SIEMENS

SIMATIC

S7-1500
S7-1500 Motion Control

Function Manual

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Preface

Purpose of the documentation

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

Required basic knowledge

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

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

Validity of the documentation

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

Conventions

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

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

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

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

Note

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

Further support

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

Table of contents

1 Documentation guide

Introduction

This modular documentation of the SIMATIC products covers diverse topics concerning your automation system.

The complete documentation for the S7-1500 system consists of the system manual, function manuals, and user manuals.

The STEP 7 information system (Online Help) also helps you to configure and program your automation system.

Documentation overview

The following table lists additional references that supplement this description of "Motion Control".

Table 1- 1 "Motion Control" documentation

Topic	Documentation	Most important contents
STEP 7 (TIA Portal)	STEP 7 Professional V12 online help	Configuring and programming with the engineering software
System description	Automation System S7-1500 (http://support.automation.siemens.com/WW/view/en/59191792)	• Application planning • Installation • Wiring • Commissioning
System diagnostics	Function manual System diagnostics (http://support.automation.siemens.com/WW/view/en/59192926)	• Basics • Function • Operation • Diagnostics via web server
Modules of the S7-1500 automation system	Manuals for the S7-1500 product range (http://support.automation.siemens.com/WW/view/en/56926743/130000)	• Interrupt, error and system alarms • Technical specifications (incl. diagnostic functions)

SIMATIC manuals

All current manuals for the SIMATIC products are available for download free of charge on the Internet (http://www.siemens.com/automation/service&support).

Introduction

2

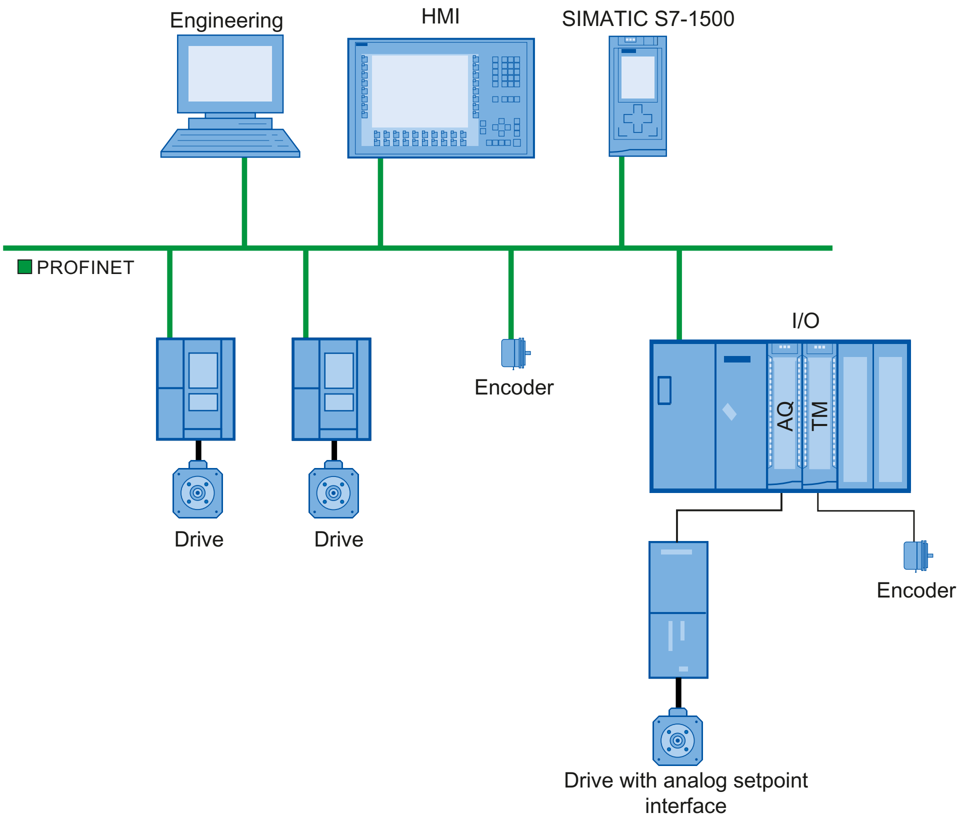
2.1 Motion Control Functionality of the CPU S7-1500

The Motion Control functionality supports the controlled positioning and movement of axes, and is a component of each CPU S7-1500.

Configuration options

You can connect drives and encoders using PROFIBUS DP and PROFINET IO.
You can connect drives with analog setpoint interfaces using an analog output (AQ).
You can additionally read encoders in by means of a technology module (TM).

The following figure shows an example configuration:

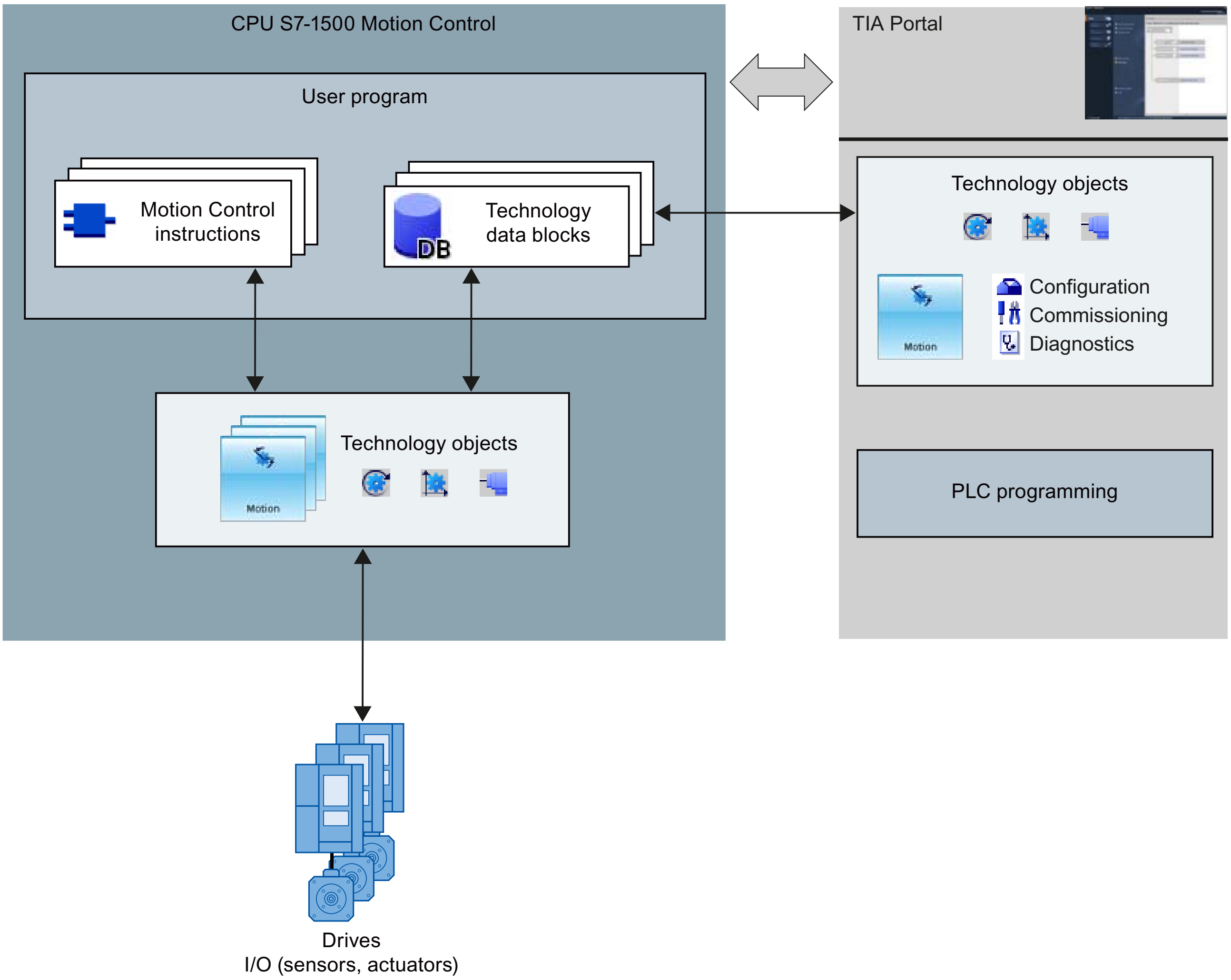


2.2 Principle of operation of Motion Control

Overview

With the TIA Portal you create a project, configure technology objects, and load the configuration into the CPU. The processing of the Motion Control functionality occurs in the CPU.
You control the technology objects by using the Motion Control instructions in your user program.
The TIA portal provides additional functions for commissioning, optimization (Page 167), and diagnostics (Page 185).

The following figure shows schematically the user interfaces and the integration of Motion Control into the CPU S7-1500. The concepts are then briefly explained:



TIA Portal

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

- Integrating and configuring hardware
- Creating and configuring technology objects
- Creating the user program
- Diagnostics

Motion Control instructions

With the Motion Control instructions you perform the desired functionality in the technology objects. The Motion Control instructions are available in the TIA Portal under "Instructions > Technology > Motion Control > S7-1500 Motion Control".

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

Technology objects

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

The configuration of the technology objects reflects the properties of the real object.
The configuration data are stored in a technology data block.

The following technology objects are available for Motion Control:

- **Speed-controlled axis technology object**

  The speed-controlled axis technology object ("SpeedAxis") permits the specification of the speed for a drive. The movement of the axis can be programmed with Motion Control instructions.

- **Positioning axis technology object**

  The positioning axis technology object ("PosAxis") permits the position-controlled positioning of a drive. Positioning jobs can be assigned to the axis with Motion Control instructions in the user program.

- **External encoder technology object**

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

Scale

For information on the number of technology objects that may be used, refer to the technical specifications of the utilized CPU.

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.
The technology data block is automatically created when the technology object is created.
In your user program, you can access the technology data block's data.

User program

The Motion Control instructions and the technology data block represent the programming interfaces for the technology objects. Using the Motion Control instructions, your user program can initiate and track Motion Control jobs in technology objects. The technology data block represents the technology object.

Drives and encoders

Drives permit the movement of the axis. They are integrated into the hardware configuration as slaves.

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

Drives and encoders are connected by means of PROFIdrive frames.
The following interfaces are possible:

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

For an analog drive connection, the setpoint can be specified via an analog output with an enabling signal. Analog inputs and outputs are made available by means of corresponding IO modules.

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

Basics 3

3.1 Functions

You can perform the Motion Control function by means of Motion Control instructions in your user program or the TIA portal (under Commissioning).

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

Function	Speed-controlled axis	Positioning axis	External encoder
Motion Control instructions (user program)			
"MC_Power (Page 205)" Enable, disable technology objects	X	X	X
"MC_Home (Page 210)" Homing technology objects, setting home position	-	X	X
"MC_MoveJog (Page 215)" Moving axes in jog mode	X	X	-
"MC_MoveVelocity (Page 220)" Moving axes with the specified speed	X	X	-
"MC_MoveRelative (Page 226)" Position axis relatively	-	X	-
"MC_MoveAbsolute (Page 231)" Position axis absolutely	-	X	-
"MC_Halt (Page 236)" Stop axis	X	X	-
"MC_Reset (Page 240)" Acknowledging alarms, restarting technology objects	X	X	X
TIA Portal			
"Axis control panel (Page 170)" Moving and homing axes using the TIA portal	X	X	-
"Optimization (Page 176)" Optimization of position control ("Kv" factor)	-	X	-

See also

Reference (Page 205)

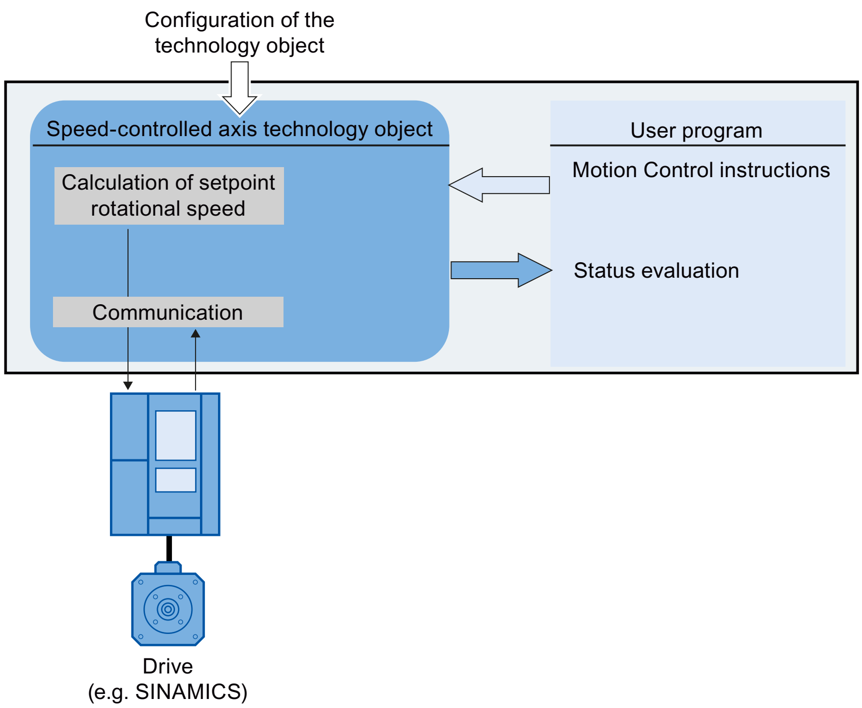
3.2 Speed-controlled axis technology object

The speed-controlled axis technology object calculates speed setpoints, taking account of the specified dynamics, and outputs them to the drive. All movements of the speed-controlled axis occur under speed control. The system takes account of an existing load gear.

A drive is assigned to each speed-controlled axis by means of a PROFIdrive message frame, or by means of an analog setpoint interface.

The speed is specified in revolutions per unit of time.

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



3.3 Positioning axis technology object

The positioning axis technology object calculates position setpoints, taking account of the specified dynamics, and outputs corresponding speed control setpoints to the drive. All movements of the positioning axis occur under position control. For absolute positioning, the physical position must be known to the positioning axis technology object.

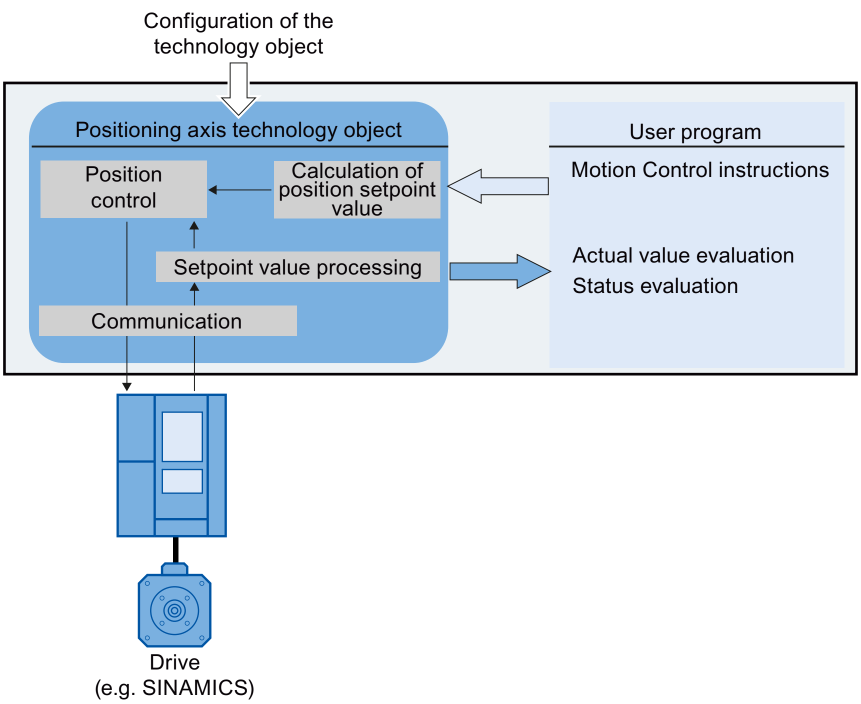
Each positioning axis is assigned a drive by means of a PROFIdrive message frame or by means of an analog setpoint interface, and an encoder by means of a PROFIdrive message frame.

The relationship between the encoder values and a defined position is created by assigning parameters for the mechanical properties and the encoder settings, as well as a homing process. The technology object can also perform movements without a position relationship, and relative position movements, even without being in a homed status.

Note

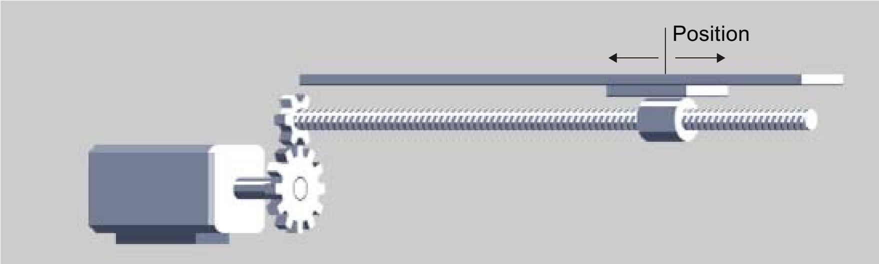
The positioning axis technology object and external encoder are independent of each other, and cannot be coupled to each other. The actual position of an external encoder cannot influence a positioning axis in its position control.

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



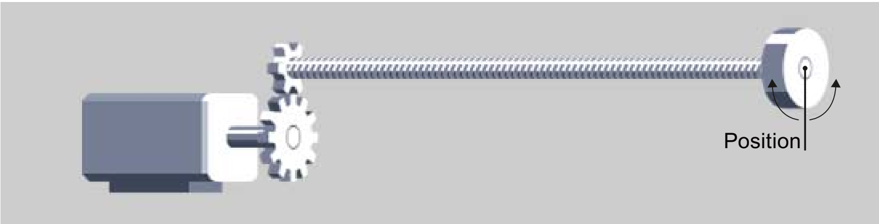
Depending on the execution of the mechanics, a positioning axis is implemented as a linear axis or rotational axis:

- **Linear axis**



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

- **Rotary axis**



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

See also

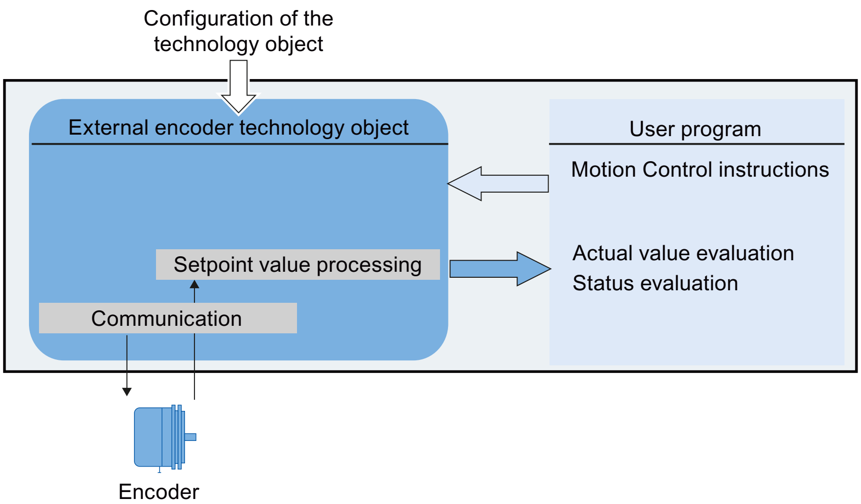
Modulo setting (Page 24)

3.4 External encoder technology object

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

The relationship between the encoder values and a defined position is created by assigning parameters for the mechanical properties and the encoder settings, as well as a homing process.

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



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

- Linear system of units

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

- Rotary system of units

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

3.5 Modulo setting

The positioning axis technology object and external encoder can be configured with the "modulo" setting.

When "modulo" is enabled, the position value of the technology object is represented by means of a recurring modulo range.

The modulo range is defined by the initial modulo value and the modulo length.

As an example, the position value of a rotary axis with an initial value = 0° and length = 360° can be represented in the modulo range from 0° to 359.9°. In this example, the resolution of the encoder is assumed to have a value of 0.1° / encoder step.

3.6 Units of measure

The following table shows the supported units of measure for distance and velocity:

Distance	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, ', ", gon	°/s, °/min, rad/s, rad/min, gon/s, gon/min

- The acceleration is correspondingly configured as a distance/s^2.
- Jerk is correspondingly configured as a distance/s^3.
- The speed is configured as revolutions per unit of time: 1/s, 1/min, 1/h

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Note

When setting or changing the units of measurement, note the effect on the depiction and the user program:

- Depiction in the technology data block
- Supply to the parameters in the user program
- Input and display of the position in the TIA Portal

All information and displays are output in the selected unit of measure.

3.7 Drive and encoder connection

3.7.1 Brief description

A speed-controlled axis is assigned a drive.
A positioning axis is assigned a drive and an encoder.
An external encoder is assigned an encoder value.

The setpoint value at the drive is specified either with PROFIdrive message frames, or with an analog output.

The following connection options are available for an encoder:

- Encoder to drive
- Encoder on technology module
- PROFIdrive-Geber directly to PROFIBUS DP / PROFINET IO

The encoder value is transmitted exclusively via PROFIdrive message frames.

PROFIdrive

PROFIdrive is the standardized standard profile for drive technology in the connection of drives and encoders via PROFIBUS DP and PROFINET IO.

Drives that support the PROFIdrive profile are connected according to the PROFIdrive standard.

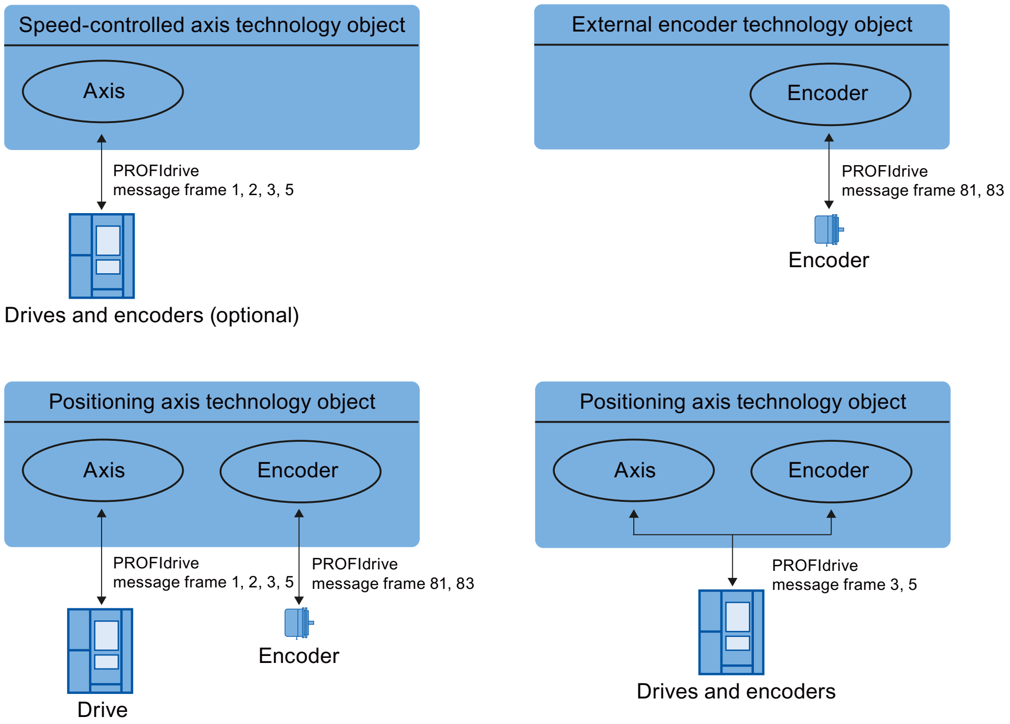
Communication between controller and drive/encoder is by means of various PROFIdrive message frames. Each of the message frames has a standardized structure. Depending on the application, you can select the applicable message frame. Control words and status words as well as setpoints and actual values are transmitted in the PROFIdrive message frames.

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

3.7.2 Frames

The transmission of the encoder value occurs either in a frame together with the setpoint (frame 3 or frame 5), or in a separate encoder frame (frame 81 or frame 83).

The following figure represents the relationship between the technology objects and the drives / encoders:



Explanation of the figure:

- The setpoint of a speed-controlled axis is transmitted to a drive via PROFIdrive frame 1, 2, 3 or 5.
- The encoder value of an external encoder is transmitted via PROFIdrive frame 81 or 83.
- The setpoint of a positioning axis is transmitted to a drive via PROFIdrive frame 1, 2, 3 or 5.
- Encoder value of the positioning axis

  The encoder value can be transmitted in the following PROFIdrive frames:

  – Transmission in the same PROFIdrive frame, in which the setpoint is also transmitted. For example, with PROFIdrive frame 3 or 5

  – Transmission in PROFIdrive frame 81 or 83.

Frame types

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

Frame	Brief description
Standard frames	
1	• 16 bit speed setpoint (NSET), • 16 bit actual speed value (NACT),
2	• 32 bit speed setpoint (NSET), • 32 bit actual speed value (NACT), • Signs of life
3	• 32 bit speed setpoint (NSET), • 32 bit actual speed value (NACT), • Actual encoder value, • Signs of life
5	• 32 bit speed setpoint (NSET), • 32 bit actual speed value (NACT), • Dynamic Servo Control (DSC), • Actual encoder value, • Signs of life
Standard encoder frames	
81	• Actual encoder value, • Signs of life
83	• 32 bit actual speed value (NACT), • Actual encoder value, • Signs of life

When connecting by means of a PROFIdrive frame, the drives and encoders are handled and switched on in accordance with the PROFIdrive profile.

3.7.3 Setting reference values

The reference values for the drive connection and encoder connection must be set identically in the controller, and in the drive or encoder.

The setpoint speed setpoint NSET and the actual speed value NACT are transmitted in the PROFIdrive message frame as a percentage value relative to 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 message frame must likewise be set identically in the controller and in the drive or encoder.

Message frame settings

The controller settings are set in the TIA Portal under "Technology object > Configuration > Hardware interface > Data transmission".

The settings for drive and encoder are set in the configuration for the respective hardware.

The following table contrasts the controller settings and corresponding PROFIdrive parameters (<TO> stands for the applicable technology object):

Setting in the TIA Portal	Controller tag in the technology data block	PROFIdrive parameter
Message frame	<TO>.Actor.Interface.Telegram	P922
Reference speed in [rpm]	<TO>.Actor.DriveParameter.ReferenceSpeed	(SINAMICS drives: P2000)
Maximum speed of the motor in [rpm]	<TO>.Actor.DriveParameter.MaxSpeed	(SINAMICS drives: P1082)
Encoder message frame	<TO>.Sensor[n].Interface.Telegram	P922
Encoder system (linear or rotary encoder)	<TO>.Sensor[n].System	P979[1] Bit0
Encoder type (0: incremental, >0: absolute or cyclically absolute)	<TO>.Sensor[n].Type	P979[5]
Resolution (linear encoder) The grid spacing is specified on the nameplate of the sensor as a separation distance of the marks on the linear measuring system.	<TO>.Sensor[n].Parameter.Resolution	P979[2]
Increments per revolution (rotary encoder)	<TO>.Sensor[n].Parameter.StepsPerRevolution	P979[2]
Number of bits for fine resolution XIST1 (cyclical actual encoder value, linear or rotary encoder)	<TO>.Sensor[n].Parameter.FineResolutionXist1	P979[3]
Number of bits for fine resolution XIST2 (absolute encoder value, linear or rotary encoder)	<TO>.Sensor[n].Parameter.FineResolutionXist2	P979[4]
Differentiable encoder revolutions (rotary absolute value encoder)	<TO>.Sensor[n].Parameter.DeterminableRevolutions	P979[5]

3.7.4 Tags

The following technology object tags are relevant for the connection of drives and encoders:

Drive frame	
<TO>.Actor.Interface.Telegram	Frame number
<TO>.Actor.DriveParameter.Reference Speed	Reference velocity / reference speed for the velocity / speed (NSET), which is transmitted as a percentage value
<TO>.Actor.DriveParameter.MaxSpeed	Maximum value for the setpoint speed of the drive (N-set)(PROFIdrive: MaxSpeed ≤ 2 × ReferenceSpeed Analog setpoint: MaxSpeed ≤ 1.17 × ReferenceSpeed)
Encoder frame	
<TO>.Sensor[n].Interface.Telegram	Frame number
<TO>.Sensor[n].System	Encoder system linear or rotary
<TO>.Sensor[n].Type	Encoder type, incremental, absolute or cyclically absolute
<TO>.Sensor[n].Parameter.StepsPer Revolution	Increments per revolution for rotary encoder
<TO>.Sensor[n].Parameter.Determinable Revolutions	Number of differentiable encoder revolutions for a multi-turn absolute value encoder
<TO>.Sensor[n].Parameter.Resolution	Resolution for linear encoder The grid spacing corresponds to the interval between two marks
Fine resolution	
<TO>.Sensor[n].Parameter.FineResolution Xist1	Number of bits for fine resolution XIST1 (cyclical actual encoder value)
<TO>.Sensor[n].Parameter.FineResolution Xist2	Number of bits for fine resolution XIST2 (absolute value of the encoder)

3.8 Actual values

3.8.1 Brief description

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

The actual position value is provided by a PROFIdrive frame. The actual value is updated after a one-off transition of the operating mode from STOP to RUN.

The actual values are represented incrementally or absolutely in the PROFIdrive frame, and standardized in the controller to the technological unit. Homing is used to convert the actual value to the physical position of the axis, or of the external encoder.

The controller supports the following types of actual values:

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

3.8.2 Incremental actual value

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

After POWER ON, position zero is displayed. The actual value is updated after a one-off transition of the operating mode from STOP to RUN. The relationship between the technology object and the mechanical position must be recreated by means of homing (Page 34).

3.8.3 Absolute actual value

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

After POWER ON, position zero is displayed. The actual value is updated after a one-off transition of the operating mode from STOP to RUN. The supplied actual value is assigned to the associated mechanical axis position by means of absolute value adjustment (Page 49). The absolute value adjustment must be performed one time. The absolute value offset is retentively saved beyond the switching on/off of the controller.

Differentiation of absolute values:

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

  Absolute value with absolute setting
- The measuring range of the encoder is smaller than the traversing range of the axis:

  Absolute value with cyclically absolute setting

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

The axis position results directly from the actual encoder value. The traversing range must be within an encoder measuring range. This means that the zero point 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 encoder value.

Absolute actual value with the setting 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 stored overruns are taken into account in the calculation of the actual position value.

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

3.8.4 Tags

The tags named in the Homing (Page 51) section are relevant for adapting actual values.

3.9 Mechanics

3.9.1 Brief description

For the application's view onto the position of the technology object, it is decisive, whether the position is represented as a unit of length (linear axis) or as a rotary unit (rotary axis).

Examples of units of length: mm, m, km

Examples of rotary units: °, rad

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

Positioning axis

The following configuration options for mechanics are supported:

- Load gear
- Leadscrew (linear axes only)
- Encoder configurations:
  - On the motor side (before the load gear)
  - On the load side (after the load gear and as applicable the leadscrew)
  - External (e.g. odometer)
- Inversion of the setpoint
- Inversion of the setpoint

External encoder

The following configuration options for mechanics are supported:

- Measuring gearbox (for rotary encoders)
- Leadscrew (only with linear system of units and rotatory encoders)
- Inversion of the setpoint

Speed-controlled axis

The following configuration options for mechanics are supported:

- Load gear
- Inversion of the setpoint

3.9.2 Tags

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

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

3.10 Homing

3.10.1 Brief description

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

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

Homing is a requirement for the indication of the correct position in the technology object, and for absolute positioning.

Homing is enabled with the Motion Control instruction "MC_Home", and is enabled for a single homing process each time.

Homing status

The technology object tag <TO>.StatusWord.HomingDone indicates whether the technology object has been homed to an axis or external encoder.

Type of homing

Homing can occur by means of an independent movement for homing (active homing), by means of a reference mark during an application-initiated movement (passive homing), or by means of direct position assignment.

A distinction is made between the following types of homing:

- Active homing

  Active homing initiates a homing movement and performs the necessary approach to the reference mark. When the reference mark is detected, the actual position is set to the configured value. It is possible to specify an offset from the home position.

  When active homing starts, current traversing movements are aborted.
  The offset is automatically traversed after the approach to home position.

- Passive homing

  The homing job does not perform its own homing motion. When the reference mark is detected during an application-initiated motion, the actual position is set to the configured value.

  Passive homing is also called homing on the fly.

- Direct homing

  The homing job directly sets the actual position to the configured value, or offsets it by this amount.

- Absolute value adjustment

  Absolute value adjustment adjusts the position of the technology object to the existing absolute actual value.

Homing mode

Depending on the type of reference mark and of the reference mark search, a distinction is made among the following homing modes (Page 36):

- **Homing with zero mark via PROFIdrive message frame and proximity switch**
- **Homing with zero mark via PROFIdrive message frame and proximity switch**
- **Homing with digital input**

3.10.2 Terms

Homing mark

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

A homing mark can be:

- **A zero mark**

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

  The zero mark is detected at the drive module or encoder module, and transmitted in the PROFIdrive frame. Perform the setting and evaluation as an encoder zero mark or external zero mark at the drive module and sensor module.
- **An edge at the digital input**

  The falling or rising edge at a digital input is used as a homing mark.

Proximity switch

If there are several zero marks in the traversing range, the proximity switch permits the selection of a specific zero mark before or after the proximity switch.

Homing mark position

This is the position assigned to the homing mark.

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

Home position

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

Home position offset

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

An offset between homing mark position and home position only has an effect during active homing. The offset is traversed after the synchronization of the axis via the Motion Control instruction "MC_Home". For axes with the modulo setting, the home position offset is always traversed using 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 is not detected or was approached from the wrong side, then the motion continues after the reversing cam in the opposite direction.

3.10.3 Homing mode

Various homing modes are available for the positioning axis technology object and the external encoder technology object. The homing mode is set in the configuration.

Homing with zero mark via PROFIdrive message frame and proximity switch

The system checks for when the proximity switch is reached. After the proximity switch is reached and is left again in the assigned homing direction, zero mark detection is enabled via the PROFIdrive message frame.

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

Homing with zero mark via PROFIdrive message frame and proximity switch

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 reference mark position.

Homing with digital input

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

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

See also

Active homing for SINAMICS drives with external zero mark (Page 280)

3.10.4 Active homing with zero mark and proximity switch

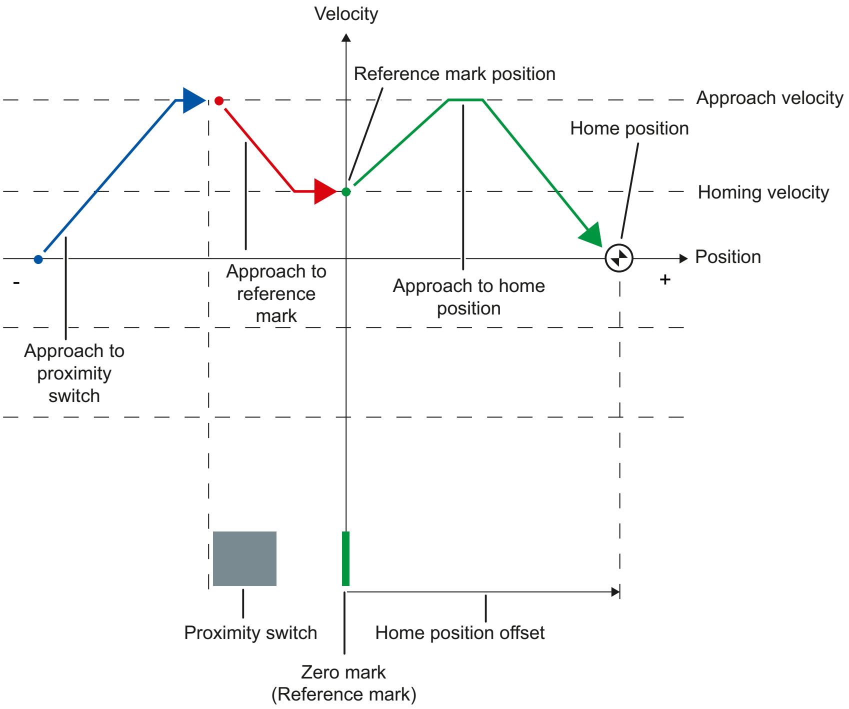
The following examples show homing motions in the positive and negative directions.

Example of homing in the positive direction

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

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

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

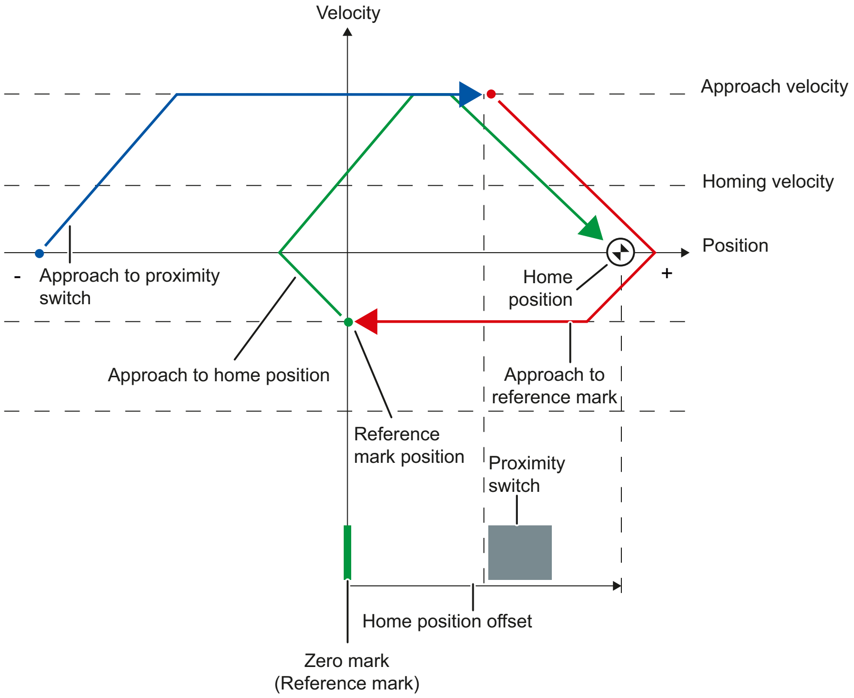


Example of homing in the negative direction

The move to the reference mark occurs in the negative direction by means of a direction reversal during the homing process. The move to the 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 zero mark and proximity switch
- Approach in the positive direction
- Homing in the negative direction
- Positive home position offset



Motion sequence

The motion occurs in the following sequence:

1. **Start of active homing via the Motion Control instruction "MC_Home"**
2. **Approach to the proximity switch**
3. **Detection of the proximity switch in the homing direction, while moving at homing velocity**
4. **Departure from the proximity switch, and approach to the reference mark**

   With the departure from the proximity switch, the detection of the reference mark is enabled.
5. **Detection of the reference mark**

   When the reference mark is detected, the position of the technology object is set depending on the configured mode.

   – Parameter "Mode" to "MC_Home" = 4

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

   – Parameter "Mode" to "MC_Home" = 5

     Position = value in tag <TO>.Homing.HomePosition minus <TO>.Sensor[n].ActiveHoming.HomePositionOffset
6. **Approach to the home position**

   – Parameter "Mode" to "MC_Home" = 4

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

   – Parameter "Mode" to "MC_Home" = 5

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

Note

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

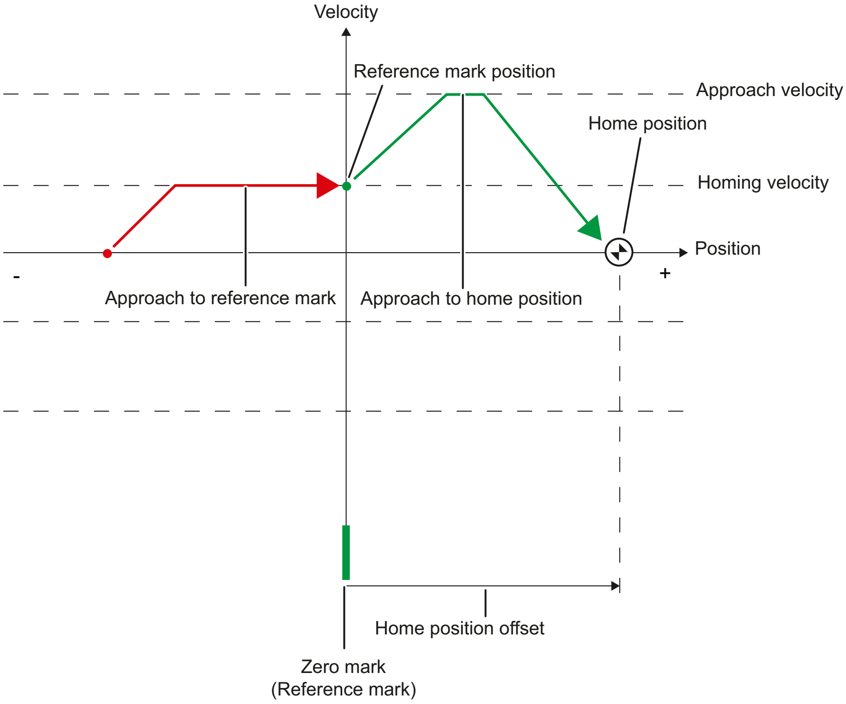
See also

Active homing for SINAMICS drives with external zero mark (Page 280)

3.10.5 Active homing with zero mark

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

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



Motion sequence

The motion occurs in the following sequence:

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

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

   – Parameter "Mode" to "MC_Home" = 4

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

   – Parameter "Mode" to "MC_Home" = 5

     Position = value in tag <TO>.Homing.HomePosition minus <TO>.Sensor[n].ActiveHoming.HomePositionOffset
4. **Approach to the home position**

   – Parameter "Mode" to "MC_Home" = 4

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

   – Parameter "Mode" to "MC_Home" = 5

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

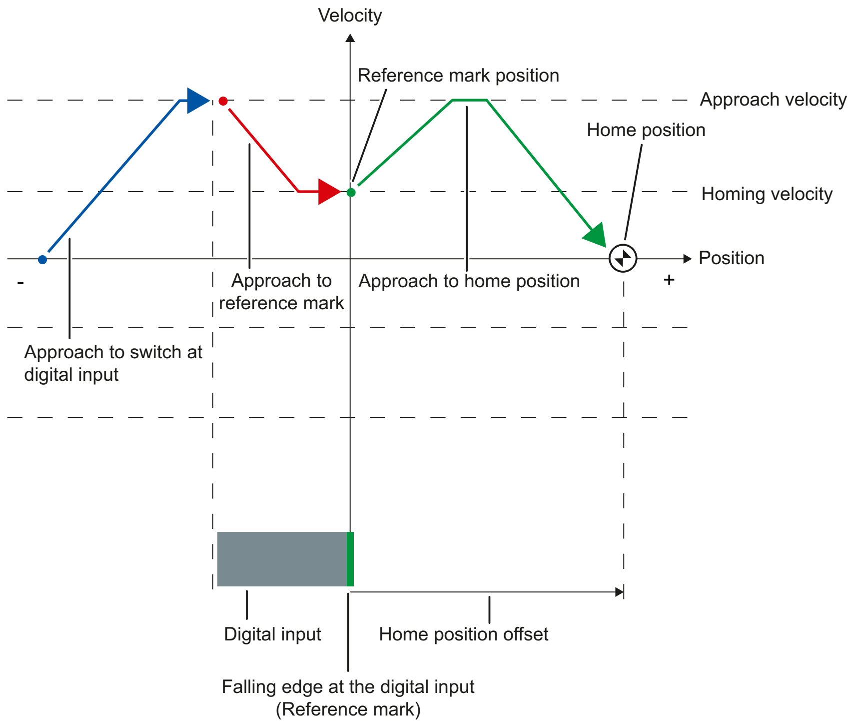
See also

Active homing for SINAMICS drives with external zero mark (Page 280)

3.10.6 Active homing with digital input

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

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



Motion sequence

The motion occurs in the following sequence:

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

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

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

   – Parameter "Mode" to "MC_Home" = 4

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

   – Parameter "Mode" to "MC_Home" = 5

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

5. **Approach to the home position**

   – Parameter "Mode" to "MC_Home" = 4

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

   – Parameter "Mode" to "MC_Home" = 5

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

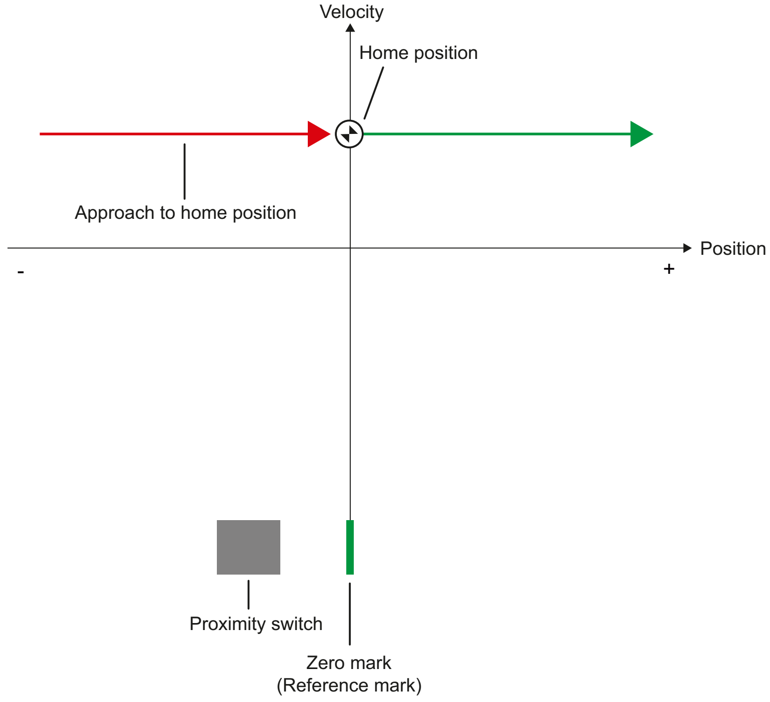
Note

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

3.10.7 Passive homing with zero mark and proximity switch

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

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



Motion sequence

The motion occurs in the following sequence:

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

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

   The departure from the proximity switch enables the detection of the reference mark.
5. **Detection of the reference mark**

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

   – Parameter "Mode" to "MC_Home" = 2

     Position = value in parameter "Position"

   – Parameter "Mode" to "MC_Home" = 3

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

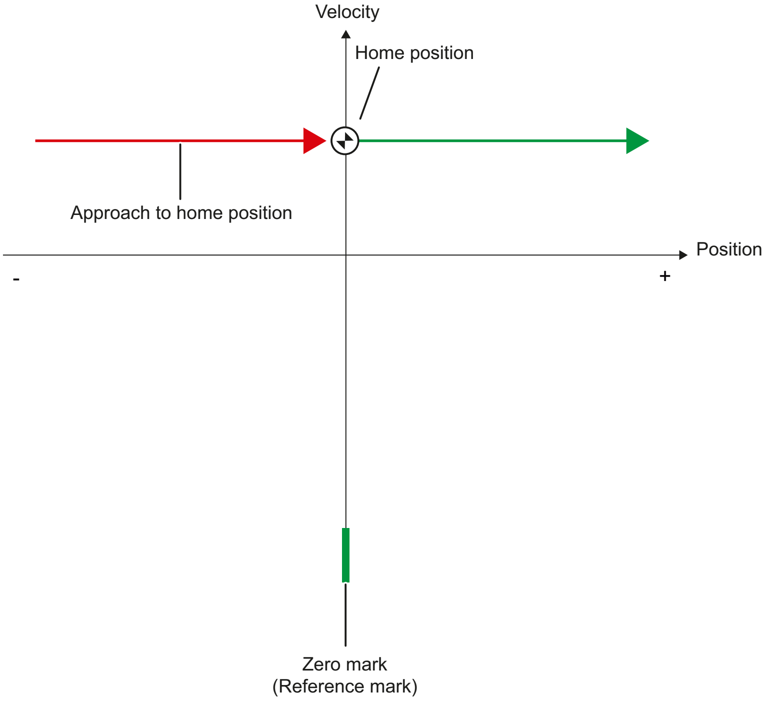
   Note

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

3.10.8 Passive homing with zero mark

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

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



Motion sequence

The motion occurs in the following sequence:

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

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

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

   – Parameter "Mode" to "MC_Home" = 2

     Position = value in parameter "Position"

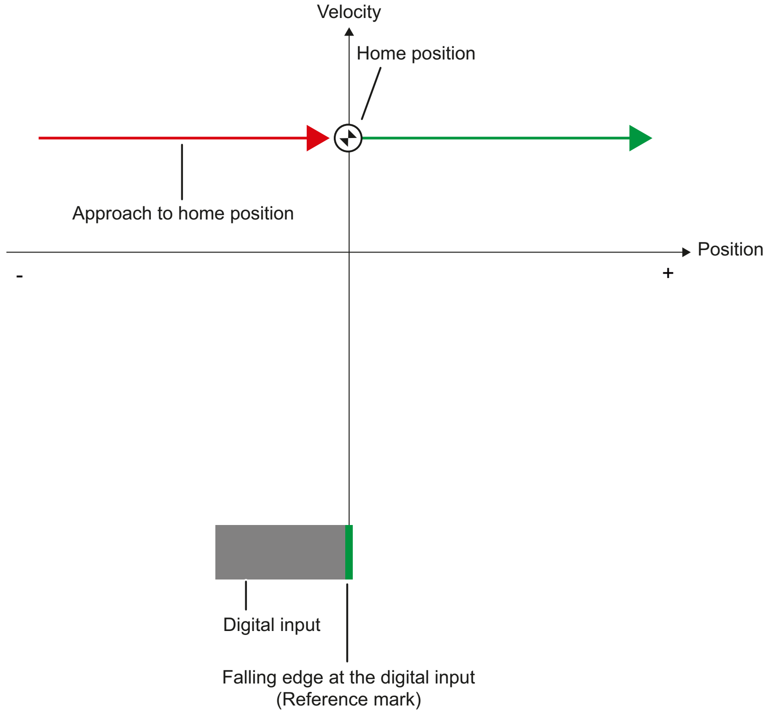
   – Parameter "Mode" to "MC_Home" = 3

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

3.10.9 Passive homing with digital input

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

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



Motion sequence

The motion occurs in the following sequence:

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

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

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

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

   – Parameter "Mode" to "MC_Home" = 2

     Position = value in parameter "Position"

   – Parameter "Mode" to "MC_Home" = 3

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

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

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

When the hardware limit switch is reached, the dynamic defaults become effective. Deceleration with the emergency stop deceleration does not occur.

NOTICE
Avoid moving to a mechanical endstop Ensure by one of the following measures, that in a direction reversal the machine does not move to a mechanical endstop. • Keep the approach velocity low. • Increase the configured acceleration / deceleration. • Increase the offset between the hardware limit switch and the mechanical endstop.

3.10.11 Direct homing

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

Set position absolutely

Proceed as follows to set the position absolutely:

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

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

Set position relatively

Proceed as follows to set the position relatively:

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

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

3.10.12 Absolute value adjustment

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

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

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

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

  Position = current position + value in parameter "Position"

3.10.13 Resetting the "Homed" status

Incremental encoder

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

- Errors in the sensor system / encoder failure
- Initiation of active homing with the Motion Control instruction "MC_Home" with "Mode" = 4, 5 (after successful completion of the homing process, the status "Homed" is set again.)
- Initiation of passive homing with the Motion Control instruction "MC_Home" with "Mode" = 2, 3 (after successful completion of the homing process, the status "Homed" is set again.)
- Replacement of the CPU
- Replacement of the SIMATIC Memory Card
- POWER OFF
- Memory reset
- Modification of the encoder configuration
- Restart of the technology object
- Restoration of the CPU factory settings
- Transfer of a different project into the controller

Absolute value encoder

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

- Errors in the sensor system / encoder failure
- Replacement of the CPU
- Modification of the encoder configuration
- Restoration of the CPU factory settings
- Transfer of a different project into the controller

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

3.10.14 Tags

The following technology object tags are relevant for homing:

Status indicators	
<TO>StatusWord.HomingCommand	Homing command active
<TO>StatusWord.HomingDone	Technology object is homed
<TO>ErrorWord.HomingFault	Error occurred during homing
Approach to the proximity switch	
<TO>.Homing.ApproachDirection	Start direction or approach direction for the approach to the proximity switch
<TO>.Homing.ApproachVelocity	Velocity for the approach to the proximity switch
Approach to the reference mark	
<TO>.Sensor[n].ActiveHoming.Direction	Homing direction
<TO>.Homing.ReferencingVelocity	Velocity for the approach to the reference mark
Approach to home position	
<TO>.Homing.ApproachVelocity	Velocity for the approach to the home position
Positions	
<TO>.Homing.AutoReversal	Reversal at the hardware limit switches
<TO>.Homing.HomePosition	Home position
<TO>.StatusSensor[n].AbsEncoderOffset	Calculated offset after the absolute value adjustment
Parameters for active homing	
<TO>.Sensor[n].ActiveHoming.Mode	Homing mode
<TO>.Sensor[n].ActiveHoming.SideInput	Side of the digital input
<TO>.Sensor[n].ActiveHoming.Direction	Homing direction or approach direction
<TO>.Sensor[n].ActiveHoming.DigitalInputAddress	I/O address of the digital input
<TO>.Sensor[n].ActiveHoming.DigitalInputBit Number	Bit number of the I/O address of the digital input
<TO>.Sensor[n].ActiveHoming.HomePosition Offset	Offset of the reference mark from the home position
Parameters for passive homing	
<TO>.Sensor[n].PassiveHoming.Mode	Homing mode
<TO>.Sensor[n].PassiveHoming.SideInput	Side of the digital input
<TO>.Sensor[n].PassiveHoming.Direction	Homing direction or approach direction
<TO>.Sensor[n].PassiveHoming.DigitalInput Address	Byte number of the I/O address of the digital input
<TO>.Sensor[n].PassiveHoming.DigitalInputBit Number	Bit number of the I/O address of the digital input

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Note

Evaluation of the bits in StatusWord, ErrorWord and WarningWord

Read the information provided in section Evaluate StatusWord, ErrorWord and WarningWord (Page 143).

3.11 Control

3.11.1 Brief description

The position controller of the positioning axis is a closed-loop P controller with pre-control of velocity.

If the drive supports Dynamic Servo Control (DSC), then a closed-loop position controller in the drive can optionally be used.

Dynamic Servo Control (DSC)

In drives that support Dynamic Servo Control (DSC), you can optionally use the closed-loop 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. The communication times between controller and drive are automatically taken into account.

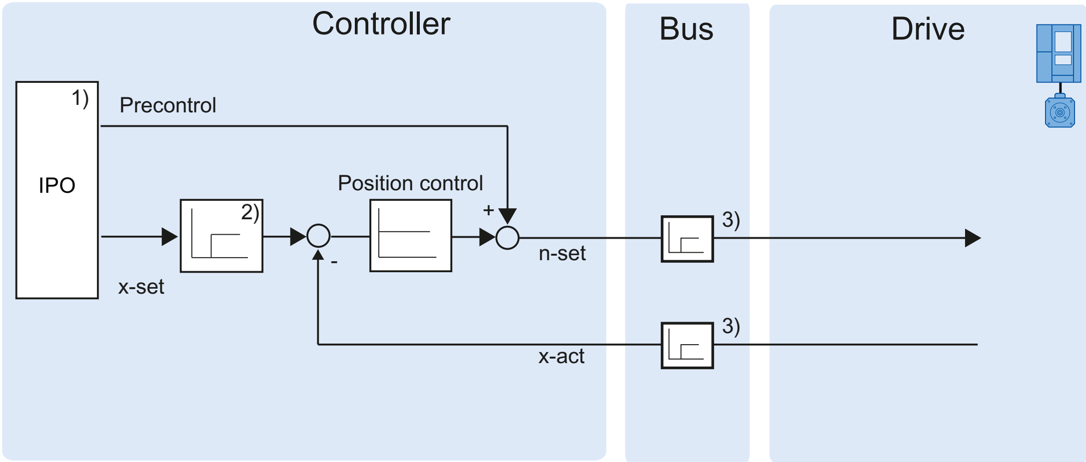
For DSC, the drive's encoder must be used and the drive must support standard frame 5.

See also

Frames (Page 26)

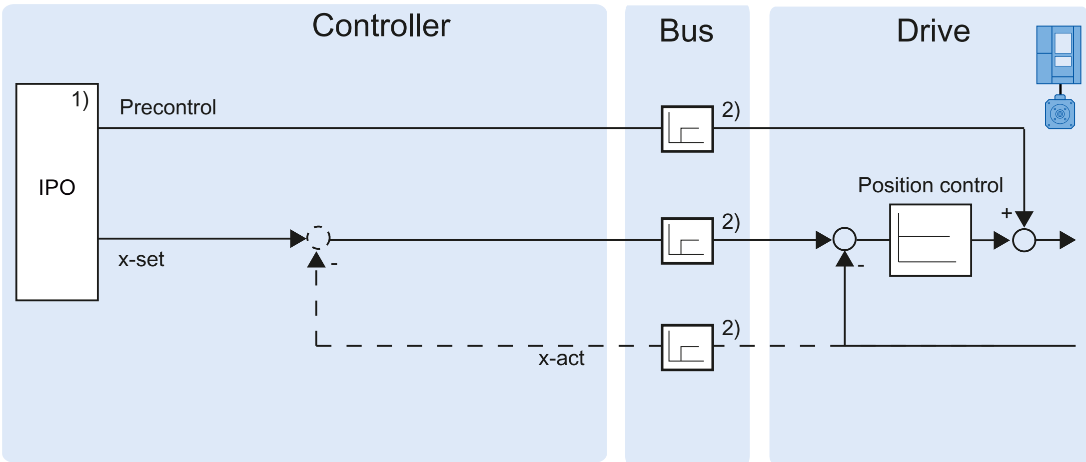
3.11.2 Control structure

The following figure shows the effective control structure without DSC:



1) Interpolator with Motion Control
2) Internal consideration of signal delays
3) Controller-drive communication

The following figure shows the effective control structure with DSC:



1) Interpolator with Motion Control
2) Controller-drive communication

3.11.3 Tags

The following technology object tags are relevant for control:

Parameter	
<TO>.PositionControl.Kv	Proportional gain in the position control
<TO>.PositionControl.EnableDSC	Enabling DSC

3.12 Position-related monitoring

3.12.1 Brief description

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

- Positioning monitoring (Page 55)

  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 56)

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

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

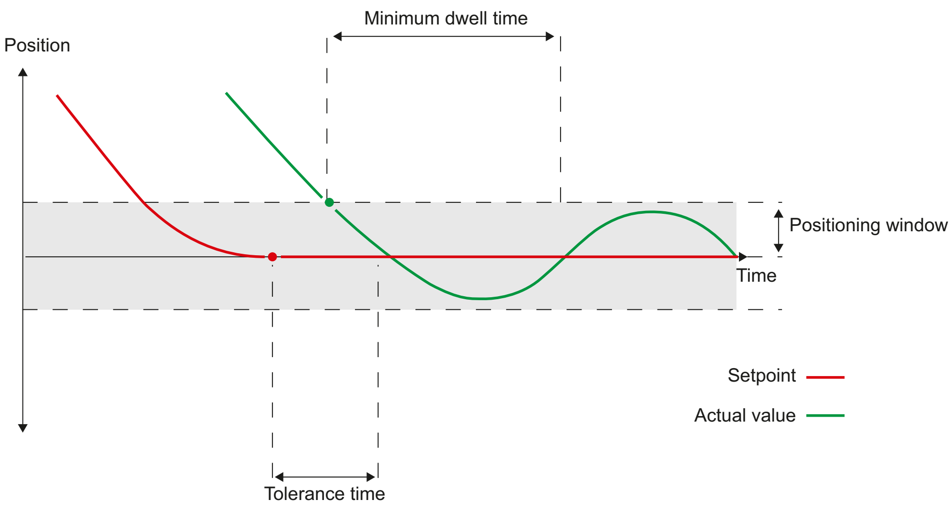
3.12.2 Positioning monitoring

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

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

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.Done is set in the technology data block. This completes a Motion Control 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 the motion, via the Motion Control instruction "MC_Halt"

Violation of positioning monitoring

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

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

3.12.3 Following error monitoring

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

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

Above this lower velocity limit, the permissible following error increases in proportion to the setpoint velocity. The maximum permissible following error may be reached at the maximum velocity.

Calculation of the following error

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

Warning limit

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

Exceedance 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).

3.12.4 Tags

The following technology object tags are relevant for positioning monitoring:

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

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

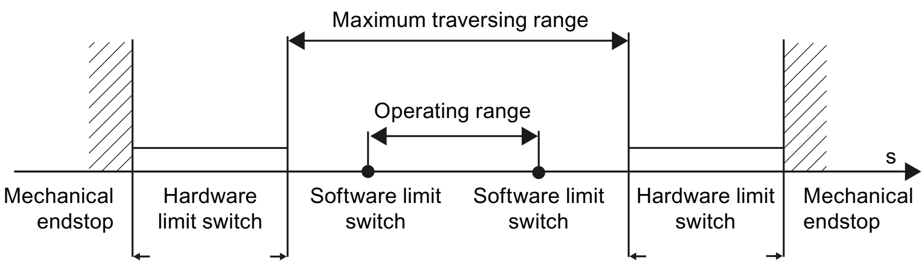
Status indicators	
<TO>.StatusPositioning.FollowingError	Current following error
<TO>.ErrorWord.FollowingErrorFault	Status indication, that the following error is too large
<TO>.WarningWord.FollowingErrorWarning	Status indication, that the following error warning limit has been reached
Control bits	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

3.13 Traversing range limitation

3.13.1 Brief description

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

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



3.13.2 Hardware limit switches

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

The positions of the hardware limit switches should be selected so that sufficient braking distance exists 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, whether the switches are approached or overshot.

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

Exception

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

Retracting

Proceed as follows to retract the axis free after approaching the hardware limit switch:

1. Acknowledge the technology alarm.
2. Move the axis in the free travel direction, until the hardware limit switch is exited.

   If you move opposite to the free travel direction before exiting the hardware limit switch, then the monitor with be triggered again.

The technology object's <TO>.ErrorWord.HWLimit tag shows the value TRUE, until the hardware limit switch is exited. As soon as the axis has traveled free, <TO>.ErrorWord.HWLimit takes the value FALSE.

3.13.3 Software limit switches

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

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

Modulo enabled

With modulo enabled, the modulo position is monitored.

The software limit switches are enabled or disabled using the tags in the technology data block. If the positions of both software limit switches are outside the modulo range, then the monitoring has no effect. It is not checked, whether the positions of the software limit switches are within the modulo range.

Approaching the software limit switches

At the beginning of a positioning motion, it is not checked, whether the software limit switches will be approached by approaching the specified target position.

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

Overshooting the software limit switches

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

Retracting

Proceed as follows to retract the axis after violation of the software limit switch:

1. Acknowledge the technology alarm.
2. Move the axis in the free travel direction, until the software limit switch is exited.

   If you move opposite to the free travel direction before exiting the software limit switch, then the monitor with be triggered again.

3.13.4 Tags

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

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

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

Status indicators	
<TO>.StatusWord.HWLimitMinActive	Negative hardware limit switch is enabled
<TO>.StatusWord.HWLimitMaxActive	Positive hardware limit switch is enabled
<TO>.ErrorWord.HWLimit	An alarm is queued; a hardware limit switch was violated
Control bits	
<TO>.PositonLimits_HW.Active	Enables / disables the monitoring of the hardware limit switches
Parameter	
<TO>.PositonLimits_HW.MinSwitchLevel	Level selection for enablement of the lower hardware limit switch: FALSE: At low level, the signal is enabled TRUE: At high level, the signal is enabled
<TO>.PositonLimits_HW.MinSwitchAddress	I/O address of the hardware limit switch for the lower or minimum position
<TO>.PositonLimits_HW.MinSwitchBit Number	Bit number of the I/O address of the hardware limit switch for the lower or minimum position
<TO>.PositonLimits_HW.MaxSwitchLevel	Level selection for enablement of the upper hardware limit switch: FALSE: At low level, the signal is enabled TRUE: At high level, the signal is enabled
<TO>.PositonLimits_HW.MaxSwitchAddress	I/O address of the hardware limit switch for the upper or maximum position
<TO>.PositonLimits_HW.MaxSwitchBit Number	Bit number of the I/O address of the hardware limit switch for the upper or maximum position

3.14 Motion Control and limit values for dynamics

3.14.1 Brief description

Motion control of the axis occurs by means of velocity profiles (Page 63). The velocity profiles are calculated in accordance with the specifications for dynamics. A velocity profile defines the behavior of the axis during approach, braking and changes in velocity.
During positioning a velocity profile is calculated, that moves the axis to the target point.

Maximum values for velocity, acceleration and jerk result from the properties of the drive and the mechanics. These maximum values can be configured in the limits for dynamics. The limits for dynamics are in effect as limits for every motion generated by means of the technology object.

The configurable emergency stop deceleration (Page 64) is triggered by the Motion Control instruction MC_Power or by a technology alarm.

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

3.14.2 Velocity profile

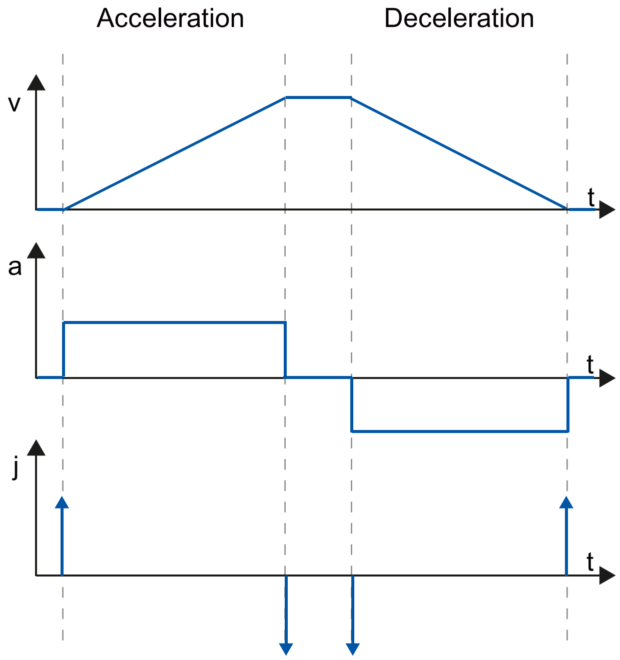
A velocity profile without jerk limit and a velocity profile with jerk limit are both supported for Motion Control of the axis.

The dynamic values for the motion are specified in the Motion Control job. Alternatively the dynamic default values 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 limit

The following figure shows velocity, acceleration and jerk:

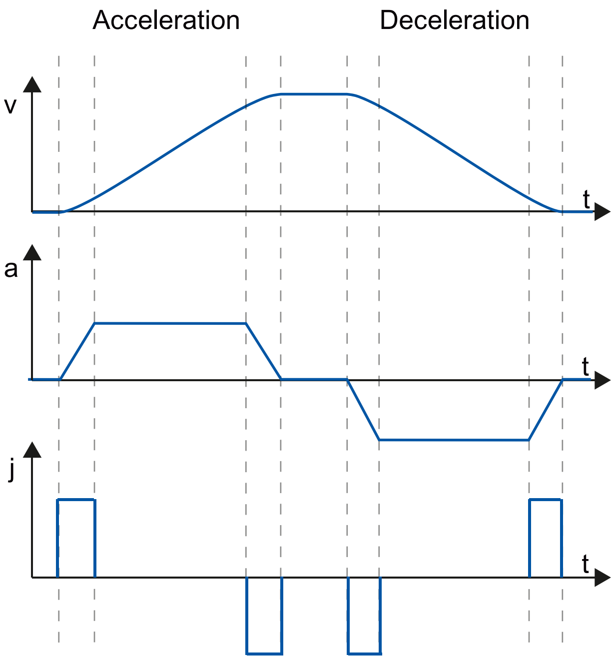


v - velocity
a - acceleration
j - jerk
t - time

A velocity without jerk limit is employed for motion with constant acceleration and deceleration.

Velocity profile with jerk limit

The following figure shows velocity, acceleration and jerk:



v - velocity
a - acceleration
j - jerk
t - time

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

3.14.3 Emergency stop deceleration

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

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

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

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

3.14.4 Tags

The following technology object tags are relevant for Motion Control:

Status	
<TO>.StatusWord	Status indicators for an active motion
<TO>.Position	Setpoint position
<TO>.Velocity	Setpoint velocity / setpoint speed
<TO>.ActualPosition	Actual position
<TO>.ActualVelocity	Actual velocity
<TO>.ActualSpeed	Actual speed of the motor (with analog setpoint = 0.0)
<TO>.Acceleration	Setpoint acceleration
<TO>.ActualAcceleration	Actual acceleration
Override	
<TO>.Override.Velocity	Velocity override
Dynamic limit values	
<TO>.DynamicLimits.MaxVelocity	Dynamic limit for maximum velocity
<TO>.DynamicLimits.MaxAcceleration	Dynamic limit for maximum acceleration
<TO>.DynamicLimits.MaxDeceleration	Dynamic limit for maximum deceleration
<TO>.DynamicLimits.MaxJerk	Dynamic limit for maximum jerk
Dynamic defaults	
<TO>.DynamicDefaults.Velocity	Default velocity
<TO>.DynamicDefaults.Acceleration	Default acceleration
<TO>.DynamicDefaults. Deceleration	Default deceleration
<TO>.DynamicDefaults.Jerk	Default jerk
<TO>.DynamicDefaults. EmergencyDeceleration	Emergency stop deceleration

3.15 Operational sequence

3.15.1 Organization Blocks for Motion Control

Description

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

The following blocks are created:

- MC-Servo [OB91]

  Calculation of the Position Controller

- MC-Interpolator [OB92]

  Controller-side evaluation of the Motion Control instructions, generation of setpoints and monitoring functionality

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

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

You can configure the cycle clock source and the priority of the organization blocks in accordance with your requirements for control performance and system load.

Cycle clock sources

An equidistant cycle is required for Motion Control functionality.

You can configure the cycle clock source in the properties of the MC-Servo [OB91] under "General > Cycle Time":

- Synchronous with the bus

  The Motion Control functionality is called synchronously with a bus system.
  You can configure the cycle time in the properties for the selected interface.
  You can select the following interfaces:

  – Isochronous PROFIBUS DP

  – Isochronous PROFINET IO

- Cyclical

  The Motion Control functionality is called cyclically with the specified cycle time.

The cycle time must be sufficiently large to allow all technology objects to be processed in one clock cycle. If the clock cycle cannot be observed, then CPU timeouts occur (see also Operational Sequence and Timeouts (Page 68)).

Priority

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

- **MC Servo [OB91]**

  Priority 17 to 31 (default value 25)
- **MC Interpolator [OB92]**

  Priority 16 to 30 (default value 24)

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

3.15.2 Process image partition "OB Servo PIP"

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

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

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

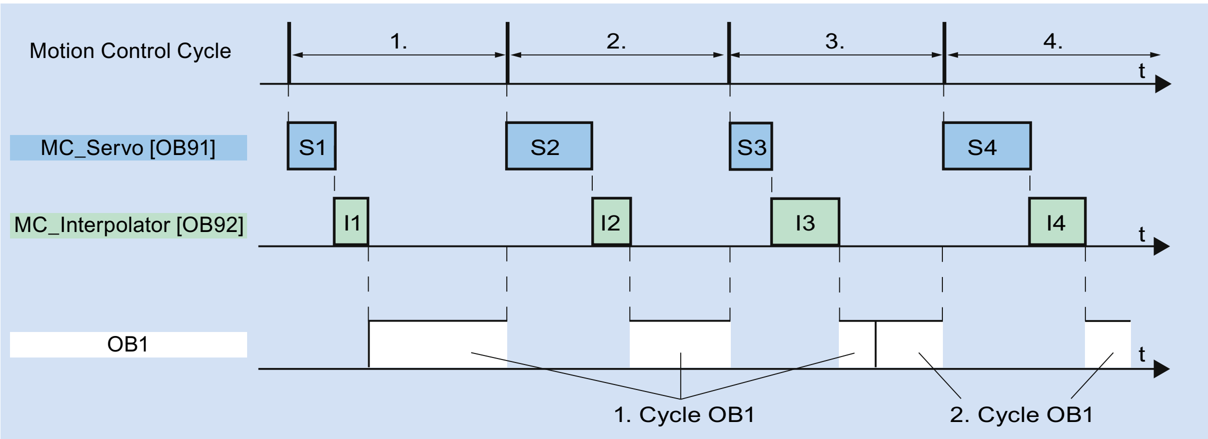
3.15.3 Operational Sequence and Timeouts

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

In each cycle (Motion Control Cycle):

- MC Servo [OB91] must be started and completely processed.
- the associated MC Interpolator [OB92] must at least be started.

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

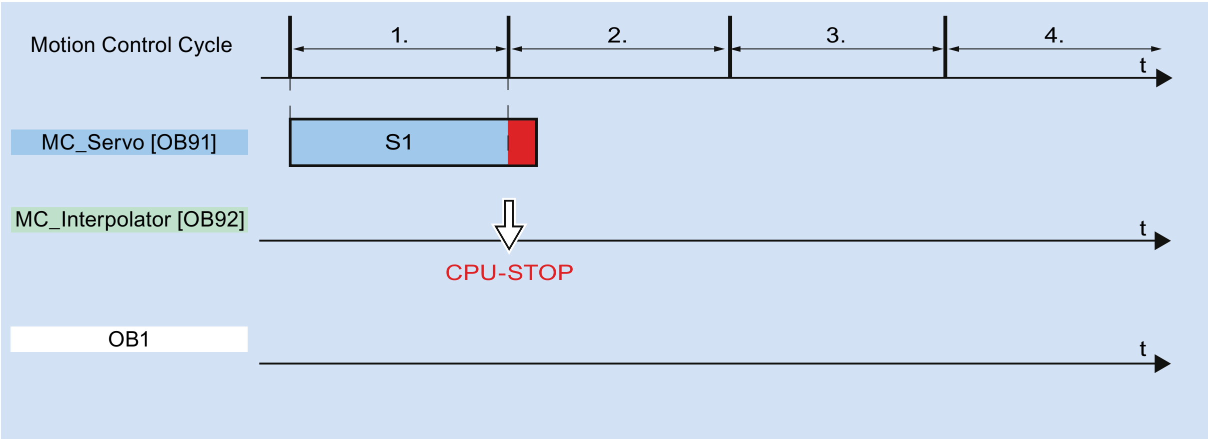


Timeouts

If the configured clock cycle for Motion Control functionality cannot be complied with, e.g. due to high CPU load or a cycle time that is too short, CPU timeouts can occur.

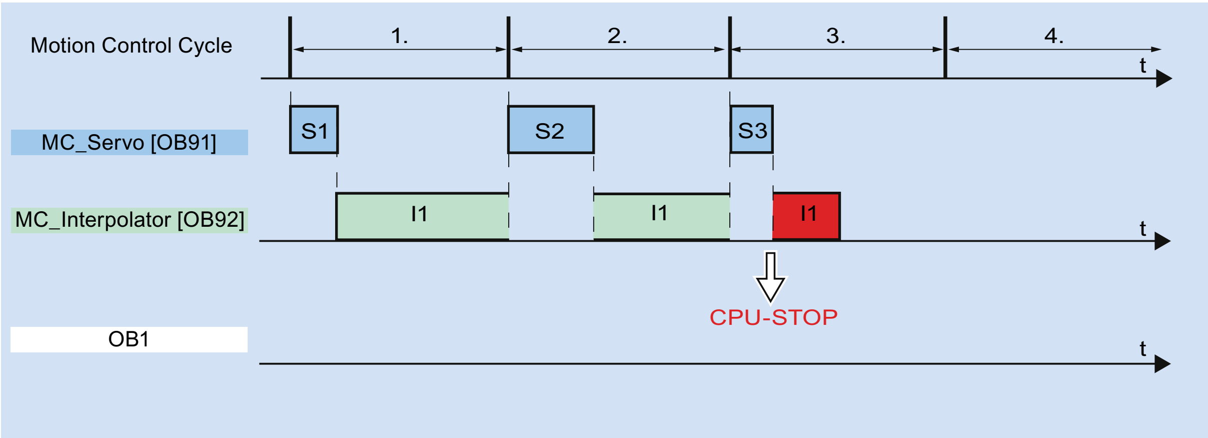
The MC Servo [OB91] does not tolerate any timeouts. A CPU timeout will cause the CPU to go into STOP mode.

The following figure shows the operational sequence for a timeout of the MC Servo [OB91]:



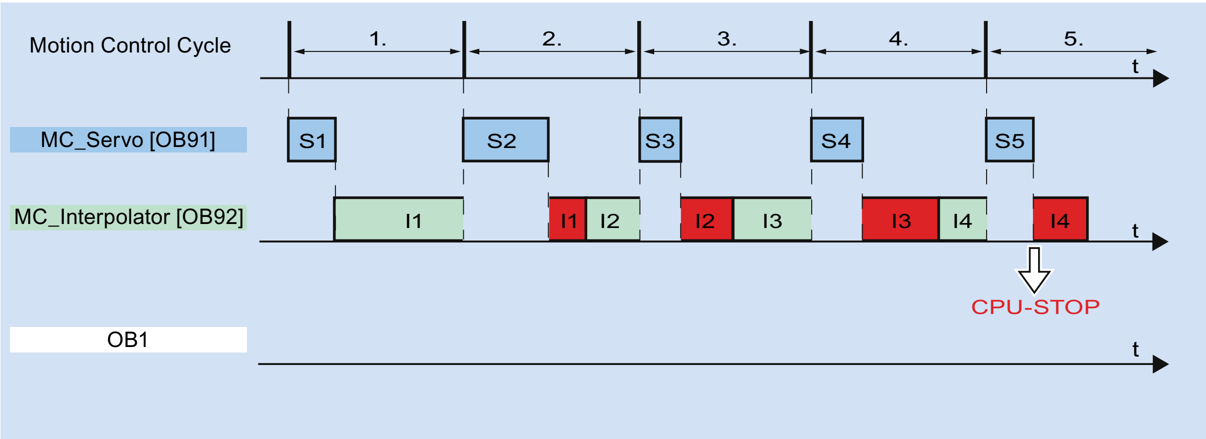
The processing of an MC Interpolator [OB92] can be interrupted by at most one call of the MC Servo [OB91]. If more interruptions occur, the CPU switches to STOP mode.

The following figure shows the operational sequence for an interruption of an MC Interpolator [OB92] over two time slices:



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

The following figure shows the operational sequence for four separate timeouts of the MC Interpolator [OB92] in a row:

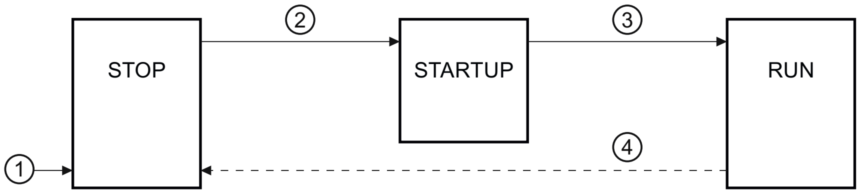


3.15.4 Operating modes

This section examines the behavior of Motion Control in each operating mode, and in the transitions between operating modes. A general description of the operating modes can be found in system manual S7-1500.

Operating modes and transitions

The CPU has three operating modes: STOP, STARTUP and RUN.
The following figure shows the operating modes and the operating mode transitions:



STOP mode

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

The technology data blocks are updated.

STARTUP mode

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

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

The technology data blocks are updated.

RUN mode

The user program is processed in RUN mode.

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

The technology data blocks are updated.

Operating mode transitions

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

No.	Operating mode transition	Behavior
①	POWER ON → STOP	The CPU performs a restart of the technology objects. The technology objects are reinitialized with the values from the load memory.
②	STOP → STARTUP	Not relevant to Motion Control.
③	STARTUP → RUN	The process outputs are enabled.
④	RUN → STOP	When the CPU changes to RUN mode after STOP mode, all technology objects are disabled in accordance with the alarm response "remove enablement". Running Motion Control jobs are terminated.

4 Guidelines

4.1 Guidelines on use of motion control

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

Requirements

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

Procedure

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

1. Add technology object (Page 83)
2. Working with the configuration editor (Page 84)
3. Programming (Page 139)
4. Downloading to CPU (Page 165)
5. Functional test in the Commissioning window (Page 167)
6. Diagnostics (Page 185)

Configuring 5

5.1 Adding and configuring drives in the device configuration

5.1.1 Add and configure PROFINET IO drives

Adding and configuring a PROFINET IO drive is described below using a SINAMICS S120 drive. Adding and configuring other PROFINET IO 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, then it must be installed in the "Extras" menu as a device description file (GSD).

Adding a drive and message frame in the device configuration

1. Open the device configuration and change to the network view.
2. In the hardware catalog, open the folder "Additional Field Devices > PROFINET IO > Drives > Siemens AG > SINAMICS".
3. Select the desired drive with the desired version, then drag it to the network view.
4. Assign the drive to the PROFINET interface of the PLC.
5. Open the drive in the device view.
6. Drag a Drive Object (DO) and a standard message frame from the hardware catalog to the slot of the device overview of the drive.

Depending on the version of the SINAMICS S120 drive, select "DO with standard telegram X", or "DO Servo" and a "Standard telegram X" for the message frame.

For more information on suitable message frames, refer to section Frames (Page 26).

Repeat step 6, if you want to add another drive and another standard message frame.

Enable isochronous operation of the drive in the device configuration

PROFINET drives can always be operated in isochronous mode or non-isochronous mode. Isochronous mode, however, increases the quality of the position control of the drive.

Proceed as follows if you want to control the drive in isochronous mode:

1. Open the device view in the drive.
2. In the properties dialog, select the tab "PROFINET Interface [X1] > Advanced options > Isochronous mode".
3. Select the "Isochronous mode" check box in this tab.

The entry for the message frame also has to be selected for isochronous mode in the detailed view.

Interconnecting the port of the PLC with the port of the drive

1. Open the topology view in the device configuration.
2. Interconnect the port of the PLC with the port of the drive.

Configuring the PLC as the sync master and setting isochronous mode

1. Select the device view of the PLC.
2. In the properties dialog, select the tab "PROFINET Interface [X1] > Advanced options > Realtime settings > Synchronization".
3. Select "Sync master" from the "Synchronization role" drop-down list.
4. Click the "Domain settings" button.
5. Open the "Domain Management > Sync Domains" tab and set the desired "Send clock" (isochronous clock).

Select drive in the configuration of the technology object

1. Add a new axis technology object, or open the configuration of an existing axis.
2. Open the configuration "Hardware interface > Drive".
3. Select "PROFIdrive" from the "Drive type" drop-down list.
4. Select the Drive Object of the PROFINET drive from the "Drive" list.

In section Add technology object (Page 83), you can learn how to add a technology object.

Result

The technology object is connected to the drive and the "MC Servo" organization block can be checked/configured.

The message frame 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 tree.
2. Select the "MC Servo" organization block.
3. Select the "Properties" command in the shortcut menu.
4. Select the "Cycle times" tab.
5. The "Synchronize to bus" item must be selected in the "Data exchange" drop-down list.
6. The "Profinet IO_System" item must be selected in the "Assigned IO" drop-down list.
7. The cycle time of "MC Servo" must match the cycle time of the bus.

Result

The PROFINET IO drive is now configured so that it can be controlled in the PROFINET IO network in isochronous mode.

The properties of the SINAMICS drive must be configured according to the configuration of the axis with a separate STARTER program.

Checking isochronous mode on the drive

If the configuration sequence described above is not adhered to during configuration of the axis, and drive-specific error occurs when the project is compiled, the setting for isochronous mode on the drive must be checked.

1. Open the device view in the drive.
2. Select standard message item 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 select the "Organization block".
   - "PIP OB Servo" must be select the "Process image".

See also

Frames (Page 26)

Add technology object (Page 83)

5.1.2 Add and configure PROFIBUS DP drives

Adding and configuring a PROFIBUS IO drive is described below using a SINAMICS S120. 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.
- You have a basic knowledge of how to configure PROFIBUS DP networks.
- The desired drive can be selected in the hardware catalog.

If the drive is not available in the Hardware Catalog, then it must be installed in the "Extras" menu as a device description file (GSD).

Adding a drive and message frame in the device configuration

1. Open the device configuration and change to the network view.
2. In the hardware catalog, open the folder
   "Additional Field Devices > PROFIBUS DP > Drives > Siemens AG > SINAMICS".
3. Select the folder of the desired drive with the desired version, then drag the drive object to the network view.
4. Assign the drive to the PROFIBUS interface of the PLC.
5. Open the drive in the device view.
6. Drag a standard message frame from the hardware catalog to the slot of the device overview of the drive.

For more information on suitable message frames, refer to section Frames (Page 26).

Use the "Axis disconnector" in the hardware catalog if you want to add another drive and another standard message frame in the device overview.

Enable isochronous operation of the drive in the device configuration

PROFIBUS drives can always be operated in cyclic mode or isochronous mode. Isochronous mode, however, increases the quality of the position control of the drive.

Proceed as follows if you want to control the drive in isochronous mode:

1. Open the device view in 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 axis technology object, or open the configuration of an existing axis.
2. Open the configuration "Hardware interface > Drive".
3. Select "PROFIdrive" from the "Drive type" drop-down list.
4. Select the standard message frame of the PROFIBUS drive from the "Drive" list.

You can learn how to add a technology object in section Add technology object (Page 83).

Result

The technology object is connected to the drive and the "MC Servo" organization block can be checked/configured.

The message frame 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 tree.
2. Select the "MC Servo" organization block.
3. Select the "Properties" command in the shortcut menu.
4. Select the "Cycle times" tab.
5. The "Synchronize to bus" item must be selected in the "Data exchange" drop-down list.
6. The "DP master system" entry must be selected in the "Assigned IO" drop-down list.
7. The cycle time of "MC Servo" must match the cycle time of the bus.

Result

The PROFIBUS DP drive is now configured so that it can be controlled in the PROFIBUS network in isochronous mode.

The properties of the SINAMICS drive must be configured according to the configuration of the axis with a separate STARTER program.

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 in the drive.
2. Select standard message item 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 select the "Organization block".
   - "PIP OB Servo" must be select the "Process image".

See also

Add technology object (Page 83)

Frames (Page 26)

5.1.3 Adding and configuring drives with analog connections

The following describes how to add and configure a drive with an analog drive connection. A technology module in the rack of the PLC is used as an example of the connection of an incremental encoder.

Requirements

The SIMATIC S7-1500 device is created in the project.

Adding and configuring an analog output module in the device configuration

1. Open the device configuration of the PLC.
2. Select an analog output module from the hardware catalog and drag the module to the rack of the PLC.
3. Select the analog output module in the device view.
4. Open the "General" tab in the properties dialog and select there "Name of the Analog Output Module > I/O Addresses".
5. Enter the desired start address.
6. In the properties dialog, select the tab "General > IO tags".
7. Enter the tag name for the desired analog output.

Adding and configuring a technology module

1. Switch to the device view of the PLC.
2. In the hardware catalog, open the folder "TM > Count > TM Count 2X24V".
3. Drag the counter module to a free slot in the rack.
4. Select the technology module in the device view.
5. In the properties dialog, open the "General" tab and select there "Count 2x24V > Basic Parameters > Channel X > Operating Mode" of the channel to be used.
6. Select "Position detection for motion control" option for "Selection of the operating mode for the channel".
7. Under "Module parameters", adapt the parameters of the incremental encoder (steps per revolution = increments per revolution).
8. Under "Reaction to CPU STOP", select the item "Continue working".

Selecting the drive and encoder in the configuration of the technology object

1. Add a new "Position axis" technology object, or open the configuration of an existing position axis.
2. Open the configuration "Hardware interface > Drive".
3. Select "Analog drive connection" from the "Drive type" drop-down list.
4. Select the previously defined tag name of the analog output from the "Output" list.
5. Open the configuration "Hardware interface > Encoder".
6. Under "Select encoder coupling" select "Encoder on technology module (TM)".
7. Select the channel of the incremental encoder from the "Technology module" list under "local modules".

You can learn how to add a technology object in section Add technology object (Page 83).

Result

The analog drive connection and the encoder connection are configured.

The analog addresses and the addresses of the TM module are assigned to the process image "PIP OB Servo".

Checking the encoder connection / drive connection

The encoder data are applied to the position control cycle clock.
If in doubt, check the following settings:

1. Switch to the device view of the PLC.
2. Select the module technology.
3. Open the properties dialog "Basic Parameters > I/O Addresses".
4. The following settings apply for the input and output addresses:
   – "MC Servo" must be select the "Organization block".
   – "PIP OB Servo" must be select the "Process image".
5. Select the analog module.
6. Open the properties dialog "Name of the Analog Module > I/O Addresses".
7. The settings from Step 4 apply for the input and output addresses

See also

Add technology object (Page 83)

5.2 Add technology object

To add a technology object in the project navigator, proceed as follows:

Requirements

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

Procedure

1. Open the CPU's folder in the project navigator.
2. Open the "Technology Objects" folder.
3. Double-click "Add new object".

   The "Add new object" dialog box opens.
4. Select the "Motion Control" technology.
5. Open the folder "Motion Control" > "SIMATIC S7-1500".
6. If you want to add an axis from an older version, then click on the Version entry and select an alternative version of the technology.
7. Select the "TO_SpeedAxis" object for a speed-controlled axis, "TO_PositioningAxis" for a positioning axis, or "TO_ExternalEncoder" for an external encoder.
8. In the "Name" field, adapt the name of the axis to your requirements.
9. Select the "Manual" option if you want to change the suggested data block number.
10. Click on "Further Information" if you want to add your own information to the technology object.
11. Click on the "OK" button if you want to add the technology object.

    Click on the "Cancel" button if you want to discard the entries.

    Activate the "Add new and open" check box if you want to open the configuration after adding the technology object.

Result

The new technology object was created and saved in the project navigator in the folder "Technology objects".

If the organization blocks "MC Servo" and "MC Interpolator" had not yet been added, they have now been added.

5.3 Working with the configuration editor

You configure the properties of a technology object in the configuration window.
To open the configuration window of the technology object in the project view, follow these steps:

1. Open the device "Technology objects" group in the project navigator.
2. Select the technology object and double-click on "Configuration".

The configuration is divided into categories which depend on the object type, for example: Basic parameters, hardware interface, extended parameters.

Configuration editor icons

Icons in the area navigation of the configuration show additional details about the status of the configuration:

	**The configuration contains default values and is complete.** The configuration contains only default values. With these default values you can use the technology object without additional changes.
	**The configuration contains values set by the user and is complete.** All input fields of the configuration contain valid values and at least one preset value has changed.
	**The configuration is incomplete or incorrect** At least one input field or drop-down list contains an invalid value. The corresponding field or the drop-down list is displayed on a red background. Click the field shows you the roll-out error message that indicates the cause of error.

5.4 Configuring the Positioning Axis technology object

5.4.1 Configuration - Basic Parameters

Axis name

Define the name of the positioning axis in this field. The technology object is listed in the project navigation under this name. The tags of the positioning axis can be used in the user program under this name.

Axis type

In this selection, configure whether the axis should perform linear or rotary motions.

User unit

In the drop-down list, select the desired measurement system for the position and velocity of the axis.

Modulo

Select the check box "Enable modulo", if you want to employ a recurring unit of measure for the axis (e.g. 0-360° for an axis of the "rotary" axis type).

- Start value

  In this field, define the position at which the modulo range should begin (e.g. 360° for an axis of the "rotary" axis type).

- Length

  In this field, define the length of the modulo range (e.g. 360° for an axis of the "rotary" axis type).

5.4.2 Hardware interface

5.4.2.1 Configuration - Drive

In the "Drive" configuration window, configure which drive type and which drive you want to use.

Drive type

In the drop-down list, select whether you want to deploy a PROFIdrive drive or a drive with an analog drive connection.

PROFIdrive drives are connected to the controller by means of a digital communication system (PROFINET or PROFIBUS). The communication occurs via PROFIdrive frames.

Drives with an analog drive connection receive the setpoint speed via an analog output signal (e.g. from -10 V to +10 V) from the PLC.

Drive (drive type: PROFIdrive)

In the "Drive" field, select an already configured PROFIdrive drive / slot. If a PROFIdrive drive was selected, then it can be configured using the "Device configuration" button.

Switch to the device configuration, and add a PROFIdrive drive in the network view, in the event that no PROFIdrive drive can be selected.

Drive (drive type: Analog drive connection)

In the "Output" field, select the PLC tag of the analog output over which the drive is to be controlled. If an output was selected, then it can be configured using the "Device configuration" button.

In order to be able to select an output, an analog output module must have been added in the device configuration, and the PLC tag name for the analog output must be defined.

Activate enable output (drive type: Analog drive connection)

In the "Enable output" field, select the PLC tag of the digital output for the enablement of the drive. With the enable output, the speed controller in the drive is enabled, or disabled.

In order to be able to select an enable output, a digital output module must have been added in the device configuration, and the PLC tag name for the digital output must be defined.

Note

If you do not use an enable output, the drive cannot be immediately disabled on the part of the system due to error responses or monitoring functions. A controlled stop of the drive is not guaranteed.

Enable ready input (drive type: Analog drive connection)

In the "Ready input" field, select the PLC tag of the digital input with which the drive is to report its operational readiness to the technology object. The power unit is switched on and the analog setpoint speed input is enabled.

In order to be able to select a ready input, a digital input module must have been added in the device configuration, and the PLC tag name for the digital input must be defined.

Note

The enable output and the ready input can be separately enabled.

The following conditions apply to the enabled ready input:

- The axis is not enabled (MC_Power Status=TRUE), until a signal is pending at the ready input.
- If the signal at the ready input goes away for an enabled axis, then the axis is disabled with an error.
- If the axis is disabled with the instruction MC_Power (Enable= FALSE), then the axis is disabled even with a pending signal at the ready input.

5.4.2.2 Configuration - Encoder

For position control, positioning axes require an actual position value in the form of an encoder position. The encoder position is transmitted to the controller by means of a PROFIdrive message frame. In the "Encoder" configuration window, configure the encoder coupling with which the encoder is to be connected.

Select encoder coupling:

In this area, select according to the graphical representation, how the encoder is to be connected.

- Connection to drive (not with analog drive connection)

  Select this option, if the encoder is connected to the drive. The configuration of the encoder occurs via the configuration of the PROFIdrive drive. The drive evaluates the encoder signals, and sends them in the PROFIdrive message frame to the controller.

- Connection via technology module (TM)

  Select this option, if the encoder is connected to a technology module (TM).

  – Technology module:

    In the "Technology module" field, select a technology module that has already been configured, and the channel to be used. If a technology module was selected, then it can be configured using the "Device configuration" button.

    Switch to the device configuration, and add a technology module, in the event that no technology module can be selected. The technology module can be driven centrally on a S7-1500 PLC, or decentrally on a distributed I/O. To connect an incremental encoder use the technology module Count2x24V, and to connect an absolute value encoder use the technology module TM PosInput2.

- Connection via PROFINET/PROFIBUS (PROFIdrive)

  Select this option, if you are deploying a PROFIdrive compatible encoder.

  – Encoder selection:

    In the "Encoder selection" field, select an already configured encoder on PROFINET/PROFIBUS. If an encoder was selected, then it can be configured using the "Device configuration" button.

    Switch to the device configuration in the network view, and add an encoder, in the event that no encoder can be selected.

5.4.2.3 Configuration - Data exchange

Configuration - Data exchange

In the "Data exchange" configuration window, you can configure the data exchange of the drive and the encoder. The configuration varies according to the drive type and encoder coupling:

Analog driver connection - Encoder to technology module (TM) (Page 89)

Analog driver connection - PROFIdrive encoder on PROFINET/PROFIBUS (Page 92)

PROFIdrive Drive - Encoder to Drive (Page 94)

PROFIdrive drive - Encoder on the technology module (TM) (Page 96)

PROFIdrive drive - PROFIdrive encoder on PROFINET/PROFIBUS (Page 98)

Analog driver connection - Encoder to technology module (TM)

Data exchange drive

In this area, you can configure the data exchange for the drive.

- Message frame:

  Since the analog drive is controlled via an analog signal, the selection of the message frame type is omitted.

- Reference speed:

  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. As an example, with an analog output with +/- 10 V, the value 10 V is output at 100%.

  Analog outputs can be overloaded by about 17%. This means that an analog output can be operated in the range from -117% to 117%, insofar as the drive permits this.

- Maximum speed

  In this field, specify the maximum speed of the drive.

- Inverting the direction

  Enable the check box if the rotation direction of the drive should be inverted.

Data exchange encoder

In this area, you can configure how the encoder data are to be evaluated.
The data must match the data in the device configuration.

- Message frame:

  The encoder data are transmitted with the drive message frame.
  Therefore no message frame selection is available.

- Encoder type:

  Depending on the encoder type, configure the following parameters:

Encoder type	Rotary incremental
Steps per revolution:	In this field, configure the number of steps that the encoder resolves per revolution.
Bits for fine resolution in the incremental actual value (Gn_XIST1)	In this field, configure the number of bits for fine resolution within the incremental actual value (Gn_XIST1).

Encoder type	Rotary absolute
Steps per revolution:	In this field, configure the number of steps that the encoder resolves per revolution.
Number of revolutions:	In this field, configure the number of revolutions that the absolute value encoder can detect.
Bits for fine resolution in the incremental actual value (Gn_XIST1)	In this field, configure the number of reserved bits for fine resolution within the incremental actual value (Gn_XIST1).
Bits for the multiplication factor of the absolute value of the fine resolution (Gn_XIST2)	In this field, configure the number of reserved bits for the multiplication factor of the absolute value of the fine resolution (Gn_XIST2).

Encoder type	Rotary cyclic absolute
Steps per revolution:	In this field, configure the number of steps that the encoder resolves per revolution.
Number of revolutions:	In this field, configure the number of revolutions that the absolute value encoder can detect.
Bits for fine resolution in the incremental actual value (Gn_XIST1)	In this field, configure the number of bits for fine resolution within the incremental actual value (Gn_XIST1).
Bits for the multiplication factor of the absolute value of the fine resolution (Gn_XIST2)	In this field, configure the number of reserved bits for the multiplication factor of the absolute value of the fine resolution (Gn_XIST2).

Encoder type	Linear incremental
Distance between two increments:	In this field, you can configure the distance between two steps of the encoder.
Bits for fine resolution in the incremental actual value (Gn_XIST1)	In this field, configure the number of bits for fine resolution within the incremental actual value (Gn_XIST1).

Encoder type	Linear absolute
Distance between two increments:	In this field, you can configure the distance between two steps of the encoder.
Bits for fine resolution in the incremental actual value (Gn_XIST1)	In this field, configure the number of bits for fine resolution within the incremental actual value (Gn_XIST1).
Bits for the multiplication factor of the absolute value of the fine resolution (Gn_XIST2)	In this field, configure the number of reserved bits for the multiplication factor of the absolute value of the fine resolution (Gn_XIST2).

Inverting the direction

Select this check box if you would like to invert the actual value of the encoder.

Analog driver connection - PROFIdrive encoder on PROFINET/PROFIBUS

Data exchange drive

In this area, you can configure the data exchange for the drive.

- Message frame:

  Since the analog drive is controlled via an analog signal, the selection of the message frame type is omitted.

- Reference speed:

  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. As an example, with an analog output with +/- 10 V, the value 10 V is output at 100%.

  Analog outputs can be overloaded by about 17%. This means that an analog output can be operated in the range from -117% to 117%, insofar as the drive permits this.

- Maximum speed

  In this field, specify the maximum speed of the drive.

- Inverting the direction

  Enable the check box if the rotation direction of the drive should be inverted.

Data exchange encoder

In this area, you can configure the encoder message frame and the criteria for how the encoder data are to be evaluated. The data must match the data in the device configuration.

- Message frame:

  In the drop-down list, select the message frame of the encoder.
  The data must match the configuration in the device configuration.

- Encoder type:

  Depending on the encoder type, configure the following parameters:

Encoder type	Rotary incremental
Steps per revolution:	In this field, configure the number of steps that the encoder resolves per revolution.
Bits for fine resolution in the incremental actual value (Gn_XIST1)	In this field, configure the number of bits for fine resolution within the incremental actual value (Gn_XIST1).

Encoder type	Rotary absolute
Steps per revolution:	In this field, configure the number of steps that the encoder resolves per revolution.
Number of revolutions:	In this field, configure the number of revolutions that the absolute value encoder can detect.
Bits for fine resolution in the incremental actual value (Gn_XIST1)	In this field, configure the number of reserved bits for fine resolution within the incremental actual value (Gn_XIST1).
Bits for fine resolution in the absolute actual value (Gn_XIST2)	In this field, configure the number of reserved bits for the multiplication factor of the absolute value of the fine resolution (Gn_XIST2).

Encoder type	Rotary cyclic absolute
Steps per revolution:	In this field, configure the number of steps that the encoder resolves per revolution.
Number of revolutions:	In this field, configure the number of revolutions that the absolute value encoder can detect.
Bits for fine resolution in the incremental actual value (Gn_XIST1)	In this field, configure the number of bits for fine resolution within the incremental actual value (Gn_XIST1).
Bits for fine resolution in the absolute actual value (Gn_XIST2)	In this field, configure the number of bits for fine resolution within the absolute actual value (Gn_XIST2).

Encoder type	Linear incremental
Distance between two increments:	In this field, you can configure the distance between two steps of the encoder.
Bits for fine resolution in the incremental actual value (Gn_XIST1)	In this field, configure the number of bits for fine resolution within the incremental actual value (Gn_XIST1).

Encoder type	Linear absolute
Distance between two increments:	In this field, you can configure the distance between two steps of the encoder.
Bits for fine resolution in the incremental actual value (Gn_XIST1)	In this field, configure the number of bits for fine resolution within the incremental actual value (Gn_XIST1).
Bits for fine resolution in the absolute actual value (Gn_XIST2)	In this field, configure the number of bits for fine resolution within the absolute actual value (Gn_XIST2).

Inverting the direction

Select this check box if you would like to invert the actual value of the encoder.

PROFIdrive Drive - Encoder to Drive

Data exchange drive

In this area, you can configure the data exchange for the drive.

- Message frame:

  In the drop-down list, select the message frame to the drive.
  The data must match the configuration in the device configuration.

- Reference speed:

  In this field, configure the reference speed of the drive in accordance with the manufacturer's specifications. The specification of the drive's speed occurs as a percentage of the reference speed in the range from -200% to 200%.

- Maximum speed

  In this field, specify the maximum speed of the drive.

- Inverting the direction

  Enable the check box if the rotation direction of the drive should be inverted.

Data exchange encoder

In this area, you can configure how the encoder data are to be evaluated.
The data must match the data in the device configuration.

- Message frame:

  The encoder data are transmitted with the drive message frame.
  Therefore no message frame selection is available.

- Encoder type:

  Depending on the encoder type, configure the following parameters:

Encoder type	Rotary incremental
Steps per revolution:	In this field, configure the number of steps that the encoder resolves per revolution.
Bits for fine resolution in the incremental actual value (Gn_XIST1)	In this field, configure the number of bits for fine resolution within the incremental actual value (Gn_XIST1).

Encoder type	Rotary absolute
Steps per revolution:	In this field, configure the number of steps that the encoder resolves per revolution.
Number of revolutions:	In this field, configure the number of revolutions that the absolute value encoder can detect.

Encoder type	Rotary absolute
Bits for fine resolution in the incremental actual value (Gn_XIST1)	In this field, configure the number of reserved bits for fine resolution within the incremental actual value (Gn_XIST1).
Bits for the multiplication factor of the absolute value of the fine resolution (Gn_XIST2)	In this field, configure the number of reserved bits for the multiplication factor of the absolute value of the fine resolution (Gn_XIST2).

Encoder type	Rotary cyclic absolute
Steps per revolution:	In this field, configure the number of steps that the encoder resolves per revolution.
Number of revolutions:	In this field, configure the number of revolutions that the absolute value encoder can detect.
Bits for fine resolution in the incremental actual value (Gn_XIST1)	In this field, configure the number of bits for fine resolution within the incremental actual value (Gn_XIST1).
Bits for the multiplication factor of the absolute value of the fine resolution (Gn_XIST2)	In this field, configure the number of reserved bits for the multiplication factor of the absolute value of the fine resolution (Gn_XIST2).

Encoder type	Linear incremental
Distance between two increments:	In this field, you can configure the distance between two steps of the encoder.
Bits for fine resolution in the incremental actual value (Gn_XIST1)	In this field, configure the number of bits for fine resolution within the incremental actual value (Gn_XIST1).

Encoder type	Linear absolute
Distance between two increments:	In this field, you can configure the distance between two steps of the encoder.
Bits for fine resolution in the incremental actual value (Gn_XIST1)	In this field, configure the number of bits for fine resolution within the incremental actual value (Gn_XIST1).
Bits for the multiplication factor of the absolute value of the fine resolution (Gn_XIST2)	In this field, configure the number of reserved bits for the multiplication factor of the absolute value of the fine resolution (Gn_XIST2).

Inverting the direction

Select this check box if you would like to invert the actual value of the encoder.

PROFIdrive drive - Encoder on the technology module (TM)

Data exchange drive

In this area, you can configure the data exchange for the drive.

- Message frame:

  In the drop-down list, select the message frame to the drive.
  The data must match the configuration in the device configuration.

- Reference speed:

  In this field, configure the reference speed of the drive in accordance with the manufacturer's specifications. The specification of the drive's speed occurs as a percentage of the reference speed in the range from -200% to 200%.

- Maximum speed

  In this field, specify the maximum speed of the drive.

- Inverting the direction

  Enable the check box if the rotation direction of the drive should be inverted.

Data exchange encoder

In this area, you can configure how the encoder data are to be evaluated.
The data must match the data in the device configuration.

- Message frame:

  The encoder data are transmitted with the drive message frame.
  Therefore no message frame selection is available.

- Encoder type:

  Depending on the encoder type, configure the following parameters:

Encoder type	Rotary incremental
Steps per revolution:	In this field, configure the number of steps that the encoder resolves per revolution.
Bits for fine resolution in the incremental actual value (Gn_XIST1)	In this field, configure the number of bits for fine resolution within the incremental actual value (Gn_XIST1).

Encoder type	Rotary absolute
Steps per revolution:	In this field, configure the number of steps that the encoder resolves per revolution.
Number of revolutions:	In this field, configure the number of revolutions that the absolute value encoder can detect.

Encoder type	Rotary absolute
Bits for fine resolution in the incremental actual value (Gn_XIST1)	In this field, configure the number of reserved bits for fine resolution within the incremental actual value (Gn_XIST1).
Bits for the multiplication factor of the absolute value of the fine resolution (Gn_XIST2)	In this field, configure the number of reserved bits for the multiplication factor of the absolute value of the fine resolution (Gn_XIST2).

Encoder type	Rotary cyclic absolute
Steps per revolution:	In this field, configure the number of steps that the encoder resolves per revolution.
Number of revolutions:	In this field, configure the number of revolutions that the absolute value encoder can detect.
Bits for fine resolution in the incremental actual value (Gn_XIST1)	In this field, configure the number of bits for fine resolution within the incremental actual value (Gn_XIST1).
Bits for the multiplication factor of the absolute value of the fine resolution (Gn_XIST2)	In this field, configure the number of reserved bits for the multiplication factor of the absolute value of the fine resolution (Gn_XIST2).

Encoder type	Linear incremental
Distance between two increments:	In this field, you can configure the distance between two steps of the encoder.
Bits for fine resolution in the incremental actual value (Gn_XIST1)	In this field, configure the number of bits for fine resolution within the incremental actual value (Gn_XIST1).

Encoder type	Linear absolute
Distance between two increments:	In this field, you can configure the distance between two steps of the encoder.
Bits for fine resolution in the incremental actual value (Gn_XIST1)	In this field, configure the number of bits for fine resolution within the incremental actual value (Gn_XIST1).
Bits for the multiplication factor of the absolute value of the fine resolution (Gn_XIST2)	In this field, configure the number of reserved bits for the multiplication factor of the absolute value of the fine resolution (Gn_XIST2).

Inverting the direction

Select this check box if you would like to invert the actual value of the encoder.

PROFIdrive drive - PROFIdrive encoder on PROFINET/PROFIBUS

Data exchange drive

In this area, you can configure the data exchange for the drive.

- Message frame:

  In the drop-down list, select the message frame to the drive.
  The data must match the configuration in the device configuration.

- Reference speed:

  In this field, configure the reference speed of the drive in accordance with the manufacturer's specifications. The specification of the drive's speed occurs as a percentage of the reference speed in the range from -200% to 200%.

- Maximum speed

  In this field, specify the maximum speed of the drive.

- Inverting the direction

  Enable the check box if the rotation direction of the drive should be inverted.

Data exchange encoder

In this area, you can configure the encoder message frame and the criteria for how the encoder data are to be evaluated. The data must match the data in the device configuration.

- Message frame:

  In the drop-down list, select the message frame of the encoder.
  The data must match the configuration in the device configuration.

- Encoder type:

  Depending on the encoder type, configure the following parameters:

Encoder type	Rotary incremental
Steps per revolution:	In this field, configure the number of steps that the encoder resolves per revolution.
Bits for fine resolution in the incremental actual value (Gn_XIST1)	In this field, configure the number of bits for fine resolution within the incremental actual value (Gn_XIST1).

Encoder type	Rotary absolute
Steps per revolution:	In this field, configure the number of steps that the encoder resolves per revolution.
Number of revolutions:	In this field, configure the number of revolutions that the absolute value encoder can detect.

Encoder type	Rotary absolute
Bits for fine resolution in the incremental actual value (Gn_XIST1)	In this field, configure the number of reserved bits for fine resolution within the incremental actual value (Gn_XIST1).
Bits for fine resolution in the absolute actual value (GN_XIST2)	In this field, configure the number of reserved bits for fine resolution within the absolute actual value (Gn_XIST2).

Encoder type	Rotary cyclic absolute
Steps per revolution:	In this field, configure the number of steps that the encoder resolves per revolution.
Number of revolutions:	In this field, configure the number of revolutions that the absolute value encoder can detect.
Bits for fine resolution in the incremental actual value (Gn_XIST1)	In this field, configure the number of bits for fine resolution within the incremental actual value (Gn_XIST1).
Bits for fine resolution in the absolute actual value (GN_XIST2)	In this field, configure the number of reserved bits for fine resolution within the absolute actual value (Gn_XIST2).

Encoder type	Linear incremental
Distance between two increments:	In this field, you can configure the distance between two steps of the encoder.
Bits for fine resolution in the incremental actual value (Gn_XIST1)	In this field, configure the number of bits for fine resolution within the incremental actual value (Gn_XIST1).

Encoder type	Linear absolute
Distance between two increments:	In this field, you can configure the distance between two steps of the encoder.
Bits for fine resolution in the incremental actual value (Gn_XIST1)	In this field, configure the number of bits for fine resolution within the incremental actual value (Gn_XIST1).
Bits for fine resolution in the absolute actual value (GN_XIST2)	In this field, configure the number of reserved bits for fine resolution within the absolute actual value (Gn_XIST2).

Inverting the direction

Select this check box if you would like to invert the actual value of the encoder.

5.4.3 Extended Parameters

5.4.3.1 Configuration - Mechanics

Configuration - Mechanics

In the "Mechanics" configuration window, you can configure the mounting type of the encoder, and the adaptation of the encoder value to the mechanical conditions.

Type of encoder mounting

In the drop-down list, select how the encoder is mounted on the mechanism.
The configuration varies depending on the axis type and the type of encoder mounting.

Axis type: Linear

Linear - On the motor shaft (Page 100)

Linear - On the motor side (Page 101)

Linear - External Measuring System (Page 101)

Axis type: Rotary

Rotary - On the motor shaft (Page 102)

Rotary - On the load side (Page 102)

Rotary - External Measuring System (Page 103)

Linear - On the motor shaft

The encoder is firmly mechanically connected with the motor shaft.
Motor and encoder form a unit.

Load gear

- **Consider load gear / leadscrew pitch**

  Activate the check box, if you want to perform the configuration based on the gear ratio and the leadscrew pitch.

  Deactivate the check box, if you want to perform the configuration based on the motor revolution and the resulting distance.

- **Number of motor revolutions / number of load revolutions**

  The gear ratio of the load gear is specified as the ratio between motor revolutions and load revolutions. Specify here an integral number of motor revolutions and the resulting number of load revolutions.

Position parameter

- **Leadscrew pitch ("Consider load gear / leadscrew pitch" enabled)**

  In this field, configure the distance by which the load is moved when the leadscrew makes one revolution.

- **Load motion per motor revolution**

  In this field, configure the load distance for one motor revolution ("Consider load gear / leadscrew pitch" disabled):

Linear - On the motor side

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

Load gear

- **Number of motor revolutions / number of load revolutions**

  The gear ratio of the load gear is specified as the ratio between motor revolutions and load revolutions. Specify here an integral number of motor revolutions and the resulting number of load revolutions.

  Select the same values for the number of motor revolutions and load revolutions, if no load gear is present.

Position parameter

- **Leadscrew pitch**

  In this field, configure the distance by which the load is moved when the leadscrew makes one revolution.

Linear - External Measuring System

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

Load gear

- **Number of motor revolutions / number of load revolutions**

  The gear ratio of the load gear is specified as the ratio between motor revolutions and load revolutions. Specify here an integral number of motor revolutions and the resulting number of load revolutions.

  Select the same values for the number of motor revolutions and load revolutions, if no load gear is present.

Position parameter

- **Load motion per motor revolution**

  In this field, configure the distance by which the load is moved when the motor makes one revolution.

- **Distance per encoder revolution**

  In this field, configure the distance recorded by the external measuring system per encoder revolution.

Rotary - On the motor shaft

The encoder is firmly mechanically connected with the motor shaft.
Motor and encoder form a unit.

Load gear

- **Number of motor revolutions / number of load revolutions**

  The gear ratio of the load gear is specified as the ratio between motor revolutions and load revolutions. Specify here an integral number of motor revolutions and the resulting number of load revolutions.

  Select the same values for the number of motor revolutions and load revolutions, if no load gear is present.

Rotary - On the load side

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

Load gear

- **Number of motor revolutions / number of load revolutions**

  The gear ratio of the load gear is specified as the ratio between motor revolutions and load revolutions. Specify here an integral number of motor revolutions and the resulting number of load revolutions.

  Select the same values for the number of motor revolutions and load revolutions, if no load gear is present.

Rotary - External Measuring System

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

Load gear

- **Number of motor revolutions / number of load revolutions**

  The gear ratio of the load gear is specified as the ratio between motor revolutions and load revolutions. Specify here an integral number of motor revolutions and the resulting number of load revolutions.

  Select the same values for the number of motor revolutions and load revolutions, if no load gear is present.

Position parameter

- **External measuring system**

  In this field, configure the value indicated by the external measuring system per load revolution.

5.4.3.2 Configuration - Position monitoring

Configure the hardware and software limit switches of the axis in the "Position monitoring" configuration window.

Enable hardware limit switches

The check box activates the function of the negative and positive hardware limit switches. The negative hardware limit switch is located on the side in the negative direction of travel, and the positive hardware limit switch on the side in the positive direction of travel.

With enabled hardware limit switches, the drive is disabled when the hardware limit switch is approached or overshot. The drive brakes with the braking ramp configured in the drive.

Exception: If a hardware limit switch is overshot during an active home position approach with activated direction reversal at the hardware limit switch, then the axis stops with the configured maximum deceleration, and continues the home position approach in the opposite direction.

Note

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

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

Negative / positive HW limit switch input

In these fields, select the PLC tags of the digital input for the negative and positive HW limit switches.

In order to be able to select an input, a digital input module must have been added in the device configuration, and the PLC tag name for the digital input must be defined.

> **CAUTION**
>
> **During installation of hardware limit switches, attention must be paid to the filter times of the digital inputs**
>
> Based on the time for a servo clock cycle 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.

Signal level selection

Select the triggering signal level ("Lower level" / "Upper level") of the hardware limit switch. At "Lower level", the input signal is FALSE after the axis has reached or passed the hardware limit switch. At "Upper level", the input signal is TRUE after the axis has reached or passed the hardware limit switch.

Enable software limit switches

This check box activates the upper and lower software limit switches. An active motion is stopped after the axis has reached a position of the software limit switch. The technological object reports a fault. After acknowledging the error, the axis can again be moved in the direction of its working range.

> **Note**
>
> Enabled software limit switches only affect a homed axis.

Lower / upper SW limit switch input

Configure the operating range of the axis using the positions of the lower and upper software limit switches.

5.4.3.3 Configuration - Dynamic limits

In the "Dynamic limits" configuration window, configure the maximum values for velocity, acceleration, deceleration and jerk of the axis.

Maximum velocity

In this field, define the maximum permitted velocity of the axis.

Maximum acceleration / maximum deceleration - ramp-up time / ramp-down time

Set the desired acceleration in the "Ramp-up time" or "Acceleration" fields.
The desired deceleration can be set in the "Ramp-down time" or "Deceleration" fields.

The relationship between ramp-up time and acceleration, and ramp-down time and deceleration can be seen in the following equations:

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

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

Note

A change in the maximum velocity influences the acceleration and deceleration values of the axis. The ramp-up and ramp-down times are retained.

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

Minimum smoothing time / maximum jerk

You can enter the jerk limit parameter in the "Minimum smoothing time" field, or alternatively in the "Maximum jerk" field:

- Set the desired jerk for the acceleration ramp and the deceleration ramp in the "Maximum jerk" field. The value 0 means that the jerk is unlimited.
- Set the desired smoothing time for the acceleration ramp in the "Minimum smoothing time" field.

Note

The configured smoothing time, which is displayed in the configuration, applies only to the acceleration ramp.

In the event that the values of the acceleration and deceleration differ, the smoothing time of the deceleration ramp is calculated according to the jerk of the acceleration ramp, and used.

The smoothing time of the deceleration is adapted as follows:

- Acceleration > Deceleration

  A smaller smoothing time is employed for the deceleration ramp, than for the acceleration ramp.
- Acceleration < Deceleration

  A larger smoothing time is employed for the deceleration ramp, than for the acceleration ramp.
- Acceleration = Deceleration

  The smoothing times of the acceleration ramp and the deceleration ramp are the same.

In the event of an error, the axis decelerates with the configured emergency stop deceleration. A configured jerk limit is not taken into account for this.

The following equations show the relationship between the smoothing times and the jerk:

$$\text{Rounding off time (acceleration ramp)} = \frac{\text{Acceleration}}{\text{Step}}$$

$$\text{Rounding off time (deceleration ramp)} = \frac{\text{Deceleration}}{\text{Step}}$$

Motion jobs initiated in the user program are executed with the selected jerk.

5.4.3.4 Configuration - Dynamic Defaults

In the "Dynamic defaults" configuration window, configure the default values for velocity, acceleration, deceleration and jerk of the axis.

The default values have an effect, when values < 0 are specified in Motion Control instructions for the "Velocity", "Acceleration", "Deceleration" or "Jerk" parameters. The default values can be applied separately for each of the parameters just listed.

The default values for acceleration and deceleration additionally have an effect on the traversing motions of active homing.

Velocity

In this field, define the default value for the velocity of the axis.

Acceleration / deceleration - ramp-up time / ramp-down time

Set the desired default value for acceleration in the "Ramp-up time" or "Acceleration" fields. The desired deceleration can be set in the "Ramp-down time" or "Deceleration" fields.

The relationship between ramp-up time and acceleration, and ramp-down time and deceleration can be seen in the following equations:

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

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

Note

A change in the velocity influences the acceleration and deceleration values of the axis. The ramp-up and ramp-down times are retained.

Smoothing time / jerk

You can enter the jerk limit parameter in the "Smoothing time" field, or alternatively in the "Jerk" field:

- Set the desired jerk for the acceleration ramp and the deceleration ramp in the "Jerk" field. The value 0 means that the jerk is disabled.
- Set the desired smoothing time for the acceleration ramp in the "Smoothing time" field.

Note

The configured smoothing time, which is displayed in the configuration, applies only to the acceleration ramp.

In the event that the values of the acceleration and deceleration differ, the smoothing time of the deceleration ramp is calculated according to the jerk of the acceleration ramp, and used.

The smoothing time of the deceleration is adapted as follows:

- Acceleration > Deceleration

  A smaller smoothing time is employed for the deceleration ramp, than for the acceleration ramp.
- Acceleration < Deceleration

  A larger smoothing time is employed for the deceleration ramp, than for the acceleration ramp.
- Acceleration = Deceleration

  The smoothing times of the acceleration ramp and the deceleration ramp are the same.

In the event of an error, the axis decelerates with the configured emergency stop deceleration. A configured jerk limit is not taken into account for this.

The following equations show the relationship between the smoothing times and the jerk:

$$\text{Rounding off time (acceleration ramp)} = \frac{\text{Acceleration}}{\text{Step}}$$

$$\text{Rounding off time (deceleration ramp)} = \frac{\text{Deceleration}}{\text{Step}}$$

Motion jobs initiated in the user program are executed with the selected jerk.

5.4.3.5 Configuration - Emergency stop

In the "Emergency stop" configuration window, you can configure the emergency stop deceleration of the axis. In the event of an error, and when disabling the axis, the axis is brought to a standstill with this deceleration using the Motion Control instruction "MC_Power" (input parameter StopMode = 0).

Emergency stop deceleration

Configure the deceleration value for emergency stop in the "Emergency stop deceleration" field or the "Emergency stop ramp-down time" field.

The relationship between emergency stop ramp-down time and emergency stop deceleration can be seen in the following equation:

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

The configuration of the emergency stop deceleration is related to the configured maximum velocity of the axis. If the maximum velocity of the axis changes, then the value of the emergency stop deceleration also changes (the emergency stop ramp-down time remains unchanged).

5.4.3.6 Homing

Homing means matching the position value of a technology object to the real, physical location of the drive. Absolute positions on the axis can only be approached with a homed axis.

In S7-1500 Motion Control, axis homing is implemented with the Motion Control instruction, "MC_Home". A distinction is made between the following operation modes of the Motion Control instruction:

Operation modes of the Motion Control instruction "MC_Home"

- Active homing

  In active homing mode, the Motion Control instruction "MC_Home" performs the configured home position approach. Active traversing motions are aborted. When the reference mark is detected, the position of the axis is set according to the configuration.

- Passive homing

  During passive homing, the motion control instruction "MC_Home" does not carry out any homing motion. The traversing motion required for this step must be implemented by the user via other motion control instructions. Active traversing motions are not aborted upon start of passive homing. When the reference mark is detected, the axis is set according to the configuration.

- Direct homing absolute

  The axis position is set regardless of the homing switch. Active traversing motions are not aborted. The value of input parameter "Position" of motion control instruction "MC_Home" is set immediately as the reference point of the axis.

- Direct homing relative

  The axis position is set regardless of the homing switch. Active traversing motions are not aborted. The following statement applies to the axis position after homing:

  New axis position = current axis position + value of parameter "Position" of instruction "MC_Home".

Active homing

Configuration - Active homing

Configure the parameters for active homing in the "Active Homing" configuration window. "Active Homing" is performed using the Motion Control instruction "MC_Home" Mode = 4 and 5.

Select the Homing Mode

Select from among the following homing modes:

Zero mark via PROFIdrive frame and proximity switch (Page 111)

Zero mark via PROFIdrive frame (Page 112)

Reference mark via digital input (Page 113)

Zero mark via PROFIdrive frame and proximity switch

Enable direction reversal at the hardware limit switch

Activate this check box to use the hardware limit switch as a reversing cam for the home position approach. After the axis has reached the hardware limit switch during active homing, it is ramped down at the configured maximum deceleration rate and then reversed.
The proximity switch is then sought in the reverse direction. If this function is not enabled and the axis reaches the hardware limit switch during active homing, then the drive is disabled and braked with the ramp configured in the drive.

Approach direction

Select the approach direction for seeking the proximity switch.

"Positive" is the approach direction in the direction of positive position values; "negative" in the direction of negative position values.

Homing direction

Select the direction in which the zero mark should be approached for homing.

Approach velocity

In this field, specify the velocity at which the proximity switch is sought during the home position approach. A possibly configured home position offset is traversed with the same velocity.

Homing velocity

In this field, specify the velocity at which the axis approaches the zero mark for homing.
For zero mark detection, the proximity switch must be exited.

Home position offset

In the case of a differing zero mark position and home position, enter the corresponding home position offset in this field. The axis approaches the home position at approach velocity.

Home position

In this field, configure the absolute coordinate of the home position. The home position configured here is in effect, when the Motion Control instruction "MC_Home" is executed with Mode = 5.

Zero mark via PROFIdrive frame

Enable direction reversal at the hardware limit switch

Activate this check box to use the hardware limit switch as a reversing cam for the home position approach. After the axis has reached the hardware limit switch during active homing, it is ramped down at the configured maximum deceleration rate and then reversed. The zero mark is then sought in the reverse direction. If this function is not enabled and the axis reaches the hardware limit switch during active homing, then the drive is disabled and braked with the ramp configured in the drive.

Homing direction

Select the direction in which the next zero mark should be approached for homing.

"Positive" is the homing direction in the direction of positive position values; "negative" in the direction of negative position values.

Approach velocity

In the "Zero mark via PROFIdrive frame" homing mode, the approach velocity for traversing the home position offset is used.

Homing velocity

In this field, specify the velocity at which the axis approaches the zero mark for homing.

Home position offset

In the case of a differing zero mark position and home position, enter the corresponding home position offset in this field. The axis approaches the home position at approach velocity.

Home position

In this field, configure the absolute coordinate of the home position. The home position configured here is in effect, when the Motion Control instruction "MC_Home" is executed with Mode = 5.

Reference mark via digital input

If a digital input is used as a reference mark, then the accuracy of the homing process is not as high as with hardware-supported homing using zero marks.

You can improve the accuracy by using a low homing velocity and a timer-supported input module.

Pay attention to the setting of short filter times at the digital input as well.

Digital input

In this field, select the PLC tag of the digital input, which should act as a reference mark (reference cam).

In order to be able to select an input, a digital input module must have been added in the device configuration, and the PLC tag name for the digital input must be defined.

Enable direction reversal at the hardware limit switch

Activate this check box to use the hardware limit switch as a reversing cam for the home position approach. After the axis has reached the hardware limit switch during active homing, it is ramped down at the configured maximum deceleration rate and then reversed. The home position switch is then sensed in reverse direction. If this function is not enabled and the axis reaches the hardware limit switch during active homing, then the drive is disabled and braked with the ramp configured in the drive.

Approach direction

Select the approach direction for seeking the reference mark.

"Positive" is the approach direction in the direction of positive position values; "negative" in the direction of negative position values.

Homing direction

Select the direction in which the reference mark should be approached for homing.

Reference mark

Select which switch position of the "digital input" is to be used as reference mark.

When a "digital input" is overshot, two switch edges are generated, which are spatially separated. The selection of the positive or negative side ensures that the reference mark is always evaluated based on the same mechanical position.

The positive side is the switch position with a greater position value; the negative side is the switch position with the lesser position value.

The selection of the side is independent of the approach direction, and independent of whether it causes a rising or falling edge.

Approach velocity

In this field, specify the velocity at which the "digital input" should be sought during the home position approach. A possibly configured home position offset is traversed with the same velocity.

Homing velocity

In this field, specify the velocity at which the axis approaches the home position for homing.

Home position offset

In the case of a differing switch position and home position, enter the corresponding home position offset in this field. The axis approaches the home position at approach velocity.

Home position

In this field, configure the absolute coordinate of the home position. The home position configured here is in effect, when the Motion Control instruction "MC_Home" is executed with Mode = 5.

Passive homing

Configuration - Passive homing

Configure the parameters for passive homing in the "Passive Homing" (homing on the fly) configuration window. The homing function "Passive Homing" is performed using the Motion Control instruction "MC_Home" Mode = 2 and 3.

Select the Homing Mode

Select from among the following homing modes:

Zero mark via PROFIdrive frame and proximity switch (Page 115)

Zero mark via PROFIdrive frame (Page 116)

Reference mark via digital input (Page 116)

Zero mark via PROFIdrive frame and proximity switch

Homing direction

Select the direction in which the zero mark should be approached for homing.
The next zero mark after exiting the proximity switch is used.

The following options are available:

- Positive

  Axis moves in the direction of higher position values.
- Negative

  Axis moves in the direction of lower position values.
- Current

  The currently effective approach direction is used for homing.

Home position

In this field, configure the absolute coordinate of the home position. The home position configured here is in effect, when the Motion Control instruction "MC_Home" is executed with Mode = 3.

Zero mark via PROFIdrive frame

Homing direction

Select the direction in which the next zero mark should be approached for homing.
The following options are available:

- Positive

  Axis moves in the direction of higher position values.
- Negative

  Axis moves in the direction of lower position values.
- Current

  The currently effective approach direction is used for homing.

Home position

In this field, configure the absolute coordinate of the home position. The home position configured here is in effect, when the Motion Control instruction "MC_Home" is executed with Mode = 3.

Reference mark via digital input

Digital input

In this dialog field, select a digital input, which should act as a reference mark (reference cam).

Homing direction

Select the direction in which the reference mark should be approached for homing.

The following options are available:

- Positive

  Axis moves in the direction of higher position values.
- Negative

  Axis moves in the direction of lower position values.
- Current

  The currently effective approach direction is used for homing.

Reference mark

Select which switch position of the "digital input" is to be used as reference mark.

When a "digital input" is overshot, two switch edges are generated, which are spatially separated. The selection of the positive or negative side ensures that the reference mark is always evaluated based on the same mechanical position.

The positive side is the switch position with a greater position value; the negative side is the switch position with the lesser position value.

The selection of the side is independent of the approach direction, and independent of whether it causes a rising or falling edge.

Home position

In this field, configure the absolute coordinate of the home position. The home position configured here is in effect, when the Motion Control instruction "MC_Home" is executed with Mode = 3.

5.4.3.7 Position monitoring

Configuration - Positioning monitoring

In the "Positioning Monitoring" configuration window, configure the criteria for monitoring the target position.

Positioning window:

In this field, configure the size of the positioning window. If the axis is located within this window, then the position is considered to be "reached".

Positioning tolerance time:

In this field, configure the tolerance time, in which the position value must reach the positioning window.

Minimum dwell time in the positioning window:

In this field, configure the minimum dwell time. The current position value must be located in the positioning window for at least the "minimum dwell time".

If one of the criteria is violated, then the axis is stopped and a positioning alarm is displayed.

Configuration - Following error

In the "Following Error" configuration window, configure the permissible deviation of the actual position of the axis from the setpoint position. The following error can be dynamically adapted to the current velocity of the axis.

Enable following error monitoring

Activate this check box, if you want to enable following error monitoring. When following error monitoring is enabled, the axis will be stopped in the error range (orange); in the warning range an alarm will be displayed.

When following error monitoring is disabled, the configured limits have no effect.

Maximum following error:

In this field, configure the following error that is permissible at maximum velocity.

Warning level:

In this field, configure a percentage of the current following error limit, above which a following error warning should be 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, then a following error warning will be output.

Following error:

In this field, configure the permissible following error for low velocities (without dynamic adaptation).

Beginning of dynamic adaptation:

In this field, configure the velocity above which the following error should be dynamically adapted. Above this velocity the following error will be adapted up to the maximum following error at the maximum velocity.

Configuration - Standstill signal

In the "Standstill Signal" configuration window, configure the criteria for standstill detection.

Standstill window:

In this field, configure the size of the standstill window. For standstill to be indicated, the velocity of the axis must be within this window.

Minimum dwell time in the standstill window:

In this field, configure the minimum dwell time in the standstill window.
The velocity of the axis must also be in the standstill window for the specified duration.

If both criteria are met, then the standstill of the axis is indicated.

5.4.3.8 Configuration - Control loop

In the "Control Loop" configuration window, 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 axis are (high stiffness), the higher the Kv factor can be configured. This reduces the following error, and a higher dynamic response is achieved.

For basic information, refer to the section " Function and structure of the optimization (Page 176) ".

Gain

In the input field, enter the gain Kv of the control loop.

Dynamic Servo Control (DSC):

For position-controlled axes (positioning axes), the position control can occur either in the CPU or in the drive, provided the drive supports the Dynamic Servo Control (DSC) control process. Select your preferred control process:

- **Position and speed control in the drive (DSC enabled)**
- **Position and speed control in the PLC**

Note

Dynamic Servo Control (DSC) is only possible with standard frame 5.

5.5 Configuring the Speed-Control Axis technology object

5.5.1 Configuration - Basic Parameters

Configure the basic properties of the technology object in the "Basic Parameters" configuration window.

Axis name

Define the name of the speed-controlled axis in this field. The technology object is listed in the project navigation under this name. The tags of the speed-controlled axis can be used in the user program under this name.

User unit

Select the measuring system for speed from the drop-down list box.

5.5.2 Hardware interface

5.5.2.1 Configuration - Drive

In the "Drive" configuration window, configure which drive type and which drive you want to use.

Drive type

In the drop-down list, select whether you want to deploy a PROFIdrive drive or a drive with an analog drive connection.

PROFIdrive drives are connected to the controller by means of a digital communication system (PROFINET or PROFIBUS). The communication occurs via PROFIdrive message frames.

Drives with an analog drive connection receive the setpoint speed via an analog output signal (e.g. from -10 V to +10 V) from the PLC.

Drive (drive type: PROFIdrive)

In the "Drive" field, select an already configured PROFIdrive drive / slot. If a PROFIdrive drive was selected, then it can be configured using the "Device configuration" button.

Switch to the device configuration, and add a PROFIdrive drive in the network view, in the event that no PROFIdrive drive can be selected.

Output (drive type: Analog drive connection)

In the "Output" field, select the PLC tag of the analog output over which the drive is to be controlled. If an output was selected, then it can be configured using the "Device configuration" button.

In order to be able to select an output, an analog output module must have been added in the device configuration, and the PLC tag name for the analog output must be defined.

Activate enable output (drive type: Analog drive connection)

In the "Enable output" field, select the PLC tag of the digital output for the enablement of the drive. With the enable output, the speed controller in the drive is enabled, or disabled.

In order to be able to select an enable output, a digital output module must have been added in the device configuration, and the PLC tag name for the digital output must be defined.

Note

If you do not use an enable output, the drive cannot be immediately disabled on the part of the system due to error responses or monitoring functions. A controlled stop of the drive is not guaranteed.

Enable ready input (drive type: Analog drive connection)

In the "Ready input" field, select the PLC tag of the digital input with which the drive is to report its operational readiness to the technology object. The power unit is switched on and the analog setpoint speed input is enabled.

In order to be able to select a ready input, a digital input module must have been added in the device configuration, and the PLC tag name for the digital input must be defined.

Note

The enable output and the ready input can be separately enabled.

The following conditions apply to the enabled ready input:

- The axis is not enabled (MC_Power Status=TRUE), until a signal is pending at the ready input.
- If the signal at the ready input goes away for an enabled axis, then the axis is disabled with an error.
- If the axis is disabled with the instruction MC_Power (Enable= FALSE), then the axis is disabled even with a pending signal at the ready input.

See also

Configuration - Data Transmission (Page 122)

5.5.2.2 Configuration - Data Transmission

Data transmission to the drive

In this area, you can configure the data transmission to the drive.

Message frame type (drive type PROFIdrive)

In the drop-down list, select the message frame to the drive.
The data must match the configuration in the device configuration.

Reference speed (drive type PROFIdrive)

In this field, configure the reference speed of the drive in accordance with the manufacturer's specifications. The specification of the drive's speed occurs as a percentage of the reference speed in the range from -200% to 200%.

Reference speed (drive type analog drive connection)

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.
As an example, with an analog output with +/- 10 V, the value 10 V is output at 100%.

Analog outputs can be overloaded by about 17%. This means that an analog output can be operated in the range from -117% to 117%, insofar as the drive permits this.

Maximum speed

In this field, specify the maximum speed of the drive.

Inverting the direction

Enable the check box if the rotation direction of the drive should be inverted.

5.5.3 Extended Parameters

5.5.3.1 Configuration - Mechanics

Configure the connection of the load to the drive in the "Mechanics" configuration window.

Use gearbox parameters for calculation

Activate this check box, if you want to take account of a load gear when calculating the load speed.

Number of motor revolutions / number of load revolutions

The gear ratio of the load gear is specified as the ratio between motor revolutions and load revolutions. Specify here an integral number of motor revolutions and the resulting number of load revolutions.

5.5.3.2 Configuration - Dynamic limits

In the "Dynamic limits" configuration window, configure the maximum values for speed, acceleration, deceleration and jerk of the axis.

Maximum speed

In this field, define the maximum permitted speed of the axis.

Maximum acceleration / maximum deceleration - ramp-up time / ramp-down time

Set the desired acceleration in the "Ramp-up time" or "Acceleration" fields.
The desired deceleration can be set in the "Ramp-down time" or "Deceleration" fields.

The relationship between ramp-up time and acceleration, and ramp-down time and deceleration can be seen in the following equations:

$$\textit{Ramp-up time} = \frac{\textit{Maximum velocity}}{\textit{Acceleration}}$$

$$\textit{Ramp-down time} = \frac{\textit{Maximum speed}}{\textit{Deceleration}}$$

Note

A change in the maximum speed influences the acceleration and deceleration values of the axis. The ramp-up and ramp-down times are retained.

Minimum smoothing time / maximum jerk

You can enter the jerk limit parameter in the "Minimum smoothing time" field, or alternatively in the "Maximum jerk" field:

- Set the desired jerk for the acceleration ramp and the deceleration ramp in the "Maximum jerk" field. The value 0 means that the jerk is unlimited.
- Set the desired smoothing time for the acceleration ramp in the "Minimum smoothing time" field.

Note

The configured smoothing time, which is displayed in the configuration, applies only to the acceleration ramp.

In the event that the values of the acceleration and deceleration differ, the smoothing time of the deceleration ramp is calculated according to the jerk of the acceleration ramp, and used.

The smoothing time of the deceleration is adapted as follows:

- Acceleration > Deceleration

  A smaller smoothing time is employed for the deceleration ramp, than for the acceleration ramp.
- Acceleration < Deceleration

  A larger smoothing time is employed for the deceleration ramp, than for the acceleration ramp.
- Acceleration = Deceleration

  The smoothing times of the acceleration ramp and the deceleration ramp are the same.

In the event of an error, the axis decelerates with the configured emergency stop deceleration. A configured jerk limit is not taken into account for this.

The following equations show the relationship between the smoothing times and the jerk:

$$\text{Rounding off time (acceleration ramp)} = \frac{\text{Acceleration}}{\text{Step}}$$

$$\text{Rounding off time (deceleration ramp)} = \frac{\text{Deceleration}}{\text{Step}}$$

Motion jobs initiated in the user program are executed with the selected jerk.

5.5.3.3 Configuration - Dynamic Defaults

In the "Dynamic defaults" configuration window, configure the default values for speed, acceleration, deceleration and jerk of the axis.

The default values have an effect, when values < 0 are specified in Motion Control instructions for the "Velocity", "Acceleration", "Deceleration" or "Jerk" parameters. The default values can be applied separately for each of the parameters just listed.

Velocity

In this field, define the default value for the speed of the axis.

Acceleration / deceleration - ramp-up time / ramp-down time

Set the desired default value for acceleration in the "Ramp-up time" or "Acceleration" fields. The desired deceleration can be set in the "Ramp-down time" or "Deceleration" fields.

The relationship between ramp-up time and acceleration, and ramp-down time and deceleration can be seen in the following equations:

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

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

Note

A change in the velocity influences the acceleration and deceleration values of the axis. The ramp-up and ramp-down times are retained.

Smoothing time / jerk

You can enter the jerk limit parameter in the "Smoothing time" field, or alternatively in the "Jerk" field:

- Set the desired jerk for the acceleration ramp and the deceleration ramp in the "Jerk" field. The value 0 means that the jerk is disabled.
- Set the desired smoothing time for the acceleration ramp in the "Smoothing time" field.

Note

The configured smoothing time, which is displayed in the configuration, applies only to the acceleration ramp.

In the event that the values of the acceleration and deceleration differ, the smoothing time of the deceleration ramp is calculated according to the jerk of the acceleration ramp, and used.

The smoothing time of the deceleration is adapted as follows:

- Acceleration > Deceleration

  A smaller smoothing time is employed for the deceleration ramp, than for the acceleration ramp.
- Acceleration < Deceleration

  A larger smoothing time is employed for the deceleration ramp, than for the acceleration ramp.
- Acceleration = Deceleration

  The smoothing times of the acceleration ramp and the deceleration ramp are the same.

In the event of an error, the axis decelerates with the configured emergency stop deceleration. A configured jerk limit is not taken into account for this.

The following equations show the relationship between the smoothing times and the jerk:

$$\text{Rounding off time (acceleration ramp)} = \frac{\text{Acceleration}}{\text{Step}}$$

$$\text{Rounding off time (deceleration ramp)} = \frac{\text{Deceleration}}{\text{Step}}$$

Motion jobs initiated in the user program are executed with the selected jerk.

5.5.3.4 Configuration - Emergency stop ramp

In the "Emergency stop ramp" configuration window, you can configure the emergency stop deceleration of the axis. In the event of an error, and when disabling the axis, the axis is brought to a standstill with this deceleration using the Motion Control instruction "MC_Power" (input parameter StopMode = 0).

Emergency stop deceleration

Configure the deceleration value for emergency stop in the "Emergency stop deceleration" field or the "Emergency stop ramp-down time" field.

The relationship between emergency stop ramp-down time and emergency stop deceleration can be seen in the following equation:

$$\textit{Emergency stop ramp-down time} = \frac{\textit{Maximum speed}}{\textit{Emergency stop deceleration}}$$

The configuration of the emergency stop deceleration is related to the configured maximum speed of the axis. If the maximum speed of the axis changes, then the value of the emergency stop deceleration also changes (the emergency stop ramp-down time remains unchanged).

5.6 Configuring the External Encoder technology object

5.6.1 Configuration - Basic Parameters

Configure the basic properties of the technology object in the "Basic Parameters" configuration window.

Name of the external encoder

Define the name of the external encoder in this field. The technology object is listed in the project navigation under this name. The tags of the external encoder can be used in the user program under this name.

Type of the external encoder

In this selection, configure whether the external encoder records linear or rotary motions.

User unit

In the drop-down list, select the desired measurement system for the position and velocity of the external encoder.

Modulo

Select the check box "Activate modulo", if you want to employ a recurring unit of measure for the external encoder (e.g. 0-360° for an external encoder of the "rotary" type).

- Start value

  In this field, define at which position the modulo range should begin
  (e.g. 360° for an external encoder of the "rotary" type).

- Length

  In this field, define the length of the modulo range
  (e.g. 360° for an external encoder of the "rotary" type).

5.6.2 Hardware interface

5.6.2.1 Configuration - Encoder

The external encoder records the position of an externally controlled drive. The encoder required for this purpose communicates the encoder position to the controller by means of a PROFIdrive frame. In the "Encoder" configuration window, configure the encoder coupling with which the encoder is to be connected.

Select encoder coupling:

In this area, select according to the graphical representation, how the encoder is to be connected.

- Connection via technology module (TM)

  Select this option, if the encoder is connected to a technology module (TM).

  – Technology module:

    In the "Technology module" field, select a technology module that has already been configured, and the channel to be used. If a technology module was selected, then it can be configured using the "Device configuration" button.

    Switch to the device configuration, and add a technology module, in the event that no technology module can be selected. The technology module can be driven centrally on a S7-1500 PLC, or decentrally on a distributed I/O. To connect an incremental encoder use the technology module Count2x24V, and to connect an absolute value encoder use the technology module TM PosInput2.

- Connection via PROFINET/PROFIBUS (PROFIdrive)

  Select this option, if you are deploying a PROFIdrive compatible encoder.

  – Encoder selection:

    In the "Encoder selection" field, select an already configured encoder on PROFINET/PROFIBUS. If an encoder was selected, then it can be configured using the "Device configuration" button.

    Switch to the device configuration in the network view, and add an encoder, in the event that no encoder can be selected.

5.6.2.2 Configuration - Data Transmission

Configuration - Data Transmission

In the "Data transmission" configuration window, configure the data transmission to the encoder. The configuration varies according to the encoder coupling:

Encoder to technology module (Page 130)

Encoder to PROFINET/PROFIBUS (Page 132)

Encoder to technology module

Encoder message frame

In this area, you can configure the encoder message frame and the criteria for how the encoder data are to be evaluated. The data must match the data in the device configuration.

Message frame

In the drop-down list for the technology module, select the message frame that you have configured in the technology module.

Encoder type

In this area, you can configure how the encoder data are to be evaluated. The data must match the data in the device configuration.

Encoder type	Rotary incremental
Steps per revolution:	In this field, configure the number of steps that the encoder resolves per revolution.
Bits for fine resolution in the incremental actual value (Gn_XIST1)	In this field, configure the number of bits for fine resolution within the incremental actual value (Gn_XIST1).

Encoder type	Rotary absolute
Steps per revolution:	In this field, configure the number of steps that the encoder resolves per revolution.
Number of revolutions:	In this field, configure the number of revolutions that the absolute value encoder can detect.
Bits for fine resolution in the incremental actual value (Gn_XIST1)	In this field, configure the number of reserved bits for fine resolution within the incremental actual value (Gn_XIST1).
Bits for the multiplication factor of the absolute value of the fine resolution (Gn_XIST2)	In this field, configure the number of reserved bits for the multiplication factor of the absolute value of the fine resolution (Gn_XIST2).

Encoder type	Rotary cyclic absolute
Steps per revolution:	In this field, configure the number of steps that the encoder resolves per revolution.
Number of revolutions:	In this field, configure the number of revolutions that the absolute value encoder can detect.
Bits for fine resolution in the incremental actual value (Gn_XIST1)	In this field, configure the number of bits for fine resolution within the incremental actual value (Gn_XIST1).
Bits for the multiplication factor of the absolute value of the fine resolution (Gn_XIST2)	In this field, configure the number of reserved bits for the multiplication factor of the absolute value of the fine resolution (Gn_XIST2).

Encoder type	Linear incremental
Distance between two increments:	In this field, you can configure the distance between two steps of the encoder.
Bits for fine resolution in the incremental actual value (Gn_XIST1)	In this field, configure the number of bits for fine resolution within the incremental actual value (Gn_XIST1).

Encoder type	Linear absolute
Distance between two increments:	In this field, you can configure the distance between two steps of the encoder.
Bits for fine resolution in the incremental actual value (Gn_XIST1)	In this field, configure the number of bits for fine resolution within the incremental actual value (Gn_XIST1).
Bits for the multiplication factor of the absolute value of the fine resolution (Gn_XIST2)	In this field, configure the number of reserved bits for the multiplication factor of the absolute value of the fine resolution (Gn_XIST2).

Inverting the direction

Select this check box if you would like to invert the actual value of the encoder.

See also

Configuration - Data Transmission (Page 130)

Encoder to PROFINET/PROFIBUS (Page 132)

Encoder to PROFINET/PROFIBUS

Encoder message frame

In this area, you can configure the encoder message frame and the criteria for how the encoder data are to be evaluated. The data must match the data in the device configuration.

Data transmission

In the drop-down list, select the message frame of the encoder.
The data must match the configuration in the device configuration.

Encoder type

Depending on the encoder type, configure the following parameters:

Encoder type	Rotary incremental
Steps per revolution:	In this field, configure the number of steps that the encoder resolves per revolution.
Bits for fine resolution in the incremental actual value (GN_XIST1)	In this field, configure the number of bits for fine resolution within the incremental actual value (GN_XIST1).

Encoder type	Rotary absolute
Steps per revolution:	In this field, configure the number of steps that the encoder resolves per revolution.
Number of revolutions:	In this field, configure the number of revolutions that the absolute value encoder can detect.
Bits for fine resolution in the incremental actual value (GN_XIST1)	In this field, configure the number of reserved bits for fine resolution within the incremental actual value (GN_XIST1).
Bits for fine resolution in the absolute actual value (GN_XIST2)	In this field, configure the number of reserved bits for fine resolution within the absolute actual value (GN_XIST2).

Encoder type	Rotary cyclic absolute
Steps per revolution:	In this field, configure the number of steps that the encoder resolves per revolution.
Number of revolutions:	In this field, configure the number of revolutions that the absolute value encoder can detect.
Bits for fine resolution in the incremental actual value (GN_XIST1)	In this field, configure the number of bits for fine resolution within the incremental actual value (GN_XIST1).
Bits for fine resolution in the absolute actual value (GN_XIST2)	In this field, configure the number of reserved bits for fine resolution within the absolute actual value (GN_XIST2).

Encoder type	Linear incremental
Distance between two increments:	In this field, you can configure the distance between two steps of the encoder.
Bits for fine resolution in the incremental actual value (GN_XIST1)	In this field, configure the number of bits for fine resolution within the incremental actual value (GN_XIST1).

Encoder type	Linear absolute
Distance between two increments:	In this field, you can configure the distance between two steps of the encoder.
Bits for fine resolution in the incremental actual value (GN_XIST1)	In this field, configure the number of bits for fine resolution within the incremental actual value (GN_XIST1).
Bits for fine resolution in the absolute actual value (GN_XIST2)	In this field, configure the number of reserved bits for fine resolution within the absolute actual value (GN_XIST2).

Inverting the direction

Select this check box if you would like to invert the actual value of the encoder.

See also

Configuration - Data Transmission (Page 130)

Encoder to technology module (Page 130)

5.6.3 Extended Parameters

5.6.3.1 Configuration - Mechanics

Configuration - Mechanics

Configure the encoder parameters for the position of the externally controlled drive in the "Mechanics" configuration window.

The configuration varies according to the type of encoder:

Linear (Page 134)

Rotary (Page 134)

Linear

Distance between two increments

In this field you can configure the distance between two steps of the incremental encoder or absolute value encoder.

See also

Configuration - Mechanics (Page 134)

Rotary (Page 134)

Rotary

Use gearbox parameters for calculation

Activate this check box, if you want to take account of a load gear when calculating the actual position. Deactivate this check box, if you want to configure the distance per encoder revolution.

Measuring gearbox

- **Number of encoder revolutions / number of load revolutions**

  The gear ratio of the measuring gearbox is specified as the ratio between encoder revolutions and load revolutions. Specify here an integral number of load revolutions and the resulting number of encoder revolutions.

  Select the same values for the number of motor revolutions and load revolutions, if no load gear is present.

Position parameter

- **Distance per encoder revolution**

  In this field, configure the value indicated by the external measuring system per encoder revolution.

See also

Configuration - Mechanics (Page 134)

Linear (Page 134)

5.6.3.2 Homing

Configuration - Homing

Configure the parameters for homing the external encoder in the "Homing" configuration window. Homing is performed using the Motion Control instruction "MC_Home" Mode = 2 and 3.

Select the Homing Mode

Select from among the following homing modes:

Zero mark via PROFIdrive frame and proximity switch (Page 135)

Zero mark via PROFIdrive frame (Page 136)

Reference mark via digital input (Page 137)

Zero mark via PROFIdrive frame and proximity switch

Homing direction

Select the direction in which the zero mark should be approached for homing.
The next zero mark after exiting the proximity switch is used.

The following options are available:

- **Positive**

  Axis moves in the direction of higher position values.

- **Negative**

  Axis moves in the direction of lower position values.

- **Current**

  The currently effective approach direction is used for homing.

Home position

In this field, configure the absolute coordinate of the home position. The home position configured here is in effect, when the Motion Control instruction "MC_Home" is executed with Mode = 3.

See also

Configuration - Homing (Page 135)

Zero mark via PROFIdrive frame (Page 136)

Reference mark via digital input (Page 137)

Zero mark via PROFIdrive frame

Homing direction

Select the direction in which the next zero mark should be approached for homing.
The following options are available:

- Positive

  Axis moves in the direction of higher position values.
- Negative

  Axis moves in the direction of lower position values.
- Current

  The currently effective approach direction is used for homing.

Home position

In this field, configure the absolute coordinate of the home position. The home position configured here is in effect, when the Motion Control instruction "MC_Home" is executed with Mode = 3.

See also

Configuration - Homing (Page 135)

Zero mark via PROFIdrive frame and proximity switch (Page 135)

Reference mark via digital input (Page 137)

Reference mark via digital input

Digital input

In this dialog field, select a digital input, which should act as a reference mark (reference cam).

Homing direction

Select the direction in which the reference mark should be approached for homing.

The following options are available:

- Positive

  Axis moves in the direction of higher position values.
- Negative

  Axis moves in the direction of lower position values.
- Current

  The currently effective approach direction is used for homing.

Reference mark

Select which switch position of the "digital input" is to be used as reference mark.

When a "digital input" is overshot, two switch edges are generated, which are spatially separated. The selection of the positive or negative side ensures that the reference mark is always evaluated based on the same mechanical position.

The positive side is the switch position with a greater position value; the negative side is the switch position with the lesser position value.

The selection of the side is independent of the approach direction, and independent of whether it causes a rising or falling edge.

Home position

In this field, configure the absolute coordinate of the home position. The home position configured here is in effect, when the Motion Control instruction "MC_Home" is executed with Mode = 3.

See also

Configuration - Homing (Page 135)

Zero mark via PROFIdrive frame (Page 136)

Zero mark via PROFIdrive frame and proximity switch (Page 135)

5.6.3.3 Configuration - Standstill signal

In the "Standstill Signal" configuration window, configure the criteria for standstill detection.

Standstill window:

In this field, configure the size of the standstill window. For standstill to be indicated, the velocity of the external encoder must be within this window.

Minimum dwell time in the standstill window:

In this field, configure the minimum dwell time in the standstill window. The velocity of the external encoder must also be in the standstill window for the specified duration.

If both criteria are met, then the standstill of the external encoder is indicated.

6 Programming

6.1 Introduction

The "Programming" section contains general information on supplying and evaluating the Motion Control instructions and on technology data blocks.

An overview of the Motion Control instructions can be found in the Functions (Page 19) section.

You can transmit jobs to the technology object by means of Motion Control instructions in the user program. You define the job using the input parameters of the Motion Control instructions. The current job status is indicated in the output parameters.

The technology data block is available to you as an additional interface to the technology object. Via your user program, you can access the technology data block's data.

6.2 Technology data block

6.2.1 Introduction

The technology data block represents the technology object and contains all configuration data, setpoint and actual values, and status information of the technology object.
The technology data block is automatically created when the technology object is created.
In your user program you can access the technology data block's data.

A listing and description of the tags can be found in the appendix, Technology Object Data Block Tags (Page 243).

6.2.2 Evaluating the technology data block

Description

Access to data in the technology data block occurs in accordance with the access to standard data blocks.

Reading values from the technology data block

In your user program you can read actual values (e.g. current position) and status information, or detect error messages in the technology object. When you program a query in your user program (e.g. current velocity), the value is directly read from the technology object.

Reading values from the technology data block takes longer than for other data blocks.
If you use these tags several times in a single cycle of your user program,
it is recommended to copy the tag values to local tags, and use the local tags
in your program.

Writing values to the technology data block

By means of the configuration of the technology object in the TIA Portal, the corresponding data are written to the technology data block. After they have been loaded into the CPU, these data are stored in the CPU on the SIMATIC Memory Card (load memory).

- **Required changes in the technology data block**

  In the following cases, it may be necessary for the user program to write values to the technology data block:

  – Adaptation of the configuration of the technology object
  (e.g. dynamic limits, software limit switches)

  – Use of overrides

  – Adaptation of position control (e.g. "Kv" parameter)

- **Efficacy of changes in the technology data block**

  Changes to values in the technology data block by the user program can take effect at various points in time. The applicable property of the individual tags can be discerned from their description in the appendix, Technology Object Data Block Tags (Page 243).

  – **Effective immediately:**

  LREAL data type

  (e.g. <TO>.Override.Velocity)

  Value changes take effect immediately when writing these tags. The technology object performs a range check on the written value, and immediately starts using the new value. If range limits are violated when writing, the technology object automatically corrects the values. If the value is below the range, then the value is set to the lower limit of the range; if the range is exceeded, then the value is set to the upper limit of the range. You write changes using direct assignments. The changes are retained until the next POWER OFF of the CPU or restart of the technology object.

  DINT/BOOL data types

  (e.g. <TO>.Senso[n].ActiveHoming.Direction)

  Changes are only permitted in the defined value range. Value changes outside the value range are not applied. If you enter invalid values, the programming error OB (OB 121) is started. You write changes using direct assignments. The changes are retained until the next POWER OFF of the CPU or restart of the technology object.

  – **Effective after restart:**

  (e.g. <TO>.Homing.AutoReversal)

  Since restart-relevant tags have dependencies on other tags, value changes cannot be applied at any arbitrary time. The changes are only used after reinitialization (restart) of the technology object. During a restart the technology object is reinitialized with the data in load memory. You therefore write changes to the starting value in load memory, using the extended instruction "WRIT_DBL" (write to data block in load memory).

  You trigger the restart in your user program using the Motion Control instruction "MC_Reset" with parameter "Restart" = TRUE. Additional information on a restart can be found in the Restarting Technology Objects (Page 163) section.

Note

Save changes with "WRIT_DBL"

Changes to immediately effective tags are lost on POWER OFF of the CPU, or restart of the technology object.

If changes in the technology data block should also be retained after POWER OFF of the CPU, or restart of the technology object, you must write the changes to the starting value in load memory using the extended instruction "WRIT_DBL".

Note

Using the "READ_DBL" and "WRIT_DBL" data block functions

The "READ_DBL" and "WRIT_DBL" data block functions can only be used on a single tag in conjunction with the tags of the technology. The "READ_DBL" and "WRIT_DBL" data block functions cannot be applied to data structures of the technology object.

Evaluation of data in the isochronous alarm OB

If you want to write the technology data block's data isochronously from a Motion Control clock cycle, there is the option of evaluating these data in the isochronous alarm OB.

For this purpose, assign the same clock cycle source (Page 66) to the isochronous alarm OB, as to the MC_Servo [OB91]. By this means, the isochronous alarm OB is called in each Motion Control clock cycle.

In the isochronous alarm OB, read the necessary data into global tags. Use these global tags for further programming.

6.2.3 Evaluate StatusWord, ErrorWord and WarningWord

Specific status and error information derived from the "StatusWord", "ErrorWord" and "WarningWord" data words can be evaluated symbolically as follows. For consistent evaluation, you should avoid using bit addresses to access these data words in the technology data block. Access to an individual bit in the technology data block only lasts as long as the access to the entire data word.

Copy the required data word as needed into a data structure, and query the individual bits from the data structure.

A description of the data words and the allocation of the individual bits can be found in the appendix, Technology Object Data Block Tags:

- StatusWord (Page 261)
- ErrorWord (Page 263)
- WarningWord (Page 265)

Requirements

The technology object has been created.

Procedure

To evaluate the individual bits in the data word "StatusWord", proceed as follows:

1. Crate a global data structure. Name the data structure, e.g. as "Status".
2. Create a double word (DWORD) in the data structure "Status". Name the data structure, e.g. as "Temp".
3. Create 32 boolean tags in the "Status" data structure. You can obtain a clearer overview by naming the boolean tags as defined for the bits in the technology DB (e.g. name the fifth boolean tag "HomingDone").
4. Copy the tag <TO>.StatusWord as needed from the technology data block to the double word "Temp" in your data structure.
5. Copy the bits of dword "Temp" to the corresponding boolean tags by means of bit access.
6. Use the boolean tags to query the status bits.

Evaluate the "ErrorWord" and "WarningWord" data words as specified in steps 1 to 6.

Example

The following example shows how you can read and save the fifth bit "HomingDone" of the data word "StatusWord":

SCL	
Status.Temp := <TO>.StatusWord;	Copy status word
Status.HomingDone := Status.Temp.X5;	Copy individual bits per bit access

STL	
L <TO>.StatusWord	Copy status word
T Status.Temp	
U Status.Temp.X5	Copy individual bits per bit access
= Status.HomingDone	

6.2.4 Change restart-relevant data

In order to change restart-relevant data in the technology data block, write to the starting values of the tags in load memory using the extended instruction "WRIT_DBL". In order for the changes to be applied, a restart of the technology object must be performed.

Whether value changes to a tag are restart-relevant, can be discerned from the description of the Tags of the Technology Data Block (Page 243)

Requirements

The technology object has been created.

Procedure

To change restart-relevant data, proceed as follows:

1. Create a data block and fill it with the restart-relevant values, that you want to change in the technology data block. In doing so, the data types must match the tags to be changed.
2. Write the values from your data block to the starting values of the tags of the technology data block in load memory, using the extended instruction "WRIT_DBL".

   If restart-relevant data were changed, this will be indicated in the <TO>.StatusWord.OnlineStartValuesChanged tag of the technology object.
3. Perform a restart of the technology object using the Motion Control instruction "MC_Reset" with parameter "Restart" = TRUE.

After the restart of the technology object, the new value is transferred into the technology data block in work memory, and is effective.

6.3 Motion Control instructions

6.3.1 Motion Control instruction parameters

Description

When creating your user program, take account of the following explanations of the Motion Control instruction parameters.

Reference to the technology object

The specification of the technology object to the Motion Control instruction occurs as follows:

- "Axis" parameter

  In the "Axis" input parameter of a Motion Control instruction, a reference to the technology object is specified, which the corresponding job should use.

Job start and receipt of the input parameters of a Motion Control instruction

When jobs are started, and when changed parameter values are received, a distinction is made between the following Motion Control instructions:

- Motion Control instructions with "Execute" parameter

  With a rising edge at the "Execute" parameter, the job is started and the values pending in the input parameters are applied.

  Subsequently changed parameter values are not applied until the next job start.

  Resetting the "Execute" parameter does not end the job, but does have an effect on the indication duration of the job status. As long as "Execute" is set to TRUE, the output parameters will be updated. If "Execute" is reset before the completion of a job, the parameters "Done", "Error" and "CommandAborted" are correspondingly set for only one call cycle.

- Motion Control instructions with "Enable" parameter

  The job is started by setting the "Enable" parameter.

  As long as "Enable" = TRUE. the job remains enabled and changed parameter values are immediately applied.

  The job is ended by resetting the "Enable" parameter.

  The input parameters "JogForward" and "JogBackward" of the "MC_MoveJog" Motion Control instruction correspond in their behavior to the "Enable" parameter.

Job status

The following output parameters indicate the status of the job processing:

- **Motion Control instructions with "Done" parameter**

  The normal completion of a job is indicated with parameter "Done" = TRUE.
- **Motion Control instructions without "Done" parameter**

  The achievement of the job target is indicated by means of other parameters (e.g. "Status", "InVelocity"). For more information, refer to the section " Tracking running jobs (Page 152).
- **"Busy" parameter**

  As long as a job is being processed, the parameter "Busy" shows the value TRUE. If a job was ended or aborted, "Busy" shows the value FALSE.
- **"CommandAborted" parameter**

  If a job was aborted by another job, CommandAborted shows the value "TRUE".
- **"Error" parameter**

  If an error occurs in the Motion Control instruction, the "Error" parameter shows the value TRUE. The ErrorID parameter shows the cause of the error.

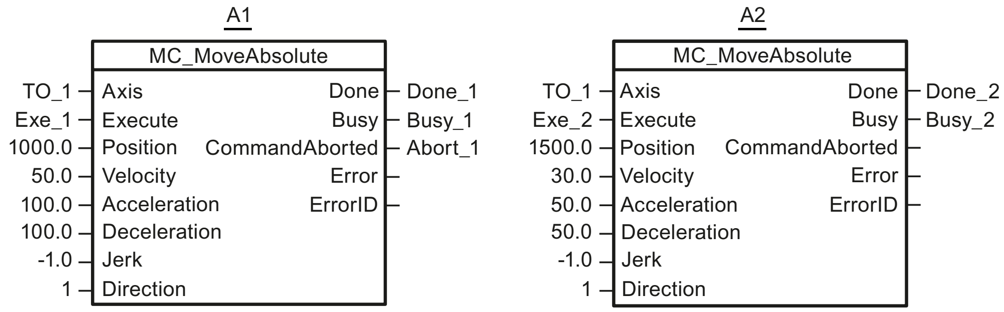
As long as the "Execute" or "Enable" parameter is set to TRUE, the output parameters will be updated. Otherwise the parameters "Done", "Error" and CommandAborted" are correspondingly only set for one cycle.

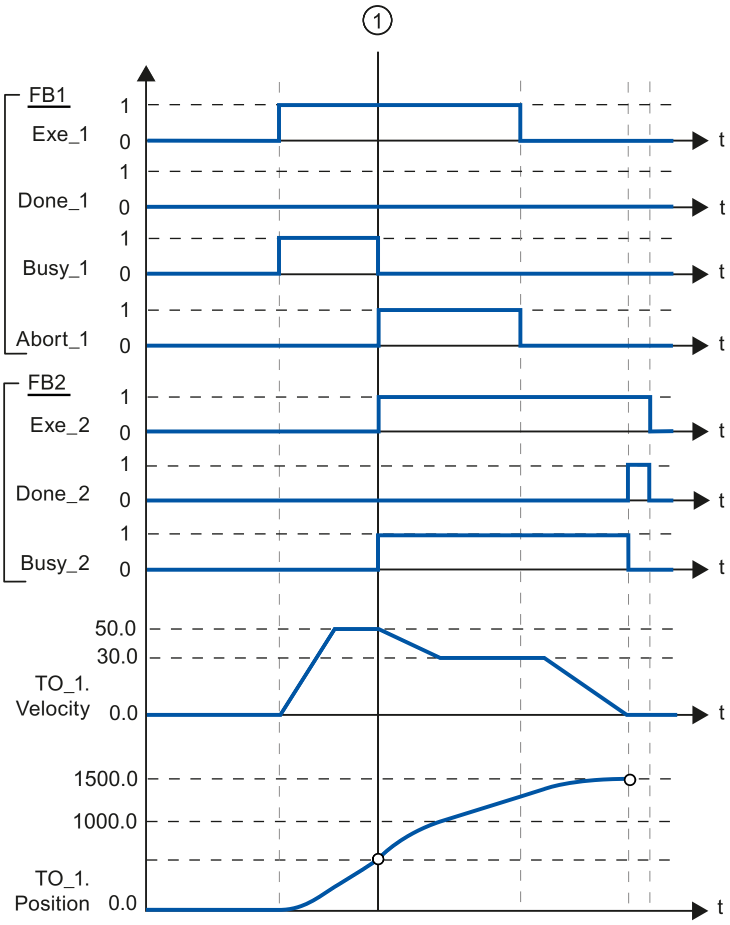
Termination of active jobs

A running Motion Control job is terminated by the initiation of a new Motion Control job. In the process, the current dynamic setpoints (acceleration, deceleration, jerk, velocity) are set to the values of the overriding job.

Example of parameter behavior

The behavior of the parameters of Motion Control instructions is shown by way of the example of two "MC_MoveAbsolute" jobs.





Using "Exe_1", an "MC_MoveAbsolute" job (A1) with target position 1000.0 is initiated. "Busy_1" is set to TRUE. The axis is accelerated to the specified velocity and moved to the target position (see TO_1.Velocity and TO_1.Position). Before the target position is reached, the job is overridden at time ① by another "MC_MoveAbsolute" job (A2). The abort is signaled via "Abort_1", and "Busy_1" is set to FALSE. The axis is braked to the velocity specified in A2, and moved to the new target position 1500.0. When the axis reaches the target position, this is signaled via "Done_2".

6.3.2 Add Motion Control instructions

You add Motion Control instructions to a program block in the same way as other instructions. You control all available functions of the technology object using the Motion Control instructions.

Requirements

The technology object was created.

Procedure

To add Motion Control instructions in your user program, proceed as follows:

1. Double click your program block in the Project Navigator (the program block must be called in the cyclical program).

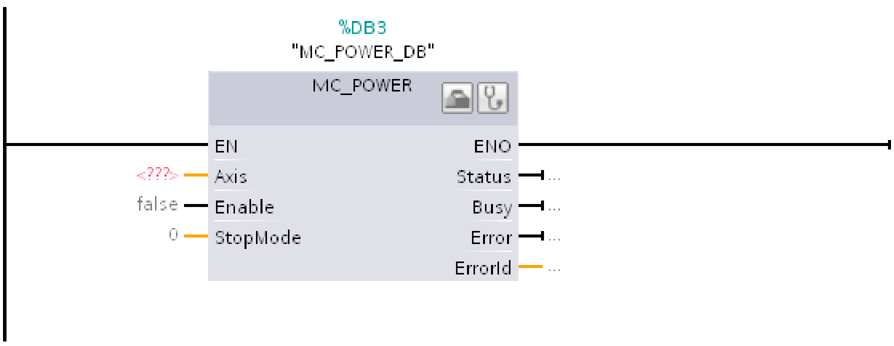
   The program block is opened in the programming editor, and the available instructions are displayed.

2. In the "Instructions" task card, open the "Technology > Motion Control > S7-1500 Motion Control" folder.
3. Drag and drop the Motion Control instruction, e.g. "MC_Power", into the desired segment of the program block.

   The "Call options" dialog opens.

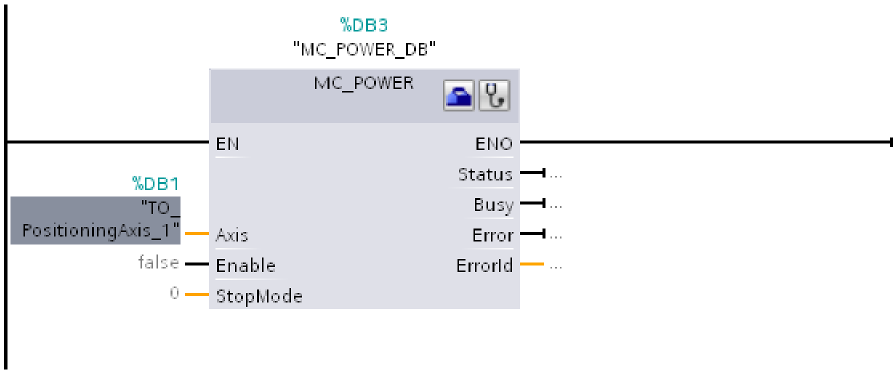
4. In the dialog, specify a name and a number for the instance data block of the Motion Control instruction.
5. Click "OK".

   The Motion Control instruction "MC_Power" is added to the segment.



   The instance data block is automatically created under "Program Blocks > System Blocks > Program Resources".

6. Input parameters without a default value (e.g. "Axis"), must be supplied.
   Mark the technology object in the Project Navigator, and drag and drop it to <...> in the "Axis" parameter.

   After specifying the technology object in the "Axis" parameter,
   the following buttons are available to you:

   To open the configuration of the technology object, click on the toolbox icon.

   To open the diagnostics of the technology object, click on the stethoscope icon.
7. Add additional Motion Control instructions in accordance with steps 3 through 6.

See also

Tracking active jobs (Page 152)

Technology data block tag (Page 243)

6.4 Starting Motion Control jobs

Description

Motion Control jobs are started by setting the "Execute" or "Enable" parameter of the Motion Control instruction. The call of the Motion Control instructions for a technology object should occur in an execution level.

When executing Motion Control jobs, you should also take note of the status of the technology object.

Starting Motion Control jobs should be performed in the following steps:

1. Query the status of the technology object.
2. Initiate new job for the technology object.
3. Check job status.

These steps are explained using the example of a job for absolute positioning.

1. Query the status of the technology object

Make sure that the technology object is in the appropriate status to perform the desired job:

- **Has the technology object been released?**

  To execute motion jobs, the technology object must be enabled.

  Enabling is performed using the Motion Control instruction "MC_Power".

  The "MC_Power.Status" parameter must show the value TRUE.

- **Is a technology alarm pending?**

  To perform motion jobs, no technology alarms may be pending. After resolving the error, acknowledge any possibly pending alarms using the Motion Control instruction "MC_Reset".

  A list of the technology alarms and alarm responses can be found in the appendix, Technology Alarms (Page 267).

- **Has the technology object been homed?**

  In order to perform a job for absolute positioning, the positioning axis technology object must be homed. The referencing occurs via the Motion Control instruction "MC_Home". The "<TO>.StatusWord.HomingDone " tag of the technology object must show the value TRUE .

2. Initiate new job for the technology object

Initiate a new job.

In the "Position" parameter of the "MC_MoveAbsolute" instruction, specify the position to which the axis should be moved. Start the job with a positive edge at the "Execute" parameter.

3. Check job status

Parameter "Done" of the Motion Control instruction indicates successful completion of a job (target reached, in this case).

If an error is detected, the "Error" parameter of the Motion Control instruction is set to TRUE, and the job is rejected.

You can program an error handling routine for the Motion Control job. For this purpose, evaluate the error indicated in the "Error" parameter. The cause of the error is indicated in the ErrorID parameter. After resolving the cause of the error, restart the job.

Output of the "Error" = TRUE and "ErrorID" = 16#8001 status information during job processing indicates that a technology alarm was triggered.

A list of the ErrorIDs can be found in the appendix, Error Detection (Page 270).

Additional information

An option for the evaluation of the individual status bits, error bits, and warning bits can be found in the Evaluating StatusWord, ErrorWord and WarningWord (Page 143) section.

6.5 Tracking active jobs

6.5.1 Introduction

The current status of the job processing is made available via the output parameters of the Motion Control instruction. These parameters are updated with each call of the Motion Control instruction.

When tracking jobs, a distinction is made between three groups:

- Motion Control instructions with "Done" parameter (Page 152)
- Motion Control instruction "MC_MoveVelocity" (Page 156)
- Motion Control instruction "MC_MoveJog" (Page 159)

6.5.2 Motion Control instructions with "Done" parameter

Description

Jobs for Motion Control instructions with the "Done" parameter are started with a positive edge at the "Execute" parameter. If the job was completed without errors and without interruption by another job (e.g. "MC_ MoveAbsolute": target position reached), then the "Done" parameter shows the value TRUE.

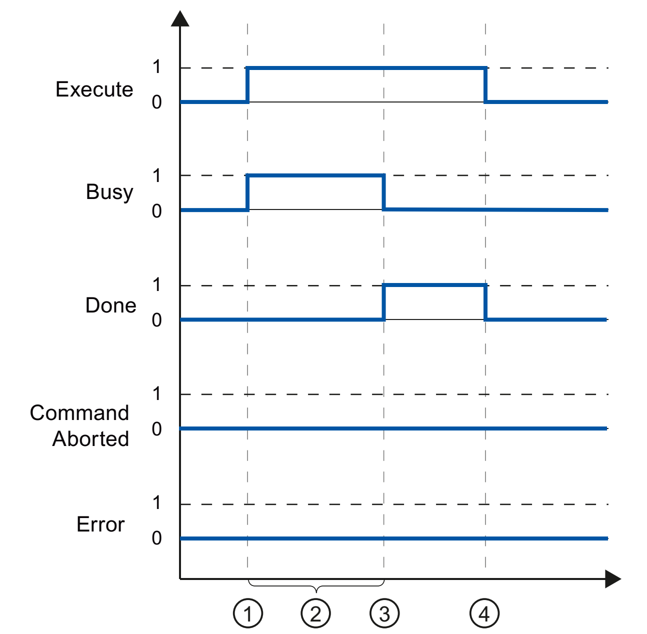
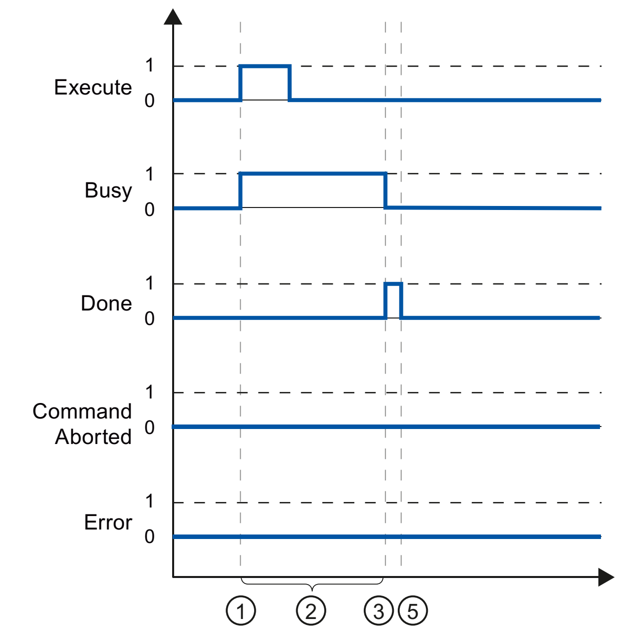
The following Motion Control instructions have a "Done" parameter:

- MC_Home
- MC_MoveRelative
- MC_MoveAbsolute
- MC_Halt
- MC_Reset

The behavior of the parameters is presented by way of example for various situations:

Complete execution of job

If the Motion Control job has been fully processed to the point of completion, then this is indicated in the "Done" parameter with the value TRUE. The signal status of the "Execute" parameter influences the indication duration in the "Done" parameter:

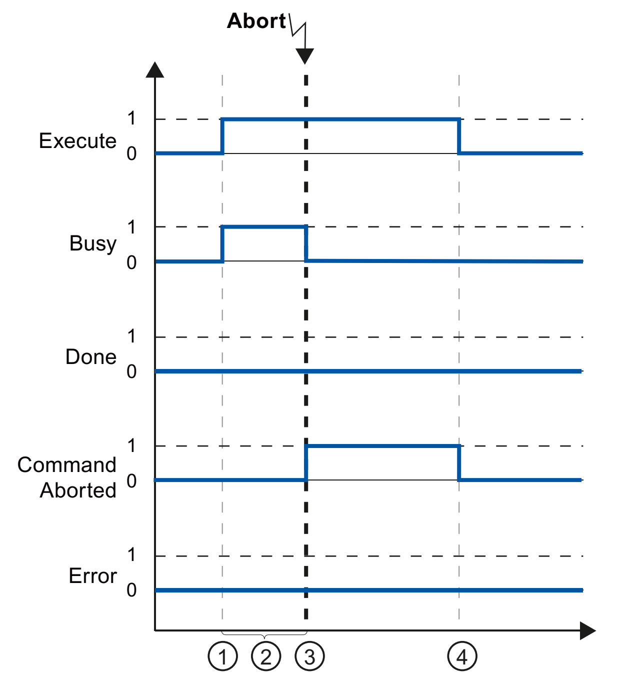
You set "Execute" **after completion** of the job to FALSE.	You set "Execute" **during processing** of the job to FALSE.
	

①	The job is started with a positive edge at the "Execute" parameter. Depending on the program, "Execute" can be reset to the FALSE value while the job is still busy, or retain the TRUE value until the job has been completed.
②	Parameter "Busy" returns the TRUE value while the job is executed.
③	When the job is complete (for example, for Motion Control instruction "MC_MoveAbsolute": target position reached) the "Busy" parameter changes to FALSE, and the "Done" parameter to TRUE.
④	As long as the "Execute" parameter retains the value TRUE after completion of the job, the "Done" parameter also retains the value TRUE.
⑤	If the "Execute" parameter has been set to FALSE before the job is complete, then the "Done" parameter only shows the value TRUE for one execution cycle.

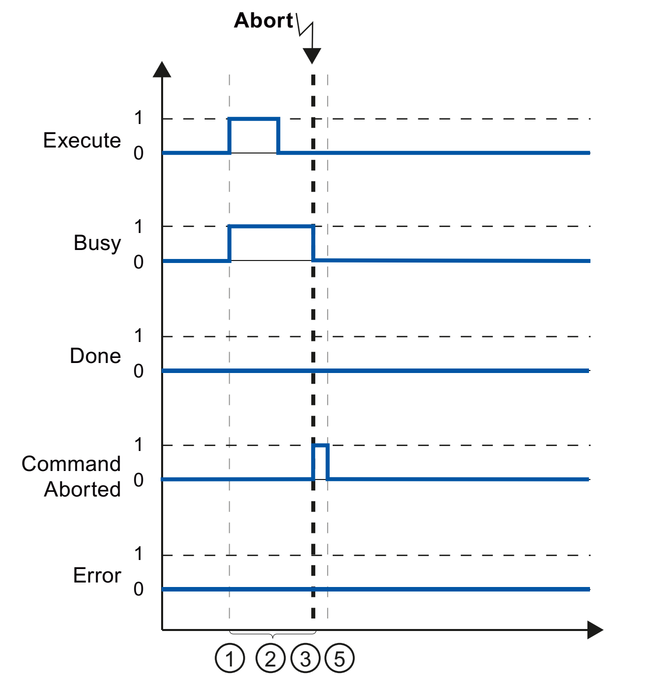
Job termination

If the Motion Control job is aborted during processing by another job, then this is indicated in the "CommandAborted" parameter with the value TRUE. The signal status of the "Execute" parameter influences the indication duration in the "CommandAborted" parameter:

You set "Execute" **after** the job is aborted to FALSE.



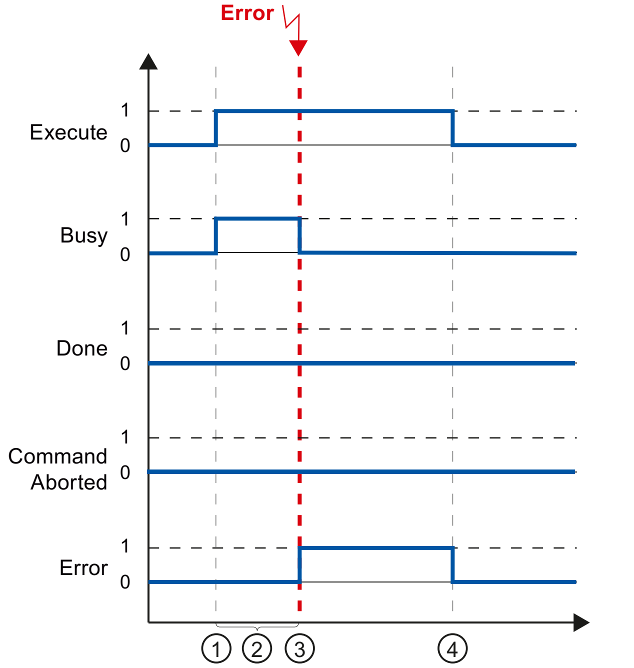
You set "Execute" **before** the job is aborted to FALSE.

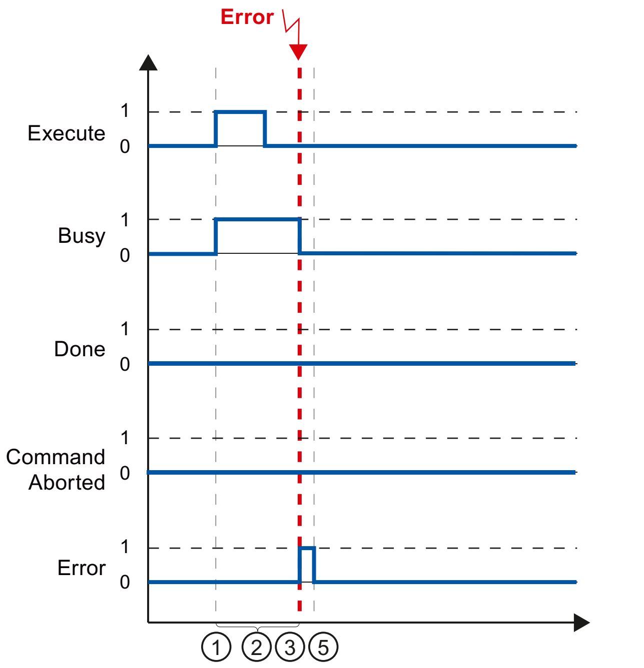


①	The job is started with a positive edge at the "Execute" parameter. Depending on the program, "Execute" can be reset to the FALSE value while the job is still busy, or retain the TRUE value until the job has been completed.
②	While the job is being processed, the "Busy" parameter shows the value TRUE.
③	During job execution, the job is aborted by another Motion Control job. When the job is aborted, the "Busy" parameter changes to "FALSE", and "CommandAborted" changes to TRUE.
④	As long as the "Execute" parameter retains the value TRUE after completion of the job, the "CommandAborted" parameter also retains the value TRUE.
⑤	If the "Execute" parameter has been set to FALSE before the job is aborted, then the "CommandAborted" parameter only shows the value TRUE for one execution cycle.

Error during job execution

If an error occurs during execution of the Motion Control job, then this is indicated in the "Error" parameter with the value TRUE. The signal status of the "Execute" parameter influences the indication duration in the "Error" parameter:

<table>
<tr><td>You set "Execute" after the occurrence of the error to FALSE.</td><td>You set "Execute" before the occurrence of the error to FALSE.</td></tr>
<tr><td>


</td><td>


</td></tr>
</table>

①	The job is started with a positive edge at the "Execute" parameter. Depending on the program, "Execute" can be reset to the FALSE value while the job is still busy, or retain the TRUE value until the job has been completed.
②	While the job is active, the "Busy" parameter shows the value TRUE.
③	An error occurs during the execution of the job. When the error occurs, the "Busy" parameter changes to "FALSE, and the "Error" parameter to TRUE.
④	As long as the "Execute" parameter retains the value TRUE after the occurrence of the error, the "Error" parameter also retains the value TRUE.
⑤	If the "Execute" parameter has been set to FALSE before the occurrence of the error, then the "Error" parameter only shows the value TRUE for one execution cycle.

6.5.3 Motion Control instruction "MC_MoveVelocity"

Description

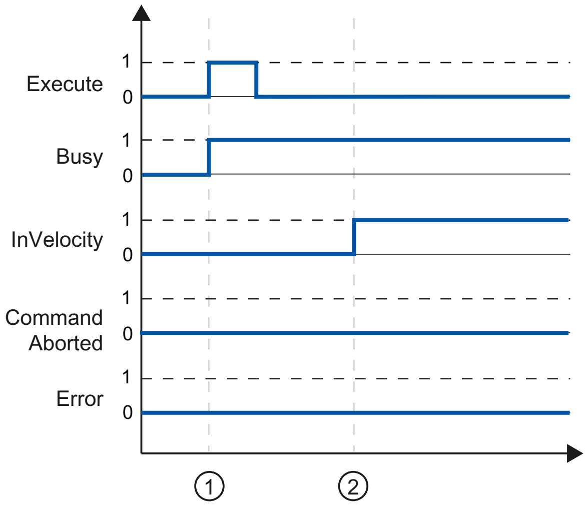
An "MC_MoveVelocity" job is started with a positive edge at the "Execute" parameter. The job objective is fulfilled when the assigned velocity is reached and the axis travels at constant velocity. When the assigned velocity is reached and maintained, this is indicated in the "InVelocity" parameter with the value TRUE.

The motion of the axis can, for example, be stopped with an "MC_Halt" job.

The behavior of the parameters is presented below for various example situations:

The assigned velocity is reached and maintained

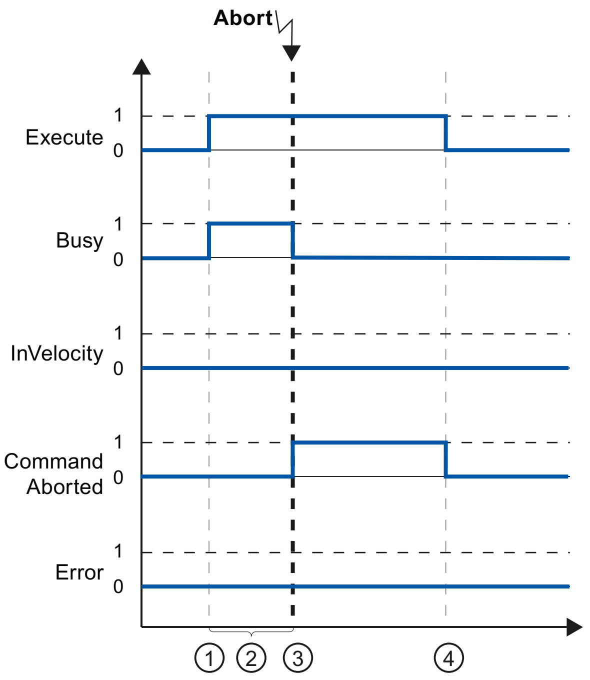
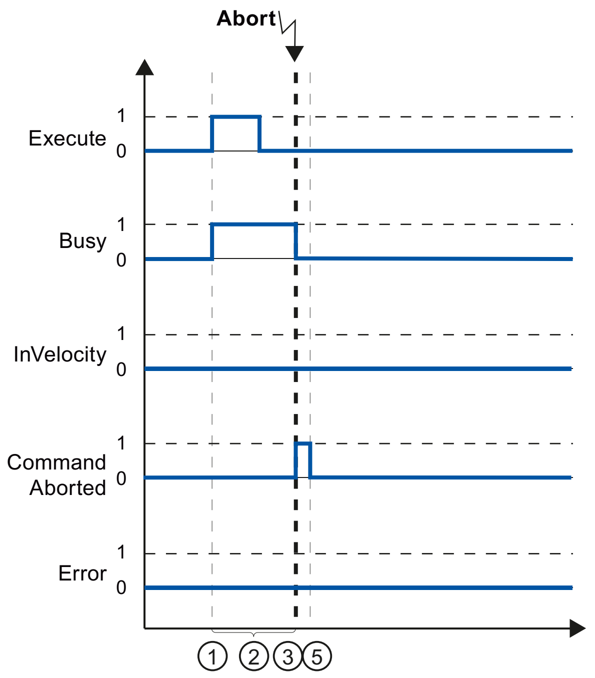
The achievement of the assigned velocity is indicated in the "InVelocity" parameter with the value TRUE. The "Execute" has no effect on the indication duration in the "InVelocity" parameter.



①	The job is started with a positive edge at the "Execute" parameter. Depending on the program, "Execute" can be reset to the FALSE value before or after the parameterized velocity has been reached. Parameter "Busy" returns the TRUE value while the job is executed.
②	When the assigned velocity is reached, the "InVelocity" parameter changes to TRUE. The "Busy" and "InVelocity" parameters retain the TRUE value until a different Motion Control job overrides the "MC_MoveVelocity" job.

The job is aborted prior to reaching the assigned velocity

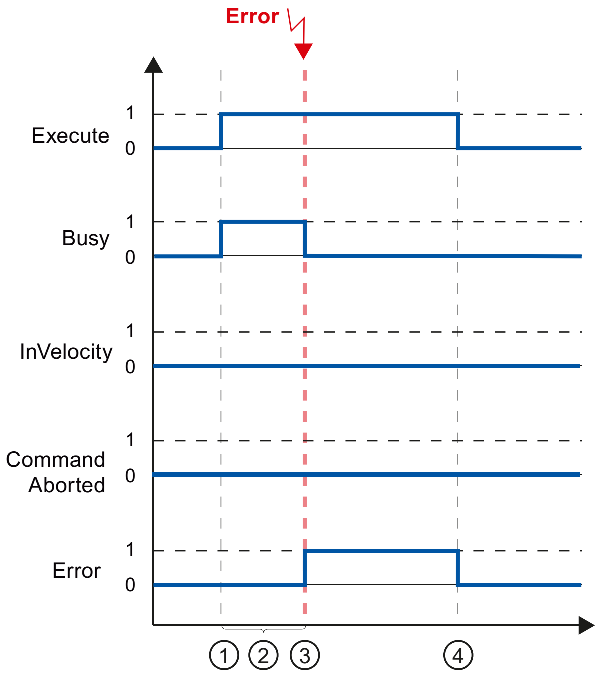
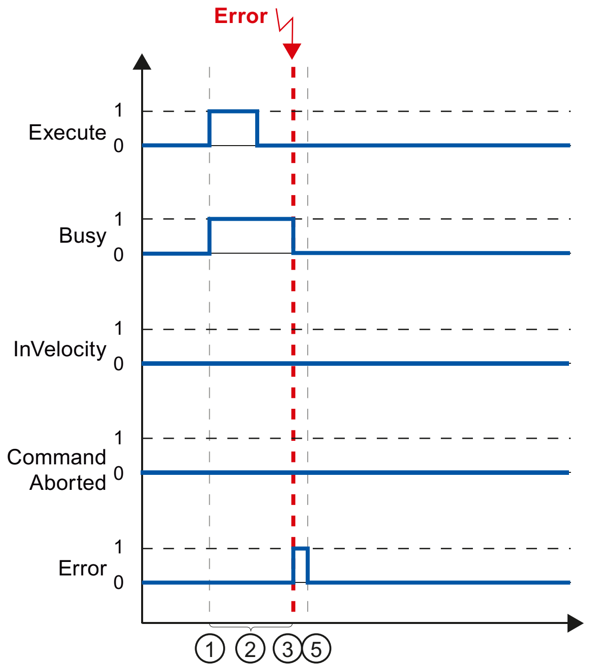
If the Motion Control job is aborted by another job before reaching the assigned velocity, then this is indicated in the "CommandAborted" parameter with the value TRUE. The signal status of the "Execute" parameter influences the indication duration in the "CommandAborted" parameter.

You set "Execute" **after** the job is aborted to FALSE.	You set "Execute" **before** the job is aborted to FALSE.
	

①	The job is started with a positive edge at the "Execute" parameter. Depending on the program, "Execute" can be reset to the FALSE value while the job is still busy, or retain the TRUE value until the job is aborted.
②	While the job is active, the "Busy" parameter shows the value TRUE.
③	During job execution, the job is aborted by another Motion Control job. When the job is aborted, the "Busy" parameter changes to "FALSE" and "CommandAborted" changes to TRUE.
④	As long as the "Execute" parameter retains the value TRUE after completion of the job, the "CommandAborted" parameter also retains the value TRUE.
⑤	If the "Execute" parameter has been set to FALSE before the job is aborted, then the "CommandAborted" parameter only shows the value TRUE for one execution cycle.

An error has occurred prior to reaching the assigned velocity

If an error occurs during execution of the Motion Control job before the assigned velocity has been reached, this is indicated in the "Error" parameter with the value TRUE. The signal status of the "Execute" parameter influences the indication duration in the "Error" parameter.

You set "Execute" **after** the occurrence of the error to FALSE.	You set "Execute" **before** the occurrence of the error to FALSE.
	

①	The job is started with a positive edge at the "Execute" parameter. Depending on the program, "Execute" can be reset to the FALSE value while the job is still busy, or retain the TRUE value until the error has occurred.
②	While the job is active, the "Busy" parameter shows the value TRUE.
③	An error occurs during the execution of the job. When the error occurs, the "Busy" parameter changes to FALSE and the "Error" parameter to TRUE.
④	As long as the "Execute" parameter retains the value TRUE after completion of the job, the "Error" parameter also retains the value TRUE.
⑤	If the "Execute" parameter has been set to FALSE before the job is aborted, then the "Error" parameter only shows the value TRUE for one execution cycle.

6.5.4 Motion Control instruction "MC_MoveJog"

Description

An "MC_MoveJog" job is started by setting the "JogForward" or "JogBackward" parameter. The job objective is fulfilled when the assigned velocity is reached and the axis travels at constant velocity. When the assigned velocity is reached and maintained, this is indicated in the "InVelocity" parameter with the value TRUE.

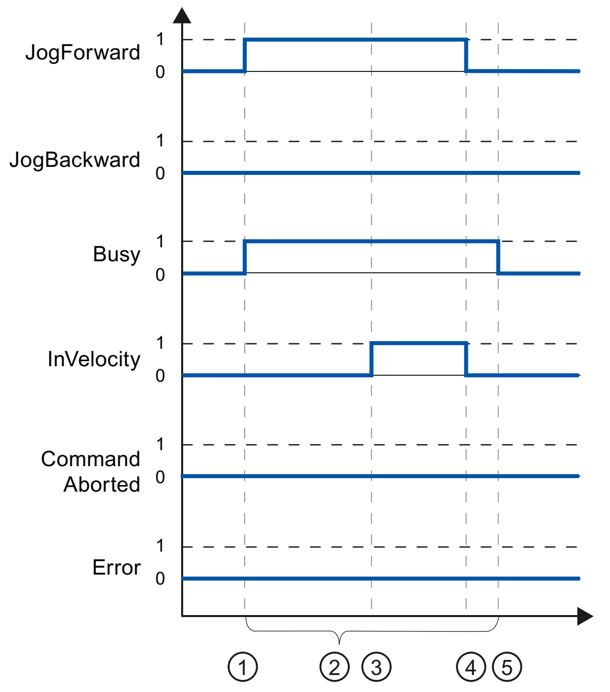
The job is complete when the "JogForward" or "JogBackward" parameter has been set to the value FALSE and the axis has come to a standstill.

The behavior of the parameters is presented below for various example situations:

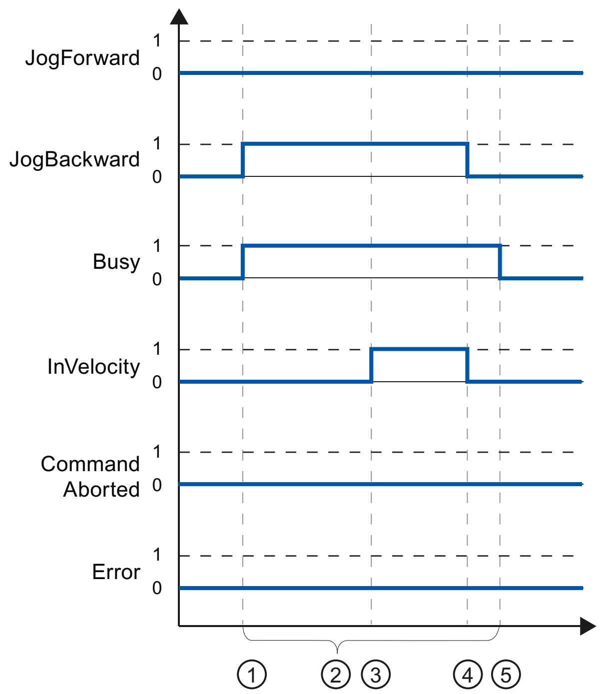
The assigned velocity is reached and maintained

If the Motion Control job has been performed up to the point of reaching the assigned velocity, then this is indicated in the "InVelocity" parameter with the value TRUE.

Jog mode is controlled by the "JogForward" parameter.



Jog mode is controlled by the "JogBackward" parameter.

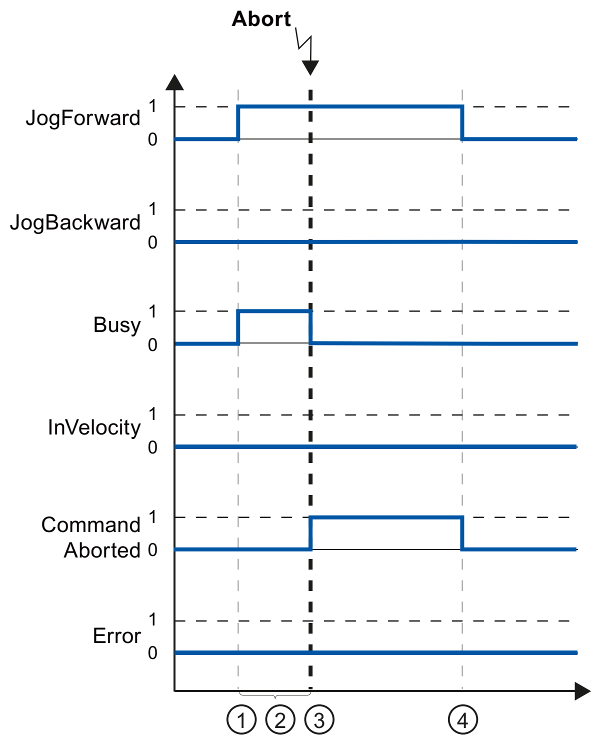


①	The job is started by setting the "JogForward" or "JogBackward" parameter.
②	While the job is active, the "Busy" parameter shows the value TRUE.
③	When the assigned velocity is reached, the "InVelocity" parameter changes to TRUE.
④	When the "JogForward" or "JogBackward" parameter is reset, the motion of the axis ends. The axis decelerates. The "InVelocity" parameter changes to FALSE.
⑤	If the axis has come to a standstill, then the Motion Control job is complete and the "Busy" parameter changes to FALSE.

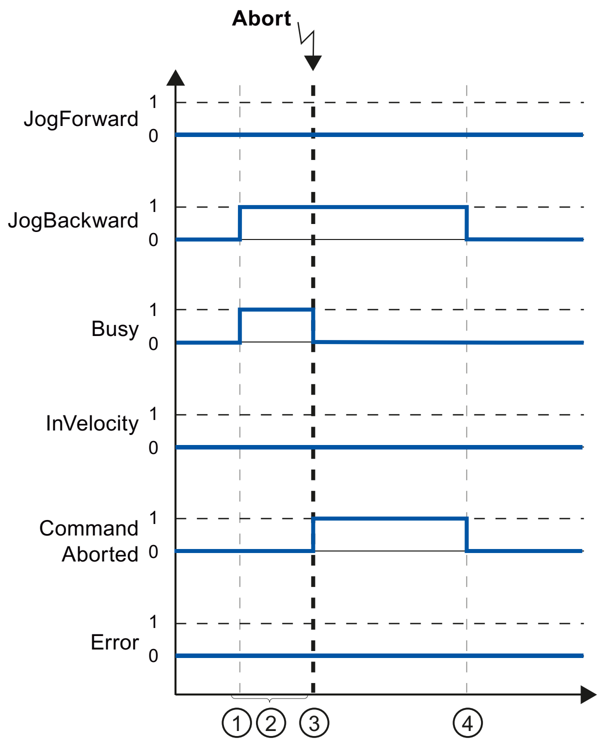
The job is aborted during execution

If the Motion Control job is aborted during processing by another job, then this is indicated in the "CommandAborted" parameter with the value TRUE. The behavior of the "CommandAborted" parameter is independent of reaching the assigned velocity.

Jog mode is controlled by the "JogForward" parameter.



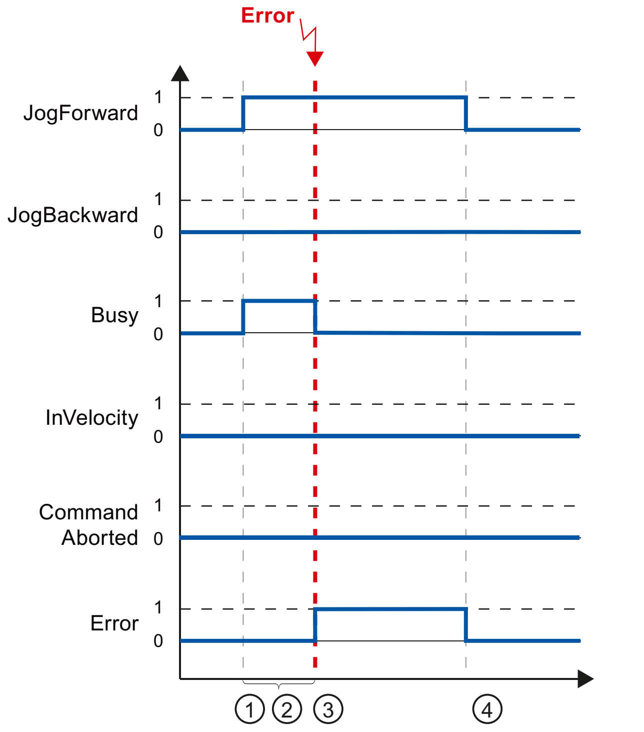
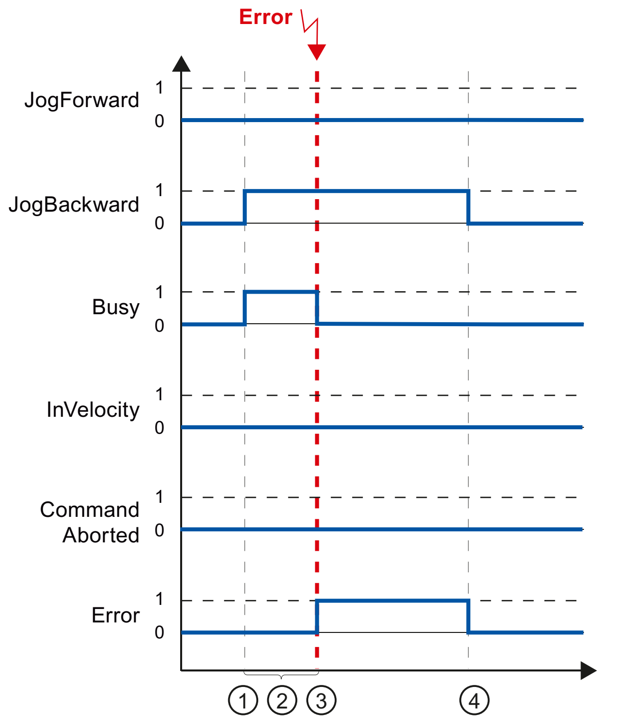
Jog mode is controlled by the "JogBackward" parameter.



①	The job is started by setting the "JogForward" or "JogBackward" parameter.
②	While the job is processing, the "Busy" parameter shows the value TRUE.
③	During job execution, the job is aborted by another Motion Control job. When the job is aborted, the "Busy" parameter changes to "FALSE" and "CommandAborted" changes to TRUE.
④	When the "JogForward" or "JogBackward" parameter is reset, the "CommandAborted" parameter likewise changes to FALSE.

An error occurs during the execution of the job

If an error occurs during execution of the Motion Control job, this is indicated in the "Error" parameter with the value TRUE. The behavior of the "Error" parameter is independent of reaching the assigned velocity.

Jog mode is controlled by the "JogForward" parameter.	Jog mode is controlled by the "JogBackward" parameter.
	

①	The job is started by setting the "JogForward" or "JogBackward" parameter.
②	While the job is active, the "Busy" parameter shows the value TRUE.
③	An error occurs during the execution of the job. When the error occurs, the "Busy" parameter changes to "FALSE", and "Error" changes to TRUE.
④	When the "JogForward" or "JogBackward" is reset to the value FALSE, the "Error" parameter likewise changes to FALSE.

6.6 Ending Motion Control jobs

When ending a job, a distinction is made between error-free completion of the job, and the termination of a motion.

Completion of the job

The completion of a Motion Control job is indicated as described in the Tracking running jobs (Page 152) section.

Termination of a motion

If a motion must be aborted, you can perform the following measures:

- "Execute MC_Halt (Page 236)"

  To abort a motion and stop the axis, you can use the "MC_Halt" instruction.

- "Disable MC_Power (Page 205)"

  In an emergency, you can stop the axis using an emergency stop ramp.
  For this purpose, set the "Enable" parameter of the "MC_Power" instruction to FALSE.
  The axis is decelerated according to the selected "StopMode" and all jobs at the technology object are aborted.

6.7 Restart of technology objects

Description

After the CPU is switched on, or after technology objects are downloaded into the CPU, the system automatically initializes the technology objects with the start values from the technology data blocks. If restart-relevant changes are detected during a reload into the CPU, a restart of the technology object is automatically performed.

If restart-relevant data have been changed in RUN mode by the user program, then the technology object must be reinitialized by the user in order for the changes to be used.

If changes in the technology data block should also be retained after the restart of the technology object, then you must write the changes to the start value in load memory using the extended instruction "WRIT_DBL".

Restart necessary

A necessary TO restart is indicated at "Technology object > Diagnostics > Status and error bits > Axis status or Encoder status > Online start value changed", as well as in the tag of technology object <TO>.StatusWord.OnlineStartValuesChanged.

Restarting a technology object

A restart of the technology object is triggered by the user by means of the "MC_Reset" Motion Control instruction, with parameter "Restart" = TRUE.

During a restart, all configuration data of the technology object are loaded from load memory into work memory. In the process, the actual values in the technology data block are overwritten.

Note the following during a restart of the technology object:

- A restart resets the "Referenced" status of a technology object with incremental actual values (<TO>.StatusWord.HominDone).
- While a restart is being performed, the technology object cannot perform any jobs.
  An active restart will be indicated under "Technology object > Diagnostics > Status and error bits > Axis status or Encoder status > Restart active", and in the <TO>.StatusWord.RestartActive tag of the technology object.
- Motion Control jobs are rejected during a restart with the "Error" = TRUE and "ErrorID" = 16#800D parameters (job not executable, because a restart is active).
- While a restart is being executed, you cannot access the technology data block.

See also

Change restart-relevant data (Page 144)

7 Downloading to CPU

Description

When downloading to the CPU S7-1500, it is always verified that the project files are consistent online and offline after the download.

The data of the technology objects are saved in technology data blocks.
The conditions for downloading blocks thus apply when loading new or modified technology objects.

You can load the following object groups into the CPU:

Context menu command "Download to device"	Description
Hardware and software	Download all new and modified blocks, and a new or modified hardware configuration
Hardware configuration	Download a new or modified hardware configuration
Software (changes only)	Download all new and modified blocks.
Software (all blocks)	Download all blocks.

Load in RUN mode

When loading in the CPU's RUN mode, it is checked whether a load without restart of the technology objects is possible.

If restart-relevant configuration values were changed, then a restart of the technology object is automatically performed after the load into the CPU.

Loading a technology object is only possible if the technology object is disabled.

Commissioning 8

8.1 Introduction

The following guidelines describe the steps that you should note when commissioning the Motion Control-specific components of your equipment.

The commissioning of other components of your automation system depends on the particular equipment configuration. Commissioning (not Motion Control) is described in the Automation System S7-1500 (http://support.automation.siemens.com/WW/view/en/59191792) system manual.

8.2 Commissioning guidelines

These guidelines serve as recommendations for commissioning equipment with Motion Control. The procedure is described using the example of a positioning axis technology object.

Requirements

- The configuration of the following components is complete:
  - CPU
  - BUS communication
  - Drives
  - Technology objects
- The user program has been created.
- The wiring of the CPU and of the associated I/O is complete.
- The commissioning and optimization of the drive is complete.

Procedure

Proceed as follows to commission the Motion Control-specific components of your equipment:

Step	Action to be performed	Supported by TIA Portal
Turn on CPU	Turn on the power supply and the CPU.	-
"Disable" position controller	Set the gain (Kv factor) of the position control loop to zero. (This setting avoids unwanted drive movements that may be caused by incorrect parameterization of the position control loop.)	"Technology object > Configuration > Extended parameters > Control loop"
Load project into the CPU	Bring the CPU to the STOP mode. Download your project to the CPU (load hardware and software).	• "Toolbar > Stop CPU" • "Toolbar > Download to device"
Create online connection to the CPU	Select the "Receive messages" check box under "Online & Diagnostics > Online Access". Configure the interface of the TIA Portal, and create an online connection with the CPU.	• Device configuration • "Online & Diagnostics > Online Access"
Disable Motion Control specific user program	In order to avoid conflicts with the axis control panel, lock the enabling of technology objects in your user program (MC_Power.Enable = FALSE).	• PLC programming • Motion Control instructions
Evaluating pending messages	Evaluate the message display in the inspector window. Resolve the causes of pending technology alarms. Acknowledge the technology alarms (Page 186).	"Inspector window > Diagnostics > Message display"
Check hardware limit switches	Click the hardware limit switches. Check for correct message display (technology alarm 531). Acknowledge the technology alarm.	"Inspector window > Diagnostics > Message display"
Check the connection and configuration of the drive (setpoint)	Bring the CPU into the RUN mode. Open the Axis control panel (Page 170) and take over control. Perform the following steps: • Enable the technology object. ⇒ The drive must turn itself on, and where applicable release the brake. The position is held. • Move the axis in jog mode at low velocity in the positive direction. ⇒ The drive must move. The actual position value must increase (positive direction). • Disable the technology object. ⇒ The drive must turn itself off, and where applicable apply the brake.	"Technology object > Commissioning > Axis control panel"
Check the connection and configuration of the encoder (actual value)	Check the scaling of the actual values (rotation direction, distance evaluation, and resolution of the encoder) ⇒ The change in the actual mechanical position must match the change in the actual values.	• "Technology object > Diagnostics > PROFIdrive frame" • "Technology object > Commissioning > Axis control panel"

Step	Action to be performed	Supported by TIA Portal
Optimize position controller	Use the Optimization (Page 176) commissioning function to optimize the gain (Kv) of the position control loop. For this purpose, adapt following error limits as needed.	"Technology object > Commissioning > Optimization"
Transfer the gain Kv to the project.	Enter the gain Kv that you determined by means of the optimization function in your configuration data. Load your project into the CPU.	"Technology object > Configuration > Extended parameters > Control loop"
Enable Motion Control specific user program	Unlock the enabling technology objects lock in your user program (MC_Power.Enable = TRUE).	• PLC programming • Motion Control instructions
Check the functioning of the user program	Check the programmed functions of your user program.	• Watch and force tables • Online and diagnostic functions
End of commissioning for a positioning axis technology object	To commission additional technology objects, perform the corresponding steps again.	See above.

8.3 Axis control panel

8.3.1 Function and structure of the axis control panel

Description

The axis control panel offers you the option of moving individual axes.

A user program is necessary for the operation of the axis control panel.
Via the TIA Portal, you can take over master control, and control the motions of the axis.

> ⚠ **WARNING**
>
> **Uncontrolled axis motions**
>
> During operation with the axis control panel, the axis can execute uncontrolled motions (e.g. due to erroneous configuration of the drive, or of the technology object).
>
> Therefore, perform the following protective measures before operation with the axis control panel:
>
> - Ensure that the EMERGENCY OFF switch is within the reach of the operator.
> - Enable the hardware limit switches.
> - Enable the software limit switches.
> - Ensure that following error monitoring is enabled.

The axis control panel of the speed-controlled axis and positioning axis can be found in the Project Navigator under "Technology object > Commissioning".

The axis control panel is divided into the following areas:

- Master control
- Axis
- Operating mode
- Controller
- Axis status
- Current values

"Master control" area

In this area, you can take over master control of the technology object, or return it to your user program.

- "Fetch" button

  Click "fetch" to set up an online connection to the CPU and take over master control for the selected technology object.

  – To take over master control, the technology object must be disabled in the user program.

  – If the online connection to the CPU fails during operation with the axis control panel, then after expiration of the signs of life monitoring, the axis will be stopped with maximum deceleration. In this case, an error message is displayed ("ErrorID" = 16#8013) and the control priority is passed back to the user program.

  – Until master control is returned, the user program has no influence on the functions of the technology object. Motion Control jobs from the user program to the technology object are rejected with the error ("ErrorID" = 16#8012: axis control panel enabled).

  – When master control is taken over, the configuration of the technology object is applied. Changes to the configuration of the technology object do not become effective until the master control has been returned. For this reason, make any changes that may be necessary before master control is taken over.

- "Relinquish" button

  Click the "Relinquish" button to return master control to your user program.

"Axis" area

In this area, you can enable or disable the technology object:

- "Enable" button

  Click the "Enable" button to activate the selected technology object. The enable is required to execute motion jobs on the axis.

- "Disable" button

  Click the "Disable" button to deactivate the selected technology object.

"Operation mode" area

Select the desired function in the drop-down list.

The following functions are available:

- **"Homing"**

  This function corresponds to active homing. The parameters for homing must be configured (see the Homing (Page 34) section).

- **"Set homing point"**

  This function corresponds to direct homing (absolute). Click "Set homing point" in the "Controller" area to set the actual position to the value specified in "Position" and to set the "Homed" state.

- **"Jog mode"**

  Motion commands occur by means of jogging. In the "Controller" area, click the "Forward" or "Backward" button to initiate a motion in the positive or negative direction.
  The motion runs for as long as you hold down the left mouse button.

- **"Predefined velocity"**

  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".

- **"Relative positioning"**

  The positioning is executed as a controlled, relative traversing motion according to the defaults assigned under "Controller".

- **"Absolute positioning"**

  The positioning is executed as a controlled, absolute traversing motion according to the defaults assigned under "Controller".

  If you have enabled the "Modulo" setting of the technology object, the buttons "Forward" and "Backward" are shown in the "Controller" area. You can leave the valid Module range with these buttons.

  If you have not enabled the "Modulo" setting of the technology object, only the "Start" button is shown in the "Controller" area. You can directly approach the entered position.

"Controller" area

You control the selected function in this area:

- Using the axis control panel, configure the following motion parameters according to the selected mode:
  - **"Position"**

    Homing and set homing point modes only
  - **"Distance"**

    Relative positioning mode only
  - **"Target position"**

    Absolute positioning mode only
  - **"Velocity"**

    Velocity specification, jog and positioning modes only

    Default: 10% of default value
  - **"Acceleration"**

    Default: 10% of default value
  - **"Deceleration"**

    Default: 10% of default value
  - **"Jerk"**

    Default: 100% of default value

  Note

  No transfer of the parameters

  The configured parameter values are discarded after master control is returned.

  Transfer the values as needed into your configuration.

- **"Start" button**

  Click the "Start" button to initiate a job in accordance with the selected operating mode.
- **"Forward" and "Backward" buttons**

  Click the "Forward" or "Backward" button to initiate a motion in the positive or negative direction in accordance with the selected operating mode.
- **"Stop" button**

  Click the "Stop" button to abort a job or pause the axis.
- **"Set homing point" button**

  Set homing point mode only

  Click the "Set homing point" button to set the actual position to the value specified in "Position".

"Axis status" area

This area displays the current status of the axis and drive:

- "Drive switched on"

  The drive is ready to execute setpoints.
- "Error"

  An error has occurred at the technology object.
- "Enabled"

  The technology object is enabled. The axis can be controlled with Motion Control instructions.
- "Homed"

  The technology object is homed.
- "More"

  Click "More" to open the "Technology object > Diagnostics > Status and error bits" dialog.
- "Pending error"

  The error that occurred most recently is displayed in the "Pending error" text box.
- "Acknowledge" button

  Click "Acknowledge" to acknowledge pending errors.

"Current values" area

The "Position" and "Velocity" fields indicate the actual position and the actual velocity of the axis.

8.3.2 Using the axis control panel

Requirements

- The CPU must be in the RUN mode.
- The project has been created and loaded into the CPU.
- The technology object is disabled.

Procedure

Proceed as follows to enable control the axis using the axis control panel:

1. Click "Fetch" in the "Master control" area to assume master control over the technology object and to set up an online connection to the CPU.

   A warning message is displayed. Click "OK" to confirm.
2. In the "Axis" area, click the "Enable" button to enable the technology object.
3. In the drop-down list in the "Operation mode" area, select the desired function of the axis control panel.
4. In the "Controller" area, specify the corresponding parameter values for your job.
5. Click the "Start", "Forward" or "Backward" button to start the job.
6. Click the "Stop" button to stop the job.
7. Repeat steps 3 through 6 for additional jobs.
8. In the "Axis" area, click the "Disable" button to disable the technology object.
9. In the "Master control" area, click the "Relinquish" button to return master control to your user program.

8.4 Optimization

8.4.1 Function and structure of the optimization

Description

The "Optimization" function supports you in determining the optimal gain (Kv factor) for the position control of the axis. The axis velocity profile is recorded by means of Trace function to this effect for the duration of a configurable positioning movement. Then you can evaluate the recording, and adapt the gain accordingly.

The "Optimization" function for the positioning axis technology object can be found in the Project Navigator under "Technology object > Commissioning".

The "Optimization" dialog is divided into the following areas:

- Master control
- Axis
- Optimize gain
- Trace

"Master control" area

In this area, you can take over master control of the technology object, or return it to your user program.

- "Fetch" button

  Click "fetch" to set up an online connection to the CPU and take over master control for the selected technology object.

  – To take over master control, the technology object must be disabled in the user program.

  – If the online connection to the CPU fails during operation with the axis control panel, then after expiration of the signs of life monitoring, the axis will be stopped with maximum deceleration. In this case, master control is returned to the user program.

  – Until master control is returned, the user program has no influence on the functions of the technology object. Motion Control jobs from the user program to the technology object are rejected with the error ("ErrorID" = 16#8012: axis control panel enabled).

  – When master control is taken over, the configuration of the technology object is applied. Changes to the configuration of the technology object do not become effective until the master control has been returned. For this reason, make any changes that may be necessary before master control is taken over.

- "Relinquish" button

  Click the "Relinquish" button to return master control to your user program.

"Axis" area

In this area, you can enable or disable the technology object:

- "Enable" button

  Click the "Enable" button to activate the selected technology object.
  The enable is required to execute motion jobs on the axis.

- "Disable" button

  Click the "Disable" button to deactivate the selected technology object.

"Optimize gain" area

You make the settings for optimization of the gain in this area:

- "Gain"

  This field displays the current gain of the position control (Kv).

  A drop-down list opens when you click the lightning icon.
  The drop-down list contains the following gain values:

  – Online actual value

  – Online start value

  – Start value project

    In the input field for the actual value, enter the new value for the gain.
    The new value is applied by clicking the "Start" button.

- "Distance"

  In this field, specify the distance for a test step.

- "Measurement duration"

  In this field, specify the duration for a test step.

- "Adapt dynamic values" checkbox

  Select this check box, if you want to adapt the dynamic values for acceleration and maximum velocity for the optimization.

- "Acceleration"

  This field indicates the default acceleration.

- "Maximum acceleration"

  This field indicates the default setting for the maximum acceleration.

- "Forward" and "Backward" buttons

  Click the "Forward" or "Backward" button to start a test step for optimization in the positive or negative direction.

Note

No transfer of the parameters

The configured parameter values are discarded after master control is returned.

Transfer the values as needed into your configuration. You can apply the gain value in your configuration using the "Project start value" value.

"Trace" area

The Trace function is displayed In the lower area of the "Optimization" dialog.

When you click the "Forward" or "Backward" button, a trace recording of the required parameters is automatically started and is displayed after completion of the test step.

After returning master control, the trace recording is deleted.

See also

Control (Page 52)

8.4.2 Optimize position controller

Requirements

- The CPU must be in the RUN mode.
- The project has been created and loaded into the CPU.
- The technology object is disabled via your user program (MC_Power.Enable = FALSE).

Optimizing position control gain (Kv)

Proceed as follows to optimize the gain (Kv):

1. In the "Master control" area, click the "Fetch" button to fetch master control for the technology object, and to establish an online connection to the CPU.

   A warning message is displayed. Click "OK" to confirm.
2. In the "Axis" area, click the "Enable" button to enable the technology object.
3. As appropriate, configure values for the distance, duration, and dynamics of a test step.
4. Enter a start value for the gain. Start with a low value.
5. Click the "Start" button to start a test step for the optimization.
   For the specified duration, a setpoint is output in accordance with the specified distance. The axis moves by the specified distance. A trace recording of the motion (setpoint and actual values) is created automatically.

Note

Adapt following error limits

If error messages from following error monitoring are repeatedly displayed during optimization, temporarily adapt the following error limits.

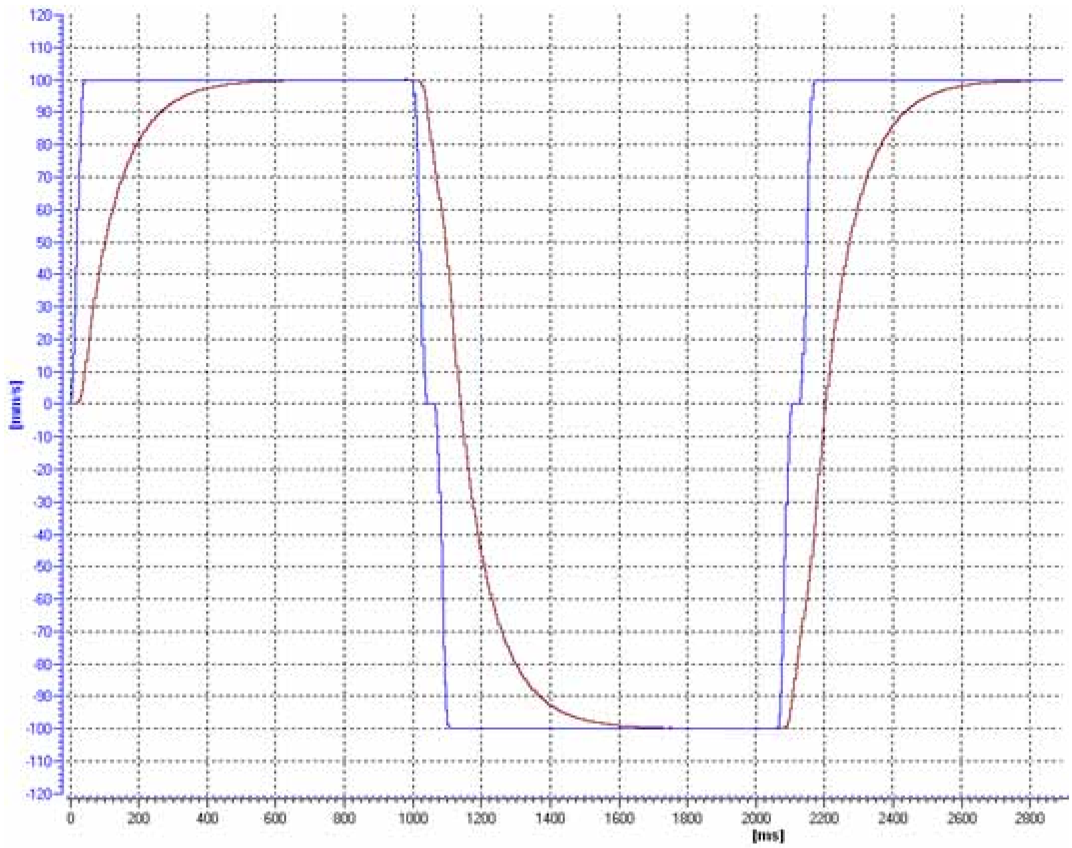
---

6. Evaluate the curve of the trace recording. Adapt the gain incrementally. Click the "Start" button after each value that you input. This applies the value and start a new movement and trace recording each time.

When adjusting the gain, pay attention to the following properties of the curve:

- The curve shows a brief compensation time.
- The curve does not show any motion reversal of the actual value.
- When approaching the setpoint, no overshoot occurs.
- The curve shows a stable overall behavior (oscillation-free curve).

The following trace recording shows a curve in which the gain is too low:

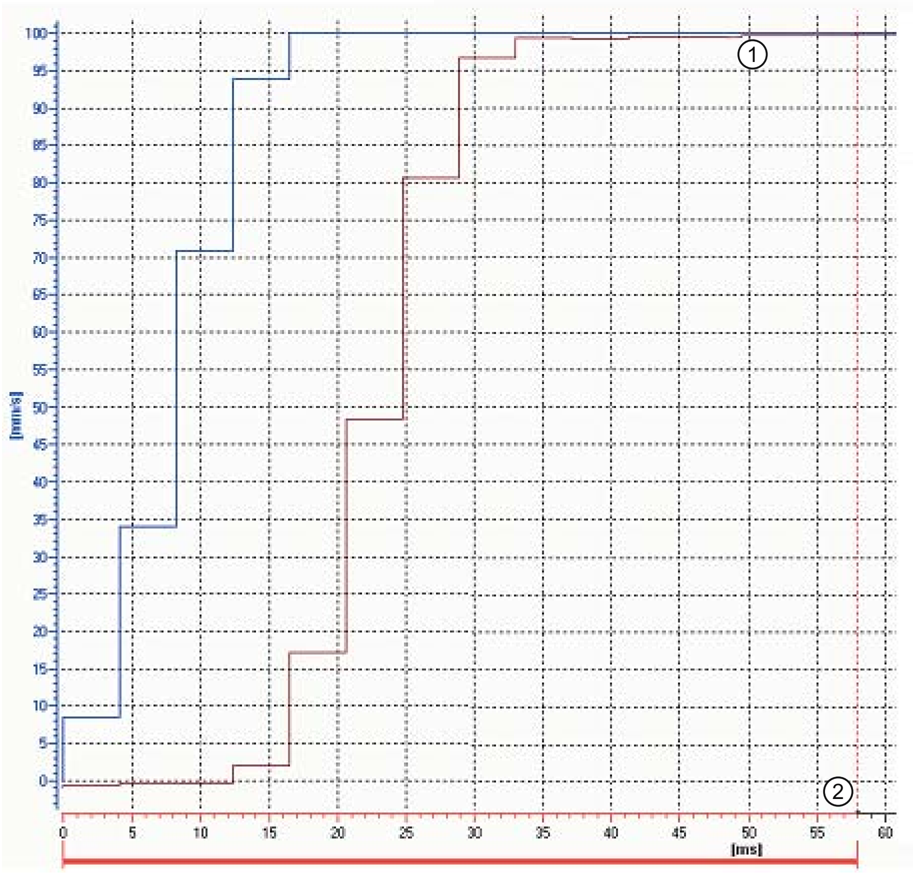


Setpoint velocity of the axis

Actual axis velocity

The curve shown has no overshoot, but shows considerable settling time.
You need to increase the gain to optimize the position controller.

The following trace recording shows a curve in which the gain is optimal (detail view):



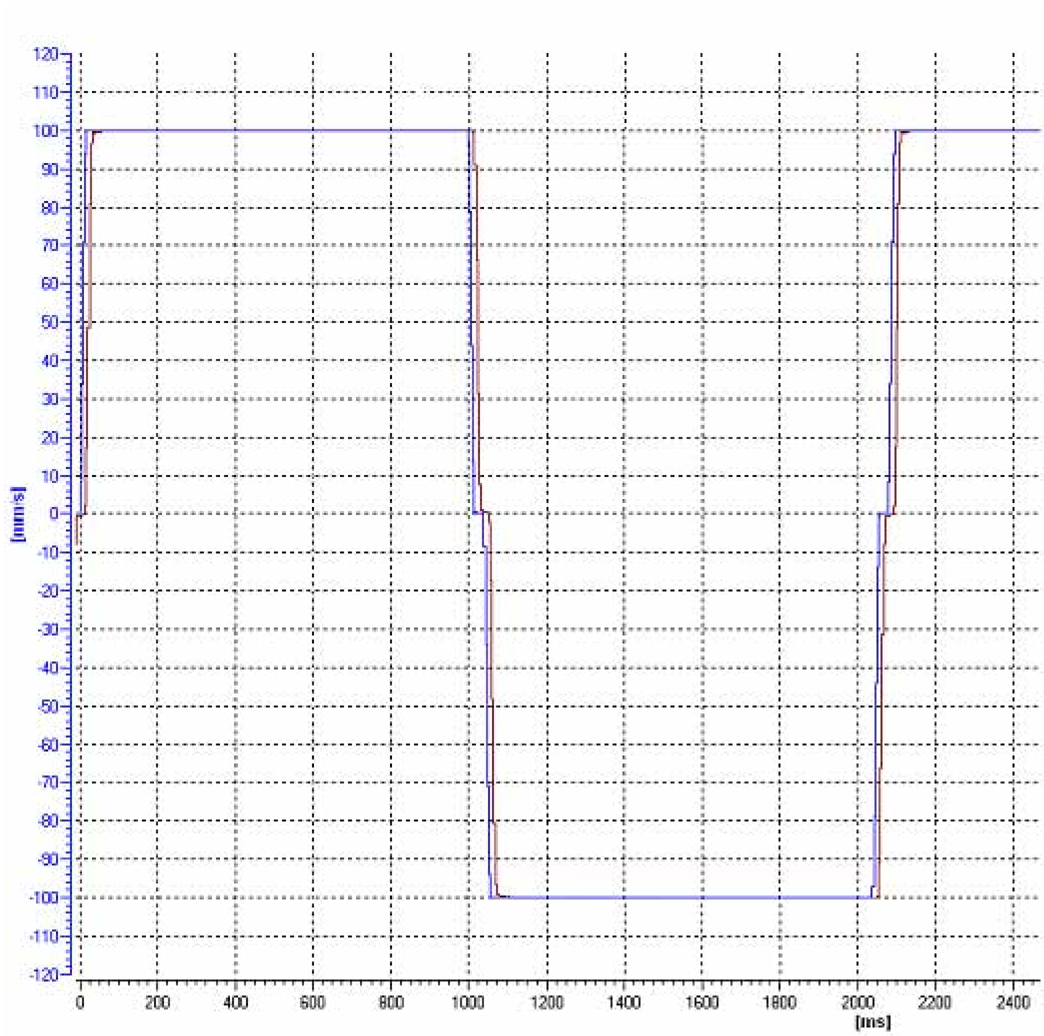
Setpoint velocity of the axis

Actual axis velocity

① No overshoot

② Fast settling time

The following trace recording shows a curve in which the gain is optimal and the overall response is steady:



Setpoint velocity of the axis

Actual axis velocity

Transferring the position control gain (Kv) to the project

Proceed as follows to transfer the determined gain (Kv) into your project:

1. Click on the lightning icon next to the "Gain" field.

   A drop-down list is displayed.
2. Enter the determined gain value in the "Project start value" field of the drop-down list.
3. In the "Axis" area, click the "Disable" button to disable the technology object.
4. In the "Master control" area, click the "Relinquish" button to return master control to your user program.
5. Load your project into the CPU.

Diagnostics 9

9.1 Introduction

The Diagnostics chapter is limited to describing the diagnostic concept for Motion Control, and describing the Diagnostics view of the individual technology objects in the TIA Portal.

For more information about system diagnostics with the S7-1500 CPU, refer to the "System diagnostics" (http://support.automation.siemens.com/WW/view/en/59192926) function manual

9.2 Diagnostic concept

The diagnostic concept encompasses alarms and associated messages, as well as error messages in the Motion Control instructions. The TIA Portal also supports you with consistency checks during configuration of the technology objects, and during the creation of your user program.

All alarms during operation (from the CPU, technology, hardware etc.) are displayed in the Inspector window of the TIA Portal. Diagnostic information that relates to technology objects (technology alarms, status information) are additionally displayed in the Diagnostics window of the respective technology object.

During Motion Control, if an error occurs at a technology object (e.g. approaching a hardware limit switch), then a technology alarm (Page 186) is triggered, and a corresponding message is displayed in the TIA Portal as well as on HMI devices.

In your user program, technology alarms are generally signaled via error bits in the technology data block. The program always displays the technology alarm that has top priority. In order to simplify error evaluation, the "Error" and "ErrorID" parameters of the Motion Control instructions also indicate that a technology alarm is pending.

Program errors (Page 190) can occur during parameter assignment or during the processing sequence of the Motion Control instructions (e.g. invalid parameter specification when calling the instruction, initiation of a job without enablement via MC_Power). Errors in Motion Control instructions are indicated when the instructions are called, by means of the "Error" and "ErrorID" parameters.

9.3 Technology alarms

Description

If an error occurs at a technology object (e.g. approaching a hardware limit switch), then a technology alarm is triggered and indicated. The impact of a technology alarm on the technology object is specified by the alarm response.

Alarm classes

Technology alarms are divided into three classes:

- Warning (can acknowledge)

  The processing of Motion Control jobs continues. The current motion of the axis can be influenced, e.g. by limitation of the current dynamic values to the configured limit values.

- Alarm (must acknowledge)

  Motion jobs are aborted in accordance with the alarm response. In order to continue job processing after resolving the cause of error, you must acknowledge the alarms.

- Fatal error

  Motion jobs are aborted in accordance with the alarm response.

  In order to be able to use the technology object again after a fatal error, you must restart the CPU.

Display of technology alarms

A technology alarm is displayed in the following locations:

- TIA Portal
  - "Technology object > Diagnostics > Status and error bits"

    Display of pending technology alarms for each technology object.
  - "Technology object > Commissioning > Axis control panel"

    Display of the last pending technology alarm for each technology object.
  - "Inspector window > Diagnostics > Message display"

    Select the "Receive messages" check box under "Online & Diagnostics > Online Access" in order to display technology alarms via the message display.

    With an online connection to the CPU, the pending technology alarms for all technology objects are displayed. Additionally, the archive view is available to you.

    The message display can also be enabled at a connected HMI, and displayed.
  - "CPU > Online & diagnostics"

    Display of the technology alarms that have been recorded in the diagnostics buffer.
- User program
  - Tag <TO>.ErrorDetail.Number and <TO>.ErrorDetail.Reaction

    Indication of the number and the response for the last technology alarm that occurred.
  - Tag <TO>.StatusWord

    Via the "Error" bit it is indicated, that a technology alarm is pending.
  - Tag <TO>.ErrorWord

    Indication of alarms and fatal errors.
  - Tag <TO>.WarningWord

    Indication of warnings.
  - Parameter "Error" and "ErrorID"

    In a Motion Control instruction, the parameters "Error" = TRUE and "ErrorID" = 16#8001 indicate that a technology alarm is pending.
- Display of the CPU

  In order to show technology alarms on the CPU display, make the following setting when loading to the CPU:
  In the "Load preview" dialog, select the action "Consistent download" for the "Text libraries" entry.

Alarm response

A technology alarm always contains an alarm response, which describes the impact on the technology object. The alarm response is specified by the system.

The following list shows the possible alarm responses in order of ascending priority:

- No response (warnings only)

  <TO>.ErrorDetail.Reaction = 0

  The processing of Motion Control jobs continues. The current motion of the axis can be influenced, e.g. by limitation of the current dynamic values to the configured limit values.

- Stop with current dynamic values

  <TO>.ErrorDetail.Reaction = 1

  Active motion commands are aborted. The axis is braked with the dynamic values that are pending in the Motion Control instruction, and brought to a standstill.

- Stop with maximum dynamic values

  <TO>.ErrorDetail.Reaction = 2

  Active motion commands are aborted. The axis is braked with the dynamic values configured under "Technology object > Extended parameters > Dynamic limits", and brought to a standstill. The configured maximum jerk is taken into account at the same time.

- Stop with emergency stop ramp

  <TO>.ErrorDetail.Reaction = 3

  Active motion commands are aborted. The axis is braked with the emergency stop deceleration configured under "Technology object > Extended parameters > Emergency stop ramp", without any jerk limit, and brought to a standstill.

- Remove enable

  <TO>.ErrorDetail.Reaction = 4

  The setpoint zero is output, and the enablement is removed. The axis is braked depending on the configuration in the drive, and is brought to a standstill.

Acknowledging technology alarms

You can acknowledge technology alarms as follows:

- TIA Portal
  - "Technology object > Diagnostics > Status and error bits"

    Click "Acknowledge" to acknowledge all alarms and warnings pending for the selected technology object.
  - "Technology object > Commissioning > Axis control panel"

    Click "Acknowledge" to acknowledge all alarms and warnings pending for the selected technology object.
  - "Inspector window > Diagnostics > Message display"

    You can acknowledge the alarms and warnings for all technology objects either individually, or all at once.

    At an HMI with enabled message display, you can likewise acknowledge the alarms and warnings for all technology objects either individually, or all at once.
- User program

  Acknowledge pending alarms at a technology object using the Motion Control instruction "MC_Reset".

Additional information

A list of the technology alarms and alarm responses can be found in the appendix, Technology Alarms (Page 267).

9.4 Errors in Motion Control instructions

Description

Errors in Motion Control instructions (e.g. invalid parameter value setting) are indicated at the "Error" and "ErrorID" output parameters.

Under the following conditions, "Error" = TRUE and "ErrorID" = 16#8xxx are indicated at the Motion Control instruction:

- Invalid status of the technology object, which prevents the execution of the job.
- Invalid parameter assignment of the Motion Control instruction, which prevents the execution of the job.
- As a result of the alarm response for an error at the technology object.

Error indication

If an error occurs in a Motion Control instruction, the "Error" parameter shows the value TRUE. The cause of the error can be found in the value of the ErrorID" parameter.

Jobs at the technology object are rejected when "Error" = TRUE. Running jobs are not influenced by rejected jobs.

If "Error" = TRUE and "ErrorID" = 16#8001 are indicated during the job processing, then a technology alarm has occurred. In this case, evaluate the indication of the technology alarm.

If "Error" = TRUE is displayed during the execution of a "MC_MoveJog" job, the axis is braked and brought to a standstill. In this case, the deceleration configured with the "MC_MoveJog" instruction takes effect.

Acknowledge errors

Acknowledging errors in Motion Control instructions is not required.

Restart a job after resolving the error.

Additional information

A list of the ErrorIDs can be found in the appendix, Error Detection (Page 270).

9.5 Speed-controlled axis technology object

9.5.1 Status and error bits

Description

You use the "Technology object > Diagnostics > Status and error bits" diagnostic function in the TIA Portal to monitor the most important 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
Enabled	The technology object is enabled. The axis can be controlled with Motion Control instructions. (<TO>.StatusWord.Enable)
Error	An error has occurred at the technology object. Detailed information about the error is available in the "Errors" area, and in the <TO>.ErrorDetail.Number and <TO>.ErrorDetail.Reaction tags of the technology object. (<TO>.StatusWord.Error)
Restart active	The technology object is being reinitialized. (<TO>.StatusWord.RestartActive)
Axis control panel enabled	The axis control panel is enabled. The axis control panel has master control over the technology object. The axis cannot be controlled from the user program. (<TO>.StatusWord.ControlPanelActive)
Drive switched on	The drive is ready to execute setpoints. (<TO>.StatusDrive.InOperation)

Motion status

The following table shows the possible axis motion status values:

Status	Description
Done (no active job)	No motion job is active at the technology object. (<TO>.StatusWord.Done)
Jog mode	The axis is being moved by a jog mode job from the Motion Control instruction "MC_MoveJog", or from the axis control panel. (<TO>.StatusWord.JogCommand)
Speed preset	The axis is traversed by means of a job with speed preset in Motion Control instruction "MC_MoveVelocity", or using the axis control panel. (<TO>.StatusWord.VelocityCommand)
Constant speed	The axis is being moved with constant speed. (<TO>.StatusWord.ConstantVelocity)
Accelerating	The axis is being accelerated. (<TO>.StatusWord.Accelerating)
Decelerating	The axis is being decelerated. (<TO>.StatusWord.Decelerating)

Warnings

The following table shows the possible warnings:

Warning	Description
Configuration adapted	One or several configuration parameters are adjusted internally at a certain time. (<TO>.WarningWord.ConfigurationFault)
Job rejected	Instruction cannot be executed. A Motion Control instruction cannot be executed, because necessary preconditions are not met. (<TO>.WarningWord.CommandNotAccepted)
Dynamic response limiting	Dynamic values were limited to the dynamic limits. (<TO>.WarningWord.DynamicError)

Error

The following table shows the possible errors:

Error	Description
System	An internal system error has occurred. (<TO>.ErrorWord.SystemFault)
Configuration	Configuration error One or more configuration parameters are inconsistent or invalid. The technology object was incorrectly configured, or editable configuration data were incorrectly modified during runtime of the user program. (<TO>.ErrorWord.ConfigurationFault)
User program	Error in the user program in a Motion Control instruction, or in its utilization. (<TO>.ErrorWord.UserFault)
Drive	Error in the drive. (<TO>.ErrorWord.DriveFault)
Data transmission	Error in communication with a connected device. (<TO>.ErrorWord.CommunicationFault)
I/O	Error accessing a logical address. (<TO>.ErrorWord.PeripheralError)
Job rejected	Instruction cannot be executed. A Motion Control instruction cannot be executed because the necessary conditions have not been fulfilled (e.g. TO not homed). (<TO>.ErrorWord.CommandNotAccepted)
Dynamic response limiting	Dynamic values were limited to the dynamic limits. (<TO>.ErrorWord.DynamicError)

Acknowledge

Click "Acknowledge" to acknowledge alarms and warnings pending.

Additional information

An option for the evaluation of the individual status bits can be found in the Evaluating StatusWord, ErrorWord and WarningWord (Page 143) section.

9.5.2 Motion status

Description

You use the "Technology object > Diagnostics > Motion status" diagnostic function in the TIA Portal to monitor the motion status of the axis. The Diagnostics function is available in online operation.

"Setpoints" area

This area displays the current setpoints.

The following table shows the meaning of the status data:

Status	Description
Current speed	Current speed setpoint for the axis (<TO>.Velocity)
Current speed override	Speed setpoint correction as percentage The speed setpoints specified in Motion Control instructions or at the axis control panel are superimposed with an override signal and corrected to a percentage value. Valid speed correction values range from 0.0 % to 200.0 %. (<TO>.Override.Velocity)

"Dynamic limits" area

This area displays the limit values for the following dynamic parameters:

- Speed

  (<TO>.DynamicLimits.MaxVelocity)
- Acceleration

  (<TO>.DynamicLimits.MaxAcceleration)
- Deceleration

  (<TO>.DynamicLimits.MaxDeceleration)

9.5.3 PROFIdrive frame

Description

The "Technology object > Diagnostics > PROFIdrive frame" diagnostics function is used in the TIA Portal to monitor the PROFIdrive frame 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 frame that the drive returns to the controller:

- Status words "SW1" and "SW2"
- The setpoint speed that was output to the drive (NSET)
- The actual speed that was signaled from the drive (NACT)

9.6 Positioning axis technology object

9.6.1 Status and error bits

Description

You use the "Technology object > Diagnostics > Status and error bits" diagnostic function in the TIA Portal to monitor the most important 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
Enabled	The technology object is enabled. The axis can be controlled with Motion Control instructions. (<TO>.StatusWord.Enable)
Homed	The technology object is homed. The relationship between the position at the technology object and the mechanical position was successfully created. (<TO>.StatusWord.HomingDone)
Error	An error has occurred at the technology object. Detailed information about the error is available in the "Errors" area, and in the <TO>.ErrorDetail.Number and <TO>.ErrorDetail.Reaction tags of the technology object. (<TO>.StatusWord.Error)
Restart active	The technology object is being reinitialized. (<TO>.StatusWord.RestartActive)
Axis control panel enabled	The axis control panel is enabled. The axis control panel has master control over the technology object. The axis cannot be controlled from the user program. (<TO>.StatusWord.ControlPanelActive)
Drive switched on	The drive is ready to execute setpoints. (<TO>.StatusDrive.InOperation)
Encoder valid	The encoder values are valid. (<TO>.StatusSensor[n].State)
Online start value changed	Restart-relevant data was changed. The changes will not be applied until after reinitialization (restart) of the technology object. (<TO>.StatusWord.OnlineStartValuesChanged)

Status limit switches

The following table shows possible enablements of the software and hardware limit switches:

Limit switch	Description
Negative software limit switch approached	The negative software limit switch was approached. (<TO>.StatusWord.SWLimitMinActive)
Positive software limit switch approached	The positive software limit switch was approached. (<TO>.StatusWord.SWLimitMaxActive)
Negative hardware limit switch approached	The negative hardware limit switch was approached. (<TO>.StatusWord.HWLimitMinActive)
Positive hardware limit switch approached	The positive hardware limit switch was approached or passed. (<TO>.StatusWord.HWLimitMaxActive)

Motion status

The following table shows the possible axis motion status values:

Status	Description
Done (no active job)	No motion job is active at the technology object. (<TO>.StatusWord.Done)
Homing job	The technology object is executing a homing job from the Motion Control instruction "MC_Home", or from the axis control panel. (<TO>.StatusWord.HomingCommand)
Jog mode	The axis is being moved by a jog mode job from the Motion Control instruction "MC_MoveJog", or from the axis control panel. (<TO>.StatusWord.JogCommand)
Velocity setpoint	A job traverses the axis at the speed setpoint specified in Motion Control instruction "MC_MoveVelocity" or at the axis control panel. (<TO>.StatusWord.VelocityCommand)
Positioning job	The axis is being moved by a positioning job from the Motion Control instructions "MC_MoveAbsolute", "MC_MoveRelative", or from the axis control panel. (<TO>.StatusWord.PositioningCommand)
Constant velocity	The axis is being moved with constant velocity. (<TO>.StatusWord.ConstantVelocity)
Standstill	The axis is at a standstill. (<TO>.StatusWord.StandStill)
Accelerating	The axis is being accelerated. (<TO>.StatusWord.Accelerating)
Decelerating	The axis is being decelerated. (<TO>.StatusWord.Decelerating)

Warnings

The following table shows the possible warnings:

Warning	Description
Configuration adapted	One or several configuration parameters are adjusted internally at a certain time. (<TO>.WarningWord.ConfigurationFault)
Job rejected	Instruction cannot be executed. A Motion Control instruction cannot be executed, because necessary preconditions are not met. (<TO>.WarningWord.CommandNotAccepted)
Dynamic response limiting	Dynamic values were limited to the dynamic limits. (<TO>.WarningWord.DynamicError)

Error

The following table shows the possible errors:

Error	Description
System	An internal system error has occurred. (<TO>.ErrorWord.SystemFault)
Configuration	Configuration error One or more configuration parameters are inconsistent or invalid. The technology object was incorrectly configured, or editable configuration data were incorrectly modified during runtime of the user program. (<TO>.ErrorWord.ConfigurationFault)
User program	Error in the user program in a Motion Control instruction, or in its utilization. (<TO>.ErrorWord.UserFault)
Drive	Error in the drive. (<TO>.ErrorWord.DriveFault)
Encoder	Error in the encoder system. (<TO>.ErrorWord.SensorFault)
Data transmission	Error in communication with a connected device. (<TO>.ErrorWord.CommunicationFault)
I/O	Error accessing a logical address. (<TO>.ErrorWord.PeripheralError)
Job rejected	Instruction cannot be executed. A Motion Control instruction cannot be executed because the necessary conditions have not been fulfilled (e.g. TO not homed). (<TO>.ErrorWord.CommandNotAccepted)
Homing	Error during a homing process. (<TO>.ErrorWord.HomingFault)
Positioning	The axis was not correctly positioned at the end of a positioning motion. (<TO>.ErrorWord.PositioningFault)

Error	Description
Dynamic response limiting	Dynamic values were limited to the dynamic limits. (<TO>.ErrorWord.DynamicError)
Following error	The maximum permitted following error was exceeded. (<TO>.ErrorWord.FollowingErrorFault)
SW limit switches	A software limit switch has been reached. (<TO>.ErrorWord.SwLimit)
Hardware limit switches	A hardware limit switch has been reached or overshot. (<TO>.ErrorWord.HWLimit)

Acknowledge

Click "Acknowledge" to acknowledge alarms and warnings pending.

Additional information

An option for the evaluation of the individual status bits can be found in the Evaluating StatusWord, ErrorWord and WarningWord (Page 143) section.

9.6.2 Motion status

Description

You use the "Technology object > Diagnostics > Motion status" diagnostic function in the TIA Portal to monitor the motion status of the axis. The Diagnostics function is available in online operation.

"Current values" 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 while a positioning job is busy. (<TO>.StatusPositioning.TargetPosition)
Current position	Actual axis position 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)
Current velocity	Actual axis velocity (<TO>.ActualVelocity)
Current velocity override	Percentage correction of the velocity override The velocity setpoints specified in Motion Control instructions or at the axis control panel are superimposed with an override signal and corrected to a percentage value. Valid velocity correction values range from 0.0 % to 200.0 %. (<TO>.Override.Velocity)

"Dynamic limits" area

The limit values for the following dynamic parameters are displayed in this area:

- Velocity

  (<TO>.DynamicLimits.MaxVelocity)
- Acceleration

  (<TO>.DynamicLimits.MaxAcceleration)
- Deceleration

  (<TO>.DynamicLimits.MaxDeceleration)

9.6.3 PROFIdrive frame

Description

The "Technology object > Diagnostics > PROFIdrive frame" diagnostics function is used in the TIA Portal to monitor the PROFIdrive frame 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 frame that the drive returns to the controller:

- Status words "SW1" and "SW2"
- The setpoint speed that was output to the drive (NSET)
- The actual speed that was signaled from the drive (NACT)

"Encoder" area

This area displays the following parameters contained in the PROFIdrive frame that the encoder returns to the controller:

- The status word "Gn_SW"
- The actual position value "Gn_XIST1" (cyclical actual encoder value)
- The actual position value "Gn_XIST2" (absolute value of the encoder)

9.7 External encoder technology object

9.7.1 Status and error bits

Description

You use the "Technology object > Diagnostics > Status and error bits" diagnostic function in the TIA Portal to monitor the most important 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
Enabled	The technology object is enabled. (<TO>.StatusWord.Enable)
Homed	The technology object is homed. The relationship between the position at the technology object and the mechanical position was successfully created. (<TO>.StatusWord.HomingDone)
Error	An error has occurred at the technology object. Detailed information about the error is available in the "Errors" area, and in the <TO>.ErrorDetail.Number and <TO>.ErrorDetail.Reaction tags of the technology object. (<TO>.StatusWord.Error)
Restart active	The technology object is being reinitialized. (<TO>.StatusWord.RestartActive)
Encoder valid	The encoder values are valid. (<TO>.StatusSensor[n].State)

Motion status

The following table shows the possible axis motion status values:

Status	Description
Done (no active job)	No active Motion Control job at the TO. (Release by "MC_Power" job excepted) (<TO>.StatusWord.Done)
Homing job	The technology object is executing a homing job from the Motion Control instruction "MC_Home". (<TO>.StatusWord.HomingCommand)

Errors

The following table shows the possible errors:

Error	Description
System	An internal system error has occurred. (<TO>.ErrorWord.SystemFault)
Configuration	Configuration error One or more configuration parameters are inconsistent or invalid. The technology object was incorrectly configured, or editable configuration data were incorrectly modified during runtime of the user program. (<TO>.ErrorWord.ConfigurationFault)
User program	Error in the user program in a Motion Control instruction, or in its utilization. (<TO>.ErrorWord.UserFault)
Encoder	Error in the encoder system. (<TO>.ErrorWord.SensorFault)
Data transmission	Missing or faulty communication. (<TO>.ErrorWord.CommunicationFault)

Acknowledgement

Click "Acknowledge" to acknowledge alarms and warnings pending.

Additional information

An option for the evaluation of the individual status bits can be found in the Evaluating StatusWord, ErrorWord and WarningWord (Page 143) section.

9.7.2 Motion status

Description

You use the "Technology object > Diagnostics > Motion status" diagnostic function in the TIA Portal to monitor the encoder values. The Diagnostics function is available in online operation.

The following table shows the meaning of the status data:

Status	Description
Current position	The "Current position" field displays the actual position value. 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)
Current velocity	The "Current velocity" field displays the actual velocity value. (<TO>.ActualVelocity)

9.7.3 PROFIdrive frame

Description

The "Technology object > Diagnostics > PROFIdrive interface" diagnostic function is used in the TIA Portal to monitor the PROFIdrive frame of the encoder. The display of the diagnostics function is available in the online mode TO.

"Encoder" area

This area displays the following parameters contained in the PROFIdrive frame that the encoder returns to the controller:

- The status word "Gn_SW"
- The actual position value "Gn_XIST1" (cyclical actual encoder value)
- The actual position value "Gn_XIST2" (absolute value of the encoder)

10 Reference

10.1 S7-1500 Motion Control

10.1.1 MC_Power

10.1.1.1 MC_Power: Enable, disable technology objects

Description

The Motion Control instruction "MC_Power" is used to enable and disable technology objects.

Applies to

- Positioning axis
- Speed-controlled axis
- External encoder

Requirements

- The technology object has been configured correctly.

Override response

- A MC_Power job cannot be aborted by any other Motion Control job.
- A MC_Power job with the 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 at the corresponding technology object in accordance with the selected "StopMode". This process cannot be aborted by the user.

Parameter

The following table shows the parameters of the "MC_POWER" Motion Control instruction:

Parameter	Declaration	Data type	Default value	Description	
Axis	InOut	TO_Axis	-	Technology object	
Enable	INPUT	BOOL	FALSE	TRUE	The technology object is enabled.
				FALSE	The technology object is disabled. All current jobs at the technology object are aborted in accordance with the configured "StopMode".
StopMode	INPUT	INT	0	Not applicable to the external encoder technology object. If you disable a technology object with a falling edge at the Enable parameter, then the axis decelerates in accordance with the selected StopMode.	
				0	Emergency stop When the technology object is disabled, the axis brakes to a standstill without any jerk limitation, using the emergency stop deceleration configured in Technology object > Configuration > Extended parameters > Emergency stop ramp. Enabling is then removed. (<TO>.DynamicDefaults.EmergencyDeceleration)
				1	Immediate stop When a technology object is disabled, the setpoint zero is output, and the enabling is removed. The axis is braked depending on the configuration in the drive, and is brought to a standstill.
				2	Stop with maximum dynamic values When the technology object is disabled, the axis brakes to a standstill using the maximum deceleration configured in "Technology object > Configuration > Extended parameters > Dynamic limits". The configured maximum jerk is taken into account at the same time. Enabling is then removed. (<TO>.DynamicLimits.MaxDeceleration; <TO>.DynamicLimits.MaxJerk)

Parameter	Declaration	Data type	Default value	Description	
Status	OUTPUT	BOOL	FALSE	Technology object enable status	
				FALSE	Disabled - A positioning axis or speed-controlled axis does not accept any Motion Control jobs. - Speed control and position control are not active. - The actual values of the technology object are not checked for validity.
				TRUE	Enabled - An enabled positioning axis or speed-controlled axis accepts Motion Control jobs. - Speed control and positioning control are active. - The actual values of the technology object are valid.
Busy	OUTPUT	BOOL	FALSE	TRUE	The job is being executed.
Error	OUTPUT	BOOL	FALSE	TRUE	An error occurred in Motion Control instruction MC_Power. The cause of the error can be found in the "ErrorID" parameter.
ErrorID	OUTPUT	WORD	16#0000	Error ID (Page 270) for parameter "Error"	

Enabling technology objects

To enable a technology object, set the Enable parameter to TRUE.

If the Status parameter shows the value TRUE, then the technology object is enabled.

If an axis is in motion when the technology object is enabled (actual velocity is present), then the axis brakes to the setpoint zero, using the maximum deceleration configured in "Technology object > Configuration > Extended parameters > Dynamic limits" (<TO>.DynamicLimits.MaxDeceleration). This braking ramp can be overridden by Motion Control jobs.

Note

Automatic enabling after acknowledgement of a technology alarm

If the technology object is disabled due to a technology alarm, then it will automatically be enabled again after the cause has been eliminated and the alarm has been acknowledged. This requires the Enable parameter to have retained the value TRUE during this process.

Disabling technology objects

To disable a technology object, set the Enable parameter to FALSE.

If an axis is in motion, then it will be braked to a standstill according to the selected "StopMode".

If the "Busy" and "Status" parameters show the value FALSE , then the disabling of the technology object has been completed.

Drive connection by means of PROFIdrive

When coupling a drive with PROFIdrive, the setpoint, enabling, and drive status are transmitted via the PROFIdrive frame.

- **Enable technology object and drive**

  The parameter ""Enable" = TRUE" is used to enable the technology object.
  The drive is enabled according to the PROFIdrive standard.

  If the tag <TO>.StatusDrive.InOperation shows the value TRUE , then the drive is ready to execute setpoints. The "Status" parameter is set to the value TRUE .

- **Disable technology object and drive**

  With the parameter "Enable" = FALSE, 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 drive**

  With the parameter "Enable" = TRUE, the enabling output ("Enable drive output") is set.

  If the drive reports back the readiness signal via the ready input ("Drive ready input"), then the "Status" parameter and the technology object's <TO>.StatusDrive.InOperation tag are set to TRUE, and the setpoint is switched at the analog output.

- **Disable technology object and drive**

  With the parameter "Enable" = FALSE, the "Status" parameter is set to the value FALSE, and the axis is braked according to the selected "StopMode". When the setpoint zero is reached, the enabling output is set to FALSE.

Additional information

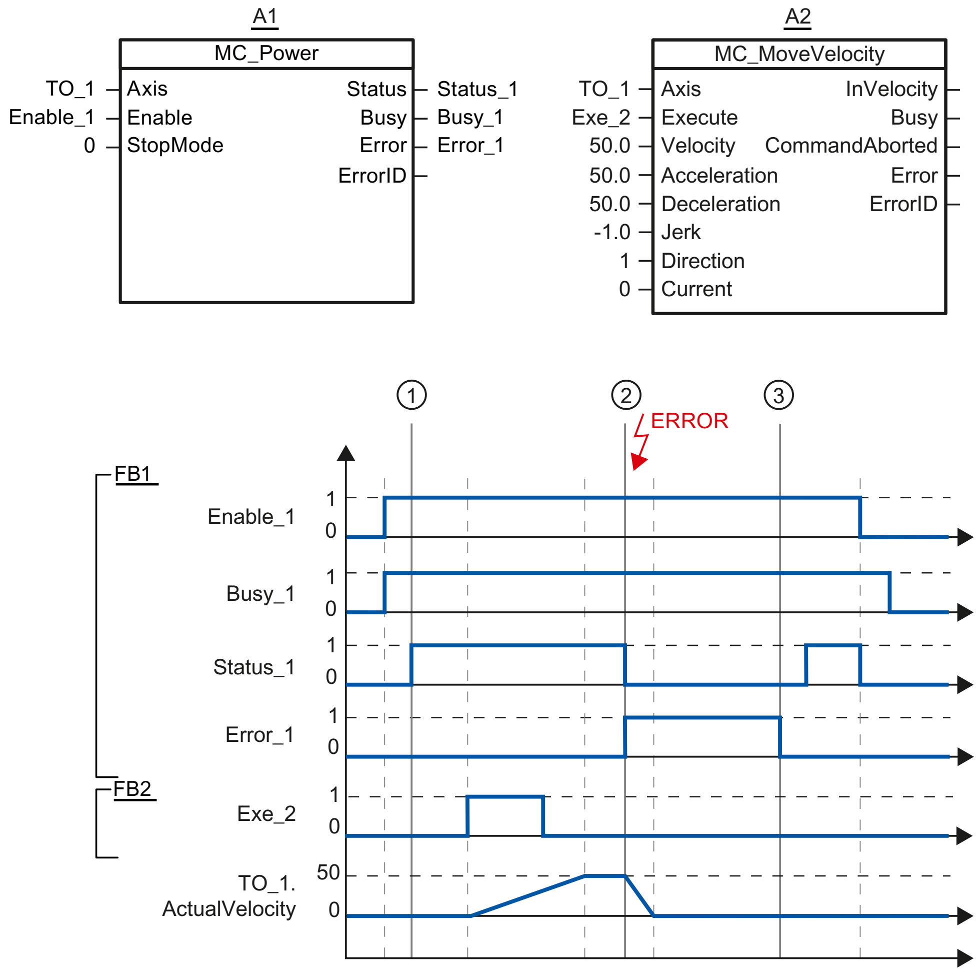
Additional information on enabling and disabling technology objects and drives can be found in the appendix, MC_Power Function Charts (Page 272).

See also

Error ID (Page 270)

10.1.1.2 MC_Power: Function chart

Function chart: Enabling a technology object, and example for alarm response



A technology object is enabled with "Enable_1= TRUE". Successful enabling 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 "Velocity Axis_1".

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 depending on the configuration in the drive, and is brought to a standstill. 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. Successful enabling can be read from "Status_1". Next the technology object is disabled with "Enable_1" = FALSE.

10.1.2 MC_Home

10.1.2.1 MC_Home: Homing technology objects, setting home position

Description

With the Motion Control instruction "MC_Home", you create the relationship between the position in the technology object and the mechanical position. 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.

The homing process occurs according to the mode selected with the "Mode" parameter, and the configuration under "Technology object > Configuration > Extended parameters > Homing".

The preset values under "Technology object > Configuration > Extended parameters > Dynamic default values" are used for the dynamic values Acceleration, Deceleration and Jerk.

Applies to

- Positioning axis
- External encoder

The following table shows which modes are possible with each of the technology objects:

Operating mode	Positioning axis with incremental encoder	Positioning axis with absolute encoder	External incremental encoder	External absolute encoder
Active homing (Mode = 4, 5)	X	-	-	-
Passive homing (Mode = 2, 3, 8)	X	-	X	-
Setting a positioning value ("Mode" = 0)	X	X	X	X
Relative shift of the actual value ("Mode" = 1)	X	X	X	X
Homing absolute encoder ("Mode" = 6, 7)	-	X	-	X

Requirements

- The technology object has been configured correctly.
- "Mode" = 2, 3, 4, 5, 8
  The technology object must be enabled.
- "Mode" = 0, 1, 2, 6, 7
  The encoder values must be valid. (<TO>.StatusSensor[n].State = 2)

Override response

- An MC_Home job for passive homing is aborted by:
  - Disabling the technology object by means of "MC_Power.Enable" = FALSE
  - "MC_Home" job with parameter "Mode" = 4, 5, 9
- An "MC_Home" job for passive homing does not abort any other Motion Control jobs.
- An "MC_Home" job for active homing is aborted by:
  - Disabling the technology object with "MC_Power.Enable" = FALSE
  - "MC_Home" job "Mode" = 4, 5
  - "MC_Halt" job
  - "MC_MoveAbsolute" job
  - "MC_MoveRelative" job
  - "MC_MoveVelocity" job
  - "MC_MoveJog" job
- An "MC_Home" job for active homing aborts the following running Motion Control jobs.
  - "MC_Home" job with parameter "Mode" = 2, 3, 4, 5
  - "MC_Halt" job
  - "MC_MoveAbsolute" job
  - "MC_MoveRelative" job
  - "MC_MoveVelocity" job
  - "MC_MoveJog" job

Parameter

The following table shows the parameters of the "MC_Home" Motion Control instruction:

<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>InOut</td><td>TO_Axis</td><td>-</td><td colspan="2">Technology object</td></tr>
<tr><td>Execute</td><td>INPUT</td><td>BOOL</td><td>FALSE</td><td colspan="2">Start of the job with a positive edge</td></tr>
<tr><td>Position</td><td>INPUT</td><td>LREAL</td><td>0.0</td><td colspan="2">The specified value is used according to the selected "Mode".</td></tr>
<tr><td rowspan="7">Mode</td><td rowspan="7">INPUT</td><td rowspan="7">INT</td><td rowspan="7">0</td><td colspan="2">Operating mode</td></tr>
<tr><td>0</td><td>Direct homing (absolute)
The current position of the technology object is set to the value of parameter "Position".</td></tr>
<tr><td>1</td><td>Direct homing (relative)
The current position of the technology object is shifted by the value of parameter "Position".</td></tr>
<tr><td>2</td><td>Passive homing
When the homing mark is detected, the actual value is set to the value of the "Position" parameter.</td></tr>
<tr><td>3</td><td>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)</td></tr>
<tr><td>4</td><td>Active homing
The TO positioning axis performs a homing movement according to the configuration. After the completion of the movement, the axis is positioned at the value of the "Position" parameter.</td></tr>
<tr><td>5</td><td>Active homing ("Position" parameter has no effect)
The TO positioning axis performs a homing movement according to the configuration. After completion of the movement, the axis is positioned at the home position configured under "Technology object > Configuration > Extended parameters > Homing > Active homing".
(<TO>.Homing.HomePosition)</td></tr>
</table>

Parameter	Declaration	Data type	Default value	Description	
				6	Absolute value adjustment (relative) The current position is set to the value of the parameter "Position". The calculated absolute value offset is stored retentively in the CPU. (<TO>.StatusSensor[n]. AbsEncoderOffset)
				7	Absolute value adjustment (absolute) The current position is set to the value of the parameter "Position". The calculated absolute value offset is stored retentively in the CPU. (<TO>.StatusSensor[n]. AbsEncoderOffset)
				8	Passive homing (without reset) Functions like mode 2, with the difference that the "homed" status is not reset when the function is enabled.
				9	Canceling passive homing A running job for passive homing is aborted.
Done	OUTPUT	BOOL	FALSE	TRUE	Job is completed
Busy	OUTPUT	BOOL	FALSE	TRUE	The job is being executed.
CommandAborted	OUTPUT	BOOL	FALSE	TRUE	During execution the job was aborted by another job.
Error	OUTPUT	BOOL	FALSE	TRUE	An error occurred during execution of the job. The job is rejected. The cause of the error can be found in the "ErrorID" parameter.
ErrorID	OUTPUT	WORD	16#0000	Error ID (Page 270) for parameter "Error"	

Resetting the "Homed" status

The "Homed" status of a technology object is reset under the following conditions (<TO>.StatusWord.HomingDone):

- **Technology objects with incremental actual values:**
  - Starting an "MC_Home" job with "Mode" = 2, 3, 4, 5

    (After successful completion of the homing operation, the "Homed" status is reset.)
  - Error in the encoder system, or encoder failure
  - Restart of the technology object
  - After POWER OFF -> POWER ON of the CPU
  - Memory reset
  - Modification of the encoder configuration
- **Technology objects with absolute actual values:**
  - Restoration of the CPU factory settings
  - Modification of the encoder configuration
  - Replacement of the CPU

Homing a technology object with "Mode" = 1..8

To home a technology object, follow these steps:

1. Check the requirements indicated above.
2. Specify the desired homing function in the "Mode" parameter.
3. Initialize the necessary parameters with values, and start the homing operation with a positive edge at the "Execute" parameter.

If the "Done" parameter shows the value TRUE, then the "MC_Home" job has been completed according to the selected "Mode". The "Homed" status of the technology object is indicated under "Technology object > Diagnostics > Status and error bits > Motion status > Homed" (<TO>.StatusWord.HomingDone).

Termination of a passive homing process with "Mode" = 9

With "Mode" = 9, the technology object is not homed. If a running "MC_Home" job for passive homing ("Mode" = 2, 3, 8) is overridden by another "MC_Home" job with "Mode" = 9, then the running job is terminated with the parameter "CommandAborted" = TRUE.
The overriding job with "Mode" = 9 signals successful execution with the parameter "Done" = TRUE.

Additional information

An option for the evaluation of the individual status bits can be found in the Evaluating StatusWord, ErrorWord and WarningWord (Page 143) section.

See also

Error ID (Page 270)

10.1.3 MC_MoveJog

10.1.3.1 MC_MoveJog: Moving axes in jog mode

Description

With the Motion Control instruction "MC_MoveJog", you can move an axis in jog mode.

Dynamic behavior during movement is defined with the parameters "Velocity", "Jerk", "Acceleration" and "Deceleration".

- Positioning axis:

  A velocity is specified in the "Velocity" parameter.
- Speed-controlled axis:

  A speed is specified at the "Velocity" parameter.

Applies to

- Positioning axis
- Speed-controlled axis

Requirements

- The technology object has been configured correctly.
- The technology object is enabled.

Override response

The "MC_MoveJog" job is aborted by:

- Disabling the axis with "MC_Power.Enable" = FALSE
- "MC_Home" job "Mode" = 4, 5
- "MC_Halt" job
- "MC_MoveAbsolute" job
- "MC_MoveRelative" job
- "MC_MoveVelocity" job
- "MC_MoveJog" job

Starting a "MC_MoveJog" job aborts the following active Motion Control jobs:

- "MC_Home" job "Mode" = 4, 5
- "MC_Halt" job
- "MC_MoveAbsolute" job
- "MC_MoveRelative" job
- "MC_MoveVelocity" job
- "MC_MoveJog" job

Parameter

The following table shows the parameters of the "MC_MoveJog" Motion Control instruction:

Parameter	Declaration	Data type	Default value	Description
Axis	InOut	TO_SpeedAxis	-	Technology object
JogForward	INPUT	BOOL	FALSE	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	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	Setpoint speed / setpoint speed for the motion process Value > 0.0: The specified value is used. Value < 0.0: The specified value is used. ("Velocity" = 0.0 is permitted)
Acceleration	INPUT	LREAL	-1.0	Acceleration Value > 0.0: The specified value is used. Value = 0.0: not permitted Value < 0.0: The acceleration configured in "Technology object > Configuration > Extended parameters > Dynamic defaults" is used. (<TO>.DynamicDefaults.Acceleration)
Deceleration	INPUT	LREAL	-1.0	Deceleration Value > 0.0: The specified value is used. Value = 0.0: not permitted Value < 0.0: The deceleration configured in "Technology object > Configuration > Extended parameters > Dynamic defaults" is used. (<TO>.DynamicDefaults.Deceleration)
Jerk	INPUT	LREAL	-1.0	Jerk Value > 0.0: Constant-acceleration velocity profile; the specified jerk is used. Value = 0.0: Trapezoid velocity profile Value < 0.0: The jerk configured in "Technology object > Configuration > Extended parameters > Dynamic defaults" is used. (<TO>.DynamicDefaults.Jerk)
InVelocity	OUTPUT	BOOL	FALSE	TRUE: The setpoint velocity / setpoint speed was reached and will be maintained.
Busy	OUTPUT	BOOL	FALSE	TRUE: The job is being executed.
CommandAborted	OUTPUT	BOOL	FALSE	TRUE: During execution the job was aborted by another job.

Parameter	Declaration	Data type	Default value	Description	
Error	OUTPUT	BOOL	FALSE	TRUE	An error occurred during execution of the job. The job is rejected. The cause of the error can be found in the "ErrorID" parameter.
ErrorID	OUTPUT	WORD	16#0000	Error ID (Page 270) for parameter "Error"	

Behavior with setpoint velocity / setpoint speed zero (Velocity" = 0.0)

An "MC_MoveJog" job with "Velocity" = 0.0 stops the axis with the configured deceleration. When the setpoint velocity / setpoint speed 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.ConstantVelocity; <TO>.StatusWord.Standstill).

Moving an axis in jog mode

Proceed as follows to move an axis in jog mode:

1. Check the requirements indicated above.
2. Move the axis in the positive direction with "JogForward", or in the negative direction with "JogBackward".

The current motion state is indicated in "Busy", "InVelocity" and "Error".

Note

Behavior when changing the override

If the velocity / speed is influenced during constant motion by a change in the override (<TO>.Override.Velocity), then the "InVelocity" parameter is reset during the acceleration or deceleration. When the newly calculated velocity is reached ("Velocity" × "Override" %), then "InVelocity" is set again.

Additional information

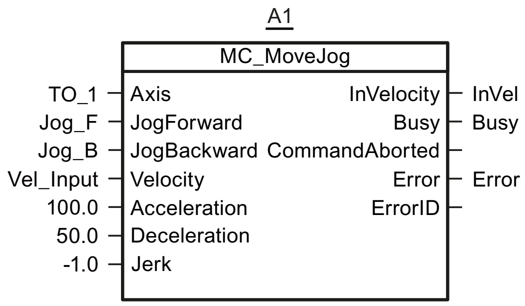
An option for the evaluation of the individual status bits can be found in the Evaluating StatusWord, ErrorWord and WarningWord (Page 143) section.

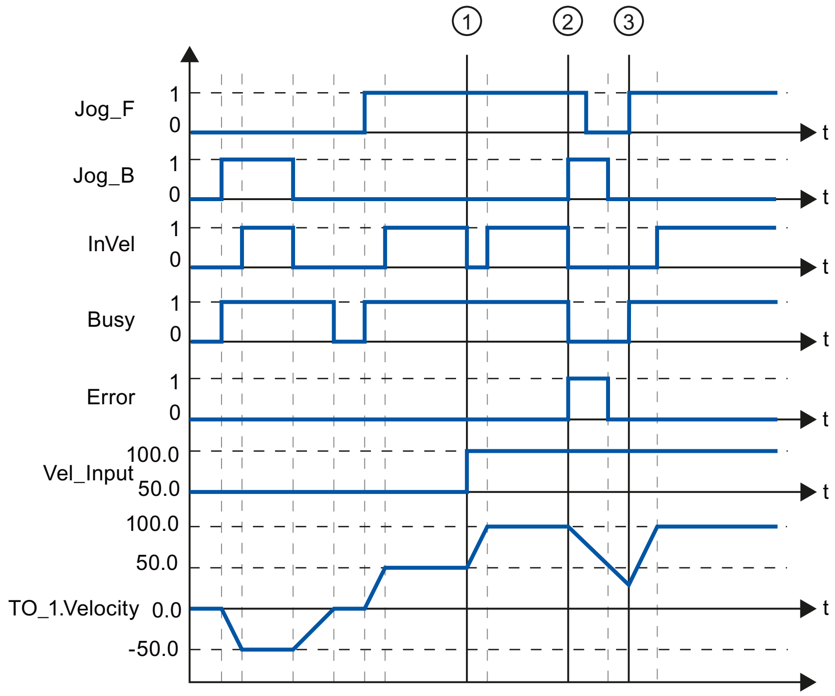
See also

Error ID (Page 270)

10.1.3.2 MC_MoveJog: Function chart

Function chart: Moving an axis in jog mode





The axis is moved in the negative direction in jog mode via "Jog_B". When the setpoint velocity -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 setpoint velocity 50.0 is reached, this is signaled via "InVel" = TRUE.

At time ①, if "Jog_F" is set, the setpoint velocity is changed to 100.0 by means of "Vel_Input". Alternatively, you can also change the setpoint velocity via the velocity override. "InVel" is reset. The axis is being accelerated. When the new setpoint velocity 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 setpoint velocity 100.0 is reached, this is signaled via "InVel" = TRUE.

10.1.4 MC_MoveVelocity

10.1.4.1 MC_MoveVelocity: Moving axes with the specified speed

Description

With the Motion Control instruction "MC_MoveVelocity", you can move an axis with a constant velocity.

Dynamic behavior during movement is defined with the parameters "Velocity", "Jerk", "Acceleration" and "Deceleration".

- Positioning axis:

  A velocity is specified in the "Velocity" parameter.
- Speed-controlled axis:

  A speed is specified at the "Velocity" parameter.

Applies to

- Positioning axis
- Speed-controlled axis

Requirements

- The technology object has been configured correctly.
- The technology object is enabled.

Override response

The "MC_MoveVelocity" is aborted by:

- Disabling the axis with "MC_Power.Enable" = FALSE
- "MC_Home" job "Mode" = 4, 5
- "MC_Halt" job
- "MC_MoveAbsolute" job
- "MC_MoveRelative" job
- "MC_MoveVelocity" job
- "MC_MoveJog" job

Starting a "MC_MoveVelocity" job aborts the following active Motion Control jobs:

- "MC_Home" job "Mode" = 4, 5
- "MC_Halt" job
- "MC_MoveAbsolute" job
- "MC_MoveRelative" job
- "MC_MoveVelocity" job
- "MC_MoveJog" job

Parameter

The following table shows the parameters of the "MC_MoveVelocity" Motion Control instruction:

Parameter	Declaration	Data type	Default value	Description
Axis	InOut	TO_SpeedAxis	-	Technology object
Execute	INPUT	BOOL	FALSE	Start of the job with a positive edge
Velocity	INPUT	LREAL	100.0	Setpoint speed / setpoint speed for the motion process ("Velocity" = 0.0 is permitted)
Acceleration	INPUT	LREAL	-1.0	Acceleration Value > 0.0: The specified value is used. Value = 0.0: not permitted Value < 0.0: The acceleration configured in "Technology object > Configuration > Extended parameters > Dynamic defaults" is used. (<TO>.DynamicDefaults.Acceleration)
Deceleration	INPUT	LREAL	-1.0	Deceleration Value > 0.0: The specified value is used. Value = 0.0: not permitted Value < 0.0: The deceleration configured in "Technology object > Configuration > Extended parameters > Dynamic defaults" is used. (<TO>.DynamicDefaults.Deceleration)
Jerk	INPUT	LREAL	-1.0	Jerk Value > 0.0: Constant-acceleration velocity profile; the specified jerk is used. Value = 0.0: Trapezoid velocity profile Value < 0.0: The jerk configured in "Technology object > Configuration > Extended parameters > Dynamic defaults" is used. (<TO>.DynamicDefaults.Jerk)
Direction	INPUT	INT	0	Direction of rotation of the axis 0: The sign of the velocity specified at the "Velocity" parameter defines the direction of rotation. 1: Positive direction of rotation Value of "Velocity" is used. 2: Negative direction of rotation Value of "Velocity" is used.

Parameter	Declaration	Data type	Default value	Description	
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.
InVelocity	OUTPUT	BOOL	FALSE	TRUE	The setpoint velocity / setpoint speed was reached and will be maintained.
Busy	OUTPUT	BOOL	FALSE	TRUE	The job is being executed.
CommandAborted	OUTPUT	BOOL	FALSE	TRUE	During execution the job was aborted by another job.
Error	OUTPUT	BOOL	FALSE	TRUE	An error occurred during execution of the job. The cause of the error can be found in the "ErrorID" parameter.
ErrorID	OUTPUT	WORD	16#0000	Error ID (Page 270) for parameter "Error"	

Behavior with setpoint velocity / setpoint speed zero (Velocity" = 0.0)

An "MC_MoveVelocity" job with "Velocity" = 0.0 stops the axis with the configured deceleration. When the setpoint velocity / setpoint speed 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.ConstantVelocity; <TO>.StatusWord.Standstill).

The parameters "InVelocity" and "Busy" show the value TRUE, until the "MC_MoveVelocity" job is overridden by another Motion Control job.

Moving an axis with constant velocity / speed

Proceed as follows to move an axis with constant velocity / speed:

1. Check the requirements indicated above.
2. At the parameter "Velocity", specify the velocity / speed, with which the axis should be moved.
3. Start the "MC_MoveVelocity" job with a positive edge at the parameter "Execute".

The current motion state is indicated in "Busy", "InVelocity" and "Error".

If the "InVelocity" parameter shows the value TRUE, then the setpoint velocity / setpoint speed was reached. The axis continues moving at this constant velocity. The parameters "InVelocity" and "Busy" show the value TRUE, until the "MC_MoveVelocity" job is overridden by another Motion Control job.

Note

Behavior when changing the override

If the velocity / speed is influenced during constant motion by a change in the override (<TO>.Override.Velocity), then the "InVelocity" parameter is reset during the acceleration or deceleration. When the newly calculated velocity / speed is reached ("Velocity" × "Override" %), then "InVelocity" is reset.

Additional information

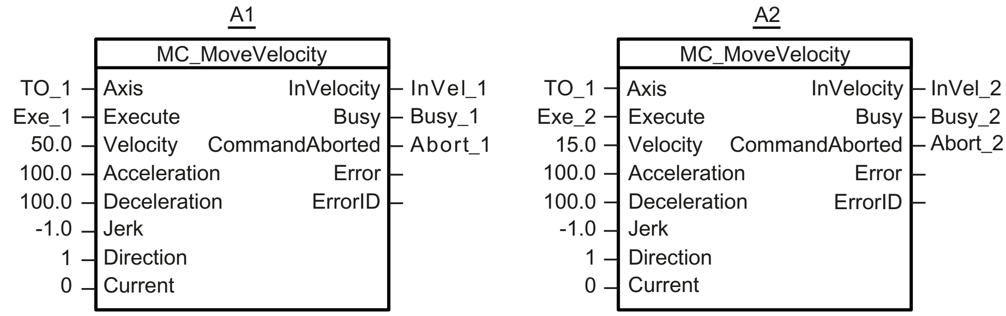
An option for the evaluation of the individual status bits can be found in the Evaluating StatusWord, ErrorWord and WarningWord (Page 143) section.

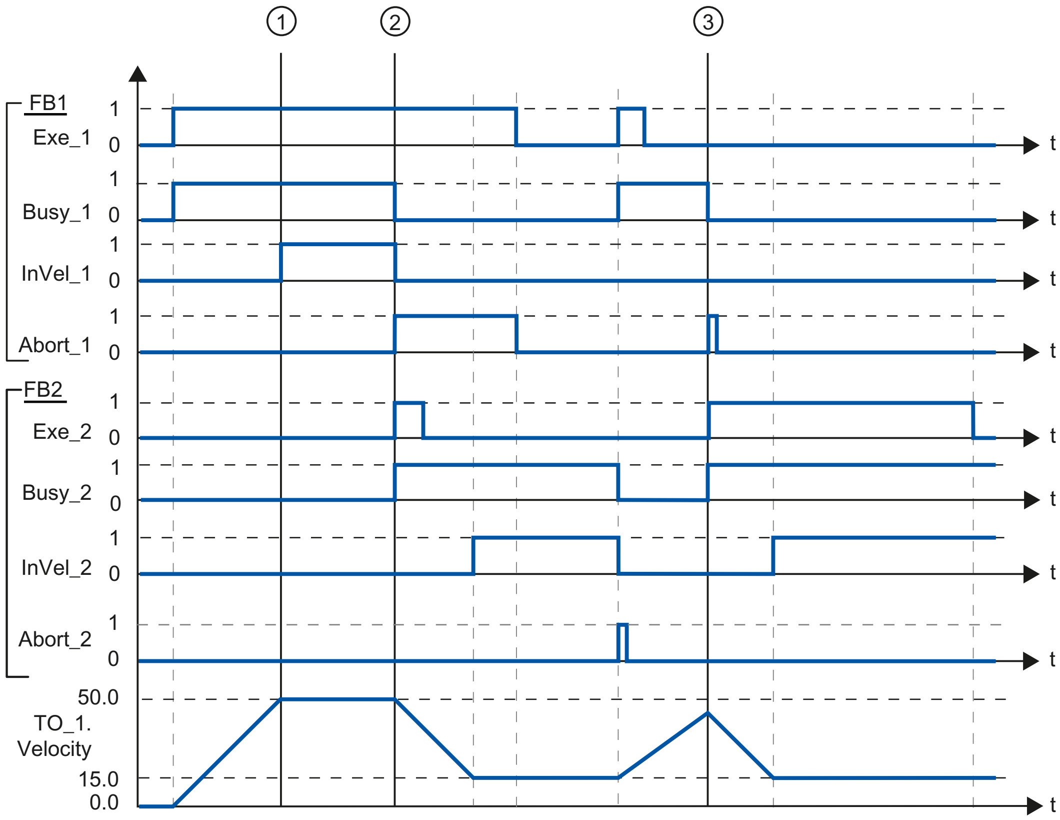
See also

Error ID (Page 270)

10.1.4.2 MC_MoveVelocity: Function chart

Function chart: Moving an axis with specification of velocity, and the response to an overriding job





A "MC_MoveVelocity" job (A1) initiated via "Exe_1" accelerates the axis and signals at time ① via "InVel_1" that the setpoint velocity 50.0 has been reached.

At time ②, the task is overridden via another "MC_MoveVelocity" job (A2). The abort is signaled via "Abort_1". When the new setpoint velocity 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 setpoint velocity 50.0. Before the setpoint velocity 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 setpoint velocity 15.0 is reached, this is signaled via "InVel_2". The axis then continues moving at the constant velocity 15.0.

10.1.5 MC_MoveRelative

10.1.5.1 MC_MoveRelative: Relative positioning of axes

Description

With the Motion Control instruction "MC_MoveRelative", you can move an axis relative to the position that exists at the beginning of job processing.

Dynamic behavior during movement is defined with the parameters "Velocity", "Jerk", "Acceleration" and "Deceleration".

Applies to

- Positioning axis

Requirements

- The technology object has been configured correctly.
- The technology object is enabled.

Override response

The "MC_MoveRelative" job is aborted by:

- Disabling the axis with "MC_Power.Enable" = FALSE
- "MC_Home" job "Mode" = 4, 5
- "MC_Halt" job
- "MC_MoveAbsolute" job
- "MC_MoveRelative" job
- "MC_MoveVelocity" job
- "MC_MoveJog" job

Starting a "MC_MoveRelative" job aborts the following active Motion Control jobs:

- "MC_Home" job "Mode" = 4, 5
- "MC_Halt" job
- "MC_MoveAbsolute" job
- "MC_MoveRelative" job
- "MC_MoveVelocity" job
- "MC_MoveJog" job

Parameter

The following table shows the parameters of the "MC_MoveRelative" Motion Control instruction:

Parameter	Declaration	Data type	Default value	Description	
Axis	InOut	TO_Positioning Axis	-	Technology object	
Execute	INPUT	BOOL	FALSE	Start of the job with a positive edge	
Distance	INPUT	LREAL	0.0	Distance for the positioning process (negative or positive)	
Velocity	INPUT	LREAL	-1.0	Setpoint velocity for the positioning Value > 0.0: The specified value is used. Value = 0.0: not permitted Value < 0.0: The velocity configured in "Technology object > Configuration > Advanced parameters > Default dynamics" is used. (<TO>.DynamicDefaults.Velocity)	
Acceleration	INPUT	LREAL	-1.0	Acceleration Value > 0.0: The specified value is used. Value = 0.0: not permitted Value < 0.0: The acceleration configured in "Technology object > Configuration > Extended parameters > Dynamic defaults" is used. (<TO>.DynamicDefaults.Acceleration)	
Deceleration	INPUT	LREAL	-1.0	Deceleration Value > 0.0: The specified value is used. Value = 0.0: not permitted Value < 0.0: The deceleration configured in "Technology object > Configuration > Extended parameters > Dynamic defaults" is used. (<TO>.DynamicDefaults.Deceleration)	
Jerk	INPUT	LREAL	-1.0	Jerk Value > 0.0: Constant-acceleration velocity profile; the specified jerk is used Value = 0.0: Trapezoid velocity profile Value < 0.0: The jerk configured in "Technology object > Configuration > Extended parameters > Dynamic defaults" is used. (<TO>.DynamicDefaults.Jerk)	
Done	OUTPUT	BOOL	FALSE	TRUE	Target position reached
Busy	OUTPUT	BOOL	FALSE	TRUE	The job is being executed.
CommandAborted	OUTPUT	BOOL	FALSE	TRUE	During execution the job was aborted by another job.

Parameter	Declaration	Data type	Default value	Description	
Error	OUTPUT	BOOL	FALSE	TRUE	An error occurred during execution of the job. The job is rejected. The cause of the error can be found in the "ErrorID" parameter.
ErrorID	OUTPUT	WORD	16#0000	Error ID (Page 270) for parameter "Error"	

Moving an axis relative to the starting position

Proceed as follows to move an axis relative to the starting position:

1. Check the requirements indicated above.
2. Specify distance to be moved in the "Distance" parameter.
3. Start the "MC_MoveRelative" job with a positive edge at the parameter "Execute".

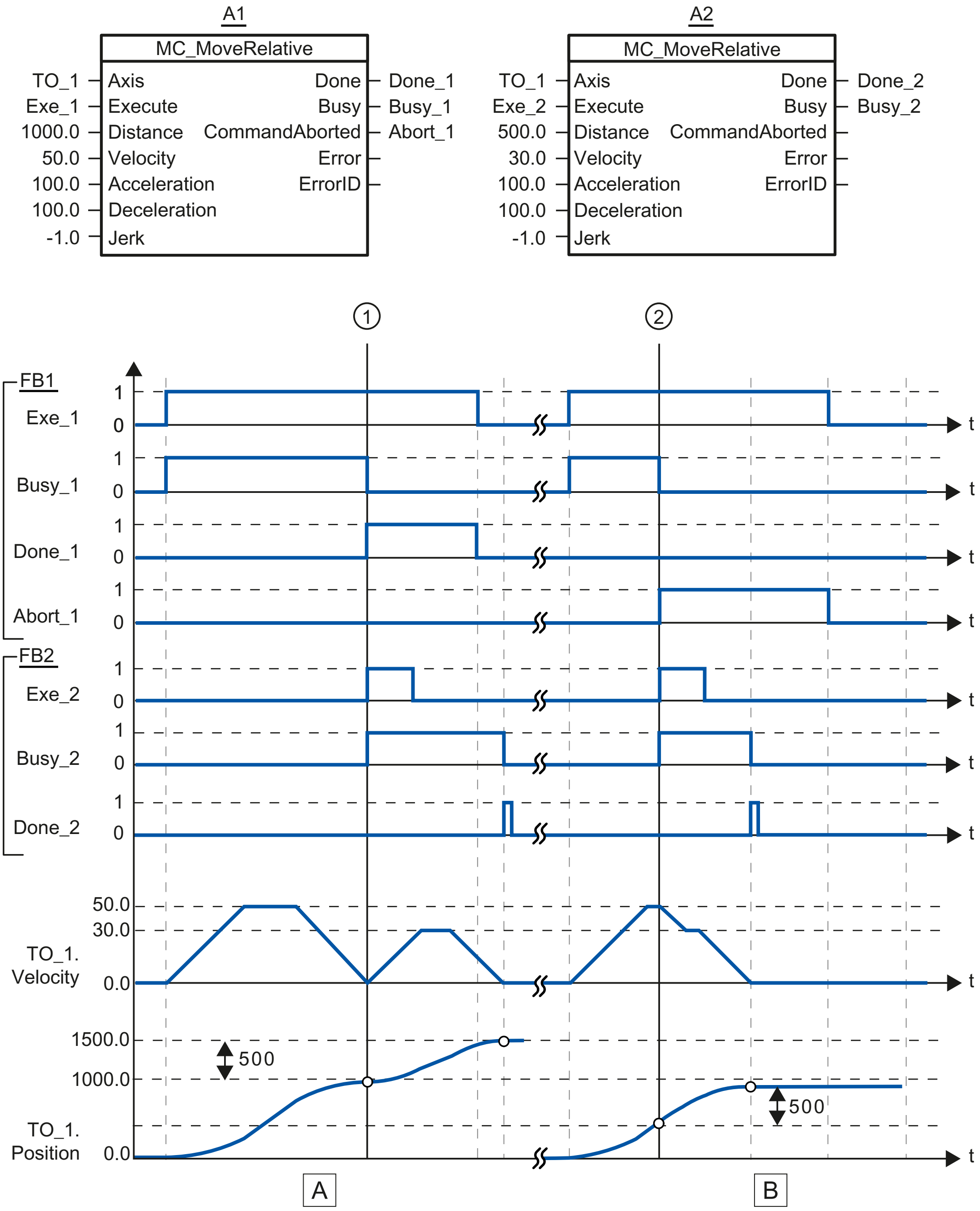
The current motion state is indicated in "Busy", "Done" and "Error".

See also

Error ID (Page 270)

10.1.5.2 MC_MoveRelative: Function chart

Function chart: Relative positioning of an axis, and the response to an overriding job



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 axis reaches the new target position, this is signaled via "Done_2". Since "Exe_2" was previously reset, "Done_2" is applied only to one cycle.
Section B	A running "MC_MoveRelative" job (A1) is overridden by another "MC_MoveRelative" job (A2). The abort is signaled at time ② via "Abort_1". The axis is then moved at the new velocity by the distance ("Distance") 500.0. When the new target position is reached, this is signaled via "Done_2".

10.1.6 MC_MoveAbsolute

10.1.6.1 MC_MoveAbsolute: Absolute positioning of axes

Description

With the Motion Control instruction "MC_MoveAbsolute", you can move an axis to an absolute position.

Dynamic behavior during movement is defined with the parameters "Velocity", "Jerk", "Acceleration" and "Deceleration".

Applies to

- Positioning axis

Requirements

- The technology object has been configured correctly.
- The technology object is enabled.
- The technology object is homed.

Override response

The "MC_MoveAbsolute" job is aborted by:

- Disabling the axis with "MC_Power.Enable" = FALSE
- "MC_Home" job "Mode" = 4, 5
- "MC_Halt" job
- "MC_MoveAbsolute" job
- "MC_MoveRelative" job
- "MC_MoveVelocity" job
- "MC_MoveJog" job

Starting a "MC_MoveAbsolute" job aborts the following active Motion Control jobs:

- "MC_Home" job "Mode" = 4, 5
- "MC_Halt" job
- "MC_MoveAbsolute" job
- "MC_MoveRelative" job
- "MC_MoveVelocity" job
- "MC_MoveJog" job

Parameter

The following table shows the parameters of the "MC_MoveAbsolute" Motion Control instruction:

Parameter	Declaration	Data type	Default value	Description
Axis	InOut	TO_Positioning Axis	-	Technology object
Execute	INPUT	BOOL	FALSE	Start of the job with a positive edge
Position	INPUT	REAL	0.0	Absolute target position
Velocity	INPUT	LREAL	-1.0	Setpoint velocity for the positioning Value > 0.0: The specified value is used. Value = 0.0: not permitted Value < 0.0: The velocity configured in "Technology object > Configuration > Advanced parameters > Default dynamics" is used. (<TO>.DynamicDefaults.Velocity)
Acceleration	INPUT	LREAL	-1.0	Acceleration Value > 0.0: The specified value is used. Value = 0.0: not permitted Value < 0.0: The acceleration configured in "Technology object > Configuration > Extended parameters > Dynamic defaults" is used. (<TO>.DynamicDefaults.Acceleration)
Deceleration	INPUT	LREAL	-1.0	Deceleration Value > 0.0: The specified value is used. Value = 0.0: not permitted Value < 0.0: The deceleration configured in "Technology object > Configuration > Extended parameters > Dynamic defaults" is used. (<TO>.DynamicDefaults.Deceleration)
Jerk	INPUT	LREAL	-1.0	Jerk Value > 0.0: Constant-acceleration velocity profile; the specified jerk is used Value = 0.0: Trapezoid velocity profile Value < 0.0: The jerk configured in "Technology object > Configuration > Extended parameters > Dynamic defaults" is used. (<TO>.DynamicDefaults.Jerk)
Direction	INPUT	INT	3	Direction of rotation of the axis Is only evaluated with "modulo" enabled. "Technology object > Configuration > Basic parameters > Enable modulo 1: Positive direction of rotation 2: Negative direction of rotation 3: Shortest path
Done	OUTPUT	BOOL	FALSE	TRUE: Target position reached.

Parameter	Declaration	Data type	Default value	Description	
Busy	OUTPUT	BOOL	FALSE	TRUE	The job is being executed.
CommandAborted	OUTPUT	BOOL	FALSE	TRUE	During execution the job was aborted by another job.
Error	OUTPUT	BOOL	FALSE	TRUE	An error occurred during execution of the job. The job is rejected. The cause of the error can be found in the "ErrorID" parameter.
ErrorID	OUTPUT	WORD	16#0000	Error ID (Page 270) for parameter "Error"	

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 at the "Position" parameter.
3. Start the "MC_MoveAbsolute" job with a positive edge at the parameter "Execute".

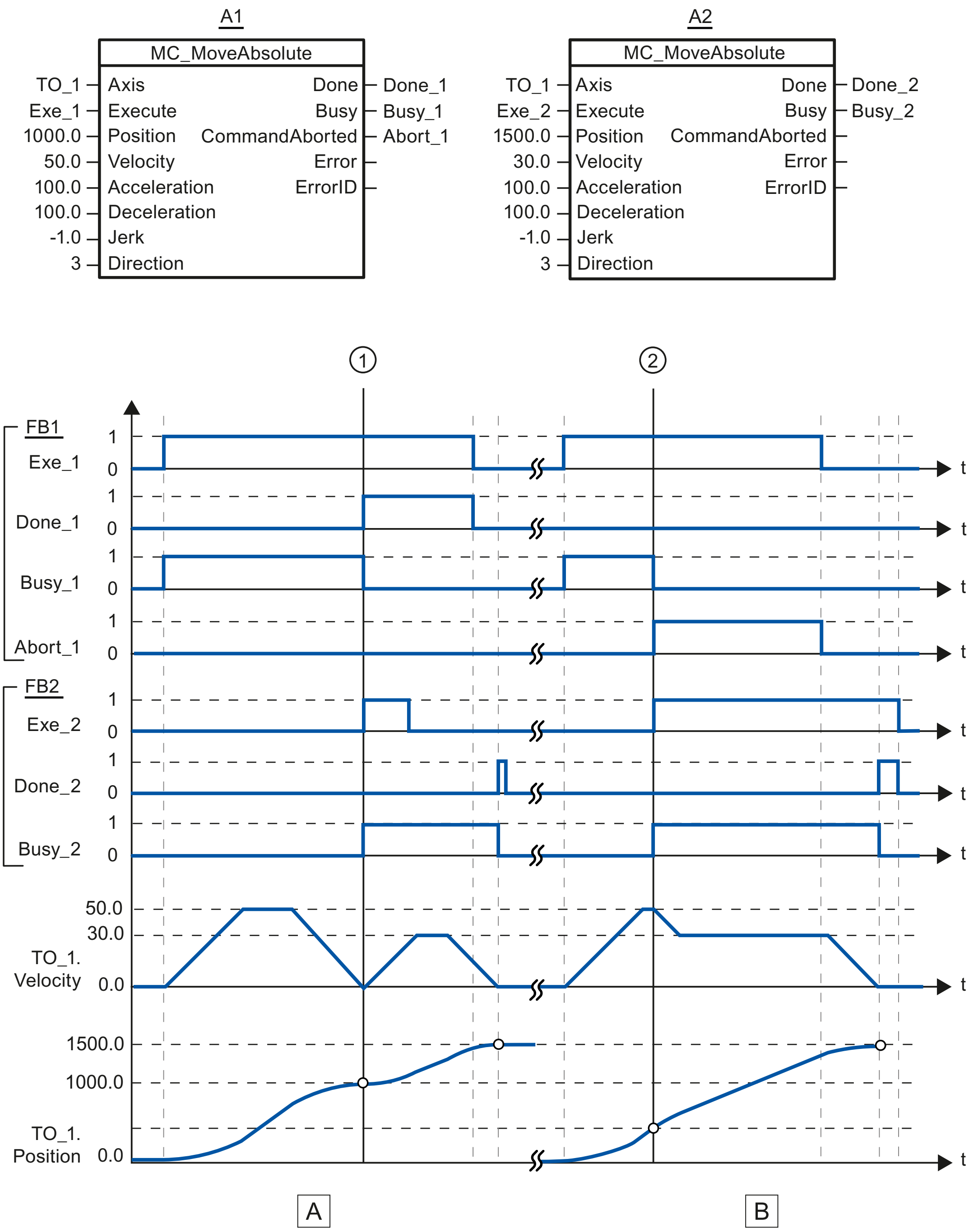
The current motion state is indicated in "Busy", "Done" and "Error".

See also

Error ID (Page 270)

10.1.6.2 MC_MoveAbsolute: Function chart

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	A running "MC_MoveAbsolute" job (A1) is overridden at time ② by another "MC_MoveAbsolute" job (A2). The abort is signaled via "Abort_1". The axis is braked to the changed velocity and moved to the new target position 1500.0. When the new target position is reached, this is signaled via "Done_2".

10.1.7 MC_Halt

10.1.7.1 MC_Halt: Halt axis

Description

With the Motion Control instruction "MC_Halt", you can brake an axis to a standstill.

Dynamic behavior during the braking process is defined with the parameters "Jerk" and "Deceleration".

Applies to

- Positioning axis
- Speed-controlled axis

Requirements

- The technology object has been configured correctly.
- The technology object is enabled.

Override response

The "MC_Halt" job is aborted by:

- Disabling the axis with "MC_Power.Enable" = FALSE
- "MC_Home" job "Mode" = 4, 5
- "MC_Halt" job
- "MC_MoveAbsolute" job
- "MC_MoveRelative" job
- "MC_MoveVelocity" job
- "MC_MoveJog" job

Starting a "MC_Halt" job aborts the following active Motion Control jobs:

- "MC_Home" job "Mode" = 4, 5
- "MC_Halt" job
- "MC_MoveAbsolute" job
- "MC_MoveRelative" job
- "MC_MoveVelocity" job
- "MC_MoveJog" job

Parameter

The following table shows the parameters of the "MC_Halt" Motion Control instruction:

Parameter	Declaration	Data type	Default value	Description	
Axis	InOut	TO_Speed Axis	-	Technology object	
Execute	INPUT	BOOL	FALSE	Start of the job with a positive edge	
Deceleration	INPUT	LREAL	-1.0	Deceleration Value > 0.0: The specified value is used. Value = 0.0: not permitted Value < 0.0: The deceleration configured in "Technology object > Configuration > Extended parameters > Dynamic defaults" is used. (<TO>.DynamicDefaults.Deceleration)	
Jerk	INPUT	LREAL	-1.0	Jerk Value > 0.0: Constant-acceleration velocity profile; the specified jerk is used Value = 0.0: Trapezoid velocity profile Value < 0.0: The jerk configured in "Technology object > Configuration > Extended parameters > Dynamic defaults" is used. (<TO>.DynamicDefaults.Jerk)	
Done	OUTPUT	BOOL	FALSE	TRUE	Zero velocity reached
Busy	OUTPUT	BOOL	FALSE	TRUE	The job is being executed.
CommandAborted	OUTPUT	BOOL	FALSE	TRUE	During execution the job was aborted by another job.
Error	OUTPUT	BOOL	FALSE	TRUE	An error occurred during execution of the job. The job is rejected. The cause of the error can be found in the "ErrorID" parameter.
ErrorID	OUTPUT	WORD	16#0000	Error ID (Page 270) for parameter "Error"	

Braking an axis with "MC_Halt"

Proceed as follows to decelerate an axis to a standstill:

1. Check the requirements indicated above.
2. Supply the parameters "Deceleration" and "Jerk" with the desired values.
3. Start the "MC_Halt" job with a positive edge at the parameter "Execute".

The current motion state is indicated in "Busy", "Done" and "Error". The standstill of the axis is indicated under "Technology object > Diagnostics > Status and error bits > Motion status > Standstill" (<TO>.StatusWord.Standstill).

Additional information

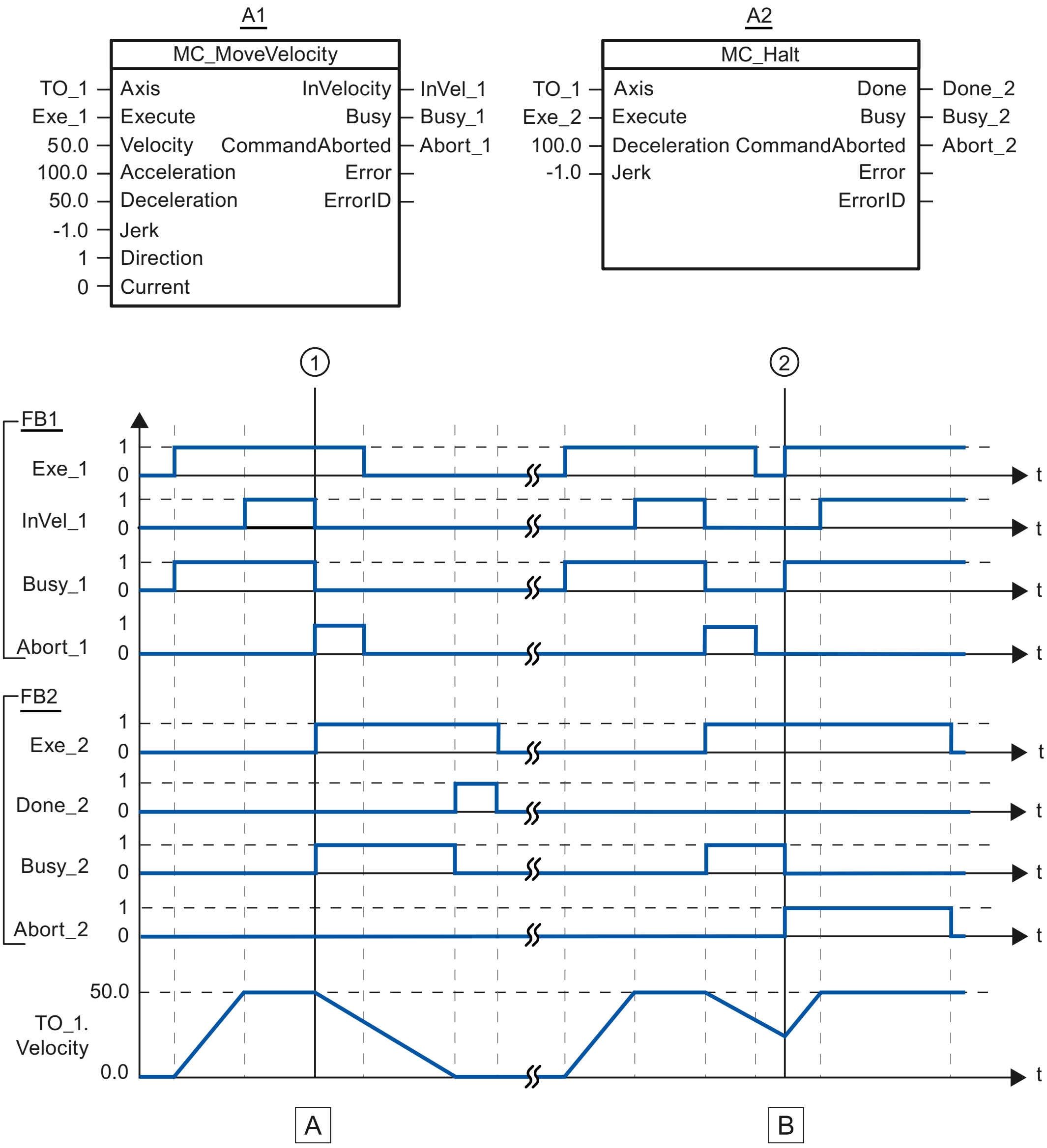
An option for the evaluation of the individual status bits can be found in the Evaluating StatusWord, ErrorWord and WarningWord (Page 143) section.

See also

Error ID (Page 270)

10.1.7.2 MC_Halt: Function chart

Function chart: Stopping an axis, and the response to an overriding job



Section A	An axis is moved with an "MC_MoveVelocity" job (A1). When the setpoint velocity 50.0 is reached, this is signaled via "InVel_1". At time ①, the "MC_MoveVelocity" job is overridden by an "MC_Halt" job (A2). The job termination is signaled via "Abort_1". The axis is braked to a standstill. Successful completion of the "MC_Halt" job is signaled via "Done_2".
Section B	The axis is moved with an "MC_MoveVelocity" job (A1). When the setpoint velocity 50.0 is reached, this is signaled via "InVel_1". Next the "MC_MoveVelocity" job is overridden by an "MC_Halt" job (A2). The job termination is signaled via "Abort_1". During the braking process the "MC_Halt" job is overridden at time ② by an "MC_MoveVelocity" job (A1). The job termination is signaled via "Abort_2". When the setpoint velocity 50.0 is reached, this is signaled via "InVel_1". The axis is then moved with constant velocity.

10.1.8 MC_Reset

10.1.8.1 MC_Reset: Acknowledging alarms, restarting technology objects

Description

All technology alarms that can be acknowledged in the user program are acknowledged with the Motion Control instruction "MC_Reset". Acknowledgment also resets the "Error" and "Warning" bits in the technology data block.

Technology objects are reinitialized (restarted) using the Motion Control instruction "MC_Reset" with "Restart" = TRUE. Upon restart of the technology object, the new configuration data are applied in the technology data block.

Applies to

- Positioning axis
- Speed-controlled axis
- External encoder

Requirements

- The cause of the error for a pending technology alarm has been resolved.
- For a restart, the technology object must be disabled.
  ("MC_Power.Status" = FALSE and "MC_Power.Busy" = FALSE)

Override response

- Parameter "Restart" = FALSE:

Processing of the instruction "MC_Reset" can be aborted by other Motion Control jobs. The MC_Reset job does not abort any running Motion Control jobs.

- Parameter "Restart" = TRUE:

The processing of the instruction "MC_Reset" with parameter "Restart" = TRUE cannot be aborted by any other Motion Control job.

Parameter

The following table shows the parameters of the "MC_Reset" Motion Control instruction:

Parameter	Declaration	Data type	Default value	Description	
Axis	InOut	TO_Axis	-	Technology object	
Execute	INPUT	BOOL	FALSE	Start of the job with a positive edge	
Restart	INPUT	BOOL	FALSE	TRUE	"Restart" Reinitialization of the technology object and acknowledgment of pending technology alarms. The technology object is reinitialized with the configured initial values.
				FALSE	Acknowledgement of queued technology alarms.
Done	OUTPUT	BOOL	FALSE	TRUE	Error has been acknowledged. Restart has been executed.
Busy	OUTPUT	BOOL	FALSE	TRUE	The job is being executed.
Command Aborted	OUTPUT	BOOL	FALSE	TRUE	During execution the job was aborted by another job.
Error	OUTPUT	BOOL	FALSE	TRUE	An error occurred during execution of the job. The job is rejected. The cause of the error can be found in the "ErrorID" parameter.
ErrorID	OUTPUT	WORD	16#0000	Error ID (Page 270) for parameter "Error"	

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 acknowledgement of the error with a positive edge at parameter "Execute".

If the Done parameter shows the value TRUE, then the error was acknowledged.

Note

Acknowledging with "Restart" = FALSE

If only the technology alarms are to be acknowledged, set "Restart" = FALSE,
The technology object cannot be used during a restart.

Restarting a technology object

Proceed as follows to restart a technology object:

1. Check the requirements indicated above.
2. Set the parameter "Restart" = TRUE.
3. Perform the restart with a positive edge at the input parameter "Execute".

If the "Done" parameter shows the value TRUE, then the restart of the technology object has been completed.

Additional information on a restart can be found in the Restarting Technology Objects (Page 163) section.

See also

Error ID (Page 270)

Appendix A

A.1 Technology data block tags

A.1.1 Legend

<table>
<tr><td>D | P | E</td><td colspan="2">Tag present at technology object:
D - Speed-controlled axis | P - Positioning axis | E - External Encoder</td></tr>
<tr><td>Tag</td><td colspan="2">Name of the tag</td></tr>
<tr><td>Data type</td><td colspan="2">Data type of the tag</td></tr>
<tr><td>Values</td><td colspan="2">Value range of the tag - minimum value to maximum value
(Without specific value input, the value range limits of the respective data type or the specification under "Description".)</td></tr>
<tr><td rowspan="4">W</td><td colspan="2">Efficacy of changes in the technology data block</td></tr>
<tr><td>DIR</td><td>Immediate:
Changes in the value occur by direct assignment, and are immediately effective.</td></tr>
<tr><td>RES</td><td>Restart:
Changes to the start value in load memory occur via the extended instruction "WRIT_DBL" (write to DB in load memory). Changes will not take effect until after restart of the technology object.</td></tr>
<tr><td>RON</td><td>Read only:
The tag cannot and must not be changed.</td></tr>
<tr><td>Description</td><td colspan="2">Description of the tag</td></tr>
</table>

L - Linear specification R - Rotary specification

Access to the tags occurs via "<TO>.<tag name>". The placeholder <TO> represents the name of the technology object.

A.1.2 Actual values and setpoints

The following tags indicate the setpoint and actual values of the technology object.

Tags

Legend (Page 243)

D	P	E	Tag	Data type	Values	W	Description
	X		Position	LREAL	-	RON	Setpoint position
X	X		Velocity	LREAL	-	RON	Setpoint velocity / setpoint speed
	X	X	ActualPosition	LREAL	-	RON	Actual position
	X	X	ActualVelocity	LREAL	-	RON	Actual velocity
X	X		ActualSpeed	LREAL	-	RON	Actual speed of the motor (with analog setpoint = 0.0)
X	X		Acceleration	LREAL	-	RON	Setpoint acceleration
	X	X	ActualAcceleration	LREAL	-	RON	Actual acceleration

A.1.3 Actor. tag

The tag structure <TO>.Actor.<tag name> contains the controller-side configuration for the drive.

Tags

Legend (Page 243)

D	P	E	Tag	Data type	Values	W	Description
X	X		Actor.	STRUCT			
X	X		Type	DINT	-	RON	Drive connection 1: PROFIdrive frame 0: Analog output
X	X		InverseDirection	BOOL	-	RES	Inversion of the setpoint FALSE: no TRUE: yes
			Interface.	STRUCT			
X	X		AddressIn	UDINT	0 to 65535	RON	Input address for the PROFIdrive frame
X	X		AdressOut	UDINT	0 to 65535	RON	Output address for the PROFIdrive frame or the analog setpoint

D	P	E	Tag			Data type	Values	W	Description
X	X				Telegram	UDINT	-	RON	PROFIdrive frame of the drive 1: NSET (16 bit), NACT (16 bit) 2: NSET (32 bit), NACT (32 bit), signs of life 3: NSET (32 bit), NACT (32 bit), actual encoder value, signs of life 5: NSETP (32-bit), NACT (32-bit), actual encoder value, sign-of-life, DSC (NSET - setpoint speed, NACT - actual speed value)
X	X				EnableDriveOutput	BOOL	-	RON	"Enable output" for analog drives FALSE: disabled TRUE: enabled
X	X				EnableDriveOutput Address	UDINT	0 to 65535	RON	Byte number for the "enable output"
X	X				EnableDriveOutput BitNumber	UDINT	0 to 7	RON	Bit number for the "enabling output"
X	X				DriveReadyInput	BOOL	-	RON	"Ready input" for analog drives The analog drive signals its readiness to receive setpoint speeds. FALSE: disabled TRUE: enabled
X	X				DriveReadyInput Address	UDINT	0 to 65535	RON	Byte number for the "ready input"
X	X				DriveReadyInputBit Number	UDINT	0 to 7	RON	Bit number for the "ready input"
				DriveParameter.					
X	X				ReferenceSpeed	LREAL	0 to 1.0E12	RES	Reference value (100%) for the setpoint speed of the drive (N-set) The setpoint speed is transmitted in the PROFIdrive frame as a standardized 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%, insofar as the drive permits this.
X	X				MaxSpeed	LREAL	0 to 1.0E12	RES	Maximum value for the setpoint speed of the drive (N-set) (PROFIdrive: MaxSpeed ≤ 2 × ReferenceSpeed Analog setpoint: MaxSpeed ≤ 1.17 × ReferenceSpeed)

See also

Evaluating the technology data block (Page 140)

A.1.4 Sensor[n]. tag

The tag structure <TO>.Sensor[n].<tag name> contains the CPU-side configuration for the encoder, and the configuration for active and passive homing.

Tags

Legend (Page 243)

D	P	E	Tag	Data type	Values	W	Description
	X		Sensor[n].	ARRAY [1..1] OF STRUCT			
	X	X	Type	DINT	-	RES	Encoder type: 0: Incremental 1: Absolute 2: Cyclically absolute
	X	X	InverseDirection	BOOL	-	RES	Inversion of the setpoint FALSE: no TRUE: yes
	X	X	System	DINT	-	RES	Encoder system 0: Linear encoder 1: Rotary encoder
	X	X	MountingMode	DINT	-	RES	Mounting type of the encoder 0: Incremental 1: Absolute 2: External
	X	X	Interface.				
	X	X	AddressIn	UDINT	0 to 65535	RON	Input address for the PROFIdrive frame
	X	X	AddressOut	UDINT	0 to 65535	RON	Output address for the PROFIdrive frame
	X	X	Telegram	UDINT	-	RON	PROFIdrive frame of the encoder 3: Actual values via drive frame (NSET (32 bit), NACT (32 bit), actual encoder value, signs of life) 5: Actual values from drive frame (NSETP (32-bit), NACT (32-bit), actual encoder value, sign-of-life, DSC) 81: Actual values via your own encoder telegram (actual encoder value, signs of life) 83: Actual values via your own encoder telegram (NACT (32 bit), actual encoder value, signs of life) For the technology object of external encoders, only frames 81 and 83 are valid. (NSET - setpoint speed, NACT - actual speed value)
	X	X	Parameter.				

D	P	E	Tag	Data type	Values	W	Description
	X	X	Resolution	LREAL	1.0E-12 to 1.0E12	RES	Resolution of a linear encoder (offset between two encoder pulses)
	X	X	StepsPerRevolution	UDINT	1 to 8388608	RES	Increments per rotary encoder revolution
	X	X	FineResolutionXist1	UDINT	0 to 31	RES	Number of bits for fine resolution Gn_XIST1 (cyclical actual encoder value)
	X	X	FineResolutionXist2	UDINT	0 to 31	RES	Number of bits for fine resolution Gn_XIST2 (absolute value of the encoder)
	X	X	Determinable Revolutions	UDINT	0 to 8388608	RES	Number of differentiable encoder revolutions for a multi-turn absolute value encoder (For a single-turn absolute value encoder = 1; for an incremental encoder = 0)
	X	X	DistancePer Revolution	LREAL	0.0 to 1.0E12	RES	Load distance per revolution of an externally mounted encoder
	X		ActiveHoming.	STRUCT			
	X		Mode	DINT	-	RES	Homing mode 0: Homing mark only 1: Homing mark and proximity switch 2: Digital input
	X		SideInput	BOOL	-	DIR	Side of the digital input for active homing: FALSE: Negative side TRUE: Positive side
	X		Direction	DINT	-	DIR	Homing direction / homing mark approach direction 1: Positive homing direction 2: Negative homing direction
	X		DigitalInputAddress	UDINT	0 to 65535	RON	Byte number of the digital input
	X		DigitalInputBit Number	UDINT	0 to 7	RON	Bit number of the digital input
	X		HomePositionOffset	LREAL	-1.0E12 to 1.0E12	DIR	Home position offset
	X	X	PassiveHoming.	STRUCT			
	X	X	Mode	DINT	-	RES	Homing mode 0: Homing mark only 1: Homing mark and proximity switch 2: Digital input
	X	X	SideInput	BOOL	-	DIR	Side of the digital input for passive homing: FALSE: Negative side TRUE: Positive side
	X	X	Direction	DINT	-	DIR	Homing direction / homing mark approach direction 0: Current homing direction 1: Positive homing direction 2: Negative homing direction

D	P	E	Tag	Data type	Values	W	Description
	X	X	DigitalInputAddress	UDINT	0 to 65535	RON	Byte number of the digital input
	X	X	DigitalInputBit Number	UDINT	0 to 7	RON	Bit number of the digital input

See also

Evaluating the technology data block (Page 140)

A.1.5 Mechanics

The following tags contain the configuration of the mechanics.

Tags

Legend (Page 243)

D	P	E	Tag	Data type	Value range	W	Description
X	X	X	LoadGear.	STRUCT			
X	X	X	Numerator	UDINT	1 to 4294967295	RES	Load gear counter
X	X	X	Denominator	UDINT	1 to 4294967295	RES	Load gear denominator
	X	X	Properties.				
	X	X	MotionType	DINT		RON	Indication of axis or motion type: 0: Linear axis or motion 1: Rotary axis or motion
	X		Mechanics.				
	X		LeadScrew	LREAL	0.0 to 1.0E12	RES	Leadscrew pitch

See also

Evaluating the technology data block (Page 140)

A.1.6 Modulo. tag

The tag structure <TO>.Modulo.<tag name> contains the modulo configuration.

Tags

Legend (Page 243)

D	P	E	Tag	Data type	Values	W	Description
	X	X	Modulo.	STRUCT			
	X	X	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
	X	X	Length	LREAL	0.001 to 1.0E12	RES	Modulo length
	X	X	StartValue	LREAL	-1.0E12 to 1.0E12	RES	Modulo start value

See also

Evaluating the technology data block (Page 140)

A.1.7 DynamicLimits. tag

The tag structure <???>.DynamicLimits.<tag name> contains the configuration of the dynamic limits. During Motion Control, no dynamic values greater than the dynamic limits are permitted. If you have specified greater values in a Motion Control instruction, then motion is performed using the dynamic limits, and a warning is indicated (alarm 501 to 503 - Dynamic values were limited).

Tags

Legend (Page 243)

D	P	E	Tag	Data type	Values	W	Description
X	X		DynamicLimits.	STRUCT			
X	X		MaxVelocity	LREAL	0.0 to 1.0E12	RES	Maximum permissible velocity of the axis
X	X		MaxAcceleration	LREAL	0.0 to 1.0E12	DIR	Maximum permissible acceleration of the axis
X	X		MaxDeceleration	LREAL	0.0 to 1.0E12	DIR	Maximum permissible deceleration of the axis
X	X		MaxJerk	LREAL	0.0 to 1.0E12	DIR	Maximum permissible jerk on the axis

See also

Evaluating the technology data block (Page 140)

A.1.8 DynamicDefaults. tag

The tag structure <???><TO>.DynamicDefaults.<tag name> contains the configuration of the dynamic defaults. These settings will be used, if you specify a dynamic value less than 0.0 in a Motion Control instruction (exceptions: MC_MoveJog.Velocity, MC_MoveVelocity.Velocity). Changes to the dynamic defaults will be applied with the next rising edge at the "Execute" parameter of a Motion Control instruction.

Tags

Legend (Page 243)

D	P	E	Tag	Data type	Values	W	Description
X	X		DynamicDefaults.	STRUCT			
X	X		Velocity	LREAL	0.0 to 1.0E12	DIR	Default velocity
X	X		Acceleration	LREAL	0 to 1.0E12	DIR	Default acceleration
X	X		Deceleration	LREAL	0 to 1.0E12	DIR	Default deceleration
X	X		Jerk	LREAL	0 to 1.0E12	DIR	Default jerk
X	X		EmergencyDeceleration	LREAL	0 to 1.0E12	DIR	Emergency stop deceleration

See also

Evaluating the technology data block (Page 140)

A.1.9 PositionLimits_SW. tag

The tag structure <???><TO>.PositionLimits_SW.<tag name> contains the configuration for position monitoring with software limit switches. Software limit switches are used to limit the traversing range of a positioning axis.

Tags

Legend (Page 243)

D	P	E	Tag	Data type	Values	W	Description
	X		PositionLimits_SW.	STRUCT			
	X		Active	BOOL	-	DIR	FALSE: Monitoring disabled TRUE: Monitoring enabled
	X		MinPosition	LREAL	-1.0E12 to 1.0E12	DIR	Position of negative software limit switches
	X		MaxPosition	LREAL	-1.0E12 to 1.0E12	DIR	Position of positive software limit switches ("MaxPosition" > "MinPosition")

See also

Evaluating the technology data block (Page 140)

A.1.10 PositionLimits_HW. tag

The tag structure <???><TO>.PositionLimits_HW.<tag name> contains the configuration for position monitoring with hardware limit switches. Hardware limit switches are used to limit the traversing range of a positioning axis.

Tags

Legend (Page 243)

D	P	E	Tag	Data type	Values	W	Description
	X		PositionLimits_HW.	STRUCT			
	X		Active	BOOL	-	RES	FALSE: Monitoring disabled TRUE: Monitoring enabled With "Active", both (negative and positive) hardware limit switches are enabled or disabled.
	X		MinSwitchLevel	BOOL	-	RES	Level selection for enablement of the negative hardware limit switch: FALSE: Lower level (low-enabled) TRUE: Upper level (high-enabled)
	X		MinSwitchAddress	UDINT	0 to 65535	RON	Byte number for the negative hardware limit switch
	X		MinSwitchBitNumber	UDINT	0 to 7	RON	Byte number for the negative hardware limit switch
	X		MaxSwitchLevel	BOOL	-	RES	Level selection for enablement of the positive hardware limit switch: FALSE: Lower level (low-enabled) TRUE: Upper level (high-enabled)
	X		MaxSwitchAddress	UDINT	0 to 65535	RON	Byte number for the positive hardware limit switch
	X		MaxSwitchBitNumber	UDINT	0 to 7	RON	Bit number for the positive hardware limit switch

See also

Evaluating the technology data block (Page 140)

A.1.11 Homing. tag

The tag structure <TO>.Homing.<tag name> contains the configuration for homing the TO.

Tags

Legend (Page 243)

D	P	E	Tag	Data type	Values	W	Description
	X	X	Homing.	STRUCT			
	X		AutoReversal	BOOL	-	RES	Reversal at the hardware limit switches FALSE: no TRUE: yes
	X		ApproachDirection	BOOL	-	DIR	Direction of approach to the homing position switch FALSE: Negative side TRUE: Positive direction
	X		ApproachVelocity	LREAL	L: 0.0 to 10000.0 mm/s R: 0.0 to 360000°/s	DIR	Approach velocity Velocity during active homing, with which the axis moves toward the proximity switch and toward home position.
	X		ReferencingVelocity	LREAL	L: 0.0 to 1000.0 mm/s R: 0.0 to 36000°/s	DIR	Homing velocity Velocity during active homing, with which the axis is moved toward home position.
	X	X	HomePosition	LREAL	-1.0E12 to 1.0E12	DIR	Home position

See also

Evaluating the technology data block (Page 140)

A.1.12 Override. tag

The tag structure <???><TO>.Override.<tag name> contains the configuration for the override parameters. The override parameters are used to apply a correction percentage to default values. An override change takes effect immediately, and is performed with the dynamic settings in effect in the Motion Control instruction.

Tags

Legend (Page 243)

D	P	E	Tag	Data type	Values	W	Description
X	X		Override.	STRUCT			
X	X		Velocity	LREAL	0.0 to 200.0%	DIR	Velocity or speed override Percentage correction of the velocity/speed

See also

Evaluating the technology data block (Page 140)

A.1.13 PositionControl. tag

The tag structure <TO>.PositionControl.<tag name> contains the settings for position control.

Tags

Legend (Page 243)

D	P	E	Tag	Data type	Values	W	Description
	X		PositionControl.				
	X		Kv	LREAL	0.0 to 2147480	DIR	Proportional gain in the position control ("Kv" > 0.0)
			Kpc	LREAL	0.0 to 150.0%	DIR	Velocity pre-control in 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%
	X		EnableDSC	BOOL	-	RES	Dynamic Servo Control (DSC) FALSE: DSC disabled TRUE: DSC enabled DSC is only possible if frame 5 is used.

See also

Evaluating the technology data block (Page 140)

A.1.14 FollowingError. tag

The tag structure <???><TO>.FollowingError.<tag name> contains the configuration for following error monitoring.

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

When the warning level is reached, a warning is output (technology alarm 522).

Tags

Legend (Page 243)

D	P	E	Tag	Data type	Values	W	Description
	X		FollowingError.	STRUCT			
	X		EnableMonitoring	BOOL	-	RES	FALSE: Following error monitoring disabled TRUE: Following error monitoring enabled
	X		MinValue	LREAL	-1.0E12 to 1.0E12	DIR	Permissible following error at velocities below the value of "MinVelocity".
	X		MaxValue	LREAL	-1.0E12 to 1.0E12	DIR	Maximum permissible following error, which may be reached at the maximum velocity.
	X		MinVelocity	LREAL	-1.0E12 to 1.0E12	DIR	"MinValue" is permissible below this velocity, and is held constant.
	X		WarningLevel	LREAL	0.0 to 100.0	DIR	Warning level: Percentage value relative to the valid maximum following error.

See also

Evaluating the technology data block (Page 140)

A.1.15 PositioningMonitoring. tag

The tag structure <???><TO>.PositioningMonitoring.<tag name> contains the configuration for position monitoring at the end of a positioning motion.

If the actual position value at the end of a positioning motion is reached within the tolerance time and remains in the positioning window for the minimum dwell time, then <TO>.StatusWord.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 area not reached within the positioning tolerance time" will be indicated.

If the minimum dwell time is not met, then technology alarm 541 "Positioning monitoring" with supplemental value 2: "Target area exited within the minimum dwell time" will be indicated.

Tags

Legend (Page 243)

D	P	E	Tag	Data type	Values	W	Description
	X		PositioningMonitoring.	STRUCT			
	X		ToleranceTime	LREAL	0.0 to 1.0E12	DIR	Tolerance time Maximum permitted duration from reaching velocity setpoint zero, until entrance into the positioning window.
	X		MinDwellTime	LREAL	0.0 to 1.0E12	DIR	Minimum dwell time in the positioning window:
	X		Window	LREAL	0.0 to 1.0E12	DIR	Positioning window

See also

Evaluating the technology data block (Page 140)

A.1.16 StandstillSignal. tag

The tag structure <???><TO>.StandstillSignal.<tag name> contains the configuration for the standstill signal.

If the actual velocity value is below the velocity threshold, and does not exceed it during the minimum dwell time, then the standstill signal <TO>.StatusWord.Standstill is set.

Tags

Legend (Page 243)

D	P	E	Tag		Data type	Values	W	Description
	X		StandstillSignal.		STRUCT			Configuration for the standstill signal
	X			VelocityThreshold	LREAL	0.0 to 1.0E12	DIR	Velocity threshold If velocity is below this threshold, then the minimum dwell time begins.
	X			MinDwellTime	LREAL	0.0 to 1.0E12	DIR	Minimum dwell time

See also

Evaluating the technology data block (Page 140)

A.1.17 StatusPositioning. tag

The tag structure <TO>.StatusPositioning.<tag name> indicates the status of a positioning motion.

Tags

Legend (Page 243)

D	P	E	Tag		Data type	Values	W	Description
	X		StatusPositioning.		STRUCT			
	X			Distance	LREAL	-	RON	Distance to the target position
	X			TargetPosition	LREAL	-	RON	Target position
	X			FollowingError	LREAL	-	RON	Current following error

See also

Evaluating the technology data block (Page 140)

A.1.18 StatusDrive. tag

The tag structure <TO>.StatusDrive.<tag name> indicates the status of the drive.

Tags

Legend (Page 243)

D	P	E	Tag	Data type	Values	W	Description
X	X		StatusDrive	STRUCT			
X	X		InOperation	BOOL	-	RON	Operational status of the drive FALSE: Drive not ready. Setpoints will not be executed. TRUE: Drive ready. Setpoints can be executed.
X	X		CommunicationOK	BOOL	-	RON	Cyclical BUS communication between controller and drive FALSE: Not established TRUE: Established
X	X		Error	BOOL	-	RON	FALSE: No error at the drive TRUE: Error at the drive

See also

Evaluating the technology data block (Page 140)

A.1.19 StatusSensor[n]. tag

The tag structure <TO>.StatusSensor[n].<tag name> indicates the status of the measuring system.

Tags

Legend (Page 243)

D	P	E	Tag		Data type	Values	W	Description
	X	X	StatusSensor[n].		ARRAY [1..1] OF STRUCT			
	X	X		State	DINT	-	RON	Status of the actual encoder value: 0: "NOT_VALID (not valid) 1: "Waiting_FOR_VALID (waiting for valid status) 2: "VALID (valid)
	X	X		CommunicationOK	BOOL	-	RON	Cyclical BUS communication between controller and encoder FALSE: Not established TRUE: Established
	X	X		Error	BOOL	-	RON	FALSE: No error in the measuring system TRUE: Error in the measuring system.
	X	X		AbsEncoderOffset	LREAL	-	RON	Home point offset to the value of an absolute value encoder. The value will be retentively stored in the CPU.

See also

Evaluating the technology data block (Page 140)

A.1.20 StatusWord. tag

The <TO>.StatusWord tag contains the status data of the technology object.

Notes on the evaluation of the individual bits (e.g. bit 5, "HomingDone") can be found in the Evaluating StatusWord, ErrorWord and WarningWord (Page 143) section.

Tags

Legend (Page 243)

D	P	E	Tag		Data type	Values	W	Description
X	X	X	StatusWord		DWORD	-	RON	Status data of the technology object
X	X	X	0	Enable				Enablement status 0: Technology object disabled 1: Technology object enabled
X	X	X	1	Error				0: No error present 1: Error present
X	X	X	2	RestartActive				0: No "Restart" active 1: "Restart" active. The technology object is being reinitialized.
X	X	X	3	OnlineStart ValuesChanged				0: "Restart" tag unchanged 1: Change in "Restart" tag. For the changes to be applied, the technology object must be reinitialized.
X	X		4	ControlPanel Active				Axis control panel 0: disabled 1: enabled
	X	X	5	HomingDone				Homing status 0: Technology object not homed 1: Technology object homed
X	X	X	6	Done				0: Motion job in process, or axis control panel enabled 1: No motion job in process and axis control panel disabled
	X		7	Standstill				Standstill signal 0: Axis in motion 1: Axis at a standstill
	X		8	Positioning Command				0: No positioning job active 1: Positioning job active ("MC_MoveReleative", "MC_MoveAbsolute")
X	X		9	JogCommand				0: No "MC_MoveJog" frame active 1: "MC_MoveJog" job
X	X		10	Velocity Command				0: No "MC_MoveVelocity" job active 1: "MC_MoveVelocity" job active
	X	X	11	Homing Command				0: No "MC_Home" job in process 1: "MC_Home" job in process
X	X		12	ConstantVelocity				0: The axis is being accelerated, decelerated, or is at a standstill. 1: Velocity setpoint reached. The axis is being moved at this constant velocity.

D	P	E	Tag		Data type	Values	W	Description
X	X		13	Accelerating				0: No acceleration process active 1: Acceleration process active
X	X		14	Decelerating				0: No deceleration process active 1: Deceleration process active
	X		15	SWLimitMin Active				Negative software limit switch 0: disabled 1: enabled
	X		16	SWLimitMax Active				Positive software limit switch 0: disabled 1: enabled
	X		17	HWLimitMin Active				Negative hardware limit switch 0: disabled 1: enabled
	X		18	HWLimitMax Active				Positive hardware limit switch 0: disabled 1: enabled
X	X		19	ErrorStopActive				Stop as a result of alarm response 0: not active 1: active
X	X		20	MC_PowerStop Active				Stop as a result of disablement via "MC_Power" 0: not active 1: active
			21 ... 31					Reserved

See also

Evaluating the technology data block (Page 140)

A.1.21 ErrorWord. tag

The <TO>.ErrorWord tag indicates errors at the technology object (technology alarms).

Notes on the evaluation of the individual bits (e.g. bit 3, CommandNotAccepted) can be found in the Evaluating StatusWord, ErrorWord and WarningWord (Page 143) section.

Tags

Legend (Page 243)

D	P	E	Tag		Data type	Values	W	Description
			ErrorWord		DWORD	-	RON	
X	X	X	0	SystemFault				System error
X	X	X	1	Configuration Fault				Configuration error One or more configuration parameters are inconsistent or invalid.
X	X	X	2	UserFault				Error in the user program in a Motion Control instruction, or in its utilization
X	X	X	3	CommandNot Accepted				Instruction cannot be executed. A Motion Control instruction cannot be executed, because necessary preconditions are not met.
X	X		4	DriveFault				Error in the drive
	X	X	5	SensorFault				Error in the encoder system.
X	X		6	DynamicError				Specified dynamic values are limited to permissible values.
X	X	X	7	Communication Fault				Communication error Missing or faulty communication.
	X		8	SWLimit				Software limit switch reached or overshot.
	X		9	HWLimit				Hardware limit switch reached or overshot.
	X	X	10	HomingFault				Error during homing process The homing cannot be completed.
	X		11	FollowingError Fault				Following error limits exceeded
	X		12	PositioningFault				Positioning error
X	X	X	13	PeripheralError				Error when accessing a logical address
			14 ... 31					Reserved

See also

Evaluating the technology data block (Page 140)

A.1.22 ErrorDetail. tag

The tag structure <TO>.ErrorDetail.<tag name> contains the alarm number and the effective local alarm response to the technology alarm that is currently pending at the technology object.

A list of the technology alarms and alarm responses can be found in the appendix, Technology Alarms (Page 267).

Tags

Legend (Page 243)

D	P	E	Tag		Data type	Values	W	Description
X	X	X	ErrorDetail.		STRUCT			
X	X	X		Number	UDINT	-	RON	Alarm number
X	X	X		Reaction	DINT	0 to 4	RON	Effective alarm response 0: No response 1: Stop with current dynamic values 2 Stop with maximum dynamic values 3: Stop with emergency stop ramp 4: Remove enable For the external encoder technology object, only alarm responses 0 and 4 are possible.

See also

Evaluating the technology data block (Page 140)

Technology alarms (Page 186)

A.1.23 WarningWord. tag

The <TO>.WarningWord tag indicates pending warnings at the technology object.

Notes on the evaluation of the individual bits (e.g. bit 11, "FollowingErrorWarning") can be found in the Evaluating StatusWord, ErrorWord and WarningWord (Page 143) section.

Tags

Legend (Page 243)

D	P	E	Tag		Data type	Values	W	Description
			WarningWord		DWORD	-	RON	
			0					Reserved
X	X	X	1	Configuration Fault				Configuration error One or several configuration parameters are adjusted internally.
			2					Reserved
X	X	X	3	CommandNot Accepted				Instruction cannot be executed. A Motion Control instruction cannot be executed, because necessary preconditions are not met.
			4					Reserved
			5					Reserved
X	X		6	DynamicError				Specified dynamic values are limited to permissible values.
			7					Reserved
			8					Reserved
			9					Reserved
			10					Reserved
	X		11	FollowingError Warning				Warning level of the following error monitoring reached / exceeded
			12					Reserved
			13					Reserved
			14 ... 31					Reserved

See also

Evaluating the technology data block (Page 140)

A.1.24 ControlPanel. tag

The tag structure <TO>.ControlPanel.<tag name> contains no application-relevant data. This tag structure is internally used.

Tags

Legend (Page 243)

D	P	E	Tag	Data type	Values	W	Description
X	X		ControlPanel.	STRUCT			
X	X		Input.	STRUCT			
X	X		Command.	ARRAY[1..2] OF STRUCT			
X	X		ReqCounter	UDINT	-	DIR	-
X	X		Type	UDINT	-	DIR	-
X	X		Position	LREAL	-	DIR	-
X	X		Velocity	LREAL	-	DIR	-
X	X		Acceleration	LREAL	-	DIR	-
X	X		Deceleration	LREAL	-	DIR	-
X	X		Jerk	LREAL	-	DIR	-
X	X		Param	LREAL	-	DIR	-
X	X		TimeOut	LREAL	-	DIR	-
X	X		EsLifeSign	UDINT	-	DIR	-
X	X		Output.	STRUCT			
X	X		Command.	ARRAY[1..2] OF STRUCT			
X	X		AckCounter	UDINT	-	RON	-
X	X		Error	BOOL	-	RON	-
X	X		ErrorID	UDINT	-	RON	-
X	X		Done	BOOL	-	RON	-
X	X		Aborted	BOOL	-	RON	-
X	X		RTLifeSign	UDINT	-	RON	-

See also

Evaluating the technology data block (Page 140)

A.1.25 InternalTOTrace. tag

The tag structure <TO>.InternalTOTrace.<tag name> contains no application-relevant data. This tag structure is internally used.

Tags

Legend (Page 243)

D	P	E	Tag	Data type	Values	W	Description
X	X	X	InternalTOTrace.	ARRAY[1..4] OF STRUCT			
X	X	X	Id	DINT	-	DIR	-
X	X	X	Value	LREAL	-	RON	-

See also

Evaluating the technology data block (Page 140)

A.2 Technology alarms

The following table shows an overview of the technology alarms and the corresponding alarm responses. When a technology alarm occurs, evaluate the entire indicated alarm text, in order to find the precise cause.

You can find the FAQs with remedies for technology alarms on the Internet (http://support.automation.siemens.com/WW/view/en/66958052).

Legend

No.	Number of the technology alarm (corresponds to <TO>.ErrorDetail.Number)
Response	Effective alarm response (corresponds to <TO>.ErrorDetail.Reaction)
Error bit	Bit that is set in <TO>.ErrorWord when the technology alarm occurs
Warning bit	Bit that is set in <TO>.WarningWord when the technology alarm occurs
Restart	To acknowledge the technology alarm, the technology object must be reinitialized (restart).
Alarm text	Indicated alarm test (limited)

List of the technology alarms

No.	Response	Error bit	Warning bit	Restart	Alarm text
101	Remove enable	Configuration Fault	-	X	Error in the configuration of the technology object
104	Stop with maximum dynamic values	Configuration Fault	-	X	Error in the specification of software limit switches
105	Remove enable	Configuration Fault	-	X	Error in the configuration of the drive
106	Remove enable	Configuration Fault	-	X	Error in the configuration of the drive's driver
107	Remove enable	Configuration Fault	-	X	Error in the configuration of the encoder
108	Remove enable	Configuration Fault	-	X	Error in the configuration of the encoder driver
109	Remove enable	Configuration Fault	-	-	Range exceedance of the incremental actual value
110	No response	-	Configuration Fault	-	Configuration is being internally adapted.
201	Remove enable	SystemFault	-	-	Internal error
202	No response	SystemFault	-	-	Internal configuration error
203	Remove enable	SystemFault	-	-	Internal error
204	Remove enable	SystemFault	-	-	Internal error
304	Stop with emergency stop ramp	UserFault	-	-	Maximum permissible velocity is zero.
305	Stop with emergency stop ramp	UserFault	-	-	Maximum permissible acceleration/deceleration is zero.
306	Stop with emergency stop ramp	UserFault	-	-	Maximum permissible jerk is zero.
307	Stop with maximum dynamic values	UserFault	-	-	Internal traversing range limit was reached.
308	Remove enable	UserFault	-	-	Internal traversing range limit was overshot.
321	Stop with emergency stop ramp	Command Not Accepted	-	-	The axis is not homed.
322	No response	-	Command Not Accepted	-	Restart of the technology object was not executed.
323	No response	-	Command Not Accepted	-	The internal traversing range would be exceeded as a result of the job.
342	Stop with emergency stop ramp	HomingFault	-	-	Reference cam / encoder zero mark was not found.
341	Remove enable	HomingFault	-	-	Error in the homing configuration

No.	Response	Error bit	Warning bit	Restart	Alarm text
401	Remove enable	Peripheral Error	-	-	Error accessing a logical address
411	Remove enable	SensorFault	-	-	Error in the encoder system.
412	Remove enable	SensorFault	-	-	Violation of the range limit for the incremental actual value
421	Remove enable	DriveFault	-	-	Error in the drive
431	Remove enable	Communication Fault	-	-	Error in the BUS communication
501	No response	-	Dynamic Error	-	Programmed velocity limited.
502	No response	-	Dynamic Error	-	Programmed acceleration/deceleration limited.
503	No response	-	Dynamic Error	-	Programmed jerk limited.
504	No response	-	Dynamic Error	-	Rotational speed monitoring active
521	Remove enable	Following Error Fault	-	-	The maximum permitted following error was exceeded.
522	No response		Following ErrorFault		The warning level of the following error was reached.
531	Remove enable	HWLimit	-	X	Hardware limit switch was reached. Only one traversing direction is possible.
533	Stop with maximum dynamic values	SWLimit	-	-	Software limit switch was reached.
534	Remove enable	SWLimit	-	-	Software limit switch was overshot.
541	Remove enable	Postioning Fault	-	-	Positioning error

See also

Technology alarms (Page 186)

A.3 Error ID

Errors in Motion Control instructions are reported by means of "Error" and "ErrorID" parameters.

Under the following conditions, "Error" = TRUE and "ErrorID" = 16#8xxx are indicated at the Motion Control instruction:

- Invalid status of the technology object, which prevents the execution of the job.
- Invalid parameter assignment of the Motion Control instruction, which prevents the execution of the job.
- As a result of the alarm response for an error at the technology object.

ErrorIDs and remedies

The following table lists all "ErrorIDs" that can be indicated in Motion Control instructions. Along with the cause of the error, the table lists corresponding troubleshooting routines:

ErrorID	Description	Remedy
16#0000	No error	-
16#8001	A technology alarm (TO error) occurred while processing the Motion Control instruction.	An error message is output in the technology data block's "ErrorDetail.number" tag. A list of the technology alarms and alarm responses can be found in the appendix, Technology Alarms (Page 267).
16#8002	Invalid value in the "Axis" parameter.	Check the value in the "Axis" parameter
16#8003	Invalid velocity	Set a valid velocity value at parameter "Velocity".
16#8004	Invalid acceleration	Set a valid acceleration value at parameter "Acceleration".
16#8005	Invalid deceleration	Set a valid deceleration value at parameter "Deceleration".
16#8006	Invalid jerk	Set a valid jerk value at parameter "Jerk".
16#8007	Invalid direction	Set a valid directional value at parameter "Direction".
	When the axis is at a standstill, "Direction" = 4 (current direction) is not permitted.	
	Invalid input Both the "JogForward" and "JogBackward" parameters set to TRUE at the same time. The axis decelerates with the most recently valid deceleration.	Reset both the "JogForward" parameter and the "JogBackward" parameter.
16#8008	Invalid distance specification	Set a valid distance value at parameter "Distance".
16#8009	Invalid position specification	Set a valid position value at parameter "Position".
16#800A	Invalid operating mode	Set a valid operating mode at parameter "Mode".
16#800B	Invalid stop mode	Set a valid stop mode at parameter "StopMode".
16#800C	Only one instance of the "MC_Power" instruction is allowed per technology object.	A technology object was specified in several instances of the "MC_Power" instruction, in the "Axis" parameter. Ensure that the technology object is only specified in one "MC_Power" instruction.

ErrorID	Description	Remedy
16#800D	Job not permitted in current mode. "Restart" is being executed.	Wait until the "Restart" of the technology object is complete.
16#800E	If the axis is activated, a "Restart" is not possible.	Before a "Restart", deactivate the technology object with "MC_Power.Enable"FALSE.
16#800F	The technology object is disabled. The job cannot be executed.	Enable the technology object with "MC_Power.Enable" = TRUE. Restart the job.
16#8010	Invalid homing mode for incremental encoder.	Absolute value adjustment is not possible at an incremental encoder ("Mode" = 6, 7). Start a homing process for an incremental encoder using parameter "Mode" = 0, 1, 2, 3, 4, 5, 8.
16#8011	Invalid homing mode for absolute encoder.	Passive and active homing ("Mode" = 2, 3, 4, 5) are not possible for an absolute value encoder. Start a homing process for an absolute encoder using parameter "Mode" = 0, 1, 6, 7.
16#8012	Command cannot be executed, because the axis control panel is enabled.	Return master control to the user program. Restart the job.
16#8013	The online connection between the CPU and the TIA Portal is down.	Check the online connection to the CPU.
16#8014	No internal job memory available.	The maximum number of motion control jobs has been reached. Reduce the number of jobs to be executed (parameter "Execute" = FALSE).
16#8015	"Restart" not possible. Error in the configuration of the technology object.	Check the configuration of the technology object.
16#8016	The actual values are not valid.	The actual values must be valid in order to execute a MC_Home job. Check the status of the actual values. The "<TO>.StatusSensor[n].State" tag of the technology object must show the value 2 (valid).
16#8FFF	Unspecified error	Please contact the Siemens agent at your local agency or branch. You will find information on whom to contact at: Contact information for Industry Automation and Drive Technologies (http://www.siemens.com/automation/partner)

See also

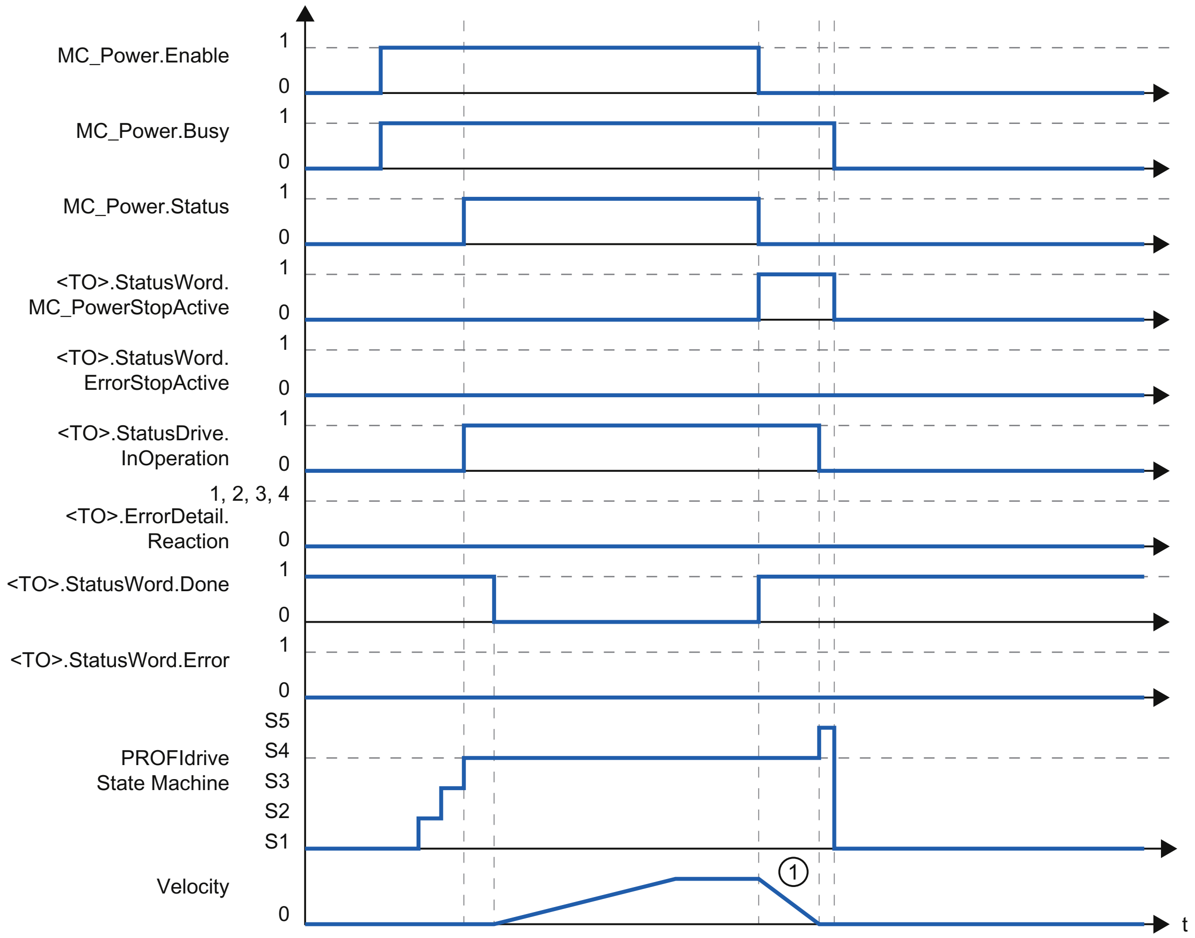
Errors in Motion Control instructions (Page 190)

A.4 MC_Power function chart

A.4.1 Drive connection via PROFIdrive

A.4.1.1 StopMode 0

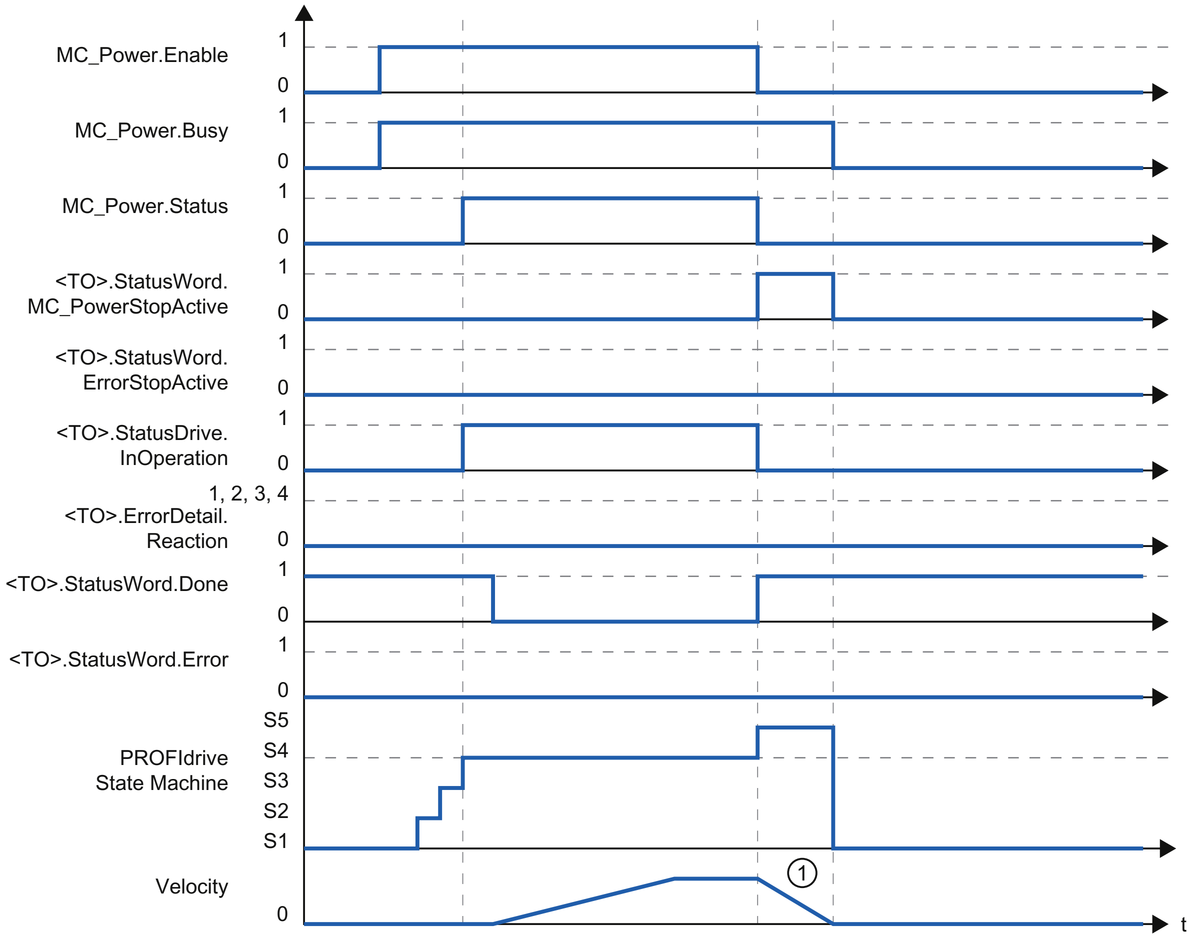
Function chart: Enabling a technology object and disabling with "StopMode" = 0



① The axis decelerates with the configured emergency stop deceleration.

A.4.1.2 StopMode 1

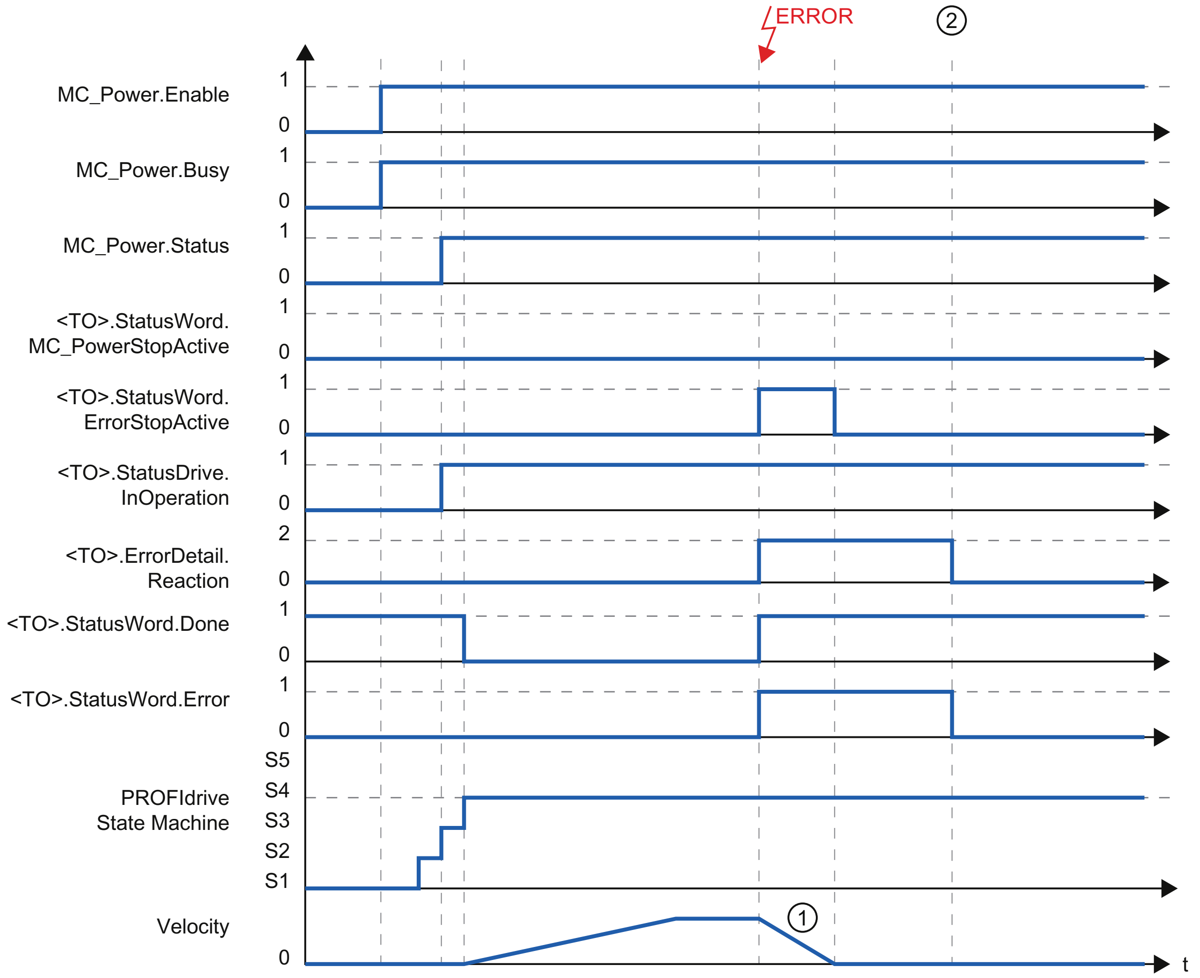
Function chart: Enabling a technology object and disabling with "StopMode" = 1



① The deceleration ramp depends on the configuration in the drive.

A.4.1.3 Alarm response "Stop with maximum dynamic values"

Function chart: Enabling a technology object and occurrence of a technology alarm with alarm response "Stop with maximum dynamic values"

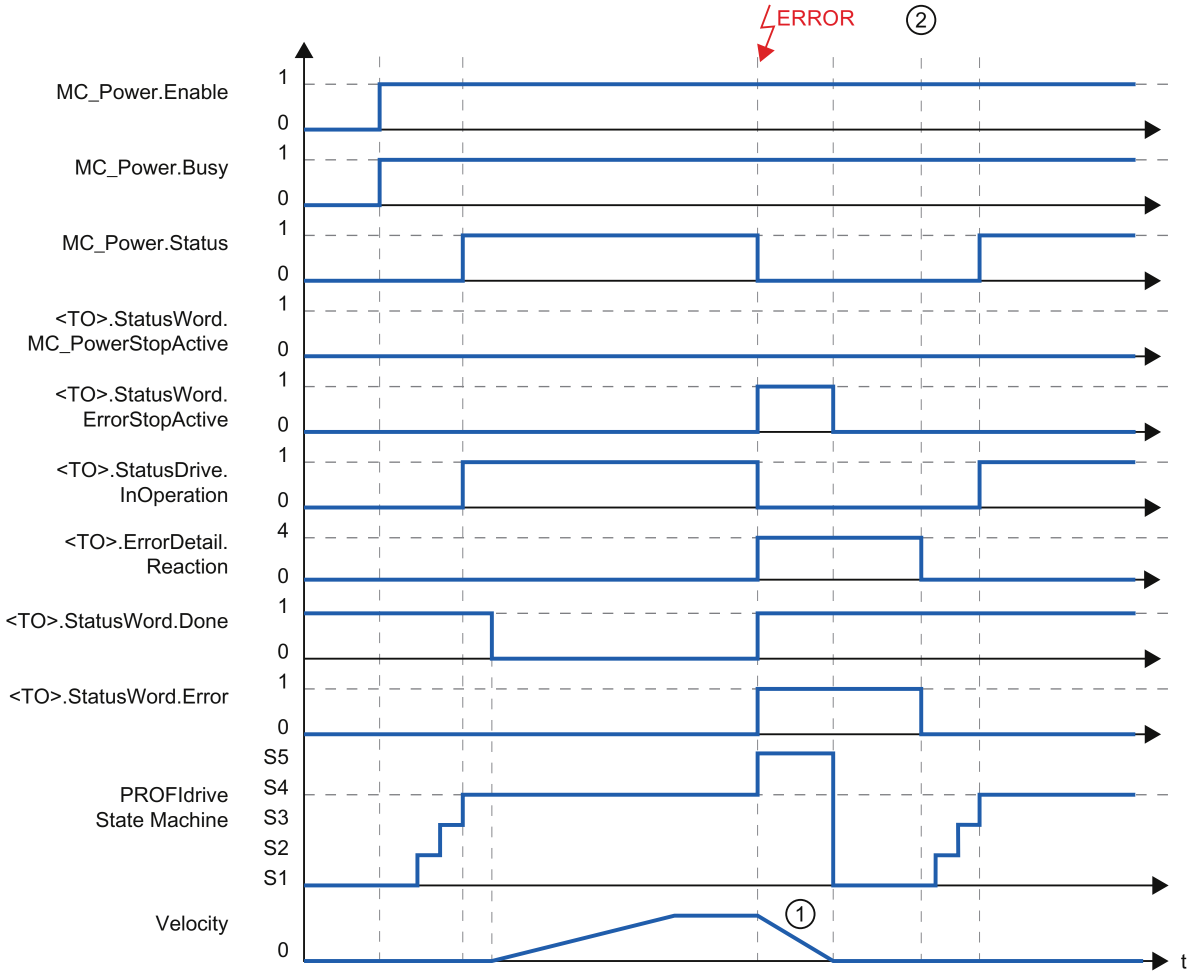


① The axis decelerates with the configured maximum deceleration.

② The technology alarm is acknowledged.

A.4.1.4 Alarm response "Remove enable"

Function chart: Enabling a technology object and occurrence of a technology alarm with alarm response "Remove enable"



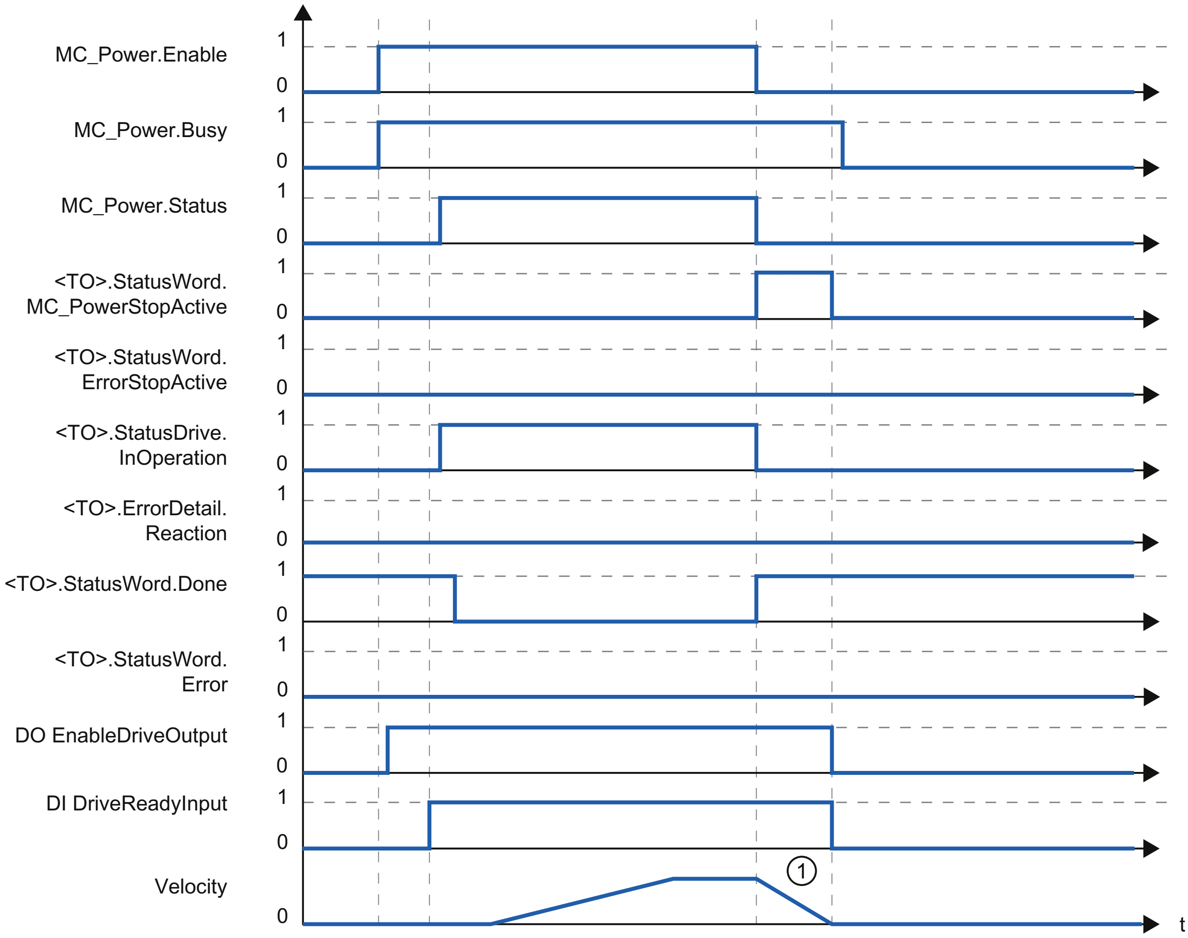
① The deceleration ramp depends on the configuration in the drive.

② The technology alarm is acknowledged at time ②.

A.4.2 Analog drive connection

A.4.2.1 StopMode 0

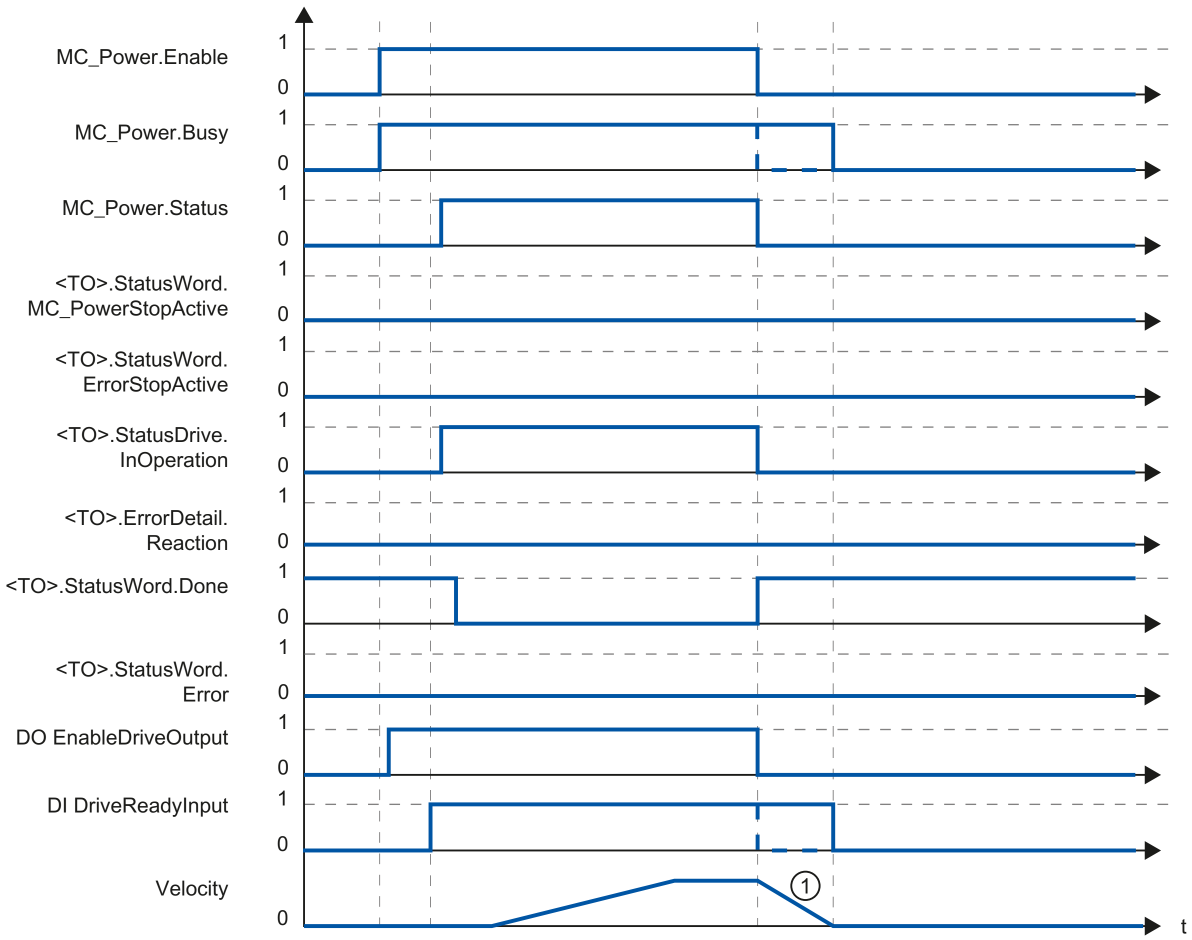
Function chart: Enabling a technology object and disabling with "StopMode" = 0



① The axis decelerates with the configured emergency stop deceleration.

A.4.2.2 StopMode 1

Function chart: Enabling a technology object and disabling with "StopMode" = 1

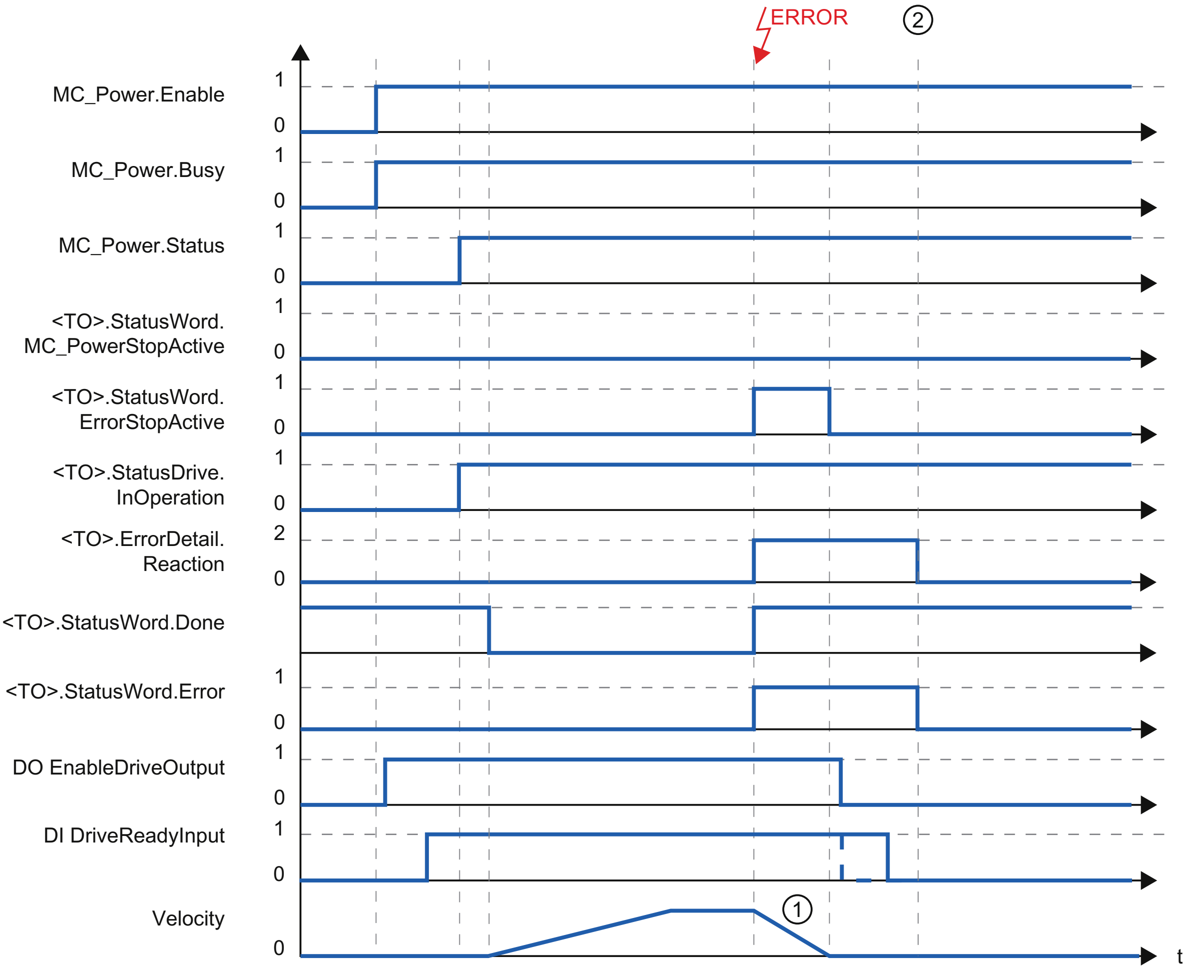


① The deceleration ramp depends on the configuration in the drive.

– – – The behavior of the ready signal of the drive "DI DriveReadyInput" is manufacturer-specific.

A.4.2.3 Alarm response "Stop with maximum dynamic values"

Function chart: Enabling a technology object and occurrence of a technology alarm with alarm response "Stop with maximum dynamic values"



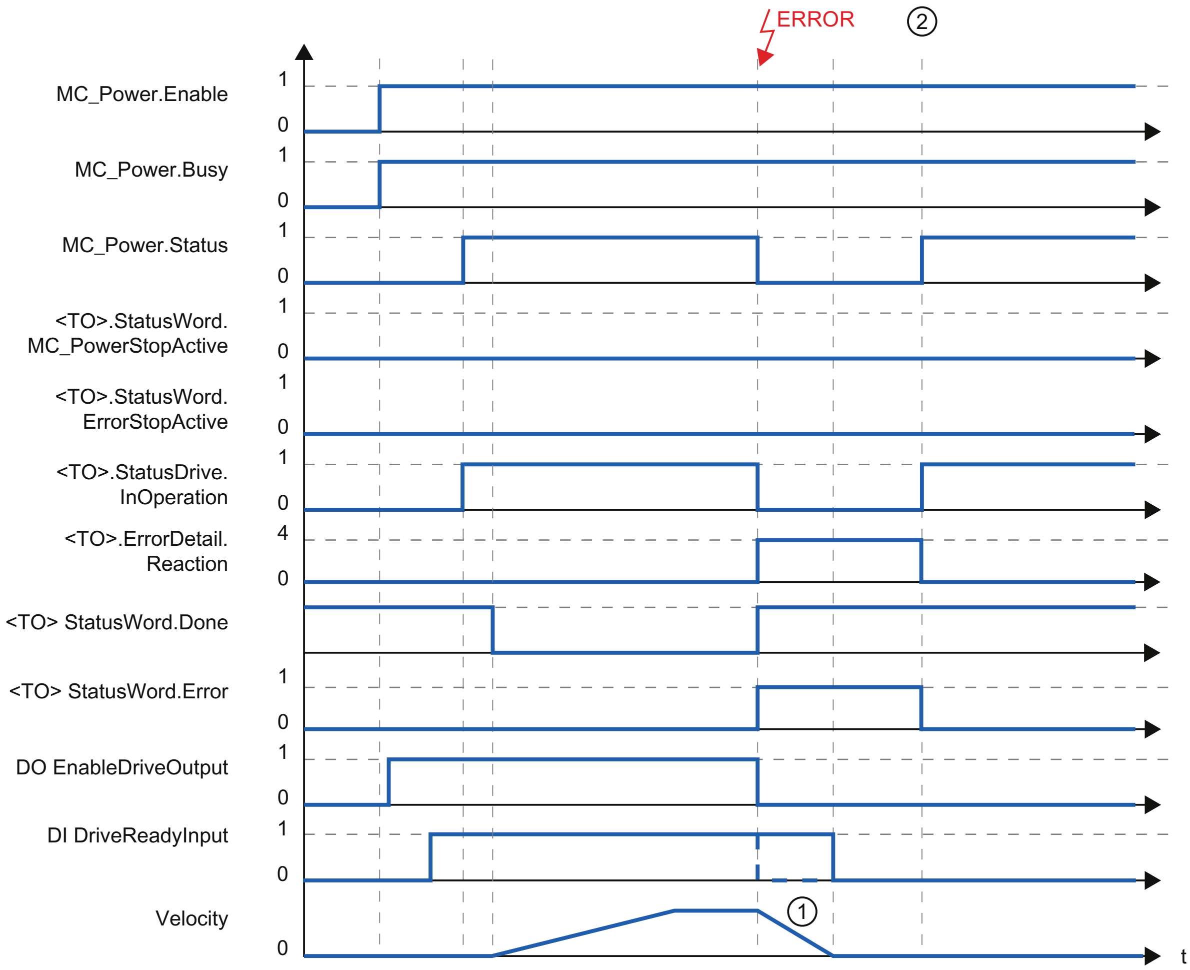
① The axis decelerates with the configured maximum deceleration.

② The technology alarm is acknowledged at time ②.

– – – The behavior of the ready signal of the drive "DI DriveReadyInput" is manufacturer-specific.

A.4.2.4 Alarm response "Remove enable"

Function chart: Enabling a technology object and occurrence of a technology alarm with alarm response "Remove enable"



①	The deceleration ramp depends on the configuration in the drive.
②	The technology alarm is acknowledged at time ②.
– – –	The behavior of the ready signal of the drive "DI DriveReadyInput" is manufacturer-specific.

A.5 SINAMICS drives

A.5.1 Active homing for SINAMICS drives with external zero mark

For SINAMICS drives with external zero mark, synchronization during active homing must always occur on the left side of the external zero mark's signal. That is to say, with a positive direction of travel synchronization is done on a positive edge, and with a negative direction of travel synchronization is done on a negative edge.

By inverting the signal, synchronization can also be done on the right sight of the signal of the external zero mark. The inversion can be configured in the drive using SINAMICS parameter P490.

Homing to an encoder zero mark or an external zero mark is configured in SINAMICS parameter P495.

Index

M

O

P

R

S

T

U

V

Z