FAST Application Software

Technology module

Flex Cam ___________________________________

Reference Manual EN

13531726

Lenze

Contents

1 About this documentation

This documentation ...

- contains detailed information on the functionalities of the "Register Control" 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 Controller (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« (parameter setting, configuration, diagnostics) • »VisiWinNET® Smart« (visualisation) • »Backup & Restore« (data backup, recovery, 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:

Planning / configuration / technical data	
☐	**Product catalogues** • Controller-based Automation • Controllers • Inverter Drives/Servo Drives
Mounting 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
Parameter setting / 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 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.

1.1 Document history

Version			Description
3.2	05/2017	TD17	• Content structure has been changed. • General revisions
3.1	04/2016	TD17	General revisions
3.0	10/2015	TD17	• Corrections and additions • Content structure has been changed.
2.1	05/2015	TD17	General revisions
2.0	01/2015	TD17	• General editorial revision • Modularisation of the contents for the »PLC Designer« online help
1.0	04/2014	TD00	First edition

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	*italics*	By setting *bEnable* 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	(🕮 6)	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 handling
		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

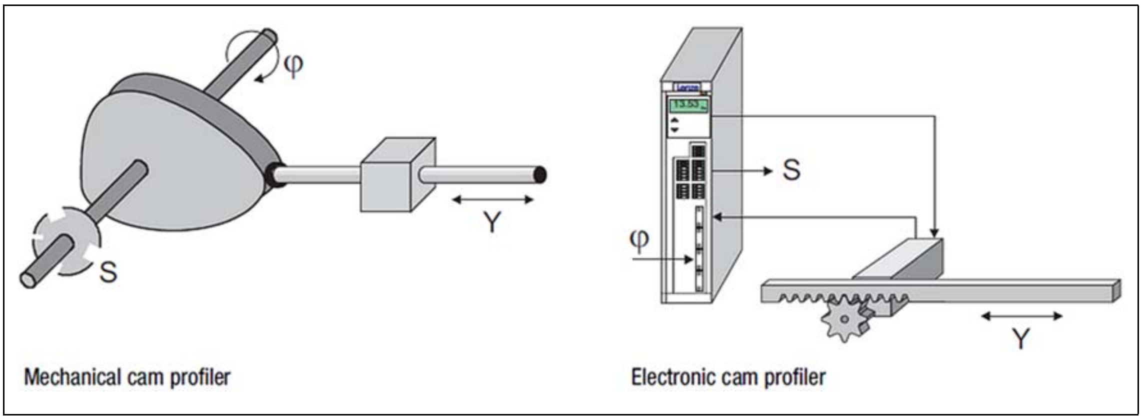
Damage or destruction of machine parts can be caused by ...

- 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 "Flex Cam" - functional description



[3-1] Typical mechanics of the technology module

The "Flex Cam" technology module is a generally admitted application for the implementation of cams.

- In the "Base" version, cams can be calculated and executed between the interpolation points with a polynomial of the fifth degree or by means of linear interpolation. Setting an offset and a scaling factor (in X and Y direction of the cam) for the master and slave axis can be carried out anytime within a cam using a ramp generator (continuous adjustment) or without the use of a ramp generator (abrupt adjustment). Furthermore it is possible to clutch in to the cam or declutch from the cam without step changes via various coupling modes.
- The "State" version provides an extended function range of the "Base" version:
  Here, a coupling mode without reversing is additionally provided. Furthermore the ramp generator can be executed for offset values and scaling factors on the master axis without reversing. Another function provided by the State version is that several cams can be executed in a specified sequence.

▸ Overview of the functions (🕮 11)

3.1 Overview of the functions

In addition to the basic functions for operating the **L_MC1P_AxisBasicControl** function block, the **stop function** and the **holding function**, the technology module offers the following functionalities which are assigned to the "Base" and "State" versions:

Functionality	Versions	
	Base	State
Manual jog (jogging) (🕮 32)	●	●
Homing (🕮 33)	●	●
Cam formats (cam handling) (🕮 34)	●	●
Executing the cam cyclically (🕮 35)	●	●
Executing the cam once (🕮 36)	●	●
Executing the master axis with cams of variable cycle lengths (🕮 37)	●	●
Executing the slave axis with cams of variable cycle lengths (🕮 38)	●	●
Change of cam (🕮 39)	●	●
Clutching in to the cam (🕮 40)	●	●
Declutching from the cam (🕮 50)	●	●
Positive opening operation / Emergency opening operation (🕮 56)	●	●
Scaling of the cam (🕮 57)	●	●
Offset for the master and slave axis (🕮 62)	●	●
Calculation of extreme values of a cam (Base version) (🕮 64)	●	●
Path-based clutch-in of the slave axis with or without reversing (🕮 65)		●
Path-based declutching of the slave axis with or without reversing (🕮 67)		●
Scaling of the cam with or without reversing (🕮 69)		●
Offset for the master and slave axis with or without reversing (🕮 70)		●
Switching sequence for cams (🕮 71)		●
Calculation of extreme values of a cam (State version) (🕮 72)		●

»PLC Designer« Online help

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

3.2 Important notes on how to operate the technology module

Setting of the operating mode

The operating mode for the slave axis has to be set to "cyclically synchronous position" (csp) because the slave axis is led via the master position value resulting from the cam.

Controlled start of the axes

Motion commands that are set in the inhibited axis state (*xAxisEnabled* = FALSE) after enable (*xRegulatorOn* = TRUE) must be activated again by a FALSE↗TRUE edge.

In this way it is prevented that the drive starts in an uncontrolled manner after controller enable.

Example Manual jog (jogging) (📖 32)**:**

1. In the inhibited axis state (*xAxisEnabled* = FALSE), *xJogPos* is set to TRUE.
   - *xRegulatorOn* = FALSE (axis is inhibited.)
     ==> "READY" state (*xAxisEnabled* = FALSE)
   - *xJogPos* = TRUE (manual jog is to be executed.)
2. Enable axis.
   - *xRegulatorOn* = TRUE
     ==> "READY" state (*xAxisEnabled* = TRUE)
3. Execute manual jog.
   - *xJogPos* = FALSE↗TRUE
     ==> "JOGPOS" state

3.3 Function block L_TT1P_FlexCam[Base/State]

The figure shows the relation of the inputs and outputs to the "Base" and "State" versions.
The additional inputs and outputs of the "State" version are shaded.

	L_TT1P_FlexCam[Base/State]		
Base			
BOOL	xEnableInternalControl	xInternalControlActive	BOOL
BOOL	xEnable	eTMState	L_TT1P_States
scCtrl_ABC	scCtrlABC	scStatusABC	scStatus_ABC
BOOL	xResetError	xError	BOOL
BOOL	xRegulatorOn	xWarning	BOOL
BOOL	xStop	eErrorID	L_IE1P_Error
BOOL	xHalt	scErrorInfo	L_TT1P_scErrorInfo
L_TT1P_scPar_FlexCam[Base/State]	scPar	xAxisEnabled	BOOL
AXIS_REF	MasterAxis	scSignalFlow	L_TT1P_scSF_FlexCam[Base/State]
AXIS_REF	SlaveAxis	xDone	BOOL
BOOL	xJogPos	xBusy	BOOL
BOOL	xJogNeg	xIsHomed	BOOL
BOOL	xHomeExecute	xHwLimitSwitchNeg	BOOL
BOOL	xHomeAbsSwitch	xHwLimitSwitchPos	BOOL
BOOL	xEnableHWLimit	xSwLimitEnabled	BOOL
BOOL	xHWLimitPos	xSwLimitSwitchActive	BOOL
BOOL	xHWLimitNeg	xCamSynchronised	BOOL
BOOL	xSyncCam	xAccDecSync	BOOL
BOOL	xSyncOutInstant	xEndOfProfile	BOOL
BOOL	xCamChangeInstant	lrSetXPosOut	LREAL
LREAL	lrSetOffsetMaster	lrSetXVelOut	LREAL
LREAL	lrSetOffsetSlave	lrSetXAccOut	LREAL
LREAL	lrSetScalingMaster	lrSetYPosOut	LREAL
LREAL	lrSetScalingSlave	lrSetYVelOut	LREAL
MC_CAM_REF	CamTable1	lrSetYAccOut	LREAL
		lrActSlavePos	LREAL
		lrActSlaveVel	LREAL
		lrSetOffsetMasterOut	LREAL
		lrSetOffsetSlaveOut	LREAL
		lrSlaveMaxPos	LREAL
		lrSlaveMinPos	LREAL
		lrSlaveMaxVel	LREAL
		lrSlaveMaxAcc	LREAL
State			
MC_CAM_REF	CamTable2	eSetCamTableOut	L_TT1P_CamTable
MC_CAM_REF	CamTable3	xCamSequencerActive	BOOL
MC_CAM_REF	CamTable4		

Data type	L_TT1P_FlexCam[Base/State]
L_TT1P_CamTable	eSetCamTable
BOOL	xCamSequencer

3.3.1 Inputs and outputs

Designator / Data type	Description	Available in version: Base	Available in version: State
MasterAxis AXIS_REF	Reference to the master axis (master axis)	●	●
SlaveAxis AXIS_REF	Reference to the slave axis	●	●

3.3.2 Inputs

Designator Data type	Description		Available in version Base	Available in version State
xEnableInternalControl BOOL	TRUE	In the visualisation, the internal control of the axis can be selected via the "Internal Control" axis.	●	●
xEnable BOOL	Execution of the function block TRUE FALSE	 The function block is executed. The function block is not executed.	●	●
scCtrlABC scCtrl_ABC	Input structure for the **L_MC1P_AxisBasicControl** function block • scCtrlABC can be used in "Ready" state. • If there is a request, the state changes to "Service". • The state change from "Service" back to "Ready" takes place if there are no more requests.		●	●
xResetError BOOL	TRUE	Reset axis error or software error.	●	●
xRegulatorOn BOOL	TRUE	Activate controller enable of the axis (via the **MC_Power** function block).	●	●
xStop BOOL	TRUE	Cancel the active movement and brake the axis to a standstill with the deceleration defined via the lrStopDec parameter. • The state changes to "Stop". • The technology module remains in the "Stop" state as long as xStop is set to TRUE (or xHalt = TRUE). • The input is also active with "Internal Control".	●	●
xHalt BOOL	TRUE	Cancel the active movement and brake the axis to a standstill with the deceleration defined via the lrHaltDec parameter. • The state changes to "Stop". • The technology module remains in the "Stop" state as long as xStop is set to TRUE (or xHalt = TRUE).	●	●
scPar L_TT1P_scPar_FlexCam[Base/State]	The parameter structure contains the parameters of the technology module. The data type depends on the version used (Base/State).		●	●
xJogPos BOOL	TRUE	Traverse axis in positive direction (manual jog). If xJogNeg is also TRUE, the traversing direction selected first remains set.	●	●
xJogNeg BOOL	TRUE	Traverse axis in negative direction (manual jog). If xJogPos is also TRUE, the traversing direction selected first remains set.	●	●
xHomeExecute BOOL	The input is edge-controlled and evaluates the rising edge. FALSE↗TRUE	 Start homing. The function is aborted via the xStop input.	●	●
xHomeAbsSwitch BOOL	TRUE	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.	●	●
xEnableHWLimit BOOL	TRUE	The evaluation of the travel range limit switch (hardware limit switch) is activated.	●	●

<table>
<tr><th rowspan="2">Designator
Data type</th><th rowspan="2" colspan="2">Description</th><th colspan="2">Available in version</th></tr>
<tr><th>Base</th><th>State</th></tr>
<tr><td rowspan="2">xHWLimitPos
BOOL</td><td colspan="2">Positive hardware limit switch
Connect this input to the corresponding digital input that is connected to the limit switch.</td><td rowspan="2">●</td><td rowspan="2">●</td></tr>
<tr><td>TRUE</td><td>The positive hardware limit switch has been reached or approached.
• The xHwLimitSwitchPos output is also set to TRUE.
• The axis is brought to a standstill with the deceleration in the alrStopDec parameter.
• The state changes to "ERROR" with the error message ’20500’ (HWLimitPos).</td></tr>
<tr><td rowspan="2">xHWLimitNeg
BOOL</td><td colspan="2">Negative hardware limit switch
Connect this input to the corresponding digital input that is connected to the limit switch.</td><td rowspan="2">●</td><td rowspan="2">●</td></tr>
<tr><td>TRUE</td><td>The negative hardware limit switch has been reached or approached.
• The xHwLimitSwitchNeg output is also set to TRUE.
• The axis is brought to a standstill with the deceleration in the alrStopDec parameter.
• The state changes to "ERROR" with the error message ’20501’ (HWLimitNeg).</td></tr>
<tr><td rowspan="2">xSyncCam
BOOL</td><td>TRUE</td><td>Clutch in to the cam, according to the coupling mode in the "eSyncMode" parameter.
• The xSyncOutInstant input is executed with a higher priority.
• As long as the input xSyncOutInstant is set to TRUE, clutch-in to the cam is not possible.</td><td rowspan="2">●</td><td rowspan="2">●</td></tr>
<tr><td>FALSE</td><td>Declutch from the cam, according to the coupling mode in the "eSyncMode" parameter.</td></tr>
<tr><td>xSyncOutInstant
BOOL</td><td>TRUE</td><td>Immediate declutching from the cam
• The slave axis is brought to a standstill with the deceleration from the lrSyncOutInstantDec parameter.
• The coupling mode in the "eSyncMode" parameter has no impact here.</td><td>●</td><td>●</td></tr>
<tr><td>xCamChangeInstant
BOOL</td><td colspan="2">With the rising edge (FALSE↗TRUE), a change-over from the currently used cam to the newly created cam takes place in the current clock cycle.</td><td>●</td><td>●</td></tr>
<tr><td>lrSetOffsetMaster
LREAL</td><td colspan="2">Position offset of the master axis
The resulting X position of the cam is produced by addition of the master axis position to the "lrSetOffsetMaster" offset.
• Unit: units
• Initial value: 0</td><td>●</td><td>●</td></tr>
<tr><td>lrSetOffsetSlave
LREAL</td><td colspan="2">Position offset of the slave axis
The resulting position of the slave axis is produced by addition of the Y position and the "lrSetOffsetSlave" offset.
• Unit: units
• Initial value: 0</td><td>●</td><td>●</td></tr>
<tr><td>lrSetScalingMaster
LREAL</td><td colspan="2">Scaling factor of the master axis
The resulting X position of the cam is produced by multiplication of the master axis position with the "lrSetScalingMaster" X scaling factor.
Negative values are not permitted.
• Initial value: 1</td><td>●</td><td>●</td></tr>
</table>

<table>
<tr><th rowspan="2">Designator
Data type</th><th rowspan="2" colspan="2">Description</th><th colspan="2">Available in version</th></tr>
<tr><th>Base</th><th>State</th></tr>
<tr><td>lrSetScalingSlave
LREAL</td><td colspan="2">Scaling factor of the slave axis
The resulting extended/compressed Y setpoint position is produced by multiplication of the Y cam value with the "lrSetScalingSlave" Y scaling factor.
Negative values are not permitted.
• Initial value: 1</td><td>●</td><td>●</td></tr>
<tr><td>CamTable1
MC_CAM_REF</td><td colspan="2">Reference to the cam 1</td><td>●</td><td>●</td></tr>
<tr><td>CamTable2
MC_CAM_REF</td><td colspan="2">Reference to the cam 2</td><td></td><td>●</td></tr>
<tr><td>CamTable3
MC_CAM_REF</td><td colspan="2">Reference to the cam 3</td><td></td><td>●</td></tr>
<tr><td>CamTable4
MC_CAM_REF</td><td colspan="2">Reference to the cam 4</td><td></td><td>●</td></tr>
<tr><td rowspan="5">eSetCamTable
L_TT1P_CamTable</td><td colspan="2">Selection of a cam
Initial value: 1 (cam 1)</td><td rowspan="5"></td><td rowspan="5">●</td></tr>
<tr><td>1</td><td>Cam 1</td></tr>
<tr><td>2</td><td>Cam 2</td></tr>
<tr><td>3</td><td>Cam 3</td></tr>
<tr><td>4</td><td>Cam 4</td></tr>
<tr><td>xCamSequencer
BOOL</td><td>TRUE</td><td>Activate switching sequence for cams.
Cams are executed according to the switching sequence in the eCamSequenceMode parameter.</td><td></td><td>●</td></tr>
</table>

3.3.3 Outputs

Designator Data type	Description		Available in version Base	 State
xInternalControlActive BOOL	TRUE	The internal control of the axis is activated via the visualisation. (xEnableInternalControl input = TRUE)	●	●
eTMState L_TT1P_States	Current state of the technology module ▸ State machine (📖 27)		●	●
scStatusABC scStatus_ABC	Structure of the status data of the **L_MC1P_AxisBasicControl** function block		●	●
xError BOOL	TRUE	There is an error in the technology module.	●	●
xWarning BOOL	TRUE	There is a warning in the technology module.	●	●
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		●	●
scSignalFlow L_TT1P_scSF_FlexCam[Base/State]	Structure of the signal flow The data type depends on the version used (Base/State). ▸ Signal flow diagrams (📖 28)		●	●
xAxisEnabled BOOL	TRUE	The axis is enabled.	●	●
xDone BOOL	TRUE	The request/action has been completed successfully.	●	●
xBusy BOOL	TRUE	The request/action is currently being executed.	●	●
xIsHomed BOOL	TRUE	The axis has been referenced (reference known).	●	●
lrSetOffsetMasterOut LREAL	Position offset between the master axis position and the X position of the cam • Unit: units		●	●
lrSetOffsetSlaveOut LREAL	Position offset between the Y position and the slave axis position • Unit: units		●	●
xHwLimitSwitchPos BOOL	TRUE	The positive hardware limit switch has been reached or approached. • The xHwLimitPos input has to be connected to the digital input that is connected to the limit switch. • The xHWLimitPos input is also set to TRUE. • The drive is brought to a standstill with the deceleration set in the lrStopDec parameter. • The state changes to "ERROR" with the error message '20500' (HWLimitPos).	●	●
xHwLimitSwitchNeg BOOL	TRUE	The negative hardware limit switch has been reached or approached. • The xHwLimitNeg input has to be connected to the digital input that is connected to the limit switch. • The xHWLimitNeg input is also set to TRUE. • The drive is brought to a standstill with the deceleration set in the lrStopDec parameter. • The state changes to "ERROR" with the error message '20501' (HWLimitNeg).	●	●

Designator / Data type	Description		Available in version: Base	Available in version: State
xSwLimitEnabled BOOL	TRUE	Activate the monitoring of the software limit positions.	●	●
xSwLimitSwitchActive BOOL	TRUE	A software limit position has been reached or exceeded. • The drive is brought to a standstill with the deceleration set in the lrStopDec parameter. • The state changes to "ERROR" with error message '20306' (SWLimitPos) or '20307' (SWLimitNeg).	●	●
xCamSynchronised BOOL	TRUE	The Y axis is synchronised with the cam.	●	●
xAccDecSync BOOL	TRUE	The synchronisation function is active. The axis is synchronised or desynchronised (clutch opens or closes).	●	●
xEndOfProfile BOOL	TRUE	Last cycle in the current cam profile • The current values are extrapolated for detection. • The signal is applied for one clock cycle.	●	●
lrSetXPosOut LREAL	Position of the X axis from the cam • Unit: units		●	●
lrSetXVelOut LREAL	Velocity of the X axis from the cam • Unit: units/s		●	●
lrSetXAccOut LREAL	Acceleration of the X axis from the cam • Unit: units/s^2		●	●
lrSetYPosOut LREAL	Position of the Y axis from the cam • Unit: units		●	●
lrSetYVelOut LREAL	Speed of the Y axis from the cam • Unit: units/s		●	●
lrSetYAccOut LREAL	Acceleration of the Y axis from the cam • Unit: units/s^2		●	●
lrActSlavePos LREAL	Current position of the slave axis • Unit: units		●	●
lrActSlaveVel LREAL	Current velocity of the slave axis • Unit: units/s		●	●
lrSlaveMaxPos LREAL	Maximum position of the slave axis The calculation is carried out when the xCamBounds input is set to TRUE. • Unit: units		●	●
lrSlaveMinPos LREAL	Minimum position of the slave axis The calculation is carried out when the xCamBounds input is set to TRUE. • Unit: units		●	●
lrSlaveMaxVel LREAL	Maximum velocity of the slave axis This value will be reached if the master axis is executed in the lrMasterVelMax parameter with maximum speed. The calculation is carried out when the xCamBounds input is set to TRUE. • Unit: units/s		●	●
lrSlaveMaxAcc LREAL	Maximum acceleration of the slave axis This value will be reached if the master axis is executed in the lrMasterVelMax parameter with maximum speed and maximum acceleration in the lrMasterAccMax parameter. The calculation is carried out when the xCamBounds input is set to TRUE. • Unit: units/s^2		●	●

Designator Data type	Description		Available in version: Base	Available in version: State
eSetCamTableOut L_TT1P_CamTable	Currently switched cam			●
	1	Cam 1		
	2	Cam 2		
	3	Cam 3		
	4	Cam 4		
xCamSequencerActive BOOL	TRUE	Switching sequence for cams is active. Cams are executed according to the switching sequence in the eCamSequenceMode parameter.		●

3.3.4 Parameters

L_TT1P_scPar_FlexCam[Base/State]

The **L_TT1P_scPar_FlexCam[Base/State]** structure contains the parameters of the technology module.

Designator Data type	Description	Available in version Base	Available in version State
lrStopDec LREAL	Deceleration for the stop function and when hardware/software limit switches and the following error monitoring function are triggered • Unit: units/s^2 • Initial value: 10000	●	●
lrStopJerk 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/s^3 • Initial value: 100000	●	●
lrHaltDec LREAL	Deceleration for the holding function Specification of the maximum speed variation which is to be used for deceleration to standstill. • Unit: units/s^2 • Initial value: 3600 • Only positive values are permissible.	●	●
lrJerk LREAL	Jerk for compensation in the case of an offset value, clutch or holding function • Unit: units/s^3 • Initial value: 100000	●	●
lrJogJerk LREAL	Jerk for manual jog • Unit: units/s^3 • Initial value: 10000	●	●
lrJogVel LREAL	Maximum speed to be used for manual jog. • Unit: units/s • Initial value: 10	●	●
lrJogAcc LREAL	Acceleration for manual jog Specification of the maximum speed variation which is to be used for acceleration. • Unit: units/s^2 • Initial value: 100	●	●
lrJogDec LREAL	Deceleration for manual jog Specification of the maximum speed variation which is to be used for deceleration to standstill. • Unit: units/s^2 • Initial value: 100	●	●
lrHomePosition LREAL	Home position for a reference run (homing) • Unit: units • Initial value: 0	●	●
xUseHomeExtParameter BOOL	Selection of the homing parameters to be used • Initial value: FALSE 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.	●	●

<table>
<tr><th rowspan="2">Designator
Data type</th><th rowspan="2" colspan="2">Description</th><th colspan="2">Available in version</th></tr>
<tr><th>Base</th><th>State</th></tr>
<tr><td>scHomeExtTP
MC_TRIGGER_REF</td><td colspan="2">Transfer of an external touch probe event
• Only relevant for "external encoder" touch probe configuration.
• For describing the MC_TRIGGER_REF structure, see the MC_TouchProbe function block.</td><td>●</td><td>●</td></tr>
<tr><td rowspan="6">eSyncMode
L_TT1P_ClutchMode</td><td colspan="2">Mode for the clutch-in/declutch process
• Initial value: 0 (absolute)</td><td rowspan="6">●</td><td rowspan="6">●</td></tr>
<tr><td>0</td><td>absolute:
Immediate coupling; the slave position is set to the Y position.</td></tr>
<tr><td>1</td><td>relative:
Immediate coupling; the slave position is set to the Y position with a relative reference.</td></tr>
<tr><td>2</td><td>ramp_pos:
Path-based coupling to the cam</td></tr>
<tr><td>3</td><td>ramp_time:
Time-based coupling within a time slot</td></tr>
<tr><td>4</td><td>ramp_VelAcc:
Profile-based coupling via parameters lrSyncVel, lrSyncAcc, lrSyncDec, lrSyncJerk</td></tr>
<tr><td rowspan="4">eSyncDirection
L_TT1P_ClutchDirection</td><td colspan="2">Clutch-in direction relating to the movement of the master axis
• The coupling process is started when the master axis rotates in the valid direction.
• Initial value: 0 (mcCurrentDirection)</td><td rowspan="4">●</td><td rowspan="4">●</td></tr>
<tr><td>-1</td><td>mcNegativeDirection:
Clutch-in in negative direction of the master axis</td></tr>
<tr><td>0</td><td>mcCurrentDirection:
Clutch-in in both directions of the master axis</td></tr>
<tr><td>1</td><td>mcPositiveDirection:
Clutch-in in positive direction of the master axis</td></tr>
<tr><td>lrMasterSyncInDist
LREAL</td><td colspan="2">Distance of the clutch-in movement of the master axis in the path-based coupling mode (parameter eSyncMode = 2)
• Unit: units
• Initial value: 100</td><td>●</td><td>●</td></tr>
<tr><td>lrMasterSyncInPos
LREAL</td><td colspan="2">The master setpoint position in the path-based coupling mode (parameter eSyncMode = 2) from which the clutch is fully closed.
• Unit: units
• Initial value: 0</td><td>●</td><td>●</td></tr>
<tr><td>lrMasterSyncOutDist
LREAL</td><td colspan="2">Distance of the declutch movement of the master axis in the path-based coupling mode (parameter eSyncMode = 2)
• Unit: units
• Initial value: 100</td><td>●</td><td>●</td></tr>
<tr><td>lrSlaveSyncOutPos
LREAL</td><td colspan="2">Declutch setpoint position of the slave axis in the ...
• path-based coupling mode (parameter eSyncMode = 2)
• time-controlled coupling mode (eSyncMode = 3)
• profile-based coupling mode (eSyncMode = 4)
In this position, the slave axis is stopped when the declutch process has been completed.
• Unit: units
• Initial value: 0</td><td>●</td><td>●</td></tr>
<tr><td>lrSyncInTime
LREAL</td><td colspan="2">Duration of the clutch-in process in the time-based coupling mode (parameter eSyncMode = 3)
• Unit: s
• Initial value: 5</td><td>●</td><td>●</td></tr>
</table>

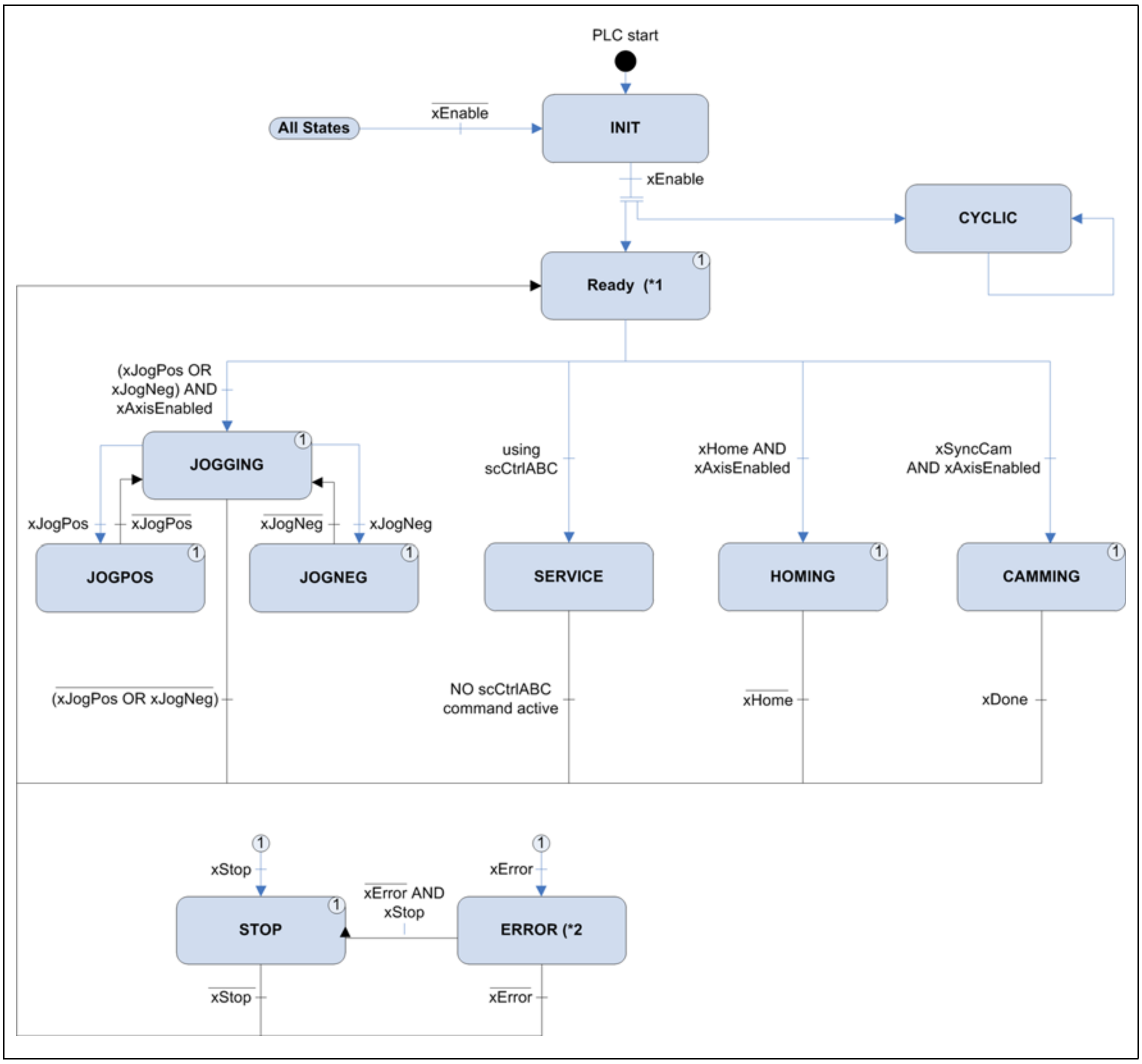
Designator Data type	Description	Available in version Base	 State
lrSyncOutTime LREAL	Duration of the declutch process in the time-based coupling mode (parameter eSyncMode = 3) • Unit: s • Initial value: 5	●	●
lrSyncOutInstantDec LREAL	Deceleration for declutching from the cam when the xSyncOutInstant input is set to TRUE. • Unit: units/s^2 • Initial value: 10000	●	●
lrSyncVel LREAL	Maximum speed at which the clutch-in/declutch process in mode eSyncMode = 4 (ramp_VelAc) is to be carried out. • Unit: units/s • Initial value: 100	●	●
lrSyncAcc LREAL	Acceleration for the clutch-in/declutch process in mode eSyncMode = 4 (ramp_VelAc) Specification of the maximum speed variation which is to be used for acceleration. • Unit: units/s^2 • Initial value: 1000	●	●
lrSyncDec LREAL	Deceleration for the clutch-in/declutch process in mode eSyncMode = 4 (ramp_VelAc) Specification of the maximum speed variation which is to be used for deceleration to standstill. • Unit: units/s^2 • Initial value: 1000	●	●
lrSyncJerk LREAL	Jerk for the clutch-in/declutch process in mode eSyncMode = 4 (ramp_VelAc) • Unit: units/s^3 • Initial value: 1000000	●	●
xCamCyclic REAL	TRUE: The cam is executed cyclically. (Initial value) FALSE: The cam is executed once.	●	●
xMasterAbsolute BOOL	Reference to the position of the master axis • Initial value: TRUE TRUE: Absolute reference between the position of the master axis and the cam FALSE: Relative reference between the position of the master axis and the cam	●	●
xSlaveAbsolute REAL	Reference to the position of the slave axis • Initial value: TRUE TRUE: Absolute reference between the position of the slave axis and the cam FALSE: Relative reference between the position of the slave axis and the cam (initial value)	●	●
eOffsetModeMaster L_TT1P_OffsetMode	Mode for accepting the offset for the master axis (input lrSetOffsetMaster) • Initial value: 0 (x_zero) 0: x_zero: Acceptance of the offset in the "zero crossing" of the cam 1: direct: Immediate acceptance of the offset 2: ramp_in: Acceptance of the offset via the ramp generator with the parameters lrOffsetScalingVel, lrOffsetScalingAcc, lrOffsetScalingDec, and lrJerk	●	●

Designator Data type	Description		Available in version Base	Available in version State
eOffsetModeSlave L_TT1P_OffsetMode	Mode for accepting the offset for the slave axis (input lrSetOffsetSlave) • Initial value: 0 (x_zero)		●	●
	0	x_zero: Acceptance of the offset in the "zero crossing" of the cam		
	1	direct: Immediate acceptance of the offset		
	2	ramp_in: Acceptance of the offset via the ramp generator with the parameters lrOffsetScalingVel, lrOffsetScalingAcc, lrOffsetScalingDec, and lrJerk		
lrOffsetScalingMasterVel LREAL	Limitation of the speed for compensating an offset and scaling change • Unit: units/s • Initial value: 100		●	●
lrOffsetScalingMasterAcc LREAL	Limitation of the acceleration for compensating an offset and scaling change • Unit: units/s^2 • Initial value: 1000		●	●
lrOffsetScalingMasterDec LREAL	Limitation of the deceleration for compensating an offset and scaling change • Unit: units/s^2 • Initial value: 1000		●	●
eScalingModeMaster L_TT1P_ScalingMode	Mode for accepting the scaling factor for the master axis (input lrSetScalingMaster) • Initial value: 0 (x_zero)		●	●
	0	x_zero: Scaling in the "zero crossing" of the cam		
	1	absolute: Absolute scaling of the position		
	2	relative: Relative scaling of the position, absolute scaling of the speed		
	3	ramp_absolute: Absolute scaling of the position via the ramp generator with the parameters lrOffsetScalingVel, lrOffsetScalingAcc, lrOffsetScalingDec, and lrJerk		
	4	ramp_relative: Relative scaling of the position via the ramp generator with the parameters lrOffsetScalingVel, lrOffsetScalingAcc, lrOffsetScalingDec, and lrJerk		

Designator / Data type	Description		Available in version: Base	Available in version: State
eScalingModeSlave L_TT1P_ScalingMode	Mode for accepting the scaling factor for the slave axis (input lrSetScalingSlave) • Initial value: 0 (x_zero)		●	●
	0	x_zero: Scaling in the "zero crossing" of the cam		
	1	absolute: Absolute scaling of the position		
	2	relative: Relative scaling of the position, absolute scaling of the speed		
	3	ramp_absolute: Absolute scaling of the position via the ramp generator with the parameters lrOffsetScalingVel, lrOffsetScalingAcc, lrOffsetScalingDec, and lrJerk		
	4	ramp_relative: Relative scaling of the position via the ramp generator with the parameters lrOffsetScalingVel, lrOffsetScalingAcc, lrOffsetScalingDec, and lrJerk		
lrOffsetScalingSlaveVel LREAL	Limitation of the speed for compensating an offset and scaling change • Unit: units/s • Initial value: 100		●	●
lrOffsetScalingSlaveAcc LREAL	Limitation of the acceleration for compensating an offset and scaling change • Unit: units/s^2 • Initial value: 1000		●	●
lrOffsetScalingSlaveDec LREAL	Limitation of the deceleration for compensating an offset and scaling change • Unit: units/s^2 • Initial value: 1000		●	●
xCalcCamBounds BOOL	TRUE	Extreme values of the slave axis (lrSlaveMaxPos, lrSlaveMinPos, lrSlaveMaxVel, lrSlaveMaxAcc) are calculated as a function of the parameters lrMasterMaxVel and lrMasterMaxAcc.	●	●
lrMasterMaxVel LREAL	Maximum speed of the master axis for checking the cams • Unit: unit/s • Initial value: 100		●	●
lrMasterMaxAcc LREAL	Maximum acceleration of the master axis for checking the cams • Unit: units/s^2 • Initial value: 1000		●	●
ePosCtrlDirection L_TT1P_Direction	Direction select for the ramp generator of the X axis and the clutch to the position • Initial value: 0 (both)			●
	0	Both: The slave axis may travel in positive and negative direction. Reversing of the X axis is permissible.		
	1	Master direction: The slave axis may only travel in the same direction as the master axis.		

<table>
<tr><th rowspan="2">Designator
Data type</th><th rowspan="2" colspan="2">Description</th><th colspan="2">Available in version</th></tr>
<tr><th>Base</th><th>State</th></tr>
<tr><td rowspan="5">eCamSequenceMode
L_TT1P_CamSequenceMode</td><td colspan="2">Switching sequence of the cams
The switching sequence is enabled via the xCamSequencer input
• Initial value: 0 (execute cam 1 cyclically)</td><td rowspan="5"></td><td rowspan="5">●</td></tr>
<tr><td>0</td><td>Execute cam 1 cyclically</td></tr>
<tr><td>1</td><td>Execute cam 3 cyclically</td></tr>
<tr><td>2</td><td>• xCamSequncer = TRUE:
cam 1 → execute cam 3 cyclically
• xCamSequncer = FALSE:
cam 3 → cam 1</td></tr>
<tr><td>3</td><td>• xCamSequncer = TRUE:
cam 1 → cam 2 → execute cam 3 cyclically
• xCamSequncer = FALSE:
cam 3 → cam 4 → cam 1</td></tr>
</table>

3.4 State machine



[3-2] State machine of the technology module

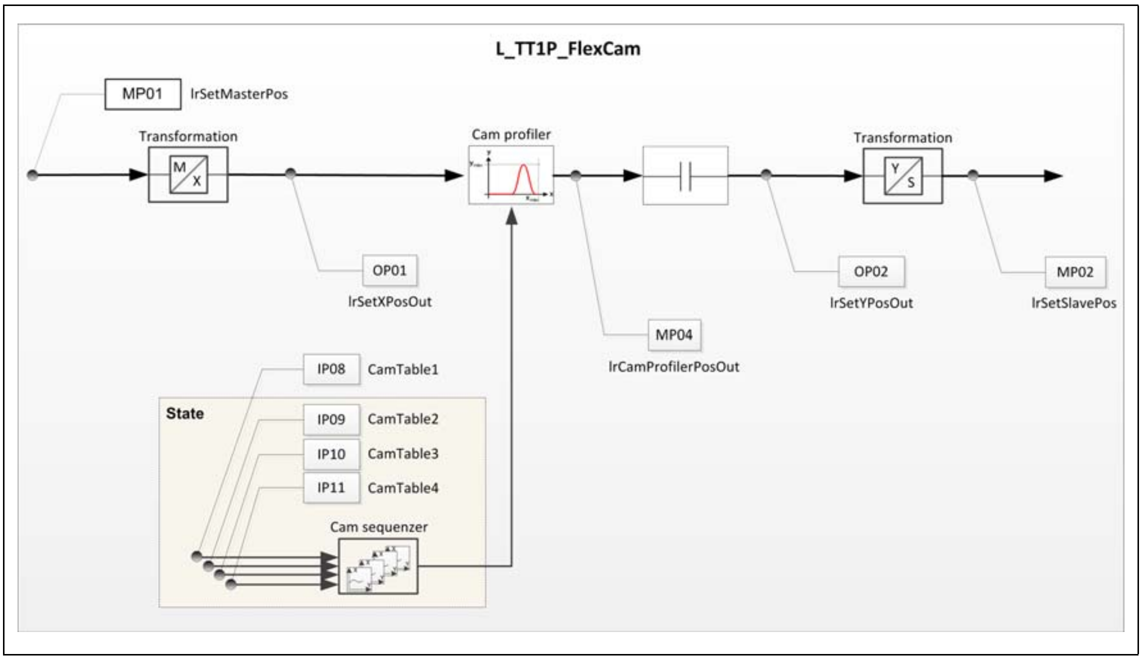
(*1 In the "Ready" state, xRegulatorOn has to be set to TRUE.

(*2 In the "ERROR" state, xResetError has to be set to TRUE in order to acknowledge and reset the errors.

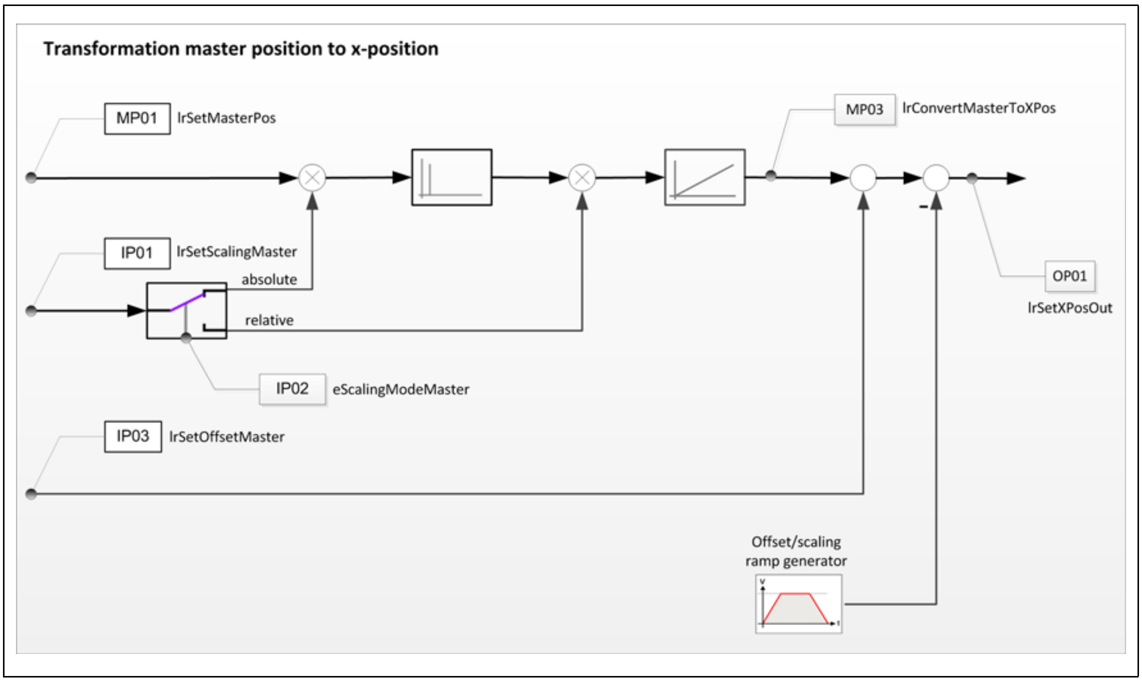
3.5 Signal flow diagrams

The illustrations show the main signal flow of the functions implemented.

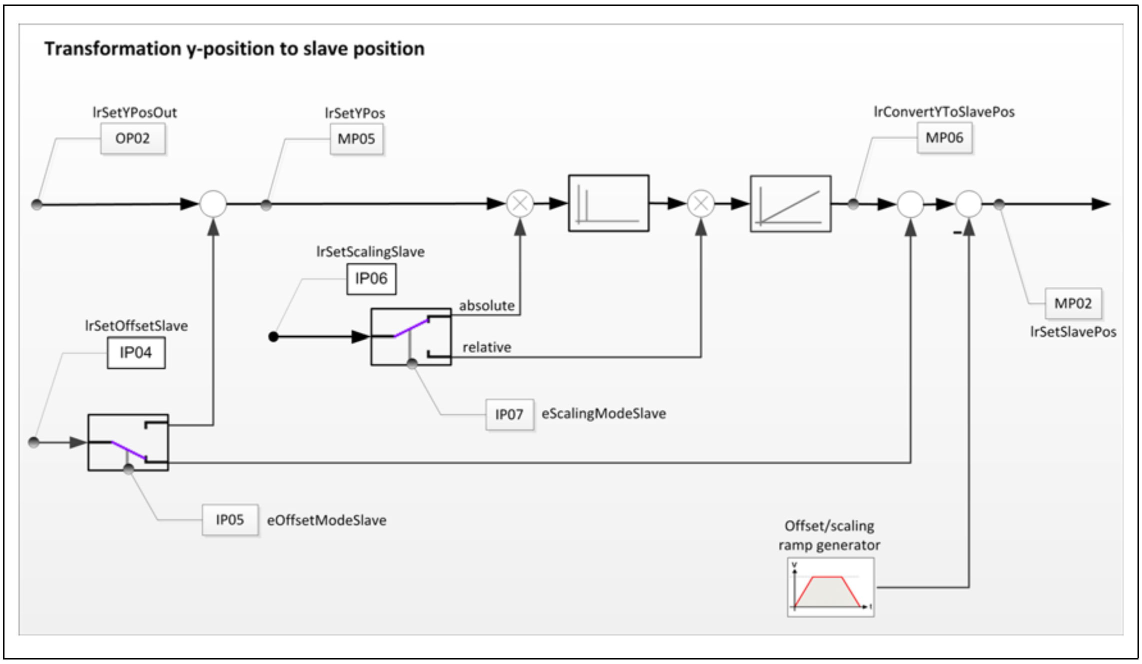
The signal flow of the additional functions such as "manual jog" is not displayed here.



[3-3] Signal flow: Flex Cam



[3-4] Signal flow: conversion from the master axis position to the X position



[3-5] Signal flow: conversion from the Y position to the slave axis position

3.5.1 Structure of the signal flow

L_TT1P_scSF_FlexCam[Base/State]

The contents of the **L_TT1P_scSF_FlexCam[Base/State]** structure are read-only and offer a practical diagnostics option within the signal flow (Signal flow diagrams (📖 28)).

<table>
<tr><th rowspan="2">Designator
Data type</th><th rowspan="2" colspan="2">Description</th><th colspan="2">Available in version</th></tr>
<tr><th>Base</th><th>State</th></tr>
<tr><td>IP01_lrSetScalingMaster
LREAL</td><td colspan="2">Scaling factor of the master axis
The resulting X position of the cam is produced by multiplication of the master axis position with the "lrSetScalingMaster" X scaling factor.
Negative values are not permitted.
• Initial value: 1</td><td>●</td><td>●</td></tr>
<tr><td rowspan="6">IP02_eScalingModeMaster
L_TT1P_ScalingMode</td><td colspan="2">Mode for accepting the scaling factor for the master axis (input lrSetScalingMaster)
• Initial value: 0</td><td rowspan="6">●</td><td rowspan="6">●</td></tr>
<tr><td>0</td><td>x_zero:
Scaling in the "zero crossing" of the cam</td></tr>
<tr><td>1</td><td>absolute:
Absolute scaling of the position</td></tr>
<tr><td>2</td><td>relative:
Relative scaling of the position, absolute scaling of the speed</td></tr>
<tr><td>3</td><td>ramp_absolute:
Absolute scaling of the position via the ramp generator with the parameters lrOffsetScalingVel, lrOffsetScalingAcc, lrOffsetScalingDec, and lrJerk</td></tr>
<tr><td>4</td><td>ramp_relative:
Relative scaling of the position via the ramp generator with the parameters lrOffsetScalingVel, lrOffsetScalingAcc, lrOffsetScalingDec, and lrJerk</td></tr>
<tr><td>IP03_lrSetOffsetMaster
LREAL</td><td colspan="2">Position offset of the master axis
The resulting X position of the cam is produced by addition of the master axis position to the "lrSetOffsetMaster" offset.
• Unit: units
• Initial value: 0</td><td>●</td><td>●</td></tr>
<tr><td>IP04_lrSetOffsetSlave
LREAL</td><td colspan="2">Position offset of the slave axis
The resulting position of the slave axis is produced by addition of the Y position and the "lrSetOffsetSlave" offset.
• Unit: units
• Initial value: 0</td><td>●</td><td>●</td></tr>
<tr><td rowspan="4">IP05_eOffsetModeSlave
L_TT1P_OffsetMode</td><td colspan="2">Mode for accepting the offset for the slave axis (input lrSetOffsetSlave)
• Initial value: 0</td><td rowspan="4">●</td><td rowspan="4">●</td></tr>
<tr><td>0</td><td>x_zero:
Acceptance of the offset in the "zero crossing" of the cam</td></tr>
<tr><td>1</td><td>direct:
Immediate acceptance of the offset</td></tr>
<tr><td>2</td><td>ramp_in:
Acceptance of the offset via the ramp generator with the parameters lrOffsetScalingVel, lrOffsetScalingAcc, lrOffsetScalingDec, and lrJerk</td></tr>
</table>

Designator / Data type	Description		Available in version: Base	Available in version: State
IP06_lrSetScalingSlave LREAL	Scaling factor of the slave axis The resulting extended/compressed Y setpoint position is produced by multiplication of the Y cam value with the "lrSetScalingSlave" Y scaling factor. Negative values are not permitted. • Initial value: 1		●	●
IP07_eScalingModeSlave L_TT1P_ScalingMode	Mode for accepting the scaling factor for the slave axis (input lrSetScalingSlave) • Initial value: 0		●	●
	0	x_zero: Scaling in the "zero crossing" of the cam		
	1	absolute: Absolute scaling of the position		
	2	relative: Relative scaling of the position, absolute scaling of the speed		
	3	ramp_absolute: Absolute scaling of the position via the ramp generator with the parameters lrOffsetScalingVel, lrOffsetScalingAcc, lrOffsetScalingDec, and lrJerk		
	4	ramp_relative: Relative scaling of the position via the ramp generator with the parameters lrOffsetScalingVel, lrOffsetScalingAcc, lrOffsetScalingDec, and lrJerk		
IP08_CamTable1 MC_CAM_REF	Reference to the cam 1		●	●
IP09_CamTable2 MC_CAM_REF	Reference to the cam 2			●
IP10_CamTable3 MC_CAM_REF	Reference to the cam 3			●
IP11_CamTable4 MC_CAM_REF	Reference to the cam 4			●
MP01_lrSetMasterPos LREAL	Set position of the master axis • Unit: units		●	●
MP02_lrSetSlavePos LREAL	Set position of the slave axis • Unit: units		●	●
MP03_lrConvertMasterToXPos LREAL	Calculated position of the X axis • Unit: units		●	●
MP04_lrCamProfilerPosOut LREAL	Y position from the cam generator • Unit: units		●	●
MP05_lrSetYPos LREAL	Resulting position of the Y axis • Unit: units		●	●
MP06_lrConvertYToSlavePos LREAL	Calculated position of the slave axis • Unit: units		●	●
OP01_lrSetXPosOut LREAL	Position of the X axis from the cam • Unit: units		●	●
OP02_lrSetYPosOut LREAL	Position of the Y axis from the cam • Unit: units		●	●

3.6 Manual jog (jogging)

Precondition

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

Execution

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

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

The current travel command cannot be replaced by another jog command. Only if both inputs have been reset, the State machine (📖 27) changes to the "Ready" state again.

Parameters to be set

The parameters for the manual jog are located in the L_TT1P_scPar_FlexCam[Base/State] (📖 21) parameter structure.

```
lrJogVel : LREAL := 10;       // Velocity [units/s]
lrJogAcc : LREAL := 100;      // Acceleration [units/s^2]
lrJogDec : LREAL := 100;      // Deceleration [units/s^2]
lrJogJerk : LREAL := 10000;   // Jerk [units/s^3]
```

The parameter values can be changed during operation. They are accepted when the *xJogPos* or *xJogNeg* input is set to TRUE again.

3.7 Homing

Precondition

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

Execution

Homing is started with a rising edge (FALSE↗TRUE) at the *xHomeExecute* input. The axis will be travelling until the home position is reached. After successful homing, the State machine (📖 27) changes back again 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* input.

Parameters to be set

The parameters for homing are located in the L_TT1P_scPar_FlexCam[Base/State] (📖 21) parameter structure.

```
xUseHomeExtParameter : BOOL := FALSE;
lrHomePosition : LREAL := 0.0;
scHomeExtParameter : L_MC1P_HomeParameter;
scHomeExtTP : MC_TRIGGER_REF;
```

3.8 Cam formats (cam handling)

The input format for the cam is defined in the **MC_CAM_REF** function block. This facilitates handling the cam data. An additional use of the **MC_CamTableSelect** function block is not required.

Cams from the »Cam Editor« are supported.

- Data model: segments or point table
- Law of motion: line (linear), polynomial of the fifth degree

Note!

During the travel process of a cam, the interpolation points within the structure must not be changed.

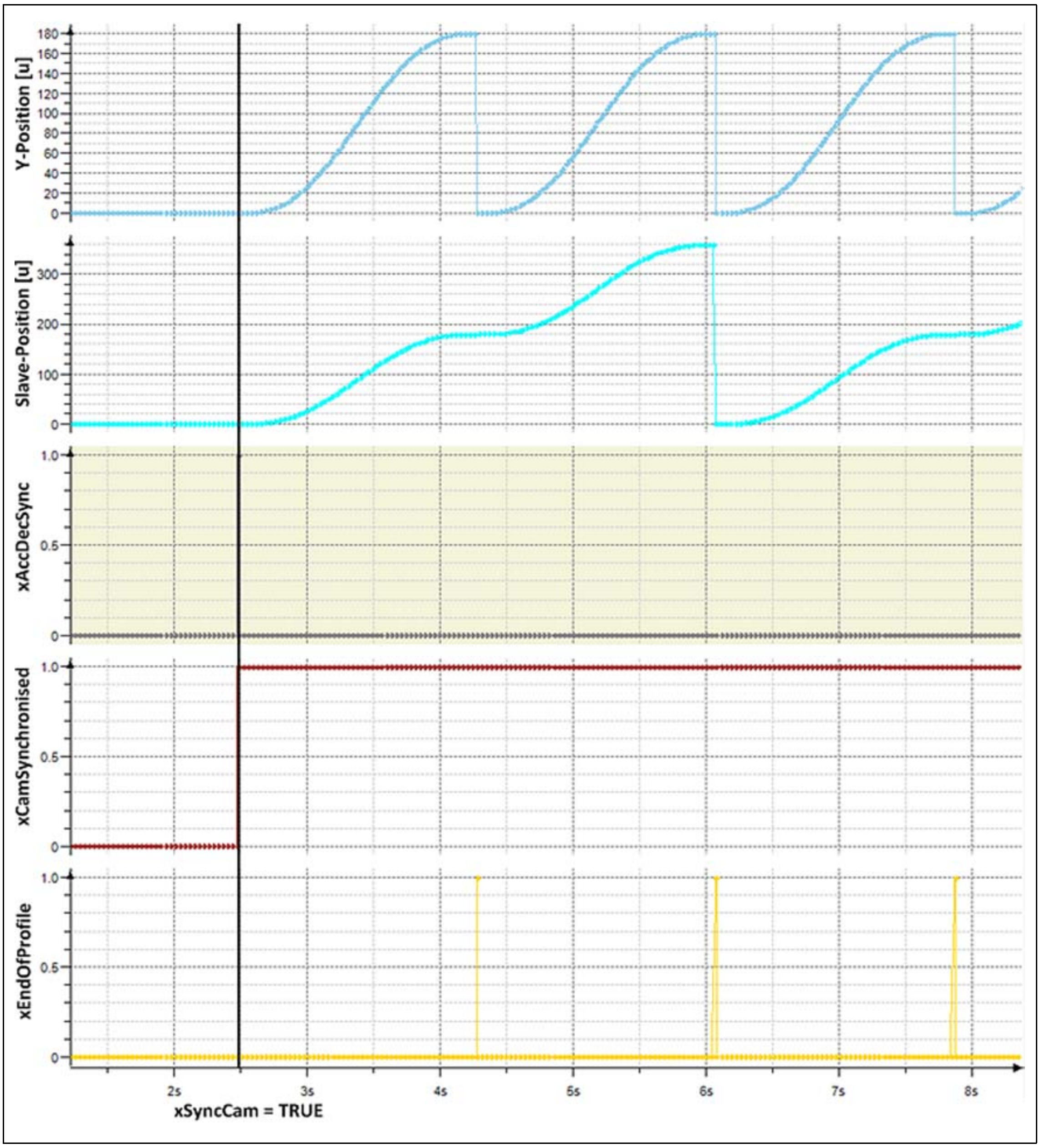
The cam data, basic conditions, or interpolation points are not copied internally, but are directly used for motion control by the technology module. Changing the data has a direct impact on the currently active cam.

3.9 Executing the cam cyclically

With the parameter *xCamCyclic* = TRUE, the cams are executed cyclically in succession.

If the position of the master axis is outside the defined range of the X axis, it is included in the calculation of the cam, i.e. from the 2nd cam onwards the reference to the master position is relative.

In this way, cam-dependent cycle lengths can be implemented without having to adapt the "external" modulo cycle length of the master axis. However, in this case, the absolute assignment between the master pulse and the profile pulse gets lost.

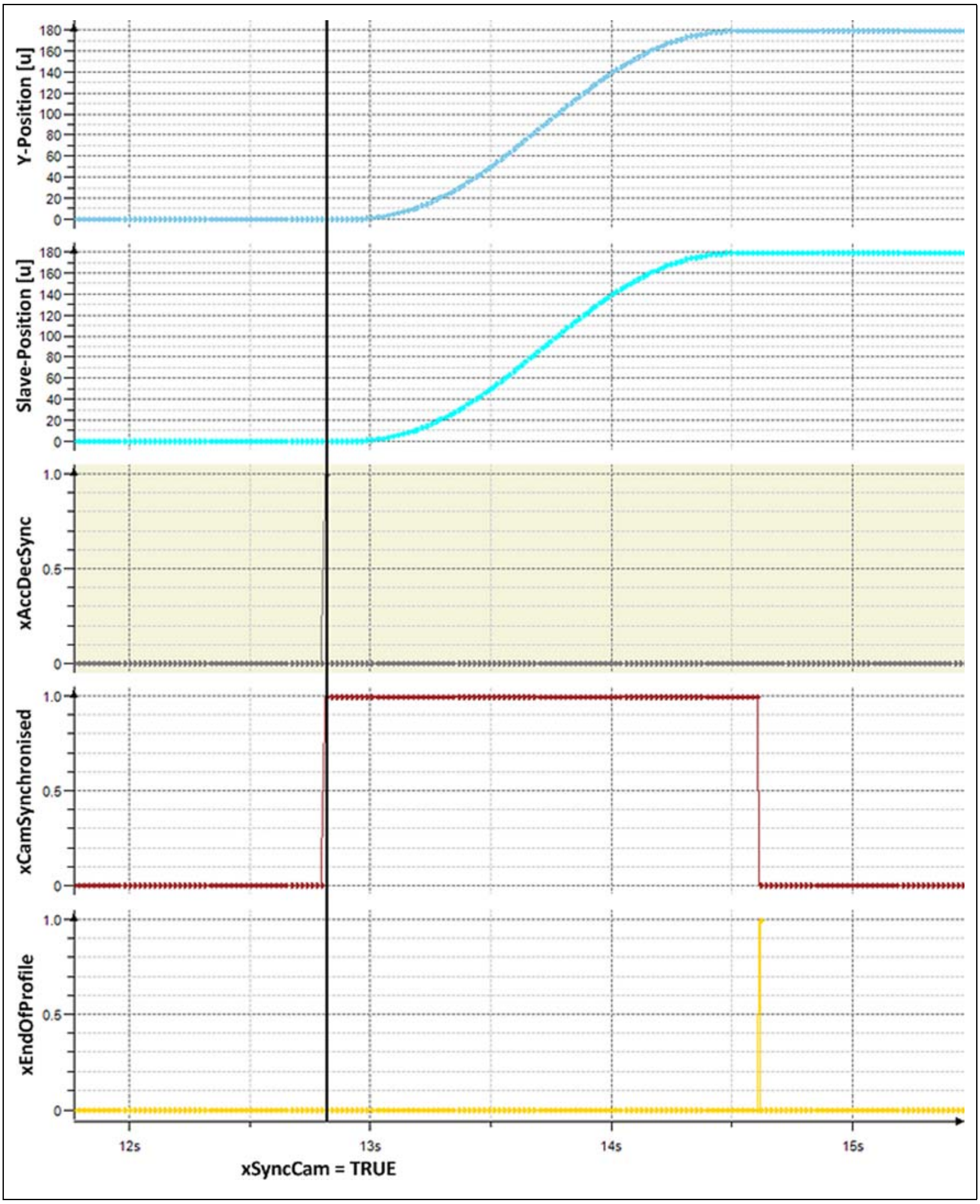


[3-6] Characteristic: Executing the cam cyclically

3.10 Executing the cam once

With the parameter *xCamCyclic* = FALSE, the cam is executed once.

If the master position is outside the cam defined, the last valid value is output.



[3-7] Characteristic: Executing the cam once

3.11 Executing the master axis with cams of variable cycle lengths

The master axis has a constant cycle length. In order to be able to execute cams with variable cycle lengths, a technology module-internal X axis with variable cycle lengths is used.

The X axis is coupled with the master axis via the parameters speed, acceleration and jerk. In order to establish the reference of the position between the X axis and the master axis, the *xMasterAbsolute* parameter is used. This always refers to the first start/cycle of the currently active cam:

- *xMasterAbsolute* = FALSE

  The X position of the cam is executed in a way that is relative with regard to the master position.

  For this purpose, the starting point of the X axis is set to the start of the cam when the cam is activated. In this way, cam-dependent cycle lengths can be implemented without having to adapt the "external" modulo cycle length of the master axis. However, the absolute assignment of the master cycle and the cam X cycle gets lost.

- *xMasterAbsolute* = TRUE

  The master position is included directly in the cam calculation.

  For this purpose, the X position is directly set to the master position when the cam is activated. The cycle assignment between the master cycle and the cam X cycle is always maintained if the X cycle length of the modulo cycle length corresponds to the master axis.

  If the X cycle length is set so that it does not equal the modulo cycle length of the master axis, the relative reference to the master axis is set automatically after the first cam cycle (see above, *xMasterAbsolute* = FALSE).

3.12 Executing the slave axis with cams of variable cycle lengths

The slave axis has a constant cycle length. In order to be able to execute cams with variable cycle lengths, a technology module-internal Y axis with variable cycle lengths is used.

The slave axis is coupled with the Y axis via the parameters speed, acceleration and jerk. In order to establish the reference of the position between the Y axis and the slave axis, the *xSlaveAbsolute* parameter is used. This always refers to the first start/cycle of the currently active cam:

- *xSlaveAbsolute* = FALSE

  When the cam is activated for the first time, an internal offset is set between the current slave position and the Y starting position. This activates the cam without any step changes of the slave axis. Cam-dependent cycle lengths can be implemented without having to adapt the "external" modulo cycle length of the slave axis. However, in this case, the absolute assignment between the slave cycle and the Y cycle of the cam gets lost.
- *xSlaveAbsolute* = TRUE

  The position of the slave axis is set to the Y position from the cam.

  During the second cam cycle, the position of the slave axis is calculated in a manner that is relative to the Y axis. The cycle assignment between the cam Y cycle and the slave axis modulo cycle is always maintained if the Y cycle length corresponds to the modulo cycle length of the slave axis.

  If the Y cycle length is set so that it does not equal the modulo cycle length of the slave axis, the relative reference to the slave axis is set automatically after the first cam cycle (see above, *xMasterAbsolute* = FALSE).

3.13 Change of cam

Note!

During the travel process of a cam, the interpolation points within the structure must not be changed.

The cam data, basic conditions, or interpolation points are not copied internally, but are directly used for motion control by the technology module. Changing the data has a direct impact on the currently active cam.

If the cam is changed at the *CamTable1* input during operation, this change is only accepted at the cam end of the slave axis after the *xEndOfProfile* output has been set to TRUE. The cam end is the end point of the cam at which the Y-side end point ends in the representation. Therefore it is ensured that the cam is always switched over at the Y-side cam end, even with an X offset available.

A plausibility check as to whether the cams are fitting together is not carried out and must be ensured by the user.

Via input *xCamChangeInstant* = TRUE, an immediate cam change can be forced. When a change-over is active, the data of the new cam are accepted immediately. A repeated coupling process does not take place.

3.14 Clutching in to the cam

The clutch-in process of the slave axis to the position of the cam (resulting Y position of the cam including the Y offset and Y scaling) is carried out by input *xSyncCam* = TRUE.

Changes in the Y offset or the Y scaling factor during the clutch-in process are not accepted. These parameters are internally "frozen" at the start of the clutch-in process and are only re-enabled when the slave axis is successfully coupled to the Y position of the cam.

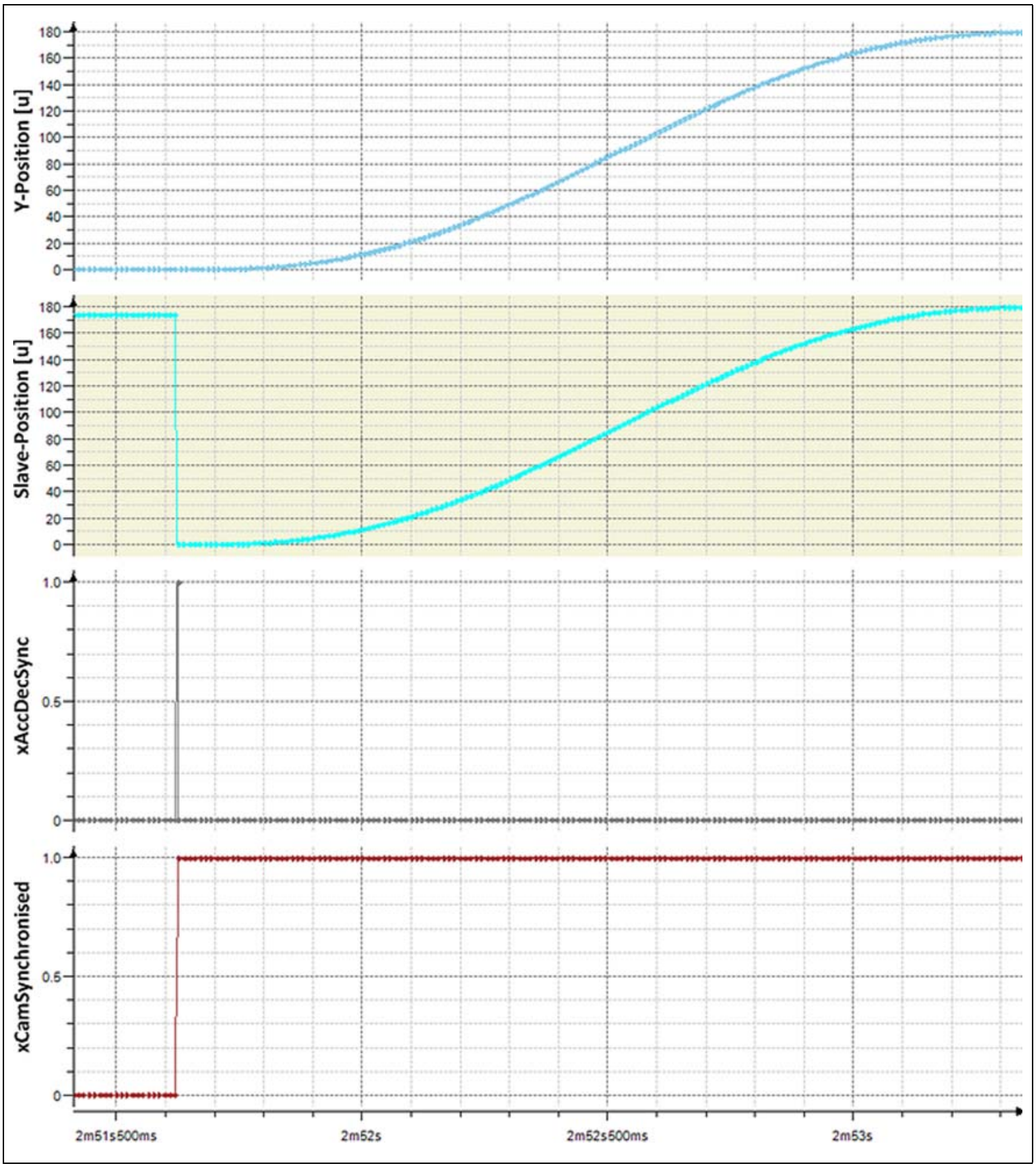
For the clutch-in process, the coupling mode can be defined via the *eSyncMode* parameter in the L_TT1P_scPar_FlexCam[Base/State] (🕮 21) parameter structure:

Coupling mode eSyncMode	More information
0 (absolute)	Clutching-in with "absolute" coupling mode (🕮 41)
1 (relative)	Clutching-in with "relative" coupling mode (🕮 42)
2 (ramp_pos)	Clutching-in with "ramp_pos" coupling mode (🕮 43)
3 (ramp_time)	Clutching-in with "ramp_time" coupling mode (🕮 46)
4 (ramp_VelAcc)	Clutching-in with "ramp_VelAcc" coupling mode (🕮 48)

3.14.1 Clutching-in with "absolute" coupling mode

The position, speed, and acceleration of the slave axis are set directly to the resulting Y position of the cam.

In order to avoid irregularities in the drive movement, the slave axis first must be traversed to the resulting Y position of the cam, or it has to be there already. If this cannot be ensured, an alternative coupling mode must be set.



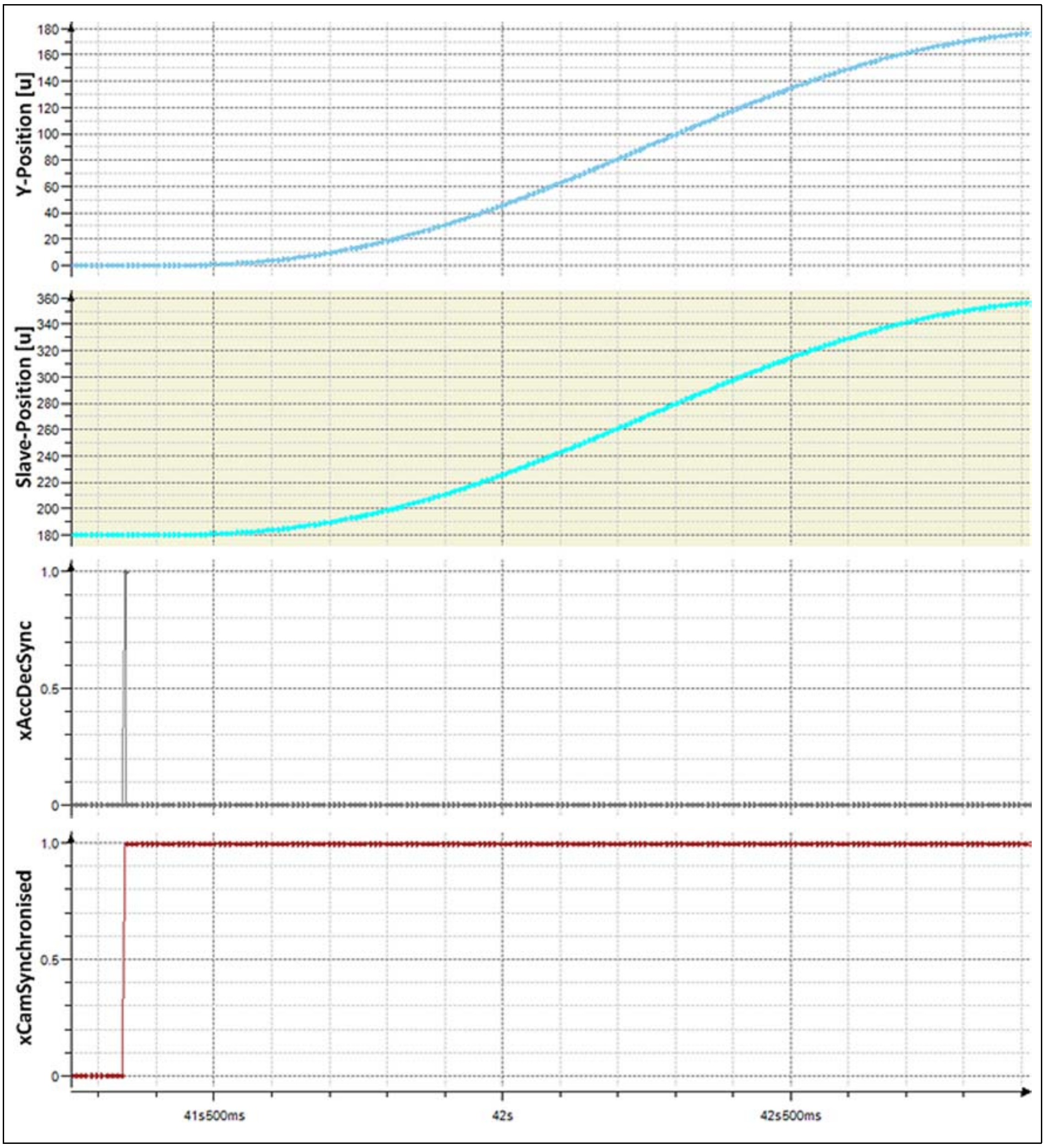
[3-8] Characteristic: clutch-in process with eSyncMode = 0 (absolute)

3.14.2 Clutching-in with "relative" coupling mode

The position, speed, and acceleration of the slave axis are set directly to the resulting Y position of the cam.

In contrast to the "absolute" mode, the slave axis does not have to be located in the resulting Y position of the cam. This brings about an offset between the position of the slave axis and the resulting Y position of the cam.

In order to avoid irregularities in the drive movement, the master axis must be at a standstill during the clutch-in process.



[3-9] Characteristic: clutch-in process with eSyncMode = 1 (relative)

3.14.3 Clutching-in with "ramp_pos" coupling mode

The slave axis is positioned to the resulting Y position of the cam in a path-based fashion via a polynomial of the fifth degree.

In this mode, the slave axis can synchronise to a cam movement that is already running, providing the possibility that the clutch-in process takes several cam cycles, the transition to cam operation taking a bit longer.

Via the *eSyncDirection* parameter, the clutch-in direction relating to the direction of rotation of the master axis is set.

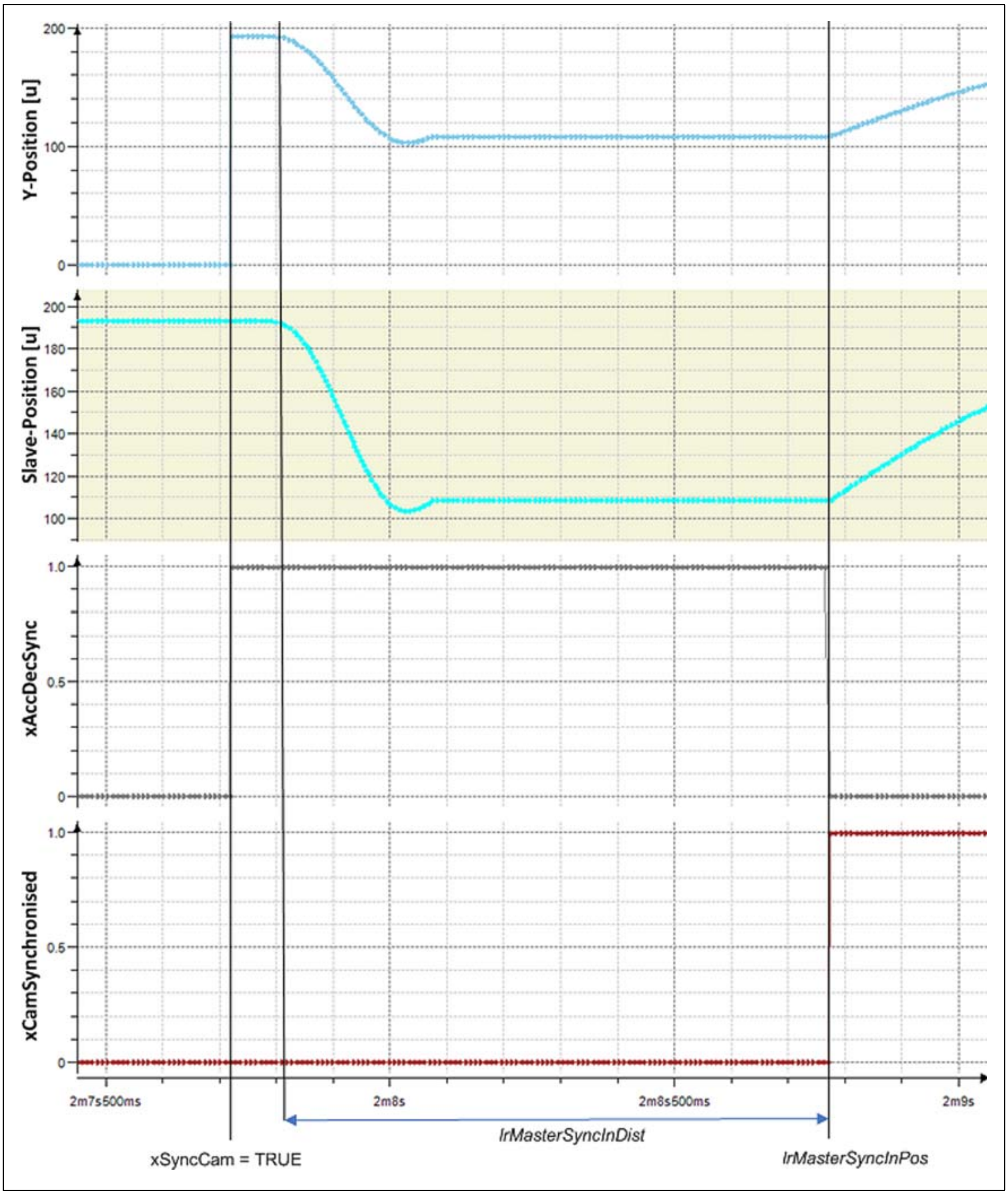
The *lrMasterSyncInPos* parameter determines the position of the master axis from which the slave axis is to be synchronised.

The *lrMasterSyncInDist* parameter is used to define the distance of the master axis over which the slave axis is traversed to the curve position. The slave axis can only be synchronised to the Y position of the cam whilst the master axis is running.

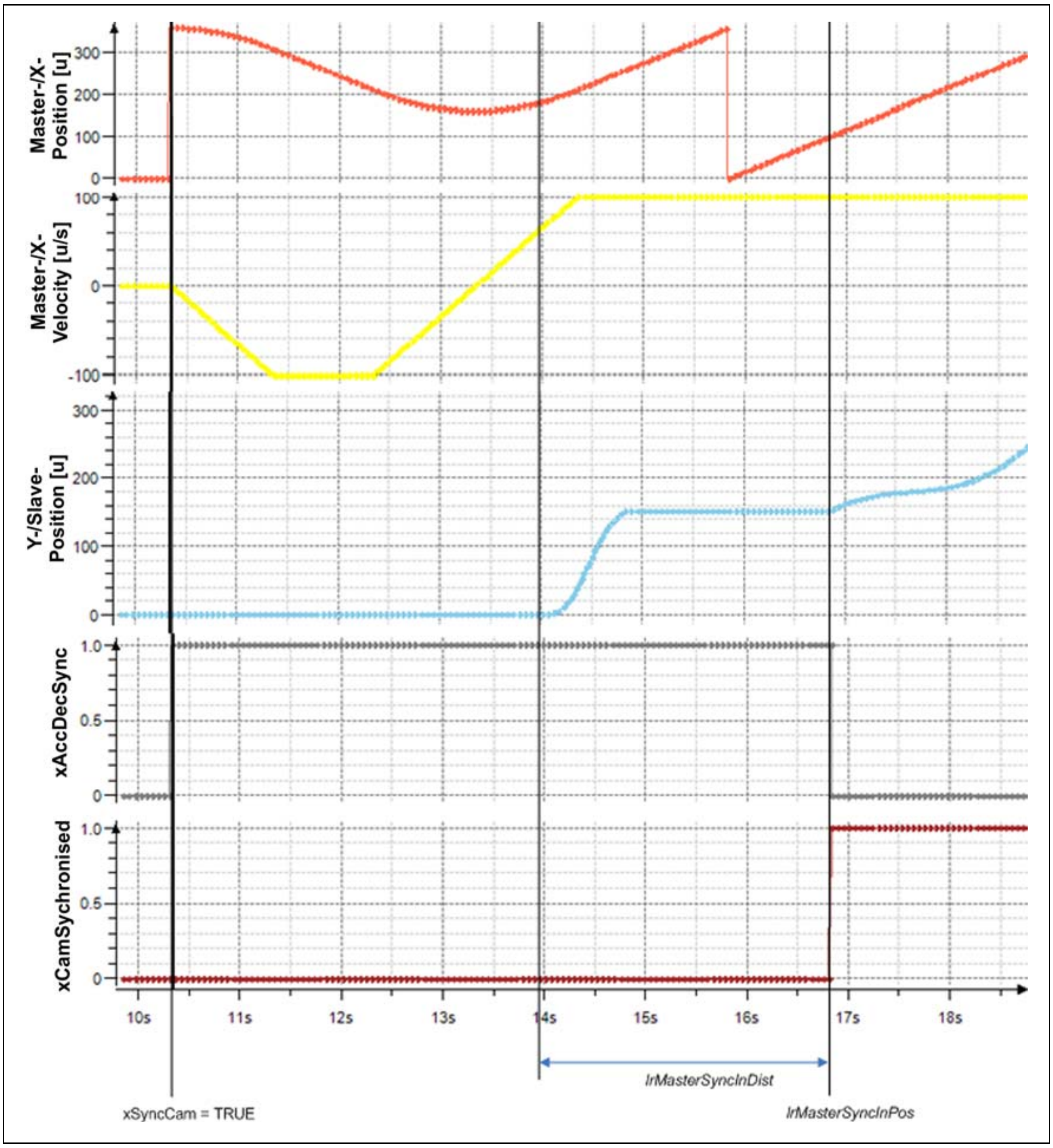
Parameters to be set

The parameters to be set are located in the L_TT1P_scPar_FlexCam[Base/State] (21) parameter structure.

```
eSyncMode : L_TT1P_SyncMode := 2;
eSyncDirection : L_TT1P_SyncDirection := 0;  // [mcCurrentDirection]
lrMasterSyncInPos : LREAL := 0;
lrMasterSyncInDist : LREAL := 100;
```



[3-10] Characteristic: clutch-in process with eSyncMode = 2 (ramp_pos)



[3-11] Characteristic: clutch-in process with eSyncMode = 2 (ramp_pos) and eSyncDirection = 1 (positive direction)

3.14.4 Clutching-in with "ramp_time" coupling mode

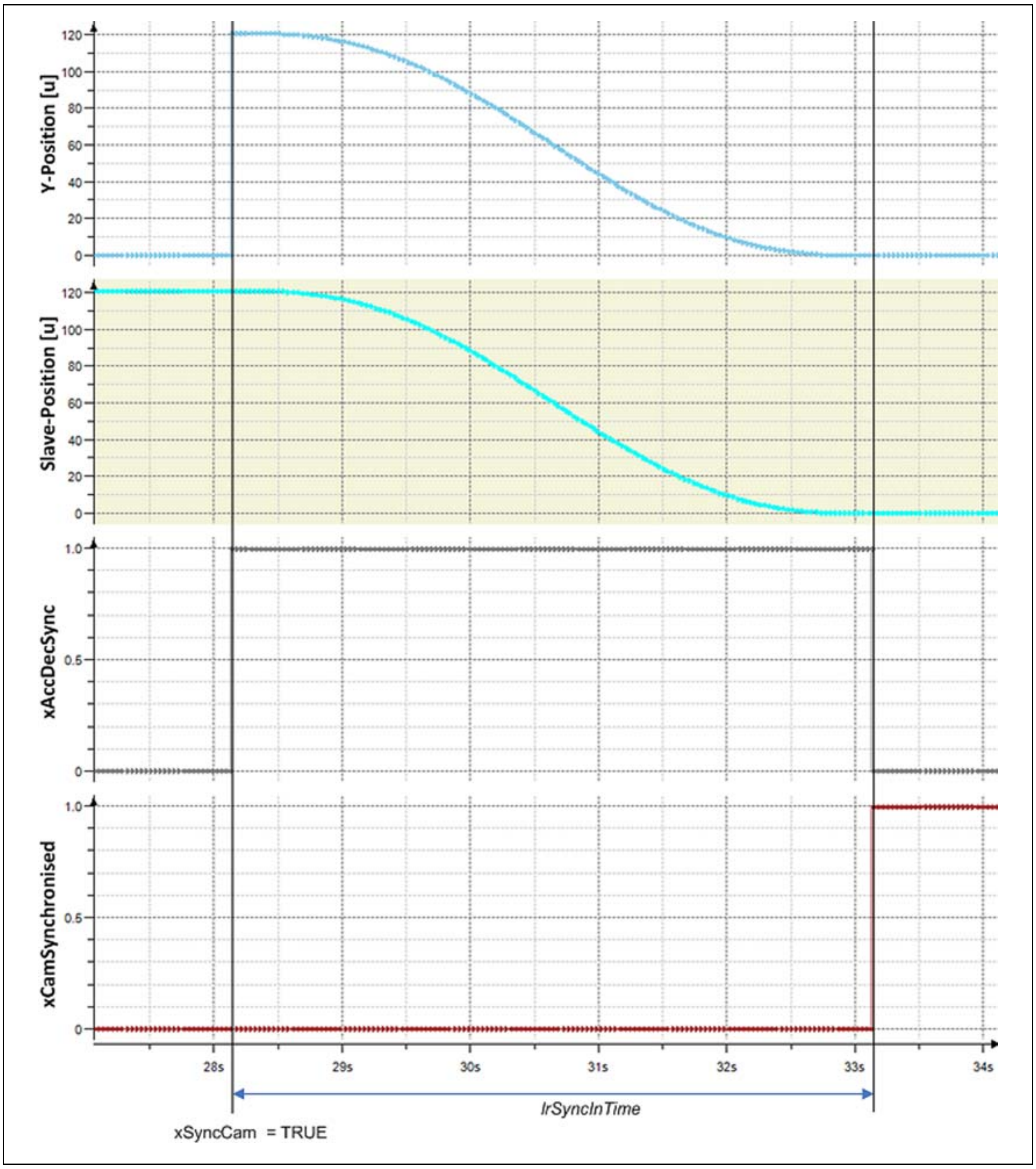
The slave axis clutches in to the resulting Y position of the cam from its current position via a polynomial of the fifth degree within a defined time (parameter *lrSyncInTime*). The movement is executed within the cycle of the modulo axes.

This coupling mode is irrespective of the movement of the master axis. The slave axis is also synchronised to the Y position of the cam whilst the master axis is at a standstill.

Parameters to be set

The parameters to be set are located in the L_TT1P_scPar_FlexCam[Base/State] (📖 21) parameter structure.

```
eSyncMode : L_TT1P_SyncMode := 3;
eSyncDirection : L_TT1P_SyncDirection := 0;  // [mcCurrentDirection]
lrSyncInTime : LREAL := 5;
```



[3-12] Characteristic: clutch-in process with eSyncMode = 3 (ramp_time)

3.14.5 Clutching-in with "ramp_VelAcc" coupling mode

The slave-axis clutches in from its current position to the resulting Y position of the cam via the profile generator and using parameters *lrSyncVel*, *lrSyncAcc*, *lrSyncDec* and *lrSyncJerk*.

The movement is executed for the modulo axes within the cycle.

The resulting speed of the slave axis in the clutch-in phase results from the sum of the cam speed and the speed in parameter *lrSyncVel*.

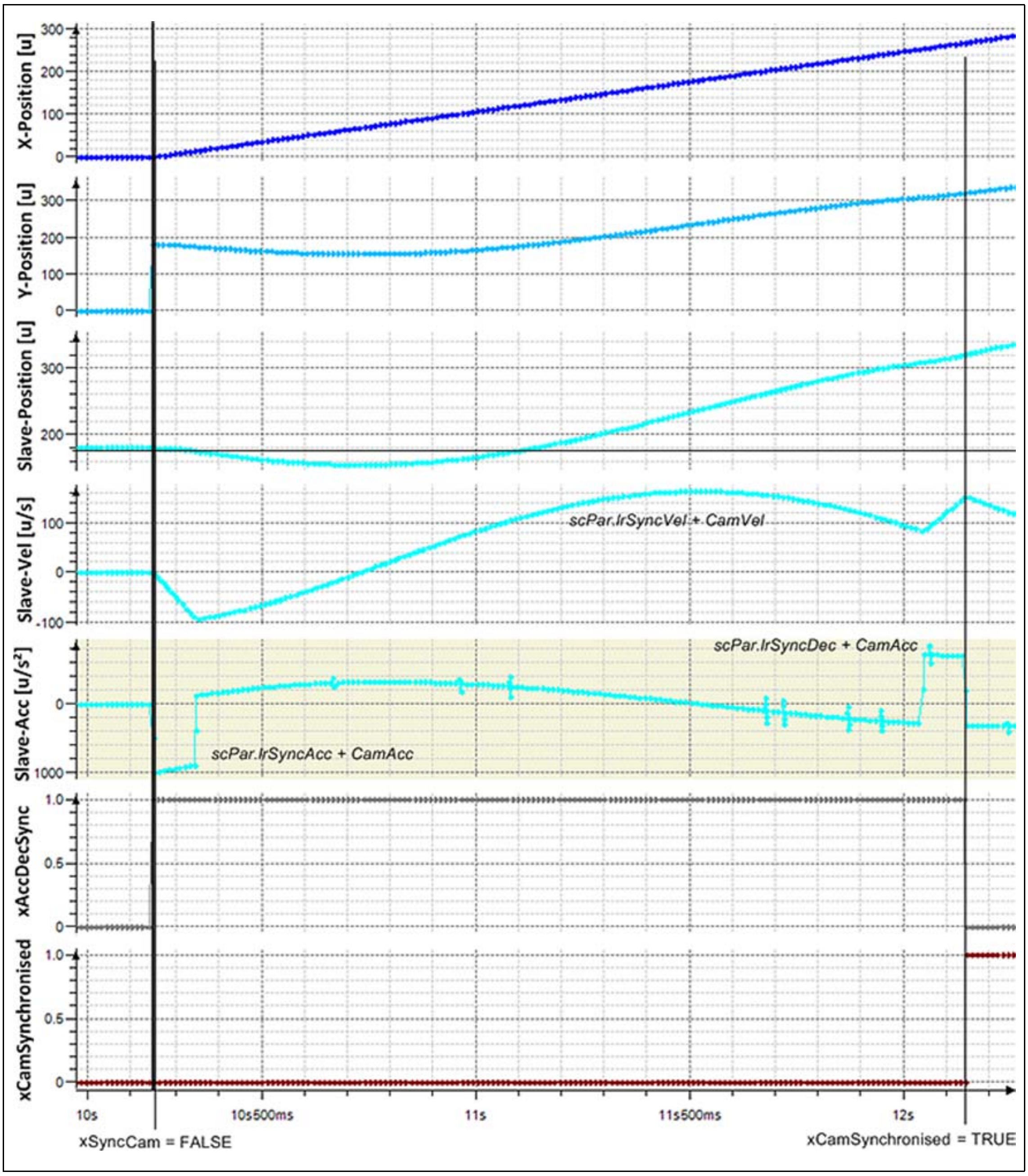
The acceleration of the slave axis in the clutch-in phase also results from the sum of the cam acceleration and the acceleration and deceleration of the clutch (parameters *lrSyncAcc*, *lrSyncDec*).

This coupling mode is irrespective of the movement of the master axis. The slave axis is also synchronised to the Y position of the cam when the master axis is at standstill.

Parameters to be set

The parameters to be set are located in the L_TT1P_scPar_FlexCam[Base/State] (📖 21) parameter structure.

```
eSyncMode : L_TT1P_SyncMode := 4;
lrSyncVel : LREAL := 100;
lrSyncAcc : LREAL := 1000;
lrSyncDec : LREAL := 1000;
lrSyncJerk : LREAL := 100000;
```



[3-13] Characteristic: clutch-in process with eSyncMode = 4 (ramp_VelAcc)

3.15 Declutching from the cam

The declutch process of the slave axis from the current position of the cam is executed using the input *xSyncCam* = FALSE.

Via the *eSyncMode* parameter, the coupling mode for the declutch process can be defined in the L_TT1P_scPar_FlexCam[Base/State] (📖 21) parameter structure:

Coupling mode eSyncMode	More information
0 (absolute)	▶ Declutching in the "absolute"/"relative" coupling mode (📖 50)
1 (relative)	
2 (ramp_pos)	▶ Declutching in the "ramp_pos" coupling mode (📖 50)
3 (ramp_time)	▶ Declutching in the "ramp_time" coupling mode (📖 52)
4 (ramp_VelAcc)	▶ Declutching in the "ramp_VelAcc" coupling mode (📖 54)

3.15.1 Declutching in the "absolute"/"relative" coupling mode

The coupling to the master axis is removed immediately with the input *xSyncCam* = FALSE.

The position of the slave axis is "frozen"; the slave speed and acceleration are set to zero.

In order to avoid step changes, the Y position of the cam or the master axis/X axis has to be at a standstill (e.g. over a resting phase in the curve progression).

3.15.2 Declutching in the "ramp_pos" coupling mode

The position-controlled declutch process at the running cam takes place with a polynomial of the fifth degree with the input *xSyncCam* = FALSE.

In this mode, declutching can only be executed whilst the master axis is running. The declutch process can take several cycles.

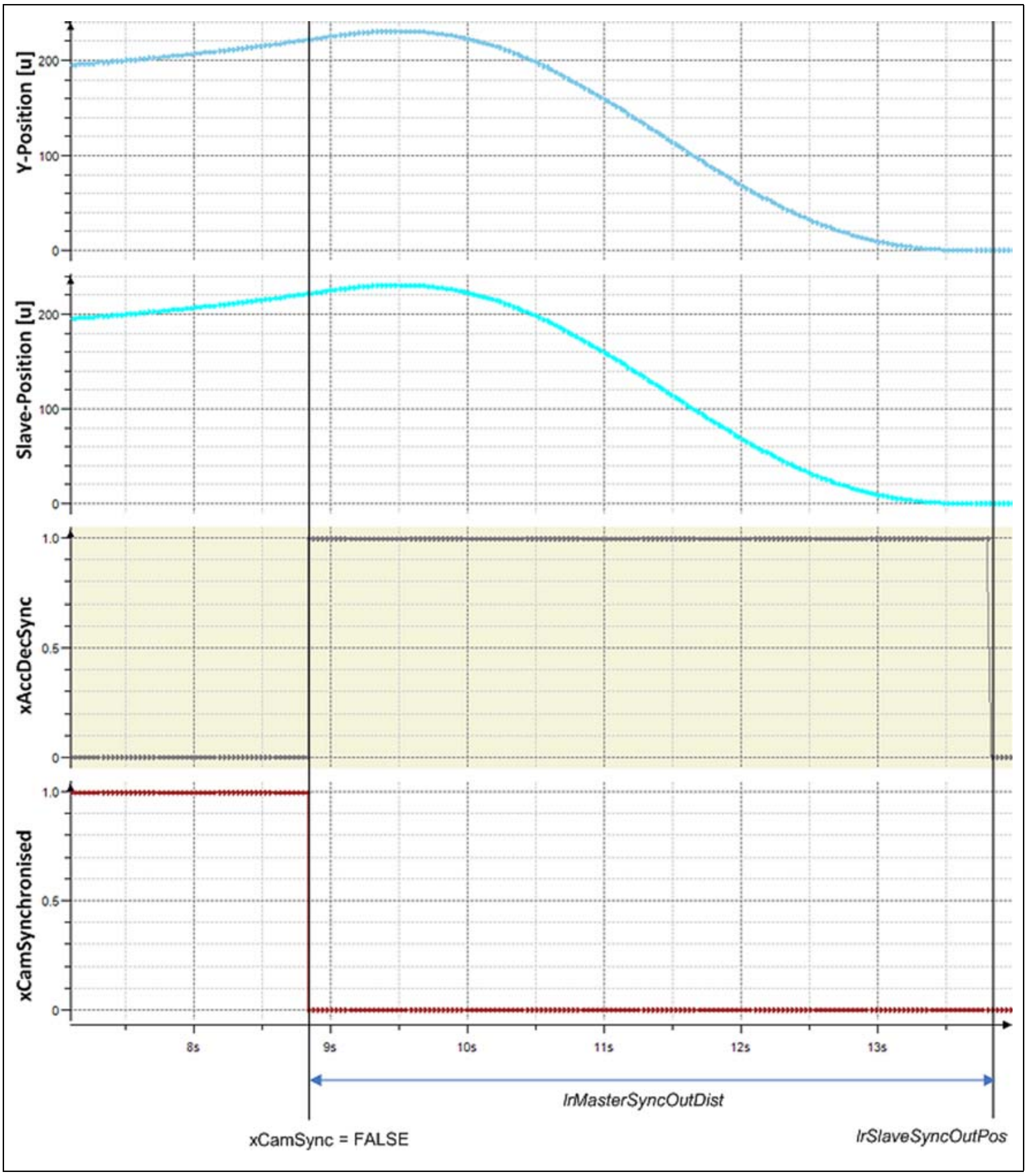
By means of the *lrMasterSyncOutDist* parameter, the braking distance of the master axis is defined, producing the position in which the slave axis releases from the cam.

The *lrSlaveSyncOutPos* parameter defines the position from which the slave axis is to be at standstill.

Parameters to be set

The parameters to be set are located in the L_TT1P_scPar_FlexCam[Base/State] (📖 21) parameter structure.

```
eSyncMode : L_TT1P_SyncMode := 2;
lrMasterSyncOutDist : LREAL := 0;
lrSlaveSyncOutPos : LREAL := 100;
```



[3-14] Characteristic: declutch process with eSyncMode = 2 (ramp_pos)

3.15.3 Declutching in the "ramp_time" coupling mode

With the input *xSyncCam* = FALSE, the slave axis is disengaged from the current Y position of the cam within the defined time in the *lrSyncOutTime* parameter.

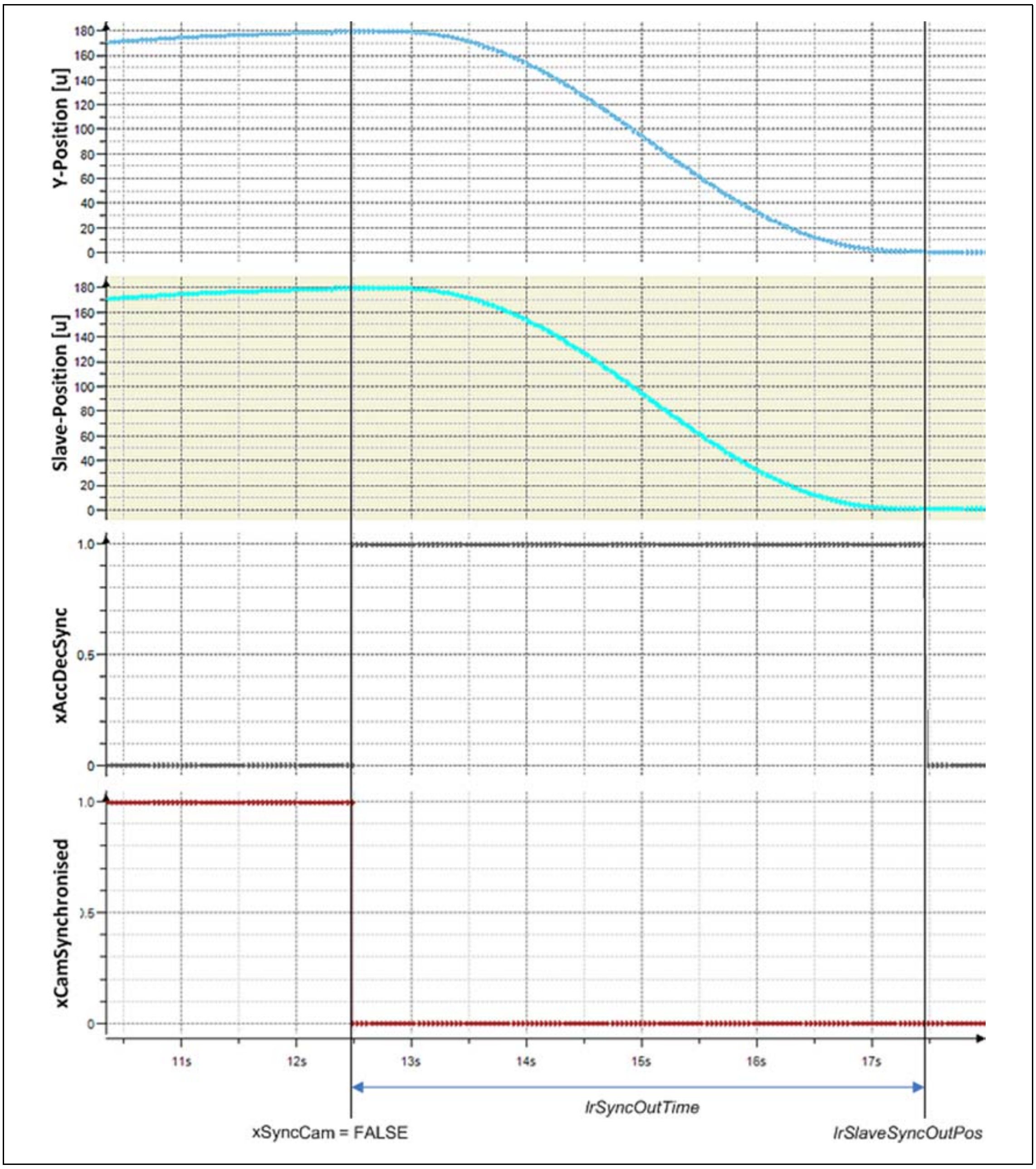
The *lrSlaveSyncOutPos* parameter defines the position from which the slave axis is to be at standstill.

This coupling mode is irrespective of the movement of the master axis.

Parameters to be set

The parameters to be set are located in the L_TT1P_scPar_FlexCam[Base/State] (🕮 21) parameter structure.

```
eSyncMode : L_TT1P_SyncMode := 3;
lrSyncOutTime : LREAL := 5;
lrSlaveSyncOutPos : LREAL := 100;
```



[3-15] Characteristic: declutch process with eSyncMode = 3 (ramp_time)

3.15.4 Declutching in the "ramp_VelAcc" coupling mode

With input *xSyncCam* = FALSE, the slave axis is declutched in a profile-controlled fashion from the current Y position of the cam, bringing the slave axis to standstill using parameters *lrSyncVel*, *lrSyncAcc*, *lrSyncDec* and *lrSyncJerk*.

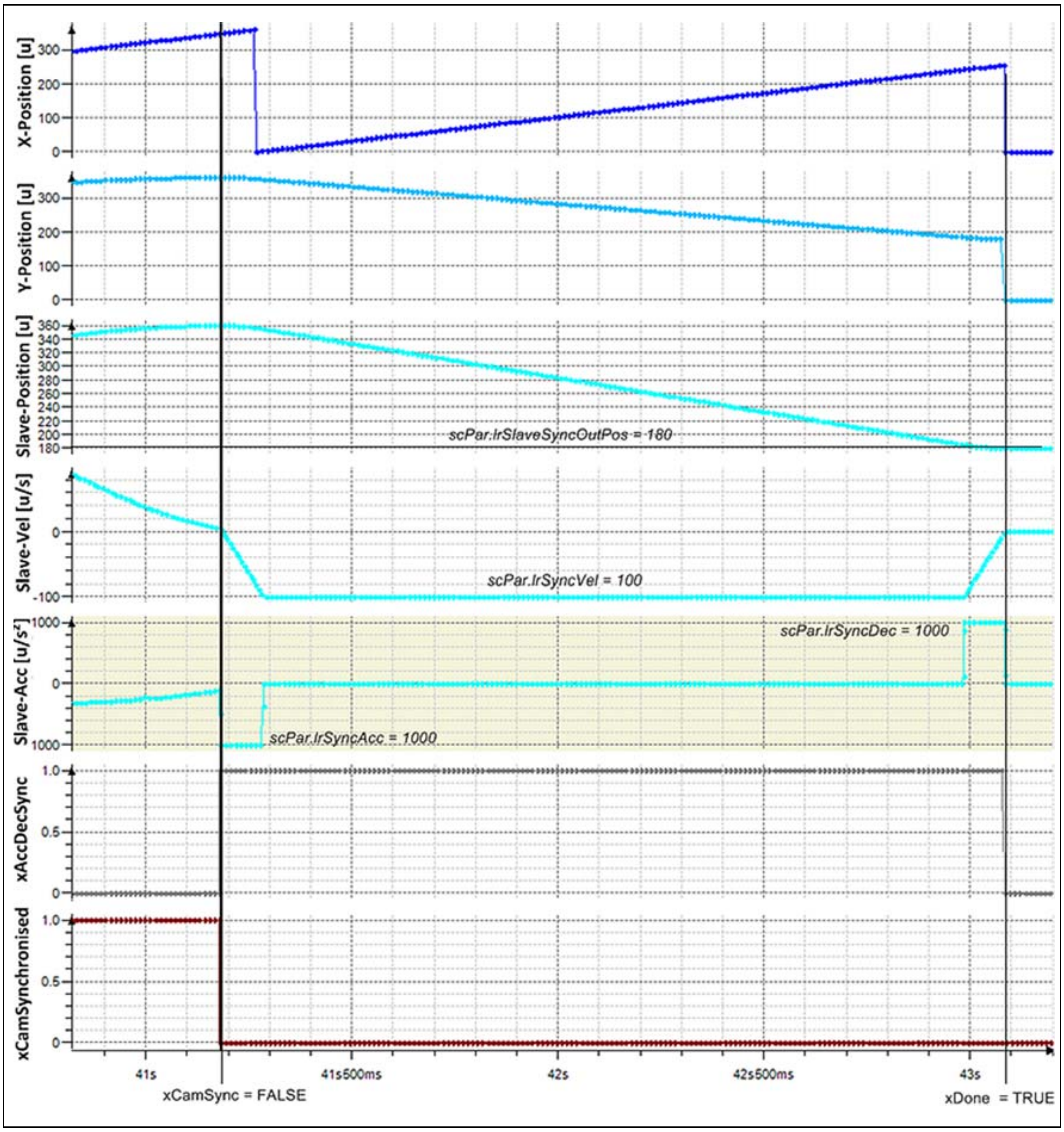
The *lrSlaveSyncOutPos* parameter defines the position from which the slave axis is to be at standstill.

This coupling mode is irrespective of the movement of the master axis.

Parameters to be set

The parameters to be set are located in the L_TT1P_scPar_FlexCam[Base/State] (📖 21) parameter structure.

```
eSyncMode : L_TT1P_SyncMode := 4;
lrSlaveSyncOutPos : LREAL := 100;
lrSyncVel : LREAL := 100;
lrSyncAcc : LREAL := 1000;
lrSyncDec : LREAL := 1000;
lrSyncJerk : LREAL := 100000;
```



[3-16] Characteristic: declutch process with eSyncMode = 4 (ramp_VelAcc)

3.16 Positive opening operation / Emergency opening operation

The input *xSyncOutInstant* = TRUE serves to immediately declutch and stop the slave axis via the deceleration specified in the *lrSyncOutInstantDec* parameter at the current curve position.

The clutch remains open as long as the input *xSyncOutInstant* is set to TRUE. The *xSyncOutInstant* input has a higher priority than the *xSyncCam* input.

The *lrSyncOutInstantDec* parameter can be found in the L_TT1P_scPar_FlexCam[Base/State] (🕮 21) parameter structure.

3.17 Scaling of the cam

The cam is scaled by the use of scaling factors via the inputs *lrSetScalingMaster* and *lrSetScalingSlave*.

The setting of the *lrSetScalingMaster* input has the effect that the X axis is extended or compressed with regard to the master axis. Via the *lrSetScalingSlave* input, the slave axis is extended or compressed with regard to the Y axis. The scaling factors do not have any impact on the length/cycle length of the cams and the axes.

The selection of the mode for accepting the scaling factors for the master axis is set via the *eScalingModeMaster* parameter, and for the slave axis via the *eScalingModeSlave* parameter.

Setting/mode in: eScalingModeMaster eScalingModeSlave	**Description**
0 (x_zero)	Standard setting: The scaling factors are accepted in the "zero crossing" of the cam. The "zero crossing" is defined as a starting point of a cam if the direction of rotation of the master is positive, or as an end point of a cam if the direction of rotation of the master is negative.
1 (absolute)	Absolute scaling of the position The scaling factors are accepted immediately after they have been selected or changed. A direct selection or change of the scaling factors causes a step change of the setpoint position even if the axes are at standstill.
2 (relative)	Relative scaling of the position, absolute scaling of the speed The scaling factors are accepted immediately after they have been selected or changed. A direct selection or change of the scaling factors causes a step change of the setpoint position even if the axes are at standstill.
3 (ramp_absolute)	Absolute Scaling of the position via the ramp generator (🕮 60) with the parameters lrOffsetScalingVel, lrOffsetScalingAcc, lrOffsetScalingDec, and lrJerk
4 (ramp_relative)	Relative Scaling of the position via the ramp generator (🕮 60) with the parameters lrOffsetScalingVel, lrOffsetScalingAcc, lrOffsetScalingDec, and lrJerk

3.17.1 Arithmetic examples: absolute and relative scaling factors on the part of the master axis

Clock cycle: Scaling factor:	t = 0 lrSetScalingMaster = 1		t = 1 lrSetScalingMaster = 2		t = 2 lrSetScalingMaster = 1	
Absolute scaling factors						
Axis	Master	X axis	Master	X axis	Master	X axis
Position	100	100	101	202	102	102
Velocity	1000	1000	1000	2000	1000	1000
Acceleration	0	0	0	0	0	0
Relative scaling factors						
Axis	Master	X axis	Master	X axis	Master	X axis
Position	100	100	101	102	102	103
Velocity	1000	1000	1000	2000	1000	1000
Acceleration	0	0	0	0	0	0
Absolute scaling factors without an absolute assignment between the master and cam cycle						
Axis	Master	X axis	Master	X axis	Master	X axis
Position	100	53	101	108	102	55
Velocity	1000	1000	1000	2000	1000	1000
Acceleration	0	0	0	0	0	0
Relative scaling factors without an absolute assignment between the master and cam cycle						
Axis	Master	X axis	Master	X axis	Master	X axis
Position	100	53	101	55	102	56
Velocity	1000	1000	1000	2000	1000	1000
Acceleration	0	0	0	0	0	0

3.17.2 Arithmetic examples: absolute and relative scaling factors on the part of the slave axis

Clock cycle: **Scaling factor:**	**t = 0** **lrSetScalingSlave = 1**		**t = 1** **lrSetScalingSlave = 2**		**t = 2** **lrSetScalingSlave = 1**	
Absolute scaling factors						
Axis	Y axis	Slave	Y axis	Slave	Y axis	Slave
Position	100	100	101	202	102	102
Velocity	1000	1000	1000	2000	1000	1000
Acceleration	0	0	0	0	0	0
Relative scaling factors						
Axis	Y axis	Slave	Y axis	Slave	Y axis	Slave
Position	100	100	101	102	102	103
Velocity	1000	1000	1000	2000	1000	1000
Acceleration	0	0	0	0	0	0
Absolute scaling factors <u>without</u> an absolute assignment between the master and cam cycle						
Axis	Y axis	Slave	Y axis	Slave	Y axis	Slave
Position	100	50	101	152	102	52
Velocity	1000	1000	1000	2000	1000	1000
Acceleration	0	0	0	0	0	0
Relative scaling factors <u>without</u> an absolute assignment between the master and cam cycle						
Axis	Y axis	Slave	Y axis	Slave	Y axis	Slave
Position	100	50	101	52	102	53
Velocity	1000	1000	1000	2000	1000	1000
Acceleration	0	0	0	0	0	0

3.17.3 Scaling of the position via the ramp generator

In order to be able to internally change the scaling factors continuously in spite of an erratic change in value at the inputs *lrSetScalingMaster* or *lrSetScalingSlave*, ramp generators can be used: ramp modes "3 (ramp_absolute)" and "4 (ramp_relative)" in the *eScalingModeMaster* or *eScalingModeSlave* parameter.

A ramp generator carries out a compensating movement via a ramp function between the last and the new scaling factor. If the scaling factor is changed again during the compensating movement of the ramp generator, the ramp generator carries out a new compensating movement with the current value.

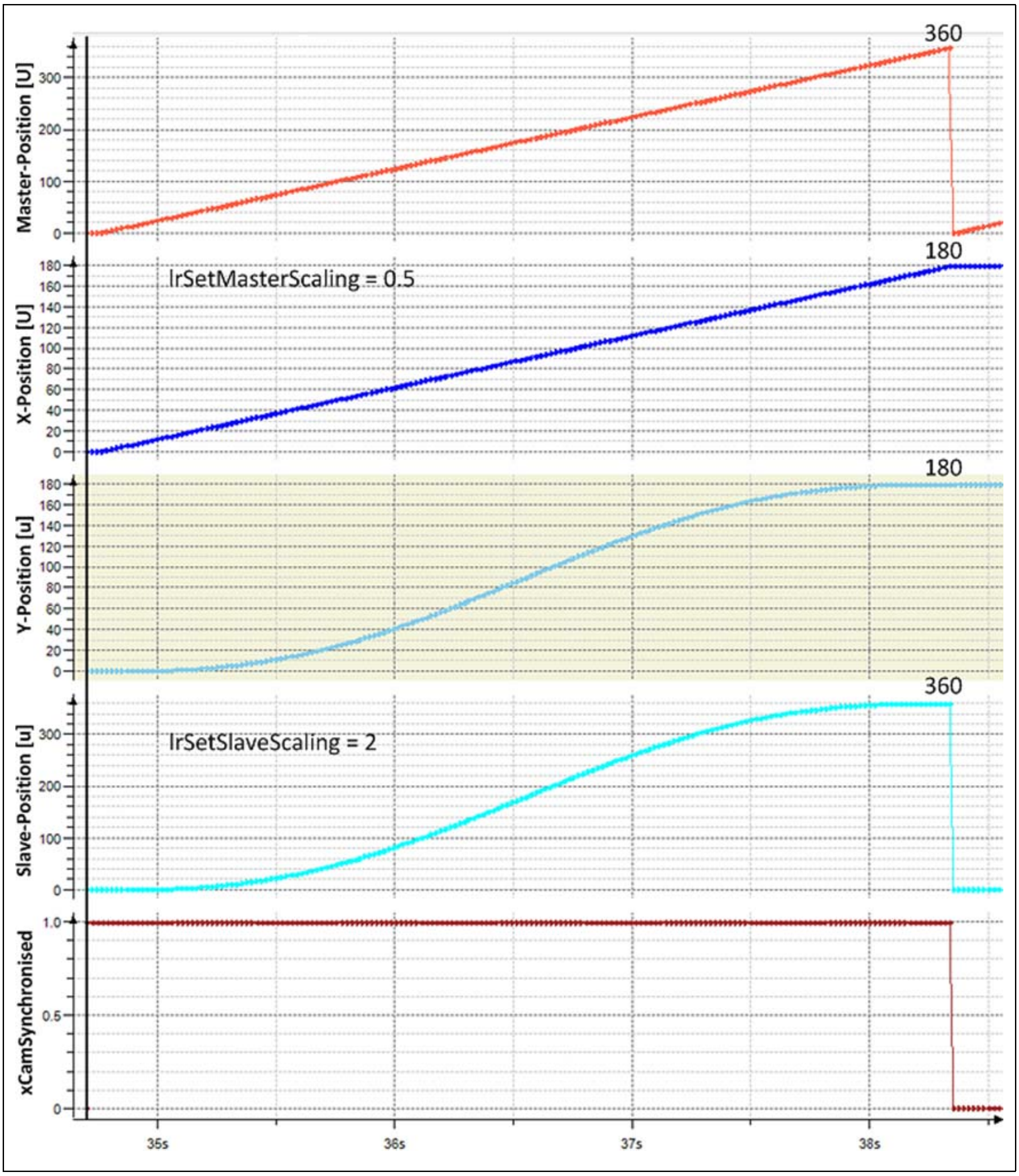
The adjustment profile for the scaling factor is set via parameters *lrOffsetScalingVel*, *lrOffsetScalingAcc*, *lrOffsetScalingDec* and *lrJerk*.

The *lrJerk* parameter is used to limit the maximum jerk. Usually the jerk is set to the 100-fold acceleration value. If the ramp generators are active and a change of cam is pending, the ramp generators are not aborted. The compensating movement is carried out completely to the end.

Parameters to be set

The parameters to be set are located in the L_TT1P_scPar_FlexCam[Base/State] (📖 21) parameter structure.

```
eScalingModeMaster : L_TT1P_ScalingMode := 0;  // [x_zero]
eScalingModeSlave : L_TT1P_ScalingMode := 0;   // [x_zero]
lrOffsetScalingVel : LREAL := 100;
lrOffsetScalingAcc : LREAL := 1000;
lrOffsetScalingDec : LREAL := 1000;
lrJerk : LREAL := 10000;
```



[3-17] Characteristic: scaling of a cam (X axis/Y axis 0..180) with a scaling factor of 0.5 for the master and 2.0 for the slave

3.18 Offset for the master and slave axis

An offset is selected via the inputs *lrSetOffsetMaster* and *lrSetOffsetSlave*.

The X position (input position for the curve function) results from the sum of the master axis position and the offset *lrSetOffsetMaster*.

The slave position results from the sum of the (optionally scaled) Y position of the cam and the offset *lrSetOffsetSlaves*.

The selection of the mode for accepting offset values for the master axis is set via the parameter *eOffsetModeMaster*, and for the slave axis via the parameter *eOffsetModeSlave*.

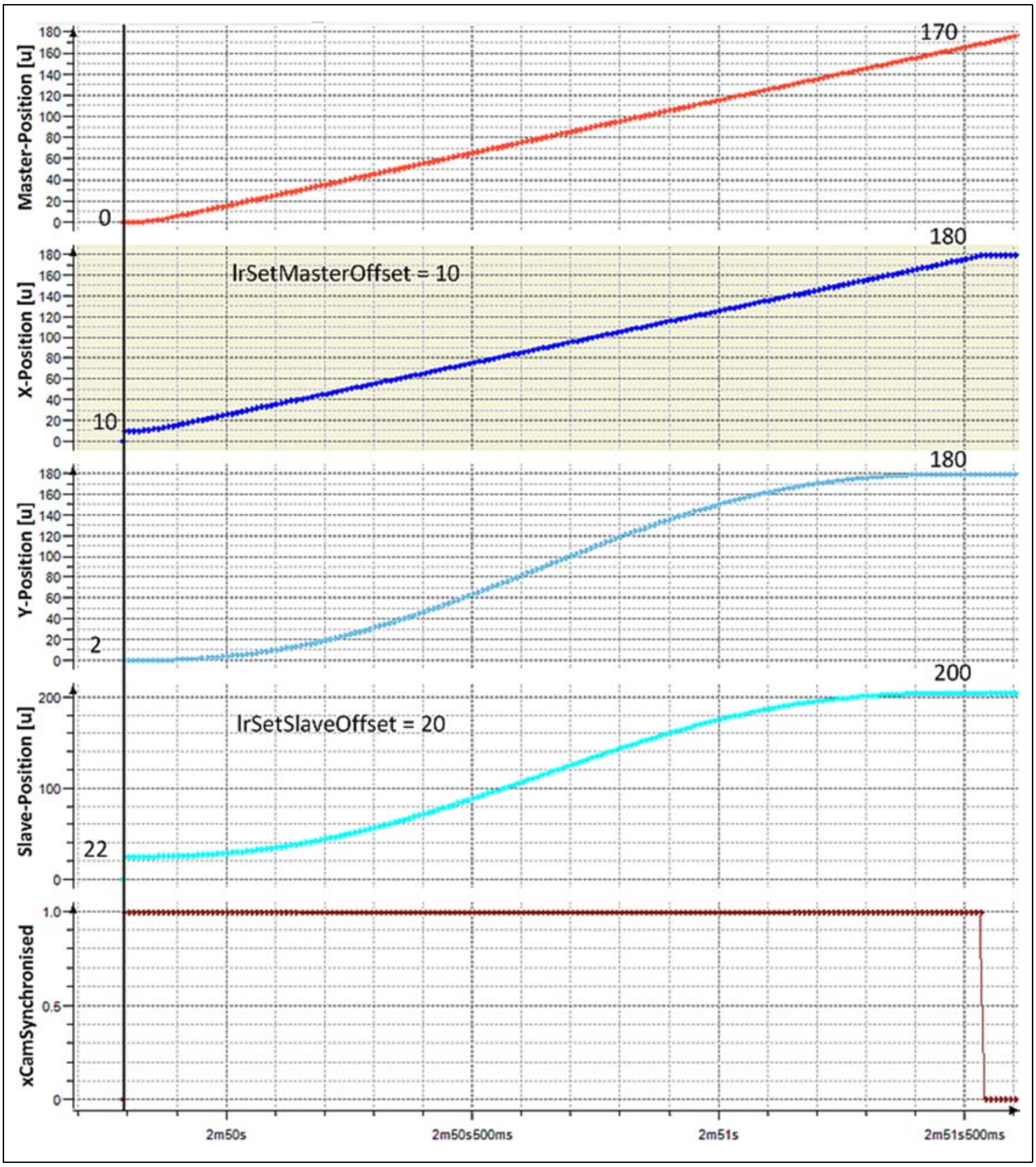
Setting/mode in: **eOffsetModeMaster** **eOffsetModeSlave**	**Description**
0 (x_zero)	Standard setting: The offset values are accepted in the "zero crossing" of the cam. The "zero crossing" is defined as the starting point of a cam if the direction of rotation of the master is positive, or as the end point of a cam if the direction of rotation of the master is negative.
1 (direct)	The offset values are accepted immediately after they have been selected or changed. A direct selection or change of the offset values causes a step change of the setpoint position even if the axes are at standstill.
2 (ramp_in)	The ramp generator leads the current offset to the target offset via the *lrOffsetScalingVel*, *lrOffsetScalingAcc*, *lrOffsetScalingDec* and *lrJerk* profile parameters. By means of the *lrJerk* parameter, the maximum jerk is limited. Usually the jerk is set to the 100-fold value of the acceleration.

If the ramp generators are active ("2 (ramp_in)" mode) and a change of cam is pending, the ramp generators are not aborted. The compensating movement is carried out completely to the end.

Parameters to be set

The parameters to be set are located in the L_TT1P_scPar_FlexCam[Base/State] (📖 21) parameter structure.

```
eOffsetModeMaster : L_TT1P_OffsetMode := 0;  // [x_zero]
eOffsetModeSlave : L_TT1P_OffsetMode := 0;   // [x_zero]
lrOffsetScalingVel : LREAL := 100;
lrOffsetScalingAcc : LREAL := 1000;
lrOffsetScalingDec : LREAL := 1000;
lrJerk : LREAL := 10000;
```



[3-18] Procedure: offset values of a cam (X axis/Y axis 0..180) with an offset value of 10 for the master and 20 for the slave

3.19 Calculation of extreme values of a cam (Base version)

The technology module provides the possibility of scanning the cam for maximum values regarding the position, speed, and acceleration at the *CamTable1* input. The maximum values are calculated with the *xCalcCamBounds* parameter = TRUE.

The calculation requires the maximum speed (*lrMasterMaxVel* parameter) and the maximum acceleration (*lrMasterMaxAcc* parameter) of the master axis.

The outputs *lrSlaveMaxVel* and *lrSlaveMaxAcc* show the maximum speed and the maximum acceleration of the slave axis. The maximum and minimum positions of the slave axis are shown at the outputs *lrSlaveMaxPos* and *lrSlaveMinPos*. These values are updated automatically.

Parameters to be set

The parameters to be set are located in the L_TT1P_scPar_FlexCam[Base/State] (📖 21) parameter structure.

```
xCalcCamBounds : BOOL := TRUE;
lrMasterMaxVel : LREAL := 100;
lrMasterMaxAcc : LREAL := 1000;
```

3.20 Path-based clutch-in of the slave axis with or without reversing

The *eSyncMode* = 2 (ramp_pos) parameter is used to position the slave axis in a path-based manner via a polynomial of the fifth degree to the resulting Y position of the cam.

In this mode, the slave axis can synchronise to a cam movement that is already running, providing the possibility that the clutch-in process takes several cam cycles, the transition to cam operation taking a bit longer.

Via the *eSyncDirection* parameter, the clutch-in direction relating to the direction of rotation of the master axis is set.

The *lrMasterSyncInPos* parameter determines the position of the master axis from which the slave axis is to be synchronised.

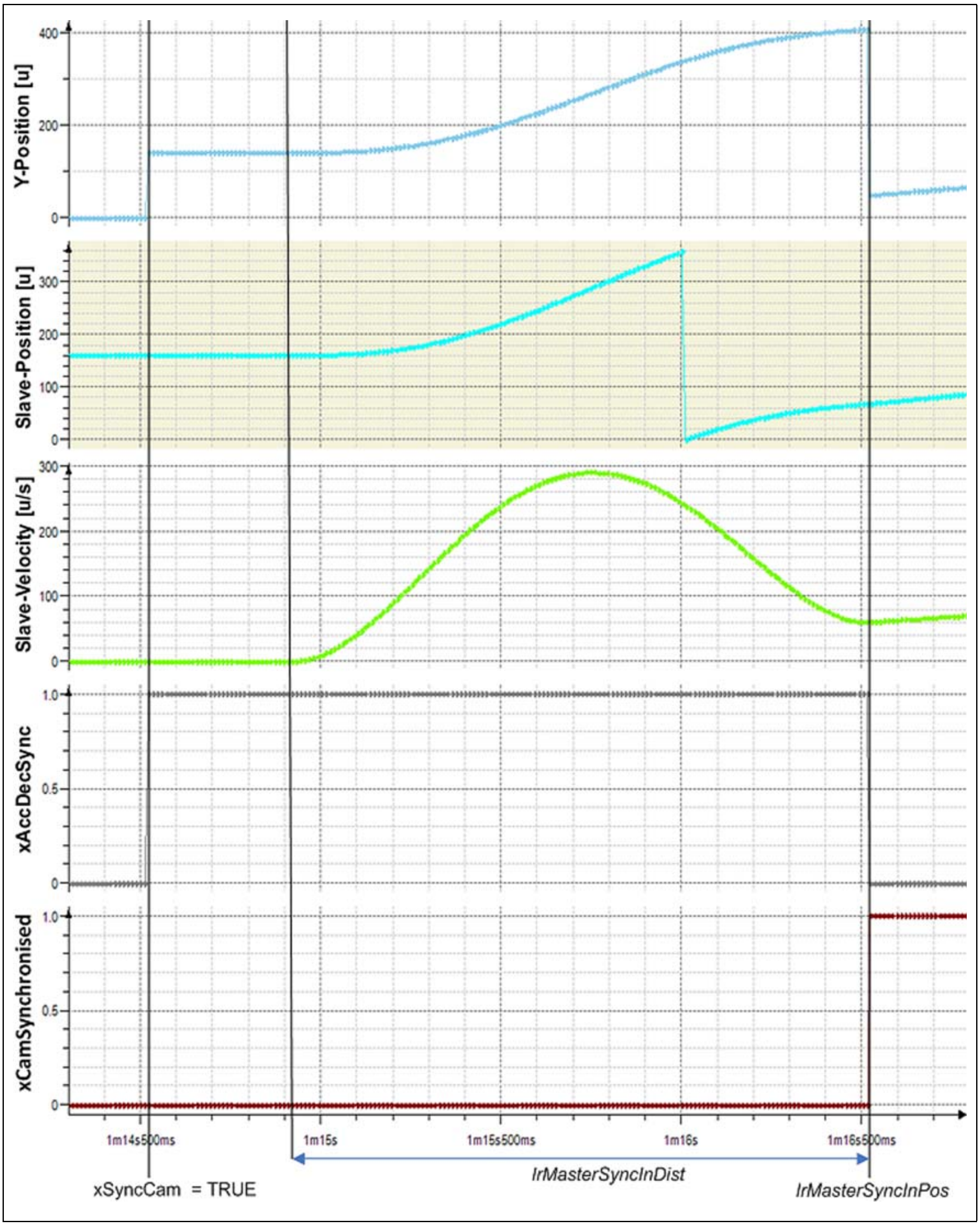
The *lrMasterSyncInDist* parameter is used to define the distance of the master axis over which the slave axis is traversed to the curve position. The slave axis can only be synchronised to the Y position of the cam whilst the master axis is running.

Parameter *ePosCtrlDirection* = 0 (both) allows for reversing of the slave axis during the clutch-in process (movement in the opposite direction of the master axis). If reversing during the clutch-in process is to be inhibited, the parameter *ePosCtrlDirection* = 1 (Direction Master) must be set.

Parameters to be set

The parameters to be set are located in the L_TT1P_scPar_FlexCam[Base/State] (📖 21) parameter structure.

```
eSyncMode : L_TT1P_SyncMode := 2;
eSyncDirection : L_TT1P_SyncDirection := 0;  // [mcCurrentDirection]
lrMasterSyncInPos : LREAL := 0;
lrMasterSyncInDist : LREAL := 100;
ePosCtrlDirection : L_TT1P_Direction := 0;  // [0: both, 1: Direction Master]
```



[3-19] Characteristic: clutch-in process with eSyncMode = 2 (ramp_pos)

3.21 Path-based declutching of the slave axis with or without reversing

In coupling mode *eSyncMode* = 2 (ramp_pos), the position-controlled declutch process at the running cam takes place with a polynomial of a fifth degree by setting the input *xSyncCam* = FALSE.

In this mode, declutching can only be executed whilst the master axis is running. The declutch process can take several cycles.

By means of the *lrMasterSyncOutDist* parameter, the braking distance of the master axis is defined, producing the position in which the slave axis releases from the cam.

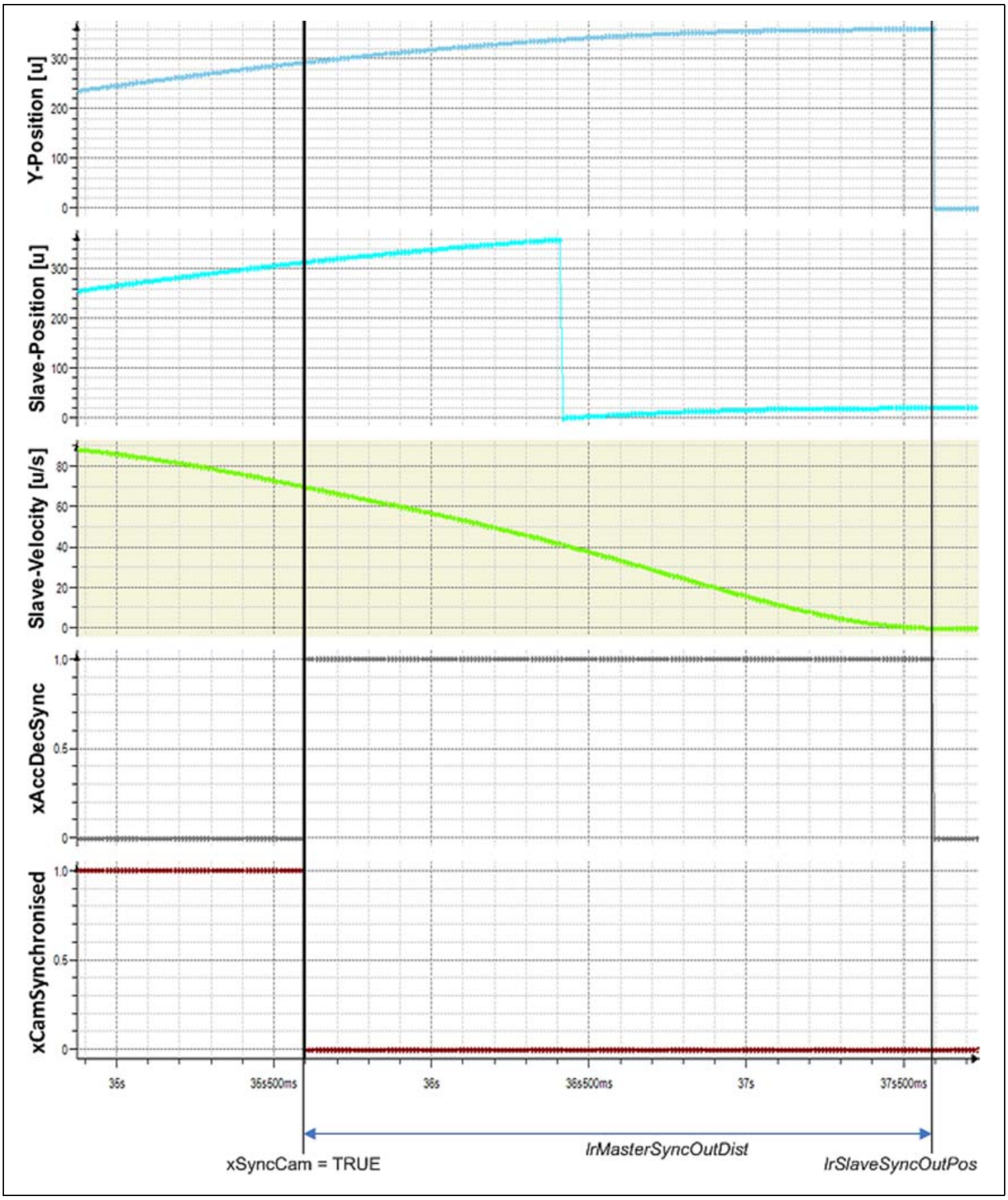
The *lrSlaveSyncOutPos* parameter defines the position from which the slave axis is to be at standstill.

Parameter *ePosCtrlDirection* = 0 (both) allows for reversing of the slave axis during the declutch process (movement in the opposite direction of the master axis). If reversing during the declutch process is to be inhibited, the parameter *ePosCtrlDirection* = 1 (Direction Master) must be set.

Parameters to be set

The parameters to be set are located in the L_TT1P_scPar_FlexCam[Base/State] (📖 21) parameter structure.

```
eSyncMode : L_TT1P_SyncMode := 2;
lrMasterSyncOutDist : LREAL := 0;
lrSlaveSyncOutPos : LREAL := 100;
ePosCtrlDirection : L_TT1P_Direction := 0;  // [0: both, 1: Direction Master]
```



[3-20] Characteristic: declutch process with eSyncMode = 2 (ramp_pos)

3.22 Scaling of the cam with or without reversing

Scaling of the cam in the State version is carried out in the same way as in the Base version:

▶ Scaling of the cam (📖 57)

The scaling factors can be accepted immediately or via the ramp generator:

▶ Scaling of the position via the ramp generator (📖 60)

In the State version, however, the compensating movement of the ramp generator can be executed without reversing by the master axis.

By means of parameter *ePosCtrlDirection* = 0 (both), reversing during the compensating movement is permitted. If reversing during the compensating movement is to be inhibited, the parameter *ePosCtrlDirection* = 1 (Direction Master) must be set.

Parameters to be set

The parameters to be set are located in the L_TT1P_scPar_FlexCam[Base/State] (📖 21) parameter structure.

```
eScalingModeMaster : L_TT1P_ScalingMode := 0;  // [x_zero]
eScalingModeSlave : L_TT1P_ScalingMode := 0;   // [x_zero]
lrOffsetScalingVel : LREAL := 100;
lrOffsetScalingAcc : LREAL := 1000;
lrOffsetScalingDec : LREAL := 1000;
lrJerk : LREAL := 10000;
ePosCtrlDirection : L_TT1P_Direction := 0;  // [0: both, 1: Direction Master]
```

3.23 Offset for the master and slave axis with or without reversing

The use of offsets for the master and slave axis in the State version is effected in the same way as in the Base version:

▸ Scaling of the cam (📖 57)

In the State version, however, the compensating movement of the ramp generator can be executed without reversing by the master axis.

By means of parameter *ePosCtrlDirection* = 0 (both), reversing during the compensating movement is permitted. If reversing during the compensating movement is to be inhibited, the parameter *ePosCtrlDirection* = 1 (Direction Master) must be set.

Parameters to be set

The parameters to be set are located in the L_TT1P_scPar_FlexCam[Base/State] (📖 21) parameter structure.

```
eOffsetModeMaster : L_TT1P_OffsetMode := 0;  // [x_zero]
eOffsetModeSlave : L_TT1P_OffsetMode := 0;   // [x_zero]
lrOffsetScalingVel : LREAL := 100;
lrOffsetScalingAcc : LREAL := 1000;
lrOffsetScalingDec : LREAL := 1000;
lrJerk : LREAL := 10000;
ePosCtrlDirection : L_TT1P_Direction := 0;  // [0: both, 1: Direction Master]
```

3.24 Switching sequence for cams

A switching sequence makes it possible to execute several cams in a sequence in succession.

The switching sequence is activated with the input *xCamSequencer* = TRUE. The output *xCamSequencerActive* returns the status, showing whether the switching sequence is executed.

The *eCamSequenceMode* parameter in the L_TT1P_scPar_FlexCam[Base/State] (📖 21) parameter structure serves to select the following switching sequences:

Setting in		Description
eCamSequenceMode	**xCamSequencer**	
0	TRUE	Cam 1 is executed cyclically.
1	TRUE	Cam 3 is executed cyclically.
2	TRUE	Cam 1 is executed once; then cam 3 is executed cyclically.
	FALSE	After cam 3, cam 1 is executed once.
3	TRUE	Cams 1 and 2 are executed once in succession; then cam 3 is executed cyclically.
	FALSE	After cam 3, cam 4 is executed once; then cam 1 is executed cyclically.

3.25 Calculation of extreme values of a cam (State version)

The State version provides the possibility of scanning a cam that is selected at the input *eSetCamTable* or all cams of a cam sequence (if input *xCamSequencer* = TRUE) with regard to maximum values of the position, speed, and acceleration. The maximum values are calculated with the parameter *xCalcCamBounds* = TRUE.

The calculation requires the maximum speed (*lrMasterMaxVel* parameter) and the maximum acceleration (*lrMasterMaxAcc* parameter) of the master axis.

The outputs *lrSlaveMaxVel* and *lrSlaveMaxAcc* show the maximum speed and the maximum acceleration of the slave axis. The maximum and minimum positions of the slave axis are shown at the outputs *lrSlaveMaxPos* and *lrSlaveMinPos*. These values are updated automatically.

Parameters to be set

The parameters to be set are located in the L_TT1P_scPar_FlexCam[Base/State] (📖 21) parameter structure.

```
xCalcCamBounds : BOOL := TRUE;
lrMasterMaxVel : LREAL := 100;
lrMasterMaxAcc : LREAL := 1000;
```

3.26 CPU utilisation (example Controller 3231 C)

The following table shows the CPU utilisation in microseconds using the example of the 3231 C controller (ATOM™ processor, 1.6 GHz).

Versions	Interconnection of the technology module	CPU utilisation	
		Average	Maximum peak

Base	xEnable := TRUE;
	xRegulatorOn := TRUE;
	xSyncCam := TRUE;
		80 µs	155 µs

State	xEnable := TRUE;
	xRegulatorOn := TRUE;
	xSyncCam := TRUE;
		95 µs	166 µs

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FEEDBACK

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.

Perhaps we have not succeeded in achieving this objective in every respect. If you have suggestions for improvement, please e-mail us to:

feedback-docu@lenze.com

Thank you very much for your support.

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