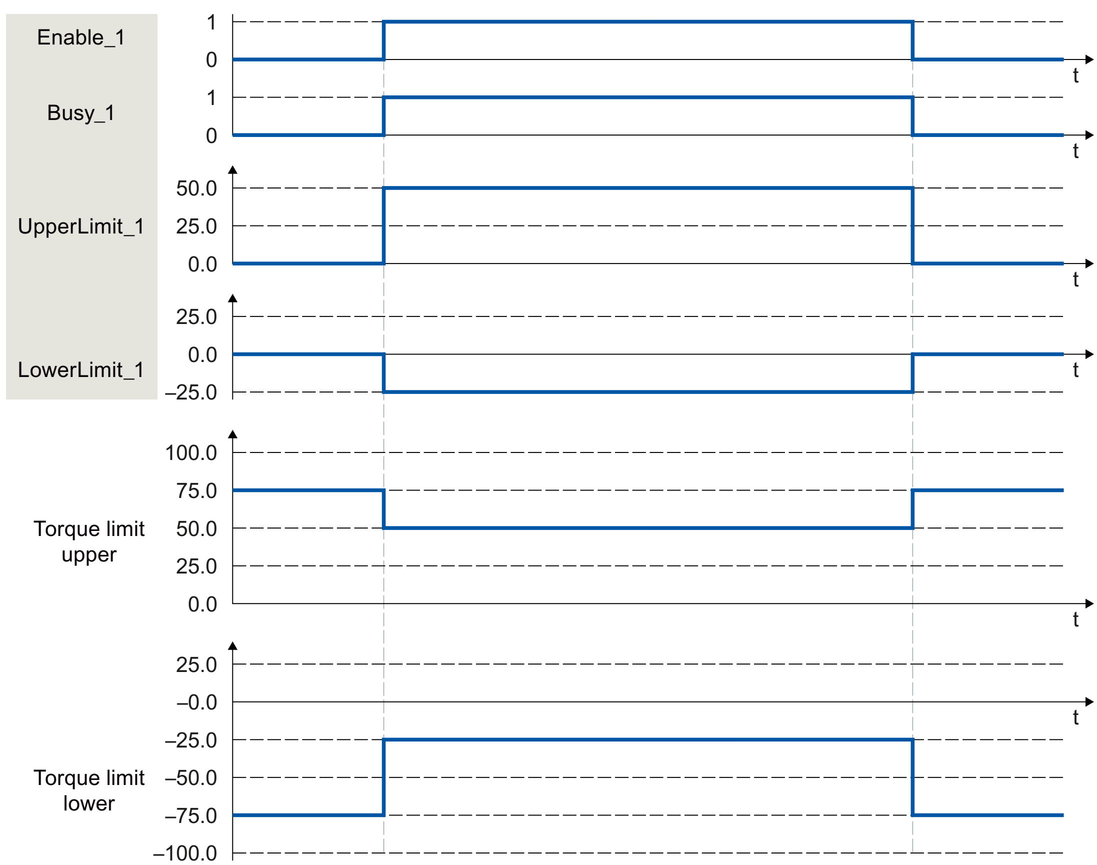
See also

Permissible torque range/force range (Page 106)

8.17.2.2 MC_TorqueRange: Function chart V7 (S7-1500, S7-1500T)

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.

8.17.3 MC_TorqueLimiting V7 (S7-1500, S7-1500T)

8.17.3.1 MC_TorqueLimiting: Activate/deactivate force/torque limit / fixed stop detection V7 (S7-1500, S7-1500T)

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.

NOTE

Multi-instance DBs

If you use multi-instances of the MC_TorqueLimiting instruction, create the multi-instances in a separate function block. This allows you to download program blocks from other sections of your user program without switching off the axes, including in RUN mode.

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 errors that prevent enabling are pending for the technology object (the technology object must not 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]).
  – P1544 Torque/force reduction analysis during travel to fixed stop to 100% (default)
  – P2194 Threshold value for the parameter "InLimitation" of < 100% (default 90%)

Fixed stop detection applies to

- Synchronous axis
- Positioning 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. Motion jobs must be executed as position-controlled.
- The technology object has been configured correctly.
- When a drive and telegram that support force/torque limiting are used, the reference torque of the drive must be correctly configured for the technology object.
- No errors that prevent enabling are pending for the technology object (the technology object must 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 the Motion Control instruction "MC_TorqueLimiting":

<table>
<tr><th>Parameter</th><th>Declaration</th><th>Data type</th><th>Default value</th><th colspan="2">Description</th></tr>
<tr><td>Axis</td><td>INPUT</td><td>TO_SpeedAxis
TO_PositioningAxis
TO_SynchronousAxis</td><td>-</td><td colspan="2">Technology object</td></tr>
<tr><td>Enable</td><td>INPUT</td><td>BOOL</td><td>FALSE</td><td>TRUE</td><td>Activate function corresponding to input parameter "Mode"</td></tr>
<tr><td rowspan="2">Limit</td><td rowspan="2">INPUT</td><td rowspan="2">LREAL</td><td rowspan="2">-1.0</td><td colspan="2">Value of force/torque limiting (in the configured unit of measurement)[1)]
If the drive and telegram do not support force/torque limiting, the specified value is irrelevant.</td></tr>
<tr><td>≥ 0.0</td><td>The value specified at the parameter is used.</td></tr>
</table>

1) Changes to input parameters "Limit" and "Mode" are also applied at the cyclic call of the Motion Control instruction when "Enable" = TRUE.

2) If "InClamping" = TRUE, all motion and synchronization jobs are canceled.

Parameter	Declaration	Data type	Default value	Description	
Limit	INPUT	LREAL	-1.0	< 0.0	The value configured in the "Torque limiting" configuration window is used. Tag Torque Limit: <TO>.TorqueLimiting.LimitDefaults.Torque Tag Force Limit: <TO>.TorqueLimiting.LimitDefaults.Force
Mode	INPUT	DINT	0	0	Force/torque limiting[1)]
				1	Fixed stop detection[1)] 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[2)]). The axis position is within the positioning tolerance.
InLimitation	OUTPUT	BOOL	FALSE	TRUE	"Mode" = 0 and 1: The drive operates at least at the threshold value (default 90%) of the torque limit/force limitation.
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 for parameter "ErrorID" You can find more detailed information in the "Error IDs" section of the "S7-1500/S7-1500T Motion Control alarms and error IDs" documentation (Page 12).	

1) Changes to input parameters "Limit" and "Mode" are also applied at the cyclic call of the Motion Control instruction when "Enable" = TRUE.

2) If "InClamping" = TRUE, all motion and synchronization jobs are canceled.

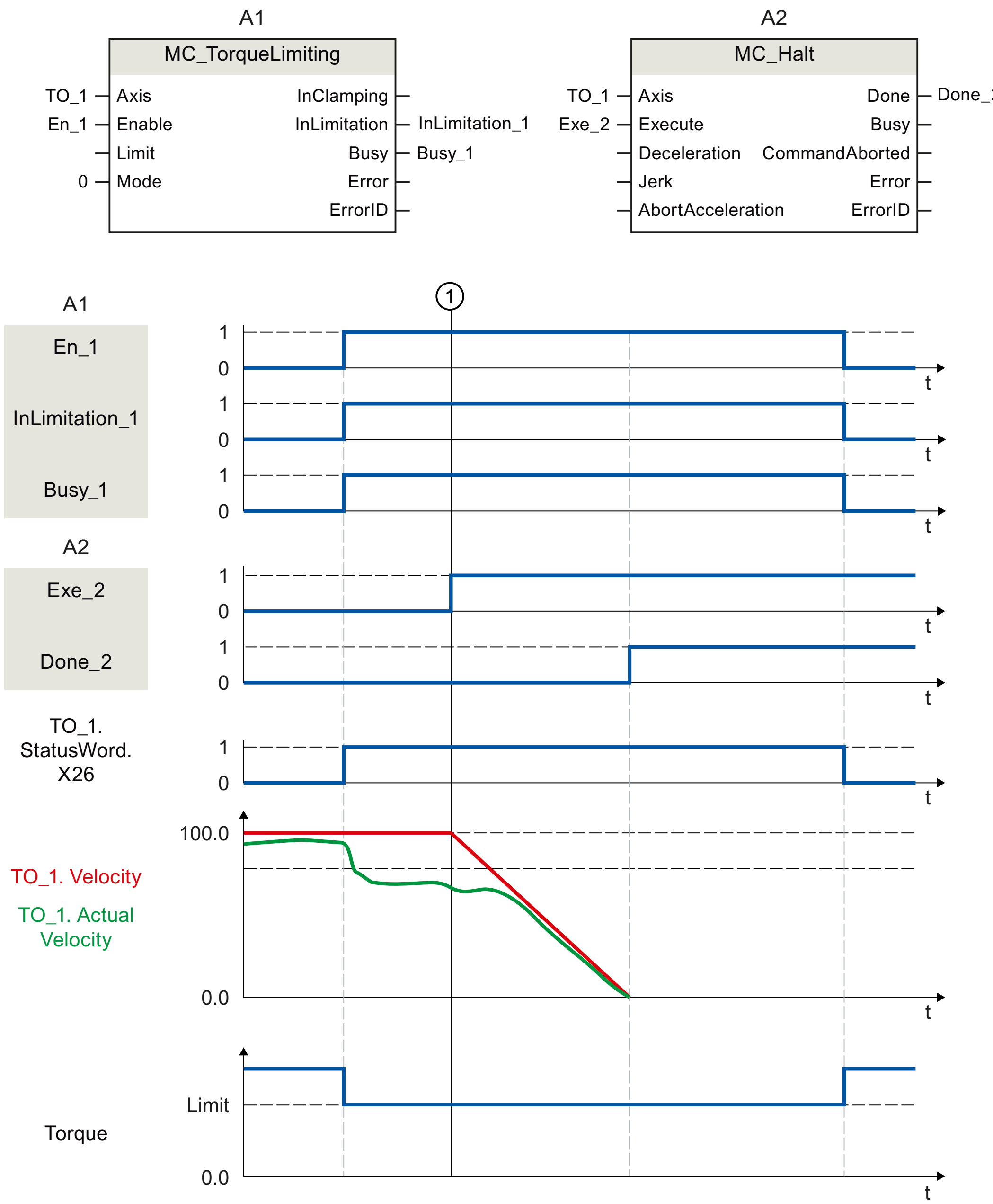
See also

Fixed stop detection (Page 104)

Force/torque limiting (Page 102)

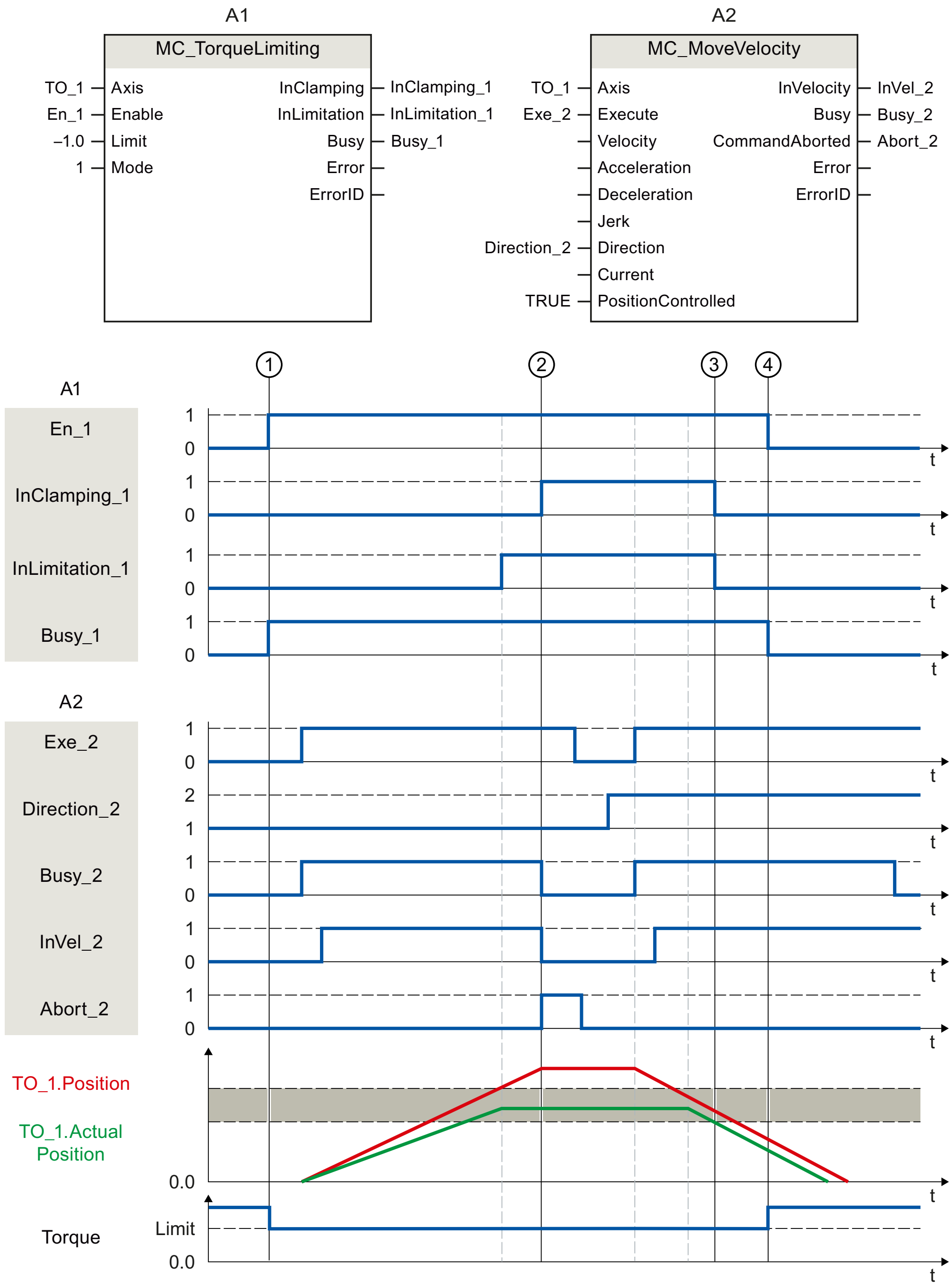
8.17.3.2 MC_TorqueLimiting: Function chart V7 (S7-1500, S7-1500T)

Function chart: Pausing 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)



Positioning tolerance

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.

8.18 Override response of Motion Control jobs V7 (S7-1500, S7-1500T)

8.18.1 Override response V7: Homing and motion jobs (S7-1500, S7-1500T)

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_Move-Absolute MC_MoveRel-ative MC_MoveVelo-city MC_MoveJog**	**MC_Stop**	**MC_Move-Superimposed MC_MotionIn-Superimposed MC_HaltSuper-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_MoveSuper-imposed **MC_MotionInSuper-imposed** **MC_HaltSuper-Imposed**	-	-	-	-	A	-

A The running job is aborted with "CommandAborted" = TRUE.

B An "MC_Stop" job is aborted by another "MC_Stop" job with a stop response that is the same or higher.

\- No effect. Running job continues to be executed.

1) The status "Busy" = TRUE, "StartSync" = FALSE, "InSync" = FALSE corresponds to a waiting synchronous operation.

2) The status "Busy" = TRUE, "StartSync" or "InSync" = TRUE corresponds to an active synchronous operation.

3) The status "Busy" = TRUE, "StartSyncOut" = FALSE corresponds to a pending desynchronization job.

4) The status "Busy" = TRUE, "StartSyncOut" = TRUE corresponds to an active desynchronization job.

⇒ 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_Stop	MC_MoveSuperimposed MC_MotionInSuperimposed MC_HaltSuperImposed	MC_MotionInVelocity MC_MotionInPosition
MC_Stop	A	A	A	B	A	A
MC_GearIn **MC_GearInVelocity**	-	A	A	-	A	-
MC_GearInPos **MC_CamIn** waiting[1)]	-	-	-	-	-	-
MC_GearInPos **MC_CamIn** active[2)]	-	A	A	-	A	-
MC_LeadingValueAdditive	-	-	-	-	-	-
MC_GearOut **MC_CamOut** waiting[3)]	-	-	-	-	-	-
MC_GearOut **MC_CamOut** active[4)]	-	-	-	-	A	-

A The running job is aborted with "CommandAborted" = TRUE.

B An "MC_Stop" job is aborted by another "MC_Stop" job with a stop response that is the same or higher.

\- No effect. Running job continues to be executed.

1) The status "Busy" = TRUE, "StartSync" = FALSE, "InSync" = FALSE corresponds to a waiting synchronous operation.

2) The status "Busy" = TRUE, "StartSync" or "InSync" = TRUE corresponds to an active synchronous operation.

3) The status "Busy" = TRUE, "StartSyncOut" = FALSE corresponds to a pending desynchronization job.

4) The status "Busy" = TRUE, "StartSyncOut" = TRUE corresponds to an active desynchronization job.

NOTE

Override response with active fixed stop

With an active force and torque limiting with "MC_TorqueLimiting", running jobs are aborted if the drive is held at the fixed stop with "InClamping" = TRUE.

8.18.2 Override response V7: Synchronous operation jobs (S7-1500, S7-1500T)

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_GearInVelocity	MC_GearInPos MC_CamIn waiting[1]	MC_GearInPos MC_CamIn active[2]	MC_PhasingAbsolute MC_PhasingRelative	MC_OffsetAbsolute MC_OffsetRelative	MC_LeadingValueAdditive	MC_GearOut MC_CamOut waiting[3]	MC_GearOut MC_CamOut active[4]
MC_Home "Mode" = 3, 5	A	A	-	-	-	-	-	-	-
MC_Halt	A	A	-	A	A	A	-	A	A
MC_MoveAbsolute MC_MoveRelative MC_MoveVelocity MC_MoveJog	A	A	-	A	A	A	-	A	A
MC_MotionInVelocity MC_MotionInPosition	A	A	A	A	A	A	-	A	A
MC_MoveSuperimposed MC_MotionInSuperimposed MC_HaltSuperImposed	-	-/N[5]	-	-	-	-	-	-	-
MC_Stop	A	A	A	A	A	A	-	A	A
MC_GearIn MC_GearInVelocity	A	A	A	A	A	A	-	A	A

A The running job is aborted with "CommandAborted" = TRUE.

N Not permitted. Running job continues to be executed. The new job is rejected.

\- No effect. Running job continues to be executed.

1) A waiting synchronous operation job ("Busy" = TRUE, "StartSync" = FALSE, "InSync" = FALSE) does not abort any active jobs. Abort with an "MC_Power" job is possible.

2) The status "Busy" = TRUE, "StartSync" or "InSync" = TRUE corresponds to an active synchronous operation.

3) A pending desynchronization job ("Busy" = TRUE, "StartSyncOut" = FALSE) does not abort any active jobs. Abort with an "MC_Power" job is possible.

4) The status "Busy" = TRUE, "StartSyncOut" = TRUE corresponds to an active desynchronization job.

5) When the following axis is in position-controlled mode, execution of the running job is continued. When the following axis is not in position-controlled mode, the new job is rejected.

6) An "MC_GearOut" job only terminates an "MC_Gear[...]" job. Correspondingly, an "MC_CamOut" job only cancels a "MC_Cam[...]" job.

7) A job with "SyncProfileReference" = 5 aborts a pending synchronous operation. Canceling a pending synchronous operation has no influence on an active synchronous operation.

⇒ Active job ⇓ New job	MC_GearIn	MC_GearInVelocity	MC_GearInPos MC_CamIn waiting[1)]	MC_GearInPos MC_CamIn active[2)]	MC_PhasingAbsolute MC_PhasingRelative	MC_OffsetAbsolute MC_OffsetRelative	MC_LeadingValueAdditive	MC_GearOut MC_CamOut waiting[3)]	MC_GearOut MC_CamOut active[4)]
MC_GearInPos **MC_CamIn** waiting[1)]	-	-	A	-	-	-	-	A	-
MC_GearInPos **MC_CamIn** active[2)]	A	A[5)]	A	A	A	A	-	A	A
MC_PhasingAbsolute **MC_PhasingRelative**	-	N	-	-	A	N	-	-	-
MC_OffsetAbsolute **MC_OffsetRelative**	-	N	-	-	N	A	-	-	-
MC_LeadingValueAdditive	-	-	-	-	-	-	A	-	-
MC_GearOut **MC_CamOut** waiting[3)]	-	N	A[6) 7)]	-	-	-	-	A[6)]	-
MC_GearOut **MC_CamOut** active[4)]	A[6)]	N	A[6) 7)]	A[6)]	A	A	-	A[6)]	-

A The running job is aborted with "CommandAborted" = TRUE.

N Not permitted. Running job continues to be executed. The new job is rejected.

\- No effect. Running job continues to be executed.

1) A waiting synchronous operation job ("Busy" = TRUE, "StartSync" = FALSE, "InSync" = FALSE) does not abort any active jobs. Abort with an "MC_Power" job is possible.

2) The status "Busy" = TRUE, "StartSync" or "InSync" = TRUE corresponds to an active synchronous operation.

3) A pending desynchronization job ("Busy" = TRUE, "StartSyncOut" = FALSE) does not abort any active jobs. Abort with an "MC_Power" job is possible.

4) The status "Busy" = TRUE, "StartSyncOut" = TRUE corresponds to an active desynchronization job.

5) When the following axis is in position-controlled mode, execution of the running job is continued. When the following axis is not in position-controlled mode, the new job is rejected.

6) An "MC_GearOut" job only terminates an "MC_Gear[...]" job. Correspondingly, an "MC_CamOut" job only cancels a "MC_Cam[...]" job.

7) A job with "SyncProfileReference" = 5 aborts a pending synchronous operation. Canceling a pending synchronous operation has no influence on an active synchronous operation.

NOTE

Override response with active fixed stop

With an active force and torque limiting with "MC_TorqueLimiting", running jobs are aborted if the drive is held at the fixed stop with "InClamping" = TRUE.

8.18.3 Override response V7: Measuring input jobs (S7-1500, S7-1500T)

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, 11, 12	-	-
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.

8.18.4 Override response V7: Kinematics motion commands (S7-1500T)

Single axis jobs are not overridden by kinematics jobs.

The following table shows how a new Motion Control job affects active kinematics motion jobs:

⇒ **Active job** ⇓ **New job**	**MC_MoveLinearAbsolute** **MC_MoveLinearRelative** **MC_MoveCircularAbsolute** **MC_MoveCircularRelative** **MC_MoveDirectAbsolute** **MC_MoveDirectRelative** **MC_TrackConveyorBelt** **MC_DefineWorkspaceZone** **MC_DefineKinematicsZone** **MC_SetWorkspaceZoneActive** **MC_SetWorkspaceZoneInactive** **MC_SetKinematicsZoneActive** **MC_SetKinematicsZoneInactive** **MC_SetOcsFrame**	**MC_GroupInterrupt**	**MC_GroupStop**
MC_Home **MC_MoveSuperimposed** **MC_GearOut** **MC_CamOut**	N	N	N
MC_Halt **MC_MoveAbsolute** **MC_MoveRelative** **MC_MoveVelocity** **MC_MoveJog** **MC_Stop** **MC_GearIn** **MC_GearInPos** **MC_GearInVelocity** **MC_CamIn** **MC_MotionInVelocity** **MC_MotionInPosition**	A	A	A
MC_GroupStop	A	A	N
MC_GroupInterrupt **MC_GroupContinue**	B	A	N
MC_MoveLinearAbsolute **MC_MoveLinearRelative** **MC_MoveCircularAbsolute** **MC_MoveCircularRelative** **MC_MoveDirectAbsolute** **MC_MoveDirectRelative** **MC_TrackConveyorBelt** **MC_DefineWorkspaceZone** **MC_DefineKinematicsZone** **MC_SetWorkspaceZoneActive** **MC_SetWorkspaceZoneInactive** **MC_SetKinematicsZoneActive** **MC_SetKinematicsZoneInactive**	-	-	N

A The running job is aborted with "CommandAborted" = TRUE.

B Running job is interrupted or resumed.

C Synchronization of the OCS with the conveyor belt is aborted with "MC_SetOcsFrame" = TRUE.

N Not permitted. Running job continues to be executed. The new job is rejected.

- No effect. Running job continues to be executed. A new kinematics job is added to the job sequence.

⇒ **Active job** ⇓ **New job**	**MC_MoveLinearAbsolute** **MC_MoveLinearRelative** **MC_MoveCircularAbsolute** **MC_MoveCircularRelative** **MC_MoveDirectAbsolute** **MC_MoveDirectRelative** **MC_TrackConveyorBelt** **MC_DefineWorkspaceZone** **MC_DefineKinematicsZone** **MC_SetWorkspaceZoneActive** **MC_SetWorkspaceZoneInactive** **MC_SetKinematicsZoneActive** **MC_SetKinematicsZoneInactive** **MC_SetOcsFrame**	**MC_GroupInterrupt**	**MC_GroupStop**
MC_SetOcsFrame	C, -	-	N

A The running job is aborted with "CommandAborted" = TRUE.

B Running job is interrupted or resumed.

C Synchronization of the OCS with the conveyor belt is aborted with "MC_SetOcsFrame" = TRUE.

N Not permitted. Running job continues to be executed. The new job is rejected.

\- No effect. Running job continues to be executed. A new kinematics job is added to the job sequence.

9 Tags of the technology object data blocks (S7-1500, S7-1500T)

9.1 Tags of the speed axis technology object (S7-1500, S7-1500T)

9.1.1 Legend (S7-1500, S7-1500T)

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 via direct assignment 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.

9.1.2 Actual values and setpoints (speed axis) (S7-1500, S7-1500T)

The following tags indicate the setpoint and actual values of the technology object.

Tags

Legend (Page 286)

Tag	Data type	Values	W	Description
Velocity	LREAL	-	RON	Velocity setpoint/speed setpoint
ActualSpeed	LREAL	-	RON	With analog setpoint = 0.0: Actual speed of motor in 1/min
Acceleration	LREAL	-	RON	Setpoint acceleration

Tag	Data type	Values	W	Description
VelocitySetpoint	LREAL	-1.0E12 to 1.0E-12	RON	Output velocity setpoint/speed setpoint

9.1.3 "Simulation" tag (speed axis) (S7-1500, S7-1500T)

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 286)

Tag		Data type	Values	W	Description	
Simulation.		TO_Struct_AxisSimulation				
	Mode	UDINT	0, 1	RES[1]	Simulation mode	
					0	No simulation, normal operation
					1	Simulation mode

[1] Technology version V2.0: RON

9.1.4 "VirtualAxis" tag (speed axis) (S7-1500, S7-1500T)

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 286)

Tag		Data type	Values	W	Description	
VirtualAxis.		TO_Struct_VirtualAxis				
	Mode	UDINT	0, 1	RON	Virtual axis	
					0	No virtual axis
					1	Axis is always and exclusively operated as virtual axis

9.1.5 "Actor" tag (speed axis) (S7-1500, S7-1500T)

The tag structure "<TO>.Actor.<tag name>" contains the controller-side configuration of the drive.

Tags

Legend (Page 286)

Tag	Data type	Values	W	Description	
Actor.	TO_Struct_Actor				
Type	DINT	0, 1	RON	Drive connection	
				0	Analog output
				1	PROFIdrive telegram
InverseDirection	BOOL	-	RES	Inversion of the setpoint	
				FALSE	No
				TRUE	Yes
DataAdaption	DINT	0, 1	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.	TO_Struct_ActorInterface				
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	Enabled
EnableDriveOutputAd-dress	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 set-points.	
				FALSE	Disabled
				TRUE	Enabled
DriveReadyInputAd-dress	VREF	0 to 65535	RON	Address for the "Enable input" for analog setpoint	
EnableTorqueData	BOOL	-	RES	Torque data	
				FALSE	Disabled
				TRUE	Enabled
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	
DriveParameter.	TO_Struct_ActorDriveParameter				

Tag	Data type	Values	W	Description
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 the standard motor setting.

9.1.6 "TorqueLimiting" tag (speed axis) (S7-1500, S7-1500T)

The tag structure "<TO>.TorqueLimiting.<tag name>" contains the configuration of the torque limiting.

Tags

Legend (Page 286)

Tag	Data type	Values	W	Description	
TorqueLimiting.	TO_Struct_TorqueLimiting				
LimitBase	DINT	0, 1	RES	Torque limiting	
				0	Motor side
				1	Load side
PositionBasedMonitorings	DINT	0, 1	RES	Positioning and following error monitoring	
				0	Monitoring deactivated
				1	Monitoring activated
LimitDefaults.	TO_Struct_TorqueLimitingLimitDefaults				
Torque	LREAL	0.0 to 1.0E12	CAL	Limiting torque	
Force	LREAL	0.0 to 1.0E12	CAL	Limiting force	

9.1.7 "LoadGear" tag (speed axis) (S7-1500, S7-1500T)

The tag structure "<TO>.LoadGear.<tag name>" contains the configuration of the load gear.

Tags

Legend (Page 286)

Tag	Data type	Value range	W	Description
LoadGear.	TO_Struct_LoadGear			
Numerator	UDINT	1 to 4294967295	RES	Load gear numerator
Denominator	UDINT	1 to 4294967295	RES	Load gear denominator

9.1.8 "Units" tag (speed axis) (S7-1500, S7-1500T)

The tag structure "<TO>.Units.<tag name>" shows the set technological units.

Tags

Legend (Page 286)

Tag	Data type	Values	W	Description	
Units.	TO_Struct_Units / TO_Struct_ExternalEncoder_Units				
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)
UnitFactor	UDINT	-	RON	Factor for internal conversion in the high-resolution units.	

9.1.9 "DynamicLimits" tag (speed axis) (S7-1500, S7-1500T)

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 specify 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 are limited).

Tags

Legend (Page 286)

Tag	Data type	Values	W	Description
DynamicLimits.	TO_Struct_DynamicLimits			
MaxVelocity	LREAL	0.0 ... 1.0E12	RES	Maximum permissible velocity of the axis
Velocity	LREAL	0.0 ... 1.0E12	DIR	Current maximum velocity of the axis The minimum from "MaxVelocity" and "Velocity" is effective for motion control.
MaxAcceleration	LREAL	0.0 ... 2.77777777777778E8	DIR	Maximum permissible acceleration of the axis
MaxDeceleration	LREAL	0.0 ... 2.77777777777778E8	DIR	Maximum permissible deceleration of the axis
MaxJerk	LREAL	0.0 ... 4629629.629	DIR	Maximum permissible jerk on the axis

9.1.10 "DynamicDefaults" tag (speed axis) (S7-1500, S7-1500T)

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 286)

Tag	Data type	Values	W	Description
DynamicDefaults.	TO_Struct_DynamicDefaults			
Velocity	LREAL	0.0 ... 1.0E12	CAL	Default velocity
Acceleration	LREAL	0.0 ... 2.77777777777778E8	CAL	Default acceleration

Tag	Data type	Values	W	Description
Deceleration	LREAL	0.0 ... 2.7777777777-7778E8	CAL	Default deceleration
Jerk	LREAL	0.0 ... 2.7777777777-7778E8	CAL	Default jerk
EmergencyDeceleration	LREAL	0.0 ... 2.7777777777-7778E8	DIR	Emergency stop deceleration

9.1.11 "Override" tag (speed axis) (S7-1500, S7-1500T)

The tag structure "<TO>.Override.<tag name>" contains the configuration of 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 286)

Tag	Data type	Values	W	Description
Override.	TO_Struct_Override			
Velocity	LREAL	0.0 to 200.0%	DIR	Velocity or speed override Percentage correction of the velocity/speed

9.1.12 "StatusDrive" tag (speed axis) (S7-1500, S7-1500T)

The tag structure "<TO>.StatusDrive.<tag name>" indicates the status of the drive.

Tags

Legend (Page 286)

Tag	Data type	Values	W	Description	
StatusDrive.	TO_Struct_StatusDrive				
InOperation	BOOL	-	RON	Operation 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	

Tag		Data type	Values	W	Description	
	CommunicationOK	BOOL	-	RON	FALSE	Cyclic communication not established. Fault ZSW1.X3 (FaultPresent) is present. Possible causes: • The CPU is in STOP. • The drive has failed. • The "ControlRequested" bit in the status word of the drive has the value "FALSE". • The drive signals an error using the status word. • For isochronous configuration, the dynamic sign of life in the telegram has failed or is not supplied by the drive.
					TRUE	Cyclic communication OK and no fault effective
	Error	BOOL	-	RON	FALSE	No drive error
					TRUE	Drive error
	AdaptionState	DINT	0 ... 4	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

9.1.13 "StatusTorqueData" tag (speed axis) (S7-1500, S7-1500T)

The tag structure "<TO>.StatusTorqueData.<tag name>" indicates the status of the torque.

Tags

Legend (Page 286)

Tag		Data type	Value range	W	Description	
StatusTorqueData.		TO_Struct_StatusTorqueData				
	CommandAdditiveT-orqueActive	DINT	-	RON	Additive torque setpoint function	
					0	Disabled
					1	Enabled
	CommandTorqueRange-Active	DINT	-	RON	Torque range above high and low limit of the torque func-tion	
					0	Disabled
					1	Enabled
	ActualTorque	LREAL	-1.0E12 to 1.0E-12	RON	Actual torque of the axis in the technological unit of the technology object for torque	

9.1.14 "StatusMotionIn" tag (speed axis) (S7-1500, S7-1500T)

The tag structure "<TO>.StatusMotionIn.<tag name>" indicates the motion status.

Tags

Legend (Page 286)

Tag		Data type	Value range	W	Description	
StatusMotionIn.		TO_Struct_StatusMotionIn				
	FunctionState	DINT	0, 1	RON	0	No "MotionIn" function active
					1	"MotionInVelocity" function active

9.1.15 "StatusWord" tag (speed axis) (S7-1500, S7-1500T)

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 "Evaluating StatusWord, ErrorWord and WarningWord" section of the "S7-1500/S7-1500T Motion Control Overview" documentation (Page 12).

Tags

Legend (Page 286)

Tag		Data type	Values	W	Description
StatusWord		DWORD	-	RON	Status information of the technology object
	Bit 0	-	-	-	"Enable" Enable status The technology object has been enabled.
	Bit 1	-	-	-	"Error" An error is present.
	Bit 2	-	-	-	"RestartActive" A restart is active. The technology object is being reinitial-ized.
	Bit 3	-	-	-	"OnlineStartValuesChanged" The restart tags have been changed. For the changes to be applied, the technology object must be reinitialized.
	Bit 4	-	-	-	"ControlPanelActive" The axis control panel is active.
	Bit 5	-	-	-	Reserved
	Bit 6	-	-	-	"Done" No motion job is in progress and the axis control panel is deactivated.
	Bit 7	-	-	-	Reserved
	Bit 8	-	-	-	Reserved
	Bit 9	-	-	-	"JogCommand" An "MC_MoveJog" job is running.

Tag	Data type	Values	W	Description
Bit 10	-	-	-	"VelocityCommand" An "MC_MoveVelocity" job is running.
Bit 11	-	-	-	Reserved
Bit 12	-	-	-	"ConstantVelocity" The velocity setpoint is reached. A constant velocity set-point is output.
Bit 13	-	-	-	"Accelerating" An acceleration operation is active.
Bit 14	-	-	-	"Decelerating" A deceleration operation is active.
Bit 15... Bit 24	-	-	-	Reserved
Bit 25	-	-	-	"AxisSimulation" The simulation is active.
Bit 26	-	-	-	"TorqueLimitingCommand" An "MC_TorqueLimiting" job is running.
Bit 27	-	-	-	"InLimitation" The drive operates at least at the threshold value (default 90%) of the torque limit.
Bit 28... Bit 31	-	-	-	Reserved

9.1.16 "StatusWord2" tag (speed axis) (S7-1500, S7-1500T)

The "<TO>.StatusWord2" tag contains the status information of the technology object.

Information on the evaluation of the individual bits (e.g. bit 0 "StopCommand") can be found in the "Evaluating StatusWord, ErrorWord and WarningWord" section of the "S7-1500/S7-1500T Motion Control Overview" documentation (Page 12).

Tags

Legend (Page 286)

Tag	Data type	Value range	W	Description
StatusWord2	DWORD	-	RON	Status information of the technology object
Bit 0	BOOL	-	RON	"StopCommand" An "MC_Stop" job is running. The technology object is dis-abled.
Bit 1 to Bit 31	BOOL	-	RON	Reserved

9.1.17 "ErrorWord" tag (speed axis) (S7-1500, S7-1500T)

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" section of the "S7-1500/S7-1500T Motion Control Overview" documentation (Page 12).

Tags

Legend (Page 286)

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" Job cannot be executed A Motion Control instruction cannot be executed because the necessary conditions 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... 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

9.1.18 "ErrorDetail" tag (speed axis) (S7-1500, S7-1500T)

The tag structure "<TO>.ErrorDetail.<tag name>" contains the alarm number and the effective local alarm response for the technology alarm that is currently pending on the technology object.
You can find a list of the technology alarms and alarm responses in the "Overview of the technology alarms" section of the "S7-1500/S7-1500T Motion Control alarms and error IDs" documentation (Page 12).

Tags

Legend (Page 286)

Tag		Data type	Values	W	Description	
ErrorDetail.		TO_Struct_ErrorDetail				
	Number	UDINT	-	RON	Alarm number	
	Reaction	DINT	0 ... 5	RON	Effective alarm response	
					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

9.1.19 "WarningWord" tag (speed axis) (S7-1500, S7-1500T)

The "<TO>.WarningWord" tag indicates pending warnings at 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" section of the "S7-1500/S7-1500T Motion Control Overview" documentation (Page 12).

Tags

Legend (Page 286)

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" Job cannot be executed A Motion Control instruction cannot be executed because the necessary conditions have not been met.
	Bit 4	-	-	-	"DriveWarning" Warning of the drive When a warning message is pending at the drive that does not result in a TO alarm, this bit is not set. Evaluate the drive warnings directly using the status word of the drive.
	Bit 5	-	-	-	Reserved

Tag	Data type	Values	W	Description
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

9.1.20 "ControlPanel" tag (speed axis) (S7-1500, S7-1500T)

The tag structure "<TO>.ControlPanel.<tag name>" contains no relevant data for you. This tag structure is internally used.

Tags

Legend (Page 286)

Tag	Data type	Values	W	Description
ControlPanel.	TO_Struct_ControlPanel			
Input.	TO_Struct_ControlPanelInput			
TimeOut	LREAL	100 to 60000	DIR	-
EsLifeSign	UDINT	-	DIR	-
Command[1..1].	ARRAY [1..1] OF TO_Struct_ControlPanelInputCmd			
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.	TO_Struct_ControlPanelOutput			
RTLifeSign	UDINT	-	RON	-
Command[1..1].	ARRAY [1..1] OF TO_Struct_ControlPanelOutputCmd			

Tag	Data type	Values	W	Description
AckCounter	UDINT	-	RON	-
Error	BOOL	-	RON	-
ErrorID	UDINT	-	RON	-
Done	BOOL	-	RON	-
Aborted	BOOL	-	RON	-

9.1.21 "InternalToTrace[1..4]" tag (speed axis) (S7-1500, S7-1500T)

The tag structure "<TO>.InternalToTrace[1..4].<tag name>" contains no relevant data for you. This tag structure is internally used.

Tags

Legend (Page 286)

Tag	Data type	Values	W	Description
InternalToTrace[1..4].	ARRAY [1..4] OF TO_Struct_Internal			
Id	DINT	-	DIR	-
Value	LREAL	-	DIR	-

9.2 Tags of the positioning axis technology object (S7-1500, S7-1500T)

9.2.1 Legend (S7-1500, S7-1500T)

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 via direct assignment 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.

9.2.2 Actual values and setpoints (positioning axis) (S7-1500, S7-1500T)

The following tags indicate the setpoint and actual values of the technology object.

Tags

Legend (Page 299)

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	For PROFIdrive drives	Actual speed of the motor
				For drives with analog setpoint interface	0.0
				For drives with linear motor	0.0
Acceleration	LREAL	-	RON	Setpoint acceleration	
ActualAcceleration	LREAL	-	RON	Actual acceleration	
OperativeSensor	UDINT	1 ... 4	RON	Operative encoder	
ModuloCycle	DINT	-2147483648 ... 2147483647	RON	Number of modulo cycles of the setpoint	
ActualModuloCycle	DINT	-2147483648 ... 2147483647	RON	Number of modulo cycles of the actual value	
VelocitySetpoint	LREAL	-1.0E12 ... 1.0E12	RON	Output velocity setpoint/speed setpoint	

9.2.3 "Simulation" tag (positioning axis) (S7-1500, S7-1500T)

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 299)

Tag		Data type	Values	W	Description	
Simulation.		TO_Struct_AxisSimulation				
	Mode	UDINT	0, 1	RES[1]	Simulation mode	
					0	No simulation, normal operation
					1	Simulation mode

1) Technology version V2.0: RON

9.2.4 "VirtualAxis" tag (positioning axis) (S7-1500, S7-1500T)

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 299)

Tag		Data type	Values	W	Description	
VirtualAxis.		TO_Struct_VirtualAxis				
	Mode	UDINT	0, 1	RON	Virtual axis	
					0	No virtual axis
					1	Axis is always and exclusively operated as virtual axis

9.2.5 "Actor" tag (positioning axis) (S7-1500, S7-1500T)

The tag structure "<TO>.Actor.<tag name>" contains the controller-side configuration of the drive.

Tags

Legend (Page 299)

Tag		Data type	Values	W	Description	
Actor.		TO_Struct_Actor				
	Type	DINT	0, 1	RON	Drive connection	
					0	Analog output
					1	PROFIdrive telegram

Tag	Data type	Values	W	Description	
InverseDirection	BOOL	-	RES	Inversion of the setpoint	
				FALSE	No
				TRUE	Yes
DataAdaption	DINT	0, 1	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)	
MotorType	DINT	0.1	DL	Motor type	
				0	Round-frame motor (standard motor)
				1	Linear motor
Interface.	TO_Struct_ActorInterface				
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	Enabled
EnableDriveOutputAd-dress	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 set-points.	
				FALSE	Disabled
				TRUE	Enabled
DriveReadyInputAd-dress	VREF	0 to 65535	RON	Address for the "Enable input" for analog setpoint	
EnableTorqueData	BOOL	-	RES	Torque data	
				FALSE	Disabled
				TRUE	Enabled
TorqueDataAddressIn	VREF	0 to 65535	RON	Input address of the supplemental telegram	
TorqueDataAddress-Out	VREF	0 to 65535	RON	Output address of the supplemental telegram	
DriveParameter.	TO_Struct_ActorDriveParameter			Valid when "<TO>.Actor.MotorType" = 0	

Tag			Data type	Values	W	Description
		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
	LinearMotorDriveParameter.		TO_Struct_LinearMotorActorDriveParameter			Valid when "<TO>.Actor.MotorType" = 1
		ReferenceVelocity	LREAL	0.0 ... 1.0E12	RES	Reference value (100%) for the velocity 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 "ReferenceVelocity". 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.
		MaxVelocity	LREAL	0.0 ... 1.0E12	RES	Maximum value for the velocity setpoint of the drive (N-set) (PROFIdrive: MaxVelocity ≤ 2 × ReferenceVelocity Analog setpoint: MaxVelocity ≤ 1.17 × ReferenceVelocity)
		ReferenceForce	LREAL	0.0 ... 1.0E12	RES	Reference value (100%) for the force of the drive

9.2.6 "TorqueLimiting" tag (positioning axis) (S7-1500, S7-1500T)

The tag structure "<TO>.TorqueLimiting.<tag name>" contains the configuration of the torque limit/force limit.

Tags

Legend (Page 299)

Tag		Data type	Values	W	Description	
TorqueLimiting.		TO_Struct_TorqueLimiting				
	LimitBase	DINT	0, 1	RES	Torque limit/force limit	
					0	Motor side
					1	Load side
					Setting is not relevant for linear motors.	
	PositionBasedMonitorings	DINT	0, 1	RES	Positioning and following error monitoring	
					0	Monitoring deactivated
					1	Monitoring activated

Tag			Data type	Values	W	Description
	LimitDefaults.		TO_Struct_TorqueLimitingLimitDefaults			
		Torque	LREAL	0.0 to 1.0E12	CAL	Limiting torque
		Force	LREAL	0.0 to 1.0E12	CAL	Limiting force

9.2.7 "Clamping" tag (positioning axis) (S7-1500, S7-1500T)

The tag structure "<TO>.Clamping.<tag name>" contains the configuration of the fixed stop detection.

Tags

Legend (Page 299)

Tag		Data type	Values	W	Description
Clamping.		TO_Struct_Clamping			
	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 the clamping monitoring

9.2.8 Sensor[1..4] tags (positioning axis) (S7-1500, S7-1500T)

The tag structure "<TO>.Sensor[1..4].<tag name>" contains the controller-end configuration for the encoder, and the configuration for active and passive homing.

Tags

Legend (Page 299)

Tag		Data type	Values	W	Description	
Sensor[1..4].		ARRAY [1..4] OF TO_Struct_Sensor				
	Existent	BOOL	-	RON	Displaying created encoders	
	Type	DINT	0 ... 2	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	0, 1	RES	Encoder system	

Tag	Data type	Values	W	Description	
System	DINT	0, 1	RES	0	"LINEAR" Linear encoder
				1	"ROTATORY" Rotary encoder
MountingMode	DINT	0 ... 2	RES	Mounting type of encoder	
				0	On motor shaft
				1	On load side
				2	External measuring system
DataAdaption	DINT	0, 1	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
ActualVelocityMode	DINT	0, 1	RES	Type of calculation for actual speed value or actual velocity value	
				0	Actual value calculation from differentiation of the position change
				1	Actual value calculation with NACT value from the PROFIdrive telegram
Interface.	TO_Struct_SensorInterface				
AddressIn	VREF	0 ... 65535	RON	Input address for the PROFIdrive telegram	
AddressOut	VREF	0 ... 65535	RON	Output address for the PROFIdrive telegram	
Number	UDINT	1 ... 2	RON	Number of the encoder in the telegram	
Parameter.	TO_Struct_SensorParameter				
Resolution	LREAL	1.0E-12 ... 1.0E12	RES	Resolution of a linear encoder (offset between two encoder pulses)	
StepsPerRevolution	UDINT	1 ... 8388608	RES	Increments per rotary encoder revolution	
FineResolutionXist1	UDINT	0 ... 31	RES	Number of bits for fine resolution "Gx_XIST1" (cyclic actual encoder value)	
FineResolutionXist2	UDINT	0 ... 31	RES	Number of bits for fine resolution "Gx_XIST2" (absolute value of the encoder)	
DeterminableRevolutions	UDINT	0 ... 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)	
DistancePerRevolution	LREAL	0.0 ... 1.0E12	RES	Load distance per revolution of an externally mounted encoder	
BehaviorGx_XIST1	DINT	0, 1	RES	Evaluation of "Gx_XIST1" bits.	

Tag			Data type	Values	W	Description	
		BehaviorGx_XIST1	DINT	0, 1	RES	0	Based on the bits of the encoder resolution. The incremental actual value "Gx_XIST1" is transmitted with less than 32 bits in the PROFIdrive telegram. For example: At 16 bits, the value ranges from 0 to 65,535.
						1	32-bit value of the encoder value The "Gx_XIST1" incremental actual value is transferred with 32 bits of 0 to 4,294,967,295 in the PROFIdrive telegram.
		ReferenceSpeed	LREAL	0.0 ... 1.0E12	RES	Reference speed for NACT in PROFIdrive telegram with rotary encoder Only relevant for "ActualVelocityMode" = 1	
		ReferenceVelocity	LREAL	0.0 ... 1.0E12	RES	Reference velocity for NACT in the PROFIdrive telegram with linear encoder Only relevant for "ActualVelocityMode" = 1	
	Backlash.		TO_Struct_Backlash				
		Enable	BOOL	-	DIR	Enable backlash compensation	
						FALSE	Disabled
						TRUE	Enabled
						If you enable/disable backlash compensation during runtime, then you have to home the axis again.	
		Size	LREAL	0.0 ... 1.0E12	DIR	Size of backlashes	
						If you change the size of backlashes during runtime, you have to home the axis again.	
		Velocity	LREAL	0.0 ... 1.0E12	DIR	Velocity for traversing of backlashes	
						0.0	Motor traverses backlashes within one servo cycle.
						> 0.0	Motor traverses backlash with the specified velocity.
		DirectionAbsolute-Homing	DINT	0, 1	DIR	Direction of movement during or before absolute encoder adjustment	
						0	Positive
						1	Negative
	ActiveHoming.		TO_Struct_SensorActiveHoming				
		Mode	DINT	0 ... 2	RES	Homing mode	
						0	Use zero mark via PROFIdrive telegram
						1	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	0, 1	CAL	Homing direction/approach direction to homing mark	

Tag	Data type	Values	W	Description	
Direction	DINT	0, 1	CAL	0	Positive homing direction
				1	Negative homing direction
DigitalInputAddress	VREF	0 ... 65535	RON	Address of digital input	
HomePositionOffset	LREAL	-1.0E12 ... 1.0E12	CAL	Home position offset	
SwitchLevel	BOOL	-	RES	Signal level that is present at the digital input when hom-ing mark is approached	
				FALSE	Low level
				TRUE	High level
PassiveHoming.	TO_Struct_SensorPassiveHoming				
Mode	DINT	0 ... 2	RES	Homing mode	
				0	Use zero mark via PROFIdrive telegram
				1	Zero mark via PROFIdrive telegram and reference cam
				2	Use homing mark via digital input
SideInput	BOOL	-	CAL	Side of the digital input for passive homing	
				FALSE	Negative side
				TRUE	Positive side
Direction	DINT	0 ... 2	CAL	Homing direction/approach direction to homing mark	
				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 hom-ing mark is approached	
				FALSE	Low level
				TRUE	High level

9.2.9 "CrossPlcSynchronousOperation" tag (positioning axis) (S7-1500, S7-1500T)

The tag structure "<TO>.CrossPlcSynchronousOperation.<tag name>" contains the configuration of the cross-PLC synchronous operation.

Tags

Legend (Page 299)

Tag	Data type	Values	W	Description
CrossPlcSynchronousOperation.	TO_Struct_CrossPlcSynchronousOperation			
. Interface[1..8].	ARRAY [1..8] of TO_Struct_CrossPlcLeadingValueInterface			
.. EnableLeadingValueOutput	BOOL	-	RON	Provide cross-PLC leading value FALSE: No TRUE: Yes
.. AddressOut	VREF	-	RON	Output address for the leading value telegram
. LocalLeadingValueDelayTime	LREAL	0.0 ... 1.0E9	RES	Delay time of leading value output on the local following axes

9.2.10 "Extrapolation" tag (positioning axis) (S7-1500, S7-1500T)

The tag structure "<TO>.Extrapolation.<tag name>" contains the configuration of the actual value extrapolation.

Tags

Legend (Page 299)

Tag	Data type	Values	W	Description
Extrapolation.	TO_Struct_Extrapolation			
. LeadingAxisDependentTime	LREAL	-	RON	Extrapolation time component (caused by leading axis) Results from the following times: • Time of actual value acquisition for the leading axis • Interpolator cycle clock • Time of position filter of actual value extrapolation (T1 + T2)
. FollowingAxisDependentTime	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 – Interpolator cycle clock – Speed control loop substitute time for the following axis – Output delay time of the setpoint at the following axis • For a following axis without velocity precontrol: – Communication cycle – Interpolator cycle clock – Position control loop equivalent time (1/Kv from "<TO>.PositionControl.Kv") – Output delay time of the setpoint at the following axis

Tag	Data type	Values	W	Description
Settings.	TO_Struct_ExtrapolationSettings			
SystemDefinedExtrapolation	DINT	0, 1	RES	Leading axis dependent time 0: Not effective 1: Effective
ExtrapolatedVelocityMode	DINT	0, 1	RES	Effective velocity value for the synchronization function 0: "FilteredVelocity" Leading value velocity from filtered actual velocity 1: "VelocityByDifferentiation" The leading value velocity results from the differentiation of the extrapolated leading value position
PositionFilter.	TO_Struct_ExtrapolationPositionFilter			
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.	TO_Struct_ExtrapolationVelocityFilter			
T1	LREAL	0.0 to 1.0E12	DIR	Velocity filter time constant T1
T2	LREAL	0.0 to 1.0E12	DIR	Velocity filter time constant T2
VelocityTolerance.	TO_Struct_ExtrapolationVelocityTolerance			
Range	LREAL	0.0 to 1.0E12	DIR	Tolerance band width for velocity
Hysteresis.	TO_Struct_ExtrapolationHysteresis			
Value	LREAL	0.0 to 1.0E12	DIR	Hysteresis of the extrapolated actual position value

9.2.11 "LoadGear" tag (positioning axis) (S7-1500, S7-1500T)

The tag structure "<TO>.LoadGear.<tag name>" contains the configuration of the load gear.

Tags

Legend (Page 299)

Tag	Data type	Value range	W	Description
LoadGear.	TO_Struct_LoadGear			
Numerator	UDINT	1 to 4294967295	RES	Load gear counter
Denominator	UDINT	1 to 4294967295	RES	Load gear denominator

9.2.12 "Properties" tag (positioning axis) (S7-1500, S7-1500T)

The tag structure "<TO>.Properties.<tag name>" contains the configuration of the type of axis or motion.

Tags

Legend (Page 299)

Tag		Data type	Value range	W	Description	
Properties.		TO_Struct_Properties				
	MotionType	DINT	0, 1	RON	Indication of axis type or motion type	
					0	Linear axis or motion
					1	Rotary axis or motion

9.2.13 "Units" tag (positioning axis) (S7-1500, S7-1500T)

The tag structure "<TO>.Units.<tag name>" shows the set technological units.

Tags

Legend (Page 299)

Tag		Data type	Values	W	Description	
Units.		TO_Struct_Units / TO_Struct_ExternalEncoder_Units				
	LengthUnit	UDINT	-	RON	Unit for position	
					1010	m
					1013	mm
					1536	mm[1)]
					1011	km
					1014	µm
					1015	nm
					1019	in
					1018	ft
					1021	mi
					1004	rad
					1005	°
					1537	°[1)]
	VelocityUnit	UDINT	-	RON	Unit for velocity	
					1521	°/s
					1539	°/s[1)]
					1522	°/min

1) Position values with higher resolution or six decimal places

Tag	Data type	Values	W	Description	
VelocityUnit	UDINT	-	RON	1086	rad/s
				1523	rad/min
				1062	mm/s
				1538	mm/s[1]
				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
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)
UnitFactor	UDINT	-	RON	Factor for internal conversion in the high-resolution units.	

1) Position values with higher resolution or six decimal places

See also

Units of measure (Page 33)

9.2.14 "Mechanics" tag (positioning axis) (S7-1500, S7-1500T)

The tag structure "<TO>.Mechanics.<tag name>" contains the configuration of the mechanics.

Tags

Legend (Page 299)

Tag	Data type	Value range	W	Description
Mechanics.	TO_Struct_Mechanics			
LeadScrew	LREAL	1.0E-12 ... 1.0E12	RES	Leadscrew pitch

9.2.15 "Modulo" tag (positioning axis) (S7-1500, S7-1500T)

The tag structure "<TO>.Modulo.<tag name>" contains the configuration of the modulo function.

Tags

Legend (Page 299)

Tag	Data type	Values	W	Description	
Modulo.	TO_Struct_Modulo				
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 1.0E-12	RES	Modulo start value	

9.2.16 "DynamicLimits" tag (positioning axis) (S7-1500, S7-1500T)

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 specify 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 are limited).

Tags

Legend (Page 299)

Tag	Data type	Values	W	Description
DynamicLimits.	TO_Struct_DynamicLimits			
MaxVelocity	LREAL	0.0 ... 1.0E12	RES	Maximum permissible velocity of the axis

Tag	Data type	Values	W	Description
Velocity	LREAL	0.0 ... 1.0E12	DIR	Current maximum velocity of the axis The minimum from "MaxVelocity" and "Velocity" is effective for motion control.
MaxAcceleration	LREAL	0.0 ... 2.77777777777778E8	DIR	Maximum permissible acceleration of the axis
MaxDeceleration	LREAL	0.0 ... 2.77777777777778E8	DIR	Maximum permissible deceleration of the axis
MaxJerk	LREAL	0.0 ... 4629629.629	DIR	Maximum permissible jerk on the axis

9.2.17 "DynamicDefaults" tag (positioning axis) (S7-1500, S7-1500T)

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 299)

Tag	Data type	Values	W	Description
DynamicDefaults.	TO_Struct_DynamicDefaults			
Velocity	LREAL	0.0 ... 1.0E12	CAL	Default velocity
Acceleration	LREAL	0.0 ... 2.77777777777778E8	CAL	Default acceleration
Deceleration	LREAL	0.0 ... 2.77777777777778E8	CAL	Default deceleration
Jerk	LREAL	0.0 ... 4629629.629	CAL	Default jerk
EmergencyDeceleration	LREAL	0.0 ... 2.77777777777778E8	DIR	Emergency stop deceleration

9.2.18 "PositionLimits_SW" tag (positioning axis) (S7-1500, S7-1500T)

The tag structure "<TO>.PositionLimits_SW.<tag name>" contains the configuration of position monitoring with software limit switches. Software limit switches are used to limit the operating range of a positioning axis.

Tags

Legend (Page 299)

Tag		Data type	Values	W	Description	
PositionLimits_SW.		TO_Struct_PositionLimitsSW				
	Active	BOOL	-	DIR	FALSE	Monitoring deactivated
					TRUE	Monitoring enabled
	MinPosition	LREAL	-1.0E12 to 1.0E-12	DIR	Position of negative software limit switches	
	MaxPosition	LREAL	-1.0E12 to 1.0E-12	DIR	Position of positive software limit switches ("MaxPosition" > "MinPosition")	
	LimitReachedBehavior	DINT	0 ... 1	RES	Alarm response when a software limit switch is approached with a single axis job	
					0	Stop with maximum dynamic values
					1	Stop with current dynamic values
	LimitExceededBehavior	DINT	0 ... 1	RES	Alarm response when overrunning a software limit switch	
					0	Disable axis
					1	Keep emergency stop and axis enable

9.2.19 "PositionLimits_HW" tag (positioning axis) (S7-1500, S7-1500T)

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 299)

Tag		Data type	Values	W	Description	
PositionLimits_HW.		TO_Struct_PositionLimitsHW				
	Active	BOOL	-	RES	FALSE	Monitoring deactivated
					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-enabled)
	MinSwitchAddress	VREF	0 to 65535	RES	Address for the negative hardware limit switch	
	MaxSwitchLevel	BOOL	-	RES	Level selection for activation of the positive hardware limit switch	
					FALSE	Low level (Low active)
					TRUE	High level (high-enabled)

Tag		Data type	Values	W	Description	
	MaxSwitchAddress	VREF	0 to 65535	RES	Address for the positive hardware limit switch	
	Mode	DINT	0 ... 1	RES	Type of HW limit switch	
					0	Switch non-traversable
					1	Switch traversable
	AppoachBehavior	DINT	0 ... 1	RES	Alarm response when approaching a HW limit switch	
					0	Disable axis
					1	Keep emergency stop and axis enable

9.2.20 "Homing" tag (positioning axis) (S7-1500, S7-1500T)

The tag structure "<TO>.Homing.<tag name>" contains the configuration for homing the TO.

Tags

Legend (Page 299)

Tag		Data type	Values	W	Description	
Homing.		TO_Struct_Homing / TO_Struct_ExternalEncoder_Homing				
	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	Linear: 0.0 to 10000.0 -mm/s	CAL	Approach velocity Velocity during active homing at which the reference output cam and home position are approached.	
			Rotary: 0.0 ... 360000.0 °/s			
	ReferencingVelocity	LREAL	Linear: 0.0 to 1000.0 m-m/s	CAL	Homing velocity Velocity during active homing at which the home position is approached.	
			Rotary: 0.0 ... 36000.0 °/s			
	HomePosition	LREAL	-1.0E12 to 1.0E-12	CAL	Home position	

9.2.21 "Override" tag (positioning axis) (S7-1500, S7-1500T)

The tag structure "<TO>.Override.<tag name>" contains the configuration of 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 299)

Tag	Data type	Values	W	Description
Override.	TO_Struct_Override			
Velocity	LREAL	0.0 to 200.0%	DIR	Velocity or speed override Percentage correction of the velocity/speed

9.2.22 "PositionControl" tag (positioning axis) (S7-1500, S7-1500T)

The tag structure "<TO>.PositionControl.<tag name>" contains the settings of position control.

Tags

Legend (Page 299)

Tag	Data type	Values	W	Description
PositionControl.	TO_Struct_PositionControl			
Kv	LREAL	0.0 ... 2147480.0	DIR	Proportional gain of the closed loop position control ("Kv" > 0.0)
Kpc	LREAL	0.0 ... 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 activated DSC is only possible with one of the following PROFIdrive telegrams: • Standard telegram 5 or 6 • SIEMENS telegram 105 or 106
SmoothingTimeByChangeDifference	LREAL	0.0 ... 1.0E12 s	DIR	Smoothing time for the manipulated variable for switching operations, for example: • Encoder switchover • Change in P-gain ("Kv") • Switchover to emergency stop ramp

Tag	Data type	Values	W	Description	
InitialOperativeSensor	UDINT	1 ... 4	RES	Active sensor after initialization of the axis (sensor number 1 to 4) This encoder is used after startup of the CPU and after a restart of the technology object. 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.	
ControlDifferenceQuantization.	TO_Struct_PositionDifferenceQuantification				
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 ... 1.0E12	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))	
VelocityModePowerOn	DINT	0 ... 1	RES	Behavior of the velocity setpoint when the axis is enabled	
				0	Velocity is set to "0" with maximum dynamic values of the axis (ramp).
				1	Velocity is immediately set to "0" without ramp.

9.2.23 "SetpointFilter" tag (positioning axis) (S7-1500, S7-1500T)

The tag structure "<TO>.SetpointFilter.<tag name>" contains the settings of the setpoint filter.

Tags

Legend (Page 299)

Tag	Data type	Values	W	Description	
SetpointFilter.	TO_Struct_SetpointFilter				
DynamicFilter.	TO_Struct_DynamicFilter				
Mode	DINT	-	RES	Dynamic filter mode	
				0	Dynamic filter not active
				1	PT1/PT2 filter + dead time

[1] The dead time T

Tag			Data type	Values	W	Description
		T1	LREAL	0.0 ... 1.0E12	DIR	First time constant of the PT2 filter in time unit of the axis
		T2	LREAL	0.0 ... 1.0E12	DIR	Second time constant of the PT2 filter in time unit of the axis
		Tt	LREAL	0.0 ... 1.0E12[1]	DIR	Additional dead time of the dynamic filter in time unit of the axis

[1] The dead time T

9.2.24 "DynamicAxisModel" tag (positioning axis) (S7-1500, S7-1500T)

The tag structure "<TO>.DynamicAxisModel.<tag name>" contains the balancing filter settings.

Tags

Legend (Page 299)

Tag		Data type	Values	W	Description
DynamicAxisModel.		TO_Struct_DynamicAxisModel			
	VelocityTimeConstant	LREAL	0.0 to 1.0E12	DIR	Speed control loop substitute time [s]
	AdditionalPositionTime-Constant	LREAL	0.0 to 1.0E12	DIR	Additive position control loop substitute time [s]

9.2.25 "FollowingError" tag (positioning axis) (S7-1500, S7-1500T)

The tag structure "<TO>.FollowingError.<tag name>" contains the configuration of the dynamic 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 299)

Tag		Data type	Values	W	Description	
FollowingError.		TO_Struct_FollowingError				
	EnableMonitoring	BOOL	-	RES	FALSE	Following error monitoring deactivated
					TRUE	Following error monitoring enabled
	MinValue	LREAL	Linear: 0.0 ... 1.0E12	DIR	Permissible following error at velocities below the value of "MinVelocity"	
			Rotary: 0.001 to 1.0E12			
	MaxValue	LREAL	Linear: 0.0 to 1.0E12	DIR	Maximum permissible following error, which may be reached at the maximum velocity.	

Tag		Data type	Values	W	Description
	MaxValue	LREAL	Rotary: 0.002 ... 1.0E12	DIR	Maximum permissible following error, which may be reached at the maximum velocity.
	MinVelocity	LREAL	0.0 ... 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
	AdditionalSetpointDelay-Time	LREAL	0.0 ... 1.0E12	DIR	Time constant for additional deceleration of position set-point to calculate the following error in the time unit of the axis

9.2.26 "PositioningMonitoring" tag (positioning axis) (S7-1500, S7-1500T)

The tag structure "<TO>.PositioningMonitoring.<tag name>" contains the configuration of 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: "Target range not reached" is displayed.

If the minimum dwell time is not met, then technology alarm 541 "Positioning monitoring" with supplemental value 2: "Exit target range again" is displayed.

Tags

Legend (Page 299)

Tag		Data type	Values	W	Description
PositioningMonitoring.		TO_Struct_PositionMonitoring			
	ToleranceTime	LREAL	0.0 to 1.0E12	DIR	Tolerance time Maximum permitted duration from reaching of velocity setpoint zero until entrance into the positioning window
	MinDwellTime	LREAL	0.0 to 1.0E12	DIR	Minimum dwell time in positioning window
	Window	LREAL	0.0 to 1.0E12	DIR	Positioning window

9.2.27 "StandstillSignal" tag (positioning axis) (S7-1500, S7-1500T)

The tag structure "<TO>.StandstillSignal.<tag name>" contains the configuration of 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 299)

Tag		Data type	Values	W	Description
StandstillSignal.		TO_Struct_StandstillSignal			Configuration for the standstill signal
	VelocityThreshold	LREAL	0.0 to 1.0E12	DIR	Velocity threshold If velocity is below this threshold, the minimum dwell time begins.
	MinDwellTime	LREAL	0.0 to 1.0E12	DIR	Minimum dwell time

9.2.28 "StatusPositioning" tag (positioning axis) (S7-1500, S7-1500T)

The tag structure "<TO>.StatusPositioning.<tag name>" indicates the status of a positioning motion.

Tags

Legend (Page 299)

Tag		Data type	Values	W	Description
StatusPositioning.		TO_Struct_StatusPositioning			
	Distance	LREAL	-1.0E12 ... 1.0E12	RON	Distance to target position
	TargetPosition	LREAL	-1.0E12 ... 1.0E12	RON	Target position
	TargetPositionModulo-Cycle	DINT	-2147483648 ... 2147483647	RON	Number of modulo cycles to target position with position-ing motions
	FollowingError	LREAL	-1.0E12 ... 1.0E12	RON	Current following error
	SetpointExecutionTime	LREAL	0 ... 1.0E12	RON	Setpoint execution time of the axis (Results from T_{Ipo}, T_{vtc} or 1/kv, T_{Send} and T_O of the axis)
	SuperimposedDistance	LREAL	0 ... 1.0E12	RON	Distance traveled with the instructions "MC_MoveSuperimposed", "MC_MotionInSuperimposed", and "MC_HaltSuperimposed". The value is reset when the base motion and the superim-posed motion are completed.

9.2.29 "StatusDrive" tag (positioning axis) (S7-1500, S7-1500T)

The tag structure "<TO>.StatusDrive.<tag name>" indicates the status of the drive.

Tags

Legend (Page 299)

Tag	Data type	Values	W	Description
StatusDrive.	TO_Struct_StatusDrive			

Tag	Data type	Values	W	Description	
Disabled	BOOL	-	RON	FALSE	Drive not switched off
				TRUE	Drive switched off
InOperation	BOOL	-	RON	Operation 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	Cyclic communication not established. Fault ZSW1.X3 (FaultPresent) is present. Possible causes: • The CPU is in STOP. • The drive has failed. • The "ControlRequested" bit in the status word of the drive has the value "FALSE". • The drive signals an error using the status word. • For isochronous configuration, the dynamic sign of life in the telegram has failed or is not supplied by the drive.
				TRUE	Cyclic communication OK and no fault effective
Error	BOOL	-	RON	FALSE	No drive error
				TRUE	Drive error
AdaptionState	DINT	0 ... 4	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

9.2.30 "StatusServo" tag (positioning axis) (S7-1500, S7-1500T)

The tag structure "<TO>.StatusServo.<tag name>" indicates the status for the balancing filter.

Tags

Legend (Page 299)

Tag		Data type	Values	W	Description
StatusServo.		TO_Struct_StatusServo			
	BalancedPosition	LREAL	-	RON	Position setpoint after the balancing filter
	ControlDifference	LREAL	-	RON	Control deviation
	PositionAfterDynamicFilter	LREAL	-	RON	Position setpoint after the dynamic filter

9.2.31 "StatusProvidedLeadingValue" tag (positioning axis) (S7-1500, S7-1500T)

The tag structure "<TO>.StatusProvidedLeadingValue.<tag name>" contains the provided leading value with leading value delay of the cross-PLC synchronous operation.

Tags

Legend (Page 299)

Tag			Data type	Values	W	Description
StatusProvidedLeadingValue.			TO_Struct_StatusProvidedLeadingValue			Provided leading value
	DelayedLeadingValue		TO_Struct_ProvidedLeadingValue			Leading value with leading value delay
		Position	LREAL	-1.0E12 to 1.0E12	RON	Position
		Velocity	LREAL	-1.0E12 to 1.0E12	RON	Velocity
		Acceleration	LREAL	-1.0E12 to 1.0E12	RON	Acceleration

9.2.32 StatusSensor[1..4] Tags (positioning axis) (S7-1500, S7-1500T)

The tag structure "<TO>.StatusSensor[1..4].<tag name>" indicates the status of the measuring system.

Tags

Legend (Page 299)

Tag		Data type	Values	W	Description	
StatusSensor[1..4].		Array [1..4] OF TO_Struct_StatusSensor				
	State	DINT	0 to 2	RON	Status of the actual encoder value	
					0	"NOT_VALID" Invalid
					1	"WAITING_FOR_VALID" Waiting for "Valid" status

Tag	Data type	Values	W	Description	
State	DINT	0 to 2	RON	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 position offset for 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	0 to 4	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
ModuloCycle	DINT	-2147483648 to 2147483647	RON	Number of modulo cycles	
Adjusted	DINT	0 ... 1	RON	Homing status of the encoder	
				0	Encoder not homed
				1	Encoder homed with one of the following homing types: • Active homing • Passive homing • Absolute encoder adjustment • Incremental encoder adjustment

9.2.33 "StatusExtrapolation" tag (positioning axis) (S7-1500, S7-1500T)

The tag structure "<TO>.StatusExtrapolation.<tag name>" indicates the status of the actual value extrapolation.

Tags

Legend (Page 299)

Tag		Data type	Values	W	Description
StatusExtrapolation.		TO_Struct_StatusExtrapolation			
	FilteredPosition	LREAL	-1.0E12 to 1.0E-12	RON	Position after position filter
	FilteredVelocity	LREAL	-1.0E12 to 1.0E-12	RON	Velocity after velocity filter and tolerance band
	ExtrapolatedPosition	LREAL	-1.0E12 to 1.0E-12	RON	Extrapolated position
	ExtrapolatedVelocity	LREAL	-1.0E12 to 1.0E-12	RON	Extrapolated velocity

9.2.34 "StatusKinematicsMotion" tag (positioning axis) (S7-1500, S7-1500T)

The "<TO>.StatusKinematicsMotion" tag contains status information of the technology object with regard to usage as kinematics axis.
Information on the evaluation of the individual bits (e.g. bit 2 "MaxDecelerationExceeded") can be found in the "Evaluating StatusWord, ErrorWord and WarningWord" section of the "S7-1500/S7-1500T Motion Control Overview" documentation (Page 12).

Tag

Legend (Page 299)

Tag		Data type	Values	W	Description	
StatusKinematicsMotion		DWORD	-	RON	Status information of the technology object	
	Bit 0	-	-	-	"MaxVelocityExceeded"	
					0	The kinematics technology object calculated a lower velocity setpoint than the maximum velocity on the axis.
					1	The kinematics technology object calculated a higher velocity setpoint than the maximum velocity on the axis.
	Bit 1	-	-	-	"MaxAccelerationExceeded"	
					0	The kinematics technology object calculated a lower setpoint acceleration calculated than the maximum acceleration of the axis.
					1	The kinematics technology object calculated a higher setpoint acceleration than the maximum acceleration of the axis.
	Bit 2	-	-	-	"MaxDecelerationExceeded"	
					0	The kinematics technology object calculated a lower setpoint deceleration than the maximum deceleration of the axis.

Tag		Data type	Values	W	Description	
	Bit 2	-	-	-	1	The kinematics technology object calculated a lower setpoint deceleration than the maximum deceleration of the axis.

9.2.35 "StatusTorqueData" tag (positioning axis) (S7-1500, S7-1500T)

The tag structure "<TO>.StatusTorqueData.<tag name>" indicates the status of the torque data/force data.

Tags

Legend (Page 299)

Tag		Data type	Value range	W	Description	
StatusTorqueData.		TO_Struct_StatusTorqueData				
	CommandAdditiveT-orqueActive	DINT	0, 1	RON	Additive setpoint torque/additive setpoint force	
					0	Inactive
					1	Active
	CommandTorqueRange-Active	DINT	0, 1	RON	Torque limits/force limits B +, B-	
					0	Inactive
					1	Active
	ActualTorque	LREAL	-1.0E12 to 1.0E-12	RON	Actual torque of the axis	
	ActualForce	LREAL	-1.0E12 ... 1.0E12	RON	Actual force of the axis	

9.2.36 "StatusMotionIn" tag (positioning axis) (S7-1500, S7-1500T)

The tag structure "<TO>.StatusMotionIn.<tag name>" indicates the status of the "MotionIn" function.

Tags

Legend (Page 299)

Tag			Data type	Value range	W	Description	
StatusMotionIn.			TO_Struct_StatusMotionIn				
	FunctionState		DINT	0 ... 2	RON	0	No "MotionIn" function active
						1	"MC_MotionInVelocity" active
						2	"MC_MotionInPosition" active
	StatusWord.		DWORD	-	RON	-	
		Bit 0	Bool	-	RON	"MaxVelocityExceeded" The configured maximum velocity is exceeded during a MotionIn movement.	

Tag			Data type	Value range	W	Description
		Bit 1 ... Bit 31	Bool	-	RON	Reserved

9.2.37 "StatusWord" tag (positioning axis) (S7-1500, S7-1500T)

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" section of the "S7-1500/S7-1500T Motion Control Overview" documentation (Page 12).

Tags

Legend (Page 299)

Tag		Data type	Values	W	Description
StatusWord		DWORD	-	RON	Status information of the technology object
	Bit 0	-	-	-	"Enable" Enable status The technology object has been enabled.
	Bit 1	-	-	-	"Error" An error is present.
	Bit 2	-	-	-	"RestartActive" A restart is active. The technology object will be reinitialized.
	Bit 3	-	-	-	"OnlineStartValuesChanged" The restart tags have been changed. For the changes to be applied, the technology object must be reinitialized.
	Bit 4	-	-	-	"ControlPanelActive" The axis control panel is active.
	Bit 5	-	-	-	"HomingDone" Homing status The technology object is homed.
	Bit 6	-	-	-	"Done" No motion job is in progress and the axis control panel is deactivated.
	Bit 7	-	-	-	"Standstill" Standstill signal The axis is at a standstill.
	Bit 8	-	-	-	"PositioningCommand" A positioning command is active ("MC_MoveRelative","MC_MoveAbsolute").
	Bit 9	-	-	-	"JogCommand" An "MC_MoveJog" job is running.
	Bit 10	-	-	-	"VelocityCommand" An "MC_MoveVelocity" job is running.
	Bit 11	-	-	-	"HomingCommand" An "MC_Home" job is being processed.

Tag		Data type	Values	W	Description
	Bit 12	-	-	-	"ConstantVelocity" The velocity setpoint is reached. A constant velocity setpoint is output.
	Bit 13	-	-	-	"Accelerating" An acceleration operation is active.
	Bit 14	-	-	-	"Decelerating" A deceleration operation is active.
	Bit 15	-	-	-	"SWLimitMinActive" A negative software limit switch has been approached or exceeded.
	Bit 16	-	-	-	"SWLimitMaxActive" A positive software limit switch has been approached or exceeded.
	Bit 17	-	-	-	"HWLimitMinActive" A negative hardware limit switch has been approached or exceeded.
	Bit 18	-	-	-	"HWLimitMaxActive" A positive hardware limit switch has been approached or exceeded.
	Bit 19 ... Bit 22	-	-	-	Reserved
	Bit 23	-	-	-	"MoveSuperimposedCommand" An "MC_MoveSuperimposed" job is running.
	Bit 24	-	-	-	Reserved
	Bit 25	-	-	-	"AxisSimulation" The technology object is in simulation.
	Bit 26	-	-	-	"TorqueLimitingCommand" An "MC_TorqueLimiting" job is running.
	Bit 27	-	-	-	"InLimitation" The drive operates at least at the threshold value (default 90%) of the torque limit/force limitation.
	Bit 28	-	-	-	"NonPositionControlled" The axis is not in position-controlled mode.
	Bit 29	-	-	-	"KinematicsMotionCommand" The axis is used for a kinematics job.
	Bit 30	-	-	-	"InClamping" The axis is clamped at a fixed stop.
	Bit 31	-	-	-	"MotionInCommand" A "MotionIn" job is running.

9.2.38 "StatusWord2" tag (positioning axis) (S7-1500, S7-1500T)

The "<TO>.StatusWord2" tag contains the status information of the technology object.

Information on the evaluation of the individual bits (e.g. bit 0 "StopCommand") can be found in the "Evaluating StatusWord, ErrorWord and WarningWord" section of the "S7-1500/S7-1500T Motion Control Overview" documentation (Page 12).

Tags

Legend (Page 299)

Tag		Data type	Value range	W	Description
StatusWord2		DWORD	-	RON	Status information of the technology object
	Bit 0	BOOL	-	RON	"StopCommand" An "MC_Stop" job is running. The technology object is disabled.
	Bit 1	BOOL	-	RON	Reserved
	Bit 2	BOOL	-	RON	"PassingBacklash" The backlash is traversed. "<TO>.ActualPosition" does not hereby change.
	Bit 3 ... Bit 5	BOOL	-	RON	Reserved
	Bit 6	BOOL	-	RON	"MotionInSuperimposedCommand" An "MC_MotionInSuperimposed" job is running.
	Bit 7	BOOL	-	RON	"HaltSuperimposedCommand" An "MC_HaltSuperimposed" job is running.
	Bit 8 ... Bit 31	BOOL	-	RON	Reserved

9.2.39 "ErrorWord" tag (positioning axis) (S7-1500, S7-1500T)

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" section of the "S7-1500/S7-1500T Motion Control Overview" documentation (Page 12).

Tags

Legend (Page 299)

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" Job cannot be executed A Motion Control instruction cannot be executed because the necessary conditions have not been met.

Tag	Data type	Values	W	Description
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
Bit 14	-	-	-	Reserved
Bit 15	-	-	-	"AdaptionError" Error in automatic data transfer
Bit 16 ... Bit 31	-	-	-	Reserved

9.2.40 "ErrorDetail" tag (positioning axis) (S7-1500, S7-1500T)

The tag structure "<TO>.ErrorDetail.<tag name>" contains the alarm number and the effective local alarm response for the technology alarm that is currently pending on the technology object.

You can find a list of the technology alarms and alarm responses in the "Overview of the technology alarms" section of the "S7-1500/S7-1500T Motion Control alarms and error IDs" documentation (Page 12).

Tags

Legend (Page 299)

Tag	Data type	Values	W	Description	
ErrorDetail.	TO_Struct_ErrorDetail				
Number	UDINT	-	RON	Alarm number	
Reaction	DINT	0 ... 5	RON	Effective alarm response	
				0	No reaction

Tag		Data type	Values	W	Description	
	Reaction	DINT	0 ... 5	RON	1	Stop with current dynamic values
					2	Stop with maximum dynamic values
					3	Stop with emergency stop ramp
					4	Remove enable
					5	Track setpoints

9.2.41 "WarningWord" tag (positioning axis) (S7-1500, S7-1500T)

The "<TO>.WarningWord" tag indicates pending warnings at 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" section of the "S7-1500/S7-1500T Motion Control Overview" documentation (Page 12).

Tags

Legend (Page 299)

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" Job cannot be executed A Motion Control instruction cannot be executed because the necessary conditions have not been met.
	Bit 4	-	-	-	"DriveWarning" Warning of the drive When a warning message is pending at the drive that does not result in a TO alarm, this bit is not set. Evaluate the drive warnings directly using the status word of the drive.
	Bit 5	-	-	-	"SensorWarning" Error in encoder system
	Bit 6	-	-	-	"DynamicWarning" Specified dynamic values are limited to permissible values.
	Bit 7	-	-	-	"CommunicationWarning" Communication error Missing or faulty communication.
	Bit 8	-	-	-	"SWLimitMin" The negative software limit switch has been approached.

Tag		Data type	Values	W	Description
	Bit 9	-	-	-	"SWLimitMax" The positive software limit switch has been approached.
	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
	Bit 14	-	-	-	Reserved
	Bit 15	-	-	-	"AdaptionWarning" Error in automatic data transfer
	Bit 16... Bit 31	-	-	-	Reserved

9.2.42 "ControlPanel" tag (positioning axis) (S7-1500, S7-1500T)

The tag structure "<TO>.ControlPanel.<tag name>" contains no relevant data for you. This tag structure is internally used.

9.2.43 "InternalToTrace" tag (positioning axis) (S7-1500, S7-1500T)

The tag structure "<TO>.InternalToTrace.<tag name>" contains no relevant data for you. This tag structure is internally used.

9.3 Tags of the technology object external encoder (S7-1500, S7-1500T)

9.3.1 Legend (S7-1500, S7-1500T)

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 via direct assignment 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.

9.3.2 Actual values and setpoints (external encoder) (S7-1500, S7-1500T)

The following tags indicate the setpoint and actual values of the technology object.

Tags

Legend (Page 331)

Tag	Data type	Values	W	Description
ActualPosition	LREAL	-	RON	Actual position
ActualVelocity	LREAL	-	RON	Actual velocity
ActualAcceleration	LREAL	-	RON	Actual acceleration
ActualModuloCycle	DINT	-2147483648 to 2147483647	RON	Number of modulo cycles of the actual value

9.3.3 "Sensor" tag (external encoder) (S7-1500, S7-1500T)

The tag structure "<TO>.Sensor.<tag name>" contains the controller-side configuration for the encoder, and the configuration for passive homing.

Tags

Legend (Page 331)

Tag	Data type	Values	W	Description	
Sensor.	TO_Struct_ExternalEncoder_Sensor				
Type	DINT	0 ... 2	RON	Encoder type	
				0	"INCREMENTAL" Incremental

Tag	Data type	Values	W	Description	
Type	DINT	0 ... 2	RON	1	"ABSOLUTE" Absolute
				2	"CYCLIC_ABSOLUTE" Cyclic absolute
InverseDirection	BOOL	-	RES	Inversion of the actual value	
				FALSE	No
				TRUE	Yes
System	DINT	0, 1	RES	Encoder system	
				0	"LINEAR" Linear encoder
				1	"ROTATORY" Rotary encoder
MountingMode	DINT	0 ... 2	RES	Mounting type of encoder	
				0	On motor shaft
				1	On load side
				2	External measuring system
DataAdaption	DINT	0, 1	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
ActualVelocityMode	DINT	0, 1	RES	Type of calculation for actual speed value or actual velocity value	
				0	Actual value calculation from differentiation of the position change
				1	Actual value calculation with NACT value from the telegram
Interface.					
AddressIn	VREF	0 ... 65535	RON	Input address for the PROFIdrive telegram	
AddressOut	VREF	0 ... 65535	RON	Output address for the PROFIdrive telegram	
Number	UDINT	1 ... 2	RON	Number of the encoder in the telegram	
Parameter.					
Resolution	LREAL	-1.0E12 ... 1.0E12	RES	Resolution of a linear encoder (offset between two encoder pulses)	
StepsPerRevolution	UDINT	1 ... 8388608	RES	Increments per rotary encoder revolution	
FineResolutionXist1	UDINT	0 ... 31	RES	Number of bits for fine resolution "Gx_XIST1" (cyclic actual encoder value)	
FineResolutionXist2	UDINT	0 ... 31	RES	Number of bits for fine resolution "Gx_XIST2" (absolute value of the encoder)	

Tag			Data type	Values	W	Description	
		DeterminableRevolutions	UDINT	0 ... 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)	
		DistancePerRevolution	LREAL	0.0 ... 1.0E12	RES	Load distance per revolution of an externally mounted encoder	
		BehaviorGx_XIST1	DINT	0, 1	RES	Evaluation of "Gx_XIST1" bits.	
						0	Based on the bits of the encoder resolution. The incremental actual value "Gx_XIST1" is transmitted with less than 32 bits in the PROFIdrive telegram. For example: At 16 bits, the value ranges from 0 to 65,535.
						1	32-bit value of the encoder value The "Gx_XIST1" incremental actual value is transferred with 32 bits of 0 to 4,294,967,295 in the PROFIdrive telegram.
		ReferenceSpeed	LREAL	0.0 ... 1.0E12	RES	Reference speed for NACT in PROFIdrive telegram with rotary encoder Only relevant for "ActualVelocityMode" = 1	
		ReferenceVelocity	LREAL	0.0 ... 1.0E12	RES	Reference velocity for NACT in the PROFIdrive telegram with linear encoder Only relevant for "ActualVelocityMode" = 1	
	PassiveHoming.		TO_Struct_SensorPassiveHoming				
		Mode	DINT	0 ... 2	RES	Homing mode	
						0	Use zero mark via PROFIdrive telegram
						1	Zero mark via PROFIdrive telegram and reference cam
						2	Use homing mark via digital input
		SideInput	BOOL	-	CAL	Side of the digital input for passive homing	
						FALSE	Negative side
						TRUE	Positive side
		Direction	DINT	0 ... 2	CAL	Homing direction/approach direction to homing mark	
						0	Positive homing direction
						1	Negative homing direction
						2	Current homing direction
		DigitalInputAddress	VREF	0 ... 65535	RON	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

9.3.4 "CrossPlcSynchronousOperation" tag (external encoder) (S7-1500, S7-1500T)

The tag structure "<TO>.CrossPlcSynchronousOperation.<tag name>" contains the configuration of the cross-PLC synchronous operation.

Tags

Legend (Page 331)

Tag	Data type	Values	W	Description
CrossPlcSynchronousOperation.	TO_Struct_CrossPlcSynchronousOperation			
Interface[1..8].	ARRAY [1..8] of TO_Struct_CrossPlcLeadingValueInterface			
EnableLeadingValueOutput	BOOL	-	RON	Provide cross-PLC leading value FALSE: No TRUE: Yes
AddressOut	VREF	-	RON	Output address for the leading value telegram
LocalLeadingValueDelayTime	LREAL	0.0 ... 1.0E9	RES	Delay time of leading value output on the local following axes

9.3.5 "Extrapolation" tag (external encoder) (S7-1500, S7-1500T)

The tag structure "<TO>.Extrapolation.<tag name>" contains the configuration of the actual value extrapolation.

Tags

Legend (Page 331)

Tag	Data type	Values	W	Description
Extrapolation.	TO_Struct_Extrapolation			
LeadingAxisDependentTime	LREAL	-	RON	Extrapolation time component (caused by leading axis) Results from the following times: • Time of actual value acquisition for the leading axis • Interpolator cycle clock • Time of position filter of actual value extrapolation (T1 + T2)
FollowingAxisDependentTime	LREAL	0.001 to 1.0E12	DIR	Extrapolation time component (caused by following axis)

Tag	Data type	Values	W	Description
				Results from the following times: • For a following axis with set velocity precontrol: – Communication cycle – Interpolator cycle clock – Speed control loop substitute time for the following axis – Output delay time of the setpoint at the following axis • For a following axis without velocity precontrol: – Communication cycle – Interpolator cycle clock – Position control loop equivalent time (1/Kv from "<TO>.PositionControl.Kv") – Output delay time of the setpoint at the following axis
Settings.	TO_Struct_ExtrapolationSettings			
SystemDefinedExtrapolation	DINT	0, 1	RES	Leading axis dependent time 0: Not effective 1: Effective
ExtrapolatedVelocityMode	DINT	0, 1	RES	Effective velocity value for the synchronization function 0: "FilteredVelocity" Leading value velocity from filtered actual velocity 1: "VelocityByDifferentiation" The leading value velocity results from the differentiation of the extrapolated leading value position
PositionFilter.	TO_Struct_ExtrapolationPositionFilter			
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.	TO_Struct_ExtrapolationVelocityFilter			
T1	LREAL	0.0 to 1.0E12	DIR	Velocity filter time constant T1
T2	LREAL	0.0 to 1.0E12	DIR	Velocity filter time constant T2
VelocityTolerance.	TO_Struct_ExtrapolationVelocityTolerance			
Range	LREAL	0.0 to 1.0E12	DIR	Tolerance band width for velocity
Hysteresis.	TO_Struct_ExtrapolationHysteresis			
Value	LREAL	0.0 to 1.0E12	DIR	Hysteresis of the extrapolated actual position value

9.3.6 "LoadGear" tag (external encoder) (S7-1500, S7-1500T)

The tag structure "<TO>.LoadGear.<tag name>" contains the configuration of the load gear.

Tags

Legend (Page 331)

Tag	Data type	Value range	W	Description
LoadGear.	TO_Struct_LoadGear			
Numerator	UDINT	1 to 4294967295	RES	Load gear counter
Denominator	UDINT	1 to 4294967295	RES	Load gear denominator

9.3.7 "Properties" tag (external encoder) (S7-1500, S7-1500T)

The tag structure "<TO>.Properties.<tag name>" contains the configuration of the type of axis or motion.

Tags

Legend (Page 331)

Tag	Data type	Value range	W	Description	
Properties.	TO_Struct_Properties				
MotionType	DINT	0, 1	RON	Display of axis type or motion type	
				0	Linear axis or motion
				1	Rotary axis or motion

9.3.8 "Units" tag (external encoder) (S7-1500, S7-1500T)

The tag structure "<TO>.Units.<tag name>" shows the set technological units.

Tags

Legend (Page 331)

Tag	Data type	Values	W	Description	
Units.	TO_Struct_Units / TO_Struct_ExternalEncoder_Units				
LengthUnit	UDINT	-	RON	Unit for position	
				1010	m
				1013	mm
				1536	mm[1)]
				1011	km
				1014	µm
				1015	nm
				1019	in

1) Position values with higher resolution or six decimal places

Tag	Data type	Values	W	Description	
LengthUnit	UDINT	-	RON	1018	ft
				1021	mi
				1004	rad
				1005	°
				1537	°[1]
VelocityUnit	UDINT	-	RON	Unit for velocity	
				1521	°/s
				1539	°/s[1]
				1522	°/min
				1086	rad/s
				1523	rad/min
				1062	mm/s
				1538	mm/s[1]
				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
UnitFactor	UDINT	-	RON	Factor for internal conversion in the high-resolution units.	

[1] Position values with higher resolution or six decimal places

9.3.9 "Mechanics" tag (external encoder) (S7-1500, S7-1500T)

The tag structure "<TO>.Mechanics.<tag name>" contains the configuration of the mechanics.

Tags

Legend (Page 331)

Tag	Data type	Value range	W	Description
Mechanics.	TO_Struct_Mechanics			

Tag	Data type	Value range	W	Description
LeadScrew	LREAL	1.0E-12 ... 1.0E12	RES	Leadscrew pitch

9.3.10 "Modulo" tag (external encoder) (S7-1500, S7-1500T)

The tag structure "<TO>.Modulo.<tag name>" contains the configuration of the modulo function.

Tags

Legend (Page 331)

Tag	Data type	Values	W	Description	
Modulo.	TO_Struct_Modulo				
Enable	BOOL	-	RES	FALSE	Modulo conversion disabled
				TRUE	Modulo conversion enabled
Length	LREAL	0.001 to 1.0E12	RES	Modulo length When modulo conversion is enabled, a check is made for modulo length > 0.0	
StartValue	LREAL	-1.0E12 to 1.0E-12	RES	Modulo start value	

9.3.11 "Homing" tag (external encoder) (S7-1500, S7-1500T)

The tag structure "<TO>.Homing.<tag name>" contains the configuration for homing the TO.

Tags

Legend (Page 331)

Tag	Data type	Values	W	Description
Homing.	TO_Struct_Homing / TO_Struct_ExternalEncoder_Homing			
HomePosition	LREAL	-1.0E12 to 1.0E-12	CAL	Home position

9.3.12 "StatusProvidedLeadingValue" tag (external encoder) (S7-1500, S7-1500T)

The tag structure "<TO>.StatusProvidedLeadingValue.<tag name>" contains the provided leading value with leading value delay of the cross-PLC synchronous operation.

Tags

Legend (Page 331)

Tag	Data type	Values	W	Description
StatusProvidedLeadingValue.	TO_Struct_StatusProvidedLeadingValue			Provided leading value
DelayedLeadingValue	TO_Struct_ProvidedLeadingValue			Leading value with leading value delay
Position	LREAL	-1.0E12 to 1.0E12	RON	Position
Velocity	LREAL	-1.0E12 to 1.0E12	RON	Velocity
Acceleration	LREAL	-1.0E12 to 1.0E12	RON	Acceleration

9.3.13 "StatusSensor" tag (external encoder) (S7-1500, S7-1500T)

The tag structure "<TO>.StatusSensor.<tag name>" indicates the status of the measuring system.

Tags

Legend (Page 331)

Tag	Data type	Values	W	Description	
StatusSensor.	TO_Struct_StatusSensor				
State	DINT	0 to 2	RON	Status of the actual encoder value	
				0	"NOT_VALID" Invalid
				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 position offset for 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	

Tag		Data type	Values	W	Description	
	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
	ModuloCycle	DINT	-2147483648 to 2147483647	RON	Number of modulo cycles	
	Adjusted	DINT	0 ... 1	RON	Homing status of the encoder	
					0	Encoder not homed
					1	Encoder homed with one of the following homing types: • Passive homing • Absolute encoder adjustment • Incremental encoder adjustment

9.3.14 "StatusExtrapolation" tag (external encoder) (S7-1500, S7-1500T)

The tag structure "<TO>.StatusExtrapolation.<tag name>" indicates the status of the actual value extrapolation.

Tags

Legend (Page 331)

Tag		Data type	Values	W	Description
StatusExtrapolation.		TO_Struct_StatusExtrapolation			
	FilteredPosition	LREAL	-1.0E12 to 1.0E12	RON	Position after position filter
	FilteredVelocity	LREAL	-1.0E12 to 1.0E12	RON	Velocity after velocity filter and tolerance band
	ExtrapolatedPosition	LREAL	-1.0E12 to 1.0E12	RON	Extrapolated position
	ExtrapolatedVelocity	LREAL	-1.0E12 to 1.0E12	RON	Extrapolated velocity

9.3.15 "StatusWord" tag (external encoder) (S7-1500, S7-1500T)

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" section of the "S7-1500/S7-1500T Motion Control Overview" documentation (Page 12).

Tag

Legend (Page 331)

Tag		Data type	Values	W	Description
StatusWord		DWORD	-	RON	Status information of the technology object
	Bit 0	-	-	-	"Enable" Enable status The technology object has been enabled.
	Bit 1	-	-	-	"Error" An error is present.
	Bit 2	-	-	-	"RestartActive" A restart is active. The technology object is being reinitial-ized.
	Bit 3	-	-	-	"OnlineStartValuesChanged" The restart tags have been changed. For the changes to be applied, the technology object must be reinitialized.
	Bit 4	-	-	-	Reserved
	Bit 5	-	-	-	"HomingDone" Homing status The technology object is homed.
	Bit 6	-	-	-	"Done" No motion job is in progress and the axis control panel is deactivated.
	Bit 7 ... Bit 10	-	-	-	Reserved
	Bit 11	-	-	-	"HomingCommand" An "MC_Home" job is being processed.
	Bit 12... Bit 31	-	-	-	Reserved

9.3.16 "ErrorWord" tag (external encoder) (S7-1500, S7-1500T)

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" section of the "S7-1500/S7-1500T Motion Control Overview" documentation (Page 12).

Tags

Legend (Page 331)

Tag	Data type	Values	W	Description
ErrorWord	DWORD	-	RON	

Tag	Data type	Values	W	Description
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" Job cannot be executed A Motion Control instruction cannot be executed because the necessary conditions 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	-	-	-	Reserved
Bit 15	-	-	-	"AdaptionError" Error in automatic data transfer
Bit 16 ... Bit 31	-	-	-	Reserved

9.3.17 "ErrorDetail" tag (external encoder) (S7-1500, S7-1500T)

The tag structure "<TO>.ErrorDetail.<tag name>" contains the alarm number and the effective local alarm response for the technology alarm that is currently pending on the technology object.

You can find a list of the technology alarms and alarm responses in the "Overview of the technology alarms" section of the "S7-1500/S7-1500T Motion Control alarms and error IDs" documentation (Page 12).

Tags

Legend (Page 331)

Tag		Data type	Values	W	Description	
ErrorDetail.		TO_Struct_ErrorDetail				
	Number	UDINT	-	RON	Alarm number	
	Reaction	DINT	0, 10	RON	Effective alarm response	
					0	No reaction
					10	Remove enable

9.3.18 "WarningWord" tag (external encoder) (S7-1500, S7-1500T)

The "<TO>.WarningWord" tag indicates pending warnings at 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" section of the "S7-1500/S7-1500T Motion Control Overview" documentation (Page 12).

Tags

Legend (Page 331)

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" Job cannot be executed A Motion Control instruction cannot be executed because the necessary conditions 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

Tag		Data type	Values	W	Description
	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	-	-	-	Reserved
	Bit 15	-	-	-	"AdaptionWarning" Error in automatic data transfer
	Bit 16... Bit 31	-	-	-	Reserved

9.3.19 "InternalToTrace[1..4]" tag (external encoder) (S7-1500, S7-1500T)

The tag structure "<TO>.InternalToTrace[1..4].<tag name>" contains no relevant data for you. This tag structure is internally used.

Tags

Legend (Page 331)

Tag		Data type	Values	W	Description
InternalToTrace[1..4].		ARRAY [1..4] OF TO_Struct_Internal			
	Id	DINT	-	DIR	-
	Value	LREAL	-	RON	-

Appendix (S7-1500, S7-1500T)

A

A.1 "MC_Power" function diagrams (S7-1500, S7-1500T)

A.1.1 Drive connection via PROFIdrive (S7-1500, S7-1500T)

A.1.1.1 PROFIdrive State Machine (S7-1500, S7-1500T)

An axis controls the PROFIdrive state machine in the drive through the control word in the PROFIdrive telegram. The PROFIdrive state machine shows the state of the drive.

The following table shows the states of the PROFIdrive state machine:

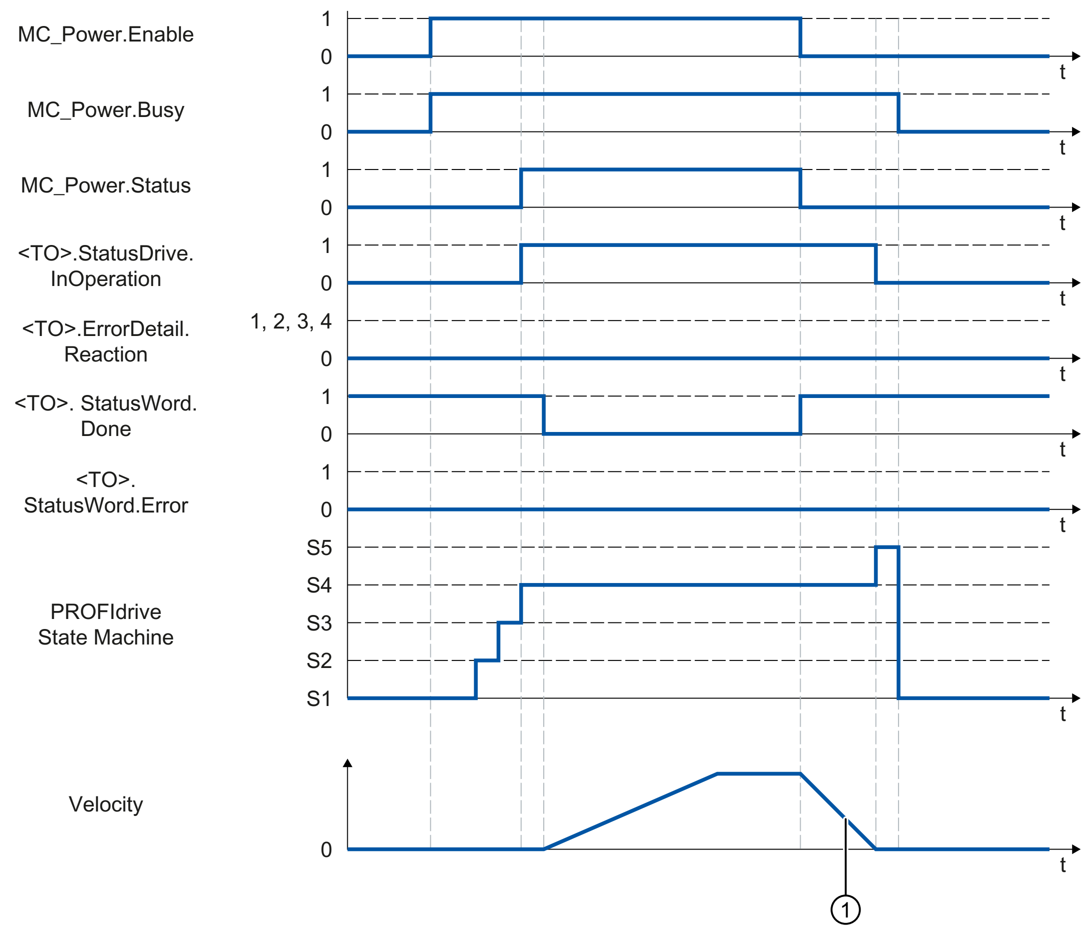
Status	Description
S1	Switching on inhibited (drive off, brake closed if necessary)
S2	Ready for power-up
S3	Switched on (drive switched on, release brake if necessary)
S4	Operation (drive released, brakes released if necessary)
S5	Switching off (braking with drive-defined ramp)

Additional information

For more information about the PROFIdrive state machine, refer to Siemens Industry Online Support in the FAQ entry 109770665 (https://support.industry.siemens.com/cs/ww/en/view/109770665).

A.1.1.2 "StopMode" = 0, 2 (S7-1500, S7-1500T)

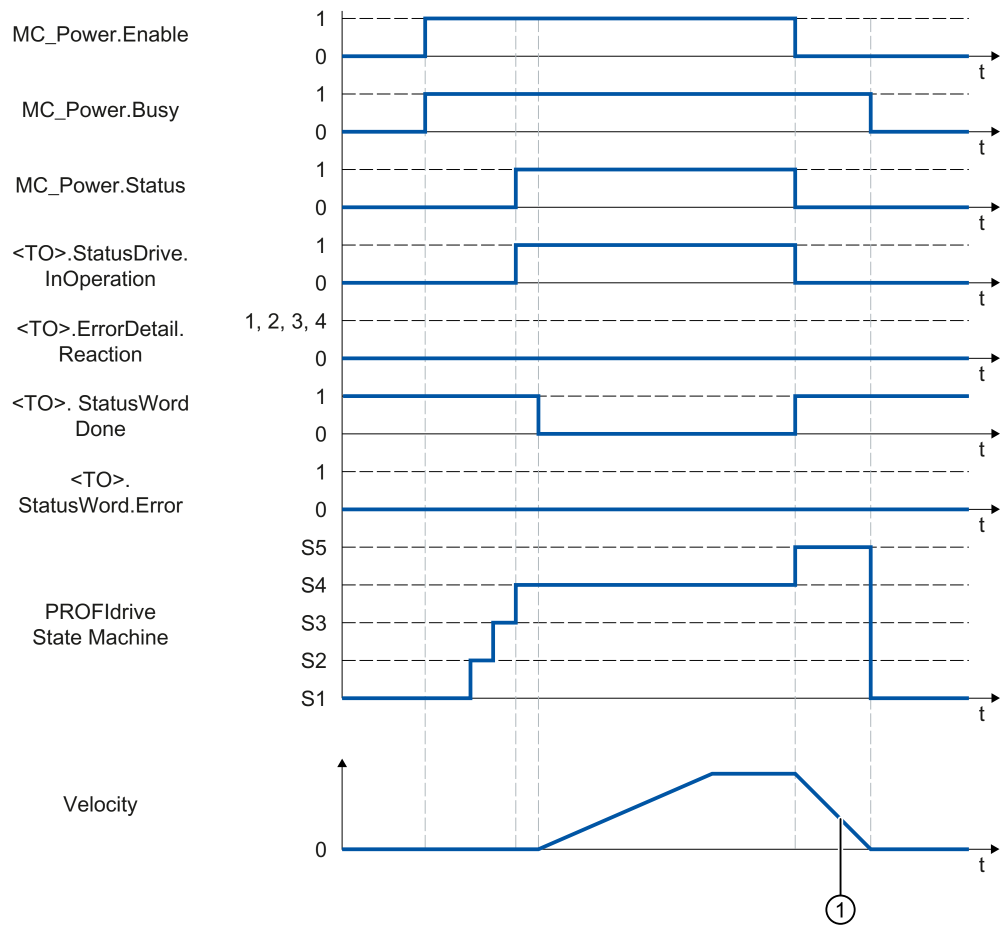
Function chart: Enabling a technology object and disabling with "StopMode" = 0, 2



①
- "StopMode" = 0
  The axis is braked with the configured emergency stop deceleration.
- "StopMode" = 2
  The axis decelerates with the configured maximum deceleration.

A.1.1.3 "StopMode" = 1 (S7-1500, S7-1500T)

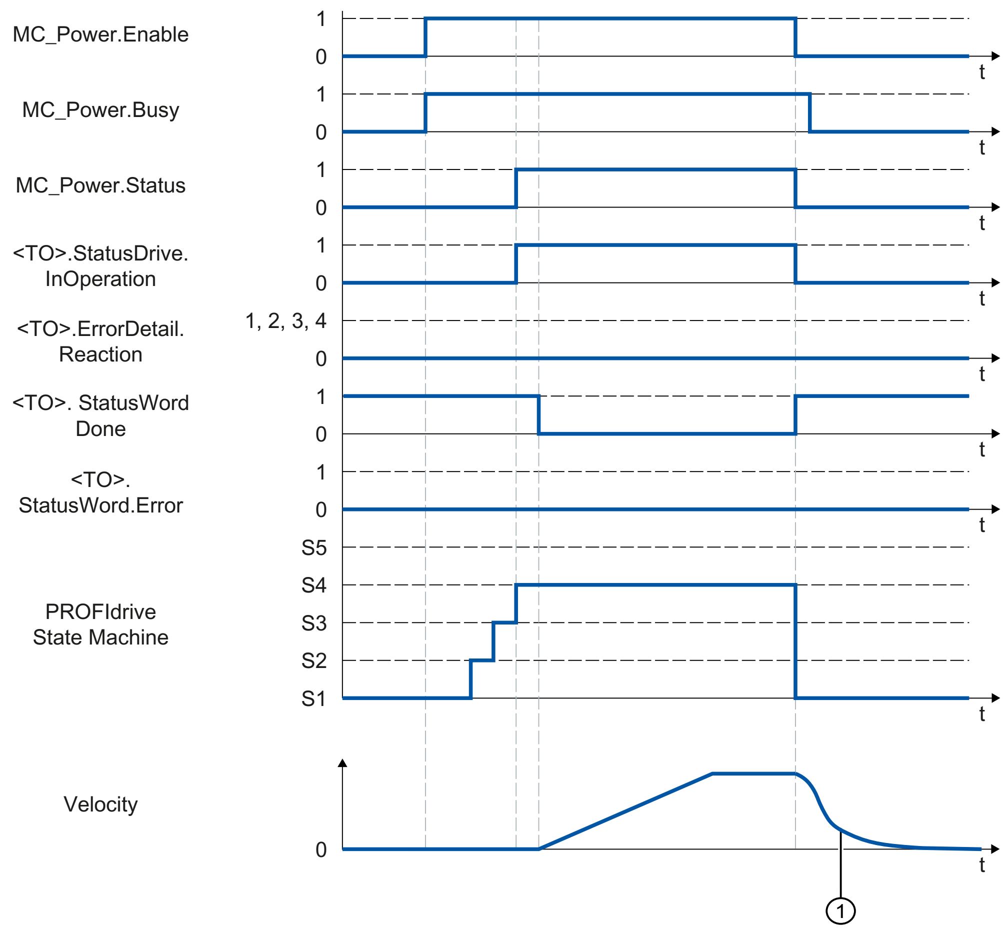
Function chart: Enabling a technology object and disabling with "StopMode" = 1



① The deceleration ramp depends on the configuration in the drive.

A.1.1.4 "StopMode" = 3 (S7-1500, S7-1500T)

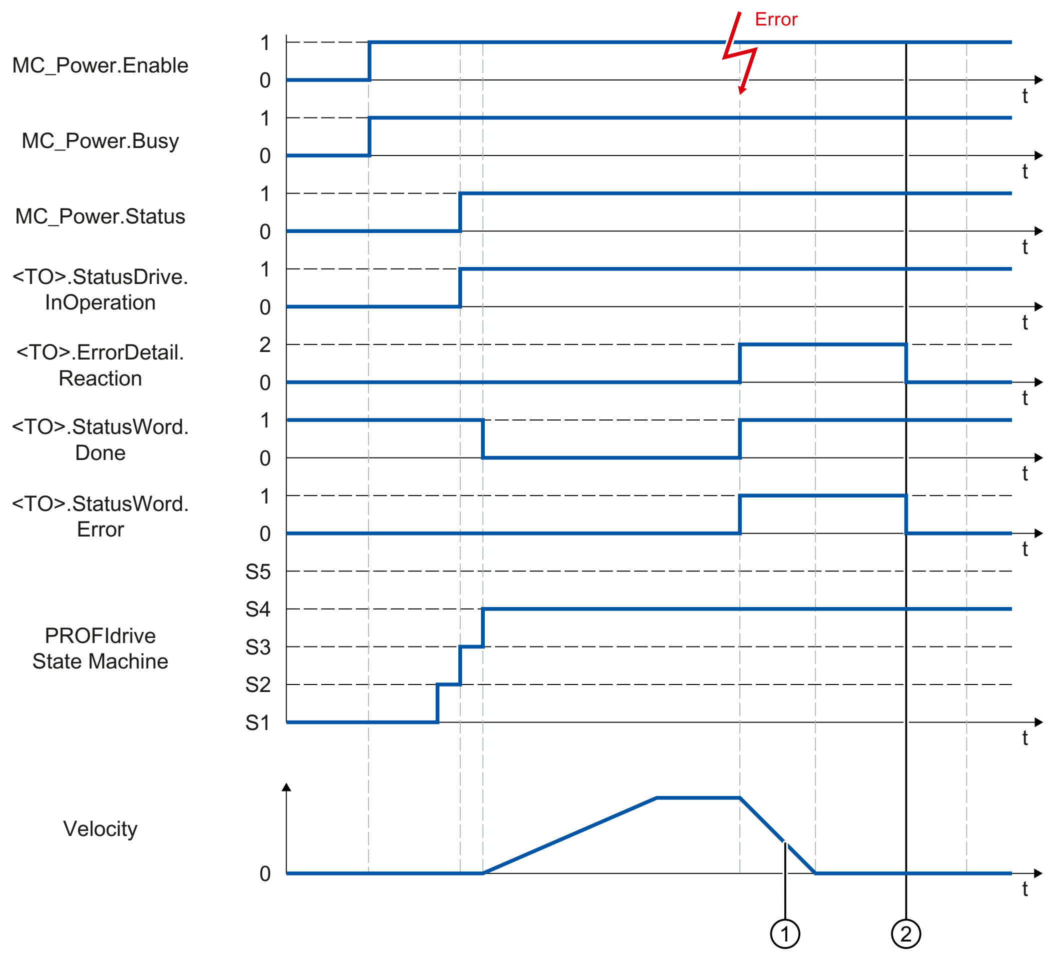
Function chart: Enabling a technology object and disabling with "StopMode" = 3



① The drive coasts down. The behavior depends on the mechanical circumstances.

A.1.1.5 Alarm reactions with braking ramp via the technology object (S7-1500, S7-1500T)

Function chart: Enabling a technology object and occurrence of a technology alarm with braking ramp via the technology object

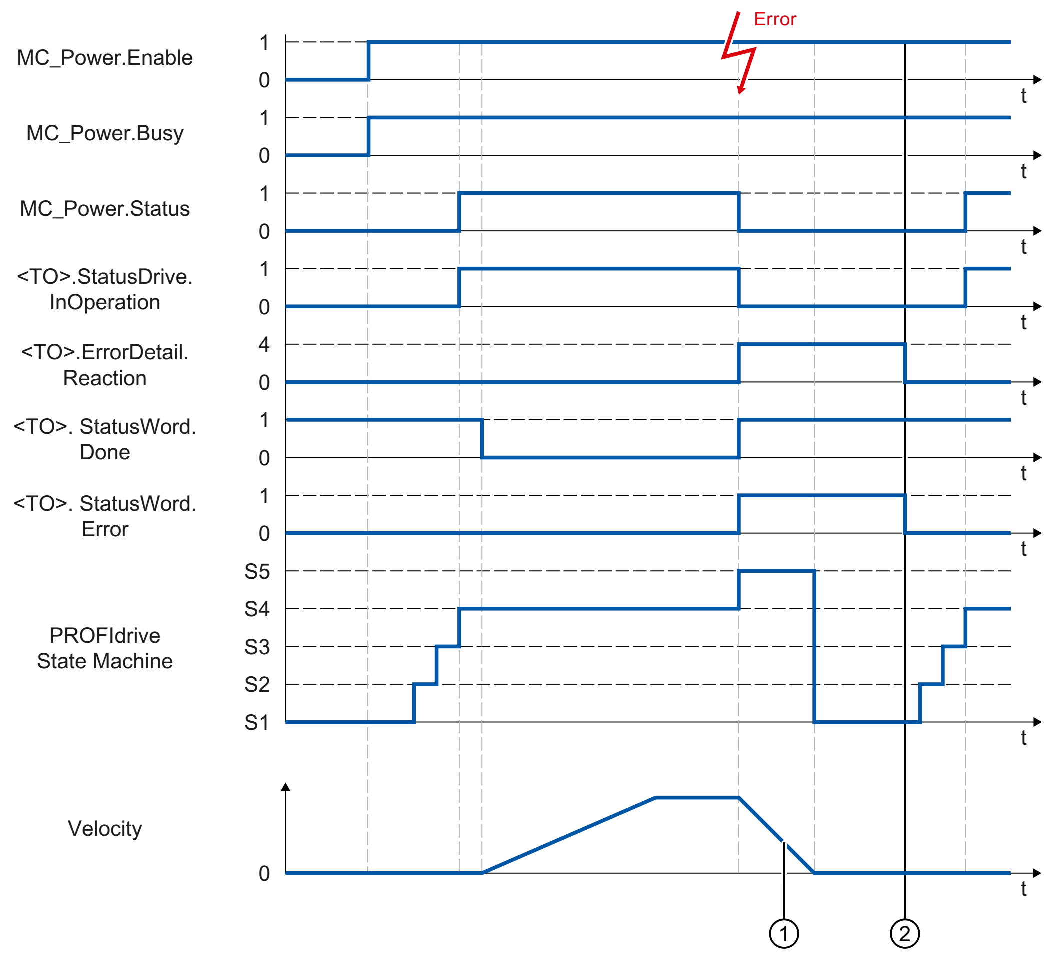


① The axis is braked based on the alarm reaction:
- Stop with current dynamic values (<TO>.ErrorDetail.Reaction = 1)
  The axis is braked with the deceleration in the Motion Control instruction.
- Stop with maximum dynamic values (<TO>.ErrorDetail.Reaction = 2)
  The axis decelerates with the configured 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.1.1.6 Alarm response "Remove enable" (S7-1500, S7-1500T)

Function chart: Enabling a technology object and occurrence of a technology alarm with alarm reaction "Remove enable"



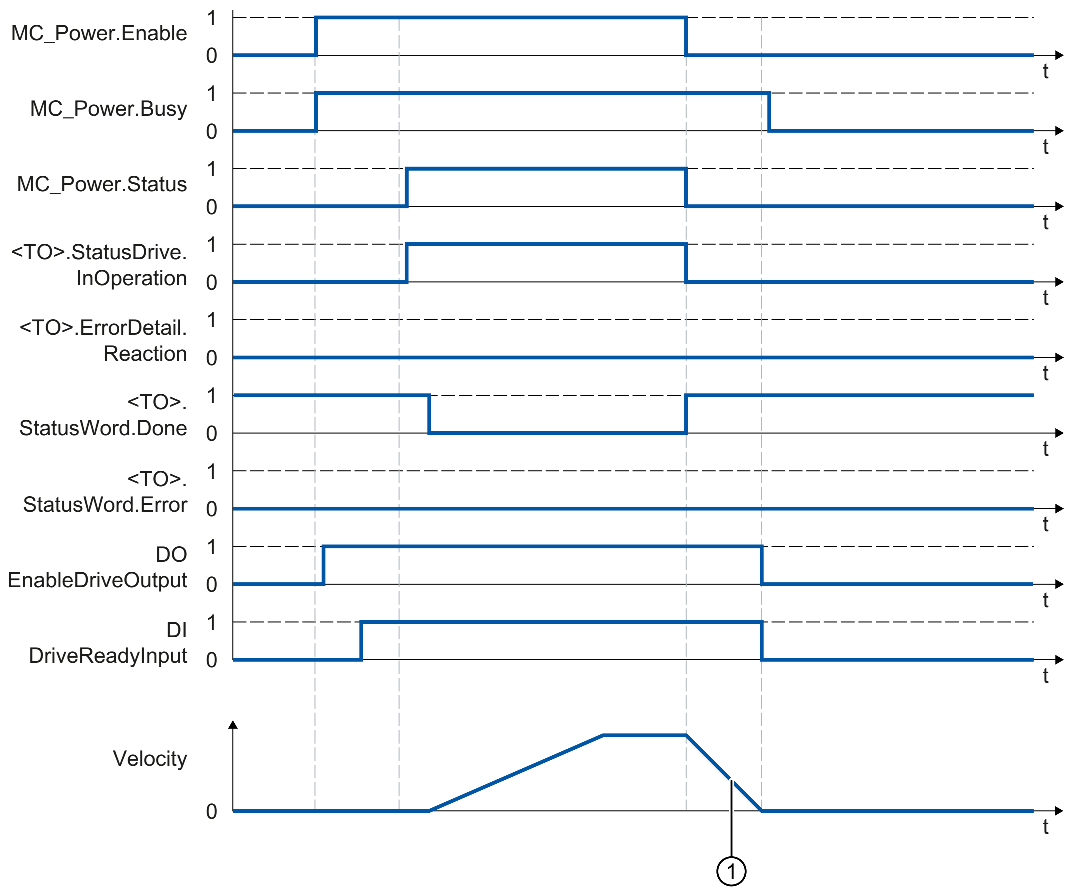
① The deceleration ramp depends on the configuration in the drive.

② The technology alarm is acknowledged at time ②.

A.1.2 Analog drive connection (S7-1500, S7-1500T)

A.1.2.1 "StopMode" = 0, 2 (S7-1500, S7-1500T)

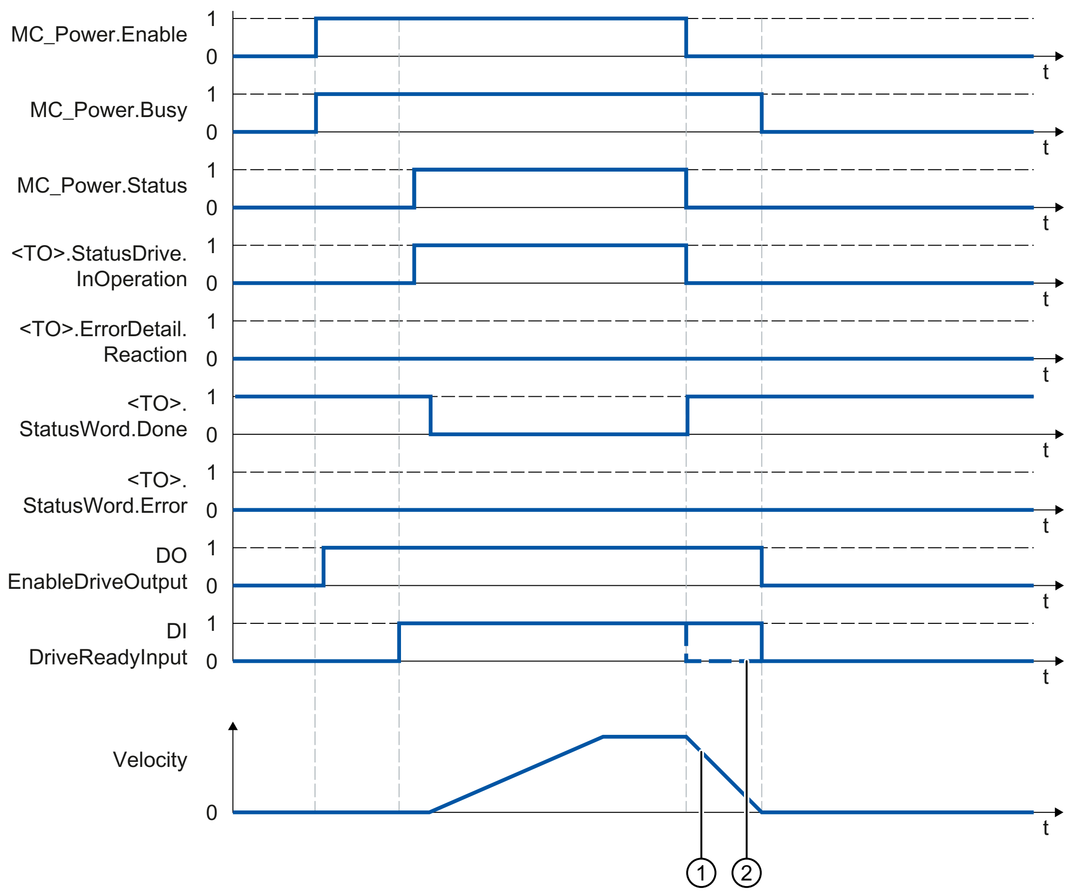
Function chart: Enabling a technology object and disabling with "StopMode" = 0, 2



①
- "StopMode" = 0
  The axis is braked with the configured emergency stop deceleration.
- "StopMode" = 2
  The axis decelerates with the configured maximum deceleration.

A.1.2.2 "StopMode" = 1 (S7-1500, S7-1500T)

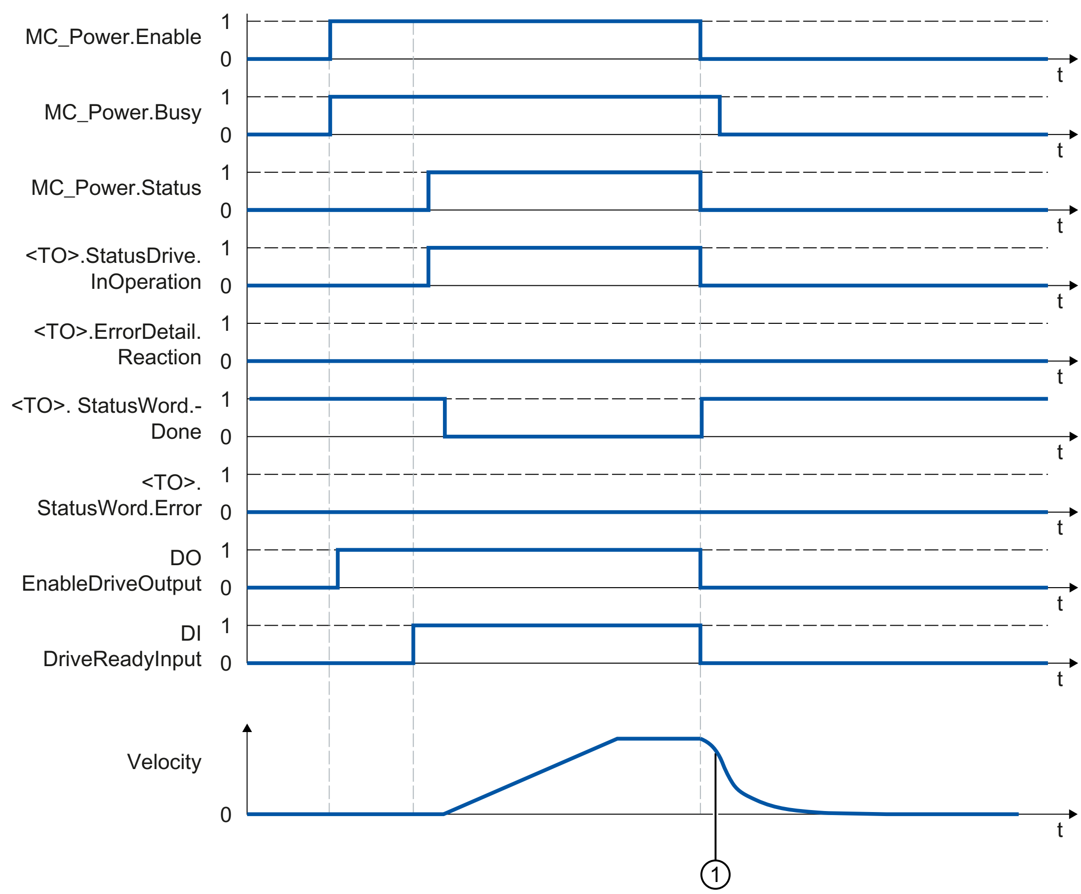
Function chart: Enabling a technology object and disabling with "StopMode" = 1



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.1.2.3 "StopMode" = 3 (S7-1500, S7-1500T)

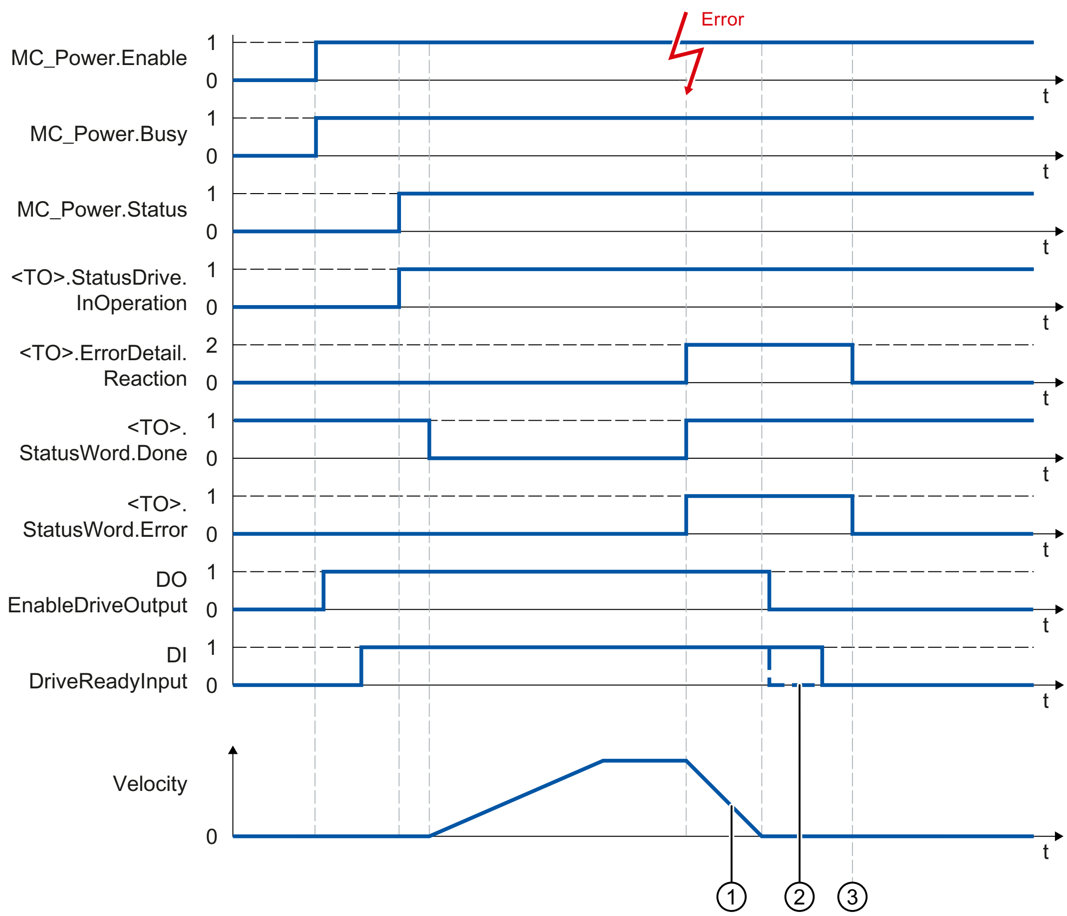
Function chart: Enabling a technology object and disabling with "StopMode" = 3



① The drive coasts down. The behavior depends on the mechanical circumstances.

A.1.2.4 Alarm reactions with braking ramp via the technology object (S7-1500, S7-1500T)

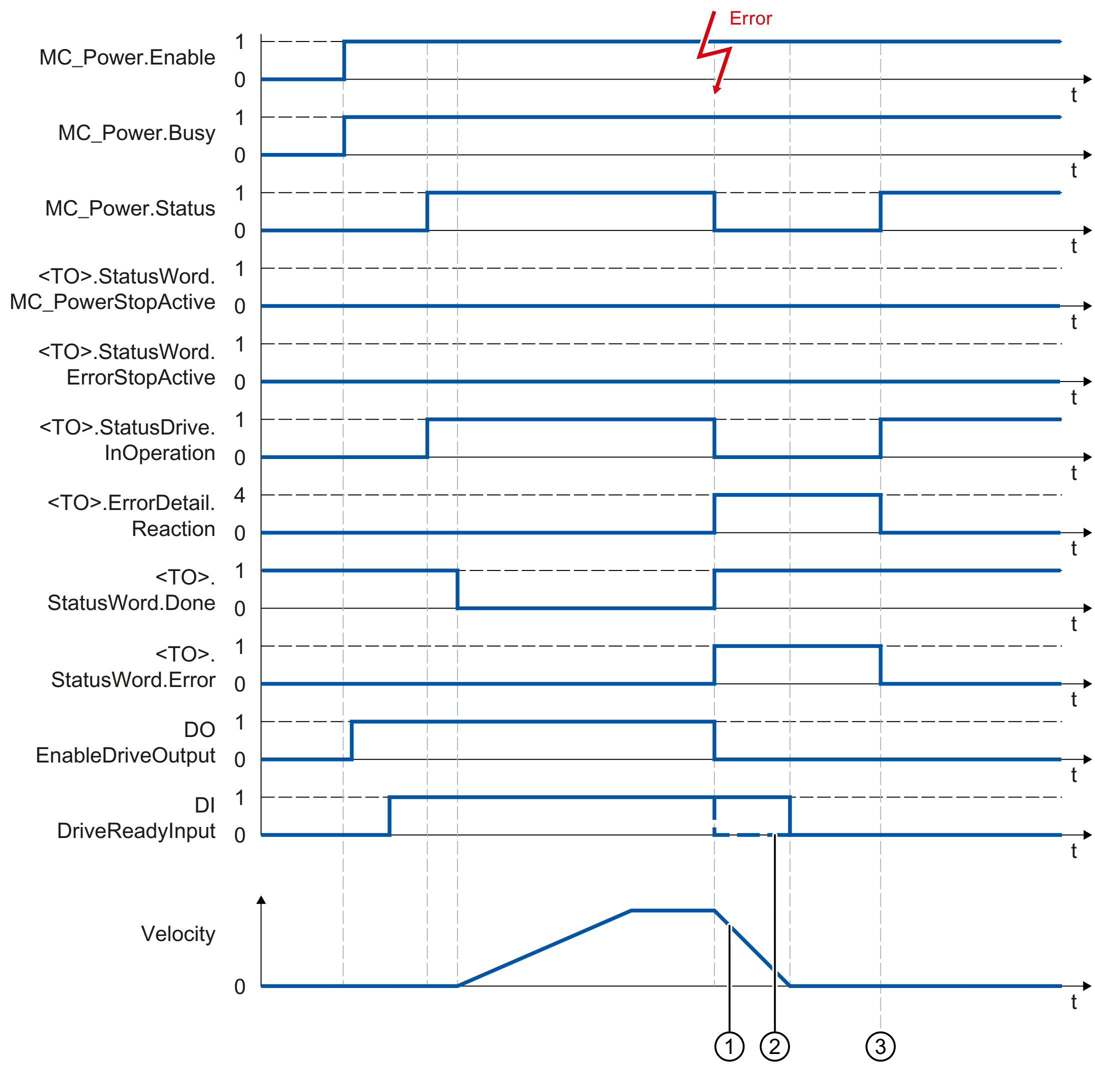
Function chart: Enabling a technology object and occurrence of a technology alarm with braking ramp via the technology object



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.1.2.5 Alarm response "Remove enable" (S7-1500, S7-1500T)

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.

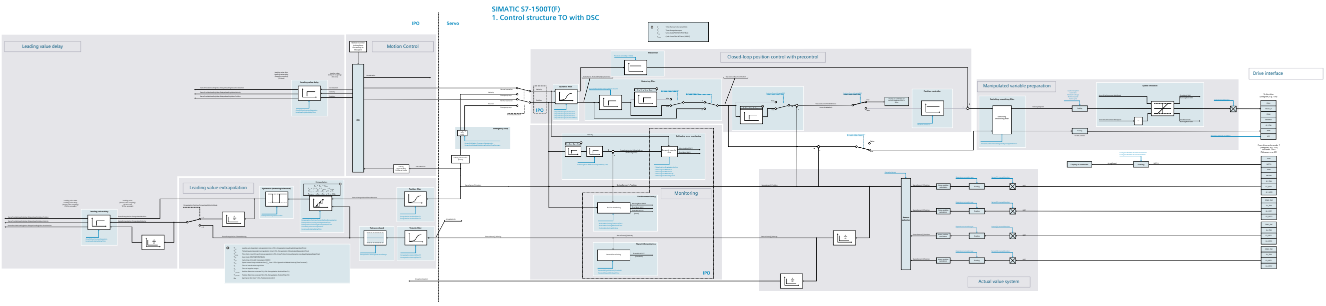
② The behavior of the ready signal of the drive "DI DriveReadyInput" is manufacturer-specific.

③ The technology alarm is acknowledged at time ③.

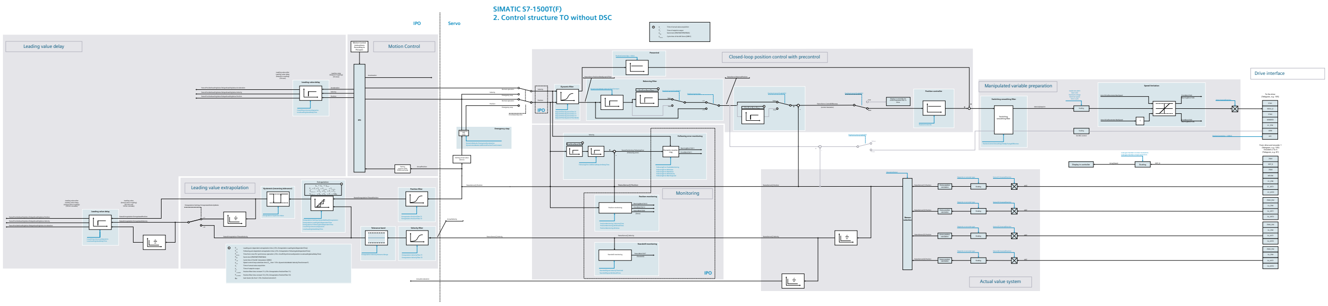
A.2 Signal flow diagrams position control (S7-1500, S7-1500T)

Signal flow diagrams position control

Position control in the drive with DSC



Position control in the CPU



Glossary

(S7-1500, S7-1500T)

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.

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.

Index

M

O

P

R

S