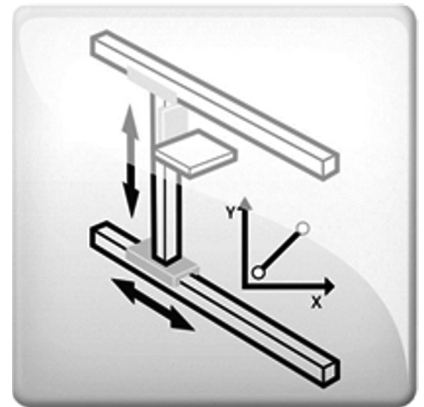


Technology module



Stacker Crane _____

Reference manual

EN



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1 About this documentation

This documentation ...

- contains detailed information on the functionalities of the »Stacker Crane« technology module;
- is part of the "Controller-based Automation" manual collection. It consists of the following sets of documentation:

Documentation type	Subject
Product catalogue	Controller-based Automation (system overview, sample topologies) Lenze Controllers (product information, technical data)
System manuals	Visualisation (system overview/sample topologies)
Communication manuals Online helps	Bus systems • Controller-based Automation EtherCAT® • Controller-based Automation CANopen® • Controller-based Automation PROFIBUS® • Controller-based Automation PROFINET®
Reference manuals Online helps	Lenze Controllers: • Controller 3200 C • Controller c300 • Controller p300 • Controller p500
Software manuals Online helps	Lenze Engineering Tools: • »PLC Designer« (programming) • »Engineer« (parameterisation, configuration, diagnostics) • »VisiWinNET® Smart« (visualisation) • »Backup & Restore« (data backup, restore, update)

More technical documentation for Lenze components

Further information on Lenze products which can be used in conjunction with Controller-based Automation can be found in the following sets of documentation:

Design / configuration / technical data	
☐	Product catalogues • Controller-based Automation • Controllers • Inverter Drives/Servo Drives
Installation and wiring	
☒	Mounting instructions • Controllers • Communication cards (MC-xxx) • I/O system 1000 (EPM-Sxxx) • Inverter Drives/Servo Drives • Communication modules
☐	Hardware manuals • Inverter Drives/Servo Drives
Parameterisation / configuration / commissioning	
☐	Online help/reference manuals • Controllers • Inverter Drives/Servo Drives • I/O system 1000 (EPM-Sxxx)
☐	Online help/communication manuals • Bus systems • Communication modules
Sample applications and templates	
☐	Online help / software manuals and reference manuals • i700 application sample • Application Samples 8400/9400 • FAST Application Template Lenze/PackML • FAST technology modules

Symbols:

-  Printed documentation
- ☐ PDF file / online help in the Lenze Engineering tool



Tip!

Current documentation and software updates with regard to Lenze products can be found in the download area at:

www.lenze.com

Target group

This documentation is intended for all persons who plan, program and commission a Lenze automation system on the basis of the Lenze FAST Application Software.

1 About this documentation

1.1 Document history

1.1 Document history

Version			Description
2.0	01/2020	TD06	Complete revision of the documentation
1.1	06/2019	TD29	Errors corrected
1.0	10/2018	TD29	First edition

1 About this documentation

1.2 Conventions used

This documentation uses the following conventions to distinguish between different types of information:

Type of information	Highlighting	Examples/notes
Spelling of numbers		
Decimal separator	Point	The decimal point is always used. For example: 1234.56
Text		
Program name	» «	»PLC Designer« ...
Variable names	<i>italics</i>	By setting <i>bEnable</i> to TRUE...
Function blocks	bold	The L_MC1P_AxisBasicControl function block ...
Function libraries		The L_TT1P_TechnologyModules function library ...
Source code	Font "Courier new"	... dwNumerator := 1; dwDenominator := 1; ...
Icons		
Page reference	 7)	Reference to further information: Page number in PDF file

Variable names

The conventions used by Lenze for the variable names of Lenze system blocks, function blocks, and functions are based on the "Hungarian Notation". This notation makes it possible to identify the most important properties (e.g. the data type) of the corresponding variable by means of its name, e.g. xAxisEnabled.

1.3

Definition of the notes used

The following signal words and symbols are used in this documentation to indicate dangers and important information:

Safety instructions

Layout of the safety instructions:

**Pictograph and signal word!**

(characterise the type and severity of danger)

Note

(describes the danger and gives information about how to prevent dangerous situations)

Pictograph	Signal word	Meaning
	Danger!	Danger of personal injury through dangerous electrical voltage Reference to an imminent danger that may result in death or serious personal injury if the corresponding measures are not taken.
	Danger!	Danger of personal injury through a general source of danger Reference to an imminent danger that may result in death or serious personal injury if the corresponding measures are not taken.
	Stop!	Danger of property damage Reference to a possible danger that may result in property damage if the corresponding measures are not taken.

Application notes

Pictograph	Signal word	Meaning
	Note!	Important note to ensure trouble-free operation
	Tip!	Useful tip for easy operation
		Reference to another document

2 Safety instructions

Please observe the safety instructions in this documentation when you want to commission an automation system or a plant with a Lenze Controller.



The device documentation contains safety instructions which must be observed!

Read the documentation supplied with the components of the automation system carefully before you start commissioning the Controller and the connected devices.



Danger!

High electrical voltage

Injury to persons caused by dangerous electrical voltage

Possible consequences

Death or severe injuries

Protective measures

Switch off the voltage supply before working on the components of the automation system.

After switching off the voltage supply, do not touch live device parts and power terminals immediately because capacitors may be charged.

Observe the corresponding information plates on the device.



Danger!

Injury to persons

Risk of injury is caused by ...

- unpredictable motor movements (e.g. unintended direction of rotation, too high velocities or jerky movement);
- impermissible operating states during the parameterisation while there is an active online connection to the device.

Possible consequences

Death or severe injuries

Protective measures

- If required, provide systems with installed inverters with additional monitoring and protective devices according to the safety regulations valid in each case (e.g. law on technical equipment, regulations for the prevention of accidents).
- During commissioning, maintain an adequate safety distance to the motor or the machine parts driven by the motor.



Stop!

Damage or destruction of machine parts

Damage or destruction of machine parts can be caused by ...

- Short circuit or static discharges (ESD);
- unpredictable motor movements (e.g. unintended direction of rotation, too high velocities or jerky movement);
- impermissible operating states during the parameterisation while there is an active online connection to the device.

Protective measures

- Always switch off the voltage supply before working on the components of the automation system.
- Do not touch electronic components and contacts unless ESD measures were taken beforehand.
- If required, provide systems with installed inverters with additional monitoring and protective devices according to the safety regulations valid in each case (e.g. law on technical equipment, regulations for the prevention of accidents).

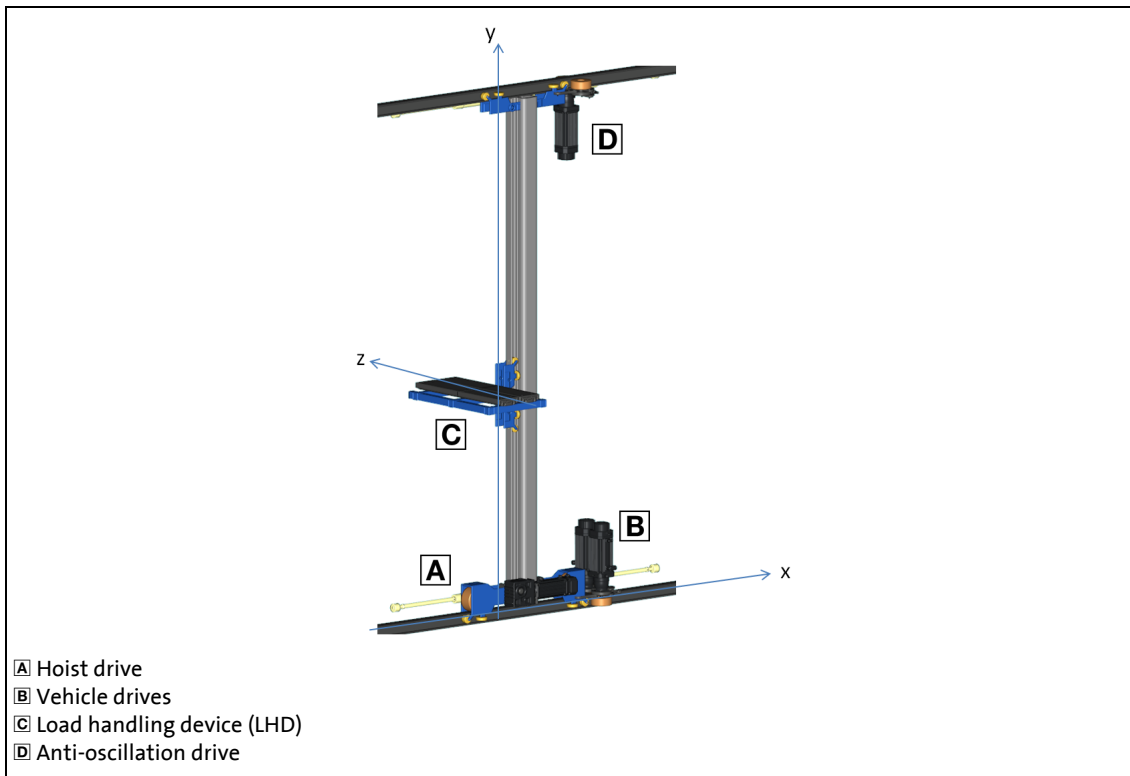
3

Overview of the technology module functions

3.1

Functional description»Stacker Crane«

A storage and retrieval unit (SRU) is a machine used in the field of storage technology for loading and unloading goods. The device usually consists of a rail-guided, single-track carriage and at least one mast. The mast is mounted on the carriage. The hoist runs on the mast and guides the load handling device (LHD) for loading and placing down goods from the high rack.



[3-1] Typical mechanics for the use of the TM

The workspace contains 3 axes:

- x axis:** The horizontal movement of the carriage on a rail along the high rack.
- y axis:** The vertical movement of the hoist along the mast.
- z axis:** The exit and entry of the load handling device into the shelves of the high rack in order to load or unload the goods.

The »Stacker Crane« technology module (TM) supports one x and one y axis.

3.2 TM functional overview

In addition to the basic functions for operating the function block **L_MC1P_AxisBasicControl**, the **stop function** and the **holding function**, the TM offers the following functionalities:

- [X-Y function](#) (📖 45)
- [Buffer travel](#) (📖 47)
- [Adapting the travel profiles \(minimum values for the travel profiles\)](#) (📖 49)
- [Brake check](#) (📖 50)
- [Bed in brake](#) (📖 55)
- [Oscillation compensation](#) (📖 60)
- [Maintenance mode](#) (📖 63)



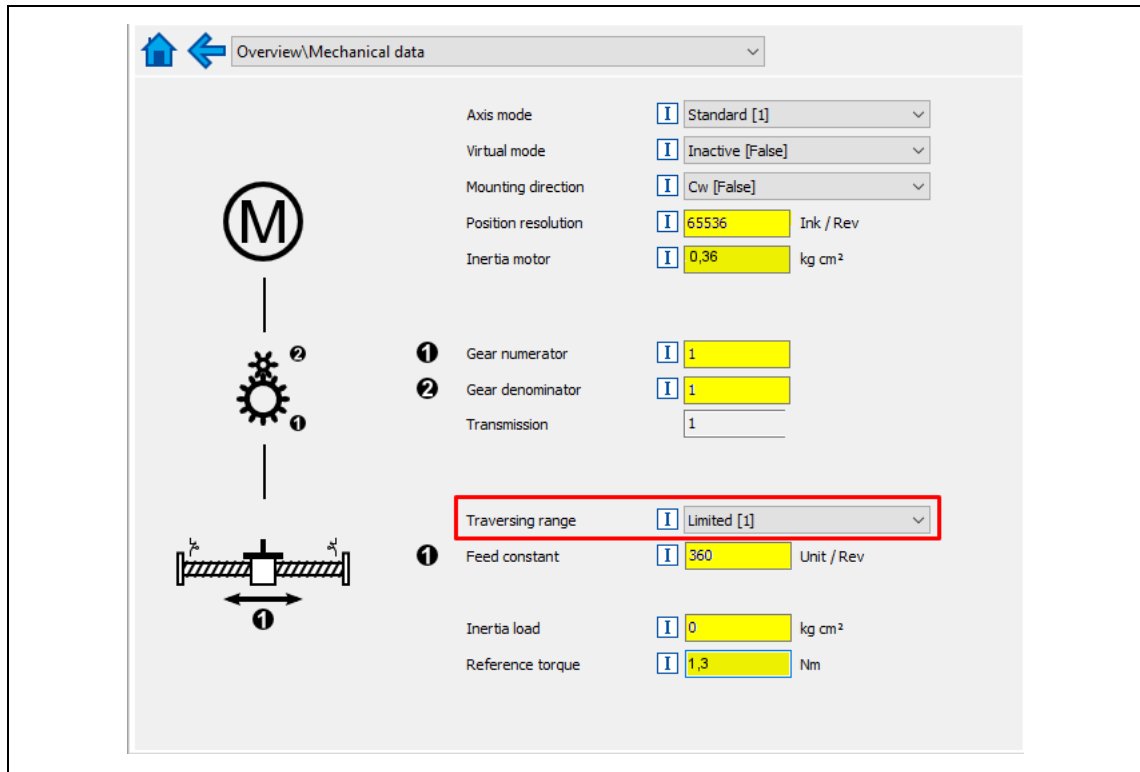
»PLC Designer« Online help

Here you will find detailed information on the **L_MC1P_AxisBasicControl** function block, the **stop function** and the **holding function**.

3.3

Important notes for setting the axes to operate the TM

The »Stacker Crane« TM only supports linear axes. Therefore, set the machine measuring system "Limited [1]" for each axis on the **Settings** tab in the »PLC Designer«:



Setting of the operating mode

Because the axes are guided via the master position value, the following must be set for the operating mode of the axes:

- Default dip
- Cyclic sync position mode (csp).

Setting of the software limit positions

The x and y axes are positioned within the workspace. The workspace for the »Stacker Crane« TM is defined via the software limit positions.



Note!

- Only activate the software limit positions for axes the reference of which is known.
- When approaching a software limit position, an error stop is triggered and the TM changes to the error status.



How to set the software limit positions in the »PLC Designer«:

1. Navigate to the menu item "Basic settings" on the **Settings** tab
2. Set software limit position monitoring: "Enable [True]"
3. Enter value for positive software limit position
4. Enter value for negative software limit position

Axis stop / error stop

If an error occurs in the axis driver, or in the event of parameterisation errors, an error stop is triggered.



How to set the Axis stop / error stop in the »PLC Designer«:

1. Navigate to the menu item "Basic settings" on the **Settings** tab
2. Enter value for QSP application deceleration
3. Enter value for QSP application jerk
4. False FB parameter response: set to "ErrorStop [TRUE]"

Following error monitoring

When the following error monitoring function is activated, the following error of the axis selected is monitored. If the error threshold is exceeded, either "Quick stop" or "Inverter disable" can be set as a response.



How to set the following error monitoring in the »PLC Designer«:

1. Navigate to the menu item "Basic settings" on the **Settings** tab
2. Enable monitoring: set "Activate [True]"
3. Enter value for warning threshold
4. Enter value for error threshold
5. Following error response: set to "Error → QSP [20]"

Positioning

To position the axes, it is required to know whether the axis has reached the target position. If the actual position remains unchanged within a time period, the "Target position reached" state (*xInPosition*) is set.



How to set the positioning in the »PLC Designer«:

1. Enter value for target position reached window
2. Enter value for target position reached time
3. Enter value for modulo positioning tolerance window

Brake control

In order to ensure trouble-free control of the brakes, the operating mode, the brake release and application time must be set.

For the hoist drive it is important to set the starting torque.



How to set the brake control in the »PLC Designer«:

1. Navigate to the menu item "Brake" on the **Settings** tab
2. Set brake operating mode: "OFF (logic in the drive [0])"
3. Enter value for brake opening time
4. Enter value for brake closing time
5. Set starting torque data source: "last stopping value [0]"
6. Enter value for feedforward control acceleration time
7. Set "Reference for acceleration time": reference torque [False]

4 Application ranges



Currently, the most common form of piece goods warehouses is the high-bay warehouse in which containers and pallets are stacked in several layers. Between the shelves are aisles through which conveyors (storage and retrieval machines) can access the storage spaces. The advantage of high-bay warehouses is the high utilisation of the storage space as well as the possibility to reach individual storage spaces via three dimensions (selection of the storage aisle, then approach of the level and storage space). This reduces access times.

Storage and retrieval machines contain the following functions and drives:

- **Travelling drive** of the storage and retrieval machine
- **Hoist drive** of the storage and retrieval machine
- **Positioning drive** to pick up and set down the pallet
- **Conveyor drive** to move into and out of the warehouse

5 Function block

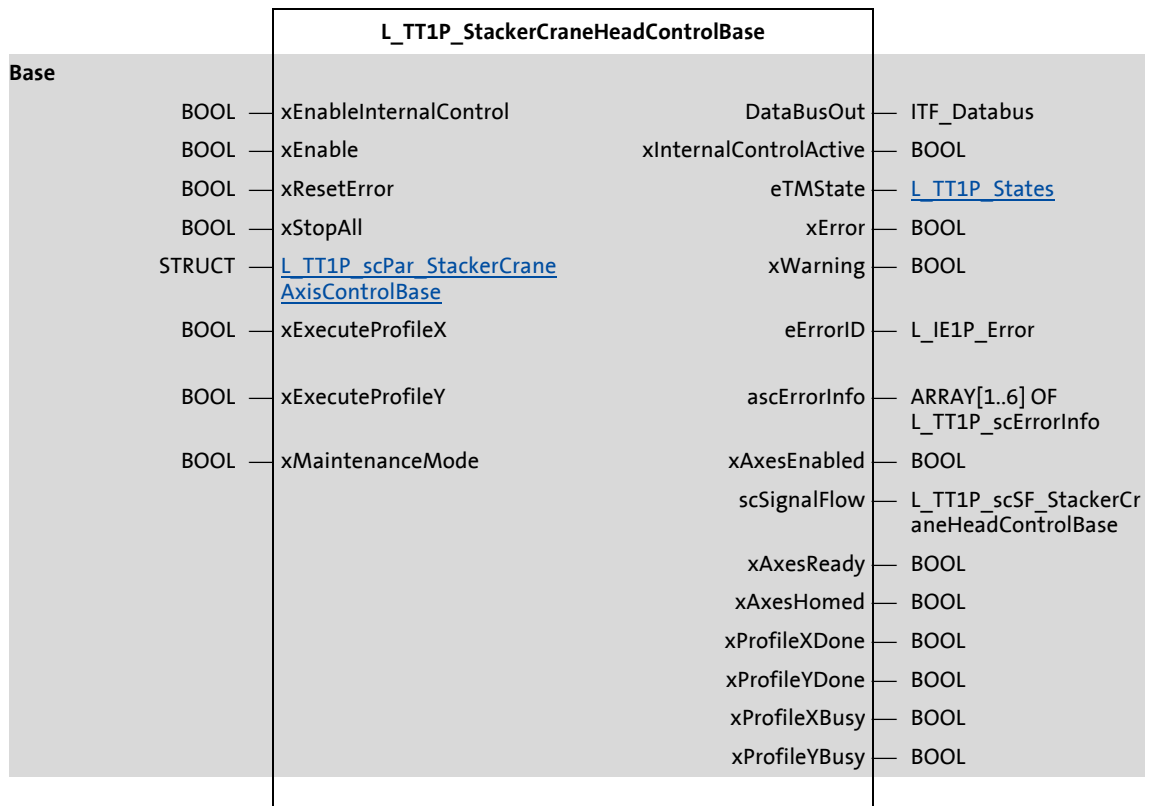
The »Stacker Crane« TM contains two function blocks which are described in this section:

- ▶ [L_TT1P_StackerCraneHeadControlBase](#) (📖 18)
- ▶ [L_TT1P_StackerCraneAxisControlBase](#) (📖 23)

5.1

L_TT1P_StackerCraneHeadControlBase function block

The figure shows the associated inputs and outputs of the function block.



5.1.1

inputs

Designator	Data type	Description
xEnableInternalControl	BOOL	TRUE The internal control of the axis can be selected via the Internal Control button (button is visible in the visualisation).
xEnable	BOOL	TM enable
		TRUE The TM is executed.
		FALSE The TM is deactivated.
xResetError	BOOL	FALSE→TRUE Reset axis or software error.
xStopAll	BOOL	TRUE Abort active movements for all axes and bring axes to a standstill with a defined deceleration. (Definition of the deceleration: <i>scPar.IrStopDec</i> at the L_TT1P_StackerCraneAxisControlBase TM) During the deceleration, the TM changes to the STOP state; the TM remains in the STOP state as long as <i>xStop</i> or <i>xHalt</i> is set. xStopAll is also active with "Internal Control"!
scPar L_TT1P_scPar_StackerCraneAxisControlBase		Parameter structure of the TM.

Designator	Data type	Description
xExecuteProfileX	BOOL	FALSE↗TRUE The input is edge-controlled and evaluates the rising edge. Activate absolute positioning for the axis. With <i>scPar. eXYMode</i> , the energy management for the positioning can be stopped. The TM switches to the MOVEXY state. The function can be aborted via <i>xStopAll</i> = TRUE, <i>xStop</i> = TRUE or <i>xHalt</i> = TRUE.
xExecuteProfileY	BOOL	FALSE↗TRUE The input is edge-controlled and evaluates the rising edge. Activate absolute positioning for the axis. With <i>scPar. eXYMode</i> , the energy management for the positioning can be stopped. The TM switches to the MOVEXY state. The function can be aborted via <i>xStopAll</i> = TRUE, <i>xStop</i> = TRUE or <i>xHalt</i> = TRUE.
xMaintenanceMode	BOOL	Enable of the maintenance mode TRUE The maintenance mode is active. Stop! Before enabling the maintenance mode, please be sure to observe the corresponding safety note in the section ▶ Maintenance mode (□ 63) The TM is in the MAINTENANCE state. In this mode, the software limit switches and the hardware limit switches are deactivated. The following error is deleted and the Jogging function is enabled. The axes are exclusively controlled in the CSV mode.

5.1.2

outputs

Designator	Data type	Description
DataBusOut	INTERFACE	Communication link ▶ Interconnection of the technology module (□ 31)
xInternalControlActive	BOOL	TRUE The control is activated via the visualisation. (The input <i>xEnableInternalControl</i> is TRUE.)
eTMState	L_TT1P_States	Current state of the TM ▶ "L_TT1P_StackerCraneHeadControlBase" state machine (□ 32)
xError	BOOL	TRUE There is an error in the TM.
xWarning	BOOL	TRUE There is a warning in the TM.
eErrorID	L_IE1P_Error	ID of the error or warning message if <i>xError</i> = TRUE or <i>xWarning</i> = TRUE. "FAST technology modules" reference manual: Here you can find information on error or warning messages.
ascErrorInfo	ARRAY[1..6] OF L_TT1P_scErrorInfo	Error information for analysing the error cause. An axis is selected via the index of the array: • 1: x axis • 2: y axis
xAxesEnabled	BOOL	TRUE All axes are enabled.
scSignalFlow	L_TT1P_scSF_StackerCrane-HeadControlBase	The structure contains the IPs, APs, MPs and OPs from the signal flow plan.

Designator	Data type	Description	
xAxesReady	BOOL	TRUE	All axes are ready for operation
xAxesEnabled		TRUE	All axes are enabled
xAxesHomed	BOOL	TRUE	All axes have been referenced ("Reference known"). This output must only be evaluated if the input <i>xAxesReady</i> = TRUE.
xProfileXDone	BOOL	TRUE	The profile generator for the x axis has reached its target position.
xProfileYDone	BOOL	TRUE	The profile generator for the y axis has reached its target position.
xProfileXBusy	BOOL	TRUE	The profile generator for the x axis is activated.
xProfileYBusy	BOOL	TRUE	The profile generator for the y axis is activated.

5.1.3 Parameter

L_TT1P_scPar_StackerCraneHeadControlBase

Designator	Data type	Description
eXYMode	L_TT1P_XYMode	Selection of the mode for the energy management acts in connection with the <i>xExecuteProfileX</i> and <i>xExecuteProfileY</i> functions. - Value range: 0 ... 5 - Initial value: 0 (NotCoordinated) Note: The override values are taken into consideration for the calculation of the profiles. The buffer travel for the x axis can be activated. The buffer travel for the y axis is <u>not</u> supported.
	0	NotCoordinated: no coordination of the axes. The function directly transfers the starting commands of the x and y axis as well as the applied override values.
	1	SyncStartStop: simultaneous starting and stopping. x and y axes start simultaneously and reach the target position isochronously (classic interpolation).
	2	AsyncStartSyncStop: asynchronous start, isochronous finish (optimum power input). y axis = lifting travel: The non-process-determining axis is started following the acceleration phase of the process-determining axis. y axis = lowering travel: x and y axes start isochronously. x and y axes always reach the target position isochronously.
	3	AsyncStartOrStop: asynchronous start or finish (optimum overall performance). y axis = lifting travel: The non-process-determining axis is started after the acceleration phase of the process-determining axis. x and y axes reach the target position isochronously. y axis = lowering travel: x and y axes start isochronously and reach the target position asynchronously.
	4	AsyncStartSyncStopTimeOpt: asynchronous start, isochronous finish (process-optimised).
	5	AsyncStartOrStopTimeOpt: asynchronous start or finish (process-optimised). Behaviour as described in the mode 2; however, the acceleration and deceleration phases may overlap due to the time limitation. The priority is "process-optimised".
scXProfile	L_TT1P_MoveAbsProfileData	Profile parameter and target position for the x axis
scYProfile	L_TT1P_MoveAbsProfileData	Profile parameter and target position for the y axis

5.1.4

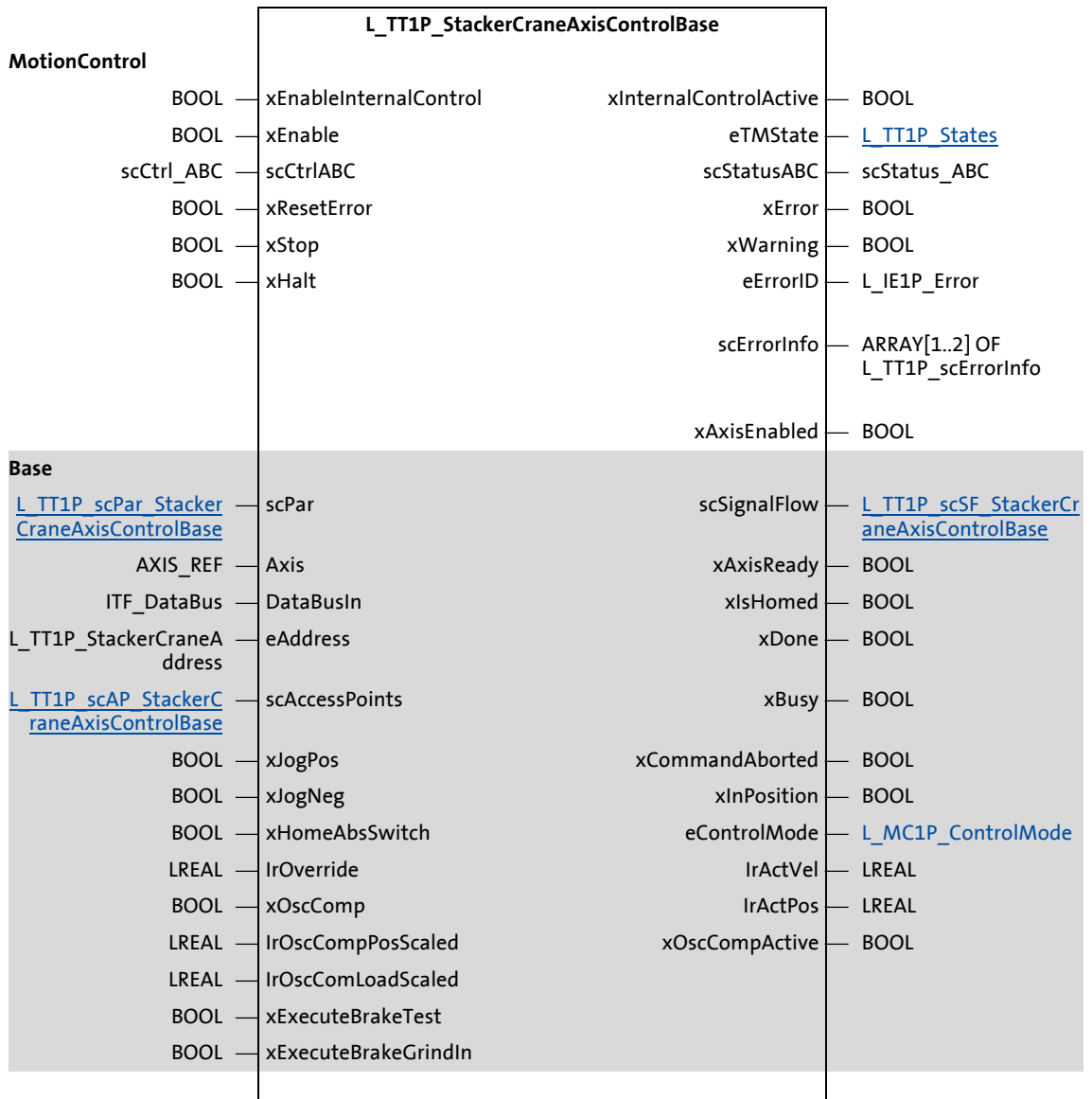
Parameter structure

L_TT1P_MoveAbsProfileData

Designator	Data type	Description
IrPos_Dist	LREAL	Absolute target position in [unit] relating to the zero position. • Unit: unit • Initial value: 0
IrVel	LREAL	Velocity in [unit/s] Specification of the maximum velocity at which positioning is to be carried out. Only positive values permissible • Unit: unit/s • Initial value: 50
IrAcc	LREAL	Acceleration in [unit/s ²] Specification of the maximum velocity variation which is to be used for acceleration. Only positive values permissible. • Unit: unit/s ² • Initial value: 100
IrDec	LREAL	Deceleration in [unit/s ²] Specification of the maximum speed variation which is to be used for deceleration to standstill. Only positive values permissible. • Unit: unit/s ² • Initial value: 100
IrJerkAcc	LREAL	Maximum jerk for acceleration [unit/s ³] • Unit: unit/s ³ • Initial value: 10000
IrJerkDec	LREAL	Maximum jerk for deceleration [unit/s ³] • Unit: unit/s ³ • Initial value: 10000

5.2

L_TT1P_StackerCraneAxisControlBase function block



5.2.1

Inputs and outputs

Designator	Data type	Description
Axis	AXIS_REF	Reference to the axis

5.2.2 inputs

Designator	Data type	Description
xEnableInternalControl	BOOL	The internal control of the axis can be selected via the Internal Control button (button is visible in the visualisation).
		TRUE The Internal Control button is made visible in the visualisation
		FALSE The internal control is deactivated and the Internal Control button is made invisible in the visualisation.
xEnable	BOOL	TM enable
		TRUE The TM is executed. The communication bus is activated.
		FALSE The TM is deactivated.
scCtrlABC	scCtrl_ABC	The input structure for the TM can be used if the READY state is applied. The state machine changes to the SERVICE state. If there are no more requests, the state changes back to READY .
xResetError	BOOL	FALSE → TRUE Reset axis or software error.
xRegulatorOn	BOOL	TRUE Activating controller enable of the axis (via the MC_Power FB)
xStop	BOOL	TRUE Cancel the active movements and bring the axis to a standstill with the deceleration defined in the <i>IrStopDec</i> parameter. - The state changes to Stop. - The STOP state is exited if (<i>Not xStop</i> AND <i>Not xHalt</i>) AND <i>eAxisState</i> = StandStill xStopAll is also active with "Internal Control"!
xHalt	BOOL	TRUE Cancel the active movement of the axis and bring the axis to a standstill with the deceleration defined in the <i>scPar.IrHaltDec</i> parameter.
scPar	L_TT1P_StackerCraneAxisControlBase	Parameter structure of the TM
DataBusIn	ITF_DataBus	Communication link
eAddress	L_TT1P_StackerCraneAddress	Selection of the axis type in a storage and retrieval unit (SRU)
		20 The TM has the function of the x axis.
		21 The TM has the function of the y axis.
scAccessPoints	L_TT1P_scAP_StackerCraneAxisControlBase	Structure of the access points. The data type depends on the version used (Base/State).
xJogPos	BOOL	TRUE With manual jog, the axis will travel in positive direction. If <i>xJogNeg</i> is also TRUE, the travel direction selected first is maintained.
xJogNeg	BOOL	TRUE With manual jog, the axis will travel in negative direction. If <i>xJogPos</i> is also TRUE, the travel direction selected first is maintained.
xHomeExecute	BOOL	The input is edge-controlled and evaluates the rising edge.
		FALSE → TRUE Start referencing of the axis. Via <i>xStop</i> = TRUE, the function can be aborted.
xHomeAbsSwitch	BOOL	Connection for reference switch For homing modes with a reference switch, connect this input to the digital signal which maps the state of the reference switch.
		TRUE Reference switch is activated

Designator	Data type	Description
IrOverride	LREAL	Factor for the global speed override. - Value range: 0.1 ... 1.0 (10 ... 100 %) - Initial value: 1.0 (100%)
xOscComp	BOOL	This input is level-controlled. Enable of the oscillation compensation function ► Oscillation compensation (□ 60) The function can only be activated if the axis is inhibited.
		TRUE The oscillation compensation function for the axis is active.
		FALSE The oscillation compensation function for the axis is deactivated.
IrOscCompPosScaled	LREAL	Specification of the scaled position for the oscillation compensation. - Value range: 0 ... 1 (0 ... 100 %) - Initial value: 0 (0 %)
IrOscCompLoadScaled	LREAL	Specification of the scaled load for the oscillation compensation. - Value range: 0 ... 1 (0 ... 100 %) - Initial value: 0 (0 %)
xExecuteBrakeTest	BOOL	The input is edge-controlled and evaluates the rising edge. Function to test the holding brake. During the brake test, the TM switches to the BRAKE_TEST state. Via <i>xStop</i> = TRUE or <i>xHalt</i> = TRUE, the function can be aborted.
		FALSE → TRUE Activate brake test for the axis
xExecuteBrakeGrindIn	BOOL	The input is edge-controlled and evaluates the rising edge. Function to grind in the holding brake. When grinding the holding brake, the TM switches to the BRAKE_GRINDIN state. Via <i>xStop</i> = TRUE or <i>xHalt</i> = TRUE, the function can be aborted.
		FALSE → TRUE Activate the grind-in of the holding brake for the axis.

5.2.3 outputs

Designator	Data type	Description
xInternalControlActive	BOOL	TRUE The internal control of the axis is activated via the visualisation. (The input <i>xEnableInternalControl</i> is TRUE.)
eTMState	L_TT1P_States	Current state of the TM ► " L_TT1P_StackerCraneHeadControlBase " state machine (32)
scStatusABC	scStatus_ABC	Structure of the status data of the function block L_MC1P_AxisBasicControl
xError	BOOL	TRUE There is an error in the TM.
xWarning	BOOL	TRUE There is a warning in the TM.
eErrorID	L_IE1P_Error	ID of the error or warning message if xError = TRUE or xWarning = TRUE. "FAST technology modules" reference manual: Here you can find information on error or warning messages.
scErrorInfo	L_TT1P_scErrorInfo	Error information structure for a more detailed analysis of the error cause
xAxisEnabled	BOOL	TRUE Axis is enabled
scSignalFlow	L_TT1P_scSF_StackerCraneAxisControlBase	Structure of the signal flow. The data type depends on the version used (Base/State).
xDone	BOOL	TRUE The request/action has been completed successfully.
xBusy	BOOL	TRUE The request / action is currently being executed.
xCommandAborted	BOOL	TRUE The function activated has been aborted by another function block.
xisHomed	BOOL	TRUE The axis has been referenced (reference known).
xInPosition	BOOL	TRUE The target position has been reached.
eControlMode	L_MC1P_ControlMode	Current control mode of the axis 0 PosCtrlDrive (csp) 1 PosCtrlPLC 2 SpeedCtrl (csv) 3 TorqueCtrl (cst)
IrActPos	LREAL	Actual position • Unit: units
IrActVel	LREAL	Current velocity • Unit: units/s
xOscCompActive	BOOL	TRUE The oscillation compensation function for the axis is active.

5.2.4 Parameter

L_TT1P_scPar_StackerCraneAxisControlBase

Designator	Data type	Description
IrStopDec	LREAL	Deceleration for the stop function and when hardware/software limit switches and the following error monitoring function are triggered - Unit: units/s² - Initial value: 10000
IrStopJerk	LREAL	Jerk for the stop function and for the triggering of the hardware limit switches, software limit positions, and the following error monitoring function - Unit: units/s³ - Initial value: 100000
IrHaltDec	LREAL	Deceleration for the holding function. Specification of the maximum speed variation which is to be used for deceleration to standstill. - Unit: units/s² - Initial value: 3600
IrJerk	LREAL	Jerk for compensating an offset value, trimming, clutch, or holding function - Unit: units/s³ - Initial value: 100000
IrJogJerk	LREAL	Jerk for manual jog - Unit: units/s³ - Initial value: 100000
IrJogVel	LREAL	Maximum speed to be used for manual jog. - Unit: units/s - Initial value: 10
IrJogAcc	LREAL	Acceleration for manual jog. Specification of the maximum velocity variation which is to be used for acceleration.
IrJogDec	LREAL	Deceleration for manual jog. Specification of the maximum speed variation which is to be used for deceleration to standstill.
IrHomePosition	LREAL	Home position for a reference run (homing) - Unit: units - Initial value: 0
xUseHomeExtParameter	BOOL	Selection of the homing parameters to be used
		FALSE The homing parameters defined in the axis data are used.
		TRUE The scHomeExtParameter homing parameters from the application are used.
scHomeExtParameter L_MC1P_HomeParameter		Homing parameters from the application Only relevant if xUseHomeExtParameter= TRUE.
scHomeExtTP MC_TRIGGER_REF		Transfer of an external touch probe event Only relevant for "External source" touch probe configuration For the description of the MC_TRIGGER_REF structure, see the MC_TouchProbe function block.
eRegulatorOnMode L_TT1P_RegulatorOnMode	Function to set the automatic inverter disable.	
	0	The automatic inverter disable is inactive. The inverter disable is controlled via the RegulatorOn input.
	1	The automatic inverter disable is activated. After the waiting time IrDisableAfterTime, during which the axis is switched to the Standstill state, the holding brake is closed and the axis is inhibited. The axis is automatically released as soon as a function is requested at the TM.

Designator	Data type	Description
IrDisableAfterTime	LREAL	Stopping time for the automatic inverter disable for the mode - Unit: s <i>eRegulatorOnMode</i> = 1
scMinLimits	L_TT1P_XYLimits	X-Y function: minimum values for the axis When manipulating the profile data, the minimum values specified must always be reached.
scBufferData	L_TT1P_XYBufferData	X-Y function: data for the buffer range Relevant for the x axis
xBufferRange	BOOL	TRUE X-Y function: Buffer limits for the axis are taken into consideration. Relevant for the x axis
IrMaintenanceVel	LREAL	The maximum velocity in maintenance mode - Unit: units/s - Initial value: 10
IrMaintenanceAcc	LREAL	The maximum acceleration in maintenance mode - Unit: units/s² - Initial value: 100
IrMaintenanceDec	LREAL	The maximum deceleration in maintenance mode - Unit: units/s² - Initial value: 100
IrMaintenanceJerk	LREAL	The maximum jerk in maintenance mode - Unit: units/s³ - Initial value: 10000
eOscCompMode	L_CT1P_OscCompMode	Mode of the oscillation compensation Initial value: 10000
		1: FAST Mode: - Shortest delay time (half an oscillation period) - Lower robustness compared to parameter insecurities Preconditions: - Knowledge of the natural frequency with an accuracy of 3 % ... 5 % - Knowledge of the amplitude ratio with an accuracy of approx. 5 %.
		2: Medium Mode: - Medium delay time (one full oscillation period) - Increased robustness (compared to the Fast mode) towards parameter insecurities Preconditions: - Knowledge of the natural frequency with an accuracy of 5 % ... 10 % - Knowledge of the amplitude ratio with an accuracy of approx. 10 %.
		3: Robust In contrast to the other modes, an exact parameter setting does not cause a complete suppression but a low residual oscillation. Mode: - Medium delay time (one oscillation period) - Increased robustness (compared the "Medium" mode) towards parameter insecurities Preconditions: - Knowledge of the natural frequency with an accuracy of 10 ... 20 % - Knowledge of the amplitude ratio with an accuracy of approx. 15 %
ascOscCompData	ARRAY[1..8] OF L_TT1P_OscillationCompensationData	Parameter structure for setting the oscillation compensation function. There is a total of 8 parameter fields available. Preconditions: There must be at least 2x parameter fields for the oscillation compensation with valid values.

Designator	Data type	Description
IrBrakeTestMotorTrq	LREAL	Brake check Test torque relating to the motor • Unit: Nm • Initial value: 0
IrBrakeTestRampTime	LREAL	Brake test: acceleration and deceleration time • Unit: s • Initial value: 0
IrBrakeTestHoldTime	LREAL	Brake test: holding time • Unit: s • Initial value: 0
IrBrakeTestPosThreshold	LREAL	Max. angle of rotation (threshold position) of the motor shaft • Unit: Degree • Initial value: 0
wBrakeGrindInCycles	WORD	Number of holding brake application cycles • Initial value: 0
eBrakeGrindMode L_MC1P_GrindInMode		Grinding mode Only relevant for the x axis • Initial value: 1
	1	Cw - grinding only in positive direction
	2	Ccw - grinding only in negative direction
	3	CwCcw - grinding first in positive, then in negative direction
	4	CcwCw - grinding first in negative, then in positive direction
IrBrakeGrindInMotorSpeed	LREAL	Grinding speed (relating to the motor without gearbox) • Unit: rpm • Initial value: 0
IrBrakeGrindInRampTime	LREAL	Acceleration and deceleration time • Unit: s • Initial value: 0
IrBrakeGrindInOnTime	LREAL	Application time of the holding brake • Unit: s • Initial value: 0
IrBrakeGrindInOffTime	LREAL	Ventilation / cooling time of the holding brake • Unit: s • Initial value: 0
eBrakeGrindInAdditionalLimits L_MC1P_AdditionalLimits		Activate / deactivate limitation of the grinding area
	1	NotActive No additional limitations of the grinding area via the module. The grinding area is limited via active software limit positions.
	2	AdditionalPosLimits The grinding area is limited via the positions at the <i>IrBrakeGrindInPosLimit1</i> and <i>IrBrakeGrindInPosLimit2</i> inputs.
IrBrakeGrindInPosLimit1	LREAL	Specification of the lower position limit for grinding the brake (at the output end). • Unit: unit
IrBrakeGrindInPosLimit2	LREAL	Specification of the upper position limit for grinding the brake (at the output end). • Unit: unit
xBrakeGrindInFinishInStartpos	BOOL	TRUE Stop grinding process in the output position
xBrakeExternalFan	BOOL	TRUE The motor and brake are forced ventilated. Force ventilating the motor and brake makes it possible to brake during the OFF time. Reducing the speed thereby shortens the grinding path.

5.2.5 scMinLimits

L_TT1P_XYLimits

Designator	Data type	Description
IrVel	LREAL	Minimum velocity Specification of the minimum velocity at which the positioning process is to be carried out. - Only positive values permissible. - Unit: unit/s
IrAcc	LREAL	Minimum acceleration Specification of the minimum velocity variation which is to be used for the acceleration. - Only positive values permissible. - Unit: unit/s²
IrDec	LREAL	Minimum deceleration Specification of the minimum velocity variation which is to be used for the deceleration. - Only positive values permissible. - Unit: unit/s²

5.2.6 scBufferData

L_TT1P_XYBufferData

Designator	Data type	Description
IrBufferPositionPos	LREAL	Position from which the buffer zone is defined in the positive travel direction. Unit: unit
IrBufferPositionNeg	LREAL	Position from which the buffer zone is defined in the negative travel direction. Unit: unit
IrBufferVelPos	LREAL	The maximum velocity in the buffer zone in the positive travel direction. Unit: unit/s
IrBufferVelNeg	LREAL	The maximum velocity in the buffer zone in the negative travel direction. Unit: unit/s

5.3 Interconnection of the technology module

A storage and retrieval machine (SRM) can be displayed with one [L TT1P StackerCraneHeadControlBase](#) TM and two [L TT1P StackerCraneAxisControlBase](#) TMs.

L TT1P StackerCraneHeadControlBase

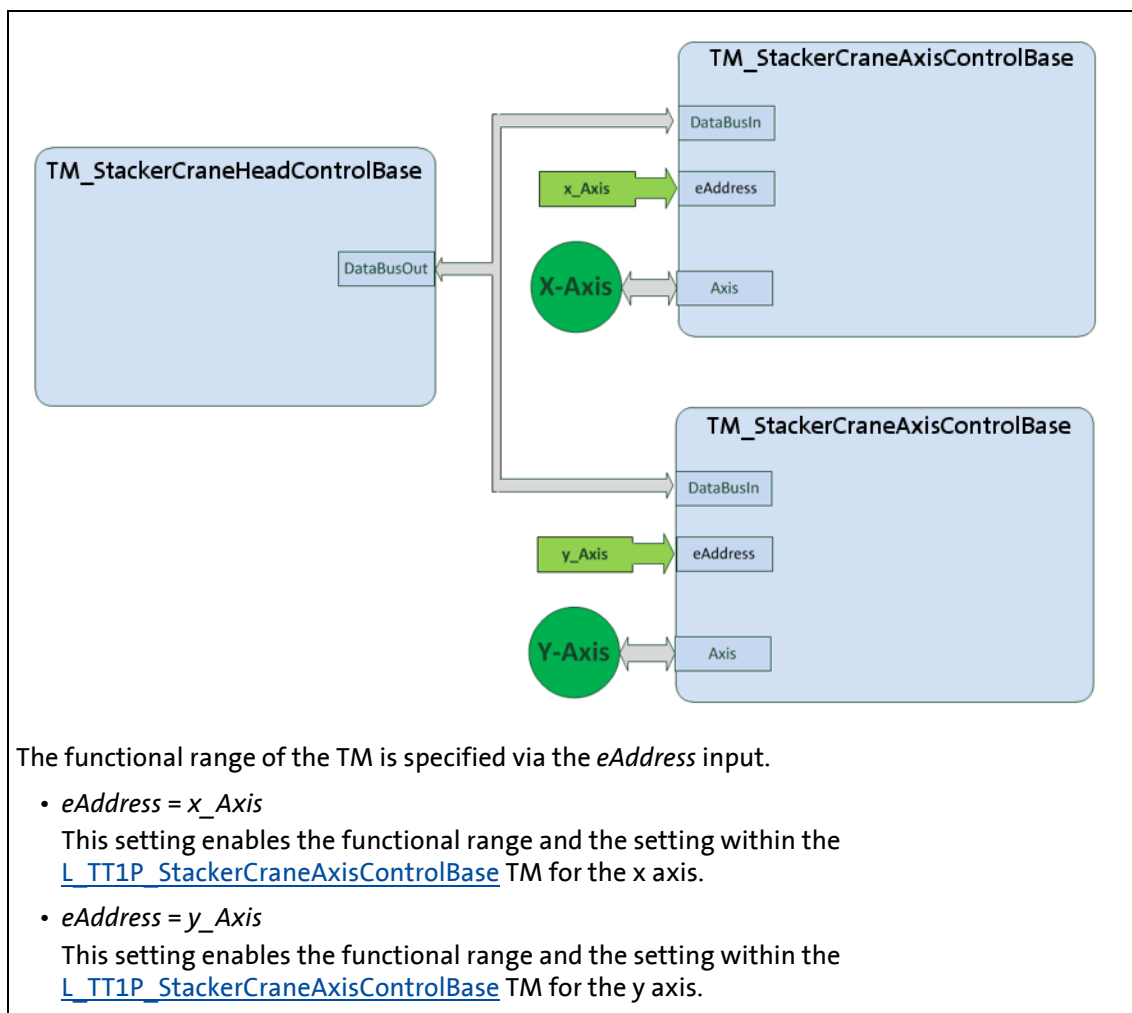
This TM controls the »Stacker Crane« technology and contains the parameters for the coordinated movement of the x and y axes.

L TT1P StackerCraneAxisControlBase

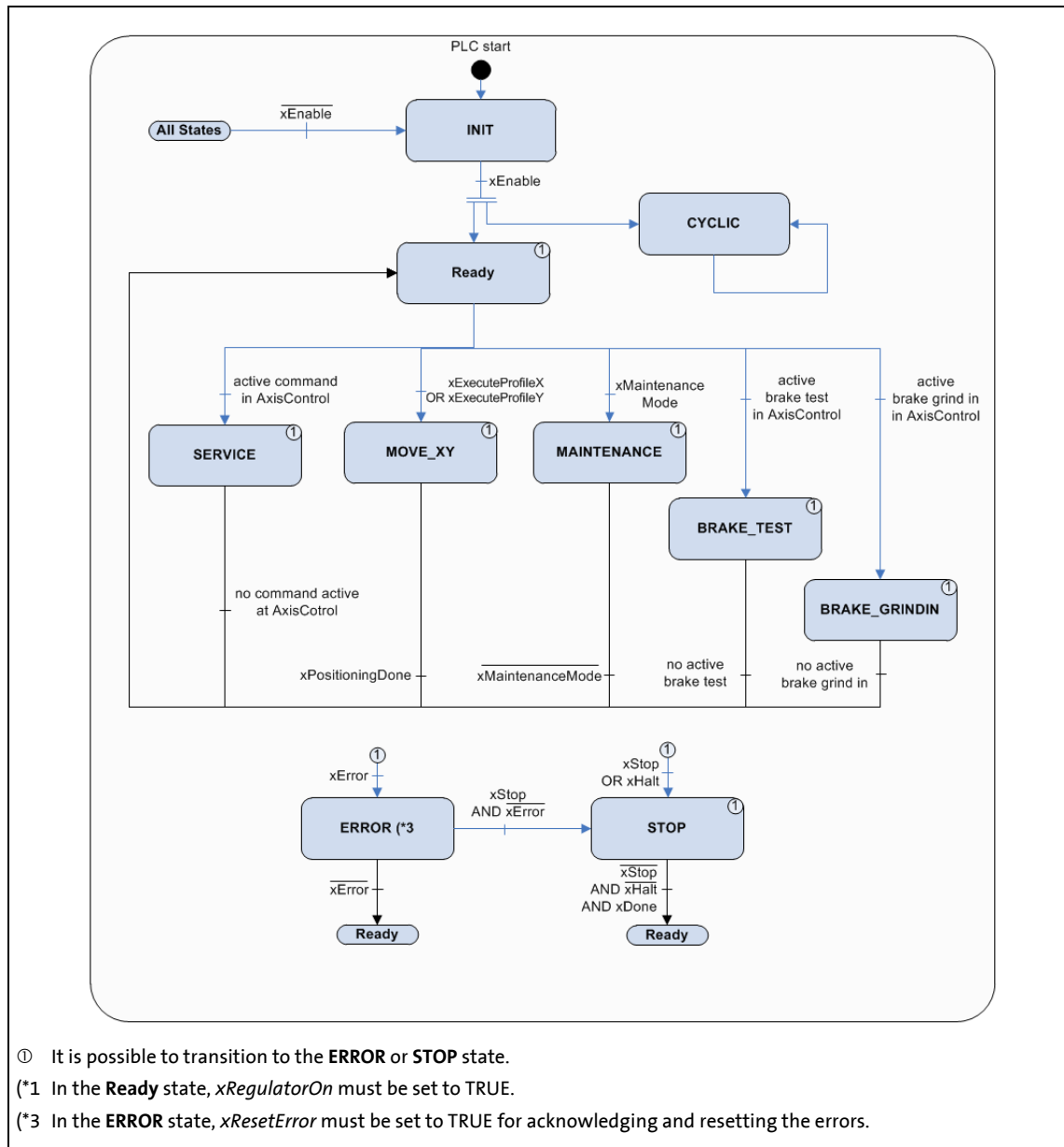
A [L TT1P StackerCraneAxisControlBase](#) TM is required for the x axis (e.g. travelling drive of an SRM) as well as for the y axis (e.g. hoist drive of an SRM).

Communication via the "DataBus"

The TMs within the technology communicate with each other via the "DataBus":



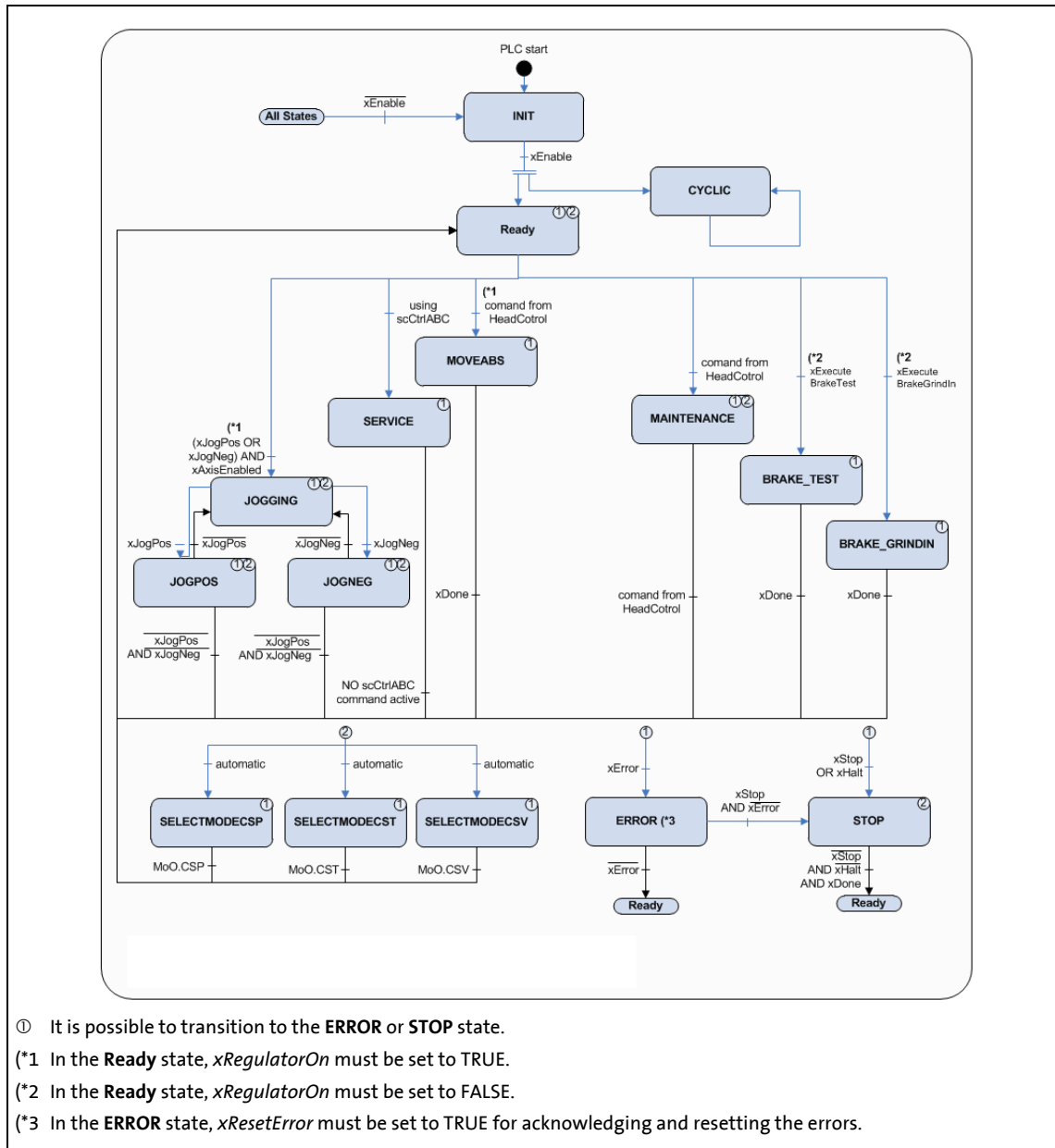
[5-1] Interconnection of the StackerCrane TM



[6-1] State machine of the L_TT1P_StackerCraneHeadControlBase technology module

6.2

"L_TT1P_StackerCraneAxisControlBase" state machine



[6-2] State machine of the technology module

6.3

States of the eTMState output (L_TT1P_States)

No.	L_TT1P_States	Description
1	INIT	Initialisation of the technology module active.
2	READY	Technology module ready for operation.
3	HOMING	Referencing active.
10	JOGGING	Manual jog active.
11	JOGPOS	Manual jog in positive direction active.
12	JOGNEG	Manual jog in negative direction active.
120	SELECTMODEVL	The operating mode is set to VL.
121	SELECTMODECSV	The operating mode is set to CSV.
123	SELECTMODECSP	The operating mode is set to CSP.
186	MOVE_XY	Coordinated absolute positioning of the X and Y axis is active
187	REPAIR	Service mode is active. All monitoring and limitation functions are deactivated.
188	BRAKE_TEST	Brake test active
189	BRAKE_GRIDIN	Brake is ground in
996	STOP	Stop/Halt active.
998	SERVICE	The technology module is in service mode. The internal L_MC1P_AxisBasicControl function block is controlled via the <i>scCtrlABC</i> input structure. The status of the function block can be viewed via the <i>scStatusABC</i> output structure.
999	ERROR	Error state
1000	SYSTEMFAULT	System fault

7

Signal flow

7.1

Structure of the signal flow

L_TT1P_scSF_StackerCraneAxisControlBase

Designator	Data type	Description
MP01_lOscCompLoadScaled	LREAL	Set scaled position for the oscillation compensation. • Value range: 0 ... 1
MP02_lOscCompPosScaled	LREAL	Set scaled load for the oscillation compensation. • Value range: 0 ... 1
MP03_lOscCompAmpRatio	LREAL	The resulting ratio of two successive amplitudes • Value range: 0 ... 1
MP04_lOscCompEigenFreq	LREAL	The resulting natural frequency of the dampened system in [Hz] • Value range: 0.4 ... 40
MP05_xOscCompBusy	BOOL	For the function of the oscillation compensation, the AxisRef was linked into the setpoint path.
MP06_xOscCompInEqOut	BOOL	The setpoint manipulation is terminated. The measuring point is only valid if <i>MP05_xOscCompBusy</i> = TRUE
		TRUE Manipulated setpoints = Application setpoints
		FALSE The setpoints are manipulated.
MP07_xOscCompActive	BOOL	Oscillation compensation is active. If <i>MP07_xOscCompActive</i> = FALSE, even though <i>MP05_xOscCompBusy</i> = TRUE, this may be due to the following causes: • The FB is waiting for the first standstill of the axis since activation • The axis is in the Disabled , Homing , or ErrorStop state, or the drive is in the QSP state • The axis is in the Stopping state and <i>AP06_xOscComp-IgnoreFilterOnStop</i> is TRUE
MP08_lOscCompSetPosOut	LREAL	Modified setpoint position. This measuring point is used for analysis purposes. An interconnection of the output is not required.
MP09_lOscCompSetVelOut	LREAL	Modified setpoint velocity. This measuring point is used for analysis purposes. An interconnection of the output is not required.
MP10_lOscCompSetAccOut	LREAL	Modified setpoint acceleration. This measuring point is used for analysis purposes. An interconnection of the output is not required.
MP11_lOscCompSetTorqueOut	LREAL	Modified setpoint torque This measuring point is used for analysis purposes. An interconnection of the output is not required.
MP12_xBrakeGrindInBusy	BOOL	TRUE The function to grind in the brakes is assigned.
MP13_xBrakeGrindInActive	BOOL	TRUE The function to grind in the brakes is currently being executed.
MP14_xBrakeGrindInDone	BOOL	TRUE The function to grind in the brake was successfully executed.
MP15_xBrakeTestBusy	BOOL	TRUE The function to reset the brakes is assigned.
MP16_xBrakeTestActive	BOOL	TRUE The function to reset the brakes is currently being executed.

Designator	Data type	Description	
MP17_xBrakeTestDone	BOOL	TRUE	The function to reset the brakes was successfully executed.
MP18_lBrakeTestIdentTorque	LREAL	Value of the torque in [Nm] at the output end, which was determined during the automatic load identification. The load identification is executed automatically for the y axis or if the following access points are set: • <i>AP13_eBrakeTestMode</i> = 1 (LoadTorqueIdentification) and • <i>AP13_xBrakeTestMode</i> = TRUE	
MP19_lBrakeTestActPosThreshold	LREAL	Current angle of rotation of the motor shaft in [degrees] during execution of the brake test.	
MP20_lBrakeTestActMotorTorque	LREAL	Current motor torque in [Nm] relating to the motor.	
MP21_xIdentConstTorqueValid	BOOL	TRUE	The identified value for the constant load torque <i>MP22_lIdentConstTorque</i> is valid.
MP22_lIdentConstTorque	LREAL	Identified constant load torque in [Nm]. The identification is carried out when the state of the axis = StandStill. In this state, the axis is enabled and the brakes are released.	
MP23_lrFiltActTorque	LREAL	Filtered and calculated torque of the axis in [Nm] from the measured current	

7.2

Structure of the access points

L_TT1P_scAP_StackerCraneAxisControlBase

Designator	Data type	Description
AP01_xSetControllerMode	BOOL	Enable of the AP01_eControlMode access point Value range: 0 ... 1
	TRUE	The access point overwrites the values at the access point in the signal flow.
AP01_eControlMode		Setting the control mode of the axis.
L_MC1P_Control-ModeSet	0	PosCtrlDrive. The control mode is set to csp. The position control is applied to the axis.
	1	PosCtrlPLC The control mode is set to csp. The position control is applied to the controller.
	10	SpeedCtrl The control mode is set to CSV.
AP05_eOscCompExecutionIndex		Ausführungsindex A maximum of two setpoint-manipulating FBs can be connected to one axis. The call sequence is defined via this input. Selection: L_MC1P_ExecutionIndex.First := 1, L_MC1P_ExecutionIndex.Second := 2 Initial value: 1
AP06_xOscCompIgnoreFilterOnStop		Consideration of the oscillation compensation function during the stop
	TRUE	Deactivation of the filter in the "Stopping" state A deactivation of the filter makes sense when the filter mechanism causes a long dead time in the system and thus the stop of the axis would be delayed considerably.
	FALSE	Oscillation compensation filter function is active for the stop function.
AP07_xOscComp-ManipulateTorque		Filtering an additive feedforward control torque
	TRUE	The additive feedforward control torque is filtered.
AP08_xOscCompAmpRatio		Enable of the AP08_IrOscCompAmpRatio access point
	TRUE	The access point overwrites the values at the access point in the signal flow.
AP08_IrOscCompAmpRatio		Ratio of two successive amplitudes. - Value range: 0 ... 1 - Initial value: 1
AP09_xOscCompEigenFreq		Enable of the AP09_IrOscCompEigenFreq access point
	TRUE	The access point overwrites the values at the access point in the signal flow.
AP09_IrOscCompEigenFreq		Natural frequency of the dampened system in [Hz] - Value range: 0.4 ... 40 - Initial value: 0
AP12_xWaitForBrakeReleased		Connection of the state of the external brake
	TRUE	The brake is inhibited. The TM is waiting for the brake to be enabled and delays all function requests.
	FALSE	The brake is released. The TM can pass the requirement through to the function enables.

Designator	Data type	Description
AP13_xBrakeTestMode		Enable of the AP13_eBrakeTestMode access point
	TRUE	The access point overwrites the values at the access point in the signal flow.
AP13_eBrakeTestMode		This access point indicates whether an available load (e.g. in the case of a hoist) should be compensated
	0	NoLoadTorque The torque specified at the IrMotorTorque input is used to test the brake.
	1	LoadTorqueldentification Load compensation takes place. For this purpose, a load identification is carried out automatically before starting.
AP14_xBrakeTestDirection		Enable of the AP14_eBrakeTestDirection access point
	TRUE	The access point overwrites the values at the access point in the signal flow.
AP14_eBrakeTestDirection MC_DIRECTION		
AP18_xBrakeGrindInMode		Enable of the AP18_eBrakeGrindInMode access point
	TRUE	The access point overwrites the values at the access point in the signal flow.
AP18_eBrakeGrindInMode		This access point overwrites the grinding mode
	1	Cw - grinding only in positive direction
	2	Ccw - grinding only in negative direction
	3	CwCcw - grinding first in positive, then in negative direction
	4	CcwCw - grinding first in negative, then in positive direction
AP20_xFiltTimeActTorque		Enable of the AP20_IrFiltTimeActTorque access point
	TRUE	The access point overwrites the values at the access point in the signal flow.
AP20_IrFiltTimeActTorque		Filter time for setting the PT1 filter for the identification of the constant torque. • Unit: s • Initial value: 0.02

8 Description of the basic functions

8.1 Activating and deactivating the technology module

8 Description of the basic functions

8.1 Activating and deactivating the technology module

Preconditions

L_TT1P_StackerCraneHeadControlBase and L_TT1P_StackerCraneAxisControlBase are connected to each other via the **DataBus**.

► [Communication via the "DataBus"](#) (31)



How to activate the technology module:

1. Set the input *xEnable* to TRUE on L_TT1P_StackerCraneHeadControlBase.
2. Set the input *xEnable* to TRUE on L_TT1P_StackerCraneAxisControlBase.
 - The technology module is initialised and enables the execution of the state machine and the respective functions for further actions.
 - The communication between L_TT1P_StackerCraneHeadControlBase and L_TT1P_StackerCraneAxisControlBase is initialised and established.



How to deactivate the activated technology module:

1. Set the input *xEnable* to FALSE on L_TT1P_StackerCraneAxisControlBase.
2. Set the input *xEnable* to FALSE on L_TT1P_StackerCraneHeadControlBase.

In the deactivated state,

- all ongoing actions and functions are cancelled
- all outputs of the technology module are reset
- the state machine is not executed anymore.
- The communication via the DataBus is terminated

8.2**Controller enable****Prerequisite**

- The axis has no fault
- DC-bus voltage is present
- STO is not active
- *xAxisReady* = TRUE

Only if the axis is enabled (*xAxisReady* = TRUE) can further functions be activated and executed in the technology module.

Execution via TM L_TT1P_StackerCraneAxisControlBase

The technology module has to be activated (input *xEnable* = TRUE) in order to enable the axis.

When the *xRegulatorOn* input = TRUE, the axis is enabled.

The state is switched to *xAxisEnabled* = TRUE if the axis is enabled and the brake is released.

Mode of operation

When the axis is enabled, the mode is switched to csp. This sets the setpoint of the axis to the actual value.

8.3

Stop

Prerequisite

- The axis is enabled.
- The brake is released.

Execution via TM **L_TT1P_StackerCraneAxisControlBase**

With a FALSE→TRUE edge at the *xStop* input, the current movement of the axis is interrupted. Due to its last current velocity value, the movement of the axis comes to a standstill along the *IrStopDec* deceleration ramp. The parameter for the *IrStopDec* deceleration ramp is set in the *scPar* of the TM.

- The [L_TT1P_StackerCraneHeadControlBase](#) TM switches to the **STOP** state.
- The [L_TT1P_StackerCraneAxisControlBase](#) TM switches to the **STOP** state.

Execution via **StackerCraneHeadControl** TM

With a FALSE→TRUE edge at the *xStopAll* input, the current movements of all axes are interrupted and come to a standstill along the *IrStopDec* deceleration ramp.

- The **L_TT1P_StackerCraneHeadControlBase** TM and the **L_TT1P_StackerAxisControlBase** TM switch to the **STOP** state.

Mode of operation

During the stop ramp, the axes switch to csv mode. The following error is deleted. The csv mode is held as long as the **Stop** request is active. When the request is reset, the system switches back to csp mode.

Parameters to be set

The parameters for the **Stop** function are located in the [L_TT1P_scPar_StackerCraneAxisControlBase](#) parameter structure.

Designator	Data type	Description
IrStopDec	LREAL	Deceleration for the Stop function and when hardware limit switches, software limit positions and the following error monitoring function are triggered. • Unit: units/s² • Initial value: 10000
IrStopJerk	LREAL	Jerk for the Stop function and when hardware limit switches, software limit positions and the following error monitoring function are triggered. • Unit: units/s³ • Initial value: 100000

8.4

Halt

Prerequisite

The axis is enabled ($xAxisEnabled = TRUE$).

Function

The holding function interrupts an active movement or the homing process.

The axis comes to a standstill with the deceleration ($IrHaltDec$ parameter) and the defined jerk ($IrJerk$ parameter).

Execution via TM L_TT1P_StackerCraneAxisControlBase

The holding function is activated with a $FALSE \rightarrow TRUE$ edge at the $xHalt$ input of the L_TT1P_StackerCraneAxisControlBase TM.

- The technology module switches to the **STOP** state as long as the $xHalt$ input is set to TRUE.
- The L_TT1P_StackerCraneHeadControlBase TM remains in the **READY** state.

If the $xHalt$ input is set to FALSE, the holding function is deactivated.

- The L_TT1P_StackerCraneAxisControlBase TM switches to the **READY** state.

Parameters to be set

The parameters for the holding function are located in the "scPar" parameter structure of the L_TT1P_StackerCraneAxisControlBase TM.

Designator	Data type	Description
IrHaltDec	LREAL	Deceleration for the holding function. Specification of the maximum speed variation which is to be used for deceleration to standstill. • Unit: units/s² • Initial value: 3600
IrJerk	LREAL	Jerk for compensating an offset value, trimming, clutch, or holding function • Unit: units/s³ • Initial value: 100000

8.4.1 Manual jog (jogging)

Prerequisite

- The TM is in the “READY” status.
- The slave axis is enabled (*xAxisEnabled* = TRUE).

Execution via TM L_TT1P_StackerCraneAxisControlBase

For manual jog of the axis, the manual jog speed *IrJogVel* is used.

If the *xJogPos* input is TRUE, the axis is traversed in the positive direction and if the *xJogNeg* input is TRUE, the axis is traversed in the negative direction. The axis is traversed for as long as the input remains set to TRUE.

- The **StackerCraneHeadControlBase** TM remains in the **READY** state.
- The **StackerCraneAxisControlBase** TM switches to the **JOGGING** state.

The current travel command cannot be replaced by another jog command. Only when both inputs have been reset does the [State machine](#) (32) change back to the **Ready** state.

Parameters to be set

The parameters for the manual jog are located in the [L_TT1P_scPar_StackerCraneAxisControlBase](#) parameter structure.

Designator	Data type	Description
IrJogJerk	LREAL	Jerk for compensating an offset value, trimming, clutch, or holding function • Unit: units/s³ • Initial value: 100000
IrJogVel	LREAL	Maximum speed to be used for manual jog. • Unit: units/s • Initial value: 10
IrJogAcc	LREAL	Acceleration for manual jog. Specification of the maximum velocity variation which is to be used for acceleration. • Unit: units/s² • Initial value: 100
IrJogDec	LREAL	Deceleration for manual jog. Specification of the maximum speed variation which is to be used for deceleration to standstill. • Unit: units/s² • Initial value: 100

8.5 Homing

Prerequisite

- The technology module is in the **Ready** state.
- The slave axis is enabled (*xAxisEnabled* = TRUE).

Execution via TM L_TT1P_StackerCraneAxisControlBase

The homing process is started with a rising edge (FALSE→TRUE) at the *xHomeExecute* input. The axis travels until the home position is reached.

- The **StackerCraneHeadControlBase** TM switches to the **SERVICE** state.
- The **StackerCraneAxisControlBase** TM switches to the **HOMING** state.

After successful referencing, the [State machine](#) (32) switches back to the **READY** state.

The homing process is not interrupted if the *xHomeExecute* input is set to FALSE too early. The function is aborted via the *xStop* or *xStop* input.

Parameters to be set

The parameters for homing are located in the [L_TT1P_scPar StackerCraneAxisControlBase](#) parameter structure.

Designator	Data type	Description	
lrHomePosition	LREAL	Home position for a reference run (homing) • Unit: units • Initial value: 0	
xUseHomeExtParameter	BOOL	Selection of the homing parameters to be used	
		TRUE	The homing parameters defined in the axis data are used.
		FALSE	The <i>scHomeExtParameter</i> homing parameters from the application are used.
scHomeExtParameter L_MC1P_Home-Parameter		Homing parameters from the application • Only relevant if <i>xUseHomeExtParameter</i> = TRUE	
scHomeExtTP MC_TRIGGER_REF		Transfer of an external touch probe event • Only relevant for "External source" touch probe configuration • For describing the MC_TRIGGER_REF structure, see the MC_TouchProbe function block.	

9 Description of the technology functions

9.1 X-Y function

Prerequisite

- The TM is in the “**READY**” status.
- All axes within the TM are enabled (*xAxesEnabled* = TRUE).

Function

With the X-Y function, two positioning axes can be controlled in two levels (carriage = X and hoist = Y) with travel profile adaptation. The intelligent coordination of hoist drive and travelling drive provides for the energy-efficient positioning of the drive without any prolongation of the positioning times.

The drives are controlled such that acceleration and deceleration phases do not occur at the same time, depending on the operating mode selected. This considerably reduces the max. possible motor power (optimal as regards the connection power) and regenerative power (optimal as regard the total power).

Type

The coordination mode is selected via the *scPar.eXYMode* parameter.

► [eXYMode](#) (□ 21)

With a FALSE→TRUE edge at the *xExecuteProfileX* and *xExecuteProfileY* input, the positioning request is set.

► [L TT1P StackerCraneHeadControlBase](#) (□ 18)

Override

The override can be set for the x and y axis at the input of the **L TT1P StackerCraneAxisControlBase** TM. The override values are taken into account when calculating the profile with the assignment via *xExecuteProfileX* and *xExecuteProfileY*. The velocity of the profile is adjusted. Changing the override values during travel does not affect the current profile. The change in the override values will take it into account in the calculation the next time the profiles are assigned.

Interaction between x and y axis

If, with an active movement of both axes, ...

- an axis, for instance, is aborted by another Move FB, the movement of the other axis is also stopped when the **ErrorStop** ramp is traversed.
- an axis changes to the **AXISERROR** status, the movement of the other axis is also stopped.

In both cases, the »Stacker Crane« TM switches to the **ERROR** state.

- The **Absolute** positioning mode is supported.
- Changes to profile data/maximum values/override during the movement are not accepted.
- If the assignment of a positioning process takes place whilst the axes are moved, the profile data are not adapted as a function of the mode.

For the carriage, a buffer travel can be activated, which, in the case of a storage and retrieval unit (SRU), is typically executed at the ends of the aisles to protect the mechanical buffers.

► [Buffer travel](#) (□ 47)

State change

With the positioning request, the »Stacker Crane« TM switches to the **MOVE_XY** state. Only when both axes (x and y) have reached the target position does the [State machine](#) of the TM change back to the **READY** state.

- The *xProfileXDone* output becomes TRUE when the x axis reaches the target position.
- The *xProfileYDone* output becomes TRUE when the y axis reaches the target position.

Parameters to be set

The parameters for the X-Y function are located in the [L TT1P_scPar StackerCraneAxisControlBase](#) parameter structure.

Designator	Data type	Description
eXYMode	L_TT1P_XYMode	Selection of the mode for energy management
scXProfile	L_TT1P_MoveProfileData	Profile parameter and target position of the x axis
scYProfile	L_TT1P_MoveProfileData	Profile parameter and target position of the y axis

The parameters to coordinate the movements are described in the section

▶ [L TT1P_MoveAbsProfileData](#) (22)



Note!

The parameters can be changed during operation. They are accepted when the positioning process is requested again.

Coordination modes

The coordination mode is selected via the [eXYMode](#) parameter.

▶ [L TT1P_scPar StackerCraneHeadControlBase](#) (21)

9.2

Buffer travel

**Note!**

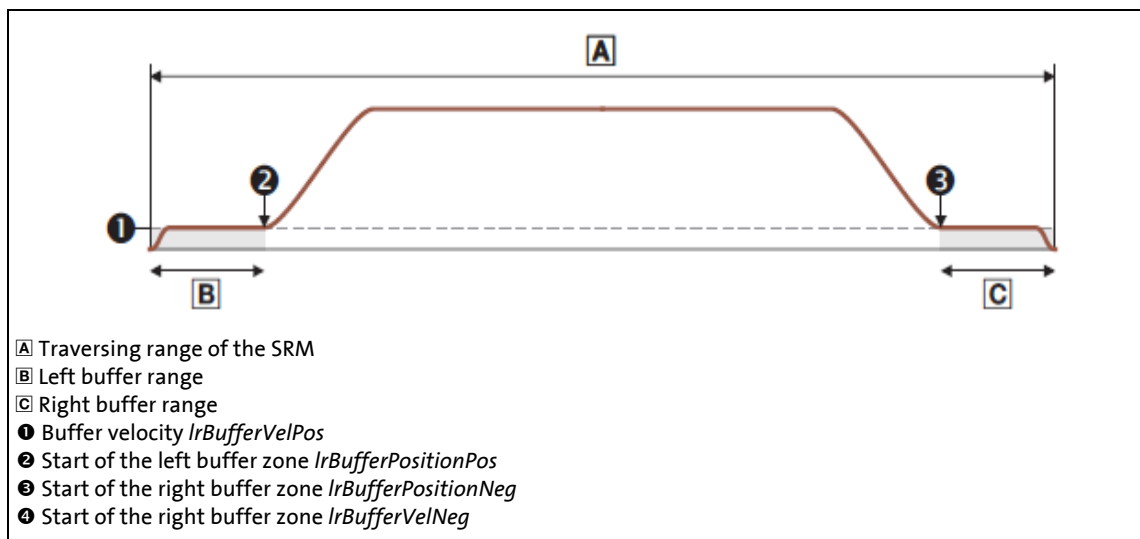
The **buffer travel** function is only enabled for the x axis.

The aisles of storage and retrieval units (SRU) are mostly provided with mechanical buffers at their ends which are to absorb the energy of the vehicle if due to an error the storage and retrieval unit (SRU) is not able to decelerate.

Usually, the path of the buffer piston is part of the normal traverse path of the storage and retrieval unit, so that the positions are approached within the buffer zone under normal operating conditions.

In order to minimise the absorption of kinetic energy in the buffer, the travel profile of the SRU drive is generated so that the buffer zone is approached at reduced speed, the buffer speed only being attained at the start of the buffer, as premature braking unnecessarily increases the positioning time.

The buffer zones are specified in absolute quantities, i.e. the start of the buffer zones in the aisle measuring system.



By setting the *scPar.xBufferRange* parameter to TRUE at the "Stacker Crane Axis Control" TM, the calculation algorithm for the buffer travel is activated. On the basis of the specified profile data and the current position at the start of the travel axis positioning (x axis) it is checked whether the buffer zone is currently approached.

- If the positioning target is within the buffer zone, the profile is internally divided into two profiles, so that the buffer velocity specified is reached at the start of the buffer zone.
- If the positioning target is outside the buffer zone, OR if a positioning process in the direction "Buffer zone exited" is started, the profile data specified are used for the traversing process, i.e. no manipulation of the profile data takes place.

**Note!**

- The **buffer travel** function is only enabled for the x axis.
- Changes with regard to the override values during an active buffer travel are not taken into consideration.

Parameters to be set

The parameters for the buffer travel are located in the [L_TT1P_StackerCraneAxisControlBase](#) parameter structure.

Designator	Data type	Description
scBufferData	L_TT1P_XYBufferData	x-y function: data for the buffer zone

The parameters within the L_TT1P_XYBufferData structure:

Designator	Data type	Description
IrBufferPositionPos	LREAL	Position from which the buffer zone is defined in the positive travel direction. • Unit: unit
IrBufferPositionNeg	LREAL	Position from which the buffer zone is defined in the negative travel direction. • Unit: unit
IrBufferVelPos	LREAL	The maximum velocity in the buffer zone in the positive travel direction. • Unit: unit/s
IrBufferVelNeg	LREAL	The maximum velocity in the buffer zone in the negative travel direction. • Unit: unit/s

9.3 Adapting the travel profiles (minimum values for the travel profiles)

Procedure for the calculation of travel profiles for the x and y axis:

1. Order the positioning process.
2. Check the states of the two axes.
3. Change the status of the TM and the PLC Open status of the axes.
4. Check the target position on the SW limit positions and the transfer of maximum values.
5. Calculate the profile for the x and y axis (separately).
6. Adapt the travel profiles depending on the selected [eXYMode](#) :
 - The slower profile is defined as the process-determining profile.
 - The faster profile is adapted to the process-determining profile.
 - If the minimum values defined are not reached, or if the process-determining axis is not "extended", the positioning profile to be manipulated is extended, i.e. the original profile form is maintained.
- ▶ [L TT1P_scPar_StackerCraneHeadControlBase](#) (📖 21)
7. Start x and y axes (may be time-delayed, depending on the selected [eXYMode](#)).
8. Monitor new travel requests and override; restart, if necessary.
9. Generate status signals.

Parameters to be set

The parameters for the manual jog are located in the [L TT1P_scPar_StackerCraneAxisControlBase](#) parameter structure.

Designator	Data type	Description
scMinLimits	L TT1P_XYLimits	X-Y function: minimum values for the axis When manipulating the profile data, the minimum values specified must always be reached.

The parameter structure contains the following variables:

Designator	Data type	Description
IrVel	LREAL	Minimum velocity • Unit: unit/s
IrAcc	LREAL	Minimum acceleration • Unit: unit/s²
IrDec	LREAL	Minimum deceleration • Unit: unit/s²

9.4

Brake check

The goal of the brake test is to determine the operational readiness of the drive holding brake.

The brake test belongs to the safety-relevant functions of a storage and retrieval machine. It is therefore recommended to repeat this test at regular intervals to check and ensure that the brake is ready for use.

Prerequisite

- The TM is in the **“READY”** status.
- The axis is inhibited and the brake is applied (*xAxisEnabled* = FALSE).

Function

When the brake test is carried out, a defined torque is applied against the closed holding brake and held for the defined duration.

A brake test has not been completed successfully if the motor shaft is rotated during the brake test.

In this case, an error status is activated and the **20529 Brake_PositionDrift** error message is displayed.

Execution via TM StackerCraneAxisControlBase**Note!**

The execution of the brake test can be aborted prematurely.

It is aborted via

- *xStop* ("L_TT1P_StackerCraneAxisControlBase" TM)
- *xStopAll* ("L_TT1P_StackerCraneHeadControlBase" TM)

If the brake test is aborted, the drive is inhibited. The brake remains engaged.

With a FALSE→TRUE edge at the *xExecuteBrakeTest* input, the brake test is started:

- Setting for the x axis: *eAddress* = *x_axis*
- Setting for the y axis: *eAddress* = *y_axis*

State change:

- "StackerCraneHeadControl" TM → **SERVICE** state
- "StackerCraneAxisControlBase" TM → **BRAKETEST** state

**Note!**

The parameters for the brake test relate to the motor end. If there is a gearbox, it remains unconsidered.

9.4.1 Brake test for the x axis

Function

The brake test torque *scPar.IrBrakeTestMotorTrq* is generated via a ramp generator with the acceleration time *scPar.IrBrakeTestRampTime* and then held for the holding time *scPar.IrBrakeTestHoldTime*.

This serves to try to rotate the motor shaft while the holding brake is applied.

Then the brake test torque is reduced via the ramp generator in the same way. When the brake test has been completed, the inverter disable is set again automatically.

Test procedure

- The axis is enabled automatically
- The brake is held closed
- The brake test torque is built up via the ramp
- This torque is held
- The brake test torque is reduced back to zero via the ramp.
- The axis is inhibited.

The direction for the torque for the x axis can be determined via the *AP14_eBrakeTestDirection* access point:

- *AP14_eBrakeTestDirection* = 0 (Cw)
- *AP14_eBrakeTestDirection* = 1 (Ccw)

Parameters to be set

The parameters for the brake test of the x axis are located in the [L TT1P StackerCraneAxisControlBase](#) TM.

Designator	Data type	Description
IrBrakeTestMotorTrq	LREAL	Brake test: test torque relating to the motor • Unit: Nm • Initial value: 0
IrBrakeTestRampTime	LREAL	Brake test: acceleration and deceleration time • Unit: s • Initial value: 0
IrBrakeTestHoldTime	LREAL	Brake test: holding time • Unit: s • Initial value: 0
IrBrakeTestPosThreshold	LREAL	Max. angle of rotation (threshold position) of the motor shaft • Unit: Degree • Initial value: 0

9.4.2 Brake test for the y axis



Note!

The torque is always established in the negative direction (Ccw, at the output end), so that the brake test always takes place going down. This creates forces that additionally act downwards on the load handling device.

The brake test for a hoist axis cannot be carried out upwards because the motor cannot usually create enough torque to provide the force due to weight and the brake test torque.

Function

First the controller is enabled and the brake is released. The load torque required to hold the hoist is identified. The resulting brake test torque is determined from the identified load torque and the parameterised brake test torque (*scPar.IrBrakeTestMotorTrq*) i.e.

$$\text{Resulting brake test torque} = IrBrakeTestMotorTrq - IdentTorque$$

The resulting brake test torque is established via a ramp generator with the acceleration time *scPar.IrBrakeTestRampTime* and then held for the holding time *scPar.IrBrakeTestHoldTime*.

The resulting brake test torque acts in the negative direction so that the resulting force is directed downwards. This serves to try to rotate the motor shaft while the holding brake is applied. Subsequently, the brake test torque is reduced via the ramp generator in the same way. When the brake test has been completed, the inverter disable is set again automatically.

Test procedure

- The axis is enabled automatically
- Load identification before the test
 - The brake is released
 - The axis is held in the position via the speed controller (in csp)
 - Torque is measured via the PT1 filter → holding torque
 - The brake is closed
 - The speed controller is turned off

Start brake test:

- The brake is held closed
- The brake test torque is built up via the ramp
 - Torque = *IrBrakeTestMotorTrq* - IdentTorque
- This torque is held
- The brake test torque is reduced back to zero via the ramp.
- The axis is inhibited.

Parameters to be set

The parameters for the brake test of the x axis are located in the [L TT1P StackerCraneAxisControlBase](#) TM.

Designator	Data type	Description
IrBrakeTestMotorTrq	LREAL	Brake test: test torque relating to the motor • Unit: Nm • Initial value: 0
IrBrakeTestRampTime	LREAL	Brake test: acceleration and deceleration time • Unit: s • Initial value: 0
IrBrakeTestHoldTime	LREAL	Brake test: holding time • Unit: s • Initial value: 0
IrBrakeTestPosThreshold	LREAL	Max. angle of rotation (threshold position) of the motor shaft • Unit: Degree • Initial value: 0

9.4.3 Evaluation of the brake test

Evaluation	Message / impact	INFO
Test OK	The <i>xDone</i> message appears.	During the test, the current position of the axis remains within the <i>lrBrakeTestPosThreshold</i> tolerance band.
Test NOK	The TM switches to the 20529 <i>Brake_PositionDrift</i> error status. The brake test is aborted	During the test, the current position of the axis exited the <i>lrBrakeTestPosThreshold</i> tolerance band. Consequence: The torque is reduced, the controller remains enabled and the axis is once again held in the position in CSP. If the error status is acknowledged via the <i>xResetError</i> input, the controller is once again inhibited if the <i>xRegulatorOn</i> input is set to FALSE.

9.5

Bed in brake

Prerequisite

- The TM is in the "READY" status.
- The axis is inhibited and the holding brake is applied (*xAxisEnabled* = FALSE).

Function

**Note!**

The execution of the "Grind in brake" function can be aborted prematurely.

It is aborted via

- *xStop* ("L_TT1P_StackerCraneAxisControlBase" TM)
- *xStopAll* ("L_TT1P_StackerCraneHeadControlBase" TM)

Aborting brings the drive to a standstill. At standstill, it is once again inhibited.

With a FALSE→TRUE edge at the *xExecuteBrakeGrindIn* input, the "Grind in brake" function is started:

- Setting for the x axis: *eAddress* = *x_axis*
- Setting for the y axis: *eAddress* = *y_axis*

State change:

- "StackerCraneHeadControl" TM → **SERVICE** state
- "StackerCraneAxisControlBase" TM → **BRAKEGRINDIN** state

The axis is enabled automatically.

Specify area for grinding

During the grinding process, the axis is traversed in a range whose limits are defined as follows:

- Limit1 → negative limitation
- Limit2 → positive limitation

The area is not exited during the grinding.

The *eBrakeGrindInAdditionalLimits* parameter serves to specify the source for determining the range:

- Limitation by the SW limit positions with *eBrakeGrindInAdditionalLimits* = NotActive
Limit 1 → positive SW limit position with parameter 51
Limit 2 → negative SW limit position with Parameter 52.
- Limitation via *scPar* with *eBrakeGrindInAdditionalLimits* = AdditionalPosLimits
Limit 1 → negative limitation with *scPar.lBrakeGrindInPosLimit1*
Limit 2 → positive limitation with *scPar.lBrakeGrindInPosLimit2*

9.5.1 Grind in brake for the x axis

The specified grinding speed *scPar.lBrakeGrindInMotorSpeed* is established via a ramp generator with the acceleration time *scPar.lBrakeGrindInRampTime*. After the grinding speed has been reached, the friction partners in the holding brake are ground by means of a pulsed control. The brake is closed for the time period *scPar.lBrakeGrindInOnTime* and opened for the time period *scPar.lBrakeGrindInOffTime*. After the number of application cycles specified in *scPar.wBrakeGrindInCycles*, the direction of rotation is changed and the grinding is carried out in the opposite direction. An application cycle consists of closing and opening the brake. The axis is then brought to a standstill again via the ramp generator.

When the grind process has been completed, inverter disable is set again automatically and the TM switches to the **READY** state.



STOP!

Disregarding the following notes may cause damage or the destruction of machine parts.

- The axis must move freely without driving against the travel range limitations.
- A limited traversing range (active software limit positions) is taken into consideration, i.e. the direction is automatically changed several times.
- The maximally permissible friction energy of the holding brake must not be exceeded (observe the specifications of the manufacturer)!

Procedure for the x axis

- The x axis is accelerated to the required speed.
- Close brake (grind in)
- Open brake again
- Let the axis continue to travel to cool off the brake
- Stop the axis
- Repeat the grind in procedure for brake in the other direction

Parameters to be set

The parameters for the "Grind in brake" function are located in the [L TT1P_scPar_StackerCraneAxisControlBase](#) parameter structure.

Designator	Data type	Description
wBrakeGrindInCycles	WORD	Number of holding brake application cycles • Initial value: 0
eBrakeGrindMode L_MC1P_GrindInMode		Grinding mode (only relevant for the x axis) • Initial value: x
	1	Cw - grinding only in positive direction
	2	Ccw - grinding only in negative direction
	3	CwCcw - grinding first in positive, then in negative direction
	4	CcwCw - grinding first in negative, then in positive direction
lBrakeGrindInMotorSpeed	LREAL	Grinding speed (relating to the motor without gearbox) • Unit: rpm • Initial value: 0

Designator	Data type	Description
lrBrakeGrindInRampTime	LREAL	Acceleration and deceleration time • Unit: s • Initial value: 0
lrBrakeGrindInOnTime	LREAL	Application time of the holding brake • Unit: s • Initial value: 0
lrBrakeGrindInOffTime	LREAL	Ventilation / cooling time of the holding brake • Unit: s • Initial value: 0
eBrakeGrindInAdditional-Limits L_MC1P_AdditionalLimits		Activate / deactivate limitation of the grinding area
		1 NotActive No additional limitations of the grinding area via the module. The grinding area is limited via active software limit positions.
		2 AdditionalPosLimits The grinding area is limited via the positions at the <i>lrBrakeGrindInPosLimit1</i> and <i>lrBrakeGrindInPosLimit2</i> inputs.
lrBrakeGrindInPosLimit1	LREAL	Specification of the lower position limit for grinding the brake (at the output end).
lrBrakeGrindInPosLimit2	LREAL	Specification of the upper position limit for grinding the brake (at the output end).
xBrakeGrindInFinishInStartpos	BOOL	TRUE Stop grinding process in the output position.
xBrakeExternalFan	BOOL	TRUE The motor and brake are forced ventilated. Force ventilating the motor and brake makes it possible to brake during the OFF time. Reducing the speed thereby shortens the grinding path.

9.5.2 Grind in brake for the y axis



Note!

The y axis is always ground in from the upper SW limit position in the travel direction of the lower SW limit position. The path from the lower SW limit position to the upper SW limit position is used as brake cooling time.

With the start of the "Grind in brake" function, the y axis is enabled and positioned automatically in the upper SW limit position, making the upper limit position the starting position for the "Grind in brake" function.

The axis is inhibited. A calculation is then carried out that uses the parameters to estimate whether the path from the starting position to the limit position will be sufficient to be able to carry out a brake grinding cycle. An error status with an error message occurs if the path is not sufficient for a brake grinding cycle. The y axis is released again automatically and the specified grinding speed *scPar.lBrakeGrindInMotorSpeed* is established via a ramp generator with the acceleration time *scPar.lBrakeGrindInRampTime* in the direction of the lower limit position if the path is sufficient for grinding the brake.

After the grinding speed has been reached, the friction partners in the holding brake are ground by means of a pulsed control. The brake is closed for the time period *scPar.lBrakeGrindInOnTime* and then opened again. The axis reverses in the lower limit position and travels to the upper end position at the grinding speed.

The axis stops in the upper limit position when the time period *scPar.lBrakeGrindInOffTime* has elapsed while travelling. The axis reverses in the upper limit position and travels in the direction of the lower limit position if the time period *scPar.lBrakeGrindInOffTime* has not been reached.

The axis ends a cycle for the "Grind in brake" function in the position of the upper limit position. The next cycle for the "Grind in brake" function is carried out again from the upper limit position.

The grind in process is terminated when the number of application cycles specified in *scPar.wBrakeGrindInCycles* have been carried out.

When the grind in process has been completed, inverter disable is set again automatically and the TM switches to the **STANDBY** state.

Procedure for the y axis

- The y axis is positioned in the upper limit position.
- The y axis is accelerated downwards to the required speed.
- Close brake (grind in)
- Open brake again
- Let the y axis continue to travel to cool off the brake
- Change the rotating direction from the lower limit position
- Reposition the y axis at the output limit position
- Repeat the next grind in cycle



Note!

Grinding the brake for the y axis is always carried out downwards (Ccw) regardless of the mode.

Parameters to be set

The parameters for the "Grind in brake" function are located in the [L TT1P_scPar StackerCraneAxisControlBase](#) parameter structure.

Designator	Data type	Description
wBrakeGrindInCycles	WORD	Number of holding brake application cycles • Initial value: 0
lrBrakeGrindInMotorSpeed	LREAL	Grinding speed (relating to the motor without gearbox) • Unit: rpm • Initial value: 0
lrBrakeGrindInRampTime	LREAL	Acceleration and deceleration time • Unit: s • Initial value: 0
lrBrakeGrindInOnTime	LREAL	Application time of the holding brake • Unit: s • Initial value: 0
lrBrakeGrindInOffTime	LREAL	Ventilation / cooling time of the holding brake • Unit: s • Initial value: 0
eBrakeGrindInAdditional-Limits L_MC1P_AdditionalLimits		Activate / deactivate limitation of the grinding area
	1	NotActive No additional limitations of the grinding area via the module. The grinding area is limited via active software limit positions.
	2	AdditionalPosLimits The grinding area is limited via the positions at the <i>lrBrakeGrindInPosLimit1</i> and <i>lrBrakeGrindInPosLimit2</i> inputs.
lrBrakeGrindInPosLimit1	LREAL	Specification of the lower position limit for grinding the brake (at the output end).
lrBrakeGrindInPosLimit2	LREAL	Specification of the upper position limit for grinding the brake (at the output end).
xBrakeGrindInFinishInStartpos	BOOL	TRUE Stop grinding process in the output position.
xBrakeExternalFan	BOOL	TRUE The motor and brake are forced ventilated. Force ventilating the motor and brake makes it possible to brake during the OFF time. Reducing the speed thereby shortens the grinding path.

9.6 Oscillation compensation

Prerequisite

- An oscillatory, dampened and homogeneous drive system.
- The natural frequency as well as the amplitude ration of the mechanical model are known or can be identified.

Function

With the active oscillation, the travel profile is filtered before it goes to the drives. The introduction of additional motion pulses in the jerk characteristic of the profile provides for the targeted compensation of the oscillation, as comprehensively as possible.

With the "normal" pulse of the jerk at the start of the acceleration or deceleration phase, an oscillation is excited. In order to compensate for this "normal" pulse, an "artificial" pulse is inserted after a time delay, acting in the opposite direction.

The process of oscillation suppression is based on a mathematical model simulating a physically oscillatory, dampened and homogeneous system. In this process, the oscillation or disruptive factors are not compensated, but the travel profiles are adapted / filtered.

The result of the compensation of an oscillation depends on the quality of the model simulation and its parameterisation.



Note!

Oscillations caused by faults (e.g. stick-slip or static friction) cannot be suppressed.

Impact on the travel profiles

The travel profiles calculated from the XY function are additionally manipulated via the filter function. The filter function of the setpoints are not taken into consideration when the travel profiles are calculated and adapted.

This causes deviations by the temporal characteristic calculated by the XY function and the temporal characteristic at the axis. As a consequence, the axes are not able to arrive at the finish isochronously, but are offset by the time difference specified by the natural frequency.

Type

The oscillation compensation is enabled by setting the *StackerCraneAxisControl.xOscComp* input to TRUE.

Parameter setting

The oscillation compensation procedure requires the information on the natural frequency of the mast as well as the damping of the oscillation.

The natural frequency of the mast depends on the height of the load handling equipment and its load.

The parameters are set via a data field (ARRAY[1 ... 8] OF STRUCT). A maximum total of 8 x data sets are possible. The natural frequency and the damping can be specified in each data set as a function of the height of the load carrying equipment and its load. Each data set can be deactivated via *xValid* = FALSE or activated via *xValid* = TRUE.

Parameters to be set

Designator	Data type	Description
xValid	BOOL	TRUE The interpolation point is activated and considered in the interpolation of the function.
IrPosScaled	LREAL	The scaled position: First input variable for the bilinear interpolation
IrLoadScaled	LREAL	The scaled load: Second input variable for the bilinear interpolation
IrEigenFrequency	LREAL	The value (wiped) of the interpolation point. In this case it is the natural frequency • Unit: Hz • Value range: 0.4 Hz ... 40 Hz (a value outside the value range causes an error) • Initial value: 0
IrAmpRatio	LREAL	The value (wiped) of the interpolation point. In this case, it is the damping • Value range: 0 ... 1 (a value outside the value range causes an error). • Initial value: 0

The resulting natural frequency as well as the amplitude ratio are determined using the bilinear interpolation from the key position data and the load and set for the oscillation damping function.

The position for the interpolation of the key data is specified via the *IrOscCompPosScaled* input (setting range 0 ... 1 with 1 = 100 %) at the "Stacker Crane Axis Control" TM. The payload is specified via the *IrOscCompLoadScaled* input (setting range 0 ... 1 with 1 = 100 %) at the "Stacker Crane Axis Control" TM.

- Bilinear interpolation is used to determine the natural frequency: $f = f(\text{payload}, Y \text{ height})$
- Bilinear interpolation is used to determine the damping: $d = f(\text{payload}, Y \text{ height})$

**Note!**

At least two data sets must be defined as a function of the height of the load handling equipment so that the bilinear interpolation can be calculated.

The height of the load handling equipment and thus the currently valid natural frequency also change while the carriage is travelling. With the use of several data sets, the change in the natural frequency and the change in the damping as a function of the LHD height can also be taken into account while travelling.

9.6.1 Executing an identification process

Excitation of the mechanics

In order to determine both parameters, the construction must be brought to oscillation with a switched-off compensation. There are two possibilities:

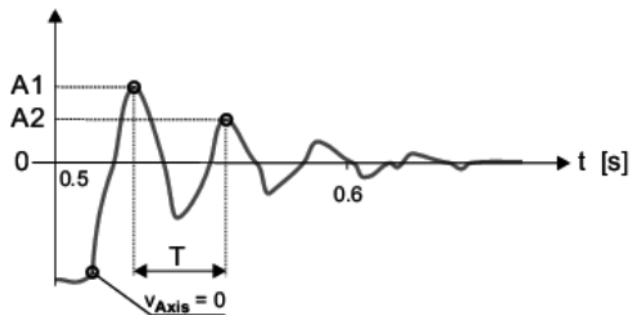
- Traverse the drive of the construction at the usual speed and then decelerate the drive, exerting a deceleration and jerk as high as possible.
- Travel the drive with a usual motion with increased jerk values.

Generating sensor information

If the axis has come to a standstill, an external measuring device (e.g. acceleration sensor, external position sensors or extension measurement) can be used to measure the oscillation. The signal should be zero-mean to the greatest possible extent, i.e. the occurring measured values should be distributed evenly around zero.

For the case that no external measuring device is available, the current torque of the axis or the following error can be frequently used as an alternative.

Evaluation of the measured signals



A1: amplitude of the first oscillation

A2: amplitude of the second oscillation

T: time for one oscillation (period)

Calculations of the natural frequency: $IrEigenFreq = 1/T$

Determination of the amplitude ratio: $IrAmpRation = A2/A1$

9.7

Maintenance mode

**Stop!**

If the maintenance mode is activated ($xMaintenanceMode = TRUE$), all monitoring functions are deactivated!

The deactivation of monitoring functions can cause machine damage! Therefore, this mode may only be used for maintenance purposes.

Prerequisite

- The TM is in the "READY" status.
- No error status

Execution (via "StackerCraneHeadControl" TM)

If the $xMaintenanceMode$ input is set to TRUE, the function is activated.

After the function is started, the "L_TT1P_StackerCraneHeadControlBase" and "L_TT1P_StackerCraneAxisControlBase" TMs switch to the **MAINTENANCE** state.

In this state

- the axes are switched to the csv mode,
- a following error is deleted,
- the controller enable of the axes can be triggered separately,
- the brakes can be released,
- the axes can be traversed in manual operation via the $xJogPos$ and $xJogNeg$ inputs at the "StackerCraneAxisControlBase" TM.
- the monitoring function of the hardware and software limit positions and the following error monitoring are deactivated.

Parameters to be set

The parameters for the "maintenance mode" function are located in the [L_TT1P_scPar_StackerCraneAxisControlBase](#) parameter structure.

Designator	Data type	Description
IrMaintenanceVel	LREAL	The maximum velocity in maintenance mode • Unit: units/s • Initial value: 10
IrMaintenanceAcc	LREAL	The maximum acceleration in maintenance mode • Unit: units/s² • Initial value: 100
IrMaintenanceDec	LREAL	The maximum deceleration in maintenance mode • Unit: units/s² • Initial value: 100
IrMaintenanceJerk	LREAL	The maximum jerk in maintenance mode • Unit: units/s³ • Initial value: 10000

When the *xMaintenanceMode* input is reset to FALSE, the "L_TT1P_StackerCraneHeadControlBase" TMs and the "L_TT1P_StackerCraneAxisControlBase" TM return to the **READY** state. The csv mode is exited and the original state of the axes is restored.

Symbols

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Your opinion is important to us

These instructions were created to the best of our knowledge and belief to give you the best possible support for handling our product.

If you have suggestions for improvement, please e-mail us to:

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Thank you for your support.

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