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Function manual

SIMATIC

S7-1500

S7-1500/S7-1500T Synchronous operation functions V5.0 in TIA Portal V16

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Function Manual

TIA Portal V16

12/2019

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Preface (S7-1500, S7-1500T)

Security information (S7-1500, S7-1500T)

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

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

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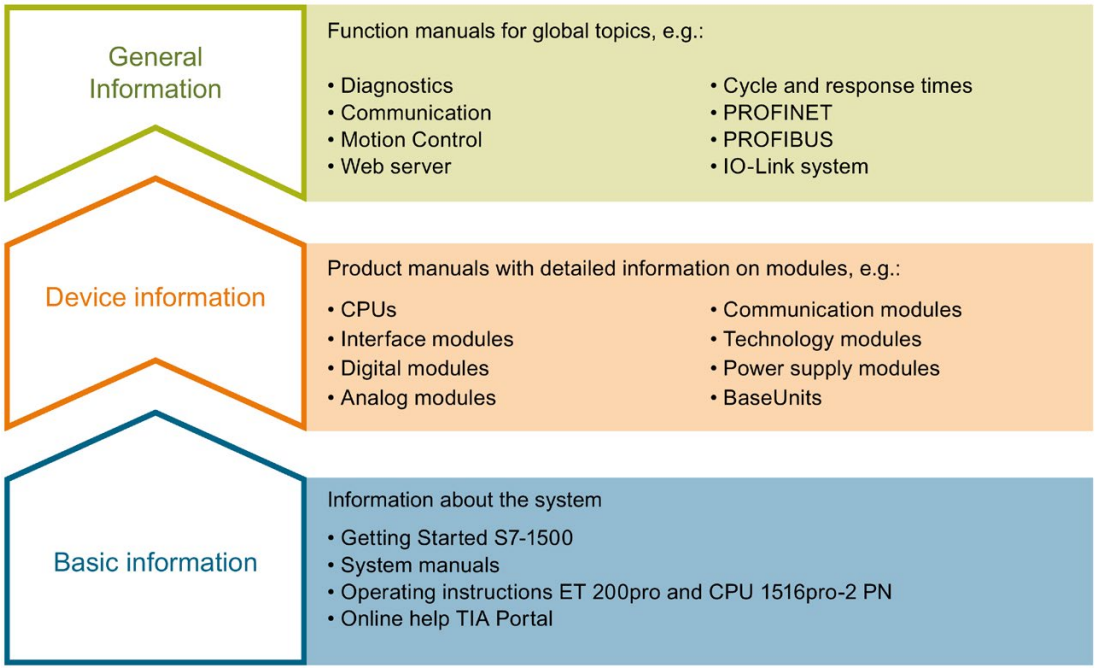
Table of contents

Function manuals Documentation Guide (S7-1500, S7-1500T) 1

The documentation for the SIMATIC S7-1500 automation system, for CPU 1516pro-2 PN based on SIMATIC S7-1500, and for the distributed I/O systems SIMATIC ET 200MP, ET 200SP and ET 200AL is divided into three areas.
This division allows you easier access to the specific information you require.



Basic information

System manuals and Getting Started manuals describe in detail the configuration, installation, wiring and commissioning of the SIMATIC S7-1500, ET 200MP, ET 200SP and ET 200AL systems; use the corresponding operating instructions for CPU 1516pro-2 PN. The STEP 7 online help supports you in configuration and programming.

Device information

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

General information

The function manuals contain detailed descriptions on general topics such as diagnostics, communication, Motion Control, Web server, OPC UA.

You can download the documentation free of charge from the Internet (https://support.industry.siemens.com/cs/ww/en/view/109742705).

Changes and additions to the manuals are documented in product information sheets.

You will find the product information on the Internet:

- S7-1500/ET 200MP (https://support.industry.siemens.com/cs/us/en/view/68052815)
- ET 200SP (https://support.industry.siemens.com/cs/us/en/view/73021864)
- ET 200AL (https://support.industry.siemens.com/cs/us/en/view/99494757)

Manual Collections

The Manual Collections contain the complete documentation of the systems put together in one file.

You will find the Manual Collections on the Internet:

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

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Application examples

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

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

Introduction (S7-1500, S7-1500T) 2

2.1 Interplay of the various documents (S7-1500, S7-1500T)

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

Documentation	Description
S7-1500/S7-1500T Motion Control overview Function manual "S7-1500/S7-1500T Motion Control overview" (https://support.industry.siemens.com/cs/ww/en/view/109766459)	This documentation describes the general Motion Control functions independent of technology objects.
Using S7-1500/S7-1500T axis functions Function manual "S7-1500/S7-1500T Axis functions" (https://support.industry.siemens.com/cs/ww/en/view/109766462)	This documentation describes the Motion Control functions for the following technology objects: • Speed axis • Positioning axis • External encoder
Using S7-1500/S7-1500T measuring input and output cam functions Function manual "S7-1500/S7-1500T Measuring input and output cam functions" (https://support.industry.siemens.com/cs/ww/en/view/109766466)	This documentation describes the Motion Control functions for the following technology objects: • Measuring input • Output cam • Cam track
Using S7-1500/S7-1500T synchronous operation functions Function manual "S7-1500/S7-1500T Synchronous operation functions" (https://support.industry.siemens.com/cs/ww/en/view/109766464)	**This documentation describes the Motion Control functions for the following technology objects:** • **Synchronous axis** • **Cam (S7-1500T)** • **Leading axis proxy (S7-1500T)**
Using S7-1500T kinematics functions Function manual "S7-1500T Kinematics functions" (https://support.industry.siemens.com/cs/ww/en/view/109766463)	This documentation describes the Motion Control functions for the following technology objects: • Kinematics (S7-1500T)

Additional information

You can find an overview and important links to the topic "SIMATIC Motion Control" in the Siemens Industry Online Support under the entry ID 109751049 (https://support.industry.siemens.com/cs/ww/en/view/109751049).

2.2 Functions (S7-1500, S7-1500T)

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

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

Motion Control instruction	Validity		Technology object		
	S7-1500	S7-1500T	Synchronous axis (Page 17)	Cam (Page 19)	Leading axis proxy (Page 164)
"MC_Power" Enable, disable technology object	X	X	X	-	-
"MC_Reset" Acknowledge alarms, restart technology objects	X	X	X	X	X
"MC_Home" Home technology object, set home position	X	X	X	-	-
"MC_Halt" Pause axis	X	X	X	-	-
"MC_MoveAbsolute" Position axis absolutely	X	X	X	-	-
"MC_MoveRelative" Position axis relatively	X	X	X	-	-
"MC_MoveVelocity" Move axis with velocity/speed set-point	X	X	X	-	-
"MC_MoveJog" Move axis in jog mode	X	X	X	-	-
"MC_MoveSuperimposed" Position axes overlapping	X	X	X	-	-
"MC_SetSensor" Set alternative encoder as operationally active encoder	-	X	X	-	-
"MC_Stop" Stop and disable axis	X	X	X	-	-
"MC_SetAxisSTW" Controlling bits of control word 1 and control word 2	X	X	X	-	-
"MC_WriteParameter" Write parameter	X	X	X	-	-

Motion Control instruction	Validity		Technology object		
	S7-1500	S7-1500T	Synchronous axis (Page 17)	Cam (Page 19)	Leading axis proxy (Page 164)
"MC_GearIn" Start gearing	X	X	X	-	X
"MC_GearInPos" Start gearing with specified synchronous positions	-	X	X	-	X
"MC_PhasingRelative" Relative shift of leading value on the following axis	-	X	X	-	X
"MC_PhasingAbsolute" Absolute shift of leading value on the following axis	-	X	X	-	X
"MC_CamIn" Start camming	-	X	X	X	X
"MC_SynchronizedMotionSimulation" Simulate synchronous operation	-	X	X	-	-
"MC_LeadingValueAdditive" Specify additive leading value	-	X	X	-	-
"MC_InterpolateCam" Interpolate cam disc	-	X	-	X	-
"MC_GetCamLeadingValue" Read out leading value of a cam	-	X	-	X	-
"MC_GetCamFollowingValue" Read out following value of a cam disc	-	X	-	X	-
"MC_MotionInVelocity" Specify motion setpoints	-	X	X	-	-
"MC_MotionInPosition" Specify motion setpoints	-	X	X	-	-
"MC_TorqueAdditive" Specify additive torque	X	X	X	-	-
"MC_TorqueRange" Set high and low torque limits	X	X	X	-	-
"MC_TorqueLimiting" Activate/deactivate force/torque limit / fixed stop detection	X	X	X	-	-

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

	Technology object		
	Synchronous axis (Page 17)	**Cam (Page 19)**	**Leading axis proxy (Page 164)**
"Axis control panel" Move and home axes using the TIA Portal	X	-	-
"Optimization" Optimization of closed loop position control	X	-	-

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

Additional functions	**Description**
Multiple encoders for positioning axis/synchronous axis	Up to four encoders can be connected to a positioning axis/synchronous axis. The encoders can be switched over during operation. Only one encoder at a time is active for closed loop position control.
Actual value coupling (Page 21)	As an alternative to the setpoint, the extrapolated actual value can be interconnected as a leading value for synchronous operation. As a result, an external encoder technology object can also be used as a leading value.
Gearing with "MC_GearInPos" (Page 33)	During gearing, the leading axis and following axis are coupled, similar to a mechanical gear unit, by a linear synchronous operation function. You use the gear ratio to specify the synchronous operation function. The synchronous positions of the leading and following axes that specify the relationship of the axes to one another can be specified in the Motion Control instruction "MC_GearInPos".
Cam technology object (Page 19)	The cam technology object (TO_Cam) defines a function f(x) by means of interpolation points and/or segments. Gaps between the defined interpolation points and segments of the cam are closed by interpolation during runtime of the user program.
Camming with "MC_CamIn" (Page 45)	During camming, the leading axis and following axis are coupled by a synchronous operation function, which you specify using a cam.
Synchronization in advance using leading value distance (Page 38) or dynamic parameters (Page 37)	Gearing is synchronized with "MC_GearInPos" and camming is synchronized with "MC_CamIn" subsequently or in advance to user-specified reference positions.
Cross-PLC synchronous operation (Page 163)	Cross-PLC synchronous operation enables synchronous operation over multiple controllers. Leading and following axes can be configured on different controllers.
Leading axis proxy technology object (Page 164)	With cross-PLC synchronous operation, the leading axis proxy technology object (TO_LeadingAxisProxy) represents the leading axis for local synchronous operation within a CPU. The leading axis proxy evaluates the leading value telegram and provides the external leading value for the local synchronous axes.

Basics of synchronous operation (S7-1500, S7-1500T) 3

In a synchronous operation, a following axis follows a leading axis. The synchronous operation relationship between the leading and following axes is specified by a synchronous operation function.

Gearing

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

Camming

During camming, the leading axis and following axis are coupled by a synchronous operation function, which you specify using a cam. The transmission behavior during camming is expressed by the cam curve.

Cross-PLC synchronous operation

With cross-PLC synchronous operation, you realize synchronous operations (gearing or camming) between axes that are on different CPUs. The synchronous operation function is executed on the CPU of the following axis.

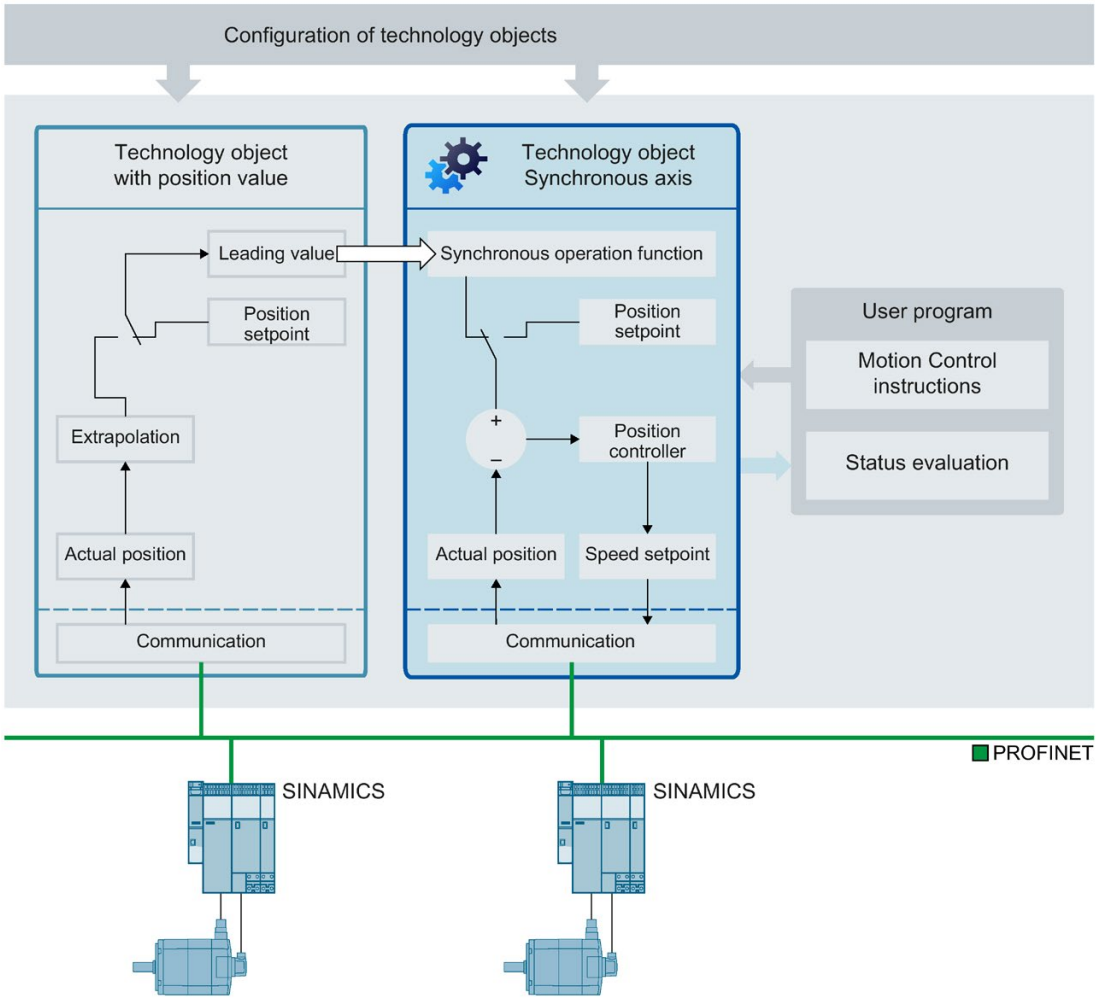
3.1 Synchronous axis technology object (S7-1500, S7-1500T)

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

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

You can find an overview of the functions of the synchronous axis technology object in the Functions (Page 13) section.

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



Synchronous operation phases

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

The synchronous operation proceeds in the following phases:

- Pending synchronous operation (S7-1500T)

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

- Synchronization

  The following axis is synchronized to the leading value.

- Synchronous motion

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

- Synchronous operation override

  Active synchronous operation is overridden by motion jobs (e.g. "MC_Halt") to the following axis.

Different dynamic limits are in effect in the phases, as described in the sections "Dynamic limits in gearing (Page 42)" and "Dynamic limits in camming (Page 61)".

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

Note

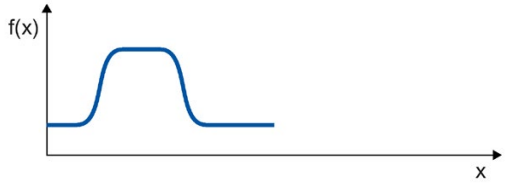
The leading values and following values are coupled without conversion in the respective configured user unit. If, for example, a linear leading axis moves by 10 mm, a rotary following axis moves by 10° with a gear ratio of 1:1.

3.2 Cam technology object (S7-1500T)

The cam technology object defines a transfer function y = f(x). The dependency of an output value on an input value is described in this transfer function in a unit-neutral manner. A cam technology object can be used multiple times.

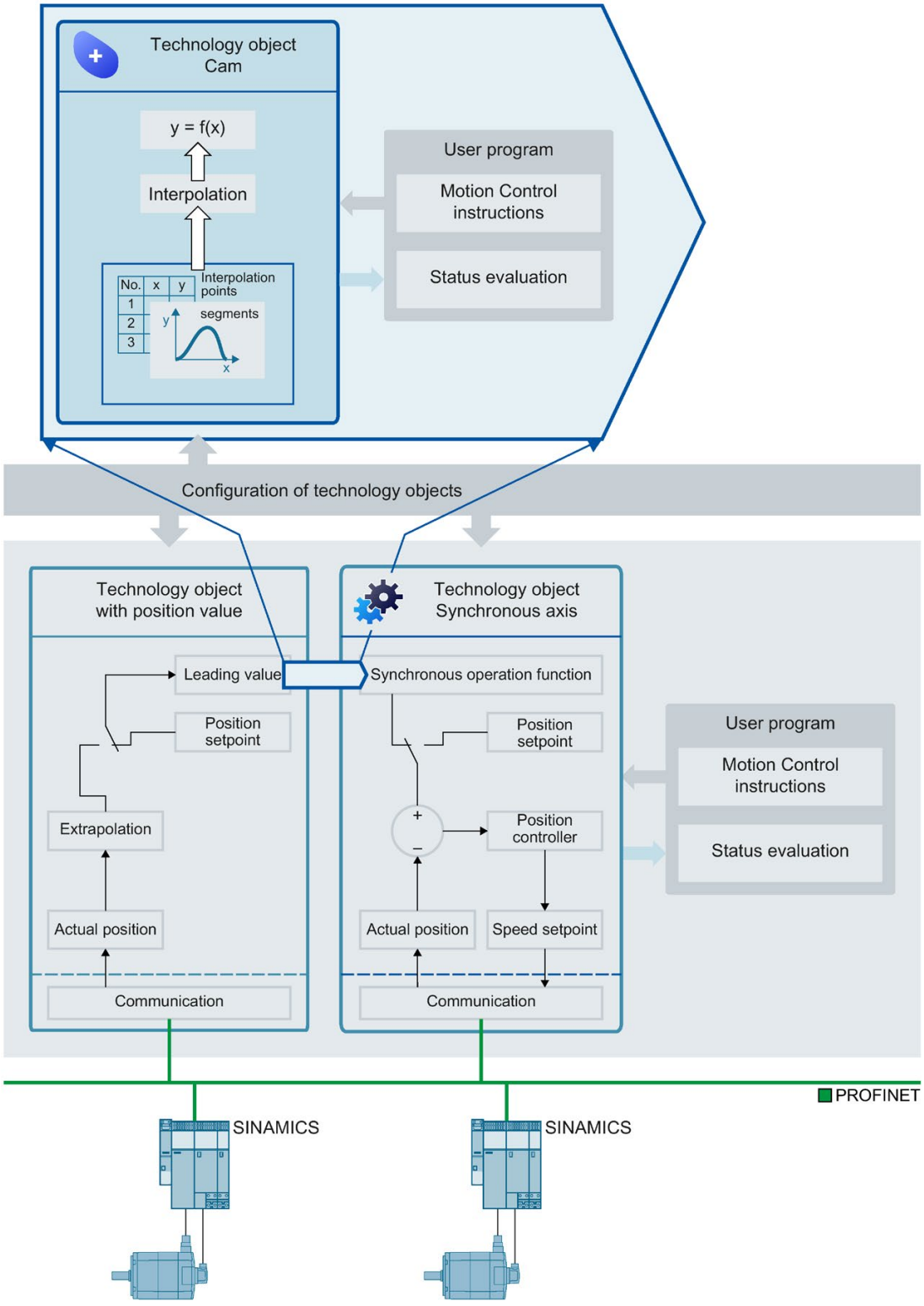
You can find an overview of the functions of the cam technology object in the Functions (Page 13) section.

You define the function y = f(x) in the configuration of the technology object (Page 105) using interpolation points and/or segments. Ranges between interpolation points and segments are interpolated using the Motion Control instruction "MC_InterpolateCam (Page 230)". The settings can be changed/redefined during runtime of the user program with the technology data block according to the appendix "Tags of the cam technology object (Page 279)".



An interpolated cam can be applied as a synchronous operation function for camming (Page 45).

The figure below shows the basic operating principle of the cam technology object:



3.3 Leading value coupling (S7-1500, S7-1500T)

The leading value for synchronous operation is provided by a leading axis, a leading axis proxy (only S7-1500T) or an external encoder (only S7-1500T). The leading value is specified and coupled in the user program with the call of the corresponding Motion Control instruction for synchronous operation. The leading value is switched when you call the Motion Control instruction again specifying a different leading axis.

The following rules apply to the leading value coupling:

- A leading axis, a leading axis proxy (only S7-1500T) or an external encoder (only S7-1500T) can output the leading value for multiple following axes.
- The synchronous axis can be interconnected with different leading values. All interconnections required during operation must be set up during configuration of the technology object.
- Only one leading value at a time is coupled and evaluated.

3.3.1 Setpoint coupling (S7-1500, S7-1500T)

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

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

- Positioning axis
- Synchronous axis
- Leading axis proxy (only S7-1500T)

3.3.2 Actual value coupling (S7-1500T)

For applications in which setpoint coupling is not possible (e.g. when using an external encoder) or does not make sense from a technical perspective, the S7-1500T CPU additionally offers actual value coupling for synchronous operation. With actual value coupling, the extrapolated actual position (Page 22) of a technology object is used as the leading value.

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

- Positioning axis
- Synchronous axis
- External encoder

3.3.3 Leading value delay (S7-1500T)

In a cross-PLC synchronous operation (Page 163), you define with the "Delayed" setting whether the leading value should be delayed for a local synchronous operation.

The leading value of the following technology objects can be delayed:

- Positioning axis
- Synchronous axis
- External encoder

3.3.4 Extrapolation of the leading values for actual value coupling (S7-1500T)

With actual value coupling (Page 21), delay times result from the processing of the actual values. To compensate for these delay times, the actual value is extrapolated on the leading value side. This means that the leading value is extrapolated based on previously known values.

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

The effective extrapolation time consists of a leading axis-dependent part, a configured following axis-dependent part and, optionally, the time from the cross-PLC synchronous operation:

- **Leading axis-dependent part**

  The part caused by the leading axis is calculated automatically and displayed at the leading axis in the "<TO>.Extrapolation.LeadingAxisDependentTime" tag of the technology object. You can disable the leading axis-dependent part using the tag "<TO>.Extrapolation.Settings.SystemDefinedExtrapolation" = 0.

- **Following axis-caused part**

  The part caused by the leading axis is calculated automatically and displayed at the following axis in the "<TO>.StatusPositioning.SetpointExecutionTime" tag of the technology object. You configure the value under "Technology object > Configuration > Extended parameters > Actual value extrapolation" (<TO>.Extrapolation.FollowingAxisDependentTime).

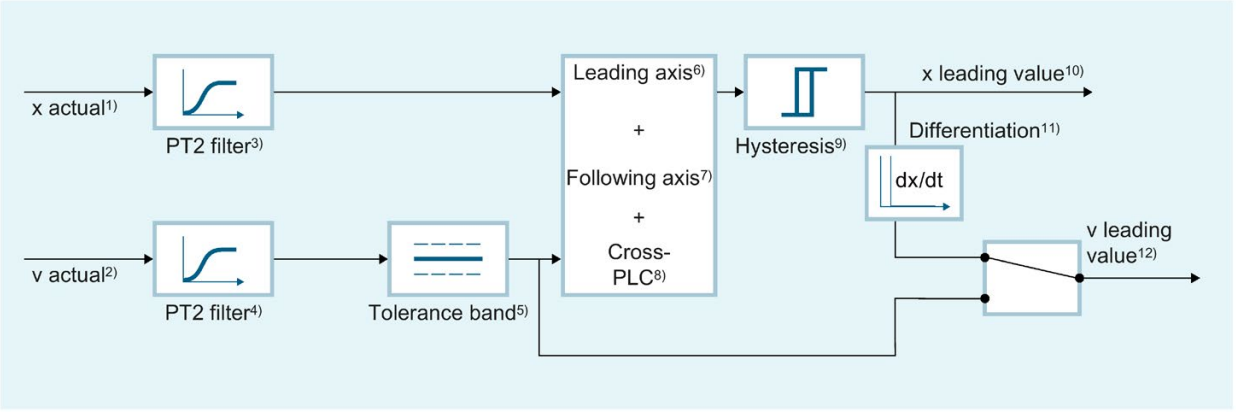
- **Time from the cross-PLC synchronous operation**

  For cross-PLC synchronous operation, the output delay of the leading value at the locally coupled following axes is automatically taken into account. The displayed value is equal to the leading value delay and corresponds to the delay time entered at the leading axis or at the external encoder. You configure the delay time under "Technology object > Configuration > Leading value settings" (<TO>.CrossPlcSynchronousOperation.LocalLeadingValueDelayTime).

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

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

The following diagram shows the sequence of the actual value extrapolation:



1) Actual position value
2) Actual velocity value
3) Actual position filters T1 (<TO>.Extrapolation.PositionFilter.T1) and T2 (<TO>.Extrapolation.PositionFilter.T2)
4) Actual velocity filters T1 (<TO>.Extrapolation.VelocityFilter.T1) and T2 (<TO>.Extrapolation.VelocityFilter.T2)
5) Tolerance band width for velocity (<TO>.Extrapolation.VelocityTolerance.Range)
6) Extrapolation time component caused by the leading axis (<TO>.Extrapolation.LeadingAxisDependentTime)
7) Extrapolation time component caused by the following axis (<TO>.Extrapolation.FollowingAxisDependentTime)
8) Portion of the extrapolation time from cross-PLC synchronous operation (<TO>.CrossPlcSynchronousOperation.LocalLeadingValueDelayTime)
9) Hysteresis value in the configured unit of length (<TO>.Extrapolation.Hysteresis.Value)
10) Extrapolated position value
11) Differentiation of the extrapolated leading value position
12) Extrapolated velocity leading value depending on the switch position:
    - Leading value velocity from filtered actual velocity ("<TO>.Extrapolation.Settings.ExtrapolatedVelocityMode" = 0)
    - Leading value velocity from differentiation of the extrapolated leading value position ("<TO>.Extrapolation.Settings.ExtrapolatedVelocityMode" = 1)

Filtering the actual values

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

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

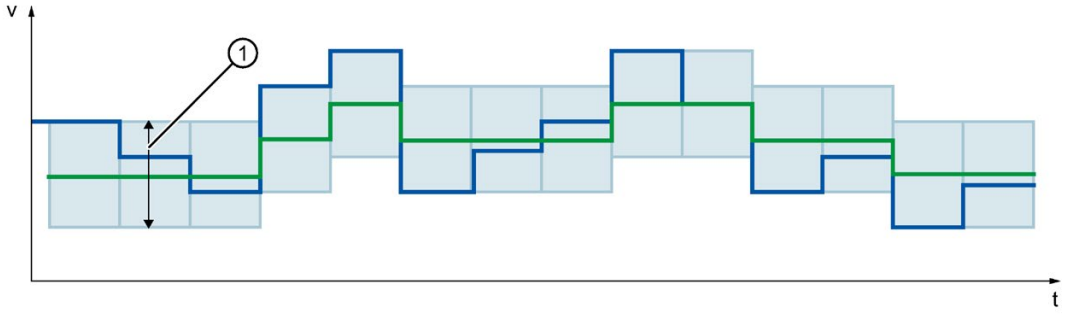
The leading value velocity results from the differentiation of the extrapolated leading value position. The filtered actual velocity can optionally be used as leading value velocity directly and without extrapolation ("<TO>.Extrapolation.Settings.ExtrapolatedVelocityMode" = 0).

Recommended settings.

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

Tolerance band

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



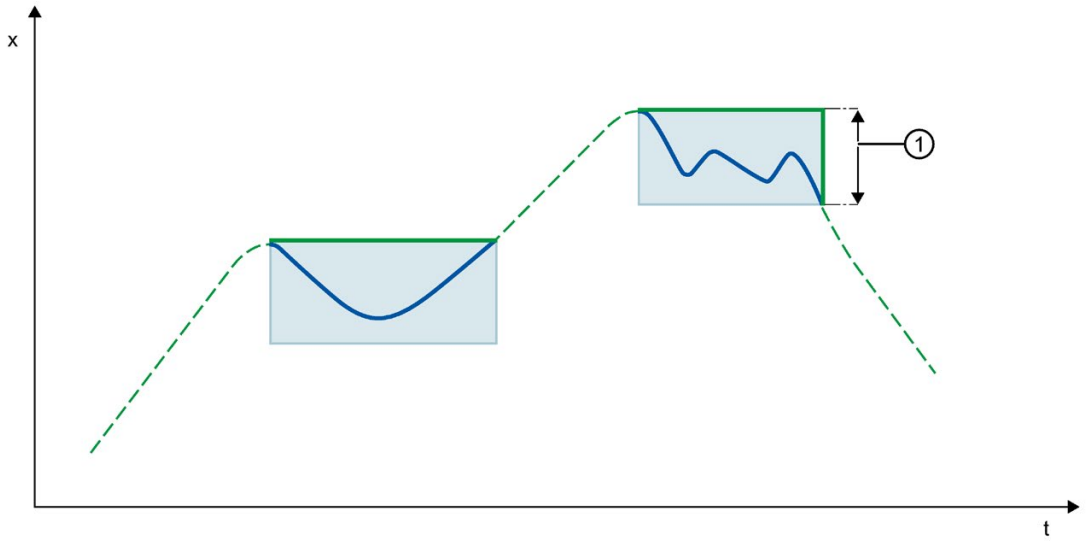
① Tolerance band

Filtered velocity before tolerance band

Filtered velocity according to tolerance band

Hysteresis

The hysteresis acts on the filtered extrapolated position value in the interpolation cycle. A change of direction only takes effect when the position value changes in the direction opposite at least by the hysteresis value. The hysteresis/reversal tolerance prevents undesired reversing of the leading value on position reversal within the tolerance band.



① Hysteresis/reversal tolerance

Extrapolated position before hysteresis/reversal tolerance

Extrapolated position after hysteresis/reversal tolerance

3.3.5 Non position controlled operation in synchronous operation (S7-1500, S7-1500T)

Synchronous operation with setpoint coupling

A following axis is set into position-controlled operation with the start of a synchronous operation job. If the leading axis is in non-position-controlled operation at the start of the synchronous operation, the synchronous operation job remains waiting. Synchronization is started only after position control has been activated and the start position of the synchronization has been reached.

Note

If the leading axis is set to the non-position-controlled mode during active synchronization, your setpoint is then set to zero. A setpoint step change is obtained as a result of coupling the setpoint of following axis. The setpoint step change is compensated according to the constant function. The only limiting factor is the maximum speed of the drive.

Synchronous operation with actual value coupling (S7-1500T)

A following axis is set into position-controlled operation with the start of a synchronous operation job. If the leading axis is in non-position-controlled operation at the start of the synchronous operation and the actual values are valid, synchronization is started.

If the leading axis is set to the non-position-controlled mode during active synchronization, the synchronization remains active.

3.3.6 Tags: Leading value coupling (S7-1500T)

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

Configuration		
Tag	**Description**	
<TO>.CrossPlcSynchronousOperation.LocalLeadingValueDelayTime	(For cross-PLC synchronous operation) The delay time of leading value output to the local following axes	
<TO>.Extrapolation.LeadingAxisDependentTime	(for the leading axis) Leading axis dependent portion of the extrapolation time, which results from T_i, T_{ipo}, and T_{Filter}.	
<TO>.Extrapolation.FollowingAxisDependentTime	(for the leading axis) Following-axis dependent portion of the extrapolation time Enter the value from the "<TO>.StatusPositioning.SetpointExecutionTime" tag of the following axis (unchanged or compensated with user-specific times).	
<TO>.Extrapolation.Settings.SystemDefinedExtrapolation	Effectiveness of the leading axis portion of the extrapolation time (<TO>.Extrapolation.LeadingAxisDependentTime)	
	0	Not effective
	1	Effective
<TO>.Extrapolation.Settings.ExtrapolatedVelocityMode	0	"FilteredVelocity" Leading value velocity from filtered actual velocity
	1	"VelocityByDifferentiation" Leading value velocity from differentiation of the extrapolated leading value position
<TO>.Extrapolation.PositionFilter.T1	Position filter time constant T1	
<TO>.Extrapolation.PositionFilter.T2	Position filter time constant T2	
<TO>.Extrapolation.VelocityFilter.T1	Velocity filter time constant T1	
<TO>.Extrapolation.VelocityFilter.T2	Velocity filter time constant T2	
<TO>.Extrapolation.VelocityTolerance.Range	Tolerance band width for velocity	
<TO>.Extrapolation.Hysteresis.Value	Hysteresis value (in the configured unit of length)	

Status indicators	
Tag	**Description**
<TO>.StatusPositioning.SetpointExecutionTime	Setpoint execution time of the axis (Results from T_{lpo}, T_{vtc} or 1/kv, T_{Send} and T_O of the axis)

3.4 Simulate synchronous operation (S7-1500T)

An active synchronous operation connection is triggered when access enables are removed or four motion jobs on a following axis. By simulating synchronous operation, you keep the synchronous operation active without overriding the synchronous operation relationship.

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

The synchronized motion simulation only affects the synchronized motion of the following axis. Setpoint changes from the synchronous operation are no longer taken into consideration at the axis and no longer forwarded to the drive. The setpoint output to the drive continues to come from the possibly superimposed motions of the following axis. The same applies to single axis commands during the synchronous operation simulation.

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

The synchronous operation remains active in simulation, including the motions through single axis jobs or with disabling the leading and/or following axis, e.g. by opening a protective door. The following axis does not have to be synchronized again after the synchronized motion simulation has been completed. The synchronous operation remains in "synchronous" status.

When the simulation is ended, the setpoints of the synchronous operation are effective immediately at the axis. Therefore, make sure that the setpoints of the following axis correspond to the setpoints from the synchronous operation relationship when simulation is ended.

See also

MC_SynchronizedMotionSimulation: Simulate synchronous operation V5 (Page 223)

3.4.1 Tags: Synchronous operation is being simulated (S7-1500T)

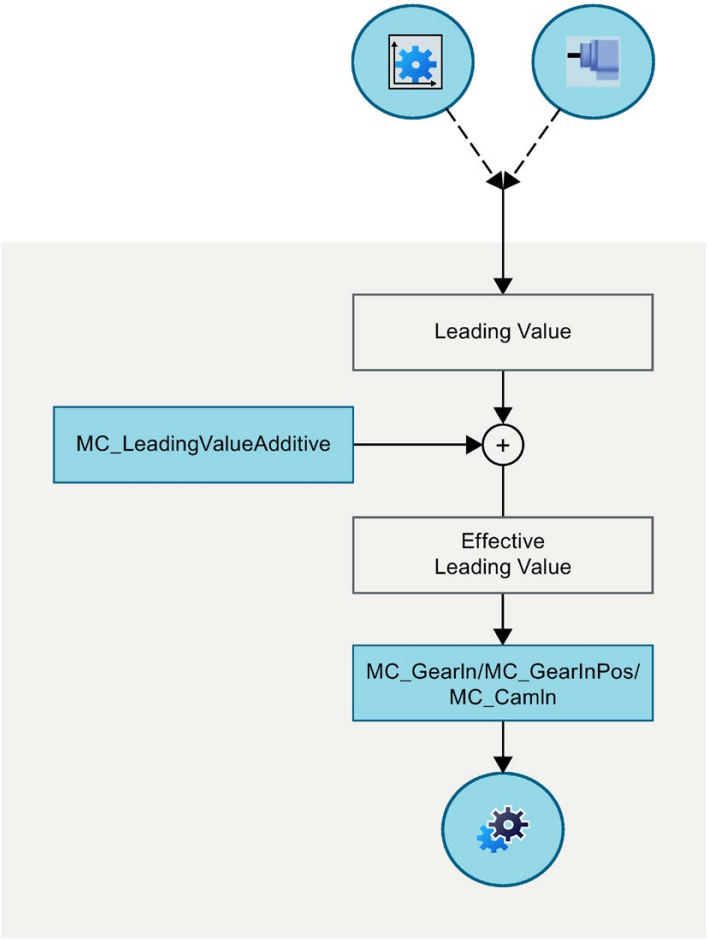
The following tags of the technology object are relevant for simulation:

Status indicators		
Tag	**Description**	
<TO>.StatusSynchronizedMotion.StatusWord.X3 (InSimulation)	Simulation of synchronous operation	
	FALSE	Not simulated
	TRUE	Simulated

3.5 Additive leading value (S7-1500T)

In addition to the active leading value on a following axis, you can also specify an additive leading value. You therefore have the possibility on the following axis to overlap the leading value from the application. With the "MC_LeadingValueAdditive" Motion Control instruction, an additive leading value becomes effective directly and without dynamic limitation at the following axis. Value changes take effect directly. The additive leading value is composed of the position, the velocity and the acceleration.

The following figure shows the general influence of the additive leading value on the following axis:



The leading axis is selected with the input parameter "Master" at the synchronous operation function. The following axis, on which the additive leading value acts, is defined by the input parameter "Axis" from the "MC_LeadingValueAdditive" job.

The effect of a "MC_LeadingValueAdditive" job depends on the status of the synchronous operation:

Status of synchronous operation	Effect on:
Not active or pending	• Start position of synchronization • Following axis dynamic response
Synchronization	• Synchronous position • Phase position • Following axis dynamic response
Synchronous motion	• Phase position • Following axis dynamic response

With a leading value switchover, the additive leading value still remains effective.

A "MC_LeadingValueAdditive" job can be started independently of the synchronous operation job. Only one "MC_LeadingValueAdditive" job can be active on a following axis.

See also

MC_LeadingValueAdditive: Specify additive leading value V5 (Page 225)

Synchronous motion (Page 184)

3.5.1 Tags: Additive leading value (S7-1500T)

The following technology object tags are relevant for the additive leading value:

Status indicators	
Tag	**Description**
<TO>.StatusSynchronizedMotion.StatusWord.X4 (LeadingValueAdditiveCommand)	Additive leading value via "MC_LeadingValueAdditive"
<TO>.StatusSynchronizedMotion.EffectiveLeadingValue.Position	Effective position of the leading value of the synchronous operation function
<TO>.StatusSynchronizedMotion.EffectiveLeadingValue.Velocity	Effective velocity of the leading value of the synchronous operation function
<TO>.StatusSynchronizedMotion.EffectiveLeadingValue.Acceleration	Effective acceleration of the leading value of the synchronous operation function

Gearing (S7-1500, S7-1500T) 4

4.1 Gearing with "MC_GearIn" (S7-1500, S7-1500T)

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

Synchronous travel with the Motion Control instruction "MC_GearIn (Page 184)" begins after synchronization when the following axis has reached the velocity and acceleration of the leading axis, taking into account the gear ratio.

Synchronization

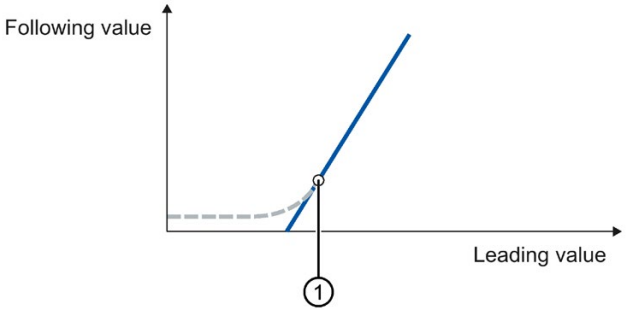
Synchronization establishes the relationship between the leading axis and following axis. Synchronization begins with the start of an "MC_GearIn" job.

For more detailed information on synchronization, refer to section "Synchronization with "MC_GearIn" (Page 36)".

Synchronous motion

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

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



———	Slope of line/transmission ratio Gear ratio = "MC_GearIn.RatioNumerator"/"MC_GearIn.RatioDenominator"
- - - - -	Synchronization
①	Position starting from which the leading and following axes move synchronously

The following value is calculated according to the following function:

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

Direction

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

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

See also

Tags: Gearing (Page 44)

MC_GearIn: Start gearing V5 (Page 184)

Dynamic limits in gearing (Page 42)

4.2 Gearing with "MC_GearInPos" with specified synchronous position (S7-1500T)

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

Synchronous travel with the Motion Control instruction "MC_GearInPos (Page 189)" begins after synchronization.

Synchronization

Synchronization establishes the relationship between the leading axis and following axis. The following options are available for this:

Synchronization mode	Description
Synchronization in advance • Using dynamic parameters • Using leading value distance	Synchronization begins in such a way that the leading and following axis are synchronous when the synchronous positions are reached.
Subsequent synchronization • Using leading value distance	Synchronization begins as soon as the leading value has reached the synchronous position of the leading axis.

The synchronous positions represent the relationship of the two axes to one another. The start of movement of the following axis is defined depending on the selected synchronization mode.

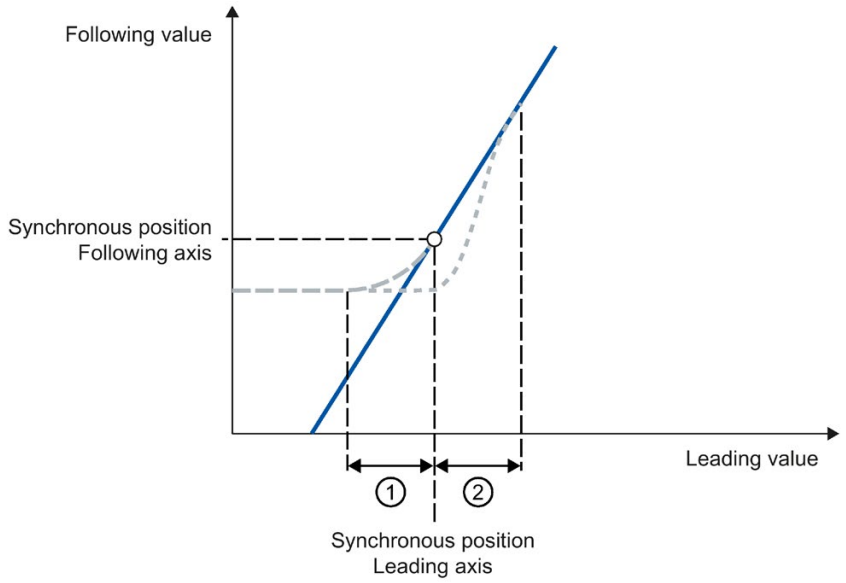
You can find more detailed information on synchronization in the following sections:

- Synchronization in advance with "MC_GearInPos" using dynamic parameters (Page 37)
- Synchronization in advance with "MC_GearInPos" using leading value distance (Page 38)
- Subsequent synchronization with "MC_GearInPos" using leading value distance (Page 40)

Synchronous motion

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

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



———	Slope of line/transmission ratio Gear ratio = "MC_GearInPos.RatioNumerator"/"MC_GearInPos.RatioDenominator"
- - - - -	Synchronization in advance
- - - - -	Subsequent synchronization
①	Leading value distance with synchronization in advance
②	Leading value distance with subsequent synchronization

The following value is calculated according to the following function:

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

Direction

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

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

See also

MC_GearInPos: Start gearing with specified synchronous positions V5 (Page 189)

MC_PhasingAbsolute: Absolute shift of leading value on the following axis V5 (Page 204)

MC_PhasingRelative: Relative shift of leading value on the following axis V5 (Page 199)

Dynamic limits in gearing (Page 42)

4.3 Synchronization (S7-1500, S7-1500T)

4.3.1 Synchronization with "MC_GearIn" (S7-1500, S7-1500T)

For synchronization using the Motion Control instruction "MC_GearIn", you specify the dynamics (acceleration, deceleration, jerk). Synchronization begins after the "MC_GearIn" job starts. Active motion jobs are overridden.

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

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

The synchronization is indicated in the "<TO>.StatusWord.X21 (Synchronizing)" tag of the technology object.

If the following axis has reached the velocity and the acceleration of the leading axis, taking into account the gear ratio, the following axis is synchronized. The following axis travels synchronously with the leading axis. The "Synchronous" status is indicated in the Motion Control instruction with parameter "InGear" = TRUE.

See also

Gearing with "MC_GearIn" (Page 31)

MC_GearIn: Start gearing V5 (Page 184)

4.3.2 Synchronization in advance with "MC_GearInPos" using dynamic parameters (S7-1500T)

For synchronization in advance using dynamic parameters with a "MC_GearInPos" job, you specify the dynamics (velocity, acceleration, deceleration, jerk). Also specify the synchronous positions of the leading and following axis, which define the relationship of the axes to one another. For synchronization in advance, the synchronous position is the position starting from which the leading and following axes are synchronous. The required travel distance (synchronization length) is calculated by the system.

After the start of the "MC_GearInPos" job with "SyncProfileReference" = 0, a motion profile for the following axis is calculated continuously. The motion profile is calculated based on the following parameters:

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

The calculation determines the synchronization length and thus the start position of the leading axis for the synchronization.

The status "Waiting" is displayed at the following axis until the leading value has reached the start position (<TO>.StatusSynchronizedMotion.WaitingFunctionState = 2).

The following axis begins to synchronize as soon as the leading value has reached the start position. The start position of the leading axis is derived in the following way:

Start position = Synchronous position of leading axis - Synchronization length

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

The dynamics of the following axis during synchronization is obtained from the calculated motion profile and the current dynamics of the leading axis. Changes in the dynamics of the leading axis during synchronization are superimposed on the calculated motion profile. This can have the result that the configured dynamic limits at the following axis are violated. This is displayed in the "<TO>.StatusSynchronizedMotion.StatusWord" tag.

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

If the leading axis is already in its synchronous position before synchronization, the following axis must also be moved to its synchronous position. In this case, establish the synchronization with an "MC_GearIn" job.

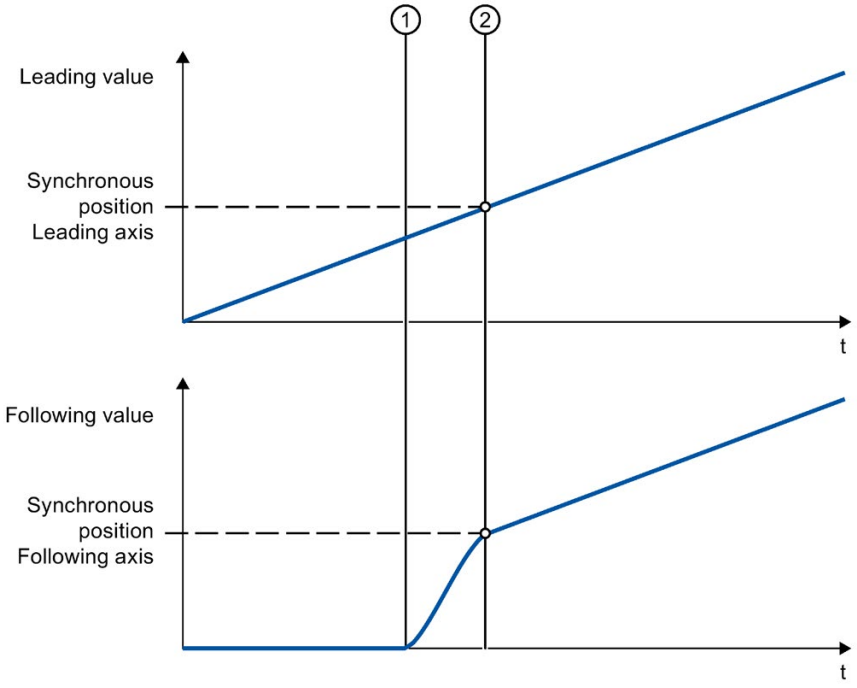
See also

Gearing with "MC_GearInPos" with specified synchronous position (Page 33)

MC_GearInPos: Start gearing with specified synchronous positions V5 (Page 189)

4.3.3 Synchronization in advance with "MC_GearInPos" using leading value distance (S7-1500T)

For synchronization in advance using the leading value distance with an "MC_GearInPos" job, you specify the synchronization length. Also specify the synchronous positions of the leading and following axis, which define the relationship of the axes to one another. For synchronization in advance, the synchronous position is the position starting from which the leading and following axes are synchronous.



① Time when synchronization starts
② Time when synchronization is complete

After the start of the "MC_GearInPos" job with "SyncProfileReference" = 1, a motion profile with the required dynamics is calculated for the following axis depending on the specified leading value distance. For this, the leading axis must be at least the leading value distance from the synchronous position.

The status "Waiting" is displayed at the following axis until the leading value has reached the start position (<TO>.StatusSynchronizedMotion.WaitingFunctionState = 2).

The following axis begins to synchronize as soon as the leading value has reached the start position. The start position of the leading axis is derived in the following way:

Start position = Synchronous position of leading axis - Synchronization length

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

The dynamics of the following axis during synchronization is obtained from the calculated motion profile and the current dynamics of the leading axis. Changes in the dynamics of the leading axis during synchronization are superimposed on the calculated motion profile in accordance with the synchronous operation function. This can have the result that the configured dynamic limits at the following axis are violated. This is displayed in the "<TO>.StatusSynchronizedMotion.StatusWord" tag.

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

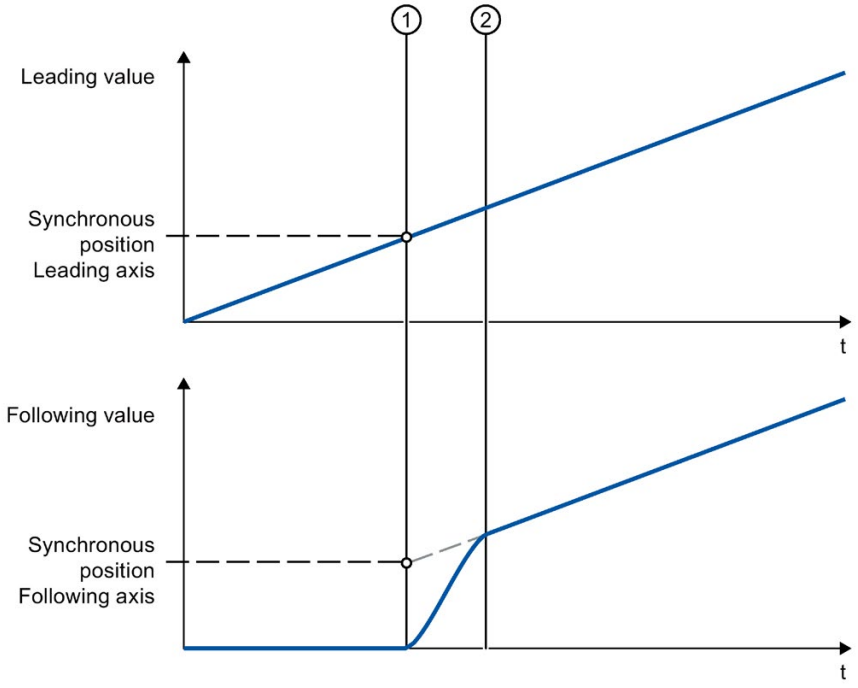
See also

Gearing with "MC_GearInPos" with specified synchronous position (Page 33)

MC_GearInPos: Start gearing with specified synchronous positions V5 (Page 189)

4.3.4 Subsequent synchronization with "MC_GearInPos" using leading value distance (S7-1500T)

For subsequent synchronization using the leading value distance with an "MC_GearInPos" job, you specify the synchronization length. Also specify the synchronous positions of the leading and following axis, which define the relationship of the axes to one another. For synchronization in advance, the synchronous position of the leading axis is the start position for synchronization.



① Time when synchronization starts
② Time when synchronization is complete

After the start of the "MC_GearInPos" job with "SyncProfileReference" = 3, a motion profile with the required dynamics is calculated for the following axis depending on the specified leading value distance.

The status "Waiting" is displayed at the following axis until the leading value has reached the synchronous position of the leading axis (<TO>.StatusSynchronizedMotion.WaitingFunctionState = 2).

Synchronization begins as soon as the leading value has reached the synchronous position of the leading axis. The synchronization is indicated by parameter "MC_GearInPos.StartSync" = TRUE as well as in the "<TO>.StatusWord.X21 (Synchronizing)" tag of the technology object. The leading value must reverse during synchronization.

The dynamics of the following axis during synchronization is obtained from the calculated motion profile and the current dynamics of the leading axis. Changes in the dynamics of the leading axis during synchronization are superimposed on the calculated motion profile in accordance with the synchronous operation function. This can have the result that the configured dynamic limits at the following axis are violated. This is displayed in the "<TO>.StatusSynchronizedMotion.StatusWord" tag.

The position of the leading axis from which the leading axis and following axis are synchronous is derived in the following way:

Position axes synchronous = Synchronous position of leading axis + Synchronization length

The following axis travels synchronously with the leading axis in accordance with the gear ratios. The "Synchronous" status is indicated in the Motion Control instruction with parameter "InSync" = TRUE.

See also

Gearing with "MC_GearInPos" with specified synchronous position (Page 33)

MC_GearInPos: Start gearing with specified synchronous positions V5 (Page 189)

4.4 Dynamic limits in gearing (S7-1500, S7-1500T)

4.4.1 Dynamic limits in gearing with "MC_GearIn" (S7-1500, S7-1500T)

Leading axis

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

Following axis

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

- **Synchronization**

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

- **Synchronous motion**

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

  If the dynamic limits configured for the following axis are exceeded, this is indicated in the "<TO>.StatusSynchronizedMotion.StatusWord" tag of the technology object. The SW limit switches continue to be monitored with the configured dynamic limits of the following axis.

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

- **Synchronous operation override**

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

See also

Gearing with "MC_GearIn" (Page 31)

MC_GearIn: Start gearing V5 (Page 184)

Override response V5: Synchronous operation jobs (Page 238)

4.4.2 Dynamic limits in gearing with "MC_GearInPos" (S7-1500T)

Leading axis

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

Following axis

If a synchronous axis is operated as a following axis in synchronous operation with the Motion Control instruction "MC_GearInPos", the following dynamic limits apply depending on the phase of the synchronous operation:

- **Pending synchronous operation**

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

- **Synchronization/synchronous motion**

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

  If the dynamic limits configured for the following axis are exceeded, this is indicated in the "<TO>.StatusSynchronizedMotion.StatusWord" tag of the technology object. The SW limit switches continue to be monitored with the configured dynamic limits of the following axis.

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

- **Synchronous operation override**

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

See also

Gearing with "MC_GearInPos" with specified synchronous position (Page 33)

MC_GearInPos: Start gearing with specified synchronous positions V5 (Page 189)

Override response V5: Synchronous operation jobs (Page 238)

4.5 Leading value shift in gearing (S7-1500T)

With the Motion Control instructions "MC_PhasingRelative (Page 199)" and "MC_PhasingAbsolute (Page 204)", the leading value can be shifted in gearing with "MC_GearIn" and "MC_GearInPos". The leading value shift is executed on the following axis. The leading axis is not affected.

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

4.6 Tags: Gearing (S7-1500T)

The following technology object tags are relevant for gearing:

Status indicators		
Tag	**Description**	
<TO>.StatusSynchronizedMotion.FunctionState	Indication of which synchronous operation function is active	
	0	No synchronous operation active
	1	Gearing ("MC_GearIn")
	2	Gearing with specified synchronous positions ("MC_GearInPos")
	3	Camming ("MC_CamIn")
<TO>.StatusSynchronizedMotion. WaitingFunctionState	Indication of which synchronous operation function is waiting	
	0	No synchronous operation waiting
	1	Reserved
	2	Gearing with specified synchronous positions waiting ("MC_GearInPos")
	3	Camming waiting ("MC_CamIn")
<TO>.StatusSynchronizedMotion.ActualMaster	When a synchronous operation job is started, the number of the technology data block of the currently used leading axis is displayed.	
	0	Synchronous operation inactive
<TO>.StatusSynchronizedMotion.PhaseShift	Current absolute leading value shift	
<TO>.StatusSynchronizedMotion.StatusWord. X0 (MaxVelocityExceeded)	Set to the value "TRUE" when the maximum velocity configured for the following axis is exceeded during synchronous operation.	
<TO>.StatusSynchronizedMotion.StatusWord. X1 (MaxAccelerationExceeded)	Set to the value "TRUE" when the maximum acceleration configured for the following axis is exceeded during synchronous operation.	
<TO>.StatusSynchronizedMotion.StatusWord. X2 (MaxDecelerationExceeded)	Set to the value "TRUE" when the maximum deceleration configured for the following axis is exceeded during synchronous operation.	
<TO>.StatusWord.X21 (Synchronizing)	Set to the value "TRUE" when the synchronous axis synchronizes to a leading value.	
<TO>.StatusWord.X22 (Synchronous)	Set to the value "TRUE" when the synchronous axis is synchronized and moves synchronously to the leading axis.	
<TO>.ErrorWord.X14 (SynchronousError)	Error during synchronous operation The leading axis specified in the Motion Control instruction was not configured as a possible leading axis.	

Camming (S7-1500T) 5

During camming, the leading axis and following axis are coupled by a synchronous operation function, which you specify using a cam (Page 19).

The utilized cam can be scaled on a job-related basis and applied shifted. To use the cam for camming, it must be interpolated (Page 48). You interpolate the cam in your user program with the Motion Control instruction "MC_InterpolateCam (Page 230)".

Synchronous travel with the Motion Control instruction "MC_CamIn (Page 209)" begins after synchronization.

Synchronous position

The synchronous position of the leading axis and the corresponding position from the cam represent the relationship of the two axes to one another. The start of movement of the following axis is defined depending on the selected synchronization mode.

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

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

The synchronous position is calculated using the following equation:

Synchronous position = (Start position of the cam x "MasterScaling") + "MasterOffset" + "MasterSyncPosition"

Synchronization

Synchronization establishes the relationship between the leading axis and following axis. The following options are available for this:

Synchronization mode	Description
Synchronization in advance • Using dynamic parameters • Using leading value distance	Synchronization begins in such a way that the leading and following axis are synchronous when the synchronous positions are reached.
Subsequent synchronization • Using leading value distance with specific synchronous position • Using leading value distance with current position as synchronous position	Synchronization begins as soon as the leading value has reached the synchronous position of the leading axis or as soon as the job takes effect.

You can find more detailed information on synchronization in the following sections:

- Synchronization in advance with "MC_CamIn" using dynamic parameters (Page 55)
- Synchronization in advance with "MC_CamIn" using leading value distance (Page 56)
- Subsequent synchronization with "MC_CamIn" using leading value distance (Page 58)

Direct synchronization

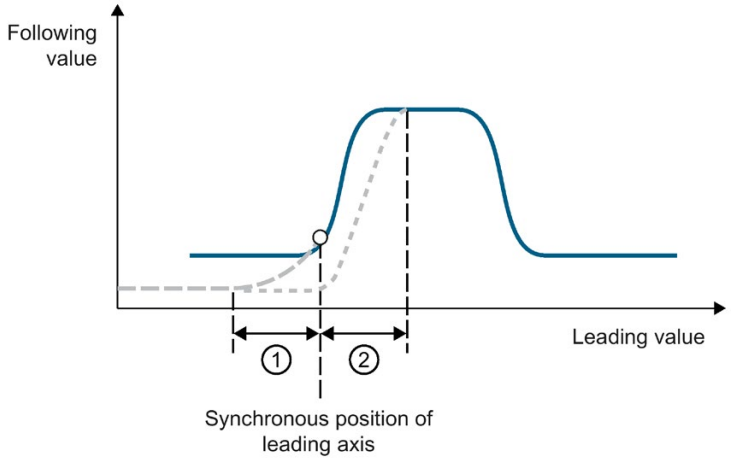
When you set the parameter "MC_CamIn.SyncProfileReference" = 2, the status is set synchronously directly at the current leading value position and at the current following value position.

For more detailed information on direct synchronization, refer to section "Direct synchronous setting with "MC_CamIn" (Page 60)".

Synchronous motion

Synchronous operation is reached after the synchronization. The "Synchronous" status is indicated by parameter "MC_CamIn.InSync" = TRUE as well as in the "<TO>.StatusWord.X22 (Synchronous)" tag of the technology object. The following axis follows the position of the leading axis according to the cam profile.

The transmission behavior during camming is expressed by the cam curve:



Transfer function:
Following value = f(leading value)

Synchronization in advance

Subsequent synchronization

① Leading value distance with synchronization in advance

② Leading value distance with subsequent synchronization

See also

MC_CamIn: Start camming V5 (Page 209)

Interpolation of the cam (Page 48)

Dynamic limits in gearing (Page 42)

5.1 Interpolation of the cam (S7-1500T)

To use a cam in the user program, you must interpolate the cam after downloading to the CPU or after adaptation of the technology object data block. The interpolation closes the gaps between the defined interpolation points and segments of the cam. The cam is interpolated from the minimum value in the leading value range to the maximum value. The minimum value in the leading value range is the first defined interpolation point/start of the first segment of the cam (<TO>.StatusCam.StartLeadingValue). The maximum value in the leading value range is the last defined interpolation point/end of the last segment of the cam (<TO>.StatusCam.EndLeadingValue).

You interpolate a cam disc in your user program with the Motion Control instruction "MC_InterpolateCam (Page 230)". When a cam is interpolated, this is indicated by the "MC_InterpolateCam.Done" parameter = TRUE and via the "<TO>.StatusWord.X5 (Interpolated)" tag = 1 in the technology data block.

You specify the interpolation in the configuration of the technology object (Page 109). The following methods are possible:

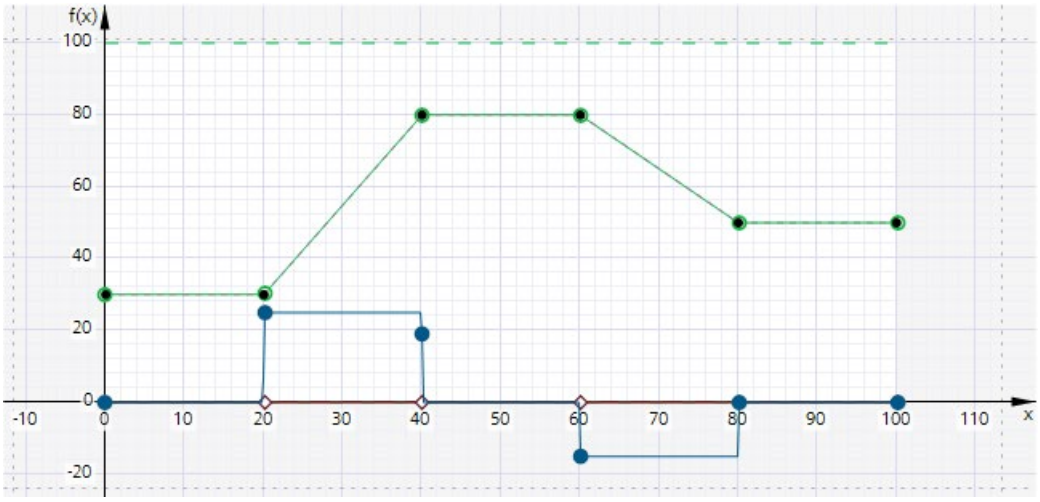
- System interpolation
- Optimization of transitions according to VDI Guideline 2143

System interpolation

With system interpolation, the transitions are interpolated according to the interpolation type and the response in the boundary points of the transition segment. The following interpolation methods are possible:

- **Linear interpolation**

  Gaps in the cam are closed with a straight line.



Specified position (point)

Interpolated position

Resulting velocity (scaled)

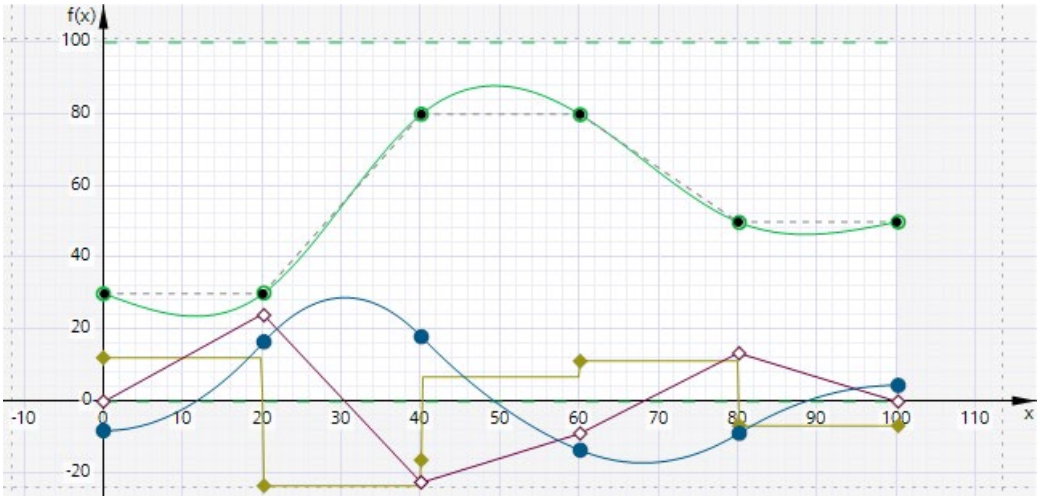
Resulting acceleration

Resulting jerk

- **Interpolation with cubic splines**

  The interpolated curve runs through the interpolation points and the segments of the curve.

  After completion of interpolation, the range of the cam can be greater than before interpolation.



Specified position (point)

Interpolated position

Resulting velocity (scaled)

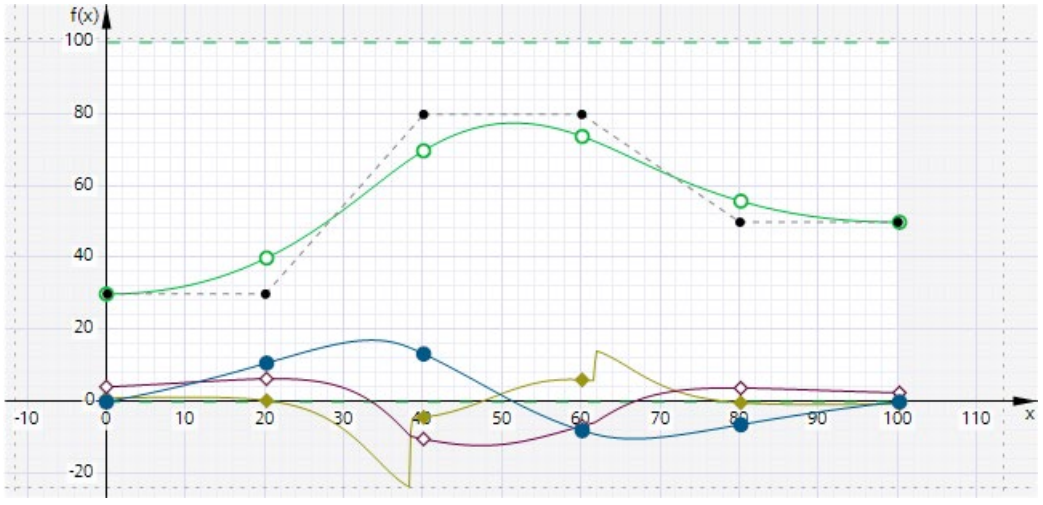
Resulting acceleration (scaled)

Resulting jerk (scaled)

- **Interpolation with Bézier splines**

  The interpolated curve runs along the interpolation points and through the segments of the curve.

  The range of the cam is not changed by interpolation.



Specified position (point)

Interpolated position

Resulting velocity (scaled)

Resulting acceleration (scaled)

Resulting jerk (scaled)

Optimization of transitions according to VDI Guideline 2143

The transitions are specified according to the motion task and the optimization settings according to the VDI Guideline 2143.

Note that the optimization of transitions according to VDI guideline 2143 directly occupies segments in the technology object data block, in contrast to system interpolation. This optimization type is thus not possible via "MC_InterpolateCam" during runtime.

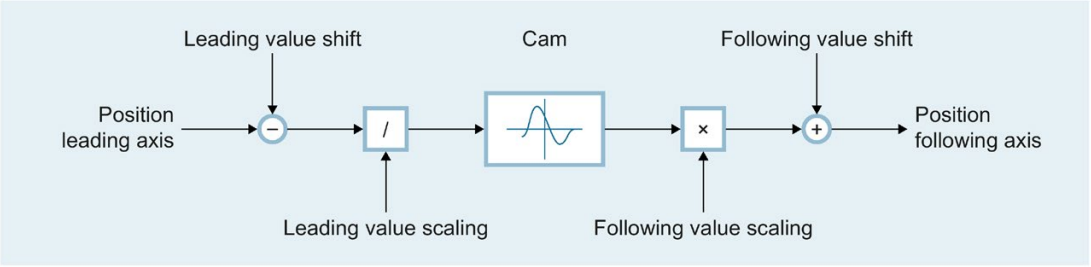
See also

MC_InterpolateCam: Interpolate cam V5 (Page 230)

5.2 Scaling and offset of the cam (S7-1500T)

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

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



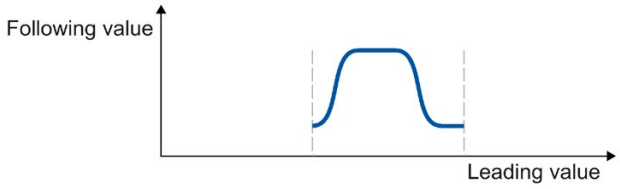
Position following axis = f[(Position leading axis - Leading value shift) / Leading value scaling] × Following value scaling + Following value shift

5.3 Cyclic and non-cyclic application of the cam (S7-1500T)

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

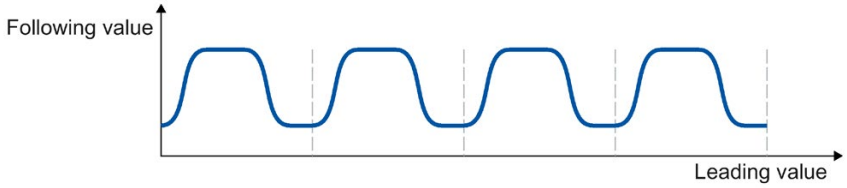
- **Not cyclic**

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



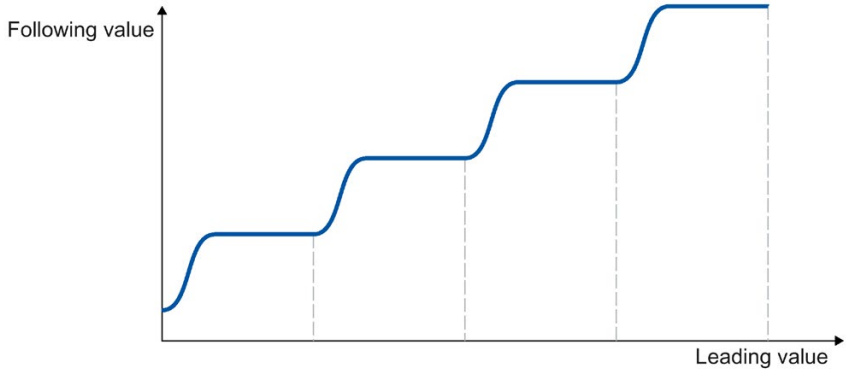
- **Cyclic**

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



- **Cyclic appending**

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



See also

Configuration of profile - System interpolation (Page 127)

5.4 Synchronization (S7-1500T)

5.4.1 Synchronization in advance with "MC_CamIn" using dynamic parameters (S7-1500T)

For synchronization using dynamic parameters, you specify the dynamics (velocity, acceleration, deceleration, jerk). Specify also the synchronous position of the leading axes. For synchronization in advance, the synchronous position of the leading axis is the position starting from which the leading and following axes are synchronous. The required travel distance (synchronization length) is calculated by the system.

After the start of the "MC_CamIn" job with "SyncProfileReference" = 0, a motion profile for the following axis is calculated continuously. The motion profile is calculated based on the following parameters:

- Specified synchronous position of the Motion Control instruction
- Specified dynamics of the Motion Control instruction
- Current position and dynamics of the leading and following axes
- Synchronous operation specified via cam

The calculation determines the synchronization length and thus the start position of the leading axis for the synchronization.

The status "Waiting" is displayed at the following axis until the leading value has reached the start position (<TO>.StatusSynchronizedMotion.WaitingFunctionState = 3).

The following axis begins to synchronize as soon as the leading value has reached the start position. The start position of the leading axis is derived in the following way:

Start position = Synchronous position of leading axis - Synchronization length

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

The dynamics of the following axis during synchronization is obtained from the calculated motion profile and the current dynamics of the leading axis. Changes in the dynamics of the leading axis during synchronization are superimposed on the calculated motion profile. This can have the result that the configured dynamic limits at the following axis are violated. This is displayed in the "<TO>.StatusSynchronizedMotion.StatusWord" tag.

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

If only the leading axis is in its synchronous position when the "MC_CamIn" job is started, the leading axis must first cross the start position to start synchronization.

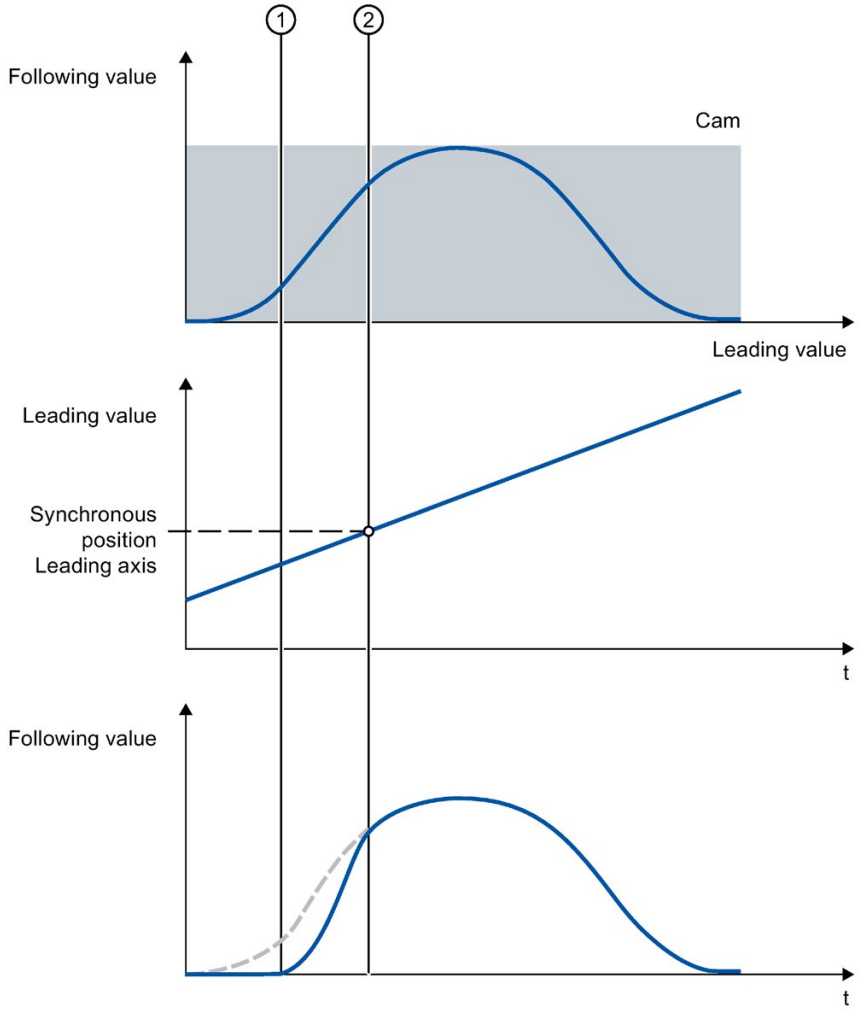
See also

Camming (Page 45)

MC_CamIn: Start camming V5 (Page 209)

5.4.2 Synchronization in advance with "MC_CamIn" using leading value distance (S7-1500T)

For synchronization in advance using the leading value distance with an "MC_CamIn" job, you specify the synchronization length. Specify also the synchronous position of the leading axis. For synchronization in advance, the synchronous position of the leading axis is the position starting from which the leading and following axes are synchronous.



① Time when synchronization starts
② Time when synchronization is complete

After the start of the "MC_CamIn" job with "SyncProfileReference" = 1, a motion profile with the required dynamics is calculated for the following axis depending on the specified leading value distance. For this, the leading axis must be at least the leading value distance from the synchronous position.

The following axis begins to synchronize as soon as the leading value has reached the start position. The start position of the leading axis is derived in the following way:

Start position = Synchronous position of leading axis - Synchronization length

The status "Waiting" is displayed at the following axis until the leading value has reached the start position (<TO>.StatusSynchronizedMotion.WaitingFunctionState = 3).

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

The dynamics of the following axis during synchronization is obtained from the calculated motion profile and the current dynamics of the leading axis. Changes in the dynamics of the leading axis during synchronization are superimposed on the calculated motion profile in accordance with the synchronous operation function. This can have the result that the configured dynamic limits at the following axis are violated. This is displayed in the "<TO>.StatusSynchronizedMotion.StatusWord" tag.

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

See also

Camming (Page 45)

MC_CamIn: Start camming V5 (Page 209)

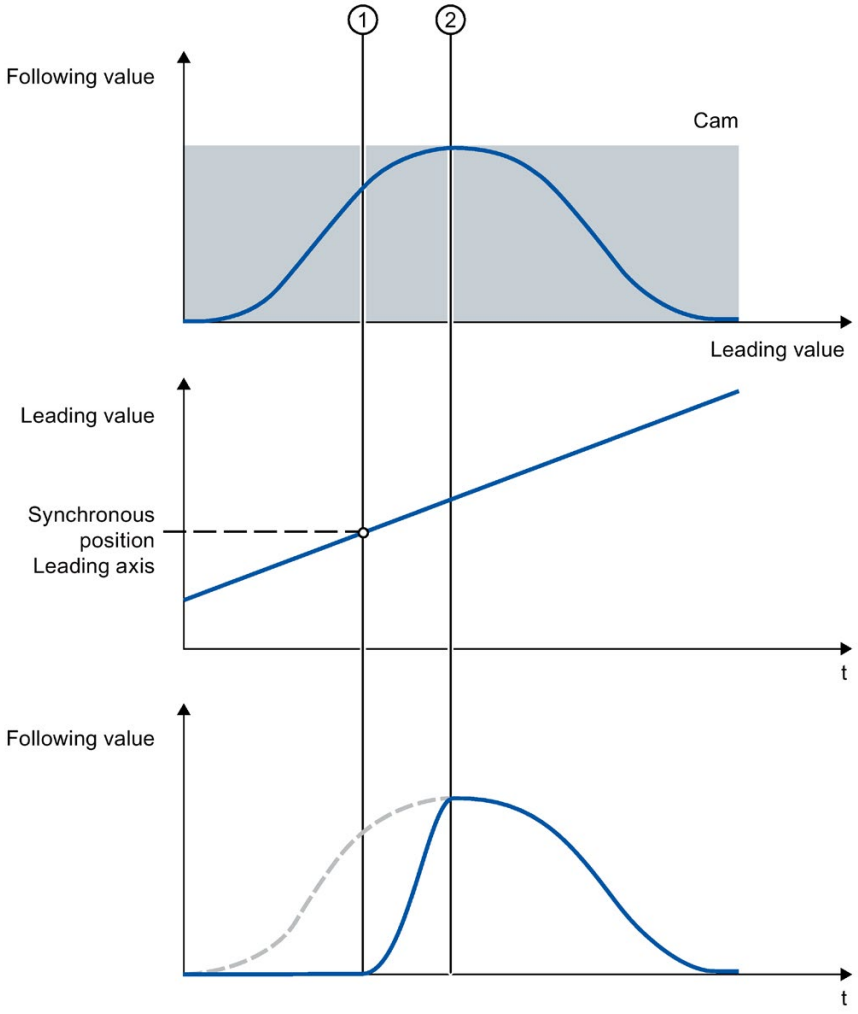
5.4.3 Subsequent synchronization with "MC_CamIn" using leading value distance (S7-1500T)

For subsequent synchronization using the leading value distance with an "MC_CamIn" job, you specify the synchronization length. Specify also the synchronous position of the leading axis. You have the following options:

- Define a specific synchronous position ("SyncProfileReference" = 3)
- Use the current position of the leading axis as synchronous position ("SyncProfileReference" = 4)

The values must each be within the definition of the cam.

For synchronization in advance, the synchronous position of the leading axis is the start position for synchronization.



① Time when synchronization starts
② Time when synchronization is complete

After the start of the "MC_CamIn" job, a motion profile with the required dynamics is calculated for the following axis depending on the specified leading value distance.

The status "Waiting" is displayed at the following axis until the leading value has reached the synchronous position of the leading axis (<TO>.StatusSynchronizedMotion.WaitingFunctionState = 3).

Synchronization begins as soon as the leading value has reached the synchronous position of the leading axis ("SyncProfileReference" = 3) or as soon as the "MC_CamIn" job takes effect ("SyncProfileReference" = 4). The synchronization is indicated by parameter "MC_CamIn.StartSync" = TRUE as well as in the "<TO>.StatusWord.X21 (Synchronizing)" tag of the technology object. The leading value must reverse during synchronization.

The dynamics of the following axis during synchronization is obtained from the calculated motion profile and the current dynamics of the leading axis. Changes in the dynamics of the leading axis during synchronization are superimposed on the calculated motion profile in accordance with the synchronous operation function. This can have the result that the configured dynamic limits at the following axis are violated. This is displayed in the "<TO>.StatusSynchronizedMotion.StatusWord" tag.

The position of the leading axis from which the leading axis and following axis are synchronous is derived in the following way:

Position axes synchronous = Synchronous position of leading axis + Synchronization length

The following axis travels synchronously with the leading axis in accordance with the cam profile. The "Synchronous" status is indicated in the Motion Control instruction with parameter "InSync" = TRUE.

See also

Camming (Page 45)

MC_CamIn: Start camming V5 (Page 209)

5.4.4 Direct synchronous setting with "MC_CamIn" (S7-1500T)

This type of synchronization is mainly suitable for synchronizing at a standstill.

After the "MC_CamIn" job has started with "SyncProfileReference" = 2, the status "Synchronous" is set directly at the current leading value position and at the current following value position. The "Synchronous" status is indicated in the Motion Control instruction with parameter "InSync" = TRUE.

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

Additional information

For more information on direct synchronous setting, refer to the FAQ entry 109758886 (https://support.industry.siemens.com/cs/ww/en/view/109758886) in the Siemens Industry Online Support.

See also

Camming (Page 45)

MC_CamIn: Start camming V5 (Page 209)

5.5 Dynamic limits in camming (S7-1500T)

Leading axis

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

Following axis

If a synchronous axis is operated as a following axis in camming with the Motion Control instruction "MC_CamIn", the following dynamic limits apply depending on the phase of the synchronous operation:

- **Pending synchronous operation**

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

- **Synchronization/synchronous motion**

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

  If the dynamic limits configured for the following axis are exceeded, this is indicated in the "<TO>.StatusSynchronizedMotion.StatusWord" tag of the technology object. The SW limit switches continue to be monitored with the configured dynamic limits of the following axis.

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

- **Synchronous operation override**

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

See also

Camming (Page 45)

MC_CamIn: Start camming V5 (Page 209)

Override response V5: Synchronous operation jobs (Page 238)

5.6 Tags: Camming (S7-1500T)

The following technology object tags are relevant for camming:

Status indicators		
Tag	**Description**	
<TO>.StatusSynchronizedMotion.FunctionState	Indication of which synchronous operation function is active	
	0	No synchronous operation active
	1	Gearing ("MC_GearIn")
	2	Gearing with specified synchronous positions ("MC_GearInPos")
	3	Camming ("MC_CamIn")
<TO>.StatusSynchronizedMotion.Waiting FunctionState	Indication of which synchronous operation function is waiting	
	0	No synchronous operation waiting
	1	Reserved
	2	Gearing with specified synchronous positions waiting ("MC_GearInPos")
	3	Camming waiting ("MC_CamIn")
<TO>.StatusSynchronizedMotion.ActualMaster	When a synchronous operation job is started, the number of the technology data block of the currently used leading axis is displayed.	
	0	Synchronous operation inactive
<TO>.StatusSynchronizedMotion.CurrentCam	Cam that is currently being used for camming	
<TO>.StatusSynchronizedMotion.MasterOffset	Current shift of the leading value range of the cam	
<TO>.StatusSynchronizedMotion.Master Scaling	Current scaling of the leading value range of the cam	
<TO>.StatusSynchronizedMotion.SlaveOffset	Current shift of the following value range of the cam	
<TO>.StatusSynchronizedMotion.SlaveScaling	Current scaling of the following value range of the cam	
<TO>.StatusSynchronizedMotion.StatusWord. X0 (MaxVelocityExceeded)	Set to the value "TRUE" when the maximum velocity configured for the following axis is exceeded during synchronous operation.	
<TO>.StatusSynchronizedMotion.StatusWord. X1 (MaxAccelerationExceeded)	Set to the value "TRUE" when the maximum acceleration configured for the following axis is exceeded during synchronous operation.	
<TO>.StatusSynchronizedMotion.StatusWord. X2 (MaxDecelerationExceeded)	Set to the value "TRUE" when the maximum deceleration configured for the following axis is exceeded during synchronous operation.	
<TO>.StatusWord.X21 (Synchronizing)	Set to the value "TRUE" when the synchronous axis synchronizes to a leading value.	
<TO>.StatusWord.X22 (Synchronous)	Set to the value "TRUE" when the synchronous axis is synchronized and moves synchronously to the leading axis.	
<TO>.ErrorWord.X14 (SynchronousError)	Error during synchronous operation The leading axis specified in the Motion Control instruction was not configured as a possible leading axis.	

Configuring (S7-1500, S7-1500T) 6

6.1 Configuring the synchronous axis technology object (S7-1500, S7-1500T)

6.1.1 Configuration - Basic Parameters (S7-1500, S7-1500T)

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

Name

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

Axis type

If you want to use the axis in the CPU exclusively as a virtual leading axis for synchronization, for example, select the "Virtual axis" check box. The configuration of a drive and encoder connection is not relevant.

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

Units of measure

In the drop-down list, select the desired units of measure for the position, velocity, torque and force of the axis.

If you wish to use six decimal places in the selected unit, select the check box "Use position values with higher resolution".

Modulo

Select the "Enable modulo" check box if you want to use a recurring system of units for the axis (e.g. 0° to 360° for an axis of the "rotary" axis type).

- **Modulo start value**

  In this field, define the position at which the modulo range should begin (e.g. 0° for an axis of the "rotary" axis type).

- **Modulo length**

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

Simulation

If you want to move a real axis in the simulation mode, select the "Activate simulation" check box.

In simulation mode, speed, positioning and synchronous axes can be simulated in the CPU without connected drives and encoders. Simulation mode is possible as of Technology Version V3.0 even without a configured drive and encoder connection.

For simulation mode without hardware connected to the CPU, you can influence the startup time of the CPU via the "Configuration time for central and distributed I/Os" parameter. You can find the parameter in the CPU properties in the "Startup" area navigation.

6.1.2 Hardware interface (S7-1500, S7-1500T)

6.1.2.1 Configuration - Drive (S7-1500, S7-1500T)

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

Drive type

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

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

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

Drive type: PROFIdrive

Data connection

In the drop-down list, select whether the data connection is to be made directly with the drive device or via an editable data block in the user program.

Drive/data block

In the "Drive" field, select an already configured PROFIdrive drive/slot. When you have selected a PROFIdrive drive, you can configure the PROFIdrive drive using the "Device configuration" and "Drive configuration" buttons.

If no PROFIdrive drive is available for selection, switch to the device configuration, and add a PROFIdrive drive in the network view. Switch to drive configuration to configure the drive.

Note

Option "Show all modules"

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

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

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

Drive type: Analog drive connection

Analog output

In the "Analog output" field, select the PLC tag of the analog output via which the drive is to be controlled.

In order to be able to select an output, you first need to add an analog output module in the device configuration and define the PLC tag name for the analog output.

Activating enable output

Select the "Activate enable output" check box if the drive supports an enable.

Select the PLC tag of the digital output for the drive enable in the corresponding field. With the enable output, the speed controller in the drive is enabled, or disabled.

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

Note

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

Enable ready input

Select the "Enable ready input" check box if the drive can signal its readiness.

Select the PLC tag of the digital input via which the drive is to signal its operational readiness to the technology object in the corresponding field. The power module is switched on and the analog speed setpoint input is enabled.

In order to be able to select a ready input, you first need to add a digital input module in the device configuration and define the PLC tag name for the digital input.

Note

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

The following boundary conditions apply to the activated ready input:

- The axis is only enabled ("MC_Power Status" = TRUE) when a signal is present at the ready input.
- If a signal is not present at the ready input on an enabled axis, the axis is disabled with an error.
- If the axis is disabled with the instruction "MC_Power" ("Enable" = FALSE), the axis is disabled even when a signal is present at the ready input.

See also

"Drive and encoder connection" section in the "S7-1500/S7-1500T Axis functions" function manual (https://support.industry.siemens.com/cs/ww/en/view/109766462)

6.1.2.2 Configuration - Encoder (S7-1500, S7-1500T)

For closed-loop position control, synchronous axes require an actual position value in the form of an encoder position. The encoder position is transmitted to the controller by means of a PROFIdrive telegram.

As well as the S7-1500, the S7-1500T also offers the possibility to configure up to four encoders and switch between the encoders. You control the switch in the user program with the Motion Control instruction "MC_SetSensor".

Encoder on startup (S7-1500T)

In the drop-down list, select the encoder that is to be active after startup of the CPU (STARTUP). The encoder must be configured and marked as "used".

This encoder is used after startup of the CPU and after a restart of the technology object. At an operating mode transition from STOP → RUN of the CPU (without restart of the technology object), the encoder that was also active before the STOP is still being used.

Use encoder (S7-1500T)

Select the "Use encoder" check box if you want to use this encoder alternatively for closed loop position control.

Data connection

In the drop-down list, select whether the data connection should be established directly with the encoder or via a data block that can be edited in the user program.

The selection is only possible for encoders that are connected via PROFIdrive and support parameter P979.

Encoder/data block

Select a previously configured encoder in this configuration field.

The following encoders can be selected:

- **Connection to the drive (not with analog drive connection)**

  The encoder is configured via the configuration of the PROFIdrive drive. The drive evaluates the encoder signals and sends them to the controller in the PROFIdrive telegram.

- **Encoder on technology module (TM)**

  Select a previously configured technology module and the channel to be used. Only technology modules set to the "Position input for Motion Control" mode are displayed for selection.

  If no technology module is available for selection, change to the device configuration and add a technology module. If you have selected a technology module, you can access the configuration of the technology module using the "Device configuration" button.

  You can operate the technology module centrally on an S7-1500 CPU or decentrally on a distributed I/O. Isochronous mode is not possible with central operation in the CPU.

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

- **PROFIdrive encoder on PROFINET/PROFIBUS (PROFIdrive)**

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

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

  Note

  Option "Show all modules"

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

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

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

Encoder type

Select the encoder type of the encoder in the drop-down list. The following encoder types are available:

- Incremental
- Absolute (measuring range > traversing range)
- Cyclic absolute (measuring range < traversing range)

Recommended settings for absolute actual values: The "Cyclic absolute" encoder type is recommended. With this setting, the position of the zero crossing of the encoder is automatically taken into consideration by the technology object.

Note

Measuring range of the absolute encoder

Observe the boundary conditions with absolute values.

You can find more information in the section "AUTOHOTSPOT" of the "S7-1500/S7-1500T Axis functions" documentation (https://support.industry.siemens.com/cs/ww/en/view/109766462).

See also

"Drive and encoder connection" section in the "S7-1500/S7-1500T Axis functions" function manual (https://support.industry.siemens.com/cs/ww/en/view/109766462)

6.1.2.3 Configuration - Data exchange with the drive (S7-1500, S7-1500T)

Configure the data exchange with the drive in the "Data exchange with the drive" configuration window.

The configuration differs according to the selected drive type:

Drive type: PROFIdrive

Drive telegram

The telegram to the drive that is set in the device configuration is preselected in the drop-down list.

Automatically apply drive values during configuration (offline)

Select the check box if you want to transfer the offline values of the drive "Reference speed", "Maximum speed" and "Reference torque" to the configuration of the technology object in the project.

Automatically apply drive values at runtime (online)

Select the check box if you want to transfer the effective values "Reference speed", "Maximum speed" and "Reference torque" online in the drive to the CPU during runtime. The drive parameters are transferred from the bus after the (re-)initialization of the technology object or the (re)start of the drive or the CPU.

Alternatively, you must synchronize the following parameters manually:

- **Reference speed**

  Configure the reference speed of the drive in accordance with the manufacturer's specifications in this field. The specification of the drive speed is a percentage of the reference speed in the range -200% to 200%.

- **Maximum speed**

  Configure the maximum speed of the drive in this field.

- **Reference torque**

  Configure the reference torque of the drive corresponding to its configuration in this field.

  The reference torque is needed for force/torque reduction, which is supported with telegram 10x.

Supplementary data

Select the "Torque data" check box if you want to configure the data connection of the torque data. If you have selected a drive with which the supplemental telegram 750 has been configured, the "Torque data" check box is preselected.

Data connection

In the drop-down list, define whether the data connection should be made via supplemental telegrams or data blocks:

- If you select the entry "Supplemental telegram" in the "Data connection" drop-down list, you can edit the "Supplemental telegram" drop-down list.
- If you select the "Data block" entry in the "Data connection" drop-down list, you can select the previously created data block which contains a tag structure of the "PD_TELx" data type ("x" stands for the additional telegram number that is used).

Data block / supplemental telegram

Select an supplemental telegram configured in the "Supplemental telegram" field.

Select the "Show all modules" check box if you want to display all submodules of the connected drive. You can also find self-defined supplemental telegrams with this function.

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

Note

Automatic transfer of drive parameters is only possible with SINAMICS drives as of V4.x. To do this, set the "Drive" data connection in the configuration window "Hardware interface > Drive".

Drive type: Analog drive connection

Reference speed

The reference speed of the drive is the speed with which the drive spins when there is an output of 100% at the analog output. The reference speed must be configured for the drive and transferred in the configuration of the technology object.

The analog value that is output at 100% depends on the type of the analog output. For example, for an analog output with +/- 10 V, the value 10 V is output at 100%.

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

Maximum speed

Specify the maximum speed of the drive in this field.

See also

"Drive and encoder connection" section in the "S7-1500/S7-1500T Axis functions" function manual (https://support.industry.siemens.com/cs/ww/en/view/109766462)

6.1.2.4 Configuration - Data exchange with encoder (S7-1500, S7-1500T)

Configure detailed encoder parameters and the data exchange of the encoder in the "Data exchange with encoder" configuration window.

If you are using an S7-1500T CPU, you need to define the settings for each of the maximum four configured encoders.

The display and selection of the configuration parameters described here is dependent on the following parameters:

- Configuration window "Basic parameters": Drive type (linear/rotary)
- Configuration window "Hardware interface > Encoder": Encoder type (incremental/absolute/cyclic absolute)
- Configuration window - "Extended parameters > Mechanics": Encoder mounting type

Settings for (S7-1500T)

In the drop-down list, select the encoder for which you wish to edit the following configurations.

Encoder telegram

The telegram to the encoder that is set in the device configuration is preselected in the drop-down list.

Automatically apply encoder values during configuration (offline)

Select the check box if you want to transfer the offline values of the encoder to the configuration of the technology object in the project.

Automatically apply encoder values during runtime (online)

Select the check box if you want to transfer the effective values online in the encoder to the CPU during runtime. The encoder parameters are transferred from the bus after the (re-)initialization of the technology object and (re)start of the encoder or the CPU.

Note

Automatic transfer of encoder parameters is only possible with PROFIdrive encoders as of product version A16. For this, "Hardware interface > Encoder" must be selected as the "Encoder" data connection in the configuration window.

Alternatively, you must manually calibrate the following parameters, depending on encoder type.

Measuring system

In the drop-down list, select the measuring procedure. The options are "Linear" and "Rotary".

Additional parameters

Depending on the selected measuring system and the encoder type selected under "Technology object > Configurations > Hardware interface > Encoders", configure the parameters described below:

- Measuring system: Rotary; encoder type: Incremental

Parameter	Description
Increments per revolution	Configure the number of increments that the encoder resolves per revolution in this field.
Bits for fine resolution in the incremental actual value (Gx_XIST1)	Configure the number of bits for fine resolution within the incremental actual value (Gx_XIST1) in this field.

- Measuring system: Rotary; encoder type: Absolute

Parameter	Description
Increments per revolution	Configure the number of increments that the encoder resolves per revolution in this field.
Number of revolutions	Configure the number of revolutions that the absolute encoder can detect in this field.
Bits for fine resolution in the incremental actual value (Gx_XIST1)	Configure the number of bits for fine resolution within the incremental actual value (Gx_XIST1) in this field.
Bits for fine resolution in the absolute actual value (Gx_XIST2)	Configure the number of bits for fine resolution within the absolute actual value (Gx_XIST2) in this field.

- Measuring system: Rotary; encoder type: Cyclic absolute

Parameter	Description
Increments per revolution	Configure the number of increments that the encoder resolves per revolution in this field.
Number of revolutions	Configure the number of revolutions that the absolute encoder can detect in this field.
Bits for fine resolution in the incremental actual value (Gx_XIST1)	Configure the number of bits for fine resolution within the incremental actual value (Gx_XIST1) in this field.
Bits for fine resolution in the absolute actual value (Gx_XIST2)	Configure the number of bits for fine resolution within the absolute actual value (Gx_XIST2) in this field.

- Measuring system: Linear; encoder type: Incremental

Parameter	Description
Distance between two increments	Configure the distance between two increments of the encoder in this field.
Bits for fine resolution in the incremental actual value (Gx_XIST1)	Configure the number of bits for fine resolution within the incremental actual value (Gx_XIST1) in this field.

- Measuring system: Linear; encoder type: Absolute

Parameter	Description
Distance between two increments	Configure the distance between two increments of the encoder in this field.
Bits for fine resolution in the incremental actual value (Gx_XIST1)	Configure the number of bits for fine resolution within the incremental actual value (Gx_XIST1) in this field.
Bits for fine resolution in the absolute actual value (Gx_XIST2)	Configure the number of bits for fine resolution within the absolute actual value (Gx_XIST2) in this field.

- Measuring system: Linear; encoder type: Cyclic absolute

Parameter	Description
Distance between two increments	Configure the distance between two increments of the encoder in this field.
Bits for fine resolution in the incremental actual value (Gx_XIST1)	Configure the number of bits for fine resolution within the incremental actual value (Gx_XIST1) in this field.
Bits for fine resolution in the absolute actual value (Gx_XIST2)	Configure the number of bits for fine resolution within the absolute actual value (Gx_XIST2) in this field.

See also

Configuration - Encoder (Page 67)

"Drive and encoder connection" section in the "S7-1500/S7-1500T Axis functions" function manual (https://support.industry.siemens.com/cs/ww/en/view/109766462)

Configuration - Mechanics (Page 78)

6.1.3 Configuration - Leading value interconnections (S7-1500, S7-1500T)

You can interconnect a synchronous axis with multiple leading value-capable technology objects. The following technology objects are leading value-capable:

- Positioning axis
- Synchronous axis (Page 17)
- External encoder (S7-1500T)
- Leading axis proxy (Page 164) (S7-1500T)

You can select only one leading value during runtime of your user program.

All interconnection required during operation must be set up during configuration of the technology object.

Interconnection overview

You open the interconnection overview via this link. With a cross-PLC synchronous operation, the interconnection overview contains an overview of the interconnected leading and following axes and their CPU assignment.

Possible leading values

In the "Possible leading values" table column, add all leading value-capable technology objects that you need during operation as leading value for the synchronous axis.

You can use the technology objects added in the table with the corresponding Motion Control instruction as leading value for the synchronous axis. All configured leading value interconnections for the technology object are displayed in the cross-reference list of the technology object.

In a cross-PLC synchronous operation, you add the corresponding leading axis proxy technology object instead of the leading axis of another CPU (only for S7-1500T CPU). The leading axis proxy technology object makes the leading value of the corresponding leading axis available locally on the CPU.

Leading value source (S7-1500T)

If you add a leading value proxy technology object in the "Possible leading values" table column, the "Leading value source" column displays which technology object of which CPU provides the leading value:

<Name of CPU>.<Name of technology object>

Type of coupling

In the "Type of coupling" table column, configure whether the leading value is to be coupled via setpoint, actual value or with a delay. "Actual value" is available only for the S7-1500T CPU.

In a cross-PLC synchronous operation, you define with the "Delayed" setting whether the leading value should be delayed for a local synchronous operation.

Coupling via setpoint is the default setting for a leading axis proxy technology object.

Consider interconnection when calculating the delay time (S7-1500T)

In the table column with the icon  , select for a leading axis proxy technology object whether this leading value interconnection should be taken into consideration in the calculation of the delay time in the interconnection overview (Page 178).

See also

Interconnection possibilities (Page 166)

Leading value coupling (Page 21)

6.1.4 Configuration - Leading value settings (S7-1500, S7-1500T)

In the "Leading value settings" configuration window, select the parameters of the leading value for cross-PLC synchronous operation.

Provision of leading value

In this area, define the settings for transferring the leading value to other CPUs:

Field	Description
Provide cross-PLC leading value	Select this check box to make the setpoint or actual value available as leading value for a cross-PLC synchronous operation.
Transfer area	In this drop-down list, select the output tag of the transfer area set up between the CPU of the leading axis and the CPUs of the following axes. You can find additional information on the transfer area in the section "Setting up communication via controller-controller data exchange (Page 171)".

Delay time of local leading value

In this area, configure the settings for local synchronous operation:

Field	Description
Allow system calculation	Select this check box to adapt the delay time of the local leading value in the system. System calculation is started when you trigger the calculation in the interconnection overview.
Delay time	If the "Allow system calculation" check box is cleared, this field can be edited. Enter the delay time in this field. The entered delay time determines the output delay of the leading value for the local following axes. (<TO>.CrossPlcSynchronousOperation.LocalLeadingValueDelayTime)
Interconnection overview	You open the interconnection overview via this link. With a cross-PLC synchronous operation, the interconnection overview contains an overview of the interconnected leading and following axes and their CPU assignment.

See also

Interconnection possibilities (Page 166)

6.1.5 Extended parameters (S7-1500, S7-1500T)

6.1.5.1 Configuration - Mechanics (S7-1500, S7-1500T)

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

Settings for (S7-1500T)

In the drop-down list, select the encoder for which the following configurations are to apply.

Encoder mounting type

In the drop-down list, select how the encoder is mounted to the mechanics.

The configuration differs depending on the axis type and the encoder mounting type selected in the "Basic parameters" configuration window.

Axis type: Linear

- Linear - On motor shaft (Page 79)
- Linear - On load side (Page 79)
- Linear - External Measuring System (Page 80)

Axis type: Rotary

- Rotary - On motor shaft (Page 80)
- Rotary - On load side (Page 81)
- Rotary - External Measuring System (Page 81)

Invert encoder direction

Select this check box if you must invert the direction of rotation of the encoder.

See also

Configuration - Data exchange with encoder (Page 72)

Section "Mechanics" in the function manual "S7-1500/S7-1500T Axis functions" (https://support.industry.siemens.com/cs/ww/en/view/109766462)

Axis type: Linear (S7-1500, S7-1500T)

Linear - On motor shaft (S7-1500, S7-1500T)

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

Drive mechanism

Select the "Invert drive direction" check box if the direction of rotation of the drive is to be inverted.

Load gear

The gear ratio of the load gear is specified as the ratio between motor revolutions and load revolutions.

In this "Number of motor revolutions" configuration field, configure the integer number of motor revolutions.

In this "Number of load revolutions" configuration field, configure the integer number of load revolutions.

Position parameters

In the "Leadscrew pitch" configuration field, configure the distance by which the load is moved when the leadscrew makes one revolution.

Linear - On load side (S7-1500, S7-1500T)

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

Drive mechanism

Select the "Invert drive direction" check box if the direction of rotation of the drive is to be inverted.

Load gear

The gear ratio of the load gear is specified as the ratio between motor revolutions and load revolutions.

In this "Number of motor revolutions" configuration field, configure the integer number of motor revolutions.

In this "Number of load revolutions" configuration field, configure the integer number of load revolutions.

Position parameters

In the "Leadscrew pitch" configuration field, configure the distance by which the load is moved when the leadscrew makes one revolution.

Linear - External Measuring System (S7-1500, S7-1500T)

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

Distance per encoder revolution

In this configuration field, configure the linear load travel per encoder revolution.

Drive mechanism

Select the "Invert drive direction" check box if the direction of rotation of the drive is to be inverted.

Load gear

The gear ratio of the load gear is specified as the ratio between motor revolutions and load revolutions.

In this "Number of motor revolutions" configuration field, configure the integer number of motor revolutions.

In this "Number of load revolutions" configuration field, configure the integer number of load revolutions.

Position parameters

In the "Leadscrew pitch" configuration field, configure the distance by which the load is moved when the leadscrew makes one revolution.

Axis type: Rotary (S7-1500, S7-1500T)

Rotary - On motor shaft (S7-1500, S7-1500T)

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

Drive mechanism

Select the "Invert drive direction" check box if the direction of rotation of the drive is to be inverted.

Load gear

The gear ratio of the load gear is specified as the ratio between motor revolutions and load revolutions.

In this "Number of motor revolutions" configuration field, configure the integer number of motor revolutions.

In this "Number of load revolutions" configuration field, configure the integer number of load revolutions.

Rotary - On load side (S7-1500, S7-1500T)

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

Drive mechanism

Select the "Invert drive direction" check box if the direction of rotation of the drive is to be inverted.

Load gear

The gear ratio of the load gear is specified as the ratio between motor revolutions and load revolutions.

In this "Number of motor revolutions" configuration field, configure the integer number of motor revolutions.

In this "Number of load revolutions" configuration field, configure the integer number of load revolutions.

Rotary - External Measuring System (S7-1500, S7-1500T)

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

Distance per encoder revolution

In this configuration field, configure the linear load travel per encoder revolution.

Drive mechanism

Select the "Invert drive direction" check box if the direction of rotation of the drive is to be inverted.

Load gear

The gear ratio of the load gear is specified as the ratio between motor revolutions and load revolutions.

In this "Number of motor revolutions" configuration field, configure the integer number of motor revolutions.

In this "Number of load revolutions" configuration field, configure the integer number of load revolutions.

6.1.5.2 Configuration - Dynamic Defaults (S7-1500, S7-1500T)

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

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

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

Velocity

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

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

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

The following equations show the relationship between the ramp-up time and acceleration and the ramp-down time and deceleration:

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

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

Note

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

Smoothing time/jerk

You can enter the jerk limit parameters in the "Smoothing time" box, or alternatively in the "Jerk" box:

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

Note

The jerk value is identical for the acceleration and deceleration ramp. The smoothing time in effect for the deceleration ramp results from the following relationships:

- **Acceleration > Deceleration**

  A shorter smoothing time is used for the deceleration ramp compared with the acceleration ramp.
- **Acceleration < Deceleration**

  A longer smoothing time is used for the deceleration ramp compared with the acceleration ramp.
- **Acceleration = Deceleration**

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

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

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

$$\text{Smoothing time (acceleration ramp)} = \frac{\text{Acceleration}}{\text{Jerk}}$$

$$\text{Smoothing time (deceleration ramp)} = \frac{\text{Deceleration}}{\text{Jerk}}$$

Motion jobs started in the user program are performed with the selected jerk.

See also

Section "Velocity profile" in the function manual "S7-1500/S7-1500T Axis functions" (https://support.industry.siemens.com/cs/ww/en/view/109766462)

6.1.5.3 Configuration - Emergency stop (S7-1500, S7-1500T)

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 deceleration/emergency stop ramp-down time

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

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

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

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

See also

Section "Emergency stop deceleration" in the function manual "S7-1500/S7-1500T Axis functions" (https://support.industry.siemens.com/cs/ww/en/view/109766462)

6.1.5.4 Limits (S7-1500, S7-1500T)

Configuration - Position limits (S7-1500, S7-1500T)

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

Enable HW limit switches

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

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

Exception:

1. If a hardware limit switch is overtraveled during an active home position approach with activated direction reversal at the hardware limit switch, the axis stops with the configured maximum deceleration and continues the home position approach in the opposite direction.
2. If the hardware limit switches were deactivated using the Motion Control instruction "MC_WriteParameter".

Note

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

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

Input of negative/positive HW limit switch

In these fields, select the PLC tag of the digital input for the negative and positive hardware limit switch.

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

CAUTION

During installation of hardware limit switches, attention must be paid to the filter times of the digital inputs.

Based on the time for one position control cycle clock and the filter time of the digital inputs, the resulting delay times must be taken into account.

The filter time is configurable in individual digital input modules in the device configuration.

The digital inputs are set to a filter time of 6.4 ms by default. If these are used as hardware limit switches, undesired decelerations may occur. If this occurs, reduce the filter time for the relevant digital inputs.

The filter time can be set under "Input filter" in the device configuration of the digital inputs.

Level selection of negative/positive HW limit switch

Select the triggering signal level ("low level"/"high level") of the hardware limit switch in the drop-down list. With "Low level", the input signal is "FALSE" after the axis has reached or passed the hardware limit switch. With "High level", the input signal is "TRUE" after the axis has reached or passed the hardware limit switch.

Enable SW limit switches

This check box activates the high and low software limit switches. When software switches are activated, an active motion comes to a stop at the position of the software limit switch. The technological object signals an error. After acknowledgment of the error, the axis can again be moved in the direction of its operating range.

Note

Activated software limit switches act only on a homed axis.

Position of negative/positive SW limit switch

Configure the operating range of the axis with the positions of the negative and positive software limit switches.

See also

Section "Traversing range limitation" in the function manual "S7-1500/S7-1500T Axis functions" (https://support.industry.siemens.com/cs/ww/en/view/109766462)

Configuration - Dynamic limits (S7-1500, S7-1500T)

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

Maximum velocity

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

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

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

The following equations show the relationship between the ramp-up time and acceleration and the ramp-down time and deceleration:

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

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

Note

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

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

Smoothing time/jerk

You can enter the jerk limit parameters in the "Smoothing time" box, or alternatively in the "Jerk" box:

- Set the desired jerk for the acceleration and deceleration ramp in the "Jerk" field. The value 0 means that the jerk is not limited.
- Set the desired smoothing time for the acceleration ramp in the "Smoothing time" field.

Note

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

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

The smoothing time of the deceleration is adapted as follows:

- **Acceleration > Deceleration**

  A shorter smoothing time is used for the deceleration ramp compared with the acceleration ramp.
- **Acceleration < Deceleration**

  A longer smoothing time is used for the deceleration ramp compared with the acceleration ramp.
- **Acceleration = Deceleration**

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

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

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

$$\text{Smoothing time (acceleration ramp)} = \frac{\text{Acceleration}}{\text{Jerk}}$$

$$\text{Smoothing time (deceleration ramp)} = \frac{\text{Deceleration}}{\text{Jerk}}$$

Motion jobs started in the user program are performed with the selected jerk.

See also

Section "Velocity profile" in the function manual "S7-1500/S7-1500T Axis functions" (https://support.industry.siemens.com/cs/ww/en/view/109766462)

Dynamic limits in gearing (Page 42)

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

Configure the force/torque limiting of the drive in the "Torque limiting" configuration window.

The configuration is only available if a drive that supports force/torque limiting is selected and a telegram 10x is used. Telegram 101 cannot be used.

Effective

In the drop-down list, select whether the limit value is to be in effect "on load side" or "on motor side".

Torque limits

Enter a default value for the torque limiting in the specified unit of measurement in this field.

The default value is in effect when the torque limiting is specified using Motion Control instruction "MC_TorqueLimiting", input parameter "Limit" < 0.

Torque limiting applies to the following axis configurations:

- Axis type is "Rotary" and limit value is in effect "On load side" or "On motor side"
- Axis type is "Linear" and limit value is in effect "On motor side"

Force limit

Enter a default value for the force limit in the specified unit of measure in this field.

The default value is in effect when the force limit is specified using Motion Control instruction "MC_TorqueLimiting", input parameter "Limit" < 0.

The force limit applies to the following axis configuration: Axis type is "Linear" and limit value is in effect "On load side"

If the efficiency of the gear and leadscrew is crucial, you can set them in the "<TO>.Actor.Efficiency" tag.

Position-related monitoring

As a result of the force/torque limiting on the drive, a larger following error may occur or the axis standstill may not be detected reliably in positioning monitoring.

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

Interconnection in the SINAMICS drive

The following interconnection is required in the SINAMICS drive:

- P1522 to a fixed value of +100%
- P1523 to a fixed value of -100% (e.g. through interconnection to fixed value parameter P2902[i]).

See also

Section "Force/torque limiting" in the function manual "S7-1500/S7-1500T Axis functions" (https://support.industry.siemens.com/cs/ww/en/view/109766462)

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

Configure the fixed stop detection in the configuration window.

A "Travel to fixed stop" can be realized by activating fixed stop detection using the Motion Control instruction "MC_TorqueLimiting" and a position-controlled motion job. The operation is also referred to as clamping.

Positioning tolerance

In this configuration field, configure the positioning tolerance that is regarded as a breaking away or turning back of the fixed stop when exceeded. To detect the breaking away or turning back of the fixed stop, the position setpoint must be located outside the positioning tolerance. The configured position tolerance must be less than the configured following error.

Following error

If the drive is stopped by a mechanical fixed stop during a motion job, the following error is increased. The accumulating following error serves as a criterion for fixed stop detection. In the "Following error" configuration field, configure the value of the following error starting from which the fixed stop detection is to take effect. The configured following error must be greater than the configured position tolerance.

Note

If the following error monitoring was activated in the position monitoring configuration, the "Maximum following error" configured there must be greater than the "Following error" of the fixed stop detection.

See also

Section "Fixed stop detection" in the function manual "S7-1500/S7-1500T Axis functions" (https://support.industry.siemens.com/cs/ww/en/view/109766462)

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

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

Operating modes of the Motion Control instruction "MC_Home"

In S7-1500 Motion Control, the axis is homed with the Motion Control instruction "MC_Home". The following operating modes are used in the process:

- **Active homing (incremental encoder)**

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

- **Passive homing (incremental encoder)**

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

- **Direct homing absolute (incremental encoder or absolute encoder)**

  The axis position is set without taking into consideration the home position switch. Active traversing motions are not aborted. The value of input parameter "Position" of Motion Control instruction "MC_Home" is set immediately as the actual position of the axis.

- **Direct homing relative (incremental encoder or absolute encoder)**

  The axis position is set without taking into consideration the home position switch. Active traversing motions are not aborted. The following statement applies to the axis position after homing:

  New axis position = Current axis position + Value of parameter "Position" of instruction "MC_Home".

See also

Section "Homing" in the function manual "S7-1500/S7-1500T Axis functions" (https://support.industry.siemens.com/cs/ww/en/view/109766462)

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

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

In the "Active Homing" configuration window, configure the parameters for active homing. "Active homing" is executed using the Motion Control instruction "MC_Home" with "Mode" = 3 and 5.

Note

Parameter "MC_Home.Mode" (S7-1500 CPU)

The "MC_Home.Mode" parameter for S7-1200 Motion Control and S7-1500 Motion Control has been standardized within the framework of technology version V2.0. This results in a new assignment of the parameter values for the "MC_Home.Mode" parameter. A comparison of the "MC_Home.Mode" parameter for technology versions V1.0 and V2.0 is available in the section "Version overview" of the "S7-1500/S7-1500T Motion Control overview" documentation (https://support.industry.siemens.com/cs/ww/en/view/109766459).

Settings for (S7-1500T)

In the drop-down list, select the encoder to which the homing settings are to apply.

Select the homing mode

Select from among the following homing modes:

- Use zero mark via PROFIdrive telegram (Page 92)
- Use reference output cam and zero mark via PROFIdrive telegram (Page 93)
- Use homing mark via digital input (Page 94)

Homing mode "Use zero mark via PROFIdrive telegram" (S7-1500, S7-1500T)

Enable direction reversal at the hardware limit switch

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

Homing direction

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

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

Approach velocity

In this field, specify the velocity which is used to traverse to the home position offset.

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.

Homing mode "Use reference output cam and zero mark via PROFIdrive telegram" (S7-1500, S7-1500T)

Enable direction reversal at the hardware limit switch

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

Approach direction

Select the approach direction for the reference output cam search.

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

Homing direction

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

Approach velocity

In this field, specify the velocity at which the reference output cam is searched for during the homing procedure. Any configured home position offset is traversed at the same velocity.

Homing velocity

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

Home position offset

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

Home position

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

Homing mode "Use homing mark via digital input" (S7-1500, S7-1500T)

When a digital input is used as a homing mark, the accuracy of the homing process is not as high as for hardware-supported homing using zero marks. You can improve the accuracy by using a low homing velocity.

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

Digital input homing mark/output cam

In this configuration field, select the PLC tag of the digital input that is to act as a homing mark (reference output cam). Also select the level at which the homing mark is to be detected.

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

Enable direction reversal at the hardware limit switch

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

Approach direction

Select the approach direction for the homing mark search.

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

Homing direction

Select the direction in which the homing mark for homing is to be approached.

Homing mark

Select the switch position of the "digital input" that is to be used as the homing mark.

When a "digital input" is crossed, two switching edges that are spatially separated from one another are generated. The selection of the positive or negative side ensures that the homing mark is always evaluated at the same mechanical position.

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

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

Approach velocity

In this field, specify the velocity at which the axis searches for the "digital input" during the home position approach. Any configured home position offset is traversed at the same velocity.

Homing velocity

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

Home position offset

If the homing mark position is different from the home position, enter the corresponding home position offset in this field. The axis approaches the home position at approach velocity.

Home position

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

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

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

Configure the parameters for passive homing in the "Passive Homing" (homing on the fly) configuration window. The "Passive homing" homing function is executed using the Motion Control instruction "MC_Home" with "Mode" = 2, 8 and 10.

Note

Parameter "MC_Home.Mode" (S7-1500 CPU)

The "MC_Home.Mode" parameter for S7-1200 Motion Control and S7-1500 Motion Control has been standardized within the framework of technology version V2.0. This results in a new assignment of the parameter values for the "MC_Home.Mode" parameter. A comparison of the "MC_Home.Mode" parameter for technology versions V1.0 and V2.0 is available in the section "Version overview" of the "S7-1500/S7-1500T Motion Control overview" documentation (https://support.industry.siemens.com/cs/ww/en/view/109766459).

Settings for

In the drop-down list, select the encoder for which the homing settings are to apply (only for S7-1500T).

Select the homing mode

Select from among the following homing modes:

- Use zero mark via PROFIdrive telegram (Page 96)
- Use reference output cam and zero mark via PROFIdrive telegram (Page 97)
- Use homing mark via digital input (Page 98)

Homing mode "Use zero mark via PROFIdrive telegram" (S7-1500, S7-1500T)

Homing direction

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

- **Positive**

  The axis moves in the direction of higher position values.

- **Negative**

  The axis moves in the direction of lower position values.

- **Current**

  The currently effective approach direction is used for homing.

Home position

In this field, configure the absolute coordinate of the home position. The home position configured here is in effect when the Motion Control instruction "MC_Home" is executed with "Mode" = 10.

Note

Parameter "MC_Home.Mode"

The "MC_Home.Mode" parameter for S7-1200 Motion Control and S7-1500 Motion Control has been standardized within the framework of technology version V2.0. This results in a new assignment of the parameter values for the "MC_Home.Mode" parameter. A comparison of the "MC_Home.Mode" parameter for technology versions V1.0 and V2.0 is available in the section "Version overview" of the "S7-1500/S7-1500T Motion Control overview" documentation (https://support.industry.siemens.com/cs/ww/en/view/109766459).

Homing mode "Use reference output cam and zero mark via PROFIdrive telegram" (S7-1500, S7-1500T)

Homing direction

Select the direction in which the zero mark should be approached for homing. The next zero mark after leaving the reference output cam is used.

The following options are available:

- **Positive**

  The axis moves in the direction of higher position values.

- **Negative**

  The axis moves in the direction of lower position values.

- **Current**

  The currently effective approach direction is used for homing.

Home position

In this field, configure the absolute coordinate of the home position. The home position configured here is in effect when the Motion Control instruction "MC_Home" is executed with "Mode" = 10.

Note

Parameter "MC_Home.Mode"

The "MC_Home.Mode" parameter for S7-1200 Motion Control and S7-1500 Motion Control has been standardized within the framework of technology version V2.0. This results in a new assignment of the parameter values for the "MC_Home.Mode" parameter. A comparison of the "MC_Home.Mode" parameter for technology versions V1.0 and V2.0 is available in the section "Version overview" of the "S7-1500/S7-1500T Motion Control overview" documentation (https://support.industry.siemens.com/cs/ww/en/view/109766459).

Homing mode "Use homing mark via digital input" (S7-1500, S7-1500T)

Digital input homing mark/output cam

In this dialog field, select a digital input that is to act as a homing mark (reference output cam). Also select the level at which the homing mark is to be detected.

Homing direction

Select the direction in which the homing mark for homing is to be approached.

The following options are available:

- **Positive**

  The axis moves in the direction of higher position values.

- **Negative**

  The axis moves in the direction of lower position values.

- **Current**

  The currently effective approach direction is used for homing.

Homing mark

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

When a "digital input" is crossed, two switching edges that are spatially separated from one another are generated. The selection of the positive or negative side ensures that the homing mark is always evaluated at the same mechanical position.

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

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

Home position

In this field, configure the absolute coordinate of the home position. The home position configured here is in effect when the Motion Control instruction "MC_Home" is executed with "Mode" = 10.

Note

Parameter "MC_Home.Mode"

The "MC_Home.Mode" parameter for S7-1200 Motion Control and S7-1500 Motion Control has been standardized within the framework of technology version V2.0. This results in a new assignment of the parameter values for the "MC_Home.Mode" parameter. A comparison of the "MC_Home.Mode" parameter for technology versions V1.0 and V2.0 is available in the section "Version overview" of the "S7-1500/S7-1500T Motion Control overview" documentation (https://support.industry.siemens.com/cs/ww/en/view/109766459).

6.1.5.6 Position monitoring functions (S7-1500, S7-1500T)

Configuration - Positioning monitoring (S7-1500, S7-1500T)

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

Positioning window

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

Tolerance time

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

Minimum dwell time in positioning window

Configure the minimum dwell time in this field. The current position value must be located in the positioning window for at least the "minimum dwell time". At the end of the hold time, the corresponding positioning job reports "Done" = TRUE.

Recommended setting: To avoid longer pauses, set values between 0 ms and 20 ms for dynamic positioning tasks.

If one of the criteria is violated, then the axis is stopped and the technology alarm 541 "Position monitoring error" is displayed (alarm response: Remove enable).

Configuration - Following error (S7-1500, S7-1500T)

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

Enable following error monitoring

Select this check box, if you want to enable following error monitoring. When following error monitoring is enabled, the axis is stopped in the error range (orange). The technology alarm 521 "Following error" is displayed (alarm response: remove enable).

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

Maximum following error

Configure the following error that is permissible at maximum velocity in this field.

Warning level

In this field, configure a percentage of the current following error limit above which a 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, the technology alarm 522 "Warning following error tolerance" is output. This is a warning and contains no alarm response.

Following error

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

Start of dynamic adjustment

Configure the velocity starting from which the following error is to be dynamically adjusted in this field. Starting from this velocity, the following error up to the maximum velocity will be adjusted to the maximum following error.

Configuration - Standstill signal (S7-1500, S7-1500T)

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

Standstill window

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

Minimum dwell time in standstill window

Configure the minimum dwell time in the standstill window in this field. The velocity of the axis must be in the standstill window for at least the specified duration.

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

See also

Section "Position monitoring functions" in the function manual "S7-1500/S7-1500T Axis functions" (https://support.industry.siemens.com/cs/ww/en/view/109766462)

6.1.5.7 Configuration - Control loop (S7-1500, S7-1500T)

In the "Control loop" configuration window, configure the precontrol and the gain Kv of the position control loop.

The Kv factor affects the following parameters:

- Positioning accuracy and stop control
- Uniformity of motion
- Positioning time

The better the mechanical conditions of the axis are (high stiffness), the higher the Kv factor can be configured. This reduces the following error, and a higher dynamic response is achieved.

Drive optimized

When the drive is optimized, the status bit lights up green. Otherwise, the status bit is gray.

Optimizing values on the drive

Use the green arrow to navigate to "Automatic controller optimization" in the optimization mask of the drive. The optimization mask of the drive is opened in online or offline mode, depending on the mode you are in. You can perform the optimization on the drive and optionally go online with the drive. You get back to the previous mask using the "Window Switcher".

Applying values from the drive

When you click the "Apply values from drive" button, a dialog box opens with the columns "Current value", "New value" and "Value on drive". Depending on the status of the drive, the online or offline values for "Speed control loop substitute time" and "Gain (Kv factor)" are displayed there.

The "New value" column can be edited. 50% of the value calculated on the drive is determined as a new value for the default setting for the gain. The new value of the gain should correspond to a maximum of 30-50% of the value on the drive. You apply the set values by clicking on "Yes".

Precontrol

Configure the percentage velocity precontrol in this field.

Speed control loop substitute time

Configure the speed control loop substitute time in this field (T_{vtc}).

When speed precontrol is activated, the setpoint is delayed by the speed control loop substitute time before the control deviation is established. This prevents an overshoot or a leading of the actual value compared with the position setpoint. The speed control loop substitute time is a simplified substitute model of the dynamic behavior of the speed control loop. The speed control loop substitute time is included in the balancing filter.

Gain (Kv factor)

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

Dynamic Servo Control (DSC)

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

- **Position control in the drive (DSC enabled)**
  With the Dynamic Servo Control (DSC) function, the position controller is executed in the drive in the cycle clock of the speed control loop. The setting of a significantly greater position controller gain factor Kv is thus enabled. This increases the dynamics for setpoint sequence and disturbance variable correction for highly dynamic drives.
- **Position control in the PLC**

Note

Dynamic Servo Control (DSC) is only possible with one of the following PROFIdrive telegrams:

- Standard telegram 5 or 6
- SIEMENS telegram 105 or 106

See also

Section "Closed loop control" in the function manual "S7-1500/S7-1500T Axis functions" (https://support.industry.siemens.com/cs/ww/en/view/109766462)

6.1.5.8 Configuration - Actual value extrapolation (S7-1500T)

Configure the properties of the extrapolation for an actual value coupling for synchronous operation in the "Actual value extrapolation" configuration window. The values set here only apply when the actual values of this axis are used as leading value.

Position filter T1 and T2

Enter the time constants of the PT2 filter for smoothing the position.

Velocity filter T1 and T2 and tolerance band width

Enter the time constants of the PT2 filter for the smoothing of the actual velocity and the tolerance band width of the smoothed actual velocity.

For optimized application of the tolerance band, enter the same bandwidth for the tolerance band as the width of the noise signal.

Hysteresis value

Enter a value for application of the hysteresis function to the extrapolated actual value of the position. The specification is made in the configured length unit.

Leading axis dependent extrapolation time (read-only)

The leading axis-dependent time is calculated from the sum of the actual value acquisition time at the leading axis, (T_i), the time of the interpolator (T_{Ipo}) and the sum of position filters T1 and T2:

Leading axis dependent extrapolation time = $T_i + T_{Ipo} + T1 + T2$

Following axis dependent extrapolation time

Specify the following axis-related proportion for the extrapolation of the leading value. The value (unchanged or offset against user-specific runtimes) from the tag "<TO>.StatusPositioning.SetpointExecutionTime" of the following axis is used as the basis.

Time from cross-PLC synchronous operation (read-only)

The time from the cross-PLC synchronous operation corresponds to the value of the deceleration time set at the axis or encoder in "Configuration > Leading value settings".

Apply leading value velocity from differentiation

When you select this check box, the leading value velocity is taken from the differentiation of the extrapolated leading value position.

When you clear this check box, the filtered actual velocity is applied.

Include leading axis condition time

When you select this check box, the leading axis dependent extrapolation time is included in the calculation of the effective extrapolation time.

When you clear this check box, the leading axis dependent extrapolation time is not included in the calculation of the effective extrapolation time.

Effective extrapolation time (read-only)

The effective extrapolation time is the sum of the leading axis-dependent time, the following axis-dependent time and the delay time of cross-PLC synchronous operation.

See also

Extrapolation of the leading values for actual value coupling (Page 22)

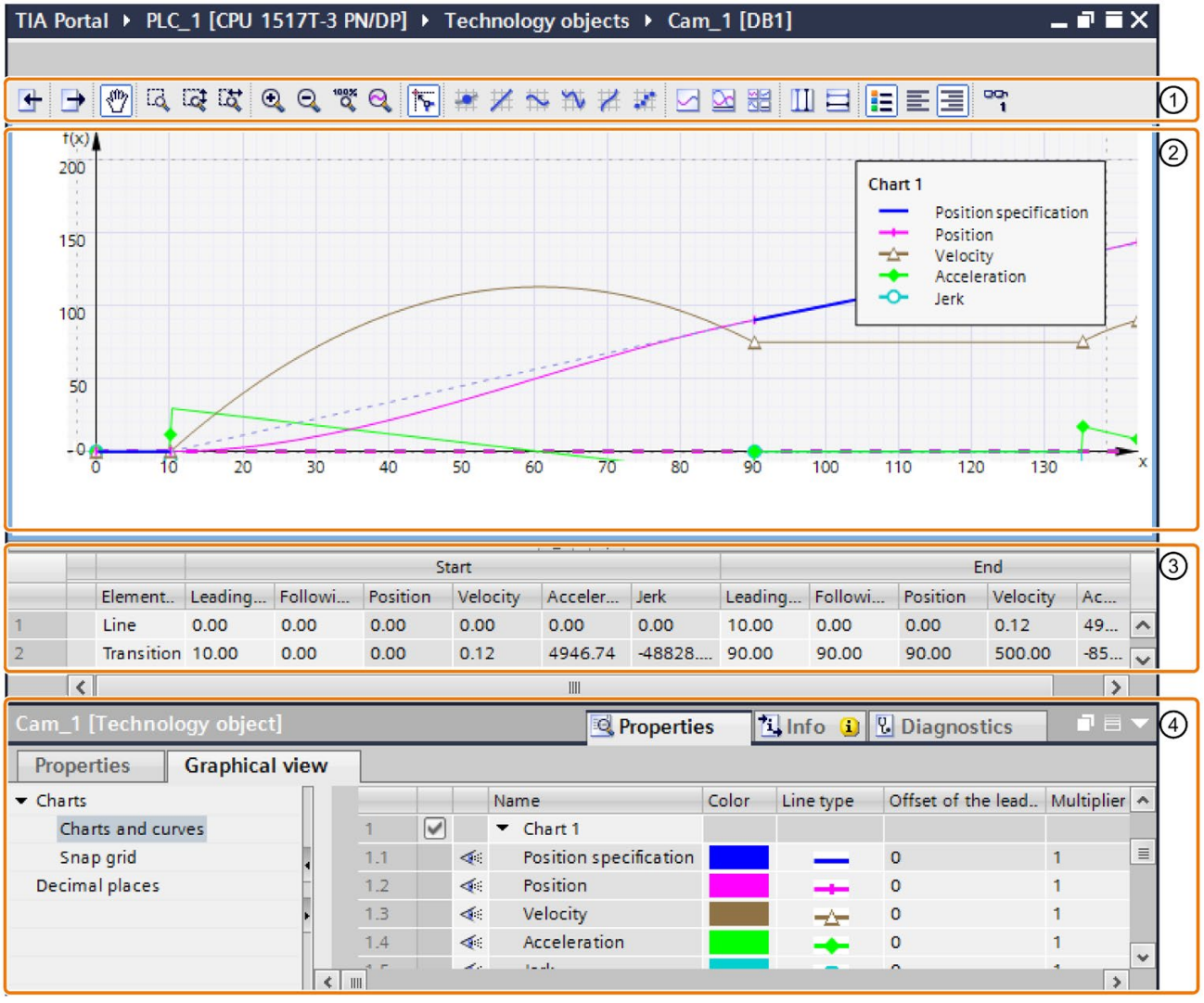
6.2 Configuring the cam technology object (S7-1500T)

6.2.1 Structure of the cam editor (S7-1500T)

You configure the cam technology object (Page 19) with an editor.

You create the cam using a diagram, a table containing the elements of the curve and the properties of the elements. Transitions are calculated between the individual elements of the cam (e.g. points, lines, polynomials). The curve reflects the path-related dependency between the leading axis (leading values, abscissa in the chart) and following axis (following values, ordinate in the chart).

The following figure shows the structure of the editor.



① Toolbar

② Graphical editor

The leading value range (definition range) is displayed on the abscissa (x axis).

The following value range (value range) is displayed on the ordinate (y axis).

③ Tabular editor

④ Properties (Inspector window)

Toolbar

You use the toolbar to operate the graphical editor and to import/export cams.

Graphical editor

In the graphical editor, you edit the elements of the curve graphically. The elements can be added, edited and deleted. Up to four charts can be created one above the other with synchronized abscissa. The setpoint curve as well as the curves for the effective position, velocity, acceleration and jerk can be displayed in the charts.

The definition of the cam starts with the first defined interpolation point or the first segment and does not corresponds to the definition range in the cam editor.

Tabular editor

All elements of the curve are listed in the tabular editor. Existing elements can be edited. New elements can be added.

Properties (Inspector window)

In the Inspector window, you configure the properties of the trend and of the selected element in the "Properties" tab, and the graphical view in the "Display" tab:

- Profile (e.g. leading and following value range, optimization and interpolation of the profile, number of elements used)
- Element (e.g. derivatives, polynomial coefficients, optimization of the element)
- Graphical view (e.g. line type, line color, scaling of the view)

Elements of the curve

The following table shows the elements that can be used to define the curve:

Element	Description
Point	A point assigns a following value to a leading value. The curve runs through the point with these coordinates. The velocity, acceleration and jerk can be defined in this point using the first, second and third derivative.
Point group	A point group combines two or more points into an commonly interpolated element and allows precise interpolation between these points.
Line	A line describes a motion with constant velocity from the start point of the line to the end point. The incline of the line specifies the constant velocity.
Sine	A sine element describes a motion according to the sine function. The sine function can be adjusted with the phase angle in the start point and end point, the period length, the amplitude as well as the oscillation zero point (offset).
Polynomial	A polynomial describes a motion according to a polynomial function of the 7th degree maximum. Polynomials can be defined by entering the boundary conditions or the polynomial coefficients. Optionally, you can configure a trigonometric polynomial component.
Inverse sine (approximated)	An inverse sine describes a motion according to the arcsine function. An inverse sine is approximated using interpolation points of the arcsine function.
Transition	Transitions interpolate the range between two elements. The ranges are automatically interpolated by the controller or using a configurable optimization according to VDI Guideline 2143. Transitions are added automatically.

Additional information

You can find more information about working with the cam editor in FAQ entry 109749820 (https://support.industry.siemens.com/cs/ww/en/view/109749820) in the Siemens Industry Online Support.

6.2.2 Operating the cam editor (S7-1500T)

The procedure described here shows the basic operation of the cam editor. This procedure serves as a recommendation.

The basic operation can include the follow tasks:

- Adapting defaults
- Creating and adapting the curve
- Interpolation/optimization of the transitions

Adapting defaults

To adjust the leading and following value range of the cam profile as well as the graphical view, follow these steps:

1. In the properties (Inspector window), open the "Profile > General (Page 125)" configuration window.
2. Configure the leading value range and the following value range of the curve definition.

   The graphical view is automatically adapted to the inputs.
3. In the area navigation of the Inspector window, open the "Display (Page 146)" tab.
4. Configure the configuration windows:
   - The display of the charts and curves
   - The grid spacing for aligning inputs in the graphical editor
   - The decimal places displayed in the cam editor.

Creating and adapting the curve

To create and adapt the curve, follow these steps:

1. Use the graphical editor and/or the tabular editor to add the elements of the cam:
   - Select the tool required for inserting the respective element in the toolbar. Place the element at the required position in the graphical editor.
   - Use <Add> to insert the corresponding elements in the "Element type" column of the tabular editor. Adjust the position of the elements using the start and end values.

   Transitions between the elements are added automatically.
2. To edit an element, select it in the graphical or tabular editor.

   The element is highlighted in the graphical and in the tabular editor. The "Element > Parameter/Characteristic" configuration window is displayed in the properties (Inspector window).
3. The elements can be adjusted as follows:
   - Move the element or the drag handles of the element in the graphical editor.
   - Adjust the start and end values in the tabular editor.
   - Configure additional element-specific parameters in the properties (Inspector window) in the "Element > Parameter (Page 132)" configuration window.
   - Set the interpolation of the transitions with the properties (Inspector window).

The number of elements used is displayed in the properties (Inspector window) in the "Profile > Statistics (Page 130)" properties window.

Setting the interpolation of the transitions (system interpolation)

The interpolation (Page 48) can be set separately for each transition. The default for interpolation of the transitions is the system interpolation. You configure the system interpolation for all transitions in the properties (Inspector window) in the "Profile > System interpolation (Page 127)" configuration window.

Setting the optimization of the transitions (according to VDI Guideline 2143)

Each transition can also be adapted separately according to the VDI Guideline 2143. The settings in the properties (Inspector window) in the "Profile > Default optimization settings (Page 126)" configuration window are hereby taken into consideration.

To adapt the optimization of a transition according to the VDI Guideline 2143, follow these steps:

1. Select the transition in the graphical or tabular editor.
2. In the properties (Inspector window), open the "Element > Characteristic (Page 142)" configuration window.
3. Select the optimization method "VDI-based optimization" in the "Optimization method" drop-down list.
4. If necessary, change the default settings.

   The selection of the parameters is automatically limited to the settings that can be applied according to VDI Guideline 2143.

The optimization of the transitions according to VDI guidelines consumes additional points and/or segments (Page 130) in the cam.

See also

Configuration charts - Charts and curves (Page 146)

6.2.3 Graphical editor (S7-1500T)

6.2.3.1 Structure of the graphical editor (S7-1500T)

The graphical editor is divided into the following areas:

- Toolbar
- Curve diagram

Toolbar

The toolbar at the top of the graphical editor provides you with buttons for the following functions:

Button	Function	Description
	Importing cam from file	See section Importing/exporting cam (Page 148)
	Exporting cam to file	See section Importing/exporting cam (Page 148)
	Edit elements/Move view	• Selecting and moving of individual elements and element • Moving the view using drag-and-drop To switch from any tool to the "Edit elements/Move view" tool, press the <Esc> key.
	Activate zoom selection	Zoom into selected area
	Activate vertical zoom	Vertical zoom into selected area without horizontal scaling Alternative: <Ctrl> +drag to ordinate keeping mouse button pressed
	Activate horizontal zoom	Horizontal zoom into selected area without vertical scaling Alternative: <Ctrl> +drag to abscissa keeping mouse button pressed
	Zoom in	Enlargement of the display Alternative: <Ctrl> + mouse wheel up in curve diagram
	Zoom out	Reduction of the display Alternative: <Ctrl> + mouse wheel down in curve diagram
	Show all	Display of entire definition and value range
	Zoom into curve	Zoom to the following value range of the curve that you selected in the legend of the chart
	Activate snap grid	Inputs and element end points are aligned to the configurable snap grid and to other element end points.
	Inserting a point	Adding a point to the chart
	Inserting a line	Adding a line to the chart
	Inserting a sine	Adding a sine element to the chart

Button	Function	Description
	Inserting a polynomial	Adding a polynomial to the chart
	Inserting an inverse sine	Adding an inverse sine to the chart
	Insert point group	Add a point group to the chart
	View: A chart with positions	Display of one chart with the following curves of the cam opened in the editor: • Preset curve • Effective position
	View: A chart with all curves	Display of one chart with the following curves of the cam opened in the editor: • Preset curve • Effective position • Effective velocity • Effective acceleration • Effective jerk
	View: Four charts with all curves	Display of four charts with the following curves of the cam opened in the editor: • Chart with setpoint curve and effective position • Chart with effective velocity • Chart with effective acceleration • Chart with effective jerk
	Vertical measuring lines	Displaying and moving of vertical measuring lines Hold down the left mouse button and drag to draw a measuring range. The vertical position of the measuring lines can be moved. The function values for the measuring line positions are displayed in the chart. The difference of the measuring lines is displayed between the measuring lines.
	Horizontal measuring lines	Displaying and moving of horizontal measuring lines Hold down the left mouse button and drag to draw a measuring range. The horizontal position of the measuring lines can be moved. The function values for the measuring line positions are displayed in the chart. The difference of the measuring lines is displayed between the measuring lines.
	Show legend	Showing or hiding of the legend in the curve diagram. To display values for a specific curve on the ordinate, click on the name of the corresponding curve in the legend.
	Show legend left	Display of the legend on the left side of the curve diagram.
	Show legend right	Display of the legend on the right side of the curve diagram.
	Read out and display online curve one time	Display of the position values of the cam read back from the CPU (orange) The cam editor reads out the cam that was already loaded into the CPU. The read out "Online curve" is displayed in the graphical editor.

Curve diagram

In the curve diagram, you enter the elements of the curve and adjust the curve by selecting and moving elements.

Chart areas outside of the leading value/following value range configured in "Profile > General (Page 125)" are grayed out. Elements outside the leading value/following value range are displayed with a warning ("Element is outside the definition range").

You can display various curves (position, velocity, acceleration and jerk) one above the other in up to four charts by configuring the graphical view accordingly. When multiple charts are displayed, you can adapt the graphs to match the separator lines.

The view can be zoomed in the manual mode by pressing <Ctrl > + Mouse wheel and <Ctrl > + while pressing the mouse button on the abscissa/ordinate.

The editor shows messages for checking the entered curve via warning triangles . The tooltip of the waring triangle shows the message text. Configure the checking of the curve in the "Check (Page 129)" configuration window.

Display of the online curve

When you click the button, the cam editor reads the data from the technology object data block and displays the curve in the graphical editor:

Cam status	Interpolation status	Description
Data not modified (CamDataChanged = 0)	Not interpolated (Interpolated = 0)	Only the points and segments of the cam are displayed.
	Interpolated (Interpolated = 1)	The interpolated cam is displayed.
Data modified (CamDataChanged = 1)	Not interpolated (Interpolated = 0)	Only the points and segments of the cam are displayed.
	Interpolated (Interpolated = 1)	The interpolated cam as well as changed points and segments are displayed.

6.2.3.2 Inserting a point (S7-1500T)

A point assigns a following value to a leading value. The curve runs through the point with these coordinates.

By means of the first, second and third derivatives, the velocity, acceleration and jerk can be defined in this point. The derivations are only taken into consideration during VDI-based optimization of transitions of the point to other elements.

Inserting a point

To add a point to the curve, follow these steps:

1. Select the "Insert point" tool in the toolbar.
2. Click on the position in chart 1 where you want to insert the point.

   The point is inserted. The coordinates are displayed for the point. The tabular editor and the view of the properties (Inspector window) are updated. A transition to any element is inserted automatically.

Moving a point

To move a point in the graphical editor, follow these steps:

1. Select the "Edit elements/Move view" tool in the toolbar.
2. Select the point in chart 1.
3. Use drag-and-drop to move the point to the desired position.

Adapting parameters

The parameters of the point can be adjusted in the tabular editor as well as in the properties (Inspector window) under "Element > Parameter (Page 133)".

6.2.3.3 Insert point group (S7-1500T)

A point group combines two or more points into an commonly interpolated element and allows precise interpolation between the points.

Insert point group

To add a point group to the trend, proceed as follows:

1. Select the "Insert point group" tool in the toolbar.
2. In Chart 1, click on the position at which you want to insert the point group.

   The point group is inserted. The coordinates of the start point and the end point are displayed at the point group. The tabular editor and the view of the properties (Inspector window) are updated. If a different element already exists, a transition to the existing element is automatically inserted.

Adapt point group

To adapt a point group in the graphical editor, proceed as follows:

1. Select the "Edit elements/Move view" tool in the toolbar.
2. Select the point group in Chart 1.

   The point group is highlighted graphically with drag handles. The following drag handles are displayed:

   – Start value of the point group
   – End value of the point group
3. Drag-and-drop the drag handles or the whole point group to the desired position.

   If further interpolation points are configured between the start point and the end point in the point group, the cam editor handles the interpolation points as follows:

   – Definition type of the leading value "Relative to the segment"

     The interpolation points are shifted relative to the start and end points.
   – Definition type of the leading value "Absolute in the profile"

     The interpolation points are not moved.

Adapting parameters

The parameters of the point group can be adapted in the graphical editor, in the tabular editor as well as in the properties (Inspector window) under "Element > Parameter (Page 133)".

6.2.3.4 Inserting a line (S7-1500T)

A line describes a motion with constant velocity from the start point of the line to the end point. The incline of the line specifies the constant velocity.

Inserting a line

To add a line to the curve, follow these steps:

1. Select the "Insert line" tool in the toolbar.
2. Use drag-and-drop in chart 1 to draw the line from the start position to the end position.

   The line is inserted. The coordinates of the start point and end point are displayed for the line. The tabular editor and the view of the properties (Inspector window) are updated. A transition to any element is inserted automatically.

Moving a line

To move a line in the graphical editor, follow these steps:

1. Select the "Edit elements/Move view" tool in the toolbar.
2. Select the line in chart 1.

   The line is graphically highlighted with drag handles. The following drag handles are displayed:

   – Start point of the line

   – End point of the line
3. Use drag-and-drop to move the drag handles or the entire line to the desired position.

Adapting parameters

The parameters of the line can be adjusted in the graphical editor, in the tabular editor as well as in the properties (Inspector window) under "Element > Parameter (Page 136)".

6.2.3.5 Inserting a sine (S7-1500T)

A sine element describes a motion according to the sine function. The sine function can be adjusted with the phase angle in the start point and end point, the period length, the amplitude as well as the oscillation zero point (offset).

Inserting a sine

To add a sine to the curve, follow these steps:

1. Select the "Insert sine" tool in the toolbar.
2. Click on the position in chart 1 where you want to insert the sine. The mouse pointer points to the start position of the sine here.

   The sine is inserted. The coordinates of the start point and end point are displayed for the sine. The tabular editor and the view of the properties (Inspector window) are updated. A transition to any element is inserted automatically.

Adjusting a sine

To adjust a sine in the graphical editor, follow these steps:

1. Select the "Edit elements/Move view" tool in the toolbar.
2. Select the sine in chart 1.

   The sine is graphically highlighted with drag handles and guide lines for the zero line and the amplitude. The following drag handles are displayed:

   – Leading value/shifting at left/right boundary

     These drag handles can also be used to adjust the inclination of an inclined sine.

   – Leading value at left/right boundary

   – Phase at left/right boundary

   – Amplitude
3. Use drag-and-drop to move the drag handles or the entire sine to the desired position.

Adapting parameters

The parameters of the sine can be adjusted in the graphical editor, in the tabular editor as well as in the properties (Inspector window) under "Element > Parameter (Page 137)".

6.2.3.6 Inserting a polynomial (S7-1500T)

A polynomial describes a motion according to a polynomial function of the 7th degree maximum. Polynomials can be defined by entering the boundary conditions or the polynomial coefficients. Optionally, you can configure a trigonometric polynomial component.

Inserting a polynomial

To add a polynomial to the curve, follow these steps:

1. Select the "Insert polynomial" tool in the toolbar.
2. Click on the position in chart 1 where you want to insert the polynomial. In so doing, the mouse pointer points to the start position of the polynomial.

   The polynomial is inserted. The coordinates of the start point and end point are displayed for the polynomial. The tabular editor and the view of the properties (Inspector window) are updated. If a different element already exists, a transition to the existing element is automatically inserted.

Adjusting a polynomial

To adjust a polynomial in the graphical editor, follow these steps:

1. Select the "Edit elements/Move view" tool in the toolbar.
2. Select the polynomial in chart 1.

   The polynomial is graphically highlighted with drag handles. The following drag handles are displayed:

   – Leading value/following value at left/right boundary
   – Position of point of inflection (lambda: relative to the element or absolute in the profile)
3. Use drag-and-drop to move the drag handles or the entire sine to the desired position.

Adapting parameters

The parameters of the polynomial can be adapted in the graphical editor, in the tabular editor as well as in the properties (Inspector window) under "Element > Parameter (Page 139)".

6.2.3.7 Inserting an inverse sine (S7-1500T)

An inverse sine describes a motion according to the arcsine function. The arcsine function is the inverse function of the sine function. An inverse sine is approximated using interpolation points of the arcsine function.

Inserting an inverse sine

To add an inverse sine to the curve, follow these steps:

1. Select the "Insert inverse sine" tool in the toolbar.
2. Click on the position in chart 1 where you want to insert the inverse sine. In so doing, the mouse pointer points to the start position of the inverse sine.

   The sine is inserted. The coordinates are displayed for the point. The tabular editor and the view of the properties (Inspector window) are updated. A transition to any element is inserted automatically.

Adjusting an inverse sine

To adjust an inverse sine in the graphical editor, follow these steps:

1. Select the "Edit elements/Move view" tool in the toolbar.
2. Select the inverse sine in chart 1.

   The inverse sine is graphically highlighted with drag handles. The following drag handles are displayed:

   – Start point of the inverse sine

   – End point of the inverse sine
3. Use drag-and-drop to move the drag handles or the entire inverse sine to the desired position.

Adapting parameters

The parameters of the inverse sine can be adjusted in the graphical editor, in the tabular editor as well as in the properties (Inspector window) under "Element > Parameter (Page 141)".

6.2.3.8 Deleting an element (S7-1500T)

To delete an element in the graphical editor, follow these steps:

1. Select the element.
2. Press the <Del> key.

   The element is deleted. The graphical editor and the view of the properties (Inspector window) are updated. A transition to any element present is also deleted.

6.2.3.9 Shortcut menu in the graphical editor (S7-1500T)

The following table shows the functions in the shortcut menu of the graphical editor:

Function	Description
Show all	Display of entire definition and value range
Zoom into curve	Displays the curve selected in the legend of the chart
Zoom in	Enlargement of the display
Zoom out	Reduction of the display
Open charts and curves	Call of the "Charts and curves (Page 146)" dialog
Cut	Removing the selected elements and copying them to the clipboard
Copy	Copying of the selected elements to the clipboard
Paste	Pasting of the elements from the clipboard to the last element
Delete	Deletion of the selected elements Transitions to existing elements are also deleted.
Paste special	Call of the "Paste elements (Page 151)" dialog
Group points	Combine the selected points into a group of points The entry is displayed under the following conditions: • Only points are selected in the graphic/tabular editor. • There are no other elements between the selected points.
Dissolve point group	Ungroups the selected point group into individual points
Show/hide measuring point labels	Showing or hiding the measuring points The entry is displayed under the following conditions: • Measuring lines are displayed. • Measuring points are hidden/shown.
Move	Call of the "Move elements (Page 151)" dialog
Scale	Call of the "Scale elements (Page 151)" dialog

See also

Dialogs in the shortcut menu (Page 151)

Configuration charts - Charts and curves (Page 146)

6.2.4 Tabular editor (S7-1500T)

6.2.4.1 Structure of the tabular editor (S7-1500T)

The tabular editor shows all elements of the curve, sorted by their leading values. The elements can be adjusted. New elements can be added.

The following properties are displayed in the corresponding column for each element of the curve:

Column/Property	Description
First column	Sequential number of the element
Second column	Display of calculation problems that might occur with warning triangle  The alarm text is displayed in the tooltip of the warning triangle.
Element type	• Display/change of element type • Adding elements Possible element types: • Point • Point group • Line • Sine • Polynomial • Inverse sine • Transition
Start	Parameter values at start point of the element
Leading value	Leading values at start point of the element
Following value	Following values at start point of the element
Position[1)]	Calculated effective position at start point of the element
Velocity[1)]	Calculated effective velocity at start point of the element
Acceleration[1)]	Calculated effective acceleration at start point of the element
Jerk[1)]	Calculated effective jerk at start point of the element
End	Parameter values at end point of the element
Leading value	Leading values at end point of the element
Following value	Following values at end point of the element
Position[1)]	Calculated effective position at end point of the element
Velocity[1)]	Calculated effective velocity at end point of the element
Acceleration[1)]	Calculated effective acceleration at end point of the element
Jerk[1)]	Calculated effective jerk at end point of the element
Comment	Optional comment for element.

[1)] Displayed according to the configuration in "Properties (Inspector window) > Graphical view > Charts and curves".

6.2.4.2 Editing the curve (S7-1500T)

The tabular editor provides you with the following options for editing the curve:

- Pasting elements
- Deleting elements
- Changing the element type
- Adjusting the leading value and following value of the boundary points

Inserting an element

To add an element in the tabular editor, follow these steps:

1. Select the desired element type from the "Add" drop-down list in the "Element type" column. "Add" is always displayed in the line after the last added element.

   The element is inserted after the last element with suitable values. The tabular editor and the view of the properties (Inspector window) are updated. A transition to any element is inserted automatically.

   The parameters of the element can be adjusted in the graphical editor, tabular editor, and properties (Inspector window).

Deleting an element

To delete an element in the tabular editor, follow these steps:

1. Select the line of the element.
2. Press the <Del> key.

   The element is deleted. The tabular editor and the view of the properties (Inspector window) are updated. A transition to any element present is also deleted.

Converting the element type

To convert the element type of an element in the tabular editor, follow these steps:

1. Select the line of the element.
2. Select the desired element type from the drop-down list in the "Element type" column.

   The element type of the element is converted to the selected element type. The tabular editor and the view of the properties (Inspector window) are updated. A transition to any element present is adjusted automatically.

Adjusting the leading value and following value of the boundary points

To change the leading value/following value of the boundary points of an element in the tabular editor, follow these steps:

1. Select the input field of the parameter to be changed.
2. Enter the desired value.

   The tabular editor and the view of the properties (Inspector window) are updated. A transition to any element present is adjusted automatically.

6.2.4.3 Shortcut menu in the tabular editor (S7-1500T)

The following table shows the functions in the shortcut menu of the tabular editor:

Function	Description
Insert row above	Insert a table row/an element before the selected line/selected element If no transition exists before the element, the selected element and the adjoining elements are changed.
Insert row below	Insert a table row/an element after the selected line/selected element If no transition exists before the element, the selected element and the adjoining elements are changed.
Cut	Removing the selected elements and copying them to the clipboard
Copy	Copying of the selected elements to the clipboard
Paste	Pasting of the elements from the clipboard to the last element
Delete	Deletion of the selected elements Transitions to existing elements are also deleted.
Paste special	Call of the "Paste elements (Page 151)" dialog
Group points	Combine the selected points into a group of points The entry is displayed under the following conditions: • Only points are selected in the graphic/tabular editor. • There are no other elements between the selected points.
Dissolve point group	Ungroups the selected point group into individual points
Move	Call of the "Move elements (Page 151)" dialog
Scale	Call of the "Scale elements (Page 151)" dialog

6.2.5 Properties (Inspector window) (S7-1500T)

6.2.5.1 Context-sensitive display (S7-1500T)

The parameters for the profile of the cam as well as for the elements are displayed in the properties (Inspector window). The corresponding parameters are displayed according to the selected element: If no element of the curve is selected, only the settings for the profile of the cam are displayed. If an element of the curve is selected, the parameters of the element are additionally displayed.

6.2.5.2 Configuration of profile - General (S7-1500T)

Configure the display range of the graphical editor in the "General" configuration window.

The inputs of the leading value range and following value range only effect the display in the graphical editor. The cam is interpolated in the definition range between the following values:

- First defined interpolation point/start of the first segment of the cam (<TO>.StatusCam.StartLeadingValue)
- Last defined interpolation point/end of the last segment of the cam (<TO>.StatusCam.EndLeadingValue)

Display range of the leading value

In this area, you configure the display range of the leading value in the graphical editor:

Parameters	Description
Start	In this field you configure the start point of the display range of the leading value.
End	In this field you configure the endpoint of the display range of the leading value.

Display range of the following value

In this area, you can configure the limitation of the following value range in the graphical editor:

Parameters	Description
Minimum	In this field you configure the lowest permissible value for the following value display range.
Maximum	In this field you configure the greatest permissible value for the following value display range.

6.2.5.3 Configuration of profile - Default optimization settings (S7-1500T)

You configure the default values for optimization of transitions according to VDI Guideline 2143 in the "Default optimization settings" configuration window. The default values are used when you use the "VDI-based optimization" optimization method for a transition (Page 142) and when you select the setting "Default optimization setting" for the continuity or the optimization target.

The cam is interpolated with the Motion Control instruction MC_InterpolateCam (Page 230) according to the settings for the VDI optimization.

Defaults for the VDI optimization

Configure the default settings for continuity requirement and optimization target in this area:

Parameters	Description
Continuity	In the drop-down list, select which parameter is continuous in the boundary points and is to be taken into consideration for optimization. • Position • Velocity • Acceleration • Jerk
Optimization target	In the drop-down list, select the optimization target according the VDI guideline: • Not specified • Velocity (Cv) • Acceleration (Ca) • Jerk (Cj) • Minimum Dynamic Moment (Cmdyn)

6.2.5.4 Configuration of profile - System interpolation (S7-1500T)

In the "System interpolation" configuration window, configure the interpolation of transitions according to the system specifications. These settings are used when you use the "System interpolation" optimization method for a transition (Page 142) (default setting).

The cam is interpolated with the Motion Control instruction "MC_InterpolateCam (Page 230)".

System interpolation settings

Configure the interpolation type and the behavior of the boundary points in this area.

Parameters	Description
Interpolation type	In the drop-down list, select the interpolation type by which the transitions in the curve are interpolated: • Linear interpolation • Interpolation with cubic splines • Interpolation with Bézier splines
Behavior at boundary	In the drop-down list, select which behavior of the boundary points applies to the interpolation: • No restrictions • First derivative continuous (velocity continuous) The cam is interpolated in such a way that the first derivative (velocity) is equal at the start and end of the cam.

6.2.5.5 Configuration of profile - Effective runtime curves (S7-1500T)

Configure the values for the leading axis and following axis that are applied to the effective curve in the "Effective runtime curves" configuration window. The runtime emulation calculates the effective curve with these applied values and displays the curve in the graphical editor with the applied limits.

The inputs are not downloaded into the CPU. This means the cam is interpolated without these inputs. You can use these applied values to test and visualize how the cam behaves during operation, e.g. when entering a scaling at "MC_CamIn".

Settings of the leading axis

Configure the calculation and display of the curve on the leading value end in this area:

Parameters	Description
Copy from axis	Using the button and the "Copy leading value settings of axis" dialog, select an axis whose maximum velocity is applied as the velocity for the leading axis.
Scaling factor	Configure a leading value-side scaling factor in this field. This allows the acceptance that a scaling is specified for an "MC_CamIn" job.
Unit of measure	In the selection list, select the unit of measurement for the leading value.
Unit of measure of the first derivative	In the selection list, select the unit of measurement for the first derivative of the leading value.
Velocity	Configure the velocity of the leading axis applied for the runtime emulation of the curve in this field.

Settings of the following axis

Configure the calculation and display of the curve on the following value side in this area:

Parameters	Description
Copy from axis	Using the button and the "Copy following value settings of axis" dialog, select an axis whose maximum dynamic values are applied as the limits to be checked during calculation and display of the curve.
Scaling factor	Configure a following value-side scaling factor in this field. This allows the acceptance that a scaling is specified for an "MC_CamIn" job.
Unit of measure	In the selection list, select the unit of measurement for the following value.
Unit of measure of the first derivative	In the selection list, select the unit of measurement for the first derivative of the following value.
Maximum velocity	Configure the maximum velocity for the following axis in this field.
Maximum acceleration	Configure the maximum acceleration for the following axis in this field.
Maximum jerk	Configure the maximum jerk for the following axis in this field.

6.2.5.6 Configuration - Check (S7-1500T)

In the "Verification" configuration window, you configure which criteria the cam editor checks when entering the curve. When you activate a check, the graphical and the tabular editor display corresponding messages via a warning triangle on the element. Use the tooltip at the warning triangle to display the message text.

Examination of limit violations

Configure the checks for compliance with the configured limits in this area:

Check/Element	Description
Observe the curve definition of the leading and following value ranges	Select the "Check curve definition of the leading and following value ranges" check box to have the cam editor check the curve accordingly.
Check adherence to the maximum values of the derivatives of the effective runtime curve	Select the "Check adherence to the maximum values of the derivatives of the effective runtime curve" check box to have the cam editor check the curve accordingly.

Verification of VDI suitability

Select the "Check the suitability of transitions in accordance with VDI" check box to have the cam editor check the VDI suitability of the curve.

The cam editor checks the following with this:

- Support of the transition classification of the currently selected VDI transition
- Boundary value adjustment according to VDI

Verification of continuity

In the "Required continuity" list, select which parameter the cam editor checks for continuity:

- Position
- Velocity
- Acceleration
- Jerk

If a function or a derivative is discontinuous, all higher derivatives are also discontinuous.

6.2.5.7 Profile - Statistics (S7-1500T)

The "Statistics" properties window shows an overview of the number of elements of the cam, as well as the minimum and maximum values of the effective curves for the slave value and the derivatives. A cam consists of a maximum of 1000 points and a maximum of 50 segments.

Used elements

This area shows the number of used elements of the curve:

Parameters	Description
Points	This field shows the number of used points of the cam. A cam consists of a maximum of 1000 points.
Segments	This field shows the number of used segments of the cam. A cam consists of a maximum of 50 segments.

The use of points and segments depends on the compilation and configuration of the elements. The following table shows the use of points and segments per element:

Element	Number of used points	Number of used segments
Point	1	0
Point at a transition with VDI-based optimization	0	0
Point group with point approximation mapping method	Number of interpolation points configured. ("Properties (Inspector window) > Element > Parameter > Approximation > Number of interpolation points") Default setting: 32	0
Point group with segment approximation mapping method	0	Number of interpolation points configured - 1
Line	0	1
Sine	0	1
Polynomial		
< of the 7th degree	0	1
of the 7th degree	0	2
Inverse sine	Number of interpolation points configured. ("Properties (Inspector window) > Element > Parameter > Approximation > Number of interpolation points") Default: 32	0
Inverse sine to the right of a transition with VDI-based optimization	Number of interpolation points configured - 1	0

Element	Number of used points	Number of used segments
Transition with system interpolation	0	0
Transition with VDI-based optimization		
Motion rule		
Sine	0	1
Sine with relative Lambda ≠ 0.5	0	2
Inclined sine	0	1
Inclined sine with relative Lambda ≠ 0.5	0	2
Polynomial	0	1
Sinus with relative Lambda ≠ 0.5	0	2
Modified acceleration trapezoid		
Motion task		
Dwell-in-reverse	0	5
Reverse-in-dwell	0	5
Dwell-in-dwell	0	6
Modified sine		
Motion task		
Dwell-in-dwell	0	3
Constant velocity-in-constant velocity	0	4
Constant-velocity-in-dwell	0	4
Dwell-in-constant velocity	0	4
Sine line combination	0	3
Harmonic combination	0	3
Double-harmonic transition	Number of interpolation points configured. ("Properties (Inspector window) > Element > Parameter > Approximation > Number of interpolation points") Default setting: 32	0
Quadratic parabola	0	2

Lambda = turning point of the curve

Value ranges

This area shows the minimum and maximum values of the effective curves for the following value and the derivatives.

Boundary conditions

The following boundary conditions apply to the input and use of points and segments:

- **Points**

  With points with the same leading values, the point that you have entered last or which is listed in the tabular editor is active.

- **Segments**
  - Gaps between segments are filled with a transition segment.
  - For gaps in the leading value range of less than 1.0E-4, segment end points and segment start points are pulled together.
  - For gaps in the leading value range greater than 1.0E-4, a new transition segment is inserted.
  - For overlaps, the new segment is inserted from the start point and used completely. When the previous segment is defined in excess of the new segment, the previous segment continues to be used after the end point of the new segment.
- **Interpolation points and segments** (mixed cams)

  The segment is used when points are defined in the same range.

6.2.5.8 Configuration of elements - Parameters (S7-1500T)

In the "Parameters/Characteristic" configuration window, configure the parameters of the selected element of the curve. The inputs are applied in the tabular and graphical editors. The element-specific parameters are displayed according to the selected element:

- Point (Page 133)
- Point group (Page 133)
- Line (Page 136)
- Sine (Page 137)
- Polynomial (Page 139)
- Inverse sine (Page 141)
- Transition (characteristic) (Page 142)

6.2.5.9 Configuration of elements - Parameters (Point) (S7-1500T)

Configure the parameters of the selected element in the "Parameters" configuration window.

Parameters

Configure the parameters of the selected point in this area:

Parameter/Option		Description
Leading value of the point		
	Leading value	In this field, configure the leading value of the point (value in the definition area).
Following values of the point		
	Following value	Configure the following value of the point (value in the range of the function) in this field.
	Use first derivative	Select the check box to specify the first derivative in the selected point and to include it in the interpolation of the cam.
	First derivative	Configure the value of the first derivative in the selected point in this field.
	Use second derivative	Select the check box to specify the second derivative in the selected point and to include it in the interpolation of the cam.
	Second derivative	Configure the value of the second derivative in the selected point in this field.
	Use third derivative	Select the check box to specify the third derivative in the selected point and to include it in the interpolation of the cam.
	Third derivative	Configure the value of the third derivative in the selected point in this field.

The derivations are taken into consideration during VDI-based optimization of transitions of the points to other elements.

See also

Inserting a point (Page 115)

6.2.5.10 Configuration elements - Parameters (point group) (S7-1500T)

Configure the parameters of the selected element in the "Parameters" configuration window.

Parameters

In this area, configure the parameters of the selected point group:

Parameter/Option	Description
Leading values of the point group	
Start	In this field, configure the start point of the point group in the leading value range (definition area).
End	In this field, configure the end point of the point group in the leading value area (definition area).
Interpolation points	
Definition type of the leading values	In the drop-down list, select how the leading values of the interpolation points are specified: • Relative to the segment You specify the leading values of the interpolation points relative to the group of points from 0.0 to 1.0. The value 0.0 corresponds to the beginning of the point group. The value 1.0 corresponds to the end of the point group. • Absolute in the profile You specify the leading values of the interpolation points as absolute values.
Definition type of the following values	In the drop-down list, select how the following values of the interpolation points are specified: • Relative to the segment You specify the following values of the interpolation points relative to the following value range of the point group from 0.0 to 1.0. The value 0.0 corresponds to the configured minimum following value of the point group. The value 1.0 corresponds to the configured maximum following value of the point group. • Absolute in the profile You specify the following values of the interpolation points as absolute values.
Minimum following value	In this field, configure the minimum following value for the point group in the following value range.
Maximum following value	In this field, configure the maximum following value of the point group in the following value range (value range).
	Use the "Add interpolation point" button to add an interpolation point to the point group.
Interpolation points	This table shows the configured interpolation points sorted by increasing leading value. Add breakpoints using the  button. Delete interpolation points by marking a row and pressing <Delete>. If you delete all points except one, the element type is changed from "Point group" to "Point".
Leading value	In this field, configure the leading value of the interpolation point (value in the definition area).
Following value	In this field, configure the following value of the interpolation point (value in the value range).

Parameter/Option	Description
Interpolation	
Interpolation type	In the drop-down list, select the interpolation type to be used for interpolating the point group: • Interpolation with cubic splines • Interpolation with Bézier splines
Approximation	
Mapping method	Select the mapping method in the drop-down list. • Point approximation • Segment approximation
Number of interpolation points	Configure the number of breakpoints for the point approximation in this field.
Maximum following value tolerance	In this field, enter the maximum permissible deviation (absolute) of the approximation from the interpolation points. If the configured value is exceeded, a warning is displayed in the graphical editor at the point group.

See also

Insert point group (Page 116)

6.2.5.11 Configuration of elements - Parameters (line) (S7-1500T)

Configure the parameters of the selected element in the "Parameters" configuration window.

Parameters

Configure the parameters of the selected line in this area:

Parameters	Description
Leading values of the line	
Start	Configure the start point of the line in the leading value range (definition range) in this field.
End	Configure the end point of the line in the leading value range (definition range) in this field.
Following values of the line	
Definition by	In the selection list, select the parameters to be used to define the line: • Following values at start and end • Following value at the start and incline • Incline and following value at end The corresponding parameters are displayed based on the selection.
Start	Configure the start point of the line in the following value range (value range) in this field.
End	Configure the end point of the line in the following value range (value range) in this field.
Incline	Configure the incline of the line in this field.

See also

Inserting a line (Page 117)

6.2.5.12 Configuration of elements - Parameters (sine) (S7-1500T)

Configure the parameters of the selected element in the "Parameters" configuration window.

Parameters

Configure the parameters of the selected sine element in this area:

Parameters	Description
Leading values of the sine	
Start	Configure the start point of the sine element in the leading value range (definition range) in this field.
End	Configure the end point of the sine element in the leading value range (definition range) in this field.
Trigonometric parameters	
Amplitude	Configure the amplitude of the sine element in this field.
Definition by	In the drop-down list, select how the sine element is defined: • Phase at start and at end • Phase at start and period length • Phase at start and frequency • Period length and phase at end • Frequency and phase at end The corresponding parameters are displayed based on the selection.
Phase angle at start	Configure the phase angle at the start of the sine element in this field.
Phase angle at end	Configure the phase angle at the end of the sine element in this field.
Period length	Configure the period length of the sine element in this field.
Frequency	Configure the frequency of the sine element in this field.

Parameters	Description
Extended parameters	
Segment type	Select the variant of the sine element in the drop-down list. • Sine • Inclined sine The corresponding parameters are displayed based on the selection. If you have configured an inclined sine, additional orientation lines are displayed in the graphical editor for the amplitude and center position.
Offset	Configure the oscillation midpoint of the sine element in this field.
Definition of inclination as a function of:	In the drop-down list, select how the inclined sine element is defined: • Offset at start and end • Offset at start and inclination • Inclination and offset at end The corresponding parameters are displayed based on the selection.
Offset at start	Configure the center of oscillation at the start of the sine element in this field.
Offset at end	Configure the center of oscillation at the end of the sine element in this field.
Inclination	Configure the inclination of the sine element in this field.

See also

Inserting a sine (Page 118)

6.2.5.13 Configuration of elements - Parameters (polynomial) (S7-1500T)

Configure the parameters of the selected element in the "Parameters" configuration window.

Parameters

Configure the parameters of the selected polynomial in this area:

Parameters	Description
Leading values of the polynomial	
Start	Configure the start point of the polynomial in the leading value range (definition range) in this field.
End	Configure the end point of the polynomial in the leading value range (definition range) in this field.
Polynomial parameters	
Definition by	In the selection list, select how the polynomial is defined: • Coefficients • Boundary values The corresponding parameters are displayed based on the selection.
Coefficients	Configure the coefficients of the 6th degree polynomial function in these fields: $P(x) = a_6x^6 + a_5x^5 + a_4x^4 + a_3x^3 + a_2x^2 + a_1x + a_0$ The coefficients are shown in scientific notation, e.g. "9.6450617283e-11".
Following value - Left boundary value	Configure the following value at the start of the polynomial in this field.
Following value - Right boundary value	Configure the following value at the end of the polynomial in this field.
Use first derivative	Select the check box to specify the first derivative in the left/right boundary value of the polynomial and to include it in the interpolation of the cam.
First derivative - left boundary value	Configure the first derivative (velocity) for the following value at the start of the polynomial in this field.
First derivative - right boundary value	Configure the first derivative (velocity) for the following value at the end of the polynomial in this field.
Use second derivative	Select the check box to specify the second derivative in the left/right boundary value of the polynomial and to include it in the interpolation of the cam.
Second derivative - left boundary value	Configure the second derivative (acceleration) for the following value at the start of the polynomial in this field.
Second derivative - right boundary value	Configure the second derivative (acceleration) for the following value at the end of the polynomial in this field.
Use third derivative	Select the check box to specify the third derivative in the left/right boundary value of the polynomial and to include it in the interpolation of the cam.
Third derivative - left boundary value	Configure the third derivative (jerk) for the following value at the start of the polynomial in this field.
Third derivation - right boundary value	Configure the third derivative (jerk) for the following value at the end of the polynomial in this field.

Parameters	Description
Lambda	In the selection list, select how the turning point of the polynomial is specified in the "Lambda position" field: • No lambda Do not enter any value. The position of the point of inflection is calculated automatically. • Relative to the element You specify the leading value of the turning point relative to the polynomial from 0.0 to 1.0. The value 0.0 corresponds to the beginning of the polynomial. The value 1.0 corresponds to the end of the polynomial. • Absolute in the profile You specify the leading value of the point of inflection as an absolute value.
	In this field, configure the leading value of the point of inflection for the polynomial according to the selection in the selection list.
Extended parameters	
Segment type	In the selection list, select whether or not the polynomial is to have a trigonometric component. When "Polynomial with trigonometric portion" is selected, the corresponding trigonometric parameters are displayed, as they are with sine. When a sine element is converted to a polynomial, the sine element is configured as a polynomial with trigonometric portion. The shape of the element is retained. You have the option to define the trigonometric portion of the polynomial using the following formula: $Y(x) = a_6x^6 + a_5x^5 + a_4x^4 + a_3x^3 + a_2x^2 + a_1x + a_0 + b_0\sin((b_1x) + b_2)$ $a_{0...6}$: Coefficient of order 0…6 of the polynomial b_0: Amplitude of the trigonometric portion b_1: Period of the trigonometric portion b_2: Phase offset of the trigonometric portion
Amplitude	Configure the amplitude of the trigonometric component in this field.
Definition by	In the selection list, select how the trigonometric component is defined: • Phase at start and at end • Phase at start and period length • Phase at start and frequency • Period length and phase at end • Frequency and phase at end The corresponding parameters are displayed based on the selection.
Phase angle at start	Configure the phase angle at the start of the trigonometric component in this field.
Phase angle at end	Configure the phase angle at the end of the trigonometric component in this field.
Period length	Configure the period length of the trigonometric component in this field.
Frequency	Configure the frequency of the trigonometric component in this field.

See also

Inserting a polynomial (Page 119)

6.2.5.14 Configuration of elements - Parameters (inverse sine) (S7-1500T)

Configure the parameters of the selected element in the "Parameters" configuration window.

The inverse sine is defined within the definition range [-1, 1]. The inverse sine can be calculated for the entire definition range or a restricted definition range of the arcsine function.

An inverse sine is approximated using interpolation points of the arcsine function.

Parameters

Configure the parameters of the selected inverse sine in this area:

Parameters	Description
Leading values of the inverse sine	
Start	Configure the start point of the inverse sine in the leading value range (definition range) in this field.
End	Configure the end point of the inverse sine in the leading value range (definition range) in this field.
Following values of the inverse sine	
Minimum	Configure the minimum value of the inverse sine in the following value range (value range) in this field.
Maximum	Configure the maximum value of the inverse sine in the following value range (value range) in this field.
Definition range	
Not mirrored/mirrored	Select whether or not the inverse sine is to be mirrored about the abscissa.
Start	Configure the start point in the definition range of the arcsine function that is to be used in this field.
End	Configure the end point in the definition range of the arcsine function that is to be used in this field.
Approximation	
Number of interpolation points	Configure the number of interpolation points for the approximation in this field.
Maximum following value tolerance	In this field, specify the maximum permitted deviation (absolute) of the approximation from the arcsine function. If the configured value is exceeded, a warning is displayed in the graphical editor for the arcsine element.

See also

Inserting an inverse sine (Page 120)

6.2.5.15 Configuration of elements - Characteristic (transition) (S7-1500T)

Configure the parameters of the selected transition in the "Characteristics" configuration window.

Characteristics

Configure the settings for optimization of the transition in this area:

Parameters	Description
Interpolation settings of the transition	
Optimization method	Select the optimization method in the drop-down list. • System interpolation The CPU defines the optimization parameters automatically according to the settings of the system interpolation (Page 127). • VDI-based optimization You adjust the optimization manually. The inputs are applied automatically according to the VDI Guideline 2143.
Motion task	The transition type is determined from the properties of the adjacent elements of the transition and displayed in this field.
Continuity at start/end	In the drop-down lists, select which parameter is continuous in the boundary points and is to be included for optimization. • Default optimization setting (setting under "Profile > Default optimization settings (Page 126)") • Position • Velocity (bumpless) • Acceleration (jerkless) • Jerk (jerk continuity permitted on one side only)
Optimization target	In the drop-down list, select the optimization target: • Default optimization setting (setting under "Profile > Default optimization settings") • Not specified • Velocity (Cv) • Acceleration (Ca) • Jerk (Cj) • Minimum Dynamic Moment (Cmdyn)

Parameters	Description
Selection of motion rule	
Motion rule	In the drop-down list, select the motion rule according to which optimization is to occur. • Line • Quadratic parabola • Sine • Polynomial • Inclined sine • Modified acceleration trapezoid • Modified sine • Harmonic combination • Double-harmonic transition • Sine line combination The selection is automatically limited to the motion rules that can be applied according to the motion task and the selected boundary conditions. Additional parameters are displayed depending on the selected motion rule. If you have changed the motion task in such a way that the motion rule can no longer be applied, a notice is displayed. In this case, you need to select a motion rule that can be applied.
Parameter used	In the drop-down list, select the parameters to be included in the optimization: • Lambda • Maximum acceleration (Ca) • Maximum deceleration (Ca*) The selection is automatically limited to the parameters that can be applied according to the motion rule.
Lambda	In the drop-down list, select the transition point in the "Lambda position" field: • No lambda Do not enter any value. The position of the point of inflection is calculated automatically. • Relative to the segment You specify the leading value of the turning point relative to the transition from 0.0 to 1.0. The value 0.0 corresponds to the beginning of the transition. The value 1.0 corresponds to the end of the transition. • Absolute in the profile You specify the leading value of the point of inflection as an absolute value.
Lambda position	In this field, configure the leading value of the turning point for the transition according to the selection in the "Lambda" drop-down list.
Maximum acceleration (Ca)	Configure the maximum acceleration (Ca) for the transition in this field.

Parameters	Description
Maximum deceleration (Ca*)	Configure the maximum deceleration (Ca*) for the transition in this field.
Approximation	
Number of interpolation points	In this field, configure the number of interpolation points for the transition.
Maximum following value tolerance	In this field, enter the maximum permitted deviation (absolute) of the approximation from the motion law. If the configured value is exceeded, a warning is displayed in the graphical editor at the transition.
Characteristic values of the transition	The characteristic values of the transition that are relevant according to VDI 2143 are displayed in this area. The maximum value and the standardized value are displayed for the following characteristic values: • Velocity (Cv) • Acceleration (Ca) • Deceleration (Ca*) • Jerk (Cj) • Dynamic torque (Cmdyn)

Motion jobs according to VDI Guideline 2143

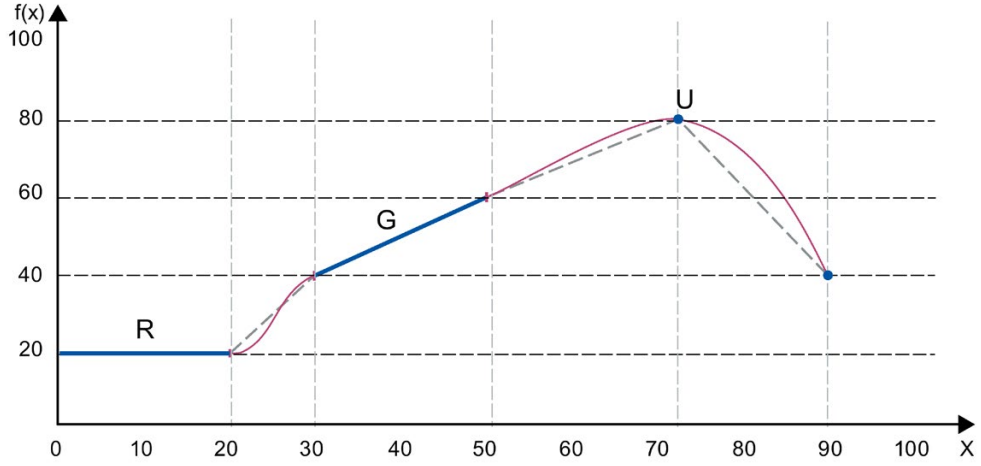
The VDI Guideline 2143 distinguishes between areas of usage and motion transitions:

- Areas of usage correspond to the sequences in a process, which means the inserted elements of the cam.
- Motion transitions are transitions between areas of usage that are not directly relevant to the process but must meet specific boundary conditions (e.g. velocity consistency).

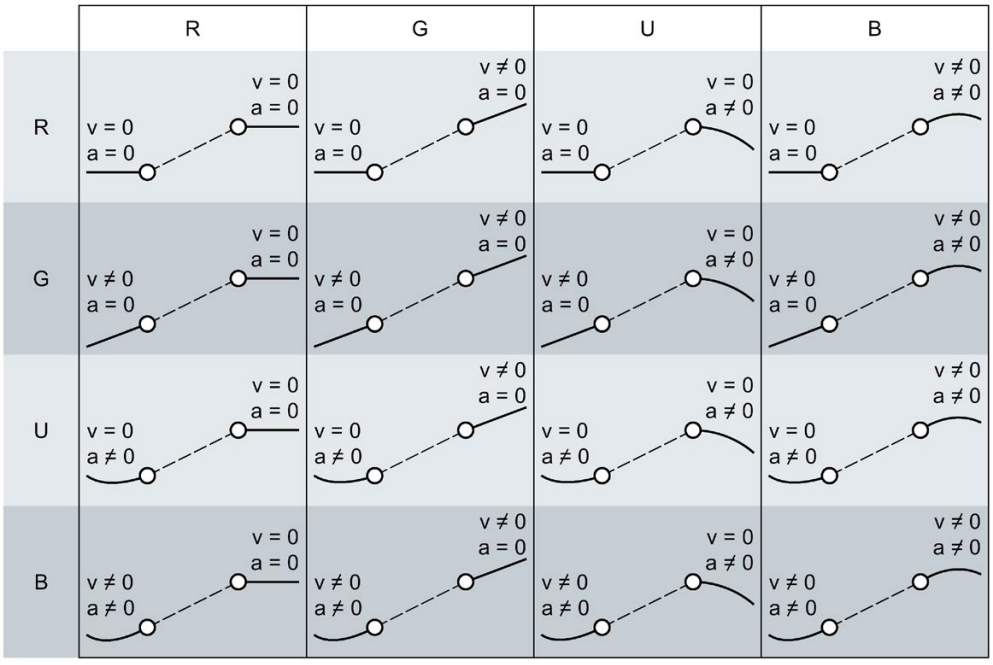
The following motion tasks are defined based on VDI guideline 2143:

Motion tasks	Designation	Properties
Dwell	R	Velocity = 0 Acceleration = 0
Constant velocity	G	Velocity ≠ 0 Acceleration = 0
Reverse	U	Velocity = 0 Acceleration ≠ 0
Motion	B	Velocity ≠ 0 Acceleration ≠ 0

The following figure shows an example of the motion tasks:



The figure below shows the possible combinations of motion tasks:



6.2.6 Representation (Inspector window) (S7-1500T)

6.2.6.1 Configuration charts - Charts and curves (S7-1500T)

In the "Charts and curves" configuration window, configure the display of the graphical editor.

"Reset to defaults" button

Use this button to reset all settings of the view of charts and curves to the default settings.

Configuration table

Configure the display of the graphical editor in the table:

Column	Description
Show	Displaying/hiding of charts 1 to 4
Visible	Displaying/hiding of curves in the chart You can show or hide online curves already offline. The curve becomes visible when you have shown the curve, established an online connection and read out the online curve.
Name	Name of chart or curve New curves can be added. Existing curves can be removed. Curves of other cams can also be displayed. The name of the other cam is also displayed in the table and in the legend of the chart. A curve can be inserted multiple times in a chart, e.g. in order to display it with different scalings.
Color	Line color of the curve
Line type	Line type of the curve
Offset of the leading values[1)]	Movement of the curve on the abscissa
Multiplier for leading values[1)]	Scaling of abscissa
Offset of the following values[1)]	Movement of the curve on the ordinate
Multiplier for following values[1)]	Scaling of ordinate

[1)] Only affects the display of the curve in the chart. You specify the scaling and shifting of the cam during camming in the Motion Control instruction "MC_CamIn".

6.2.6.2 Configuration charts - Snap grid (S7-1500T)

In the "Snap grid" configuration window, you configure the grid spacing for aligning inputs to the grid in the graphical editor. When "Snap" is activated, inputs and element end points are aligned to this grid and to other element end points.

Snap grid spacing

In this area, configure the grid spacing of the snap grid:

Parameter	Description
Grid spacing leading value	Configure the grid spacing on the abscissa (leading values) in this field.
Grid spacing following value	Configure the grid spacing on the ordinate (following values) in this field.

6.2.6.3 Configuration - Decimal places (S7-1500T)

In the "Decimal places" configuration window, you configure how many decimal places are used to represent the values in the graphical and tabular editor as well as in the configuration windows. The values are rounded in the displays. The settings do not affect the calculation of the curves. The curves are calculated with higher accuracy regardless of the settings.

Displayed decimal places

In this area, configure the displayed decimal places:

Parameter	Description
Tabular editor and configuration window	In this field, configure the number of decimal places for displaying values in the tabular editor and in the configuration windows.
Graphical editor	In this field, configure the number of decimal places for displaying values in the graphical editor.

6.2.7 Importing/exporting cam (S7-1500T)

You can use the toolbar to export cams from the cam editor and import cams into the cam editor.

Importing cam

NOTICE
Machine damage
Importing corrupt files (.txt, .csv) can result in unwanted behavior of the axes.
Each time you import a cam from a file, check the integrity of the imported data.

The following table shows the supported file formats for importing/exporting a cam:

File format		Comment
Import format		
	SIMOTION SCOUT CamTool format/MCD *.txt, *.csv	MCD exchange format is automatically detected, imported data: • Interpolated points • Lines • Sine elements • Inverse sine elements • Polynomials • Transitions
	Proprietary binary format *.bin	The binary format is used for exchanging cams between multiple TIA Portal installations and external applications.

To import a cam, follow these steps:

1. In the toolbar, click the icon "Import cam from file".

   The "Cam import" dialog opens.
2. Select the file type of the file you want to import.
3. Select the file you want to import from the file directory.
4. Click the "Open" button.

   The cam is opened in the cam editor. All previous entries in the editor are discarded.

Exporting cam

The following table shows the structure of the "Cam export" dialog:

Parameter/Element		Description
Export format		
	Export as	Select the export format in the drop-down list: • MCD exchange format • SIMOTION SCOUT CamTool format • Point list • Binary format
	Delimiters	In the drop-down list, select the delimiter with which the data fields are to be separated in the file: • Comma • Tab
	Number of points	In this field, configure the number of points to be exported to a point list. The more points exported, the more precise the configured cam formed by the point list. Possible values: 0 to 1E5 Default setting: 360
Additional curves		Point list only
	Velocity	Select the "Velocity" check box when the derivative curve of the velocity is to be exported in addition to the position.
	Acceleration	Select the "Acceleration" check box if you want to export the derivative curve of the acceleration in addition to the position.
	Jerk	Select the "Jerk" check box when the derivative curve of the jerk is to be exported in addition to the position.
Directory for export		
	File name	Enter a file name in this field.
	Directory	In this field, enter the directory into which the file is to be written.
Export		Export the file
Cancel		Cancellation of export and closing of the dialog

To export a cam, follow these steps:

1. In the toolbar, click the icon "Export cam to file".

   The "Cam export" dialog opens.
2. Select the export format in the "Export as" drop-down list.
3. Optionally, configure the delimiter, the number of points, and the additional curves for the export.
4. Enter a file name in the "File name" box.
5. Select the directory to which the file is written.
6. Click "Export".

See also

Structure of the graphical editor (Page 112)

6.2.8 Dialogs in the shortcut menu (S7-1500T)

The following dialogs can be called with the shortcut menu of the graphical and tabular editor:

- Pasting elements
- Moving elements
- Scaling elements

"Paste elements" dialog

The following table shows the structure of the "Paste elements" dialog:

Parameter/Element	Description	
Insert mode	Select the Insert mode from the selection list:	
	Overwrite from the end to the left	You overwrite the selected elements with the elements from the clipboard starting from the end in the direction of smaller leading values. The end of the inserted elements then lies at the end of the selected elements. Elements that are located in the leading value range of the elements in the clipboard are overwritten or truncated.
	Overwrite from the start to the right	Starting from the start, you overwrite the selected elements with the elements from the clipboard in the direction of larger leading values. The start of the inserted elements then lies at the start of the selected elements. Elements that are located in the leading value range of the elements in the clipboard are overwritten or truncated.
	Overwrite from the middle	Starting from the center, you overwrite the selected elements with the elements from the clipboard. The center of the inserted elements then lies at the center of the selected elements. Elements that are located in the leading value range of the elements in the clipboard are overwritten or truncated.
	Scale selection to the leading value range	The elements in the clipboard are scaled to the leading value range of selected elements. The start and end of the inserted elements then lie at the start and end of the selected elements.
	Apply leading values from the clipboard	The elements in the clipboard are pasted with the leading values at the start and end. Elements that are located in the leading value range of the elements in the clipboard are overwritten or truncated.
Paste	Pasting of the elements from the clipboard with the selected mode	
Cancel	Cancellation of paste operation and closing of the dialog	

"Move elements" dialog

The following table shows the structure of the "Move elements" dialog:

Parameter/Element	Description
Horizontal distance	In this field, enter the shift of the selection on the abscissa (x axis).
Vertical distance	In this field, enter the shift of the selection on the ordinate (y axis).
Move	Move the selection by the entered distance
Cancel	Cancellation of move operation and closing of the dialog

"Scale elements" dialog

The following table shows the structure of the "Scale elements" dialog:

Parameter/Element	Description	
Adjust to leading value range	In this field, enter the scaling length (leading value side) to which you want to scale the selection.	
Anchor point	Select the direction of scaling in the selection list:	
	Left boundary	The selection is adjusted by the left boundary point to the scaling length.
	Center	The selection is adjusted by the center point to the scaling length.
	Right boundary	The selection is adjusted by the right boundary point to the scaling length.
Scale	Scaling with the selected parameter values	
Cancel	Cancellation of scaling and closing of the dialog	

See also

Shortcut menu in the tabular editor (Page 124)

Shortcut menu in the graphical editor (Page 121)

Diagnostics (S7-1500, S7-1500T) 7

The "Diagnostics" section is limited to describing the diagnostics view of the synchronous axis technology object in the TIA Portal.

You will find a description of Motion Control diagnostics in the following sections of the "S7-1500/S7-1500T Motion Control overview" documentation (https://support.industry.siemens.com/cs/ww/en/view/109766459):

- Diagnostic concept
- Technology alarms
- Errors in Motion Control instructions

A comprehensive description of the system diagnostics of the S7-1500 CPU can be found in the "Diagnostics" function manual (https://support.automation.siemens.com/WW/view/en/59192926).

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

7.1.1 Status and error bits (S7-1500, S7-1500T)

You use the "Technology object > Diagnostics > Status and error bits" diagnostic function in the TIA Portal to monitor the status and error messages for the technology object. The diagnostics function is available in online operation.

The meaning of the status and error messages is described in the following tables. The associated technology object tag is given in parentheses.

Axis status

The following table shows the possible axis status values:

Status	Description
Simulation active	The axis is simulated in the CPU. Setpoints are not output to the drive. (<TO>.StatusWord.X25 (AxisSimulation))
Enabled	The technology object has been enabled. You can move the axis with motion jobs. (<TO>.StatusWord.X0 (Enable))
Position-controlled mode	The axis is in position-controlled mode. (Inversion of <TO>.StatusWord.X28 (NonPositionControlled))
Homed	The technology object is homed. The relationship between the position in the technology object and the mechanical position was successfully created. (<TO>.StatusWord.X5 (HomingDone))
Error	An error occurred at the technology object. Detailed information about the error is available in the "Error" area and in the "<TO>.ErrorDetail.Number" and "<TO>.ErrorDetail.Reaction" tags of the technology object. (<TO>.StatusWord.X1 (Error))
Restart active	The technology object is being reinitialized. (<TO>.StatusWord.X2 (RestartActive))
Axis control panel active	The axis control panel is active. The axis control panel has master control over the technology object. You cannot control the axis from the user program. (<TO>.StatusWord.X4 (ControlPanelActive))
Drive ready	Drive is ready to execute setpoints. (<TO>.StatusDrive.InOperation)
Encoder values valid	Encoder values are valid (<TO>.StatusSensor[1].State)
Encoder values valid (S7-1500T)	The encoder values of encoder 1, encoder 2, encoder 3 or encoder 4 are valid. (<TO>.StatusSensor[1..4].State)

Status	Description
Active encoder	Encoder is operational. (<TO>.OperativeSensor)
Active encoder (S7-1500T)	The encoder in effect operationally is encoder 1, encoder 2, encoder 3 or encoder 4. (<TO>.OperativeSensor)
Restart required	Data relevant for the restart has been changed. The changes are applied only after a restart of the technology object. (<TO>.StatusWord.X3 (OnlineStartValuesChanged))

Status limit switch

The following table shows the possibilities for enabling the software and hardware limit switches:

Status	Description
Negative SW limit switch approached	The negative software limit switch was reached. (<TO>.StatusWord.X15 (SWLimitMinActive))
Positive SW limit switch approached	The positive software limit switch was reached. (<TO>.StatusWord.X16 (SWLimitMaxActive))
Negative HW limit switch approached	The negative hardware limit switch has been approached or overtraveled. (<TO>.StatusWord.X17 (HWLimitMinActive))
Positive HW limit switch approached	The positive hardware limit switch has been approached or overtraveled. (<TO>.StatusWord.X18 (HWLimitMaxActive))

Motion status

The following table shows the possible axis motion status values:

Status	Description
Done (no job running)	No job active at technology object. (<TO>.StatusWord.X6 (Done))
Homing job	The technology object executes a homing job of the Motion Control instruction "MC_Home" or from the axis control panel. (<TO>.StatusWord.X11 (HomingCommand))
Jog	The axis is being moved with a job for jog mode of Motion Control instruction "MC_MoveJog". (<TO>.StatusWord.X9 (JogCommand))
Velocity specification	The axis is traversed with a job with velocity specification of the Motion Control instruction "MC_MoveVelocity" or from the axis control panel. (<TO>.StatusWord.X10 (VelocityCommand))
Positioning job	The axis is traversed with a positioning job of Motion Control instruction "MC_MoveAbsolute" or "MC_MoveRelative" or from the axis control panel. (<TO>.StatusWord.X8 (PositioningCommand))
Constant velocity	The axis is moved with constant velocity or is stationary. (<TO>.StatusWord.X12 (ConstantVelocity))
Standstill	The axis is in standstill. (<TO>.StatusWord.X7 (StandStill))
Accelerating	Axis is being accelerated. (<TO>.StatusWord.X13 (Accelerating))
Decelerating	The axis is being decelerated. (<TO>.StatusWord.X14 (Decelerating))
Torque limit active	At least the threshold value (default 90%) of the preset force/torque limitation acts on the axis. (<TO>.StatusWord.X27 (InLimitation))
Stop job active	The axis is stopped and disabled by Motion Control instruction "MC_Stop". (<TO>.StatusWord2.X0 (StopCommand))

Synchronous operation status

Status	Description
Synchronization	The axis is synchronized to the leading value of a leading axis. (<TO>.StatusWord.X21 (Synchronizing))
Synchronous	The axis is synchronized and moves synchronously to the leading axis. (<TO>.StatusWord.X22 (Synchronous))
Synchronization pending (S7-1500T)	A synchronous operation is pending until the leading value reaches the start position for synchronization. (<TO>.StatusSynchronizedMotion.WaitingFunctionState.X2 (GearInPosWaiting); <TO>.StatusSynchronizedMotion.WaitingFunctionState.X3 (CamInWaiting))
Additive leading value active (S7-1500T)	The axis receives an additive leading value with the Motion Control instruction "MC_LeadingValueAdditive". (<TO>.StatusSynchronizedMotion.StatusWord.X4 (LeadingValueAdditiveCommand))
Superimposed profile (S7-1500T)	The axis is being moved superimposed with a job of Motion Control instruction "MC_MoveSuperimposed". (<TO>.StatusWord.X23 (SuperimposedMotionCommand))

Error

The following table shows the possible errors:

Error	Description
System	A system-internal error has occurred. (<TO>.ErrorWord.X0 (SystemFault))
Configuration	A configuration error has occurred. One or more configuration parameters are inconsistent or invalid. The technology object was incorrectly configured, or editable configuration data was incorrectly modified during runtime of the user program. (<TO>.ErrorWord.X1 (ConfigFault))
User program	An error occurred in the user program at a Motion Control instruction or its use. (<TO>.ErrorWord.X2 (UserFault))
Drive	An error occurred in the drive. (<TO>.ErrorWord.X4 (DriveFault))
Encoder	An error occurred in the encoder system. (<TO>.ErrorWord.X5 (SensorFault))
Encoder (S7-1500T)	An error has occurred in the encoder system of encoder 1, encoder 2, encoder 3 or encoder 4. (<TO>.ErrorWord.X5 (SensorFault))
Data exchange	Communication with a connected device is faulty. (<TO>.ErrorWord.X7 (CommunicationFault))

Error	Description
I/O	An error occurred accessing a logical address. (<TO>.ErrorWord.X13 (PeripheralError))
Job rejected	A job cannot be executed. You cannot execute a Motion Control instruction because necessary requirements are not fulfilled (for example, technology object not homed). (<TO>.ErrorWord.X3 (CommandNotAccepted))
Homing	An error occurred during a homing process. (<TO>.ErrorWord.X10 (HomingFault))
Positioning	The positioning axis was not positioned correctly at the end of a positioning motion. (<TO>.ErrorWord.X12 (PositioningFault))
Dynamic limitation	The dynamic values are limited to the dynamic limits. (<TO>.ErrorWord.X6 (DynamicError))
Following error	The maximum permitted following error has been exceeded. (<TO>.ErrorWord.X11 (FollowingErrorFault))
SW limit switch	A software limit switch has been reached. (<TO>.ErrorWord.X8 (SwLimit))
HW limit switch	A hardware limit switch has been reached or overtraveled. (<TO>.ErrorWord.X9 (HWLimit))
Adapt	An error occurred during data adaption. (<TO>.ErrorWord.X15 (AdaptionError))
Synchronization	Synchronous axis only An error occurred during synchronization. The leading axis specified for the corresponding Motion Control instruction was not configured as a possible leading axis. (<TO>.ErrorWord.X14 (SynchronousError))

Warnings

The following table shows the possible warnings:

Warning	Description
Configuration	One or several configuration parameters are adjusted internally at a certain time. (<TO>.WarningWord.X1 (ConfigWarning))
Job rejected	Job cannot be executed. You cannot execute a Motion Control instruction because necessary requirements are not fulfilled. (<TO>.WarningWord.X3 (CommandNotAccepted))
Dynamic limitation	The dynamic values are limited to the dynamic limits. (<TO>.WarningWord.X6 (DynamicWarning))
Synchronization	Synchronous axis only An error occurred during synchronization. The leading axis specified for the corresponding Motion Control instruction was not configured as a possible leading axis. (<TO>.WarningWord.X14 (SynchronousWarning))

Alarm display

For additional information and to acknowledge the error, go to the Inspector window by clicking on the "Alarm display" link.

Additional information

An option for evaluating the individual status bits can be found in the section "Evaluating StatusWord, ErrorWord and WarningWord" of the "S7-1500/S7-1500T Motion Control overview" (https://support.industry.siemens.com/cs/ww/en/view/109766459) documentation.

7.1.2 Motion status (S7-1500, S7-1500T)

You use the "Technology object > Diagnostics > Motion status" diagnostic function in the TIA Portal to monitor the motion status of the axis. The diagnostics function is available in online operation.

"Setpoints" area

The following table shows the meaning of the status data:

Status	Description
Target position	Current target position of an active positioning job The target position value is only valid during execution of a positioning job. (<TO>.StatusPositioning.TargetPosition)
Position setpoint	Setpoint position of the axis (<TO>.Position)
Velocity setpoint	Velocity setpoint of the axis (<TO>.Velocity)
Velocity override	Percentage correction of the velocity specification The velocity setpoint specified in Motion Control instructions or set by the axis control panel is superimposed with an override signal and corrected as a percentage. Valid velocity correction values range from 0.0 % to 200.0 %. (<TO>.Override.Velocity)

"Current values" area

The following table shows the meaning of the status data:

Status	Description
Operative encoder	Operative encoder of the axis
Actual position	Actual position of the axis If the technology object is not homed, then the value is displayed relative to the position that existed when the technology object was enabled. (<TO>.ActualPosition)
Actual velocity	Actual velocity of the axis (<TO>.ActualVelocity)
Following error	Following error of the axis (<TO>.StatusPositioning.FollowingError)

"Dynamic limits" area

This area displays the limit values for the dynamic parameters.

The following table shows the meaning of the status data:

Status	Description
Velocity	Configured maximum velocity (<TO>.DynamicLimits.MaxVelocity)
Acceleration	Configured maximum acceleration (<TO>.DynamicLimits.MaxAcceleration)
Deceleration	Configured maximum deceleration (<TO>.DynamicLimits.MaxDeceleration)
Jerk	Configured maximum jerk (<TO>.DynamicLimits.MaxJerk)

7.1.3 PROFIdrive telegram (S7-1500, S7-1500T)

The "Technology object > Diagnostics > PROFIdrive telegram" diagnostics function is used in the TIA Portal to monitor the PROFIdrive telegrams returned by the drive and encoder. The display of the Diagnostics function is available in online operation.

"Drive" area

This area displays the following parameters contained in the PROFIdrive telegram from the drive to the controller:

- Status words "ZSW1" and "ZSW2"
- The speed setpoint (NSET) that was output to the drive
- The actual speed that was signaled from the drive (NACT)

"Encoder" area

This area displays the following parameters contained in the PROFIdrive telegram from the encoder to the controller:

- Status word "Gx_ZSW"
- The actual position value "Gx_XIST1" (cyclic actual encoder value)
- The actual position value "Gx_XIST2" (absolute encoder value)

Areas "Encoder 1" to "Encoder 4" (S7-1500T)

The "Encoder 1" to "Encoder 4" areas display the following parameters from the PROFIdrive telegram of the corresponding encoder to the controller:

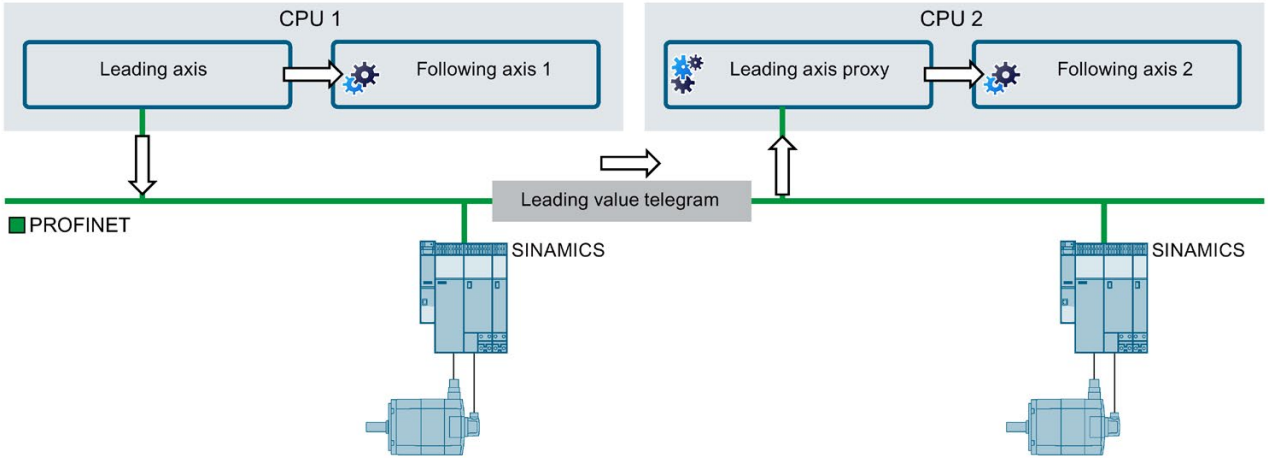
- Status word "Gx_ZSW"
- The actual position value "Gx_XIST1" (cyclic actual encoder value)
- The actual position value "Gx_XIST2" (absolute encoder value)

Cross-PLC synchronous operation (S7-1500T) 8

8.1 Basics (S7-1500T)

With cross-PLC synchronous operation, you realize synchronous operations (gearing or camming) between axes that are on different CPUs. All following axes of a leading value are hereby synchronous to one another with consideration of the respective synchronous operation function. All following axes receive the same leading value at the same time. You can configure and operate the following axes on different CPUs within a project. You can also configure the leading axis on any CPU of the same project.

The figure below shows the operating principle based on an example with two following axes on two CPUs:



⇨ Leading value

The leading axis and a local following axis 1 are located on CPU 1. The leading axis and the following axis 1 are interconnected to a synchronous operation.

The leading axis makes the leading value available for cross-PLC synchronous operation. The leading value is transferred to CPU 2 by means of a leading value telegram via PROFINET IO with IRT.

On CPU 2, a leading axis proxy reads the leading value. A following axis 2 is interconnected locally with the leading axis proxy as leading axis.

The following axes 1 and 2 are synchronous and follow the same leading value.

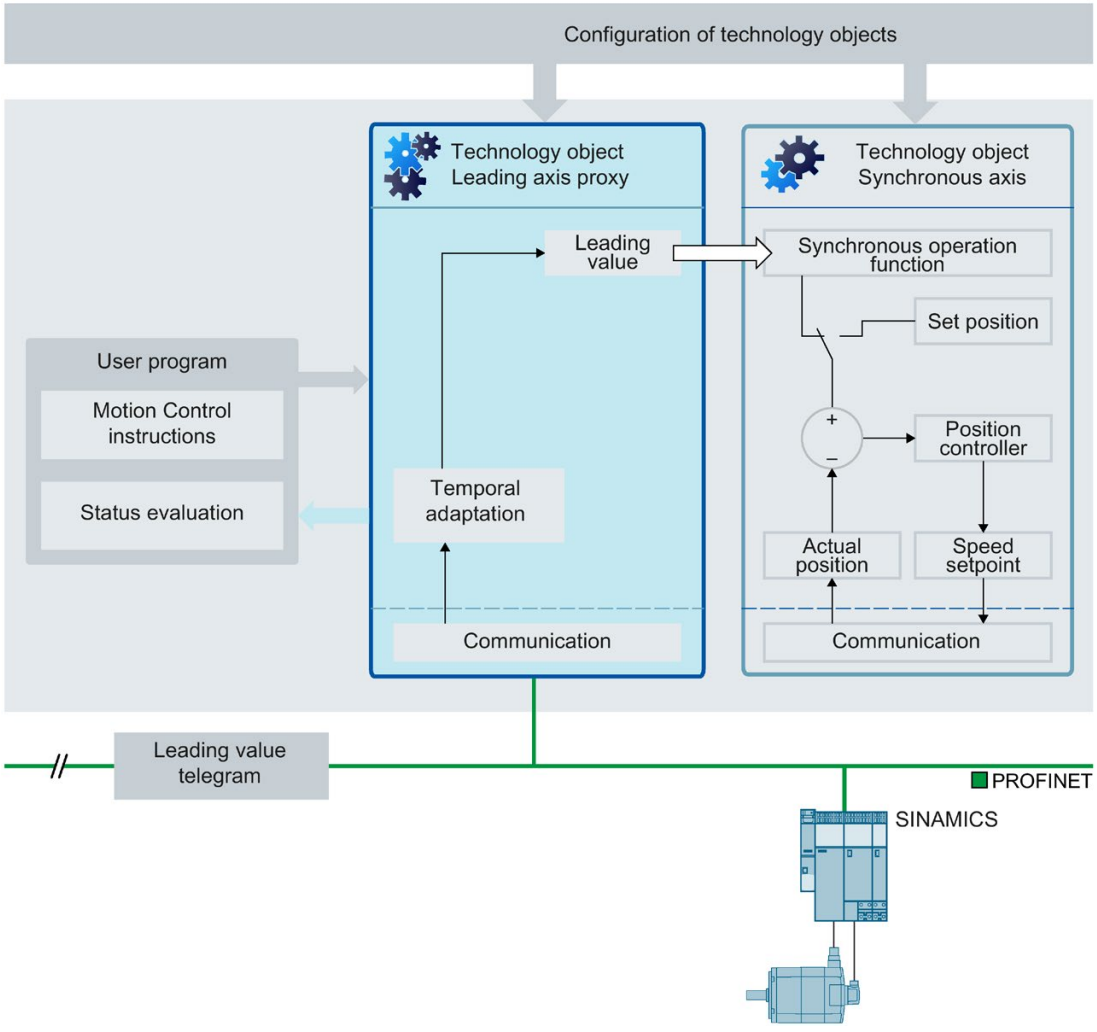
The S7-1500 and S7-1500T CPUs can make the leading value available for a cross-PLC synchronous operation. You need to use an S7-1500T CPU as the CPU that receives the leading value via a leading value proxy.

8.1.1 Leading axis proxy technology object (S7-1500T)

With cross-PLC synchronous operation, the leading axis proxy technology object represents the leading axis for local synchronous operation within a CPU. The leading axis proxy adjust the time of the leading value so that the following axes on the different CPUs are synchronous, and it provides the leading value for the local following axes.

You can find an overview of the functions of the technology object in the "Functions (Page 13)" section.

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



8.1.2 Communication via PROFINET IO with IRT (S7-1500T)

In a cross-PLC synchronous operation, the leading value is transferred via PROFINET IO with IRT. "Controller-controller data exchange" is used for the communication between the CPUs within a project. For this purpose, the CPUs must be on a bus and belong to the same sync domain.

Provision of leading value via controller-controller data exchange

With communication by means of controller-controller data exchange, the leading value is made available once within a project and can then by received by multiple CPUs on the same bus. Leading axis proxies that are interconnected with the same leading value can be configured on different CPUs. In addition, it is possible to make multiple leading values of different leading axes available on different CPUs via the same bus.

You can find additional information in the section "Setting up communication via controller-controller data exchange (Page 171)" and in the function manual "SIMATIC S7-1500, ET 200MP, ET 200SP, ET 200AL, ET 200pro Communication" (https://support.industry.siemens.com/cs/ww/en/view/59192925).

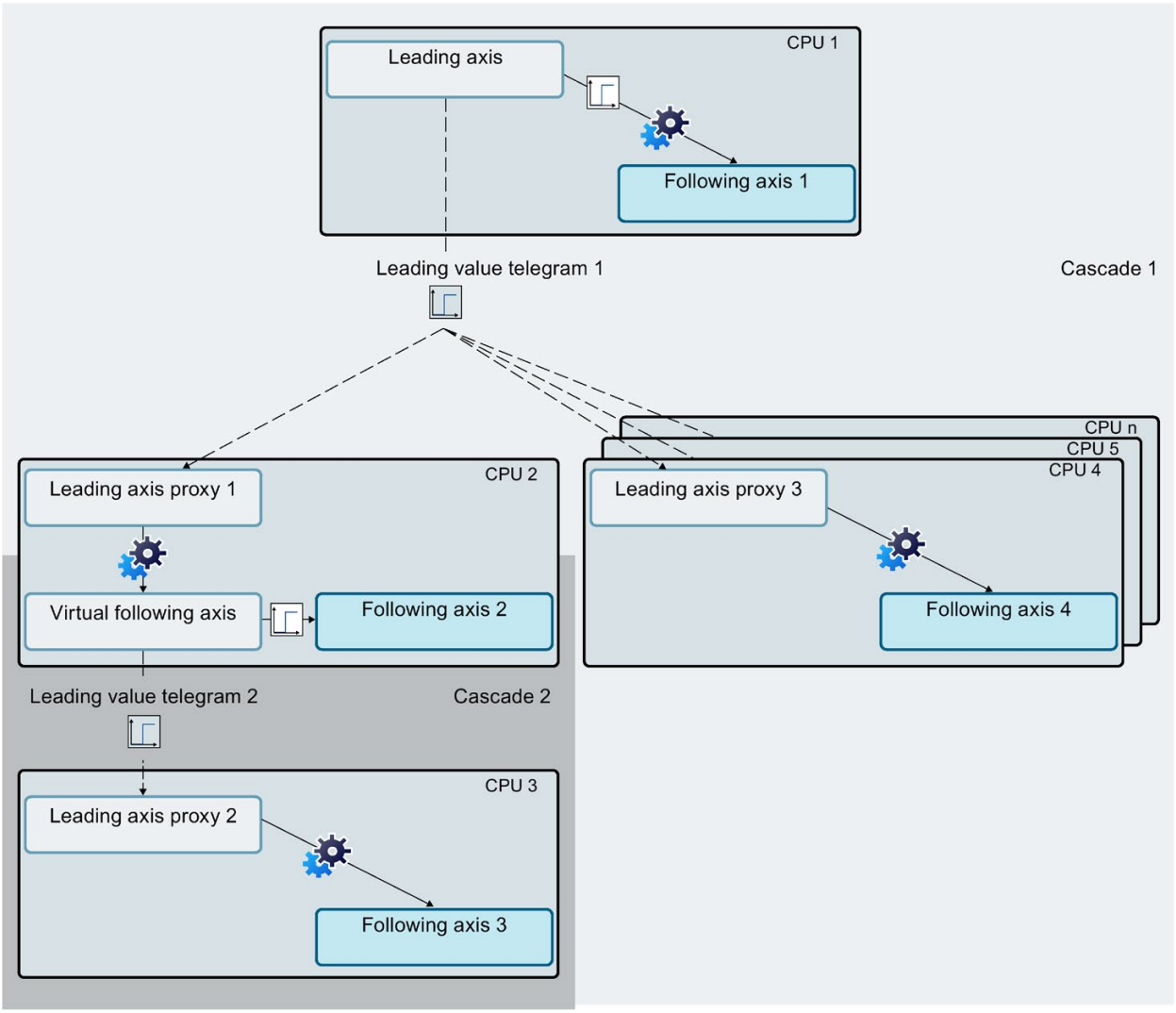
Tolerance time

If an external leading value becomes invalid or a communication error occurs, a technology alarm 900 is output after a tolerance time. You can configure this tolerance time (Page 175) on the leading axis proxy technology object under "Technology object > Configuration > Leading value settings".

Note that the leading value is still being extrapolated during the tolerance time and that the following axis continues to move. Therefore, set the tolerance time as brief as possible.

8.1.3 Interconnection possibilities (S7-1500T)

The figure below shows the schematic structure of synchronous following axes with different synchronous operation functions that are distributed over multiple CPUs:



Leading value delay that can be configured at the leading axis (delay time)

Delay time caused by the processing and transfer of the leading value

Gearing (example)

You can interconnect a positioning axis, external encoder or synchronous axis technology object as the leading axis on CPU 1.

Cascaded interconnection

With a cascaded interconnection, a following axis makes a cross-PLC leading value available to a leading axis proxy again. Use a virtual axis for this purpose.

The figure above shows two cascades: The interconnection between the leading axis and the following axes 2 and 4 is the first cascade. The interconnection between the virtual following axis and the following axes 3 is the second cascade.

Communication and time response

In the processing and transfer of the leading value, a delay time occurs between the generation of the leading value on the leading axis one on CPU and the provision of the leading value for the following axes at the leading axis proxy on the other CPUs. The following axes of the other CPUs receive the leading value with a time delay.

In principle, the delay time per cascade is:

Delay time = 2 x application cycle of the CPU of the leading axis proxy

To achieve synchronicity between the local following axes of the CPU of the leading axis and the following axes of other CPUs without extrapolating the leading value at the leading axis proxy, the leading value can be delayed at the leading axis for the local following axes. The delay time can be compensated for with these configurable delay times.

Therefore, in the figure above, a delay time is set at the leading axis on CPU 1, which delays the leading value output to the local following axis 1. In addition, a delay time at the virtual following axis on CPU 2 is set, because CPU 3 is present in a cascade. All following axes thus receive the same leading value at the same time.

During configuration of the following axis under "Leading value interconnections", you select the entry "Delayed" as type of coupling so that the leading value is delayed for local synchronous operation.

Recommendation: Use a virtual axis as leading axis.

Delay time

You can calculate and view the delay times in the interconnection overview (Page 178). The application cycles of the leading axis proxy and any cascading present are included in the calculation of the delay times.

Alternatively, you can manually configure the delay times on the leading axis and on the virtual following axis. In this way, you can consider additional requirements from your specific application, for example.

Depending on the set delay time, the leading value at the leading axis proxy is automatically interpolated or extrapolated. The automatic interpolation and extrapolation guarantees the synchronicity of all following axes. In the connection view, an indication of whether the leading value is interpolated or extrapolated is provided for each route of a leading value (Page 180).

With an extrapolation, deviations in the following values can occur in the event of velocity changes. With constant velocity, these deviations are automatically compensated for. With an interpolation, no deviations of the following values occur in the event of velocity changes.

Recursive interconnection

When all axes are active, the leading axis becomes the following axis of its own leading value with a recursive interconnection. During the configuration, recursive interconnections are displayed in the interconnection overview. No delay times can be calculated for recursive interconnections. Recursive interconnections over multiple CPUs are not detected during runtime.

A recursive interconnection that is in effect during runtime is not permitted.

8.1.4 Tags: Cross-PLC synchronous operation (S7-1500T)

Positioning axis/synchronous axis/external encoder

The following tags of the positioning axis, synchronous axis and external encoder are relevant for cross-PLC synchronous operation:

Tag	Description	
<TO>.CrossPlcSynchronousOperation.Interface[1..1].EnableLeadingValueOutput	Provide cross-PLC leading value	
	FALSE	No
	TRUE	Yes
<TO>.CrossPlcSynchronousOperation.Interface[1..1].AddressOut	Output address for the telegram of cross-PLC synchronous operation	
<TO>.CrossPlcSynchronousOperation.LocalLeadingValueDelayTime	Delay time for setpoint coupling with delayed leading value	
<TO>.StatusProvidedLeadingValue.DelayedLeadingValue.Position	Position of the provided leading value	
<TO>.StatusProvidedLeadingValue.DelayedLeadingValue.Velocity	Velocity of the provided leading value	
<TO>.StatusProvidedLeadingValue.DelayedLeadingValue.Acceleration	Acceleration of the provided leading value	

Leading axis proxy

The following leading axis proxy technology object tags are relevant for cross-PLC synchronous operation:

Tag	Description	
<TO>.Position	Position of the leading value for local synchronous operation	
<TO>.Velocity	Velocity of the leading value for local synchronous operation	
<TO>.Acceleration	Acceleration of the leading value for local synchronous operation	
<TO>.Interface.AddressIn	Input address for the telegram of the external leading value	
<TO>.Parameter.LocalLeadingValueDelayTime	Delay time of leading value output on the local following axis which, in turn, provides a leading value	
<TO>.Parameter.ToleranceTimeExternalLeading ValueInvalid	Tolerance time until a technology alarm is triggered when the external leading value becomes invalid	
<TO>.StatusExternalLeadingValue.ModuloLength	Modulo length of the external leading value	
<TO>.StatusExternalLeadingValue.ModuloStartValue	Modulo start value of the external leading value	
<TO>.StatusExternalLeadingValue.AdjustmentTime	Time by which the external leading value is adjusted	
	< 0	The external leading value is interpolated by this time.
	> 0	The external leading value is extrapolated by this time.
<TO>.StatusWord.X4 (LeadingValueValid)	Validity of the external leading value	
	0	Leading value does not exist or is not valid
	1	Leading value exists and is valid
<TO>.StatusWord.X5 (LeadingValueModulo)	Modulo functionality	
	0	Leading value without modulo functionality
	1	Leading value with modulo functionality
<TO>.StatusWord.X6 (LeadingAxisControl)	Follow-up mode	
	0	Leading axis in follow-up mode
	1	Leading axis not in follow-up mode

8.2 Configuring (S7-1500T)

8.2.1 Setting up communication via controller-controller data exchange (S7-1500T)

In a cross-PLC synchronous operation, the leading value is transferred via PROFINET IO with IRT. "Controller-controller data exchange" is used for the communication between the CPUs within a project.

For this purpose, you first set up the transfer areas for the required communication directions between the interconnected CPUs. You then create input and output tags for the CPUs which reference the relevant transfer areas. You can then select these tags for the transfer area when configuring the leading axis and the leading axis proxy.

Hereafter, the sender CPU is the CPU on which a leading axis provides a leading value. The receiver CPU is the CPU on which a leading axis proxy reads the leading value.

Requirements

- You have set up a network via PROFINET IO with IRT.
- You have connected the IRT ports of the CPUs in the network view and in the topology view.
- You have assigned the same sync domain to all CPUs.
- You have configured a CPU as sync master.
- You have configured all other CPUs as sync slaves.

Adding communication directions

To add the communication directions, proceed as follows:

1. Open the "I/O communication" tab in the network view.
2. To create a communication direction from the sender CPU to the receiver CPU, select the sender CPU.
3. Drag-and-drop the receiver CPU into the "Drop or select the device here" field of the "Partner 2" table column of the corresponding PROFINET interface.

   The communication direction from sender CPU to receiver CPU is created.
4. Repeat steps 2 and 3 for all communication directions required between the interconnected CPUs.

Note

Communication direction from the receiver CPU to the sender CPU

If necessary, also set up a communication direction from the receiver CPU to the sender CPU, e.g. to transfer application-specific status information.

Configuring transfer areas

To configure the transfer areas, follow these steps:

1. In the "I/O communication" tab in the network view, select a communication direction of a selected CPU.
2. Add a transfer area in the Inspector window under "Properties > General > Direct data exchange" by entering a name.
3. Repeat steps 1 and 2 for all created configuration directions.
4. Configure the created transfer area in the Inspector window "Properties > General > Direct data exchange > <Name of transfer area>":
   - In the "Start address" fields, define the start address of the assigned logical address area of the sender and of the receiver.

     Note

     Multiple receiver CPUs in the same cascade (1:n relationship)

     If multiple receiver CPUs receive the same leading value of the sender CPU, select the same address area for the transfer area between the sender CPU and the receiver CPU n that you defined between the sender CPU and the receiver CPU 1 under "Properties > General > Direct data exchange" in the "Partner address" table column.

   - In the "Organization block" fields, select the MC-Servo OB of the respective CPU.

     Note

     "MC-Servo [OB91]" organization block

     When you create a technology object, an MC-Servo OB is created automatically.

   - Define a data length of 48 bytes in the "Data length [byte]" field.
5. Repeat step 4 for all created transfer areas.

Creating tags

To create the output tag of a sender CPU and the input tag of a receiver CPU, proceed as follows:

1. Open the PLC tags of a CPU via the project tree "<Name of CPU> > PLC tags > Show all tags".

   The "PLC tags" table opens.

2. Enter the name of the new tag in the "Name" column.
3. In the "Data type" column, specify the "DX_TEL_SyncOp" data type.

   Note

   Data type "DX_TEL_SyncOp"

   If you have created a technology object V5.0, the data type "DX_TEL_SyncOp" is available in the drop-down list.

4. Enter the configured start address of the transfer area in the "Address" column with the following prefix:
   - "%Q" for an output tag on the sender CPU
   - "%I" for an input tag on the receiver CPU
5. Repeat steps 1 to 4 for the respective sender and receiver CPUs of all configured transfer areas.

Result

You have set up communication via controller-controller data exchange. During configuration of the leading axis and the leading axis proxy, you can now select the configured tags for the transfer areas in the "Transfer area" field under "Technology object > Configuration > Leading value settings".

You can find additional information on the topic of "Controller-controller data exchange" in the function manual "SIMATIC S7-1500, ET 200MP, ET 200SP, ET 200AL, ET 200pro Communication" (https://support.industry.siemens.com/cs/ww/en/view/59192925).

8.2.2 Configure provision of leading value (S7-1500T)

In the "Leading value settings" configuration window of the leading axis, configure the parameters of the leading value transfer.

You can find additional information depending on the technology object in the following sections:

Technology object	Section
Positioning axis	Section "Configuration - Leading value settings" of the "S7-1500/S7-1500T Axis functions" documentation (https://support.industry.siemens.com/cs/ww/en/view/109766462)
External encoder	Section "Configuration - Leading value settings" of the "S7-1500/S7-1500T Axis functions" documentation (https://support.industry.siemens.com/cs/ww/en/view/109766462)
Synchronous axis	"Configuration - Leading value settings (Page 77)" section

8.2.3 Configuring the leading axis proxy technology object (S7-1500T)

8.2.3.1 Configuration - Basic parameters (S7-1500T)

Configure the name of the technology object in the "Basic parameters" configuration window.

Name

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

8.2.3.2 Configuration - Leading value settings (S7-1500T)

In the "Leading value settings" configuration window, select the parameters of the leading value transfer.

Provision of leading value

In this area, define the settings for transferring the leading value to other CPUs:

Field	Description
Transfer area	In this drop-down list, select the input tag of the transfer area set up between the CPU of the leading axis and the CPUs of the following axes. When the technology object is copied, the selected transfer area is applied to the copy. You can find additional information on the transfer area in the section "Setting up communication via controller-controller data exchange (Page 171)".

Leading value monitoring

In this area, define the settings for leading value monitoring:

Field	Description
Tolerance time invalid leading value	In this input field, enter the tolerance time within which a valid leading value is expected. **Note** Note that the leading value is still being extrapolated during the tolerance time and that the following axis continues to move. Therefore, set the tolerance time as brief as possible.

Delay time of local leading value

In this area, configure the settings for local synchronous operation:

Field	Description
Allow system calculation	Select this check box to adapt the delay time of the local leading value in the system. System calculation is started when you trigger the calculation in the interconnection overview.
Delay time	If the "Allow system calculation" check box is cleared, this field can be edited. In this field (<TO>.Parameter.LocalLeadingValueDelayTime), enter the same delay time that is set at the virtual local following axis which, in turn, provides a cross-PLC leading value within a cascade (<TO>.CrossPlcSynchronousOperation.LocalLeadingValueDelayTime).
Interconnection overview	You open the interconnection overview via this link. With a cross-PLC synchronous operation, the interconnection overview contains an overview of the interconnected leading and following axes and their CPU assignment.

See also

Interconnection possibilities (Page 166)

Communication via PROFINET IO with IRT (Page 165)

8.2.4 Working with the interconnection overview table (S7-1500T)

8.2.4.1 Opening the interconnection overview (S7-1500T)

The interconnection overview contains an overview of the interconnected leading and following axes and their CPU assignment. In the interconnection overview, you also trigger the system calculation of the delay time.

Requirement

- You have created technology objects in the project for:
  - Leading axis
  - Following axis
  - Leading axis proxy
- You have interconnected the CPUs and technology objects with one another.

Procedure

To open the interconnection overview, follow these steps:

1. Select one of the following technology objects in the project navigation:
   - Positioning axis
   - Synchronous axis
   - External encoder
   - Leading axis proxy
2. Select the "Interconnection overview" command from the shortcut menu.

Result

The interconnection overview opens.

8.2.4.2 Interconnection overview (S7-1500T)

The interconnection overview contains an overview of the interconnected leading and following axes and their CPU assignment in tabular form.

Toolbar

The toolbar at the top of the interconnection overview provides the following functions via buttons:

Button	Description
	You update the view of the interconnection overview with this icon.
Calculate delay times	You trigger calculation of delay times with this button. The delay time is only calculated if the check box "Allow system calculation" is selected under "Leading value settings" during configuration of the technology objects. You can only trigger the calculation of the delay times if the values are not current and the technology objects are not recursively connected.

Filtering the view

You have the following options above the table to filter the view of the interconnection overview:

Field	Description
Enter text filter	In this field, enter a term by which the view should be filtered.
Show delay times	Select this check box to show the "Delay time" columns which contain the delay times.
Show local synchronous operations	Select this check box to display the local leading value interconnections in addition to the cross-PLC leading value interconnections.

Interconnection overview table

The interconnection overview table contains the following information and functions:

Column		Description
Leading value source		
	PLC	This column displays the CPU of the leading axis.
	Leading axis	This column displays the name of the leading axis. You open the configuration of the technology object via the link.
		 If this icon is displayed in the "Leading axis" column, the interconnection is excluded from the system calculation of the delay time. In the configuration of the leading axis, the check box "Allow system calculation" is not selected under "Leading value settings".
	DT	This column displays the delay time in ms. This column is only displayed when the "Show delay times" check box is selected.
	Leading value output	This column displays the type of the leading value output.
Recipient		
	PLC	This column displays the CPU of the following axis.
	Following axis	This column displays the name of the following axis. You open the configuration of the technology object via the link.
	Routes	When you select a row, the icon  is displayed in this column. You open the "Routes" area with this icon.
	Leading axis proxy	The name of the leading axis proxy is displayed in this column. You open the configuration of the technology object via the link.
		 If this icon is displayed in the "Leading axis proxy" column, the interconnection is excluded from the system calculation of the delay time. In the configuration of the leading axis proxy, the check box "Allow system calculation" is not selected under "Leading value settings".
	DT	This column displays the delay time in ms. This column is only displayed when the "Show delay times" check box is selected.
Interconnection		 If this icon is displayed in the "Interconnection" column, the interconnection is affected by a recursion.
		 If this icon is displayed in the "Interconnection" column, the interconnection is affected by a recursion, but at least one interconnection is excluded from the calculation of the delay time.
		 If this icon is displayed in the "Interconnection" column, the interconnection is excluded from the system calculation of the delay time.
		 With this icon, you open the configuration of the following axis.
		If the configured delay time corresponds to the calculated delay time, the icon  is displayed in this column.

8.2.4.3 Showing routes (S7-1500T)

The routes of the leading value of a selected following axis are shown in the area underneath the interconnection overview table. The leading value is tracked back from the following axis to the leading axis source. If there are multiple routes, they are displayed next to one another.

Requirement

- You have opened the interconnection overview.

Procedure

To display the existing routes of a following axis, follow these steps:

1. Select the row of the corresponding following axis in the table.
2. To show the routes, click the icon in the "Routes" column.

Result

All routes are displayed in the area below the table for the selected following axis. Routes affected by a recursion are not displayed.

It is indicated underneath a route whether the leading value is interpolated or extrapolated:

- If all cascades interpolate, "Interpolated" is displayed.
- If at least one cascade extrapolates, "Extrapolated" is displayed.

8.2.4.4 Setting the delay times (S7-1500T)

You can calculate and view the delay times in the interconnection overview. Alternatively, you can manually configure the delay times on the leading axis and on the virtual following axes. Depending on the set delay time, the leading value at the leading axis proxy is automatically interpolated or extrapolated.

Requirements

- You have interconnected the CPUs and technology objects with one another.
- Except for the delay time, the technology objects are fully configured.

Procedure

To set the delay times, proceed as follows:

1. In the configuration of the technology objects under "Leading value settings", select the check box "Allow system calculation".
2. Open the interconnection overview.
3. In the interconnection overview, click on "Calculate delay times".
4. Check the calculated delay times in the columns "DT" of the interconnection overview.
5. In the routes, check whether a leading value is interpolated or extrapolated at the leading axis proxy (<TO>.StatusExternalLeadingValue.AdjustmentTime (Page 290)).
6. To adjust the delay time, if necessary, and take into account additional requirements from your special application, for example, proceed as follows:
   - In the configuration of the leading axis and the virtual following axes under "Leading value settings", select the check box "Allow system calculation".
   - Enter the corresponding value in the "Delay time" input field.

8.3 Diagnostics (S7-1500T)

The "Diagnostics" section is limited to describing the diagnostics view of the leading axis proxy technology object in the TIA Portal.

You will find a description of Motion Control diagnostics in the following sections of the "S7-1500/S7-1500T Motion Control overview" documentation (https://support.industry.siemens.com/cs/ww/en/view/109766459):

- Diagnostic concept
- Technology alarms
- Errors in Motion Control instructions

A comprehensive description of the system diagnostics of the S7-1500 CPU can be found in the "Diagnostics" function manual (https://support.automation.siemens.com/WW/view/en/59192926).

You can find an example of the diagnostics of cross-PLC synchronous operation with the project trace in the Siemens Industry Online Support in the FAQ entry 109770938 (https://support.industry.siemens.com/cs/ww/en/view/109770938).

8.3.1 Leading axis proxy technology object (S7-1500T)

8.3.1.1 Status and error bits (S7-1500T)

You use the "Technology object > Diagnostics > Status and error bits" diagnostic function in the TIA Portal to monitor the status and error messages for the technology object. The diagnostics function is available in online operation.

The meaning of the status and error messages is described in the following tables. The associated technology object tag is given in parentheses.

Leading axis proxy status

The following table shows the possible states of the leading axis proxy:

Status	Description
Error	An error occurred at the technology object. Detailed information about the error is available in the "Error" area and in the "<TO>.ErrorDetail.Number" and "<TO>.ErrorDetail.Reaction" tags of the technology object. (<TO>.StatusWord.X1 (Error))
Restart active	The technology object is being reinitialized. (<TO>.StatusWord.X2 (RestartActive))
Restart required	Data relevant for the restart has been changed. The changes are applied only after a restart of the technology object. (<TO.>StatusWord.X3 (OnlineStartValuesChanged))
External leading value valid	The external leading value exists and is valid. (<TO>.StatusWord.X4 (LeadingValueValid))

Warnings

The following table shows the possible warnings:

Warning	Description
System	A system-internal error has occurred. (<TO>.WarningWord.X0 (SystemWarning))
Configuration	One or more configuration parameters are being internally adapted temporarily. (<TO>.WarningWord.X1 (ConfigWarning))
User program	An error has occurred in the user program. (<TO>.WarningWord.X2 (UserWarning))
Job rejected	Job cannot be executed. You cannot execute a Motion Control instruction because necessary requirements are not fulfilled. (<TO>.WarningWord.X3 (CommandNotAccepted))
Data exchange	An error in the communication has occurred. (<TO>.WarningWord.X7 (CommunicationWarning))

Error

The following table shows the possible errors:

Error	Description
System	A system-internal error has occurred. (<TO>.ErrorWord.X0 (SystemFault))
Configuration	A configuration error has occurred. One or more configuration parameters are inconsistent or invalid. The technology object was incorrectly configured, or editable configuration data was incorrectly modified during runtime of the user program. (<TO>.ErrorWord.X1 (ConfigFault))
User program	An error occurred in the user program at a Motion Control instruction or its use. (<TO>.ErrorWord.X2 (UserFault))
Job rejected	A job cannot be executed. You cannot execute a Motion Control instruction because necessary requirements are not fulfilled (for example, technology object not homed). (<TO>.ErrorWord.X3 (CommandNotAccepted))

Alarm display

For additional information and to acknowledge the error, go to the Inspector window by clicking on the "Alarm display" link.

Instructions (S7-1500, S7-1500T) 9

9.1 Synchronous motion (S7-1500, S7-1500T)

9.1.1 MC_GearIn V5 (S7-1500, S7-1500T)

9.1.1.1 MC_GearIn: Start gearing V5 (S7-1500, S7-1500T)

Description

With the Motion Control instruction "MC_GearIn", you start a gearing (Page 31) operation between a leading axis and a following axis.

You define the dynamic behavior of the following axis for synchronization with parameters "Jerk", "Acceleration" and "Deceleration".

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

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

You specify the gear ratio as the relationship between two integers (numerator/denominator) with the parameters "RatioNumerator" and "RatioDenominator".

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

- Positive gear ratio:

  The leading and following axes move in the same direction.
- Negative gear ratio:

  The following axis moves in the opposite direction of the leading axis.

You can start synchronous operation when the leading axis is at a standstill or when it is in motion.

Applies to

- Synchronous axis

Requirement

- The technology objects of the leading axis and the following axis have been configured correctly.
- The leading axis is a positioning axis, a synchronous axis, an external encoder or a leading axis proxy.
- The following axis is a synchronous axis.
- The leading axis is specified as possible leading axis in the configuration of the following axis in "Technology object > Configuration > Leading value interconnections".
- The following axis is enabled.

Override response

The override response for "MC_GearIn" jobs is described in section "Override response V5: Synchronous operation jobs (Page 238)".

Disabling the following axis with "MC_Power.Enable" = FALSE aborts the synchronous operation in every status.

Disabling the leading axis with "MC_Power", in contrast, does not abort synchronous operation. The following axis follows the leading axis even during the braking ramp and after the leading axis is enabled again.

Parameters

The following table shows the parameters of Motion Control instruction "MC_GearIn":

Parameters	Declaration	Data type	Default value	Description
Master	INPUT	TO_PositioningAxis TO_SynchronousAxis TO_ExternalEncoder TO_LeadingAxisProxy	-	Leading axis technology object
Slave	INPUT	TO_SynchronousAxis	-	Following axis technology object
Execute	INPUT	BOOL	FALSE	TRUE: Start job with a positive edge
RatioNumerator	INPUT	DINT	1	Gear ratio numerator Permitted integer values: -2147483648 to 2147483647 (value 0 not permitted)
RatioDenominator	INPUT	DINT	1	Gear ratio denominator Permitted integer values: 1 to 2147483647

Parameters	Declaration	Data type	Default value	Description	
Acceleration	INPUT	LREAL	-1.0	Acceleration	
				> 0.0	The specified value is used.
				= 0.0	Not permitted
				< 0.0	The acceleration configured in "Technology object > Configuration > Extended parameters > Dynamic defaults" is used. (<TO>.DynamicDefaults.Acceleration)
Deceleration	INPUT	LREAL	-1.0	Deceleration	
				> 0.0	The specified value is used.
				= 0.0	Not permitted
				< 0.0	The deceleration configured in "Technology object > Configuration > Extended parameters > Dynamic defaults" is used. (<TO>.DynamicDefaults.Deceleration)
Jerk	INPUT	LREAL	-1.0	Jerk	
				> 0.0	Constant acceleration velocity profile The specified value is used.
				= 0.0	Trapezoid velocity profile
				< 0.0	The jerk configured in "Technology object > Configuration > Extended parameters > Dynamic defaults" is used. (<TO>.DynamicDefaults.Jerk)
InGear	OUTPUT	BOOL	FALSE	TRUE	Synchronous operation reached The following axis is synchronized and moves synchronously to the leading axis.
Busy	OUTPUT	BOOL	FALSE	TRUE	The job is being processed.
CommandAborted	OUTPUT	BOOL	FALSE	TRUE	The job was aborted by another job during execution.
Error	OUTPUT	BOOL	FALSE	TRUE	An error occurred while processing the job. The job is rejected. The cause of the error can be found in the "ErrorID" parameter.
ErrorID	OUTPUT	WORD	0	Error ID for parameter "ErrorID"	

Starting synchronous operation

To start synchronous operation with the Motion Control instruction "MC_GearIn", follow these steps:

1. Check the requirements indicated above.
2. Specify the leading axis, the following axis and the gear ratio at the corresponding parameters.
3. Start the "MC_GearIn" job with a positive edge at parameter "Execute".

   The following axis is synchronized to the leading value of the leading axis. If the "InGear" parameter shows the value "TRUE", the following axis is synchronized and moves synchronously to the leading axis. The parameters "InGear" and "Busy" show the value "TRUE" until the "MC_GearIn" job is overridden by another Motion Control job.

See also

Gearing with "MC_GearIn" (Page 31)

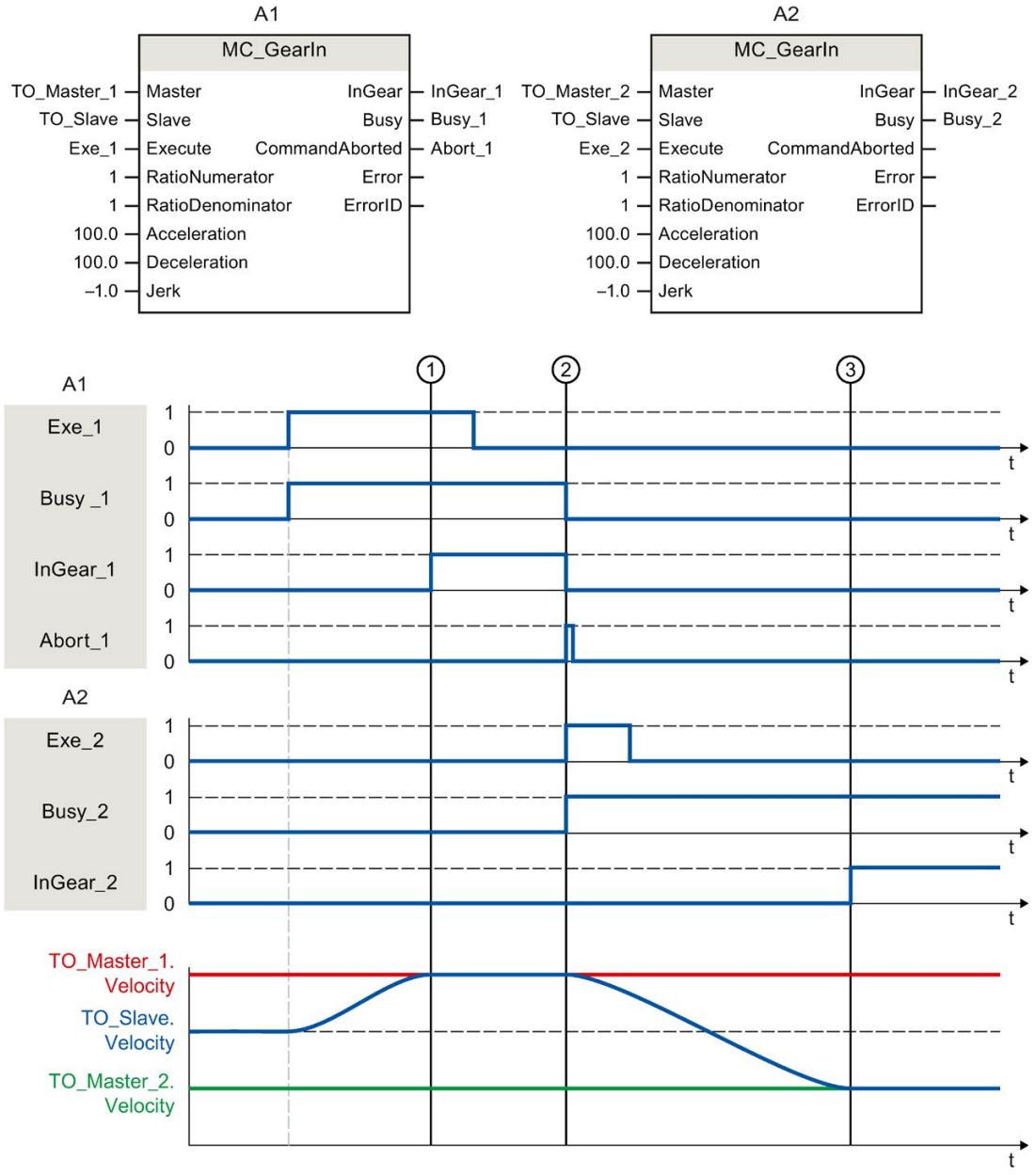
Override response V5: Synchronous operation jobs (Page 238)

Synchronization with "MC_GearIn" (Page 36)

Section "Error detection Motion Control instructions" of the documentation "S7-1500/S7-1500T Motion Control Overview".
(https://support.industry.siemens.com/cs/ww/en/view/109766459)

9.1.1.2 MC_GearIn: Function chart V5 (S7-1500, S7-1500T)

Function chart: Synchronizing and switching the leading value



Using "Exe_1", an "MC_GearIn" job (A1) is initiated. The following axis (TO_Slave) is synchronized to the leading axis (TO_Master_1). "InGear_1" signals at time ① that the following axis is synchronized and moves synchronously to the leading axis.

At time ②, synchronous operation is overridden by another "MC_GearIn" job (A2). The abort is signaled via "Abort_1". The following axis is synchronized to the new leading axis (TO_Master_2). "InGear_2" signals at time ③ that the following axis is synchronized and moves synchronously to the leading axis.

9.1.2 MC_GearInPos V5 (S7-1500T)

9.1.2.1 MC_GearInPos: Start gearing with specified synchronous positions V5 (S7-1500T)

Description

With the Motion Control instruction "MC_GearInPos", you start a gearing (Page 33) operation between a leading axis and a following axis. The synchronous operation is synchronized depending on the specified synchronous position for the leading and following axis.

The following types of synchronization (Page 36) are possible:

- Synchronization in advance using dynamic parameters ("SyncProfileReference" = 0)
- Synchronization in advance using leading value distance ("SyncProfileReference" = 1)
- Subsequent synchronization using leading value distance ("SyncProfileReference" = 3)

You specify the gear ratio as the relationship between two integers (numerator/denominator) with the parameters "RatioNumerator" and "RatioDenominator".

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

- Positive gear ratio:

  The leading and following axes move in the same direction.

- Negative gear ratio:

  The following axis moves in the opposite direction of the leading axis.

You can start synchronous operation when the leading axis is at a standstill or when it is in motion.

Applies to

- Synchronous axis

Requirement

- The technology objects of the leading axis and the following axis have been configured correctly.
- The leading axis is a positioning axis, synchronous axis, external encoder or leading axis proxy.
- The following axis is a synchronous axis.
- The leading axis is specified as possible leading axis in the configuration of the following axis under "Technology object > Configuration > Leading value interconnections".
- The following axis is enabled.
- With synchronization in advance using leading value distance, the leading axis must be at least the specified distance ("MasterStartDistance") from the synchronization position ("MasterSyncPosition") when starting the job.

Override response

The override response for "MC_GearInPos" jobs is described in section "Override response V5: Synchronous operation jobs (Page 238)".

Disabling the following axis with "MC_Power.Enable" = FALSE aborts the synchronous operation in every status.

Disabling the leading axis with "MC_Power", in contrast, does not abort synchronous operation. The following axis follows the leading axis even during the braking ramp and after the leading axis is enabled again.

Parameters

The following table shows the parameters of Motion Control instruction "MC_GearInPos":

Parameters	Declaration	Data type	Default value	Description
Master	INPUT	TO_PositioningAxis TO_SynchronousAxis TO_ExternalEncoder TO_LeadingAxisProxy	-	Leading axis technology object
Slave	INPUT	TO_SynchronousAxis	-	Following axis technology object
Execute	INPUT	BOOL	FALSE	TRUE: Start job with a positive edge
RatioNumerator	INPUT	DINT	1	Gear ratio numerator Permitted integer values: -2147483648 to 2147483647 (value 0 not permitted)
RatioDenominator	INPUT	DINT	1	Gear ratio denominator Permitted integer values: 1 to 2147483647

Parameters	Declaration	Data type	Default value	Description	
MasterSyncPosition	INPUT	LREAL	0.0	Synchronous position of leading axis	
				When "SyncProfileReference" = 0, 1: Position of the leading axis from which the axes are synchronous and the synchronization is completed.	
				When "SyncProfileReference" = 3: Position of the leading axis from which synchronization starts	
SlaveSyncPosition	INPUT	LREAL	0.0	Synchronous position of following axis	
				When "SyncProfileReference" = 0, 1: Position of the following axis from which the axes are synchronous and the synchronization is completed.	
				When "SyncProfileReference" = 3: Position of the following axis, which is assigned to the synchronous position of the leading axis.	
SyncProfileReference	INPUT	DINT	1	Type of synchronization	
				0	Synchronization in advance using dynamic parameters
				1	Synchronization in advance using leading value distance
				2	Reserved
				3	Subsequent synchronization using leading value distance
				4	Reserved
MasterStartDistance	INPUT	LREAL	1.0	When "SyncProfileReference" = 1, 3: Leading value distance	
				When "SyncProfileReference" = 0: Not relevant	
Velocity	INPUT	LREAL	-1.0	When "SyncProfileReference" = 0: Velocity	
				> 0.0	The specified value is used.
				= 0.0	Not permitted
				< 0.0	The velocity configured in "Technology object > Configuration > Extended parameters > Dynamic defaults" is used. (<TO>.DynamicDefaults.Velocity)
				When "SyncProfileReference" = 1, 3: Not relevant	

Parameters	Declaration	Data type	Default value	Description	
Acceleration	INPUT	LREAL	-1.0	When "SyncProfileReference" = 0: Acceleration	
				> 0.0	The specified value is used.
				= 0.0	Not permitted
				< 0.0	The acceleration configured in "Technology object > Configuration > Extended parameters > Dynamic defaults" is used. (<TO>.DynamicDefaults.Acceleration)
				When "SyncProfileReference" = 1, 3: Not relevant	
Deceleration	INPUT	LREAL	-1.0	When "SyncProfileReference" = 0: Deceleration	
				> 0.0	The specified value is used.
				= 0.0	Not permitted
				< 0.0	The deceleration configured in "Technology object > Configuration > Extended parameters > Dynamic defaults" is used. (<TO>.DynamicDefaults.Deceleration)
				When "SyncProfileReference" = 1, 3: Not relevant	
Jerk	INPUT	LREAL	-1.0	When "SyncProfileReference" = 0: Jerk	
				> 0.0	Constant acceleration velocity profile The specified value is used.
				= 0.0	Trapezoid velocity profile
				< 0.0	The jerk configured in "Technology object > Configuration > Extended parameters > Dynamic defaults" is used. (<TO>.DynamicDefaults.Jerk)
				When "SyncProfileReference" = 1, 3: Not relevant	

Parameters	Declaration	Data type	Default value	Description	
SyncDirection	INPUT	DINT	3	Direction of synchronization (in effect for axes with activated Modulo setting)	
				1	Positive direction The following axis may only travel in positive direction during synchronization.
				2	Negative direction The following axis may only travel in negative direction during synchronization.
				3	Shortest distance Changes in direction are permitted for the following axis during synchronization.
StartSync	OUTPUT	BOOL	FALSE	TRUE	The following axis is synchronized to the leading axis.
InSync	OUTPUT	BOOL	FALSE	TRUE	Synchronous operation reached The following axis is synchronized and moves synchronously to the leading axis.
Busy	OUTPUT	BOOL	FALSE	TRUE	The job is being processed.
CommandAborted	OUTPUT	BOOL	FALSE	TRUE	The job was aborted by another job during execution.
Error	OUTPUT	BOOL	FALSE	TRUE	An error occurred while processing the job. The job is rejected. The cause of the error can be found in the "ErrorID" parameter.
ErrorID	OUTPUT	WORD	0	Error ID for parameter "ErrorID"	

Starting synchronous operation

To start synchronous operation with the Motion Control instruction "MC_GearInPos", follow these steps:

1. Check the requirements indicated above.
2. Specify the leading axis, the following axis, the gear ratio and the synchronous position with the corresponding parameters.
3. Start the "MC_GearInPos" job with a positive edge at parameter "Execute".

   The following axis is synchronized to the leading value of the leading axis. If the "InSync" parameter shows the value "TRUE", the following axis is synchronized and moves synchronously to the leading axis. The parameters "InSync" and "Busy" show the value "TRUE" until the "MC_GearInPos" job is overridden by another Motion Control job.

See also

Gearing with "MC_GearInPos" with specified synchronous position (Page 33)

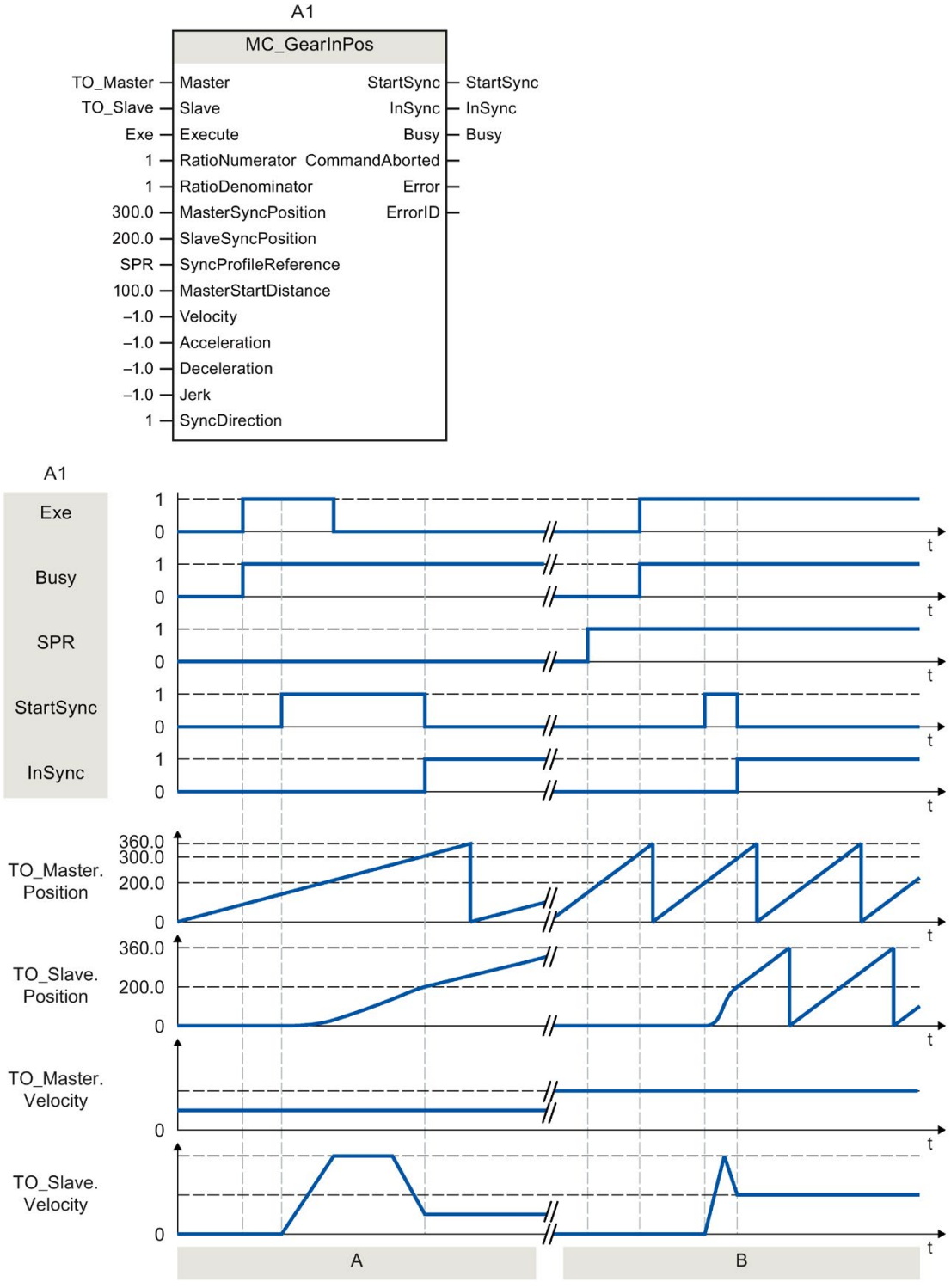
Override response V5: Synchronous operation jobs (Page 238)

Section "Error detection Motion Control instructions" of the documentation "S7-1500/S7-1500T Motion Control Overview".
(https://support.industry.siemens.com/cs/ww/en/view/109766459)

Synchronization (Page 36)

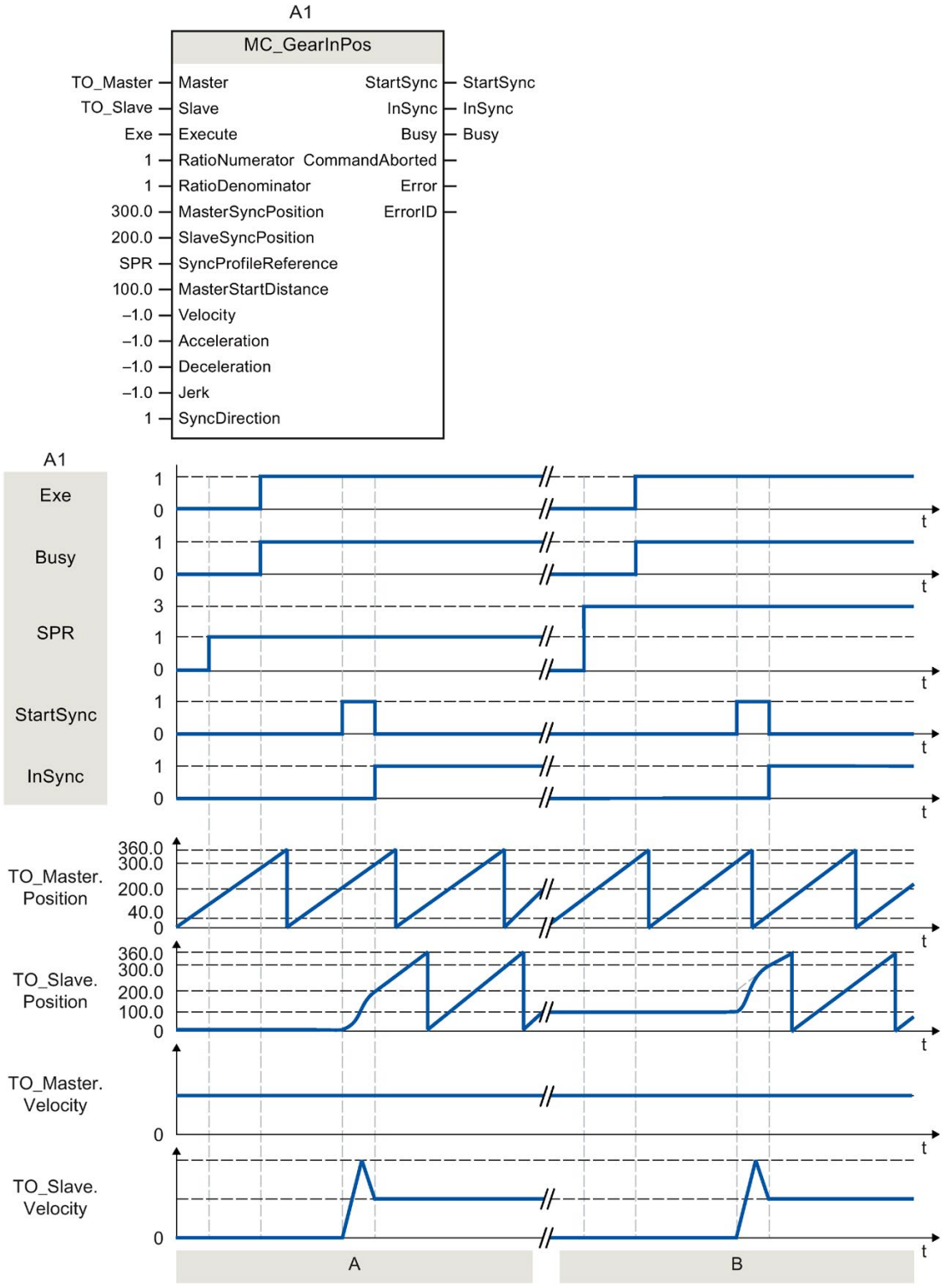
9.1.2.2 MC_GearInPos: Function chart V5 (S7-1500T)

Function chart: Synchronization in advance using dynamic parameters/leading value distance



Section A	Using "Exe", an "MC_GearInPos" job (A1) is initiated. The start of the synchronization is displayed with "StartSync". The following axis (TO_Slave) is synchronized in advance to the leading axis (TO_Master) by means of the specified dynamic parameters. The distance required for synchronization is calculated by the system. When the specified reference positions "MasterSyncPosition" and "SlaveSyncPosition" are reached, "InSync" signals that the following axis is synchronized and moving synchronously to the leading axis.
Section B	Using "Exe", an "MC_GearInPos" job (A1) is initiated. The start of the synchronization is displayed with "StartSync". The following axis (TO_Slave) is synchronized to the leading axis (TO_Master) by means of the specified leading value distance ("MasterStartDistance"). The dynamic response required for synchronization is calculated by the system. When the specified reference positions "MasterSyncPosition" and "SlaveSyncPosition" are reached, "InSync" signals that the following axis is synchronized and moving synchronously to the leading axis.

Function chart: Synchronization in advance/subsequent synchronization via leading value distance



Section A	Using "Exe", an "MC_GearInPos" job (A1) is initiated. The start of the synchronization is displayed with "StartSync". The following axis (TO_Slave) is synchronized to the leading axis (TO_Master) by means of the specified leading value distance ("MasterStartDistance"). The dynamic response required for synchronization is calculated by the system. When the specified reference positions "MasterSyncPosition" and "SlaveSyncPosition" are reached, "InSync" signals that the following axis is synchronized and moving synchronously to the leading axis.
Section B	Using "Exe", an "MC_GearInPos" job (A1) is initiated. When the specified reference position "MasterSyncPosition" is reached, the start of synchronization is indicated via "StartSync". The following axis (TO_Slave) is synchronized subsequently to the leading axis (TO_Master) by means of the specified leading value distance "MasterStartDistance". The dynamics required for synchronization is calculated by the system. "InSync" signals that the following axis is synchronized and moving synchronously to the leading axis.

9.1.3 MC_PhasingRelative V5 (S7-1500T)

9.1.3.1 MC_PhasingRelative: Relative shift of leading value on the following axis V5 (S7-1500T)

Description

With the Motion Control instruction "MC_PhasingRelative", you shift the leading value on a following axis during gearing with "MC_GearIn" and "MC_GearInPos" relative to the existing leading value shift. The position of the leading axis is not affected by this.

You define the dynamic response of the motion of the following axis with the parameters "Velocity", "Jerk", "Acceleration", and "Deceleration". The dynamic values are added to the values of the synchronous operation motion.

Applies to

- Synchronous axis

Requirement

- The technology objects of the leading axis and the following axis have been configured correctly.
- The leading axis is a positioning axis, synchronous axis, external encoder or leading axis proxy.
- The following axis is a synchronous axis.
- The leading axis is specified as possible leading axis in the configuration of the following axis in "Technology object > Configuration > Leading value interconnections".
- By means of the Motion Control instruction "MC_GearIn" or "MC_GearInPos", the following axis is synchronized to the leading axis ("MC_GearIn.InGear" = TRUE or "MC_GearInPos.InSync" = TRUE).
- The following axis is enabled.

Override response

The override response for "MC_PhasingRelative" jobs is described in section "Override response V5: Synchronous operation jobs (Page 238)".

Disabling the leading axis with "MC_Power.Enable" = FALSE does not abort the leading value shift. The following axis follows the leading axis even during the braking ramp and after the leading axis is enabled again.

Parameters

The following table shows the parameters of Motion Control instruction "MC_PhasingRelative":

Parameters	Declaration	Data type	Default value	Description	
Master	INPUT	TO_PositioningAxis TO_SynchronousAxis TO_ExternalEncoder TO_LeadingAxisProxy	-	Leading axis technology object	
Slave	INPUT	TO_SynchronousAxis	-	Following axis technology object	
Execute	INPUT	BOOL	FALSE	TRUE	Start job with a positive edge
PhaseShift	INPUT	LREAL	0.0	Relative leading value shift	
Velocity	INPUT	LREAL	-1.0	Velocity of the following axis for leading value shift (added to synchronous operation motion)	
				> 0.0	The specified value is used.
				= 0.0	Not permitted
				< 0.0	The velocity configured in "Technology object > Configuration > Extended parameters > Dynamic defaults" is used. (<TO>.DynamicDefaults.Velocity)
Acceleration	INPUT	LREAL	-1.0	Acceleration of the following axis for leading value shift (added to synchronous operation motion)	
				> 0.0	The specified value is used.
				= 0.0	Not permitted
				< 0.0	The acceleration configured in "Technology object > Configuration > Extended parameters > Dynamic defaults" is used. (<TO>.DynamicDefaults.Acceleration)
Deceleration	INPUT	LREAL	-1.0	Deceleration of the following axis for leading value shift (added to synchronous operation motion)	
				> 0.0	The specified value is used.
				= 0.0	Not permitted
				< 0.0	The deceleration configured in "Technology object > Configuration > Extended parameters > Dynamic defaults" is used. (<TO>.DynamicDefaults.Deceleration)

Parameters	Declaration	Data type	Default value	Description	
Jerk	INPUT	LREAL	-1.0	Jerk of the following axis for leading value shift (added to synchronous operation motion)	
				> 0.0	Constant acceleration velocity profile The specified value is used.
				= 0.0	Trapezoid velocity profile
				< 0.0	The jerk configured in "Technology object > Configuration > Extended parameters > Dynamic defaults" is used. (<TO>.DynamicDefaults.Jerk)
Done	OUTPUT	BOOL	FALSE	TRUE	Leading value shift is finished.
Busy	OUTPUT	BOOL	FALSE	TRUE	The job is being processed.
CommandAborted	OUTPUT	BOOL	FALSE	TRUE	The job was aborted by another job during execution.
Error	OUTPUT	BOOL	FALSE	TRUE	An error occurred while processing the job. The job is rejected. The cause of the error can be found in the "ErrorID" parameter.
ErrorID	OUTPUT	WORD	0	Error ID for parameter "ErrorID"	
CoveredPhaseShift	OUTPUT	LREAL	0.0	As long as "Busy" = TRUE: Display of leading value shift completed up to now	

Start relative leading value shift

To start a relative leading value shift with the Motion Control instruction "MC_PhasingRelative", follow these steps:

1. Check the requirements indicated above.
2. Specify the relative leading value shift in the "PhaseShift" parameter.
3. Start the "MC_PhasingRelative" job with a positive edge at parameter "Execute".

   The current motion state is indicated in parameters "Busy", "CoveredPhaseShift", "Done" and "Error".

See also

Override response V5: Synchronous operation jobs (Page 238)

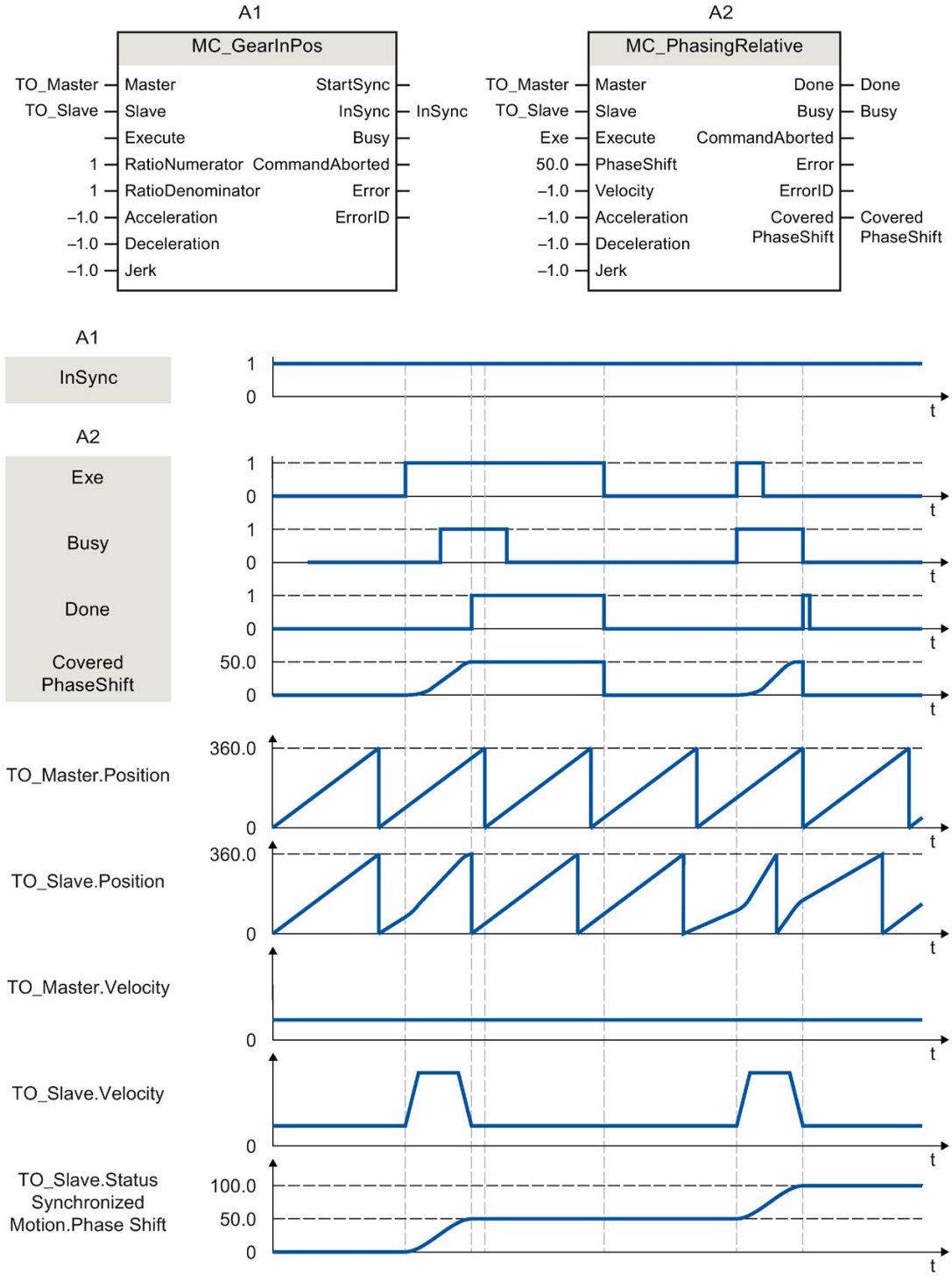
Section "Error detection Motion Control instructions" of the documentation "S7-1500/S7-1500T Motion Control Overview".
(https://support.industry.siemens.com/cs/ww/en/view/109766459)

MC_GearIn V5 (Page 184)

MC_GearInPos V5 (Page 189)

9.1.3.2 MC_PhasingRelative: Function chart V5 (S7-1500T)

Function chart: Relative shift of leading value



During an active gearing operation with "MC_GearInPos" (A1), a "MC_PhasingRelative" job (A2) is initiated using "Exe". The leading value shift is performed with the dynamics specified additively to the synchronous operation motion. "Done" indicates that the leading value was successfully shifted. The leading value shift 50.0 resulting from the job is indicated in "CoveredPhaseShift". The absolute leading value shift 50.0 is indicated in the tag of the technology object <TO>.StatusSynchronizedMotion.PhaseShift. The motion of the leading axis is not affected.

After the leading value shift, the "MC_PhasingRelative" job (A2) is initiated again using "Exe". The leading value shift is performed again with the dynamics specified additively to the synchronous operation motion. "Done" indicates that the leading value was successfully shifted. The leading value shift 50.0 resulting from the job is indicated in "CoveredPhaseShift". The absolute leading value shift 100.0 is indicated in the tag of the technology object <TO>.StatusSynchronizedMotion.PhaseShift.

9.1.4 MC_PhasingAbsolute V5 (S7-1500T)

9.1.4.1 MC_PhasingAbsolute: Absolute shift of leading value on the following axis V5 (S7-1500T)

Description

With the Motion Control instruction "MC_PhasingAbsolute", you shift the leading value on a following axis during gearing with "MC_GearIn" and "MC_GearInPos" as an absolute shift. The position of the leading axis is not affected by this.

You define the dynamic response of the motion of the following axis with the parameters "Velocity", "Jerk", "Acceleration", and "Deceleration". The dynamic values are added to the values of the synchronous operation motion.

Applies to

- Synchronous axis

Requirement

- The technology objects of the leading axis and the following axis have been configured correctly.
- The leading axis is a positioning axis, synchronous axis, external encoder or leading axis proxy.
- The following axis is a synchronous axis.
- The leading axis is specified as possible leading axis in the configuration of the following axis in "Technology object > Configuration > Leading value interconnections".
- By means of the Motion Control instruction "MC_GearIn" or "MC_GearInPos", the following axis is synchronized to the leading axis ("MC_GearIn.InGear" = TRUE or "MC_GearInPos.InSync" = TRUE).
- The following axis is enabled.

Override response

The override response for "MC_PhasingAbsolute" jobs is described in section "Override response V5: Synchronous operation jobs (Page 238)".

Disabling the leading axis with "MC_Power.Enable" = FALSE does not abort the leading value shift. The following axis follows the leading axis even during the braking ramp and after the leading axis is enabled again.

Parameters

The following table shows the parameters of Motion Control instruction "MC_PhasingAbsolute":

Parameters	Declaration	Data type	Default value	Description	
Master	INPUT	TO_PositioningAxis TO_SynchronousAxis TO_ExternalEncoder TO_LeadingAxisProxy	-	Leading axis technology object	
Slave	INPUT	TO_SynchronousAxis	-	Following axis technology object	
Execute	INPUT	BOOL	FALSE	TRUE	Start job with a positive edge
PhaseShift	INPUT	LREAL	0.0	Absolute leading value shift	
Velocity	INPUT	LREAL	-1.0	Velocity of the following axis for leading value shift (added to synchronous operation motion)	
				> 0.0	The specified value is used.
				= 0.0	Not permitted
				< 0.0	The velocity configured in "Technology object > Configuration > Extended parameters > Dynamic defaults" is used. (<TO>.DynamicDefaults.Velocity)
Acceleration	INPUT	LREAL	-1.0	Acceleration of the following axis for leading value shift (added to synchronous operation motion)	
				> 0.0	The specified value is used.
				= 0.0	Not permitted
				< 0.0	The acceleration configured in "Technology object > Configuration > Extended parameters > Dynamic defaults" is used. (<TO>.DynamicDefaults.Acceleration)
Deceleration	INPUT	LREAL	-1.0	Deceleration of the following axis for leading value shift (added to synchronous operation motion)	
				> 0.0	The specified value is used.
				= 0.0	Not permitted
				< 0.0	The deceleration configured in "Technology object > Configuration > Extended parameters > Dynamic defaults" is used. (<TO>.DynamicDefaults.Deceleration)

Parameters	Declaration	Data type	Default value	Description	
Jerk	INPUT	LREAL	-1.0	Jerk of the following axis for leading value shift (added to synchronous operation motion)	
				> 0.0	Constant acceleration velocity profile The specified value is used.
				= 0.0	Trapezoid velocity profile
				< 0.0	The jerk configured in "Technology object > Configuration > Extended parameters > Dynamic defaults" is used. (<TO>.DynamicDefaults.Jerk)
Done	OUTPUT	BOOL	FALSE	TRUE	Leading value shift is finished.
Busy	OUTPUT	BOOL	FALSE	TRUE	The job is being processed.
CommandAborted	OUTPUT	BOOL	FALSE	TRUE	The job was aborted by another job during execution.
Error	OUTPUT	BOOL	FALSE	TRUE	An error occurred while processing the job. The job is rejected. The cause of the error can be found in the "ErrorID" parameter.
ErrorID	OUTPUT	WORD	0	Error ID for parameter "ErrorID"	
AbsolutePhaseShift	OUTPUT	LREAL	0.0	As long as "Busy" = TRUE: Display of leading value shift completed up to now	

Start absolute leading value shift

To start an absolute leading value shift with the Motion Control instruction "MC_PhasingAbsolute", follow these steps:

1. Check the requirements indicated above.
2. Specify the absolute leading value shift in the "PhaseShift" parameter.
3. Start the "MC_PhasingAbsolute" job with a positive edge at parameter "Execute".

   The current motion state is indicated in parameters "Busy", "AbsolutePhaseShift", "Done" and "Error".

See also

Override response V5: Synchronous operation jobs (Page 238)

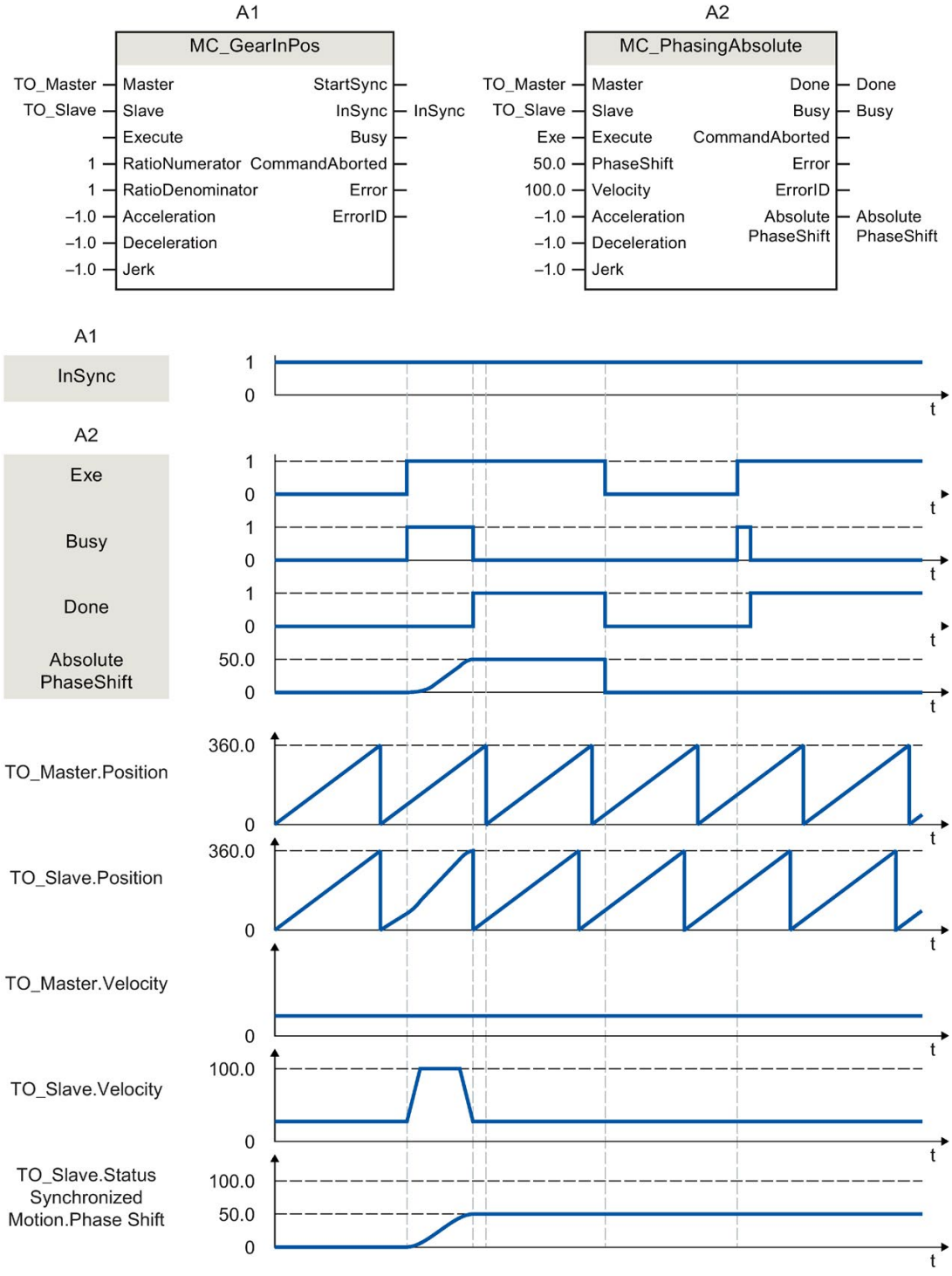
Section "Error detection Motion Control instructions" of the documentation "S7-1500/S7-1500T Motion Control Overview".
(https://support.industry.siemens.com/cs/ww/en/view/109766459)

MC_GearIn V5 (Page 184)

MC_GearInPos V5 (Page 189)

9.1.4.2 MC_PhasingAbsolute: Function chart V5 (S7-1500T)

Function chart: Absolute shift of leading value



During an active gearing operation with "MC_GearInPos" (A1), a "MC_PhasingAbsolute" job (A2) is initiated using "Exe". The leading value shift is performed with the dynamics specified additively to the synchronous operation motion. "Done" indicates that the leading value was successfully shifted. The leading value shift 50.0 resulting from the job is indicated in "AbsolutePhaseShift". The absolute leading value shift 50.0 is indicated in the tag of the technology object <TO>.StatusSynchronizedMotion.PhaseShift. The motion of the leading axis is not affected.

After the leading value shift, the "MC_PhasingAbsolute" job (A2) is initiated again using "Exe". Because the leading value shift (<TO>.StatusSynchronizedMotion.PhaseShift) is already 50.0, the leading value is not shifted.

9.1.5 MC_CamIn V5 (S7-1500T)

9.1.5.1 MC_CamIn: Start camming V5 (S7-1500T)

Description

With the Motion Control instruction "MC_CamIn", you start a camming (Page 45) operation between a leading axis and a following axis. The synchronous operation is synchronized depending on the specified synchronous position of the leading axis.

A cam is defined between the start position (<TO>.StatusCam.StartLeadingValue) and end position (<TO>.StatusCam.EndLeadingValue) after the interpolation. The specification for leading and following value range in the configuration of the technology object (Page 105) only effect the display in the graphical editor.

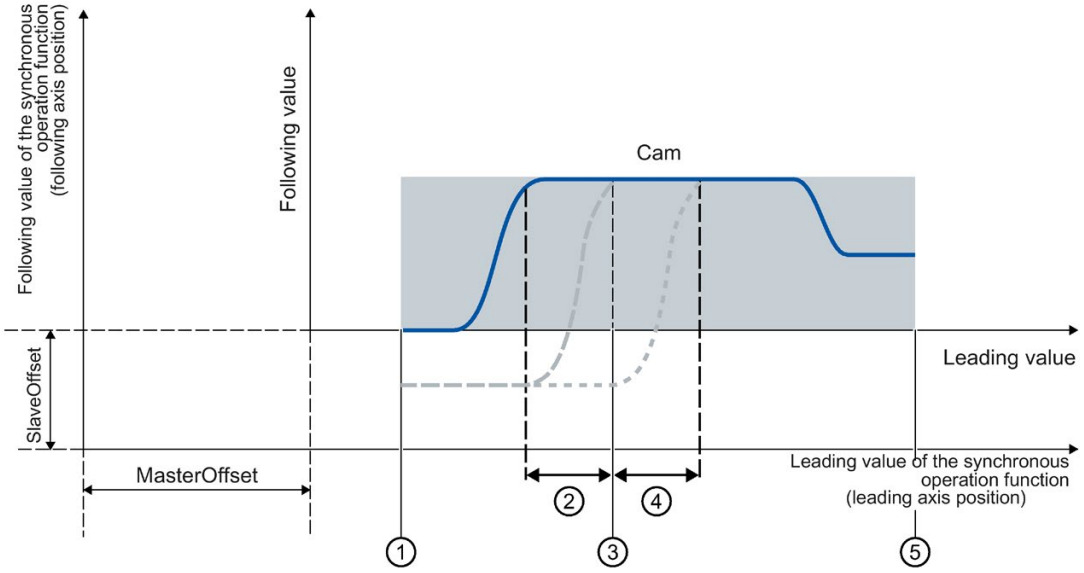
With the "MasterSyncPosition" parameter, you specify the synchronization position in the cam relative to the starting position of the cam. The synchronous position establishes the relationship between leading value and following value, independent of the type of synchronization. With "MasterSyncPosition" ≠ 0.0, you move the synchronous position within the cam without changing the position of the cam.

The synchronous position of the leading axis results from the starting position of the cam and the "MasterSyncPosition" and "MasterOffset" parameters.

With the "MasterOffset" parameter, you offset the leading values of the cam (with "SyncProfileReference" = 0, 1, 3, 4). This determines the position of the cam in relation to the leading value of the synchronous operation function. This is how you move the cam to the required position range.

The following figure shows the basic effect of the leading value and following value offset as well as the position of the cam with the following parameter values:

- "MasterOffset" > 0
- Start position of the cam > 0
- "MasterSyncPosition" > 0



① Start position of the cam
First defined interpolation point/start of the first segment of the cam (<TO>.StatusCam.StartLeadingValue)

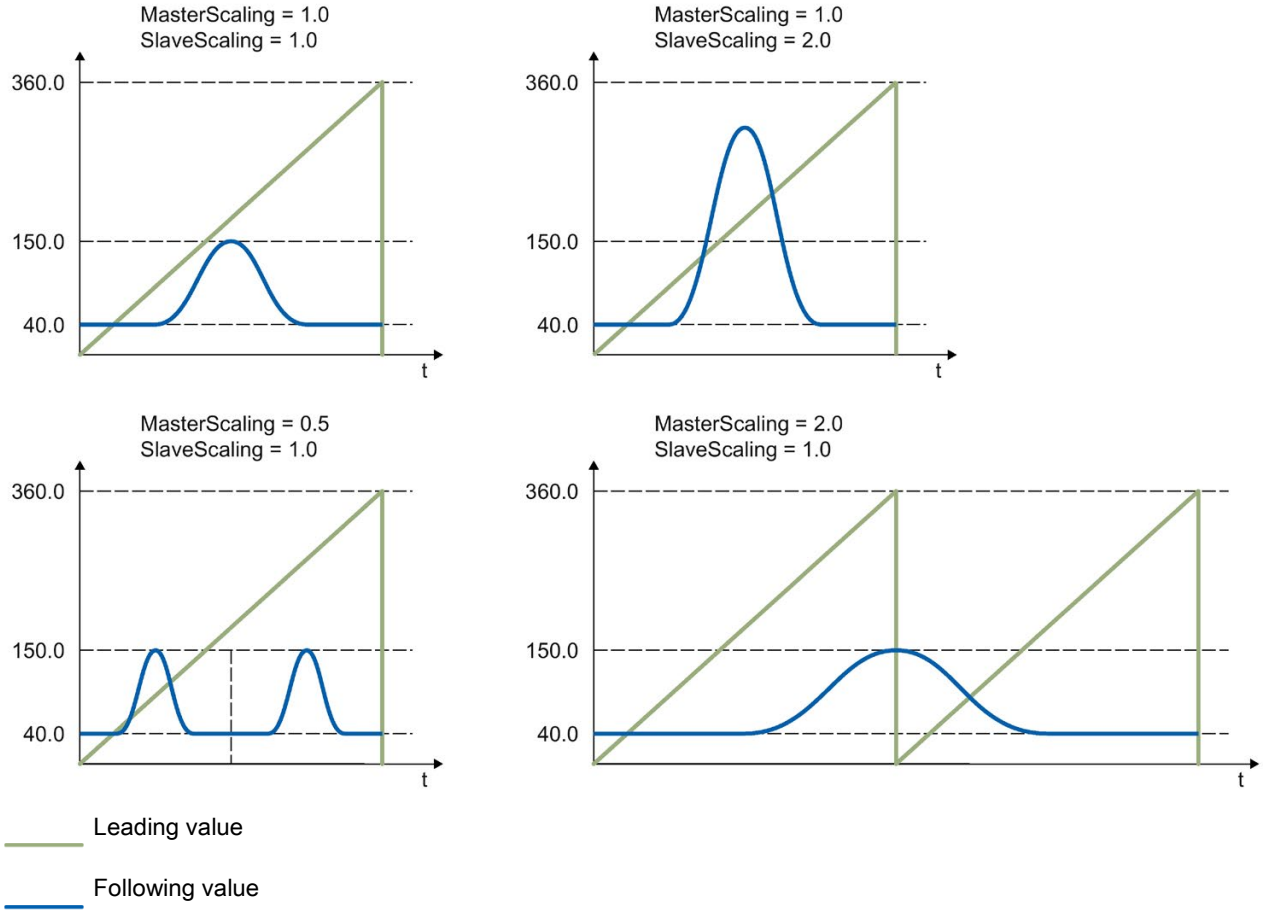
② Leading value distance with synchronization in advance ("MasterStartDistance")

③ Synchronous position of the leading axis relative to the starting position of the cam ("MasterSyncPosition")

④ Leading value distance with subsequent synchronization ("MasterStartDistance")

⑤ End position of the cam
Last defined interpolation point/end of the last segment of the cam (<TO>.StatusCam.EndLeadingValue)

The figure below shows the basic effect of scaling the cam with the parameters "MasterScaling" and "SlaveScaling":



The following types of synchronization (Page 55) are possible:

- Synchronization in advance using dynamic parameters or leading value distance ("SyncProfileReference" = 0 or 1)

  The synchronous operation is synchronized in advance to the specified synchronous position of the leading axis ("MasterSyncPosition"). When the leading axis has reached the synchronous position, the leading and following axis move synchronously.

  To run through the entire cam, specify the value 0.0 (default value) in "MasterSyncPosition".

- Direct synchronous setting ("SyncProfileReference" = 2)

  Synchronous operation is immediately set to synchronous. You use the "MasterSyncPosition" parameter to set the exact synchronous position in the cam. This setting is mainly suitable for synchronizing at a standstill.

- Subsequent synchronization using leading value distance ("SyncProfileReference" = 3)

  The synchronous operation is synchronized subsequently starting from the specified synchronous position of the leading axis ("MasterSyncPosition").

- Subsequent synchronization using leading value distance starting from current leading value position ("SyncProfileReference" = 4)

  The synchronous operation is synchronized subsequently starting from the current position of the leading axis.

You can start synchronization when the leading axis or following axis is at a standstill or when it is in motion.

Applies to

- Cam
- Synchronous axis

Requirement

- The technology objects of the leading axis, following axis, and cam have been configured correctly.
- The leading axis is a positioning axis, synchronous axis, external encoder or leading axis proxy.
- The following axis is a synchronous axis.
- The leading axis is specified as possible leading axis in the configuration of the following axis under "Technology object > Configuration > Leading value interconnections".
- The following axis is enabled.
- The cam is interpolated with "MC_InterpolateCam".
- With synchronization in advance using leading value distance, the leading axis must be at least the specified distance ("MasterStartDistance") from the synchronization position ("MasterSyncPosition") when starting the job.

Override response

The override response for "MC_CamIn" jobs is described in section "Override response V5: Synchronous operation jobs (Page 238)".

Disabling the following axis with "MC_Power.Enable" = FALSE aborts the synchronous operation in every status.

Disabling the leading axis with "MC_Power", in contrast, does not abort synchronous operation. The following axis follows the leading axis even during the braking ramp and after the leading axis is enabled again.

Parameters

The following table shows the parameters of Motion Control instruction "MC_CamIn":

Parameter	Declaration	Data type	Default value	Description
Master	INPUT	TO_PositioningAxis TO_SynchronousAxis TO_ExternalEncoder TO_LeadingAxisProxy	-	Leading axis technology object
Slave	INPUT	TO_SynchronousAxis	-	Following axis technology object
Cam	INPUT	TO_Cam	-	Cam technology object
Execute	INPUT	BOOL	FALSE	TRUE: Start job with a positive edge
MasterOffset	INPUT	LREAL	0.0	When "SyncProfileReference" = 0, 1, 3, 4: Offset of the leading values of cam The cam technology object is not changed.
				When "SyncProfileReference" = 2: Not relevant
SlaveOffset	INPUT	LREAL	0.0	When "SyncProfileReference" = 0, 1, 3, 4: Offset of the following values of cam The cam technology object is not changed.
				When "SyncProfileReference" = 2: Not relevant
MasterScaling	INPUT	LREAL	1.0	Scaling the leading values of the cam The cam technology object is not changed.
SlaveScaling	INPUT	LREAL	1.0	Scaling the following values of the cam The cam technology object is not changed.

Parameter	Declaration	Data type	Default value	Description	
MasterSyncPosition	INPUT	LREAL	0.0	Synchronous position of leading axis	
				When "SyncProfileReference" = 0, 1, 2: Position of the leading axis (relative to the starting position of the cam), from which the axes are synchronous and synchronization is complete. The value must be within the definition of the cam.	
				When "SyncProfileReference" = 3: Position of the leading axis (relative to the starting position of the cam) from which the synchronization begins The value must be within the definition of the cam.	
				When "SyncProfileReference" = 4: Not relevant	
SyncProfileReference	INPUT	DINT	1	Synchronization profile	
				0	Synchronization in advance using dynamic parameters
				1	Synchronization in advance using leading value distance
				2	Direct synchronous setting
				3	Subsequent synchronization using leading value distance
				4	Subsequent synchronization using leading value distance starting from current leading value position
MasterStartDistance	INPUT	LREAL	0.0	When "SyncProfileReference" = 1, 3, 4: Leading value distance Distance of the leading axis during the synchronization	
				When "SyncProfileReference" = 0, 2: Not relevant	
Velocity	INPUT	LREAL	-1.0	When "SyncProfileReference" = 0: Velocity	
				> 0.0	The specified value is used.
				= 0.0	Not permitted
				< 0.0	The velocity configured in "Technology object > Configuration > Extended parameters > Dynamic defaults" is used. (<TO>.DynamicDefaults.Velocity)
				When "SyncProfileReference" = 1, 2, 3, 4: Not relevant	

Parameter	Declaration	Data type	Default value	Description	
Acceleration	INPUT	LREAL	-1.0	When "SyncProfileReference" = 0: Acceleration	
				> 0.0	The specified value is used.
				= 0.0	Not permitted
				< 0.0	The acceleration configured in "Technology object > Configuration > Extended parameters > Dynamic defaults" is used. (<TO>.DynamicDefaults.Acceleration)
				When "SyncProfileReference" = 1, 2, 3, 4: Not relevant	
Deceleration	INPUT	LREAL	-1.0	When "SyncProfileReference" = 0: Deceleration	
				> 0.0	The specified value is used.
				= 0.0	Not permitted
				< 0.0	The deceleration configured in "Technology object > Configuration > Extended parameters > Dynamic defaults" is used. (<TO>.DynamicDefaults.Deceleration)
				When "SyncProfileReference" = 1, 2, 3, 4: Not relevant	
Jerk	INPUT	LREAL	-1.0	When "SyncProfileReference" = 0: Jerk	
				> 0.0	Constant acceleration velocity profile The specified value is used.
				= 0.0	Trapezoid velocity profile
				< 0.0	The jerk configured in "Technology object > Configuration > Extended parameters > Dynamic defaults" is used. (<TO>.DynamicDefaults.Jerk)
				When "SyncProfileReference" = 1, 2, 3, 4: Not relevant	
ApplicationMode	INPUT	DINT	0	Application of the cam	
				0	Once/not cyclic
				1	Cyclic (absolute application on the following value side)
				2	Cyclic appending (continuously appending on the following value side)

Parameter	Declaration	Data type	Default value	Description	
SyncDirection	INPUT	DINT	3	Direction of synchronization (in effect for axes with activated Modulo setting)	
				1	Positive direction The following axis may only travel in positive direction during synchronization.
				2	Negative direction The following axis may only travel in negative direction during synchronization.
				3	Shortest distance Changes in direction are permitted for the following axis during synchronization.
StartSync	OUTPUT	BOOL	FALSE	TRUE	The following axis is synchronized to the leading axis.
InSync	OUTPUT	BOOL	FALSE	TRUE	Synchronous operation reached The following axis is synchronized and moves synchronously to the leading axis.
Busy	OUTPUT	BOOL	FALSE	TRUE	The job is being processed.
CommandAborted	OUTPUT	BOOL	FALSE	TRUE	The job was aborted by another job during execution.
Error	OUTPUT	BOOL	FALSE	TRUE	An error occurred while processing the job. The job is rejected. The cause of the error can be found in the "ErrorID" parameter.
ErrorID	OUTPUT	WORD	0	Error ID for parameter "ErrorID"	
EndOfProfile	OUTPUT	BOOL	FALSE	TRUE	The end of the cam has been reached. Displayed for at least one call of "MC_CamIn" in the user program when the cam is used cyclically.

Starting synchronous operation

To start synchronous operation with the Motion Control instruction "MC_CamIn", follow these steps:

1. Check the requirements indicated above.
2. Specify the leading axis, the following axis, the utilized cam and the synchronous position in the corresponding parameters.
3. Start the "MC_CamIn" job with a positive edge at parameter "Execute".

   The following axis is synchronized to the leading value of the leading axis. If the "InSync" parameter shows the value "TRUE", the following axis is synchronized and moves synchronously to the leading axis. With cyclic application of the cam, the "InSync" and "Busy" parameters show the value "TRUE" until the "MC_CamIn" job is overridden by another Motion Control job. With non-cyclic application of the cam, the "InSync" and "Busy" parameters are set to the value "FALSE" when the parameter "EndOfProfile" is set to the value "TRUE".

See also

Camming (Page 45)

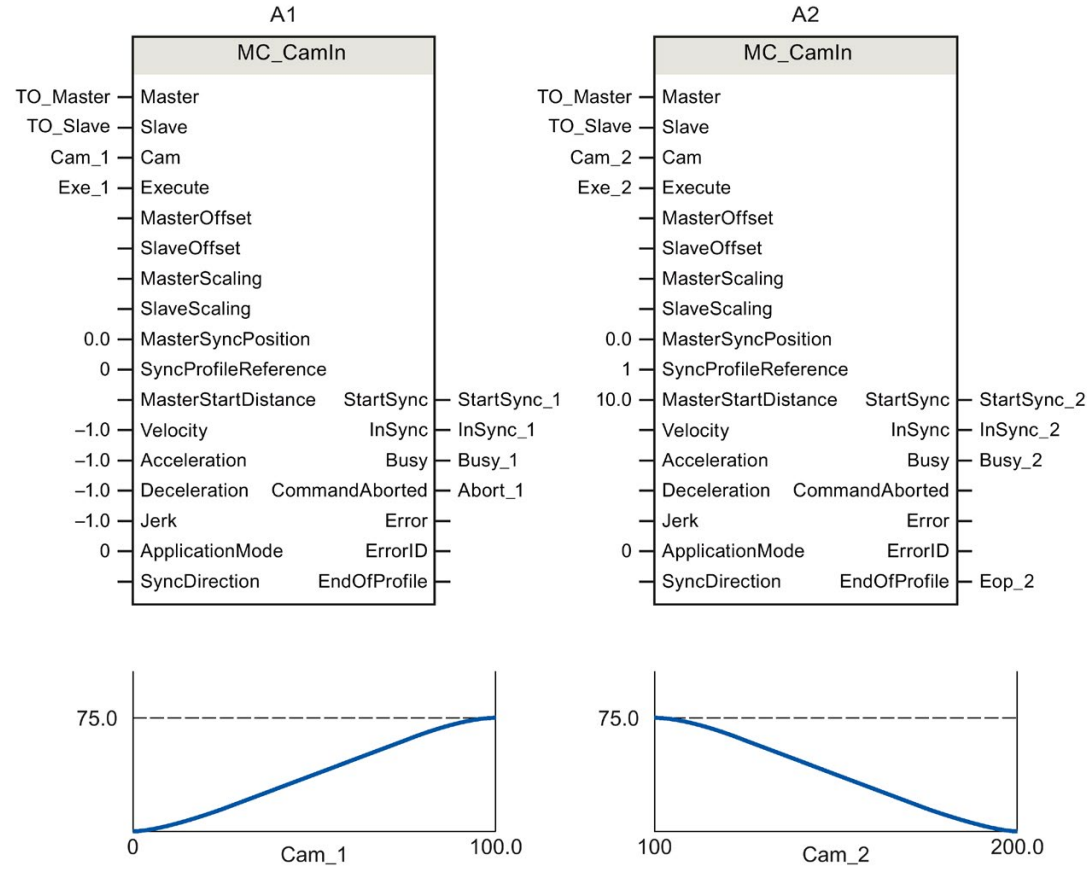
Override response V5: Synchronous operation jobs (Page 238)

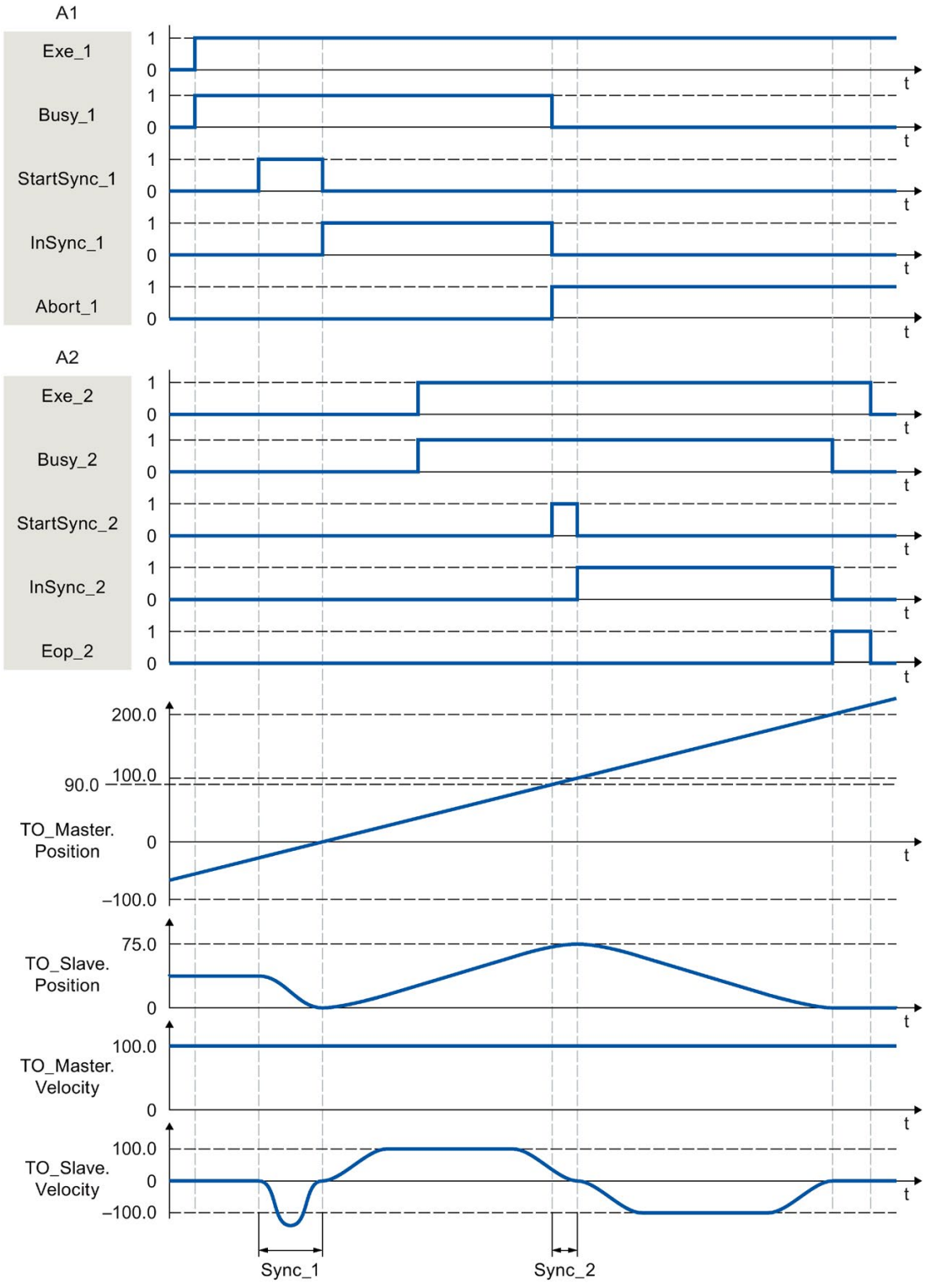
Section "Error detection Motion Control instructions" of the documentation "S7-1500/S7-1500T Motion Control Overview".
(https://support.industry.siemens.com/cs/ww/en/view/109766459)

Synchronization (Page 55)

9.1.5.2 MC_CamIn: Function chart V5 (S7-1500T)

Function chart: Synchronization in advance via dynamic parameters/leading value distance and switching of the cam

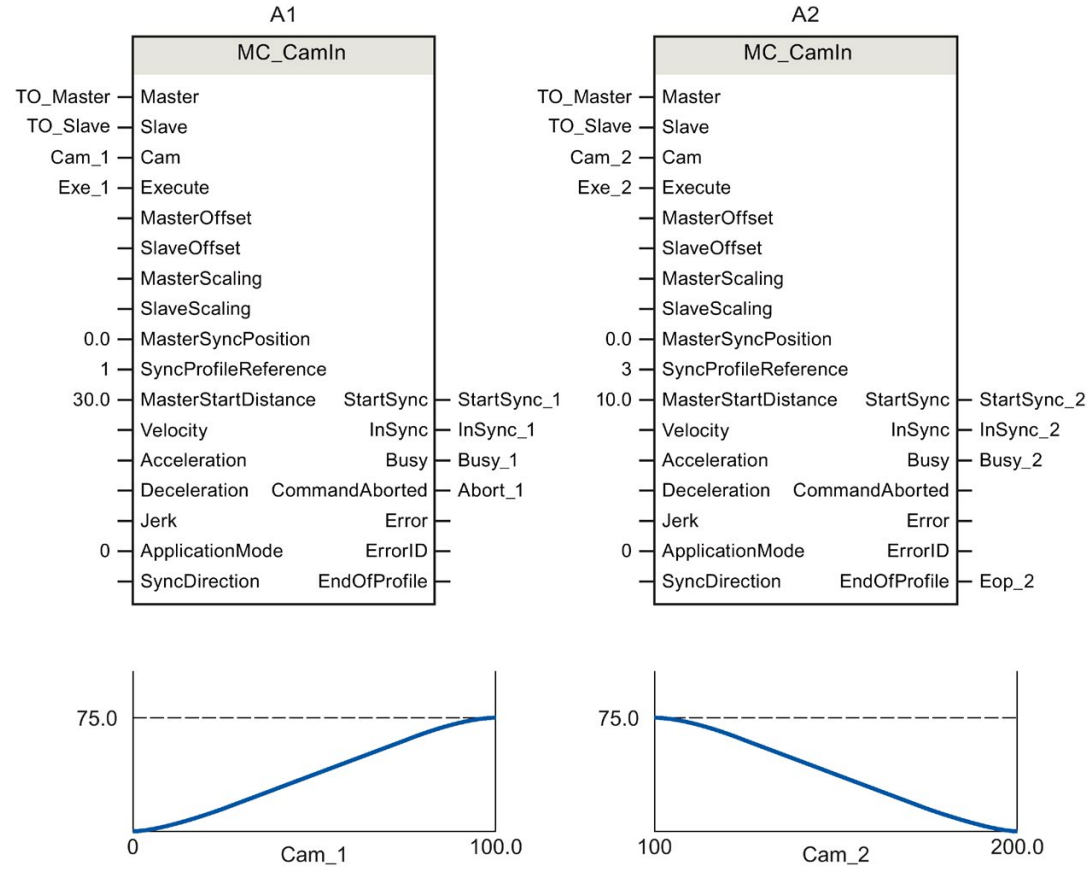


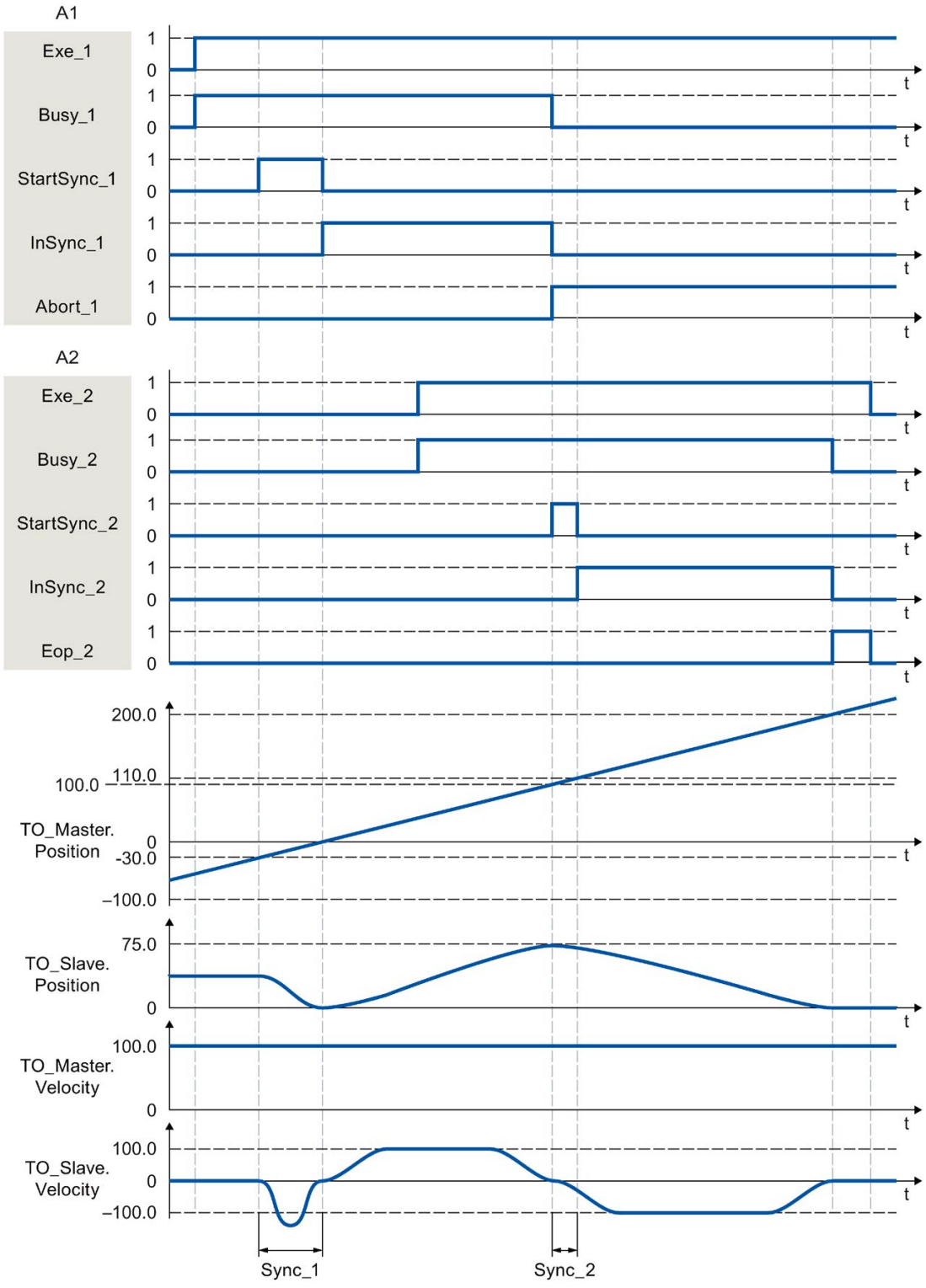

A1
Exe_1
Busy_1
StartSync_1
InSync_1
Abort_1
A2
Exe_2
Busy_2
StartSync_2
InSync_2
Eop_2
1
0
t
200.0
100.0
90.0
TO_Master.
Position
–100.0
75.0
TO_Slave.
Position
TO_Master.
Velocity
TO_Slave.
Velocity
Sync_1
Sync_2

Using "Exe_1", an "MC_CamIn" job (A1) is initiated. The start of the synchronization is displayed with "StartSync_1". The following axis (TO_Slave) is synchronized in advance to the cam (Cam_1) within the range "Sync_1" by means of the specified dynamic parameters. The distance required for synchronization is calculated by the system. When the specified reference position "MasterSyncPosition" relative to the start of the cam is reached, "InSync_1" signals that the following axis is synchronized and moves synchronously to the leading axis.

The synchronous operation is overridden by another "MC_CamIn" job (A2). The abort is signaled via "Abort_1". The start of the synchronization is displayed with "StartSync_2". The following axis is synchronized in advance to the new cam (Cam_2) within the range "Sync_2" by means of the specified leading value distance "MasterStartDistance". Within the range "Sync_2", the axis does not follow the cam "Cam_1" The dynamic response required for synchronization is calculated by the system. When the specified reference position "MasterSyncPosition" relative to the start of the cam is reached, "InSync_2" signals that the following axis is synchronized and moves synchronously to the leading axis.

Function chart: Synchronization in advance/subsequent synchronization via leading value distance and switching the cam




A1
Exe_1
Busy_1
StartSync_1
InSync_1
Abort_1
A2
Exe_2
Busy_2
StartSync_2
InSync_2
Eop_2
1
0
t
200.0
110.0
100.0
TO_Master.
Position
-30.0
–100.0
75.0
TO_Slave.
Position
TO_Master.
Velocity
TO_Slave.
Velocity
Sync_1
Sync_2

Using "Exe_1", an "MC_CamIn" job (A1) is initiated. The start of the synchronization is displayed with "StartSync_1". The following axis (TO_Slave) is synchronized in advance to the cam (Cam_1) within the range "Sync_1" by means of the specified leading value distance "MasterStartDistance". The dynamic response required for synchronization is calculated by the system. When the specified reference position "MasterSyncPosition" relative to the start of the cam is reached, "InSync_1" signals that the following axis is synchronized and moves synchronously to the leading axis.

The synchronous operation is overridden by another "MC_CamIn" job (A2). The abort is signaled via "Abort_1". When the specified reference position "MasterSyncPosition" in relation to the start of the cam disk is reached, the start of synchronization is indicated via "StartSync_2". The following axis is synchronized subsequently to the new cam (Cam_2) within the range "Sync_2" by means of the specified leading value distance "MasterStartDistance". Within the range "Sync_2", the axis does not follow the cam "Cam_1" The dynamic response required for synchronization is calculated by the system. "InSync_2" signals that the following axis is synchronized and moving synchronously to the leading axis.

9.1.6 MC_SynchronizedMotionSimulation V5 (S7-1500T)

9.1.6.1 MC_SynchronizedMotionSimulation: Simulate synchronous operation V5 (S7-1500T)

Description

With the Motion Control instruction "MC_SynchronizedMotionSimulation", you simulate an active synchronous operation on a following axis. As a result, a synchronous operation remains active when the following axis is disabled with a "MC_Power" job. The following axis does not have to be synchronized again after being enabled again.

With the start of a "MC_SynchronizedMotionSimulation" job, the velocity setpoint from the synchronous operation is set to zero. If an overlaid movement is active on the following axis at the start of the simulation, the setpoints of this overlaid movement will continue to be output.

Setpoints of motion jobs that are started during synchronous operation simulation are output to the drive.

If the position of the following axis at the end of the simulation differs from the position at the start of the simulation, this triggers a setpoint step-change.

Applies to

- Synchronous axis

Requirement

- The technology object has been configured correctly.
- The following axis is a synchronous axis.
- Synchronous operation is active on the technology object in status "Synchronous" (<TO>.StatusWord.X22 = TRUE).

Override response

An "MC_SynchronizedMotionSimulation" job is not aborted by any other Motion Control job. The simulated synchronous operation remains active even when the following axis is disabled with "MC_Power.Enable" = FALSE or "MC_Stop".

A restart of the technology object stops the simulation and aborts the synchronous operation.

A new "MC_SynchronizedMotionSimulation" job does not abort any other Motion Control jobs. With "MC_SynchronizedMotionSimulation.Enable" = TRUE, synchronous operation jobs are rejected.

Parameters

The following table shows the parameters of Motion Control instruction "MC_SynchronizedMotionSimulation":

Parameters	Declaration	Data type	Default value	Description	
Slave	INPUT	TO_SynchronousAxis	-	Following axis technology object	
Enable	INPUT	BOOL	FALSE	TRUE	Simulation of synchronous operation is started.
				FALSE	Simulation of the synchronous operation is stopped.
InSimulation	OUTPUT	BOOL	FALSE	TRUE	Synchronous operation is being simulated
Busy	OUTPUT	BOOL	FALSE	TRUE	The job is being processed.
Error	OUTPUT	BOOL	FALSE	TRUE	An error occurred while processing the job. The job is rejected. The cause of the error can be found in the "ErrorID" parameter.
ErrorID	OUTPUT	WORD	0	Error ID for parameter "ErrorID"	

Continuing synchronous operation when the following axis is disabled

In order not to stop synchronous operation with "MC_SynchronizedMotionSimulation" Motion Control instruction when the following axis is disabled, follow these steps:

1. Check the requirements indicated above.
2. Specify the following axis in the "Slave" parameter.
3. Bring the leading axis to a standstill (e.g. with "MC_Halt").
4. Start the simulation of the synchronous operation on the following axis with "MC_SynchronizedMotionSimulation.Enable" = TRUE.
5. When the "InSimulation" parameter shows the value TRUE, disable the following axis. The synchronous operation remains active in the simulation.
6. To reset synchronous operation again after the following axis is enabled, stop synchronous operation simulation with "MC_SynchronizedMotionSimulation.Enable" = FALSE.

   The synchronous operation simulation is stopped. The following axis follows the leading axis without re-synchronization.

See also

Section "Error detection Motion Control instructions" of the documentation "S7-1500/S7-1500T Motion Control Overview". (https://support.industry.siemens.com/cs/ww/en/view/109766459)

9.1.7 MC_LeadingValueAdditive V5 (S7-1500T)

9.1.7.1 MC_LeadingValueAdditive: Specify additive leading value V5 (S7-1500T)

Description

With the Motion Control instruction "MC_LeadingValueAdditive", you specify an additive leading value cyclically in addition to the active leading value of a following axis.

The additive leading value consists of position, velocity and acceleration. Changes to the specified values are effective immediately without consideration of the dynamic limits.

You specify the additive position value with the "Position" parameter. You specify the additive velocity value with the "Velocity" parameter. You specify the additive acceleration value with the "Acceleration" parameter.

The additive value is effective with the parameter "Enable" = TRUE. The values are valid as long as the parameter "Busy" = TRUE. The additive leading value becomes ineffective with "Enable" = FALSE.

Applies to

- Synchronous axis

Requirement

- The technology object has been configured correctly.
- The technology object has been enabled or is in simulation with an "MC_SynchronizedMotionSimulation" job.

Override response

The override response for "MC_LeadingValueAdditive" jobs is described in section "Override response V5: Synchronous operation jobs (Page 238)".

If a synchronous operation is overridden by another synchronous operation, the additive leading value remains valid.

An "MC_LeadingValueAdditive" job is aborted by an "MC_Stop" job and by an "MC_Reset" job with "Restart" = TRUE.

Parameters

The following table shows the parameters of Motion Control instruction "MC_LeadingValueAdditive":

Parameter	Declaration	Data type	Default value	Description	
Axis	INPUT	TO_SynchronousAxis	-	Technology object on which the additive values act.	
Enable	INPUT	BOOL	FALSE	TRUE	The leading value is adapted.
				FALSE	The leading value is not adapted.
Position	INPUT	LREAL	0.0	Additive position value	
Velocity	INPUT	LREAL	0.0	Additive velocity value Observe the dynamic limits.	
Acceleration	INPUT	LREAL	0.0	Additive acceleration value Observe the dynamic limits.	
Busy	OUTPUT	BOOL	FALSE	TRUE	The additive values are valid.
Error	OUTPUT	BOOL	FALSE	TRUE	An error occurred while processing the job. The job is rejected. The cause of the error can be found in the "ErrorID" parameter.
ErrorID	OUTPUT	WORD	16#0000	Error ID for parameter "ErrorID"	

See also

Override response V5: Synchronous operation jobs (Page 238)

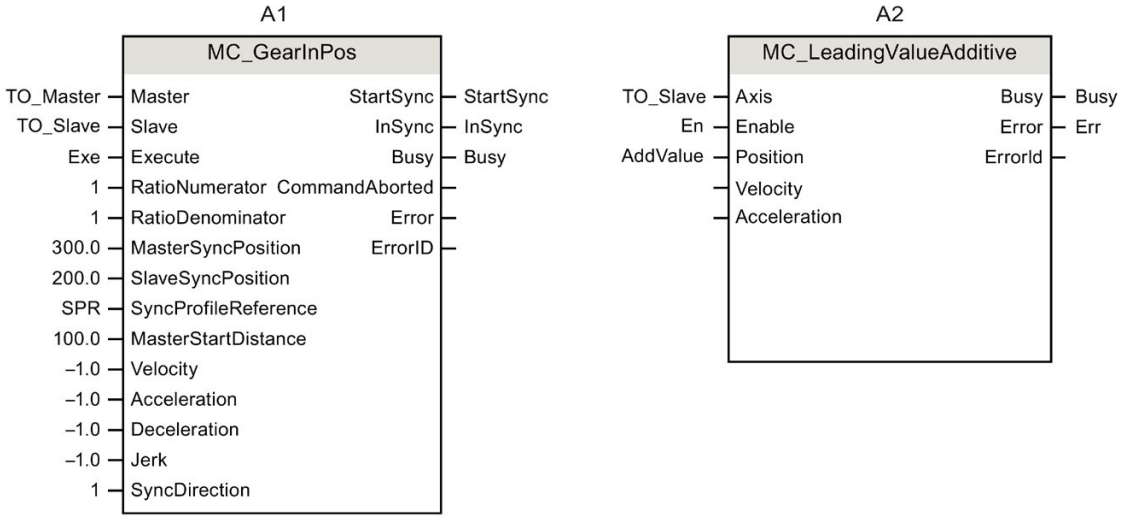
Additive leading value (Page 29)

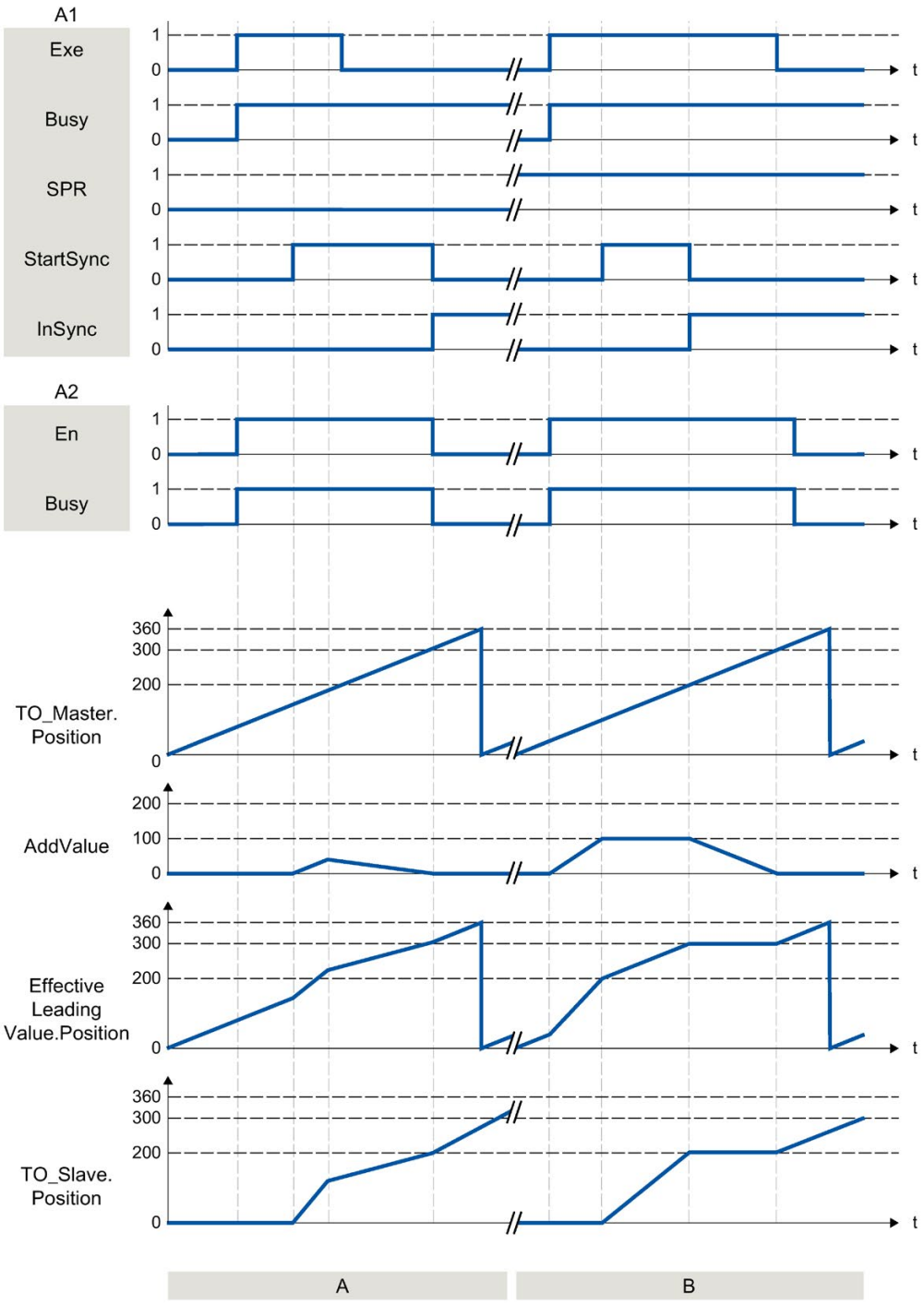
Section "Error detection Motion Control instructions" of the documentation "S7-1500/S7-1500T Motion Control Overview".
(https://support.industry.siemens.com/cs/ww/en/view/109766459)

Override response of Motion Control jobs V5 (Page 236)

9.1.7.2 MC_LeadingValueAdditive V5: Function chart (S7-1500T)

Function chart: Specify additive leading value




A1
Exe
Busy
SPR
StartSync
InSync
A2
En
Busy
TO_Master.
Position
AddValue
Effective
Leading
Value.Position
TO_Slave.
Position
1
0
t
360
300
200
100
A
B

Section A	Via "Exe" = TRUE, a "MC_GearInPos" job (A1) is started with synchronization in advance via dynamic parameters. At the same time, a "MC_LeadingValueAdditive" job (A2) is started via "En" = TRUE. The leading axis (TO_Master) calculates the effective leading value (EffectiveLeadingValue.Position) and the time for starting the synchronization. When the A1 job displays "StartSync" = TRUE, the following axis (TO_Slave) synchronizes with the given specified dynamic parameters. The additive leading value is continuously increased in the user program, added to the effective leading value and has the effect of increased dynamic response of the following axis. When the additive leading value is reduced, the dynamic response of the following axis is also reduced. If the additive leading value is 0.0, the effective leading value follows the leading value of the leading axis. The following axis synchronizes to the original synchronous position and the job A1 shows "InSync" = TRUE. The job A2 is terminated with "En" = FALSE.
Section B	Via "En" = TRUE, a "MC_LeadingValueAdditive" job (A2) is started before a synchronous operation job. The user program continuously increases the additive leading value to the value "100.0". With "Exe" = TRUE a "MC_GearInPos" job (A1) is started with synchronization in advance via leading value distance. The leading axis calculates the effective leading value (EffectiveLeadingValue.Position). When the effective leading value reaches "200.0", synchronization starts and the A1 job shows "StartSync" = TRUE. At this point the leading axis has reached the value "100.0". The following axis is synchronized. The synchronous position is moved by the additive leading value. As soon as "InSync" = TRUE, the additive leading value is continuously reduced. While the leading value (TO_Master.Position) increases from 200.0 to 300.0, the additive leading value (AddValue) decreases from 100.0 to 0.0. The effective leading value remains at 200.0 and the following axis does not move. If the additive leading value is 0.0, the effective leading value follows the leading value of the leading axis. The shift is canceled and the motion of the following axis is continued. The job A2 is terminated with "En" = FALSE.

9.2 Cam (S7-1500T)

9.2.1 MC_InterpolateCam V5 (S7-1500T)

9.2.1.1 MC_InterpolateCam: Interpolate cam V5 (S7-1500T)

Description

With the Motion Control instruction "MC_InterpolateCam", you interpolate a cam.

The interpolation closes the gaps between the defined interpolation points and segments of the cam. The cam is interpolated between the following values in the definition range:

- First defined interpolation point/start of the first segment of the cam (<TO>.StatusCam.StartLeadingValue)
- Last defined interpolation point/end of the last segment of the cam (<TO>.StatusCam.EndLeadingValue)

After interpolation, an explicit value in the value range is assigned to each value in the definition range.

The interpolation type defines how missing ranges are interpolated. You specify the interpolation type in the configuration of the technology object (Page 105). The following interpolation methods are possible:

- Linear interpolation
- Interpolation with cubic splines
- Interpolation with Bézier splines

Applies to

- Cam

Requirement

- The technology object has been configured correctly.
- The cam is not currently being used, e.g. for camming.

Override response

- An "MC_InterpolateCam" job is not aborted by any other Motion Control job.
- A new "MC_InterpolateCam" job does not abort any active Motion Control jobs.

Parameters

The following table shows the parameters of Motion Control instruction "MC_InterpolateCam":

Parameters	Declaration	Data type	Default value	Description	
Cam	INPUT	TO_Cam	-	Cam technology object	
Execute	INPUT	BOOL	FALSE	TRUE	Start job with a positive edge
Done	OUTPUT	BOOL	FALSE	TRUE	The cam is interpolated.
Busy	OUTPUT	BOOL	FALSE	TRUE	The job is being processed.
Error	OUTPUT	BOOL	FALSE	TRUE	An error occurred while processing the job. The job is rejected. The cause of the error can be found in the "ErrorID" parameter.
ErrorID	OUTPUT	WORD	0	Error ID for parameter "ErrorID"	

Interpolating a cam

To interpolate a cam with the "MC_InterpolateCam" Motion Control instruction, follow these steps:

1. Check the requirements indicated above.
2. Specify the cam to be interpolated in the "Cam" parameter.
3. Start the "MC_InterpolateCam" job with a positive edge at parameter "Execute".

   The cam is interpolated. When the "Done" parameter shows the value "TRUE", the interpolation is finished.

See also

Section "Error detection Motion Control instructions" of the documentation "S7-1500/S7-1500T Motion Control Overview".
(https://support.industry.siemens.com/cs/ww/en/view/109766459)

9.2.2 MC_GetCamLeadingValue V5 (S7-1500T)

9.2.2.1 MC_GetCamLeadingValue: Read out leading value of a cam V5 (S7-1500T)

Description

With the Motion Control instruction "MC_GetCamLeadingValue", you read the leading value that is defined for a following value from a cam.

Because the same following values can be defined for different leading values, an approximation of the leading value can specified in the "ApproachValue" parameter.

Applies to

- Cam

Requirement

- The technology object has been configured correctly.
- The cam is interpolated.

Override response

- An "MC_GetCamLeadingValue" job is not aborted by any other Motion Control job.
- A new "MC_GetCamLeadingValue" job does not abort any active Motion Control jobs.

Parameters

The following table shows the parameters of Motion Control instruction "MC_GetCamLeadingValue":

Parameter	Declaration	Data type	Default value	Description	
Cam	INPUT	TO_Cam	-	Cam technology object	
Execute	INPUT	BOOL	FALSE	TRUE	Start job with a positive edge
FollowingValue	INPUT	LREAL	0.0	Following value for which the leading value is read	
ApproachLeading Value	INPUT	LREAL	0.0	Approximation value for the searched for leading value If the following value is used multiple times in the cam, it can be used to limit the searched leading value.	
Done	OUTPUT	BOOL	FALSE	TRUE	The leading value was read.
Busy	OUTPUT	BOOL	FALSE	TRUE	The job is being processed.
Error	OUTPUT	BOOL	FALSE	TRUE	An error occurred while processing the job. The job is rejected. The cause of the error can be found in the "ErrorID" parameter.
ErrorID	OUTPUT	WORD	0	Error ID for parameter "ErrorID"	
Value	OUTPUT	LREAL	-	Read leading value (position) (valid when "Done" = TRUE)	

Reading a leading value

To read a leading value from a cam with the "MC_GetCamLeadingValue" Motion Control instruction, follow these steps:

1. Check the requirements indicated above.
2. Specify the cam, the following value, and the approximation value for the searched-for leading value in the corresponding parameters.
3. Start the "MC_GetCamLeadingValue" job with a positive edge at parameter "Execute".

   When the "Done" parameter shows the value "TRUE", the leading value has been determined. The calculation of the leading value can take several cycles. The leading value is output in the "Value" parameter.

See also

Section "Error detection Motion Control instructions" of the documentation "S7-1500/S7-1500T Motion Control Overview".
(https://support.industry.siemens.com/cs/ww/en/view/109766459)

9.2.3 MC_GetCamFollowingValue V5 (S7-1500T)

9.2.3.1 MC_GetCamFollowingValue: Read out following value of a cam disc V5 (S7-1500T)

Description

With the Motion Control instruction "MC_GetCamFollowingValue", you read the following value and the first and second derivative of the following value for a leading value from a cam.

Applies to

- Cam

Requirement

- The technology object has been configured correctly.
- The cam is interpolated.

Override response

- An "MC_GetCamFollowingValue" job is not aborted by any other Motion Control job.
- A new "MC_GetCamFollowingValue" job does not abort any active Motion Control jobs.

Parameters

The following table shows the parameters of Motion Control instruction "MC_GetCamFollowingValue":

Parameters	Declaration	Data type	Default value	Description	
Cam	INPUT	TO_Cam	-	Cam technology object	
Execute	INPUT	BOOL	FALSE	TRUE	Start job with a positive edge
LeadingValue	INPUT	LREAL	0.0	Leading value for which the following value is read	
Done	OUTPUT	BOOL	FALSE	TRUE	The following value was read.
Busy	OUTPUT	BOOL	FALSE	TRUE	The job is being processed.
Error	OUTPUT	BOOL	FALSE	TRUE	An error occurred while processing the job. The job is rejected. The cause of the error can be found in the "ErrorID" parameter.
ErrorID	OUTPUT	WORD	0	Error ID for parameter "ErrorID"	
Value	OUTPUT	LREAL	-	Read following value (position) (valid when "Done" = TRUE)	
FirstDerivative	OUTPUT	LREAL	-	First derivative of read following value (valid when "Done" = TRUE)	
SecondDerivative	OUTPUT	LREAL	-	Second derivative of read following value (valid when "Done" = TRUE)	

Reading a following value

To read a following value from a cam with the "MC_GetCamFollowingValue" Motion Control instruction, follow these steps:

1. Check the requirements indicated above.
2. Specify the cam and the leading value in the corresponding parameters.
3. Start the "MC_GetCamFollowingValue" job with a positive edge at parameter "Execute".

   When the "Done" parameter shows the value "TRUE", the following value has been read. The following value and the derivatives are output in the "Value", "FirstDerivative" and "SecondDerivative" parameters.

See also

Section "Error detection Motion Control instructions" of the documentation "S7-1500/S7-1500T Motion Control Overview".
(https://support.industry.siemens.com/cs/ww/en/view/109766459)

9.3 Override response of Motion Control jobs V5 (S7-1500, S7-1500T)

9.3.1 Override response V5: Homing and motion jobs (S7-1500, S7-1500T)

The following table shows how a new Motion Control job affects active homing and motion jobs:

⇒ Active job ⇓ New job	MC_Home "Mode" = 2, 8, 10	MC_Home ("Mode" = 3, 5)	MC_Halt MC_MoveAbsolute MC_MoveRelative MC_MoveVelocity MC_MoveJog	MC_Stop	MC_MoveSuperimposed	MC_MotionInVelocity MC_MotionInPosition
MC_Home "Mode" = 3, 5	A	A	A	-	A	A
MC_Home "Mode" = 9	A	-	-	-	-	-
MC_Halt **MC_MoveAbsolute** **MC_MoveRelative** **MC_MoveVelocity** **MC_MoveJog** **MC_MotionInVelocity** **MC_MotionInPosition**	-	A	A	-	A	A
MC_MoveSuperimposed	-	-	-	-	A	-
MC_Stop	A	A	A	B	A	A

⇒ Active job ⇓ New job	MC_Home "Mode" = 2, 8, 10	MC_Home ("Mode" = 3, 5)	MC_Halt MC_MoveAbsolute MC_MoveRelative MC_MoveVelocity MC_MoveJog	MC_Stop	MC_MoveSuperimposed	MC_MotionInVelocity MC_MotionInPosition
MC_GearIn	-	A	A	-	A	-
MC_GearInPos **MC_CamIn** waiting[1)]	-	-	-	-	-	-
MC_GearInPos **MC_CamIn** active[2)]	-	A	A	-	A	-
MC_LeadingValue **Additive**	-	-	-	-	-	-

A The running job is aborted with "CommandAborted" = TRUE.

B An "MC_Stop" job is aborted by another "MC_Stop" job with a stop response that is the same or higher.

- No effect. Running job continues to be executed.

1) The status "Busy" = TRUE, "StartSync" = FALSE, "InSync" = FALSE corresponds to a waiting synchronous operation.

2) The status "Busy" = TRUE, "StartSync" or "InSync" = TRUE corresponds to an active synchronous operation.

Note

Fixed stop

With an active force and torque limitation with "MC_TorqueLimiting", running jobs are aborted if the drive is held at the fixed stop with "InClamping" = TRUE.

9.3.2 Override response V5: Synchronous operation jobs (S7-1500, S7-1500T)

The following table shows how a new Motion Control job affects the motion of the axis on active synchronous operation jobs:

⇒ Active job ⇓ New job	MC_GearIn	MC_GearInPos MC_CamIn waiting[1]	MC_GearInPos MC_CamIn active[2]	MC_Phasing-Absolute MC_Phasing-Relative	MC_Leading-ValueAdditive
MC_Home "Mode" = 3, 5	A	-	-	-	-
MC_Halt	A	-	A	A	-
MC_MoveAbsolute MC_MoveRelative MC_MoveVelocity MC_MoveJog	A	-	A	A	-
MC_MotionInVelocity MC_MotionInPosition	A	A	A	-	-
MC_MoveSuperimposed	-	-	-	-	-
MC_Stop	A	A	A	A	A
MC_GearIn	A	A	A	A	-
MC_GearInPos MC_CamIn waiting[1]	-	A	-	-	-
MC_GearInPos MC_CamIn active[2]	A	A	A	A	-
MC_PhasingAbsolute MC_PhasingRelative	-	-	-	A	-
MC_LeadingValueAdditive	-	-	-	-	A

A The running job is aborted with "CommandAborted" = TRUE.

- No effect. Running job continues to be executed.

1) A waiting synchronous operation job ("Busy" = TRUE, "StartSync" = FALSE, "InSync" = FALSE) does not abort any active jobs. Abort with an "MC_Power" job is possible.

2) The status "Busy" = TRUE, "StartSync" or "InSync" = TRUE corresponds to active synchronous operation.

Note

Fixed stop

With an active force and torque limitation with "MC_TorqueLimiting", running jobs are aborted if the drive is held at the fixed stop with "InClamping" = TRUE.

9.3.3 Override response V5: Measuring input jobs (S7-1500, S7-1500T)

The following table shows which new Motion Control jobs will override active measuring input jobs:

⇒ Active job ⇓ New job	MC_MeasuringInput	MC_MeasuringInputCyclic
MC_Home "Mode" = 2, 3, 5, 8, 9, 10	A	A
MC_Home "Mode" = 0, 1, 6, 7, 11, 12	-	-
MC_MeasuringInput MC_MeasuringInputCyclic MC_AbortMeasuringInput	A	A

A The running job is aborted with "CommandAborted" = TRUE.

- No effect. Running job continues to be executed.

9.3.4 Override response V5: Kinematics motion commands (S7-1500T)

Single axis jobs are not overridden by kinematics jobs.

The following table shows how a new Motion Control job affects active kinematics motion jobs:

⇒ Active job ⇓ New job	MC_MoveLinearAbsolute MC_MoveLinearRelative MC_MoveCircularAbsolute MC_MoveCircularRelative MC_MoveDirectAbsolute MC_MoveDirectRelative MC_TrackConveyorBelt MC_DefineWorkspaceZone MC_DefineKinematicsZone MC_SetWorkspaceZoneActive MC_SetWorkspaceZoneInactive MC_SetKinematicsZoneActive MC_SetKinematicsZoneInactive MC_SetOcsFrame	MC_GroupInterrupt	MC_GroupStop
MC_Home MC_MoveSuperimposed	N	N	N
MC_Halt MC_MoveAbsolute MC_MoveRelative MC_MoveVelocity MC_MoveJog MC_Stop MC_GearIn MC_GearInPos MC_CamIn MC_MotionInVelocity MC_MotionInPosition	A	A	A
MC_GroupStop	A	A	N
MC_GroupInterrupt MC_GroupContinue	B	A	N

⇒ Active job ⇓ New job	MC_MoveLinearAbsolute MC_MoveLinearRelative MC_MoveCircularAbsolute MC_MoveCircularRelative MC_MoveDirectAbsolute MC_MoveDirectRelative MC_TrackConveyorBelt MC_DefineWorkspaceZone MC_DefineKinematicsZone MC_SetWorkspaceZoneActive MC_SetWorkspaceZoneInactive MC_SetKinematicsZoneActive MC_SetKinematicsZoneInactive MC_SetOcsFrame	MC_GroupInterrupt	MC_GroupStop
MC_MoveLinearAbsolute MC_MoveLinearRelative MC_MoveCircularAbsolute MC_MoveCircularRelative MC_MoveDirectAbsolute MC_MoveDirectRelative MC_TrackConveyorBelt MC_DefineWorkspaceZone MC_DefineKinematicsZone MC_SetWorkspaceZoneActive MC_SetWorkspaceZoneInactive MC_SetKinematicsZoneActive MC_SetKinematicsZoneInactive	-	-	N
MC_SetOcsFrame	C, -	-	N

A The running job is aborted with "CommandAborted" = TRUE.

B Running job is interrupted or resumed.

C Synchronization of the OCS with the conveyor belt is aborted with "MC_SetOcsFrame" = TRUE.

N Not permitted. Running job continues to be executed. The new job is rejected.

- No effect. Running job continues to be executed. A new kinematics job is added to the job sequence.

Appendix (S7-1500, S7-1500T) A

A.1 Tags of the synchronous axis technology object (S7-1500, S7-1500T)

A.1.1 Legend (S7-1500, S7-1500T)

Tag	Name of the tag	
Data type	Data type of the tag	
Values	Value range of the tag - minimum value to maximum value (L - linear specification R - rotary specification) If no specific value is shown, the value range limits of the relevant data type apply or the information under "Description".	
W	Effectiveness of changes in the technology data block	
	DIR	Direct: Values are changed directly and take effect at the start of the next MC-Servo [OB91].
	CAL	At call of Motion Control instruction: Values are changed directly and take effect at the start of the next MC-Servo [OB91] after the call of the corresponding Motion Control instruction in the user program.
	RES	Restart: Changes to the start value in the load memory are made using the extended instruction "WRIT_DBL" (write to DB in load memory). Changes will not take effect until after restart of the technology object.
	RON	Read only: The tag cannot and must not be changed during runtime of the user program.
Description	Description of the tag	

Access to the tags is with "<TO>.<tag name>". The placeholder <TO> represents the name of the technology object.

A.1.2 Actual values and setpoints (synchronous axis) (S7-1500, S7-1500T)

The following tags indicate the setpoint and actual values of the technology object.

Tags

Legend (Page 242)

Tag	Data type	Values	W	Description
Position	LREAL	-	RON	Position setpoint
Velocity	LREAL	-	RON	Velocity setpoint/speed setpoint
ActualPosition	LREAL	-	RON	Actual position
ActualVelocity	LREAL	-	RON	Actual velocity
ActualSpeed	LREAL	-	RON	With analog setpoint = 0.0: Actual speed of the motor
Acceleration	LREAL	-	RON	Setpoint acceleration
ActualAcceleration	LREAL	-	RON	Actual acceleration
OperativeSensor	UDINT	1 … 4	RON	Operative encoder
ModuloCycle	DINT	-2147483648 … 2147483647	RON	Number of modulo cycles of the setpoint
ActualModuloCycle	DINT	-2147483648 … 2147483647	RON	Number of modulo cycles of the actual value
VelocitySetpoint	LREAL	-1.0E12 … 1.0E12	RON	Output velocity setpoint/speed setpoint

A.1.3 "Simulation" tag (synchronous axis) (S7-1500, S7-1500T)

The tag structure "<TO>.Simulation.<tag name>" contains the configuration of the simulation mode. In simulation mode, you can simulate axes without a real drive in the CPU.

Tags

Legend (Page 242)

Tag	Data type	Values	W	Description	
Simulation.	TO_Struct_AxisSimulation				
Mode	UDINT	0, 1	RES[1)]	Simulation mode	
				0	No simulation, normal operation
				1	Simulation mode

1) Technology version V2.0: RON

A.1.4 "VirtualAxis" tag (synchronous axis) (S7-1500, S7-1500T)

The tag structure "<TO>.VirtualAxis.<tag name>" contains the configuration of the simulation mode. In simulation mode, you can simulate axes without a real drive in the CPU.

Tags

Legend (Page 242)

Tag	Data type	Values	W	Description	
VirtualAxis.	TO_Struct_VirrtualAxis				
Mode	UDINT	0, 1	RON	Virtual axis	
				0	No virtual axis
				1	Axis is always and exclusively operated as virtual axis

A.1.5 "Actor" tag (synchronous axis) (S7-1500, S7-1500T)

The tag structure "<TO>.Actor.<tag name>" contains the controller-side configuration of the drive.

Tags

Legend (Page 242)

Tag	Data type	Values	W	Description	
Actor.	TO_Struct_Actor				
Type	DINT	0, 1	RON	Drive connection	
				0	Analog output
				1	PROFIdrive telegram
InverseDirection	BOOL	-	RES	Inversion of the setpoint	
				FALSE	No
				TRUE	Yes
DataAdaption	DINT	0, 1	RES	Automatic transfer of the drive values reference speed, maximum speed and reference torque	
				0	No automatic transfer, manual configuration of values
				1	Automatic transfer of values configured in the drive to the configuration of the technology object
Efficiency	LREAL	0.0 … 1.0	RES	Efficiency of mechanics (gear and leadscrew)	

Tag	Data type	Values	W	Description	
Interface.	TO_Struct_ActorInterface				
AddressIn	VREF	0 … 65535	RON	Input address for the PROFIdrive telegram	
AddressOut	VREF	0 … 65535	RON	Output address for the PROFIdrive telegram or the analog setpoint	
EnableDriveOutput	BOOL	-	RES	"Enable output" for analog drives	
				FALSE	Disabled
				TRUE	Enabled
EnableDriveOutput Address	VREF	0 … 65535	RON	Address for the "Enable output" for analog setpoint	
DriveReadyInput	BOOL	-	RES	"Ready input" for analog drives The analog drive signals its readiness to receive speed setpoints.	
				FALSE	Disabled
				TRUE	Enabled
DriveReadyInput Address	VREF	0 … 65535	RON	Address for the "Enable input" for analog setpoint	
EnableTorqueData	BOOL	-	RES	Torque data	
				FALSE	Disabled
				TRUE	Enabled
TorqueDataAddress In	VREF	0 … 65535	RON	Input address of the supplemental telegram	
TorqueDataAddress Out	VREF	0 … 65535	RON	Output address of the supplemental telegram	
DriveParameter.	TO_Struct_ActorDriveParameter				
ReferenceSpeed	LREAL	0.0 … 1.0E12	RES	Reference value (100%) for the speed setpoint (N-set) of the drive The speed setpoint is transferred in the PROFIdrive telegram as a normalized value from -200% to 200% of the "ReferenceSpeed". For setpoint specification via an analog output, the analog output can be operated in the range from -117% to 117%, provided the drive permits this.	
MaxSpeed	LREAL	0.0 … 1.0E12	RES	Maximum value for the speed setpoint of the drive (N-set) (PROFIdrive: MaxSpeed ≤ 2 × ReferenceSpeed Analog setpoint: MaxSpeed ≤ 1.17 × ReferenceSpeed)	
ReferenceTorque	LREAL	0.0 … 1.0E12	RES	Reference value (100%) for the drive torque	

A.1.6 "TorqueLimiting" tag (synchronous axis) (S7-1500, S7-1500T)

The tag structure "<TO>.TorqueLimiting.<tag name>" contains the configuration of the torque limiting.

Tags

Legend (Page 242)

Tag	Data type	Values	W	Description	
TorqueLimiting.	TO_Struct_TorqueLimiting				
LimitBase	DINT	0, 1	RES	Torque limiting	
				0	Motor side
				1	Load side
PositionBased Monitorings	DINT	0, 1	RES	Positioning and following error monitoring	
				0	Monitoring deactivated
				1	Monitoring activated
LimitDefaults.	TO_Struct_TorqueLimitingLimit Defaults				
Torque	LREAL	0.0 … 1.0E12	CAL	Limiting torque	
Force	LREAL	0.0 … 1.0E12	CAL	Limiting force	

A.1.7 "Clamping" tag (synchronous axis) (S7-1500, S7-1500T)

The tag structure "<TO>.Clamping.<tag name>" contains the configuration of the fixed stop detection.

Tags

Legend (Page 242)

Tag	Data type	Values	W	Description
Clamping.	TO_Struct_Clamping			
FollowingError Deviation	LREAL	0.001 … 1.0E12	DIR	Value of the following error starting from which the fixed stop is detected.
PositionTolerance	LREAL	0.001 … 1.0E12	DIR	Position tolerance for the clamping monitoring

A.1.8 "Sensor[1..4]" tags (synchronous axis) (S7-1500, S7-1500T)

The tag structure "<TO>.Sensor[1..4].<tag name>" contains the controller-end configuration of the encoder and the configuration of active and passive homing.

Tags

Legend (Page 242)

Tag	Data type	Values	W	Description	
Sensor[1..4].	ARRAY [1..4] OF TO_Struct_Sensor/TO_Struct_ExternalEncoder_Sensor				
Existent	BOOL	-	RON	Displaying created encoders	
Type	DINT	0 … 2	RON	Encoder type	
				0	"INCREMENTAL" Incremental
				1	"ABSOLUTE" Absolute
				2	"CYCLIC_ABSOLUTE" Cyclic absolute
InverseDirection	BOOL	-	RES	Inversion of the actual value	
				FALSE	No
				TRUE	Yes
System	DINT	0, 1	RES	Encoder system	
				0	"LINEAR" Linear encoder
				1	"ROTATORY" Rotary encoder
MountingMode	DINT	0 … 2	RES	Mounting type of encoder	
				0	On motor shaft
				1	On load side
				2	External measuring system
DataAdaption	DINT	0, 1	RES	Automatic transfer of the drive values reference speed, maximum speed and reference torque in the device	
				0	No automatic transfer, manual configuration of values
				1	Automatic transfer of values configured in the drive to the configuration of the technology object

Tag	Data type	Values	W	Description	
Interface.	TO_Struct_SensorInterface				
AddressIn	VREF	0 … 65535	RON	Input address for the PROFIdrive telegram	
AddressOut	VREF	0 … 65535	RON	Output address for the PROFIdrive telegram	
Number	UDINT	1 … 2	RON	Number of the encoder in the telegram	
Parameter.	TO_Struct_SensorParameter				
Resolution	LREAL	-1.0E12 … 1.0E12	RES	Resolution of a linear encoder (offset between two encoder pulses)	
StepsPerRevolution	UDINT	1 … 8388608	RES	Increments per rotary encoder revolution	
FineResolutionXist1	UDINT	0 … 31	RES	Number of bits for fine resolution Gx_XIST1 (cyclic actual encoder value)	
FineResolutionXist2	UDINT	0 … 31	RES	Number of bits for fine resolution Gx_XIST2 (absolute value of encoder)	
Determinable Revolutions	UDINT	0 … 8388608	RES	Number of differentiable encoder revolutions for a multi-turn absolute encoder (For a single-turn absolute encoder = 1; for an incremental encoder = 0)	
DistancePer Revolution	LREAL	0.0 … 1.0E12	RES	Load distance per revolution of an externally mounted encoder	
BehaviorGx_XIST1	DINT	-	RES	Evaluation of Gx_XIST1 bits	
				0	Based on the bits of the encoder resolution
				1	32-bit value of the encoder value
ActiveHoming.	TO_Struct_SensorActiveHoming				
Mode	DINT	0 … 2	RES	Homing mode	
				0	Use zero mark via PROFIdrive telegram
				1	Zero mark via PROFIdrive telegram and reference output cam
				2	Use homing mark via digital input
SideInput	BOOL	-	CAL	Side of the digital input for active homing	
				FALSE	Negative side
				TRUE	Positive side
Direction	DINT	0, 1	CAL	Homing direction/approach direction on the homing mark	
				0	Positive homing direction
				1	Negative homing direction
DigitalInputAddress	VREF	0 … 65535	RON	Address of digital input	
HomePositionOffset	LREAL	-1.0E12 … 1.0E12	CAL	Home position offset	
SwitchLevel	BOOL	-	RES	Signal level that is present at the digital input when homing mark is approached	
				FALSE	Low level
				TRUE	High level

Tag	Data type	Values	W	Description	
PassiveHoming.	TO_Struct_SensorPassiveHoming				
Mode	DINT	0 … 2	RES	Homing mode	
				0	Use zero mark via PROFIdrive telegram
				1	Zero mark via PROFIdrive telegram and reference output cam
				2	Use homing mark via digital input
SideInput	BOOL	-	CAL	Side of the digital input for passive homing	
				FALSE	Negative side
				TRUE	Positive side
Direction	DINT	0 … 2	CAL	Homing direction/approach direction on the homing mark	
				0	Positive homing direction
				1	Negative homing direction
				2	Current homing direction
DigitalInputAddress	VREF	0 … 65535	RON	Address of digital input	
SwitchLevel	BOOL	-	RES	Signal level that is present at the digital input when homing mark is approached	
				FALSE	Low level
				TRUE	High level

A.1.9 "CrossPlcSynchronousOperation" tag (synchronous axis) (S7-1500, S7-1500T)

The tag structure "<TO>.CrossPlcSynchronousOperation.<tag name>" contains the configuration of the cross-PLC synchronous operation.

Tags

Legend (Page 242)

Tag	Data type	Values	W	Description	
CrossPlcSynchronous Operation.	TO_Struct_CrossPlcSynchronous Operation				
Interface[1..1].	ARRAY [1..1] of TO_Struct_CrossPlcLeading ValueInterface				
EnableLeading ValueOutput	BOOL	-	RON	Provide cross-PLC leading value	
				FALSE	No
				TRUE	Yes
AddressOut	VREF	-	RON	Output address for the leading value telegram	
LocalLeadingValue DelayTime	LREAL	0.0 … 1.0E12	DIR	Delay time of leading value output at the local following axes	

A.1.10 "Extrapolation" tag (synchronous axis) (S7-1500, S7-1500T)

The tag structure "<TO>.Extrapolation.<tag name>" contains the configuration of the actual value extrapolation.

Tags

Legend (Page 242)

Tag	Data type	Values	W	Description	
Extrapolation.	TO_Struct_Extrapolation				
LeadingAxis DependentTime	LREAL	-	RON	Extrapolation time component (caused by leading axis) Results from the following times: • Time of actual value acquisition for the leading axis • Interpolator cycle clock • Time of position filter of actual value extrapolation (T1 + T2)	
FollowingAxis DependentTime	LREAL	0.0 … 1.0E12	DIR	Extrapolation time component (caused by following axis) Results from the following times: • For a following axis with set velocity precontrol: – Communication cycle – Interpolator cycle clock – Speed control loop substitute time for the following axis – Output delay time of the setpoint at the following axis • For a following axis without velocity precontrol: – Communication cycle – Interpolator cycle clock – Position control loop equivalent time (1/Kv from "<TO>.PositionControl.Kv") – Output delay time of the setpoint at the following axis	
Settings.	TO_Struct_ExtrapolationSettings				
SystemDefined Extrapolation	DINT	0, 1	RES	Leading axis dependent time	
				0	Not effective
				1	Effective
ExtrapolatedVelocity Mode	DINT	0, 1	RES	Effective velocity value for the synchronization function	
				0	"FilteredVelocity" Leading value velocity from filtered actual velocity
				1	"VelocityByDifferentiation" The leading value velocity results from the differentiation of the extrapolated leading value position

Tag	Data type	Values	W	Description
PositionFilter.	TO_Struct_ExtrapolationPositionFilter			
T1	LREAL	0.0 … 1.0E12	DIR	Position filter time constant T1
T2	LREAL	0.0 … 1.0E12	DIR	Position filter time constant T2
VelocityFilter.	TO_Struct_ExtrapolationVelocityFilter			
T1	LREAL	0.0 … 1.0E12	DIR	Velocity filter time constant T1
T2	LREAL	0.0 … 1.0E12	DIR	Velocity filter time constant T2
VelocityTolerance.	TO_Struct_ExtrapolationVelocityTolerance			
Range	LREAL	0.0 … 1.0E12	DIR	Tolerance band width for velocity
Hysteresis.	TO_Struct_ExtrapolationHysteresis			
Value	LREAL	0.0 … 1.0E12	DIR	Hysteresis of the extrapolated actual position value

A.1.11 "LoadGear" tag (synchronous axis) (S7-1500, S7-1500T)

The tag structure "<TO>.LoadGear.<tag name>" contains the configuration of the load gear.

Tags

Legend (Page 242)

Tag	Data type	Value range	W	Description
LoadGear.	TO_Struct_LoadGear			
Numerator	UDINT	1 … 4294967295	RES	Load gear counter
Denominator	UDINT	1 … 4294967295	RES	Load gear denominator

A.1.12 "Properties" tag (synchronous axis) (S7-1500, S7-1500T)

The tag structure "<TO>.Properties.<tag name>" contains the configuration of the type of axis or motion.

Tags

Legend (Page 242)

Tag	Data type	Value range	W	Description	
Properties.	TO_Struct_Properties				
MotionType	DINT	0, 1	RON	Indication of axis type or motion type	
				0	Linear axis or motion
				1	Rotary axis or motion

A.1.13 "Units" tag (synchronous axis) (S7-1500, S7-1500T)

The tag structure "<TO>.Units.<tag name>" shows the set technological units.

Tags

Legend (Page 242)

Tag	Data type	Values	W	Description	
Units.	TO_Struct_Units/TO_Struct_ExternalEncoder_Units				
LengthUnit	UDINT	-	RON	Unit for position	
				1010	m
				1013	mm
				1536	mm[1)]
				1011	km
				1014	µm
				1015	nm
				1019	in
				1018	ft
				1021	mi
				1004	rad
				1005	°
				1537	°[1)]

Tag	Data type	Values	W	Description	
VelocityUnit	UDINT	-	RON	Unit for velocity	
				1521	°/s
				1539	°/s[1)]
				1522	°/min
				1086	rad/s
				1523	rad/min
				1062	mm/s
				1538	mm/s[1)]
				1061	m/s
				1524	mm/min
				1525	m/min
				1526	mm/h
				1063	m/h
				1527	km/min
				1064	km/h
				1066	in/s
				1069	in/min
				1067	ft/s
				1070	ft/min
				1075	mi/h
TimeUnit	UDINT	-	RON	Unit for time	
				1054	s
TorqueUnit	UDINT	-	RON	Unit for torque	
				1126	Nm
				1128	kNm
				1529	lbf in (pound-force-inch)
				1530	lbf ft
				1531	ozf in (ounce-force-inch)
				1532	ozf ft
				1533	pdl in (poundal-inch)
				1534	pdl ft
ForceUnit	UDINT	-	RON	Unit for force	
				1120	N
				1122	kN
				1094	lbf (pound-force)
				1093	ozf (ounce-force)
				1535	pdl (poundals)
UnitFactor	UDINT	-	RON	Factor for internal conversion in the high-resolution units.	

[1)] Position values with higher resolution or six decimal places

A.1.14 "Mechanics" tag (synchronous axis) (S7-1500, S7-1500T)

The tag structure "<TO>.Mechanics.<tag name>" contains the configuration of the mechanics.

Tags

Legend (Page 242)

Tag	Data type	Value range	W	Description
Mechanics.	TO_Struct_Mechanics			
LeadScrew	LREAL	0.0 … 1.0E12	RES	Leadscrew pitch

A.1.15 "Modulo" tag (synchronous axis) (S7-1500, S7-1500T)

The tag structure "<TO>.Modulo.<tag name>" contains the configuration of the modulo function.

Tags

Legend (Page 242)

Tag	Data type	Values	W	Description	
Modulo.	TO_Struct_Modulo				
Enable	BOOL	-	RES	FALSE	Modulo conversion disabled
				TRUE	Modulo conversion enabled
				When modulo conversion is enabled, a check is made for modulo length > 0.0	
Length	LREAL	0.001 … 1.0E12	RES	Modulo length	
StartValue	LREAL	-1.0E12 … 1.0E12	RES	Modulo start value	

A.1.16 "DynamicLimits" tag (synchronous axis) (S7-1500, S7-1500T)

The tag structure "<TO>.DynamicLimits.<tag name>" contains the configuration of the dynamic limits. During Motion Control, no dynamic values greater than the dynamic limits are permitted. If you 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 are limited).

Tags

Legend (Page 242)

Tag	Data type	Values	W	Description
DynamicLimits.	TO_Struct_DynamicLimits			
MaxVelocity	LREAL	0.0 … 1.0E12	RES	Maximum permissible velocity of the axis
Velocity	LREAL	0.0 … 1.0E12	DIR	Current maximum velocity of the axis
MaxAcceleration	LREAL	0.0 … 1.0E12	DIR	Maximum permissible acceleration of the axis
MaxDeceleration	LREAL	0.0 … 1.0E12	DIR	Maximum permissible deceleration of the axis
MaxJerk	LREAL	0.0 … 1.0E12	DIR	Maximum permissible jerk on the axis

A.1.17 "DynamicDefaults" tag (synchronous axis) (S7-1500, S7-1500T)

The tag structure "<TO>.DynamicDefaults.<tag name>" contains the configuration of the dynamic defaults. These settings will be used when you specify a dynamic value less than 0.0 in a Motion Control instruction (exceptions: "MC_MoveJog.Velocity", "MC_MoveVelocity.Velocity"). Changes to the default dynamic values will be applied at the next positive edge at the "Execute" parameter of a Motion Control instruction.

Tags

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Tag	Data type	Values	W	Description
DynamicDefaults.	TO_Struct_DynamicDefaults			
Velocity	LREAL	0.0 … 1.0E12	CAL	Default velocity
Acceleration	LREAL	0.0 … 1.0E12	CAL	Default acceleration
Deceleration	LREAL	0.0 … 1.0E12	CAL	Default deceleration
Jerk	LREAL	0.0 … 1.0E12	CAL	Default jerk
Emergency Deceleration	LREAL	0.0 … 1.0E12	DIR	Emergency stop deceleration

A.1.18 "PositionLimits_SW" tag (synchronous axis) (S7-1500, S7-1500T)

The tag structure "<TO>.PositionLimits_SW.<tag name>" contains the configuration of position monitoring with software limit switches. Software limit switches are used to limit the operating range of a synchronous axis.

Tags

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Tag	Data type	Values	W	Description	
PositionLimits_SW.	TO_Struct_PositionLimitsSW				
Active	BOOL	-	DIR	FALSE	Monitoring deactivated
				TRUE	Monitoring activated
MinPosition	LREAL	-1.0E12 … 1.0E12	DIR	Position of negative software limit switches	
MaxPosition	LREAL	-1.0E12 … 1.0E12	DIR	Position of positive software limit switches ("MaxPosition" > "MinPosition")	

A.1.19 "PositionLimits_HW" tag (synchronous axis) (S7-1500, S7-1500T)

The tag structure "<TO>.PositionLimits_HW.<tag name>" contains the configuration of position monitoring with hardware limit switches. Hardware limit switches are used to limit the traversing range of a synchronous axis.

Tags

Legend (Page 242)

Tag	Data type	Values	W	Description	
PositionLimits_HW.	TO_Struct_PositionLimitsHW				
Active	BOOL	-	RES	FALSE	Monitoring deactivated
				TRUE	Monitoring activated
				With "Active", both (negative and positive) hardware limit switches are activated or deactivated.	
MinSwitchLevel	BOOL	-	RES	Level selection for activation of the negative hardware limit switch	
				FALSE	Low level (Low active)
				TRUE	High level (High active)
MinSwitchAddress	VREF	0 … 65535	RON	Address for the negative hardware limit switch	
MaxSwitchLevel	BOOL	-	RES	Level selection for activation of the positive hardware limit switch	
				FALSE	Low level (Low active)
				TRUE	High level (High active)
MaxSwitchAddress	VREF	0 … 65535	RON	Address for the positive hardware limit switch	

A.1.20 "Homing" tag (synchronous axis) (S7-1500, S7-1500T)

The tag structure "<TO>.Homing.<tag name>" contains the configuration for homing the TO.

Tags

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Tag	Data type	Values	W	Description
Homing.	TO_Struct_Homing / TO_Struct_ExternalEncoder_Homing			
AutoReversal	BOOL	-	RES	Reversal at the hardware limit switches
			FALSE	No
			TRUE	Yes
ApproachDirection	BOOL	-	CAL	Direction of approach to the homing position switch
			FALSE	Positive direction
			TRUE	Negative direction
ApproachVelocity	LREAL	Linear: 0.0 … 10000.0 mm/s Rotary: 0.0 ... 360000.0 °/s	CAL	Approach velocity Velocity during active homing at which the reference cam and home position are approached.
ReferencingVelocity	LREAL	Linear: 0.0 … 1000.0 mm/s Rotary: 0.0 ... 36000.0 °/s	CAL	Homing velocity Velocity during active homing at which the home position is approached.
HomePosition	LREAL	-1.0E12 … 1.0E12	CAL	Home position

A.1.21 "Override" tag (synchronous axis) (S7-1500, S7-1500T)

The tag structure "<TO>.Override.<tag name>" contains the configuration of override parameters. The override parameters are used to apply a correction percentage to default values. An override change takes effect immediately, and is performed with the dynamic settings in effect in the Motion Control instruction.

Tags

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Tag	Data type	Values	W	Description
Override.	TO_Struct_Override			
Velocity	LREAL	0.0 … 200.0%	DIR	Velocity or speed override Percentage correction of the velocity/speed

A.1.22 "PositionControl" tag (synchronous axis) (S7-1500, S7-1500T)

The tag structure "<TO>.PositionControl.<tag name>" contains the settings of position control.

Tags

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Tag	Data type	Values	W	Description
PositionControl.	TO_Struct_PositionControl			
Kv	LREAL	0.0 … 2147480.0	DIR	Proportional gain of the closed loop position control ("Kv" > 0.0)
Kpc	LREAL	0.0 … 150.0 %	DIR	Velocity precontrol of the position control Recommended setting: • Isochronous drive connection via PROFIdrive: 100.0% • Non-isochronous drive connection via PROFIdrive: 0.0 to 100.0% • Analog drive connection: 0.0 to 100.0%
EnableDSC	BOOL	-	RES	Dynamic Servo Control (DSC) FALSE: DSC disabled TRUE: DSC activated DSC is only possible with one of the following PROFIdrive telegrams: • Standard telegram 5 or 6 • SIEMENS telegram 105 or 106
SmoothingTimeBy-ChangeDifference	LREAL	0.0 … 1.0E12 s	DIR	Smoothing time for the manipulated variable for switching operations, for example: • Encoder switchover • Change in P-gain ("Kv") • Switchover to emergency stop ramp
InitialOperativeSensor	UDINT	1 … 4	RES	Active sensor after initialization of the axis (sensor number 1 to 4) This encoder is used after startup of the CPU and after a restart of the technology object. At an operating mode transition from STOP → RUN of the CPU (without restart of the technology object), the encoder that was also active before the STOP is still being used.

Tag	Data type	Values	W	Description	
ControlDifference Quantization.	TO_Struct_PositionDifference Quantification				
Mode	DINT	-	RES	Type of quantification Configuration of a quantization when a drive with stepper motor interface is connected	
				0	No quantification
				1	Quantization corresponding to encoder resolution
				2	Quantization to a direct value
				(configuration is performed using the parameter view (data structure))	
Value	LREAL	0.001 … 1.0E12	RES	Value of quantification Configuration of a value for quantization to a direct value (<TO>.PositionControl.ControlDifferenceQuantization. Mode = 2) (configuration is performed using the parameter view (data structure))	

A.1.23 "DynamicAxisModel" tag (synchronous axis) (S7-1500, S7-1500T)

The tag structure "<TO>.DynamicAxisModel.<tag name>" contains the settings of the balancing filter.

Tags

Legend (Page 242)

Tag	Data type	Values	W	Description
DynamicAxisModel.	TO_Struct_DynamicAxisModel			Time constants for braking ramp generation with alarm response "Brake with emergency stop ramp"
VelocityTimeConstant	LREAL	0.0 … 1.0E12	DIR	Speed control loop substitute time [s]
AdditionalPosition-TimeConstant	LREAL	0.0 … 1.0E12	DIR	Additive position control loop substitute time [s]

A.1.24 "FollowingError" tag (synchronous axis) (S7-1500, S7-1500T)

The tag structure "<TO>.FollowingError.<tag name>" contains the configuration of the dynamic following error monitoring.

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

When the warning level is reached, a warning is output (technology alarm 522).

Tags

Legend (Page 242)

Tag	Data type	Values	W	Description	
FollowingError.	TO_Struct_FollowingError				
EnableMonitoring	BOOL	-	RES	FALSE	Following error monitoring deactivated
				TRUE	Following error monitoring enabled
MinValue	LREAL	Linear: 0.0 … 1.0E12 Rotary: 0.001 … 1.0E12	DIR	Permissible following error at velocities below the value of "MinVelocity"	
MaxValue	LREAL	Linear: 0.0 … 1.0E12 Rotary: 0.002 ... 1.0E12	DIR	Maximum permissible following error, which may be reached at the maximum velocity.	
MinVelocity	LREAL	0.0 … 1.0E12	DIR	"MinValue" is permissible below this velocity and is held constant.	
WarningLevel	LREAL	0.0 … 100.0	DIR	Warning level Percentage value relative to the valid maximum following error	

A.1.25 "PositioningMonitoring" tag (synchronous axis) (S7-1500, S7-1500T)

The tag structure "<TO>.PositioningMonitoring.<tag name>" contains the configuration of position monitoring at the end of a positioning motion.

If the actual position value at the end of a positioning motion is reached within the tolerance time and remains in the positioning window for the minimum dwell time, then "<TO>.StatusWord.X5 (Done)" is set in the technology data block. This completes a Motion Control job.

If the tolerance time is exceeded, then technology alarm 541 "Positioning monitoring" with supplemental value 1: "Target range not reached" is displayed.

If the minimum dwell time is not met, then technology alarm 541 "Positioning monitoring" with supplemental value 2: "Exit target range again" is displayed.

Tags

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Tag	Data type	Values	W	Description
PositioningMonitoring.	TO_Struct_PositionMonitoring			
ToleranceTime	LREAL	0.0 … 1.0E12	DIR	Tolerance time Maximum permitted duration from reaching of velocity setpoint zero until entrance into the positioning window
MinDwellTime	LREAL	0.0 … 1.0E12	DIR	Minimum dwell time in positioning window
Window	LREAL	0.0 … 1.0E12	DIR	Positioning window

A.1.26 "StandstillSignal" tag (synchronous axis) (S7-1500, S7-1500T)

The tag structure "<TO>.StandstillSignal.<tag name>" contains the configuration of the standstill signal.

If the actual velocity value is below the velocity threshold, and does not exceed it during the minimum dwell time, then the standstill signal "<TO>.StatusWord.X7 (Standstill)" is set.

Tags

Legend (Page 242)

Tag	Data type	Values	W	Description
StandstillSignal.	TO_Struct_StandstillSignal			Configuration for the standstill signal
VelocityThreshold	LREAL	0.0 … 1.0E12	DIR	Velocity threshold If velocity is below this threshold, the minimum dwell time begins.
MinDwellTime	LREAL	0.0 … 1.0E12	DIR	Minimum dwell time

A.1.27 "StatusProvidedLeadingValue" tag (synchronous axis) (S7-1500, S7-1500T)

The tag structure "<TO>.StatusProvidedLeadingValue.<tag name>" contains the provided leading value with leading value delay of the cross-PLC synchronous operation.

Tags

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Tag	Data type	Values	W	Description
StatusProvidedLeadingValue.	TO_Struct_StatusProvidedLeadingValue			Provided leading value
DelayedLeadingValue	TO_Struct_ProvidedLeadingValue			Leading value with leading value delay
Position	LREAL	-1.0E12 … 1.0E12	RON	Position
Velocity	LREAL	-1.0E12 … 1.0E12	RON	Velocity
Acceleration	LREAL	-1.0E12 … 1.0E12	RON	Acceleration

A.1.28 "StatusPositioning" tag (synchronous axis) (S7-1500, S7-1500T)

The tag structure "<TO>.StatusPositioning.<tag name>" indicates the status of a positioning motion.

Tags

Legend (Page 242)

Tag	Data type	Values	W	Description
StatusPositioning.	TO_Struct_StatusPositioning			
Distance	LREAL	-1.0E12 … 1.0E12	RON	Distance to the target position
TargetPosition	LREAL	-1.0E12 … 1.0E12	RON	Target position
TargetPositionModuloCycle	DINT	-2147483648 … 2147483647	RON	Number of modulo cycles to target position with positioning motions
FollowingError	LREAL	-1.0E12 … 1.0E12	RON	Current following error
SetpointExecutionTime	LREAL	-1.0E12 … 1.0E12	RON	Setpoint execution time of the axis (Results from T_{Ipo}, T_{vtc} or 1/kv, T_{Send} and T_O of the axis)

A.1.29 "StatusDrive" tag (synchronous axis) (S7-1500, S7-1500T)

The tag structure "<TO>.StatusDrive.<tag name>" indicates the status of the drive.

Tags

Legend (Page 242)

Tag	Data type	Values	W	Description	
StatusDrive.	TO_Struct_StatusDrive				
Disabled	BOOL	-	RON	FALSE	Drive not switched off
				TRUE	Drive switched off
InOperation	BOOL	-	RON	Operational status of the drive	
				FALSE	Drive not ready Setpoints will not be executed.
				TRUE	Drive ready Setpoints can be executed.
CommunicationOK	BOOL	-	RON	Cyclic BUS communication between controller and drive	
				FALSE	Not established
				TRUE	Established
Error	BOOL	-	RON	FALSE	No drive error
				TRUE	Drive error
AdaptionState	DINT	0 … 4	RON	Status of automatic data transfer of drive parameters	
				0	"NOT_ADAPTED" Data not transferred
				1	"IN_ADAPTION" Data transfer in progress
				2	"ADAPTED" Data transfer complete
				3	"NOT_APPLICABLE" Data transfer not selected, not possible
				4	"ADAPTION_ERROR" Error during data transfer

A.1.30 "StatusServo" tag (synchronous axis) (S7-1500, S7-1500T)

The tag structure "<TO>.StatusServo.<tag name>" indicates the status for the balancing filter.

Tags

Legend (Page 242)

Tag		Data type	Values	W	Description
StatusServo.		TO_Struct_StatusServo			
	BalancedPosition	LREAL	-	RON	Position after the balancing filter
	ControlDifference	LREAL	-	RON	Control error

A.1.31 "StatusSensor[1..4]" tags (synchronous axis) (S7-1500, S7-1500T)

The tag structure "<TO>.StatusSensor[1..4].<tag name>" indicates the status of the measuring system.

Tags

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Tag	Data type	Values	W	Description	
StatusSensor[1..4].	Array [1..4] OF TO_Struct_StatusSensor				
State	DINT	0 … 2	RON	Status of the actual encoder value	
				0	"NOT_VALID" Invalid
				1	"WAITING_FOR_VALID" Waiting for "Valid" status
				2	"VALID" Valid
CommunicationOK	BOOL	-	RON	Cyclic BUS communication between controller and encoder	
				FALSE	Not established
				TRUE	Established
Error	BOOL	-	RON	FALSE	No error in the measuring system
				TRUE	Error in the measuring system.
AbsEncoderOffset	LREAL	-	RON	Home point offset to the value of an absolute value encoder. The value will be retentively stored in the CPU.	
Control	BOOL	-	RON	FALSE	Encoder is not active
				TRUE	Encoder is active
Position	LREAL	-	RON	Encoder position	
Velocity	LREAL	-	RON	Encoder velocity	
AdaptionState	DINT	0 … 4	RON	Status of automatic data transfer of encoder parameters	
				0	"NOT_ADAPTED" Data not transferred
				1	"IN_ADAPTION" Data transfer in progress
				2	"ADAPTED" Data transfer complete
				3	"NOT_APPLICABLE" Data transfer not selected, not possible
				4	"ADAPTION_ERROR" Error during data transfer
ModuloCycle	DINT	-2147483648 … 2147483647	RON	Number of modulo cycles	

A.1.32 "StatusExtrapolation" tag (synchronous axis) (S7-1500, S7-1500T)

The tag structure "<TO>.StatusExtrapolation.<tag name>" indicates the status of the actual value extrapolation.

Tags

Legend (Page 242)

Tag	Data type	Values	W	Description
StatusExtrapolation.	TO_Struct_StatusExtrapolation			
FilteredPosition	LREAL	-1.0E12 … 1.0E12	RON	Position after position filter
FilteredVelocity	LREAL	-1.0E12 … 1.0E12	RON	Velocity after velocity filter and tolerance band
ExtrapolatedPosition	LREAL	-1.0E12 … 1.0E12	RON	Extrapolated position
ExtrapolatedVelocity	LREAL	-1.0E12 … 1.0E12	RON	Extrapolated velocity

A.1.33 "StatusSynchronizedMotion" tag (synchronous axis) (S7-1500, S7-1500T)

The tag structure "<TO>.StatusSynchronizedMotion.<tag name>" indicates the status of the synchronous operation.

Tags

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Tag	Data type	Value range	W	Description	
StatusSynchronizedMotion.	TO_Struct_StatusSynchronized Motion				
FunctionState	DINT	0 … 3	RON	Indication of which synchronous operation function is active	
				0	No synchronous operation active
				1	Gearing ("MC_GearIn")
				2	Gearing with specified synchronous positions ("MC_GearInPos")
				3	Camming ("MC_CamIn")
WaitingFunctionState	DINT	0 … 3	RON	Indication of which synchronous operation function is waiting	
				0	No synchronous operation waiting
				1	Reserved
				2	Gearing with specified synchronous positions waiting ("MC_GearInPos")
				3	Camming waiting ("MC_CamIn")

Tag	Data type	Value range	W	Description
PhaseShift	LREAL	-1.0E12 … 1.0E12	RON	Current absolute leading value shift
ActualMaster	DB_ANY	0 … 65535	RON	When a synchronous operation job is started, the number of the technology data block of the currently used leading axis is displayed.
				0 Synchronous operation inactive
ActualCam	DB_ANY	0 … 65535	RON	Cam that is currently being used for camming
MasterOffset	LREAL	-1.0E12 … 1.0E12	RON	Current shift of the leading value range of the cam
MasterScaling	LREAL	-1.0E12 … 1.0E12	RON	Current scaling of the leading value range of the cam
SlaveOffset	LREAL	-1.0E12 … 1.0E12	RON	Current shift of the following value range of the cam
SlaveScaling	LREAL	-1.0E12 … 1.0E12	RON	Current scaling of the following value range of the cam
EffectiveLeadingValue.	TO_Struct_EffectiveLeadingValue			Effective leading value of the synchronous operation function
Position	LREAL	-1.0E12 … 1.0E12	RON	Position
Velocity	LREAL	-1.0E12 … 1.0E12	RON	Velocity
Acceleration	LREAL	-1.0E12 … 1.0E12	RON	Acceleration
StatusWord.	DWORD	-	RON	Status information of synchronous operation
Bit 0	BOOL	-	RON	"MaxVelocityExceeded" Configured maximum velocity is exceeded during synchronous operation.
Bit 1	BOOL	-	RON	"MaxAccelerationExceeded" Configured maximum acceleration is exceeded during synchronous operation.
Bit 2	BOOL	-	RON	"MaxDecelerationExceeded" Configured maximum deceleration is exceeded during synchronous operation.
Bit 3	BOOL	-	RON	"InSimulation" Simulation of synchronous operation
				FALSE Not simulated
				TRUE Simulated
Bit 4	BOOL	-	RON	"LeadingValueAdditiveCommand" Additive leading value via "MC_LeadingValueAdditive"
				FALSE No additive leading value active
				TRUE Additive leading value active
Bit 5 … Bit 31	BOOL	-	RON	Reserved

A.1.34 "StatusKinematicsMotion" tag (synchronous axis) (S7-1500, S7-1500T)

The "<TO>.StatusKinematicsMotion" tag contains the status information of the technology object.

Information on the evaluation of the individual bits (e.g. bit 2 "MaxDecelerationExceeded") can be found in the "Evaluating StatusWord, ErrorWord and WarningWord" section of the "S7-1500/S7-1500T Motion Control overview" (https://support.industry.siemens.com/cs/ww/en/view/109766459) documentation.

Tags

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Tag	Data type	Values	W	Description	
StatusKinematicsMotion	DWORD	-	RON	Status information of the technology object	
Bit 0	-	-	-	"MaxVelocityExceeded"	
				0	The kinematics technology object calculated a lower velocity setpoint than the maximum velocity on the axis.
				1	The kinematics technology object calculated a higher velocity setpoint than the maximum velocity on the axis.
Bit 1	-	-	-	"MaxAccelerationExceeded"	
				0	The kinematics technology object calculated a lower setpoint acceleration calculated than the maximum acceleration of the axis.
				1	The kinematics technology object calculated a higher setpoint acceleration than the maximum acceleration of the axis.
Bit 2	-	-	-	"MaxDecelerationExceeded"	
				0	The kinematics technology object calculated a lower setpoint deceleration than the maximum deceleration of the axis.
				1	The kinematics technology object calculated a lower setpoint deceleration than the maximum deceleration of the axis.

A.1.35 "StatusTorqueData" tag (synchronous axis) (S7-1500, S7-1500T)

The tag structure "<TO>.StatusTorqueData.<tag name>" indicates the status of the torque data.

Tags

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Tag	Data type	Value range	W	Description	
StatusTorqueData.	TO_Struct_StatusTorqueData				
CommandAdditiveTorqueActive	DINT	0, 1	RON	Additive setpoint torque	
				0	Inactive
				1	Active
CommandTorqueRangeActive	DINT	0, 1	RON	Torque limits B +, B-	
				0	Inactive
				1	Active
ActualTorque	LREAL	-1.0E12 … 1.0E12	RON	Actual torque of the axis	

A.1.36 "StatusMotionIn" tag (synchronous axis) (S7-1500, S7-1500T)

The tag structure "<TO>.StatusMotionIn.<tag name>" indicates the status of the "MotionIn" function.

Tags

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Tag	Data type	Value range	W	Description	
StatusMotionIn.	TO_Struct_StatusMotionIn				
FunctionState	DINT	0 … 2	RON	0	No "MotionIn" function active
				1	"MC_MotionInVelocity" active
				2	"MC_MotionInPosition" active

A.1.37 "StatusWord" tag (synchronous axis) (S7-1500, S7-1500T)

The "<TO>.StatusWord" tag contains the status information of the technology object.

Information on the evaluation of the individual bits (e.g. bit 5 "HomingDone") can be found in the "Evaluating StatusWord, ErrorWord and WarningWord" section of the "S7-1500/S7-1500T Motion Control overview" (https://support.industry.siemens.com/cs/ww/en/view/109766459) documentation.

Tag

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Tag	Data type	Values	W	Description	
StatusWord	DWORD	-	RON	Status information of the technology object	
Bit 0	-	-	-	"Enable" Enable status	
				0	The technology object is disabled.
				1	The technology object has been enabled.
Bit 1	-	-	-	"Error"	
				0	No error is present.
				1	An error is present.
Bit 2	-	-	-	"RestartActive"	
				0	No restart is active.
				1	A restart is active. The technology object is being reinitialized.
Bit 3	-	-	-	"OnlineStartValuesChanged"	
				0	The restart tags are unchanged.
				1	The restart tags have been changed. For the changes to be applied, the technology object must be reinitialized.
Bit 4	-	-	-	"ControlPanelActive"	
				0	The axis control panel is deactivated.
				1	The axis control panel is active.
Bit 5	-	-	-	"HomingDone" Homing status	
				0	The technology object is not homed.
				1	The technology object is homed.
Bit 6	-	-	-	"Done"	
				0	A motion job is in progress or the axis control panel is activated.
				1	No motion job is in progress and the axis control panel is deactivated.
Bit 7	-	-	-	"Standstill" Standstill signal	
				0	The axis is in motion.
				1	The axis is at a standstill.

Tag	Data type	Values	W	Description	
Bit 8	-	-	-	"PositioningCommand"	
				0	No positioning job is active.
				1	A positioning job is active ("MC_MoveRelative","MC_MoveAbsolute").
Bit 9	-	-	-	"JogCommand"	
				0	No "MC_MoveJog" job is active.
				1	An "MC_MoveJog" job is running.
Bit 10	-	-	-	"VelocityCommand"	
				0	No "MC_MoveVelocity" job is active.
				1	An "MC_MoveVelocity" job is running.
Bit 11	-	-	-	"HomingCommand"	
				0	No "MC_Home" job is in progress.
				1	An "MC_Home" job is being processed.
Bit 12	-	-	-	"ConstantVelocity"	
				0	The axis is accelerated or decelerated.
				1	The setpoint velocity is reached. A constant velocity setpoint is output.
Bit 13	-	-	-	"Accelerating"	
				0	No acceleration operation is active.
				1	An acceleration operation is active.
Bit 14	-	-	-	"Decelerating"	
				0	No deceleration process is active.
				1	A deceleration operation is active.
Bit 15	-	-	-	"SWLimitMinActive"	
				0	No negative software limit switch was approached.
				1	A negative software limit switch was reached or exceeded.
Bit 16	-	-	-	"SWLimitMaxActive"	
				0	No positive software limit switch was approached.
				1	A positive software limit switch was reached or exceeded.
Bit 17	-	-	-	"HWLimitMinActive"	
				0	No negative hardware limit switch was approached.
				1	A negative hardware limit switch was reached or exceeded.
Bit 18	-	-	-	"HWLimitMaxActive"	
				0	No positive hardware limit switch was approached.
				1	A positive hardware limit switch was reached or exceeded.
Bit 19	-	-	-	Reserved	

Tag	Data type	Values	W	Description	
Bit 20	-	-	-	Reserved	
Bit 21	-	-	-	"Synchronizing"	
				0	The axis does not synchronize to a leading value.
				1	The axis synchronizes to a leading value.
Bit 22	-	-	-	"Synchronous"	
				0	The axis moves asynchronous to a leading value.
				1	The axis moves synchronously to a leading value.
Bit 23	-	-	-	"SuperimposedMotionCommand"	
				0	No overlaid movement is active.
				1	An overlaid movement is running.
Bit 24	-	-	-	"PhasingCommand"	
				0	No Motion Control instruction for leading value shift is active.
				1	A Motion Control instruction for leading value shift is active.
Bit 25	-	-	-	"AxisSimulation"	
				0	The simulation is not running.
				1	The simulation is active.
Bit 26	-	-	-	"TorqueLimitingCommand"	
				0	No "MC_TorqueLimiting" job is active.
				1	An "MC_TorqueLimiting" job is running.
Bit 27	-	-	-	"InLimitation"	
				0	The drive does not operate at the torque limit.
				1	The drive operates at least at the threshold value (default 90%) of the torque limit.
Bit 28	-	-	-	"NonPositionControlled"	
				0	The axis is in position-controlled mode.
				1	The axis is not in position-controlled mode.
Bit 29	-	-	-	"KinematicsMotionCommand"	
				0	The axis is not used for a kinematics job.
				1	The axis is used for a kinematics job.
Bit 30	-	-	-	"InClamping"	
				0	The axis is not clamped at a fixed stop.
				1	The axis is clamped at a fixed stop.
Bit 31	-	-	-	"MotionInCommand"	
				0	No "MotionIn" job is active.
				1	An "MotionIn" job is running.

A.1.38 "StatusWord2" tag (synchronous axis) (S7-1500, S7-1500T)

The "<TO>.StatusWord2" tag contains the status information of the technology object.

Information on the evaluation of the individual bits (e.g. bit 0 "StopCommand") can be found in the "Evaluating StatusWord, ErrorWord and WarningWord" section of the "S7-1500/S7-1500T Motion Control overview" (https://support.industry.siemens.com/cs/ww/en/view/109766459) documentation.

Tags

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Tag	Data type	Value range	W	Description	
StatusWord2	DWORD	-	RON	Status information of the technology object	
Bit 0	BOOL	-	RON	"StopCommand"	
				0	No "MC_Stop" job is active.
				1	An "MC_Stop" job is running. The technology object is disabled.
Bit 1 … Bit 31	BOOL	-	RON	Reserved	

A.1.39 "ErrorWord" tag (synchronous axis) (S7-1500, S7-1500T)

The "<TO>.ErrorWord" tag indicates technology object errors (technology alarms).

Information on the evaluation of the individual bits (e.g. bit 3 "CommandNotAccepted") can be found in the "Evaluating StatusWord, ErrorWord and WarningWord" section of the "S7-1500/S7-1500T Motion Control overview" (https://support.industry.siemens.com/cs/ww/en/view/109766459) documentation.

Tag

Legend (Page 242)

Tag	Data type	Values	W	Description
ErrorWord	DWORD	-	RON	
Bit 0	-	-	-	"SystemFault" A system-internal error has occurred.
Bit 1	-	-	-	"ConfigFault" Configuration error One or more configuration parameters are inconsistent or invalid.
Bit 2	-	-	-	"UserFault" Error in user program at a Motion Control instruction or its use

Tag	Data type	Values	W	Description
Bit 3	-	-	-	"CommandNotAccepted" Job cannot be executed A Motion Control instruction cannot be executed because the necessary conditions are not met.
Bit 4	-	-	-	"DriveFault" Error in drive
Bit 5	-	-	-	"SensorFault" Error in encoder system
Bit 6	-	-	-	"DynamicError" Specified dynamic values are limited to permissible values.
Bit 7	-	-	-	"CommunicationFault" Communication error Missing or faulty communication.
Bit 8	-	-	-	"SWLimit" Software limit switch reached or overtraveled.
Bit 9	-	-	-	"HWLimit" Hardware limit switch reached or overtraveled.
Bit 10	-	-	-	"HomingError" Error during homing operation The homing cannot be completed.
Bit 11	-	-	-	"FollowingErrorFault" Following error limits exceeded
Bit 12	-	-	-	"PositioningFault" Positioning error
Bit 13	-	-	-	"PeripheralError" Error accessing a logical address
Bit 14	-	-	-	"SynchronousError" Error during synchronous operation The leading axis specified in the Motion Control instruction was not configured as a possible leading axis.
Bit 15	-	-	-	"AdaptionError" Error in automatic data transfer
Bit 16 ... Bit 31	-	-	-	Reserved

A.1.40 "ErrorDetail" tag (synchronous axis) (S7-1500, S7-1500T)

The tag structure "<TO>.ErrorDetail.<tag name>" contains the alarm number and the effective local alarm reaction for the technology alarm that is currently pending on the technology object.

You can find a list of the technology alarms and alarm reactions in the "Technology alarms" section of the "S7-1500/S7-1500T Motion Control overview" (https://support.industry.siemens.com/cs/ww/en/view/109766459) documentation.

Tags

Legend (Page 242)

Tag	Data type	Values	W	Description	
ErrorDetail.	TO_Struct_ErrorDetail				
Number	UDINT	-	RON	Alarm number	
Reaction	DINT	0 … 5	RON	Effective alarm reaction	
				0	No reaction
				1	Stop with current dynamic values
				2	Stop with maximum dynamic values
				3	Stop with emergency stop ramp
				4	Remove enable
				5	Track setpoints

A.1.41 "WarningWord" tag (synchronous axis) (S7-1500, S7-1500T)

The "<TO>.WarningWord" tag indicates pending warnings at the technology object.

Information on the evaluation of the individual bits (e.g. bit 13 "PeripheralWarning") can be found in the "Evaluating StatusWord, ErrorWord and WarningWord" section of the "S7-1500/S7-1500T Motion Control overview" (https://support.industry.siemens.com/cs/ww/en/view/109766459) documentation.

Tag

Legend (Page 242)

Tag	Data type	Values	W	Description
WarningWord	DWORD	-	RON	
Bit 0	-	-	-	"SystemWarning" A system-internal error has occurred.
Bit 1	-	-	-	"ConfigWarning" Configuration error One or several configuration parameters are adjusted internally.
Bit 2	-	-	-	"UserWarning" Error in user program at a Motion Control instruction or its use
Bit 3	-	-	-	"CommandNotAccepted" Job cannot be executed A Motion Control instruction cannot be executed because the necessary conditions are not met.
Bit 4	-	-	-	"DriveWarning" Error in drive
Bit 5	-	-	-	"SensorWarning" Error in encoder system
Bit 6	-	-	-	"DynamicWarning" Specified dynamic values are limited to permissible values.
Bit 7	-	-	-	"CommunicationWarning" Communication error Missing or faulty communication.
Bit 8	-	-	-	"SWLimitMin"
Bit 9	-	-	-	"SWLimitMax"
Bit 10	-	-	-	"HomingWarning" Error during homing operation The homing cannot be completed.
Bit 11	-	-	-	"FollowingErrorWarning" Warning limit of following error monitoring reached/exceeded

Tag	Data type	Values	W	Description
Bit 12	-	-	-	"PositioningWarning" Positioning error
Bit 13	-	-	-	"PeripheralWarning" Error accessing a logical address
Bit 14	-	-	-	"SynchronousWarning" Error during synchronous operation The leading axis specified in the Motion Control instruction was not configured as a possible leading axis.
Bit 15	-	-	-	"AdaptionWarning" Error in automatic data transfer
Bit 16... Bit 31	-	-	-	Reserved

A.1.42 "ControlPanel" tag (synchronous axis) (S7-1500, S7-1500T)

The tag structure "<TO>.ControlPanel.<tag name>" contains no user-relevant data. This tag structure is internally used.

A.1.43 "InternalToTrace" tag (synchronous axis) (S7-1500, S7-1500T)

The tag structure "<TO>.InternalToTrace.<tag name>" contains no user-relevant data. This tag structure is internally used.

A.2 Tags of the cam technology object (S7-1500T)

A.2.1 Legend (S7-1500T)

Tag	Name of the tag	
Data type	Data type of the tag	
Values	Value range of the tag - minimum value to maximum value If no specific value is shown, the value range limits of the relevant data type apply or the information under "Description".	
W	Effectiveness of changes in the technology data block	
	DIR	Direct: Values are changed directly and take effect at the start of the next MC-Servo [OB91].
	CAL	At call of Motion Control instruction: Values are changed directly and take effect at the start of the next MC-Servo [OB91] after the call of the corresponding Motion Control instruction in the user program.
	RES	Restart: Changes to the start value in the load memory are made using the extended instruction "WRIT_DBL" (write to DB in load memory). Changes will not take effect until after restart of the technology object.
	RON	Read only: The tag cannot and must not be changed during runtime of the user program.
Description	Description of the tag	

Access to the tags is with "<TO>.<tag name>". The placeholder <TO> represents the name of the technology object.

A.2.2 "Point[1..1000]" tag (cam) (S7-1500T)

The tag structure "<TO>.Point[1..1000].<tag name>" contains the defined points of the cam.

Tags

Legend (Page 279)

Tag	Data type	Values	W	Description
Point[1..1000].	ARRAY [1..1000] OF TO_Cam_Struct_PointData			
x	LREAL	-1.0E12 … 1.0E12	CAL	Value of the point in the definition range
y	LREAL	-1.0E12 … 1.0E12	CAL	Value of the point in the range of the function

A.2.3 "ValidPoints[1..1000]" tag (cam) (S7-1500T)

The tag structure "<TO>.ValidPoint[1-1000].<tag name>" shows the validity of the defined points of the cam.

Tags

Legend (Page 279)

Tag	Data type	Values	W	Description	
ValidPoint[1..1000].	ARRAY [1..1000] OF BOOL				
ValidPoint	BOOL	-	CAL	Indicates whether the defined point is valid.	
				FALSE	Invalid
				TRUE	Valid

A.2.4 "Segment[1..50]" tag (cam) (S7-1500T)

The tag structure "<TO>.Segment[1..50].<tag name>" contains the defined segments of the cam.

Tags

Legend (Page 279)

Tag	Data type	Values	W	Description
Segment[1..50].	ARRAY [1..50] OF TO_Cam_Struct_SegmentData			
xmin	LREAL	-1.0E12 … 1.0E12	CAL	Start coordinates of the segment
xmax	LREAL	-1.0E12 … 1.0E12	CAL	End coordinates of the segment
a0	LREAL	-1.0E12 … 1.0E12	CAL	Coefficient A0 for x^0 of the polynomial for the segment
a1	LREAL	-1.0E12 … 1.0E12	CAL	Coefficient A1 for x^1 of the polynomial for the segment
a2	LREAL	-1.0E12 … 1.0E12	CAL	Coefficient A2 for x^2 of the polynomial for the segment
a3	LREAL	-1.0E12 … 1.0E12	CAL	Coefficient A3 for x^3 of the polynomial for the segment
a4	LREAL	-1.0E12 … 1.0E12	CAL	Coefficient A4 for x^4 of the polynomial for the segment
a5	LREAL	-1.0E12 … 1.0E12	CAL	Coefficient A5 for x^5 of the polynomial for the segment
a6	LREAL	-1.0E12 … 1.0E12	CAL	Coefficient A6 for x^6 of the polynomial for the segment
sineAmplitude	LREAL	-1.0E12 … 1.0E12	CAL	Amplitude of the sine element
sinePeriod	LREAL	-1.0E12 … 1.0E12	CAL	Period length of the sine element [rad]
sinePhase	LREAL	-1.0E12 … 1.0E12	CAL	Phase offset of the sine element [rad]

A.2.5 "ValidSegments[1..50]" tag (cam) (S7-1500T)

The tag structure "<TO>.ValidSegment[1..50].<tag name>" shows the validity of the defined segments of the cam.

Tags

Legend (Page 279)

Tag	Data type	Values	W	Description	
ValidSegment[1..50].	ARRAY [1..50] OF BOOL				
ValidSegment	BOOL	-	CAL	Indicates whether the defined segment is valid.	
				FALSE	Invalid
				TRUE	Valid

A.2.6 "InterpolationSettings" tag (cam) (S7-1500T)

The tag structure "<TO>.InterpolationSettings.<tag name>" contains the configuration for the interpolation of the cam.

Tags

Legend (Page 279)

Tag	Data type	Values	W	Description	
InterpolationSettings.	TO_Cam_Struct_Interpolation Settings				
InterpolationMode	DINT	0 … 2	CAL	Interpolation type	
				0	Linear
				1	C splines
				2	B splines
BoundaryConditions	DINT	0, 1	CAL	Characteristics of the boundary points	
				0	No profile start or profile end conditions
				1	First derivative equal at profile start and end

A.2.7 "StatusCam" tag (cam) (S7-1500T)

The tag structure "<TO>.StatusCam.<tag name>" indicates the status of the cam.

Tags

Legend (Page 279)

Tag	Data type	Values	W	Description
StatusCam.	TO_Cam_Struct_StatusCam			
StartLeadingValue	LREAL	-1.0E12 … 1.0E12	RON	First defined interpolation point/start of the first segment of the cam (Start value of the cam definition range)
EndLeadingValue	LREAL	-1.0E12 … 1.0E12	RON	Last defined interpolation point/end of the last segment of the cam (End value of the definition range of the cam)

A.2.8 "StatusWord" tag (cam) (S7-1500T)

The "<TO>.StatusWord" tag contains the status information of the technology object.

Information on the evaluation of the individual bits (e.g. bit 4 "CamDataChanged") can be found in the "Evaluating StatusWord, ErrorWord and WarningWord" section of the "S7-1500/S7-1500T Motion Control overview" (https://support.industry.siemens.com/cs/ww/en/view/109766459) documentation.

Tags

Legend (Page 279)

Tag	Data type	Values	W	Description	
StatusWord	DWORD	-	RON	Status information of the technology object	
Bit 0	-	-	-	"Control" Use status	
				0	Cam not in use
				1	Cam in use
Bit 1	-	-	-	"Error"	
				0	No error present
				1	Error present
Bit 2	-	-	-	"RestartActive"	
				0	No restart active
				1	Restart active The technology object is being reinitialized.
Bit 3	-	-	-	"OnlineStartValuesChanged"	
				0	Restart tags unchanged
				1	Change to Restart tags For the changes to be applied, the technology object must be reinitialized.
Bit 4	-	-	-	"CamDataChanged"	
				0	No change
				1	The definition range of the cam has changed in the technology data block.
Bit 5	-	-	-	"Interpolated"	
				0	Cam is not interpolated
				1	Cam is interpolated
Bit 6	-	-	-	"InInterpolation"	
				0	Cam not undergoing interpolation
				1	Cam undergoing interpolation
Bit 7... Bit 31	-	-	-	Reserved	

A.2.9 "ErrorWord" tag (cam) (S7-1500T)

The "<TO>.ErrorWord" tag indicates technology object errors (technology alarms).

Information on the evaluation of the individual bits (e.g. bit 3 "CommandNotAccepted") can be found in the "Evaluating StatusWord, ErrorWord and WarningWord" section of the "S7-1500/S7-1500T Motion Control overview" (https://support.industry.siemens.com/cs/ww/en/view/109766459) documentation.

Tags

Legend (Page 279)

Tag	Data type	Values	W	Description
ErrorWord	DWORD	-	RON	
Bit 0	-	-	-	"SystemFault" A system-internal error has occurred.
Bit 1	-	-	-	"ConfigFault" Configuration error One or more configuration parameters are inconsistent or invalid.
Bit 2	-	-	-	"UserFault" Error in user program at a Motion Control instruction or its use
Bit 3	-	-	-	"CommandNotAccepted" Job cannot be executed A Motion Control instruction cannot be executed because the necessary conditions are not met.
Bit 4 … Bit 31	-	-	-	Reserved

A.2.10 "ErrorDetail" tag (cam) (S7-1500T)

The tag structure "<TO>.ErrorDetail.<tag name>" contains the alarm number and the effective local alarm reaction for the technology alarm that is currently pending on the technology object.

You can find a list of the technology alarms and alarm reactions in the "Technology alarms" section of the "S7-1500/S7-1500T Motion Control overview" (https://support.industry.siemens.com/cs/ww/en/view/109766459) documentation.

Tags

Legend (Page 279)

Tag	Data type	Values	W	Description	
ErrorDetail.	TO_Struct_ErrorDetail				
Number	UDINT	-	RON	Alarm number	
Reaction	DINT	0, 6	RON	Effective alarm reaction	
				0	No reaction
				6	Terminate processing of the technology object

A.2.11 "WarningWord" tag (cam) (S7-1500T)

The "<TO>.WarningWord" tag indicates pending warnings at the technology object.

Information on the evaluation of the individual bits (e.g. bit 3 "CommandNotAccepted") can be found in the "Evaluating StatusWord, ErrorWord and WarningWord" section of the "S7-1500/S7-1500T Motion Control overview" (https://support.industry.siemens.com/cs/ww/en/view/109766459) documentation.

Tags

Legend (Page 279)

Tag	Data type	Values	W	Description
WarningWord	DWORD	-	RON	
Bit 0	-	-	-	"SystemWarning" A system-internal error has occurred.
Bit 1	-	-	-	"ConfigWarning" Configuration error One or more configuration parameters are inconsistent or invalid.
Bit 2	-	-	-	"UserWarning" Error in user program at a Motion Control instruction or its use
Bit 3	-	-	-	"CommandNotAccepted" Job cannot be executed A Motion Control instruction cannot be executed because the necessary conditions are not met.
Bit 4 … Bit 31	-	-	-	Reserved

A.3 Tags of the leading axis proxy technology object (S7-1500T)

A.3.1 Legend (S7-1500T)

Tag	Name of the tag	
Data type	Data type of the tag	
Values	Value range of the tag - minimum value to maximum value If no specific value is shown, the value range limits of the relevant data type apply or the information under "Description".	
W	Effectiveness of changes in the technology data block	
	DIR	Direct: Values are changed directly and take effect at the start of the next MC-Servo [OB91].
	CAL	At call of Motion Control instruction: Values are changed directly and take effect at the start of the next MC-Servo [OB91] after the call of the corresponding Motion Control instruction in the user program.
	RES	Restart: Changes to the start value in the load memory are made using the extended instruction "WRIT_DBL" (write to DB in load memory). Changes will not take effect until after restart of the technology object.
	RON	Read only: The tag cannot and must not be changed during runtime of the user program.
Description	Description of the tag	

Access to the tags is with "<TO>.<tag name>". The placeholder <TO> represents the name of the technology object.

A.3.2 Leading value (leading axis proxy) (S7-1500T)

The following tags indicate the leading value parameters of the technology object for local synchronous operation.

Tags

Legend (Page 288)

Tag	Data type	Values	W	Description
Position	LREAL	-	RON	Adapted leading value for local synchronous operation
Velocity	LREAL	-	RON	Leading value velocity for local synchronous operation
Acceleration	LREAL	-	RON	Leading value velocity for local synchronous operation

A.3.3 "Interface" tag (leading axis proxy) (S7-1500T)

The tag structure "<TO>.Interface.<Tag name>" contains the input address of the telegram.

Tags

Legend (Page 288)

Tag	Data type	Values	W	Description
Interface.	TO_Struct_LeadingAxisProxy_Interface			
AddressIn	VRef	-	RON	Input address for the telegram of the external leading value

A.3.4 "Parameter" tag (leading axis proxy) (S7-1500T)

The tag structure "<TO>.Parameter.<tag name>" contains parameters for leading value adaptation.

Tags

Legend (Page 288)

Tag	Data type	Values	W	Description
Parameter.	TO_Struct_LeadingAxisProxy_Parameter			
LocalLeadingValueDelayTime	LREAL	0.0 … 1.0E12	DIR	Delay time of virtual local following axis which, in turn, provides a cross-PLC leading value with a cascade (<TO>.CrossPlcSynchronousOperation.LocalLeadingValueDelayTime)
ToleranceTimeExternalLeadingValueInvalid	LREAL	0.0 … 1.0E12	DIR	Tolerance time until a technology alarm is triggered when the external leading value becomes invalid

A.3.5 "StatusExternalLeadingValue" tag (leading axis proxy) (S7-1500T)

The tag structure "<TO>.StatusExternalLeadingValue.<Tag name>" contains the parameter values of the external leading value.

Tags

Legend (Page 288)

Tag	Data type	Values	W	Description	
StatusExternalLeadingValue.	TO_Struct_LeadingAxisProxy_StatusData				
ModuloLength	LREAL	0.0 … 1.0E12	RON	Modulo length of the external leading value	
ModuloStartValue	LREAL	-1.0E12 … 1.0E12	RON	Modulo start value of the external leading value	
AdjustmentTime	LREAL	-1.0E12 … 1.0E12	RON	Time by which the external leading value is adjusted	
				< 0	The external leading value is interpolated by this time.
				> 0	The external leading value is extrapolated by this time.

A.3.6 "StatusWord" tag (leading axis proxy) (S7-1500T)

The "<TO>.StatusWord" tag contains the status information of the technology object.

Information on the evaluation of the individual bits (e.g. bit 4 "LeadingValueValid") can be found in the "Evaluating StatusWord, ErrorWord and WarningWord" section of the "S7-1500/S7-1500T Motion Control overview" (https://support.industry.siemens.com/cs/ww/en/view/109766459) documentation.

Tags

Legend (Page 288)

Tag	Data type	Values	W	Description	
StatusWord	DWORD	-	RON	Status information of the technology object	
Bit 0	-	-	-	"Control" Use status	
				0	Leading axis proxy not in operation
				1	Leading axis proxy in operation
Bit 1	-	-	-	"Error"	
				0	No error present
				1	Error present
Bit 2	-	-	-	"RestartActive"	
				0	No restart active
				1	Restart active The technology object is being reinitialized.
Bit 3	-	-	-	"OnlineStartValuesChanged"	
				0	Restart tags unchanged
				1	Change to Restart tags For the changes to be applied, the technology object must be reinitialized.
Bit 4	-	-	-	"LeadingValueValid"	
				0	Leading value does not exist or is not valid
				1	Leading value exists and is valid
Bit 5	-	-	-	"LeadingValueModulo"	
				0	Leading value without modulo functionality
				1	Leading value with modulo functionality
Bit 6	-	-	-	"LeadingAxisControl"	
				0	Leading axis in tracking mode
				1	Leading axis not in tracking mode
Bit 7 … Bit 31	-	-	-	Reserved	

A.3.7 "'ErrorWord" tag (leading axis proxy) (S7-1500T)

The "<TO>.ErrorWord" tag indicates technology object errors (technology alarms).

Information on the evaluation of the individual bits (e.g. bit 3 "CommandNotAccepted") can be found in the "Evaluating StatusWord, ErrorWord and WarningWord" section of the "S7-1500/S7-1500T Motion Control overview" (https://support.industry.siemens.com/cs/ww/en/view/109766459) documentation.

Tags

Legend (Page 288)

Tag	Data type	Values	W	Description
ErrorWord	DWORD	-	RON	
Bit 0	-	-	-	"SystemFault" System error
Bit 1	-	-	-	"ConfigFault" Configuration error One or more configuration parameters are inconsistent or invalid.
Bit 2	-	-	-	"UserFault" Error in user program at a Motion Control instruction or its use
Bit 3	-	-	-	"CommandNotAccepted" Job cannot be executed A Motion Control instruction cannot be executed because the necessary conditions are not met.
Bit 4 … Bit 7	-	-	-	Reserved
Bit 7	-	-	-	"CommunicationFault" Communication error Missing or faulty communication.
Bit 8 … Bit 31	-	-	-	Reserved

A.3.8 "ErrorDetail" tag (leading axis proxy) (S7-1500T)

The tag structure "<TO>.ErrorDetail.<tag name>" contains the alarm number and the effective local alarm reaction for the technology alarm that is currently pending on the technology object.

You can find a list of the technology alarms and alarm reactions in the "Technology alarms" section of the "S7-1500/S7-1500T Motion Control overview" documentation (https://support.industry.siemens.com/cs/ww/en/view/109766459).

Tags

Legend (Page 288)

Tag	Data type	Values	W	Description	
ErrorDetail.	TO_Struct_ErrorDetail				
Number	UDINT	-	RON	Alarm number	
Reaction	DINT	0, 13	RON	Effective alarm reaction	
				0	No reaction
				13	Invalid leading value

A.3.9 "WarningWord" tag (leading axis proxy) (S7-1500T)

The "<TO>.WarningWord" tag indicates pending warnings at the technology object.

Information on the evaluation of the individual bits (e.g. bit 1 "ConfigWarning") can be found in the "Evaluating StatusWord, ErrorWord and WarningWord" section of the "S7-1500/S7-1500T Motion Control overview" (https://support.industry.siemens.com/cs/ww/en/view/109766459) documentation.

Tags

Legend (Page 288)

Tag	Data type	Values	W	Description
WarningWord	DWORD	-	RON	
Bit 0	-	-	-	"SystemWarning" A system-internal error has occurred.
Bit 1	-	-	-	"ConfigWarning" Configuration error One or several configuration parameters are adjusted internally.
Bit 2	-	-	-	"UserWarning" Error in user program at a Motion Control instruction or its use
Bit 3	-	-	-	"CommandNotAccepted" Job cannot be executed A Motion Control instruction cannot be executed because the necessary conditions are not met.
Bit 4 … Bit 6	-	-	-	Reserved
Bit 7	-	-	-	"CommunicationWarning" Communication error Missing or faulty communication.
Bit 8 … Bit 31	-	-	-	Reserved

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