FAST Application Software

Technology module

Register Control

Reference Manual EN

13531742

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
3.3	05/2017	TD17	• Content structure has been changed. • General revisions
3.2	11/2016	TD29	Interconnection examples supplemented: Register control (🕮 43)
3.1	04/2016	TD17	General revisions
3.0	11/2015	TD17	• Corrections and additions • New: Relative clutching-in/declutching (🕮 38) • 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	**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

Stop!

Damage or destruction of machine parts

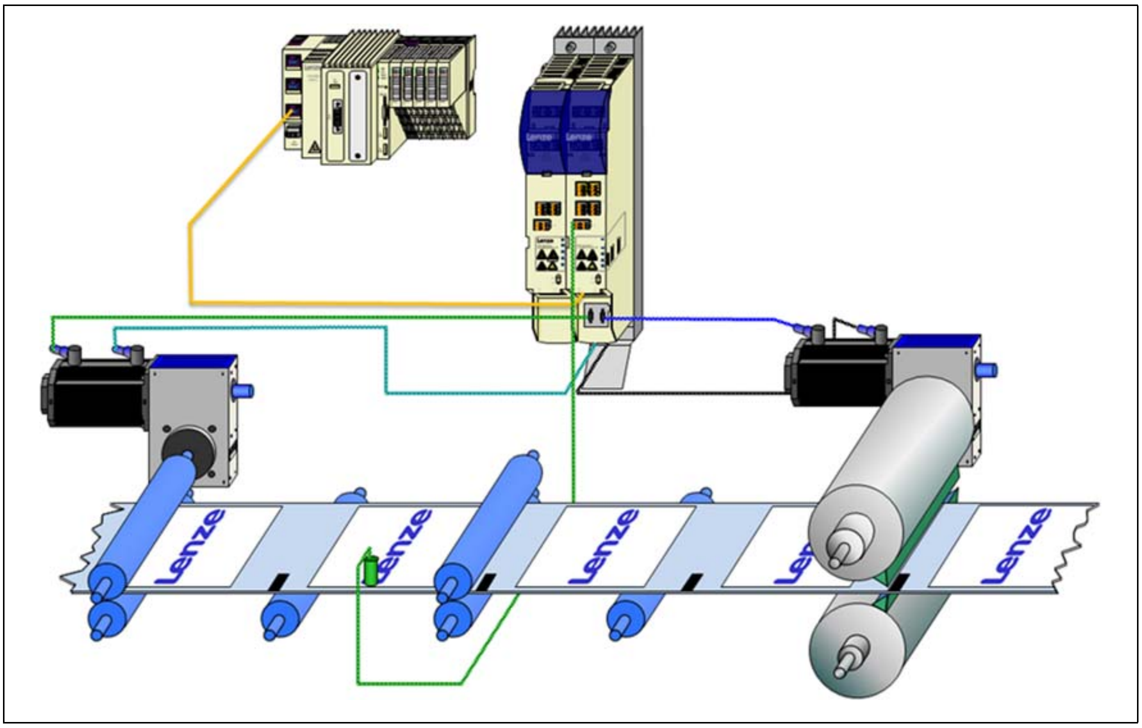
Damage or destruction of machine parts can be caused by ...

- 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 Functional description of "Register Control"



[3-1] Typical mechanics of the technology module

The "RegisterControl" technology module meets the following requirements:

- A slave axis will follow the master axis in speed synchronism. This means that a cycle of the master will initiate a cycle of the slave.
- As a higher-level control loop, the integrated register controller controls positioning relatively to the mark detected on the material. This serves to compensate position deviations of the material mark towards the master position.
- A position offset between master axis and slave axis can be set.
- The slave axis can be declutched at a certain position and then clutched in again.

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) (🕮 34)	●	●
Homing (🕮 35)	●	●
Synchronism (SyncPos) with clutch-in/declutch mechanism (🕮 36)	●	●
▶ Direct clutching-in/declutching (🕮 37)	●	●
▶ Relative clutching-in/declutching (🕮 38)	●	●
Gearbox factor for different clock cycles (🕮 39)	●	●
Position offset during synchronism (🕮 41)	●	●
Trimming (🕮 42)	●	●
Register control (🕮 43)	●	●
Teaching function (🕮 48)		●
Touch probe failure detection (🕮 50)		●
Mark register (🕮 51)		●
Hiding marks (🕮 53)		●
Gearbox factor correction (🕮 55)		●

»PLC Designer« Online help

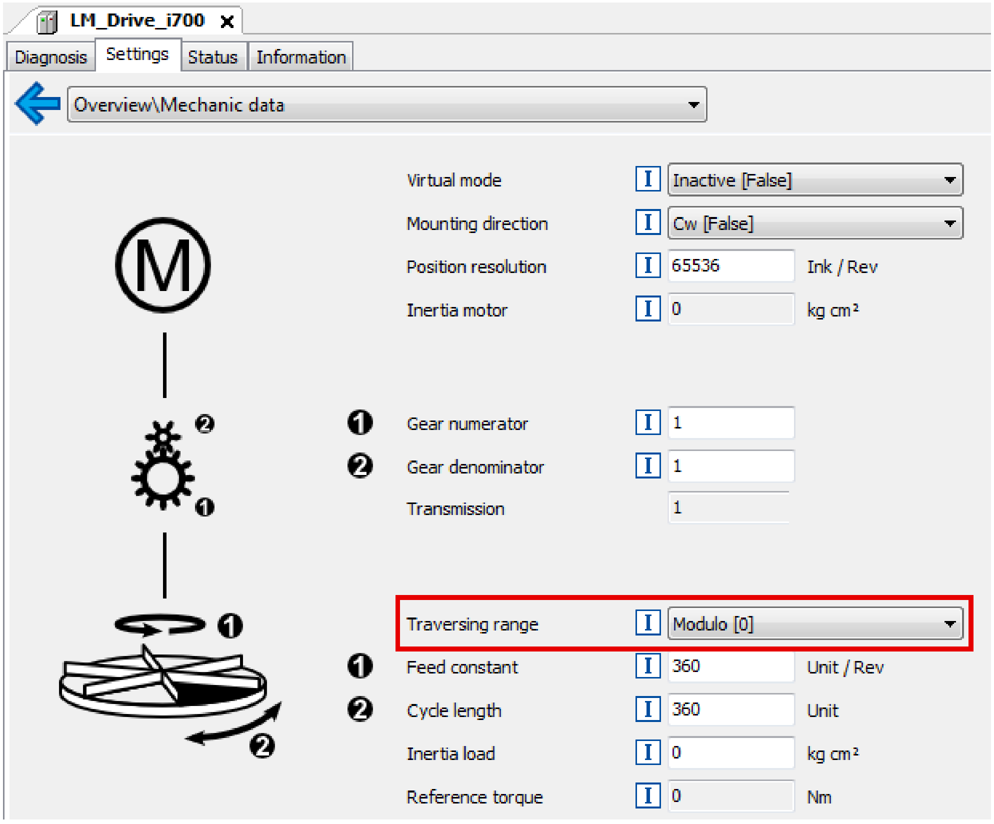
Here you will find detailed information on the **L_MC1P_AxisBasicControl** function block, the **stop function** and the **holding function**.

3.2 Important notes on how to operate the technology module

The "Register Control" technology module only supports rotary axes:

- The master axis has to be a rotary axis and
- the slave axis has to be a rotary axis.

Go to the »PLC Designer« and set the "Modulo" machine measuring system for each axis under the **Settings** tab:



Setting of the operating mode

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

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) (📖 34)**:**

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_RegisterControl[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_RegisterControl[Base/State]

Input type	Input	Output	Output type
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_RegisterControl[Base/State]	scPar	xAxisEnabled	BOOL
AXIS_REF	MasterAxis	scSignalFlow	L_TT1P_scSF_RegisterControl[Base/State]
AXIS_REF	SlaveAxis	xDone	BOOL
L_TT1P_scAP_RegisterControl[Base/State]	scAccessPoints	xBusy	BOOL
BOOL	xJogPos	xIsHomed	BOOL
BOOL	xJogNeg	lrActVel	LREAL
BOOL	xHomeExecute	lrActPos	LREAL
BOOL	xHomeAbsSwitsch	lrOffset	LREAL
LREAL	lrSetOffsetMaster	lrOffsetTrim	LREAL
LREAL	lrSetOffsetSlave	lrOffsetTotal	LREAL
BOOL	xTrimPos	xSynchronised	BOOL
BOOL	xTrimNeg	xAccDecSync	BOOL
BOOL	xSyncPos	lrOffsetSyncPos	LREAL
BOOL	xSyncInstant	lrSetRegPosOut	LREAL
BOOL	xSyncOutInstant	lrMarkSensorPos	LREAL
BOOL	xSyncPosRestore	lrActMarkError	LREAL
BOOL	xMarkReceive	lrActMarkDist	LREAL
LREAL	lrActMarkPosIn	xMarkReceived	BOOL
LREAL	lrCycPosExtEncoder	lrRegMarkPos	LREAL
BOOL	xLoadRegPos	xCorrActive	BOOL
LREAL	lrLoadRegPos	xCorrLimited	BOOL
State			
BOOL	xGearFactorCorr	xMarkWindowOpen	BOOL
BOOL	xGearFactorCorrHold	xMarkOutOfWindow	BOOL
BOOL	xTeachMarkWindow	xMarkNotDetected	BOOL
		xMarkWindowTeached	BOOL
		lrAverageGearFactorCorr	LREAL
		xGearFactorCorrLimited	BOOL

3.3.1 Inputs and outputs

Designator Data type	Description	Available in version	
		Base	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	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	The function block is executed.		
	FALSE	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. In the State version, the first touch probe mark subsequently has to be saved again with the teaching function.	●	●
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_RegisterControl[Base/State]	The parameter structure contains the parameters of the technology module. The data type depends on the version used (Base/State).		●	●
scAccessPoints L_TT1P_scAP_RegisterControl[Base/State]	Structure of the access points 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.	●	●

<table>
<tr><th rowspan="2">Designator
Data type</th><th colspan="2" rowspan="2">Description</th><th colspan="2">Available in version</th></tr>
<tr><th>Base</th><th>State</th></tr>
<tr><td>xJogNeg
BOOL</td><td>TRUE</td><td>Traverse axis in negative direction (manual jog).
If xJogPos is also TRUE, the traversing direction selected first remains set.</td><td>●</td><td>●</td></tr>
<tr><td rowspan="2">xHomeExecute
BOOL</td><td colspan="2">The input is edge-controlled and evaluates the rising edge.</td><td rowspan="2">●</td><td rowspan="2">●</td></tr>
<tr><td>FALSE↗TRUE</td><td>Start homing.
The function is aborted via the xStop input.</td></tr>
<tr><td>xHomeAbsSwitch
BOOL</td><td>TRUE</td><td>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.</td><td>●</td><td>●</td></tr>
<tr><td>lrSetOffsetMaster
LREAL</td><td colspan="2">Position offset of the master axis
• When xLoadOffsetMaster = TRUE. the offset is loaded cyclically.
• When xLoadOffsetMaster = FALSE, the offset is run via the profile generator.
• The position is approached in the "POS_IS_SYNCHRONISED" state (slave is clutched in) when the value changes.
• Unit: units (unit of the register)</td><td>●</td><td>●</td></tr>
<tr><td>lrSetOffsetSlave
LREAL</td><td colspan="2">Position offset of the slave axis
• When xLoadOffsetSlave = TRUE, the offset is loaded cyclically.
• When xLoadOffsetSlave = FALSE, the offset is run via the profile generator.
• The position is approached in the "POS_IS_SYNCHRONISED" state (slave is clutched in) when the value changes.
• Unit: units</td><td>●</td><td>●</td></tr>
<tr><td>xTrimPos
BOOL</td><td>TRUE</td><td>Trim velocity in positive direction.
If xTrimNeg is also TRUE, the traversing direction selected first remains set.</td><td>●</td><td>●</td></tr>
<tr><td>xTrimNeg
BOOL</td><td>TRUE</td><td>Trim velocity in negative direction.
If xTrimPos is also TRUE, the traversing direction selected first remains set.</td><td>●</td><td>●</td></tr>
<tr><td>xSyncPos
BOOL</td><td>TRUE</td><td>Activate register control.
The register position is adapted to the detected touch probe mark.</td><td>●</td><td>●</td></tr>
<tr><td>xSyncInstant
BOOL</td><td>TRUE</td><td>Synchronisation with relative position coupling (in connection with xSyncPos)
• Master axis at standstill:
The slave axis directly (abruptly) clutches in to its current position.
• Master axis in motion:
The slave axis immediately clutches in via the clutching distance in the lrSlaveSyncInDist parameter (by analogy with a velocity coupling).</td><td>●</td><td>●</td></tr>
<tr><td>xSyncOutInstant
BOOL</td><td>TRUE</td><td>Declutching with relative position coupling
• Master axis at standstill:
The slave axis directly (abruptly) clutches in to its current position.
• Master axis in motion:
The slave axis immediately declutches via the clutching distance in the lrSlaveSyncOutDist parameter (by analogy with a velocity coupling or MC_Halt).</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 rowspan="2">xSyncPosRestore
BOOL</td><td>FALSE↗TRUE</td><td>A FALSE↗TRUE edge serves to compensate the position offset generated by a relative clutch-in by means of these parameters:
• eOffsetSlaveDirection
• eOffsetSlaveProfileType
• lrOffsetSlaveVelPos
• lrOffsetSlaveVelNeg
• lrOffsetSlaveAccDec</td><td rowspan="2">●</td><td rowspan="2">●</td></tr>
<tr><td>TRUE↘FALSE</td><td>A TRUE↘FALSE edge aborts the synchronisation process.
A possibly remaining position offset is displayed at the lrOffsetSyncPos output.</td></tr>
<tr><td>xMarkReceive
BOOL</td><td>TRUE</td><td>A touch probe mark has been detected in the connected touch probe sensor.</td><td>●</td><td>●</td></tr>
<tr><td>lrActMarkPosIn
LREAL</td><td colspan="2">Current position of the touch probe mark with regard to the axis reference used.
• Unit: units</td><td>●</td><td>●</td></tr>
<tr><td>lrCycPosExtEncoder
LREAL</td><td colspan="2">Cyclic position of the external encoder in case the touch probe from the encoder axis is used.
(eTpMode parameter = 2: External encoder)
• Unit: units</td><td>●</td><td>●</td></tr>
<tr><td>xLoadRegPos
BOOL</td><td>TRUE</td><td>The register position at the lrLoadRegPos input is loaded manually.
This input is only evaluated when the register control (xSyncPos input = FALSE) is <u>inactive</u>.</td><td>●</td><td>●</td></tr>
<tr><td>lrLoadRegPos
LREAL</td><td colspan="2">Position to be loaded for the register (when xLoadRegPos = TRUE).
• Unit: units</td><td>●</td><td>●</td></tr>
<tr><td>xTeachMarkWindow
BOOL</td><td>TRUE</td><td>The touch probe window is referenced. (Teaching function for setting-up operation)
• Behaviour in <u>declutched</u> state:
When a touch probe mark has been detected, the touch probe window is adjusted to the position of the detected mark and activated. In addition, the register position is set to the value of the internally calculated setpoint position of the sensor.
• Behaviour in <u>clutched-in</u> state:
When a touch probe mark has been detected, the touch probe window is adjusted to the position of the detected mark and activated.
After successful execution, the xMarkWindowTeached output is set to TRUE.</td><td></td><td>●</td></tr>
<tr><td>xGearFactorCorr
BOOL</td><td>TRUE</td><td>Activation of the gearbox factor correction (compensation of deviating register lengths)
• The speed setpoint is corrected by the medium difference of the touch probe correction values.
• The correction is active as long as the register control is activated (xSyncPos input = TRUE).</td><td></td><td>●</td></tr>
<tr><td>xGearFactorCorrHold
BOOL</td><td>TRUE</td><td>The current gearbox factor correction value is held.</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 (📖 25)		●	●
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_RegisterControl[Base/State]	Structure of the signal flow The data type depends on the version used (Base/State). ▸ Signal flow diagrams (📖 26)		●	●
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).	●	●
lrActVel LREAL	Current velocity • Unit: units/s		●	●
lrActPos LREAL	Current position • Unit: units		●	●
lrOffset LREAL	Current position offset with regard to the untrimmed master position without any offset of the register (master offset + slave offset). • Unit: units		●	●
lrOffsetTrim LREAL	Position offset from the trimming function between the master axis and the slave axis • Unit: units		●	●
lrOffsetTotal LREAL	The total position offset between the master axis and the slave axis contains the information of the master offset, slave offset and offset from the trimming function and the offset caused by relative clutch-in. • Unit: units		●	●
xSynchronised BOOL	TRUE	The axis is clutched-in in a precise position with regard to the register position	●	●
xAccDecSync BOOL	TRUE	The synchronisation function is active. The axis is synchronised or desynchronised (clutch opens or closes).	●	●

Designator Data type	Description		Available in version Base	State
lrOffsetSyncPos LREAL	Position offset caused by relative clutch-in. • Unit: units		●	●
lrSetRegPosOut LREAL	Setpoint position of the register for register control The setpoint position is always within a rotary modulo cycle with the cycle length of the lrMarkDist parameter. • Unit: units		●	●
lrMarkSensorPos LREAL	The internally calculated position within the register cycle on which the touch probe mark is expected. • Unit: units		●	●
lrActMarkError LREAL	Current deviation between the position of the detected touch probe mark and the expected touch probe position • **Base:** lrActMarkError corresponds to the touch probe error at the output of the limitation module. • **State:** lrActMarkError corresponds to the touch probe error at the output of the touch probe module. • Unit: mm		●	●
lrActMarkDist LREAL	Register length between the last two touch probe marks • Unit: mm		●	●
xMarkReceived BOOL	TRUE	A touch probe mark has been detected. • **Base:** xMarkReceived corresponds to the output at the limitation module. • **State:** xMarkReceived corresponds to the output at the touch probe module.	●	●
lrRegMarkPos LREAL	The converted actual position of the current touch probe mark within the register cycle • Unit: units		●	●
xCorrActive BOOL	TRUE	Activate compensating movement.	●	●
xCorrLimited BOOL	TRUE	The touch probe difference is limited to the maximum value.	●	●
xMarkWindowOpen BOOL	TRUE	Touch probe window open. A valid touch probe mark has been detected.		●
xMarkOutOfWindow BOOL	TRUE	A touch probe mark has been detected outside of the touch probe window.		●
xMarkNotDetected BOOL	TRUE	No touch probe mark has been detected within the touch probe window.		●
xMarkWindowTeached BOOL	TRUE	Homing of the touch probe window is completed.		●
lrAverageGearFactorCorr LREAL	Effective gearbox factor for the gearbox factor correction			●
xGearFactorCorrLimited BOOL	TRUE	The gearbox factor correction is limited.		●

3.3.4 Parameters

L_TT1P_scPar_RegisterControl[Base/State]

The **L_TT1P_scPar_RegisterControl[Base/State]** structure contains the parameters of the technology module.

Designator Data type	Description	Available in version	
		Base	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 compensating an offset value, trimming, 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) or position to which the measuring system is set when the first touch probe mark is recognised. • 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.	●	●

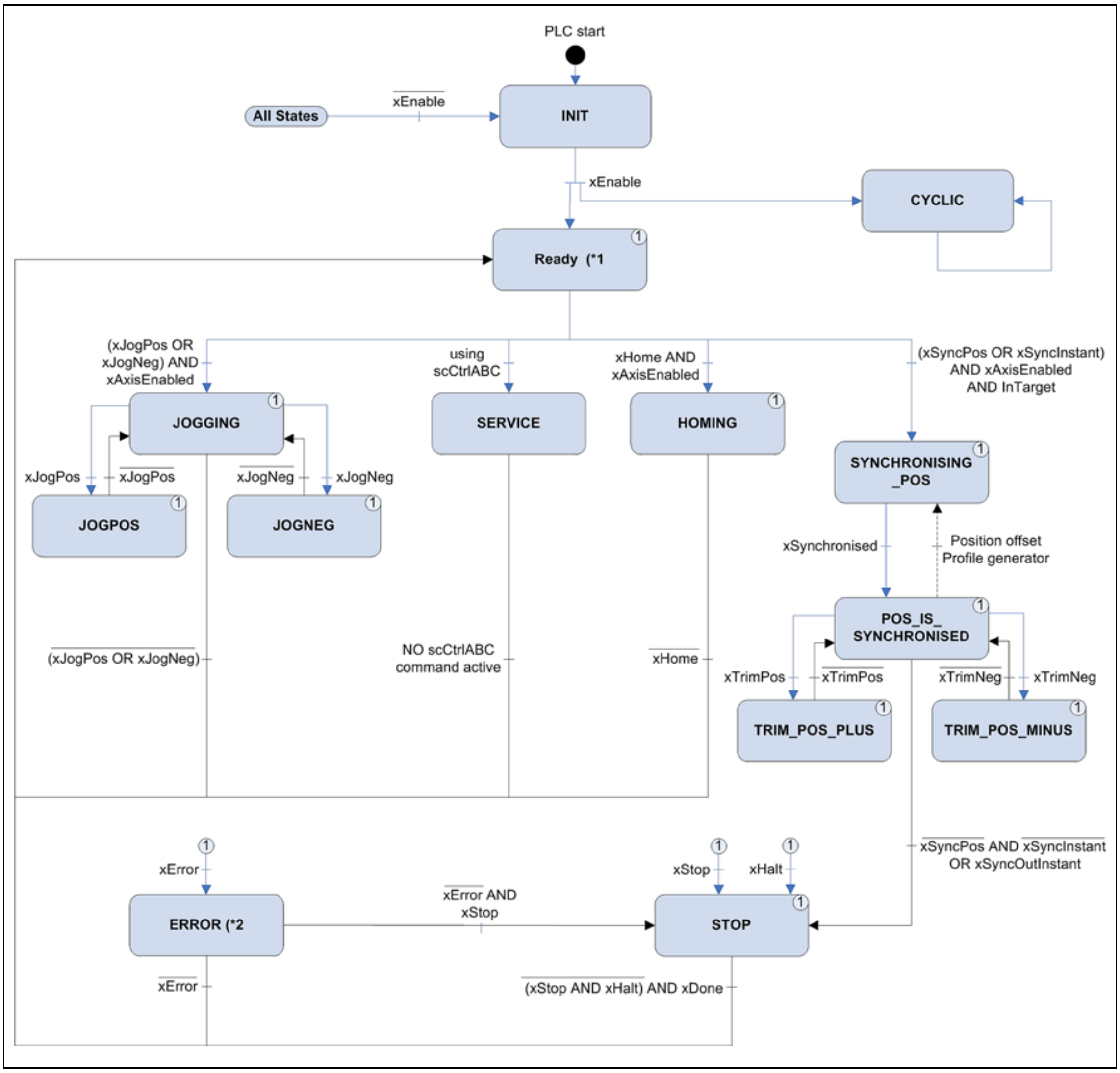
Designator / Data type	Description		Available in version: Base	Available in version: State
scHomeExtTP MC_TRIGGER_REF	Transfer of an external touch probe event • Only relevant for "external encoder" touch probe configuration. • For describing the MC_TRIGGER_REF structure, see the **MC_TouchProbe** function block.		●	●
dwNumerator DWORD	This value is included in the resulting synchronous factor as numerator term. • Initial value: 1		●	●
dwDenominator DWORD	This value is included in the resulting synchronous factor as denominator term. • Initial value: 1		●	●
xLoadSyncPos BOOL	Automatic calculation and selection of the gearbox output position for direct clutch-in • Initial value: FALSE ▶ Direct clutching-in/declutching (📖 37)		●	●
	TRUE	The output position of the gearbox is calculated considering the current slave position. After this process, a direct, jerk-free clutch-in is possible.		
lrTrimAcc LREAL	Acceleration for trimming Selection of the velocity change relative to the master to be used for accelerating. The acceleration acting on the drive is the sum of master and slave acceleration. • Unit: units/s^2 • Initial value: 100		●	●
lrTrimDec LREAL	Deceleration for trimming Selection of the velocity change relative to the master to be used for decelerating. The deceleration acting on the drive is the sum of master and slave deceleration. • Unit: units/s^2 • Initial value: 100		●	●
lrTrimVel LREAL	Velocity for trimming Selection of the velocity used for trimming. • Unit: units/s • Initial value: 50		●	●
lrSlaveSyncInDist LREAL	Distance of the clutch-in movement from the slave axis (path-based coupling mode). • Unit: units • Initial value: 90		●	●
lrSlaveSyncOutDist LREAL	Distance of the declutch movement from the slave axis (path-based coupling mode). • Unit: units • Initial value: 90		●	●
lrSlaveSyncOutPos LREAL	Declutch setpoint position of the slave axis At this position, the slave axis is stopped as soon as the declutch process has been carried out (path-based clutch mode). • Unit: units • Initial value: 0		●	●
eOffsetSlaveDirection LREAL	Direction select for the profile generator of the slave position offset • Initial value: 1 (Direction Master)		●	●
	0	Both: The axis may travel in positive and negative direction		
	1	Master direction: The slave axis may only travel in the same direction as the master axis.		

Designator Data type	Description		Available in version	
			Base	State
eOffsetSlaveProfileType L_TT1P_ProfileType	Profile type of the profile generator • Initial value: 2 (5th degree polynomial)		●	●
	0	poly_4th_order (4th order polynomial)		
	1	poly_2nd_order (2nd order polynomial)		
	2	poly_5th_order (5th order polynomial)		
lrOffsetSlaveVelPos LREAL	Maximum positive velocity to be used for the profile. The sum of this velocity and the velocity of the master is the velocity acting on the slave axis. • Unit: units/s • Initial value: 100		●	●
lrOffsetSlaveVelNeg LREAL	Maximum negative velocity to be used for the profile. The sum of this velocity and the velocity of the master is the velocity acting on the slave axis. • Unit: units/s • Initial value: 100		●	●
lrOffsetSlaveAccDec LREAL	Maximum acceleration to be used for the profile. The sum of this acceleration and the one of the master is the acceleration acting on the slave axis. • Unit: units/s^2 • Initial value: 1000		●	●
xLoadOffsetSlave BOOL	Loading the position offset for the slave axis (lrSetOffsetSlave input) • Initial value: FALSE		●	●
	TRUE	The position offset is loaded cyclically.		
	FALSE	The position offset is run via the profile generator.		
lrSensorToolDistance LREAL	Distance of the touch probe sensor to the attack position of the tool (e.g. cutting blade, printheads) on the material This parameter is required to automatically calculate the mark register. If touch probe sensor and axis are within one register cycle, this value can be set to "0". • Unit: units • Initial value: 0		●	●
xMarkCorrection BOOL	TRUE	Activate correction of the touch probe deviation. • Initial value: TRUE	●	●
lrMarkDist LREAL	Register length in units of the measuring system of the master axis • Initial value: 360.0		●	●
lrCycleLengthExtEncoder LREAL	Cycle time for the external encoder (Only relevant if eTpMode parameter is set = "2: External encoder") • Unit: s • Initial value: 360		●	●
eTPMode L_TT1P_TpMode	Touch probe source • Initial value: 0 (master axis)		●	●
	0	Master axis		
	1	Slave axis		
	2	External encoder		
lrMaxCorrPos LREAL	Maximum positive correction distance per register cycle • Unit for axis: units • Unit for register: mm • Initial value: 30.0		●	●

<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>lrMaxCorrNeg
LREAL</td><td colspan="2">Maximum negative correction distance per register cycle
• Unit for axis: units
• Unit for register: mm
• Initial value: -30.0</td><td>●</td><td>●</td></tr>
<tr><td rowspan="4">eSourceForCorrWindow
L_TT1P_CorrectionMode</td><td colspan="2">Selection for the parameterisation of the compensating movement correction window and the mark window (only State version)
• Initial value: slave</td><td rowspan="4">●</td><td rowspan="4">●</td></tr>
<tr><td>Master</td><td>The correction window is given in units of the measuring system of the master axis and is applied to the master position created in the technology module.</td></tr>
<tr><td>Register</td><td>The correction window is given in units of the register measuring system and is applied to the register position generated in the technology module.</td></tr>
<tr><td>Slave</td><td>The correction window is given in units of the measuring system
of the slave axis and is applied to the slave position generated in the technology module.</td></tr>
<tr><td>lrUpperCorrPos
LREAL</td><td colspan="2">Upper limit value of the correction window for the compensating movement of the touch probe correction
The window must not amount to the entire cycle length.
• Unit for axis: units
• Unit for register: mm
• Initial value: 180</td><td>●</td><td>●</td></tr>
<tr><td>lrLowerCorrPos
LREAL</td><td colspan="2">Lower limit value of the correction window for the compensating movement of the touch probe correction
• Unit for axis: units
• Unit for register: mm
• Initial value: 90</td><td>●</td><td>●</td></tr>
<tr><td>lrTrimDist
LREAL</td><td colspan="2">Increment for trimming in units of the register measuring system
• Unit: mm
• Initial value: 1</td><td>●</td><td>●</td></tr>
<tr><td rowspan="3">eTrimMode
L_TT1P_TrimMode</td><td colspan="2">Type of trimming
• Initial value: 0 (trimming via positioning profile)</td><td rowspan="3">●</td><td rowspan="3">●</td></tr>
<tr><td>0</td><td>Trimming via speed profile</td></tr>
<tr><td>1</td><td>Trimming via positioning profile (with lrTrimDist increment)</td></tr>
<tr><td rowspan="3">eOffsetMasterDirection
LREAL</td><td colspan="2">Direction select for the profile generator of the master position offset
• Initial value: 0 (both)</td><td rowspan="3">●</td><td rowspan="3">●</td></tr>
<tr><td>0</td><td>Both:
The slave axis may travel in positive and negative direction. Reversing of the X axis is permissible.</td></tr>
<tr><td>1</td><td>Master direction:
The slave axis may only travel in the same direction as the master axis.</td></tr>
<tr><td rowspan="4">eOffsetMasterProfileType
L_TT1P_ProfileType</td><td colspan="2">Profile type of the profile generator for the master position offset
• Initial value: 2 (5th degree polynomial)</td><td rowspan="4">●</td><td rowspan="4">●</td></tr>
<tr><td>0</td><td>poly_4th_order (4th order polynomial)</td></tr>
<tr><td>1</td><td>poly_2nd_order (2nd order polynomial)</td></tr>
<tr><td>2</td><td>poly_5th_order (5th order polynomial)</td></tr>
</table>

Designator Data type	Description	Available in version Base	Available in version State
lrOffsetMasterVelPos LREAL	Maximum positive velocity to be used for the profile (master position offset). The sum of this velocity and the velocity of the master is the velocity acting on the slave axis. • Unit: units/s • Initial value: 100	●	●
lrOffsetMasterVelNeg LREAL	Maximum negative velocity to be used for the profile (master position offset). The sum of this velocity and the velocity of the master is the velocity acting on the slave axis. • Unit: units/s • Initial value: 100	●	●
lrOffsetMasterAccDec LREAL	Maximum acceleration to be used for the profile (master position offset). The sum of this acceleration and the one of the master is the acceleration acting on the slave axis. **Note:** This parameter does not apply to profiles of the following type: "5th grade polynomial" (eOffsetMasterProfileType parameter). • Unit: units/s^2 • Initial value: 1000	●	●
xLoadOffsetMaster BOOL	Loading of the position offset for the master axis (lrSetOffsetMaster input) • Initial value: FALSE TRUE: The position offset is loaded cyclically. FALSE: The position offset is run via the profile generator.	●	●
lrMarkWindowSize LREAL	Size of the touch probe window with regard to the register measuring system. The touch probe window is put symmetrically around the expected touch probe position. • Unit: mm • Initial value: 90		●
lrSetOffsetMarkWindow LREAL	Offset for shifting the touch probe window with regard to the register measuring system. • Unit: mm • Initial value: 0		●
lrGearFactorCorrGain LREAL	Gain factor of the gearbox factor correction • Initial value: 0.1		●
lrMaxGearFactorCorr LREAL	Maximum deviation of the gearbox factor correction • Unit: units • Initial value: 10		●
dwMaxNumberVirtualMarks DWORD	Maximum number of permitted touch probe failures If no touch probe is detected within the touch probe window, an artificial mark is generated. This happens as long as the number of marks set here is not exceeded. If the number of marks was exceeded, the xError output is set to TRUE. • Initial value: 5		●

3.4 State machine



[3-2] State machine of the technology module

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

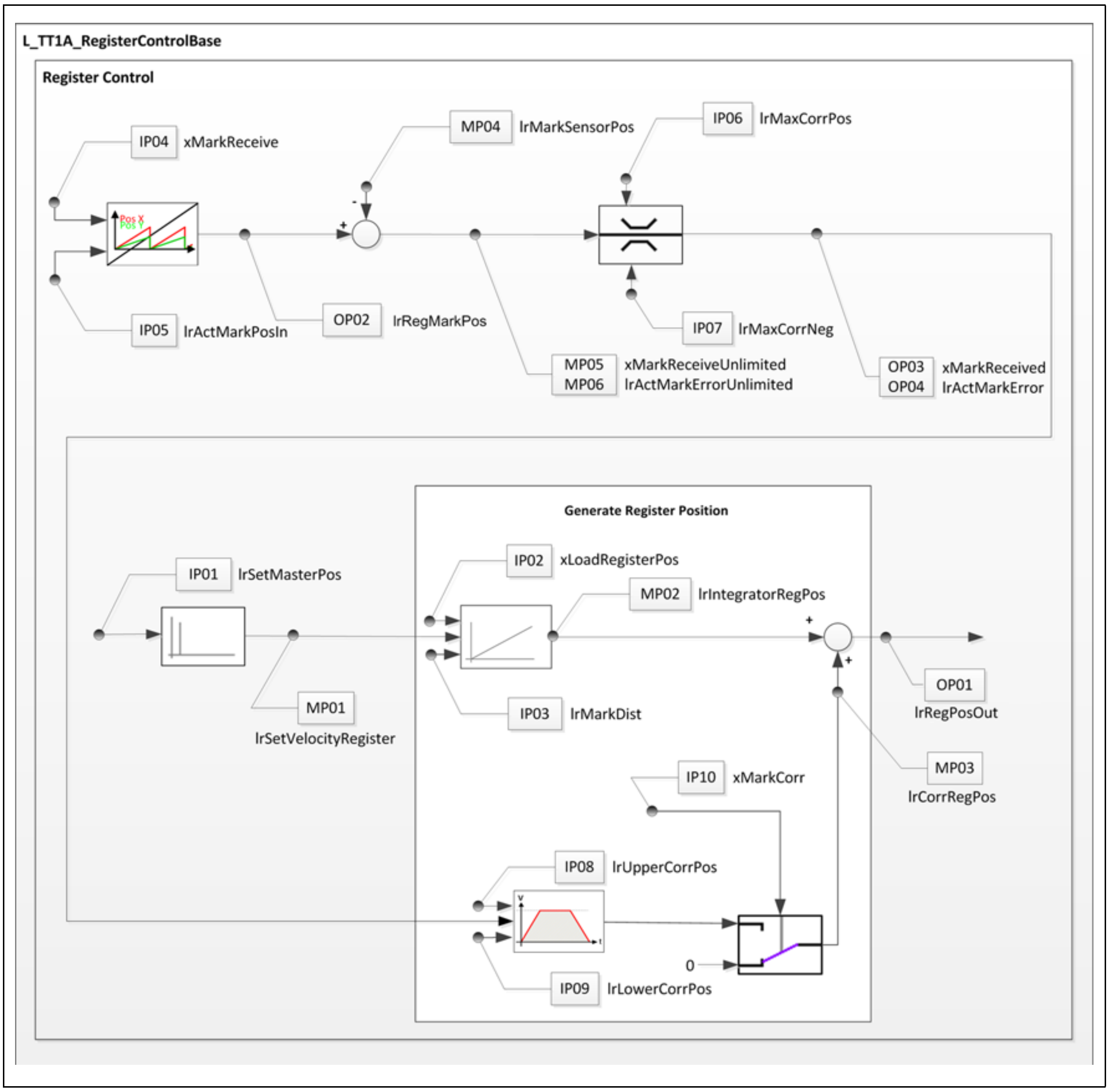
(*2 In the "ERROR" state, xResetError has to be set to TRUE in order to acknowledge and reset the errors.

3.5 Signal flow diagrams

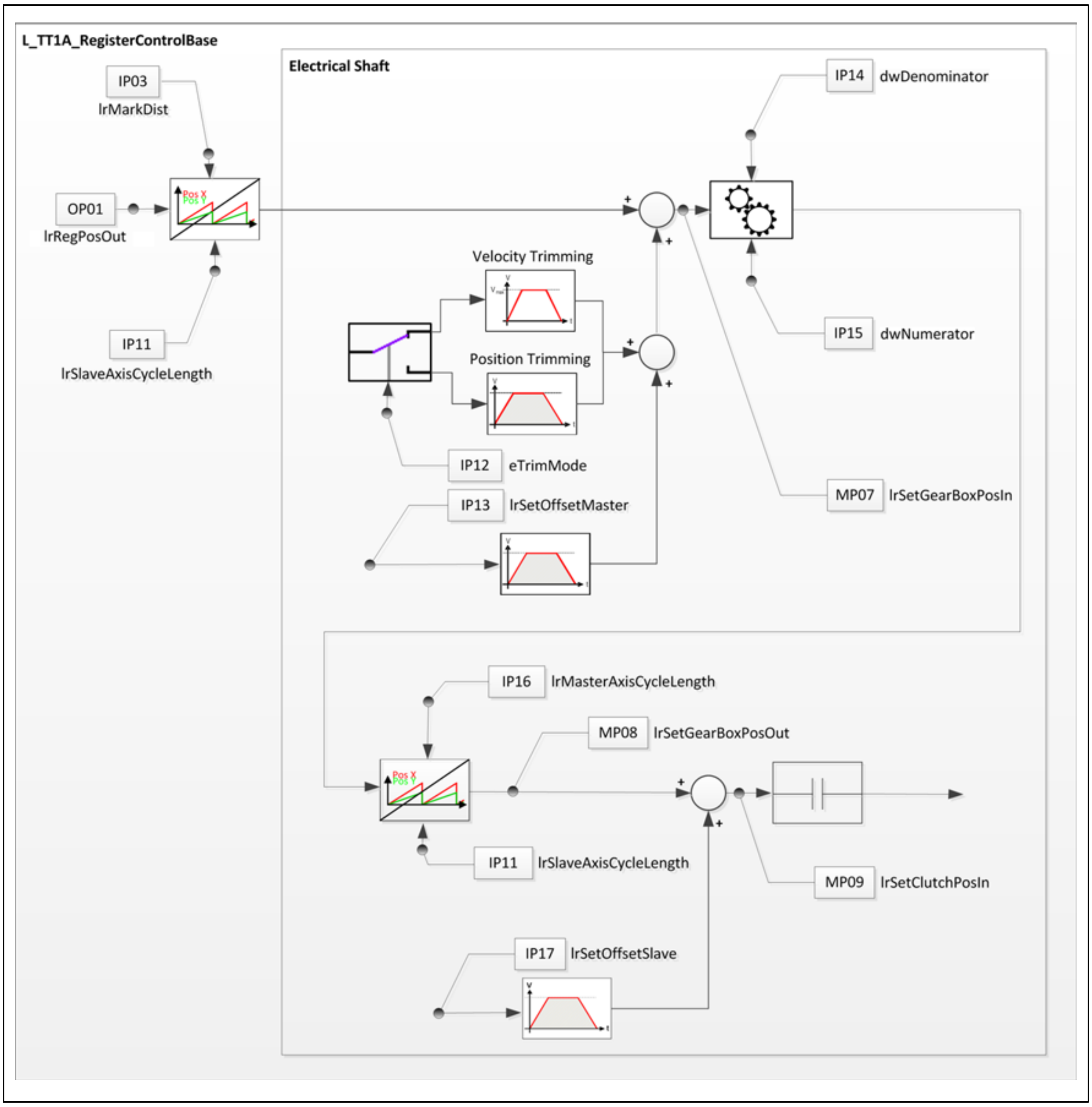
The illustrations show the main signal flow of the functions implemented.

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

3.5.1 Register Control Base version

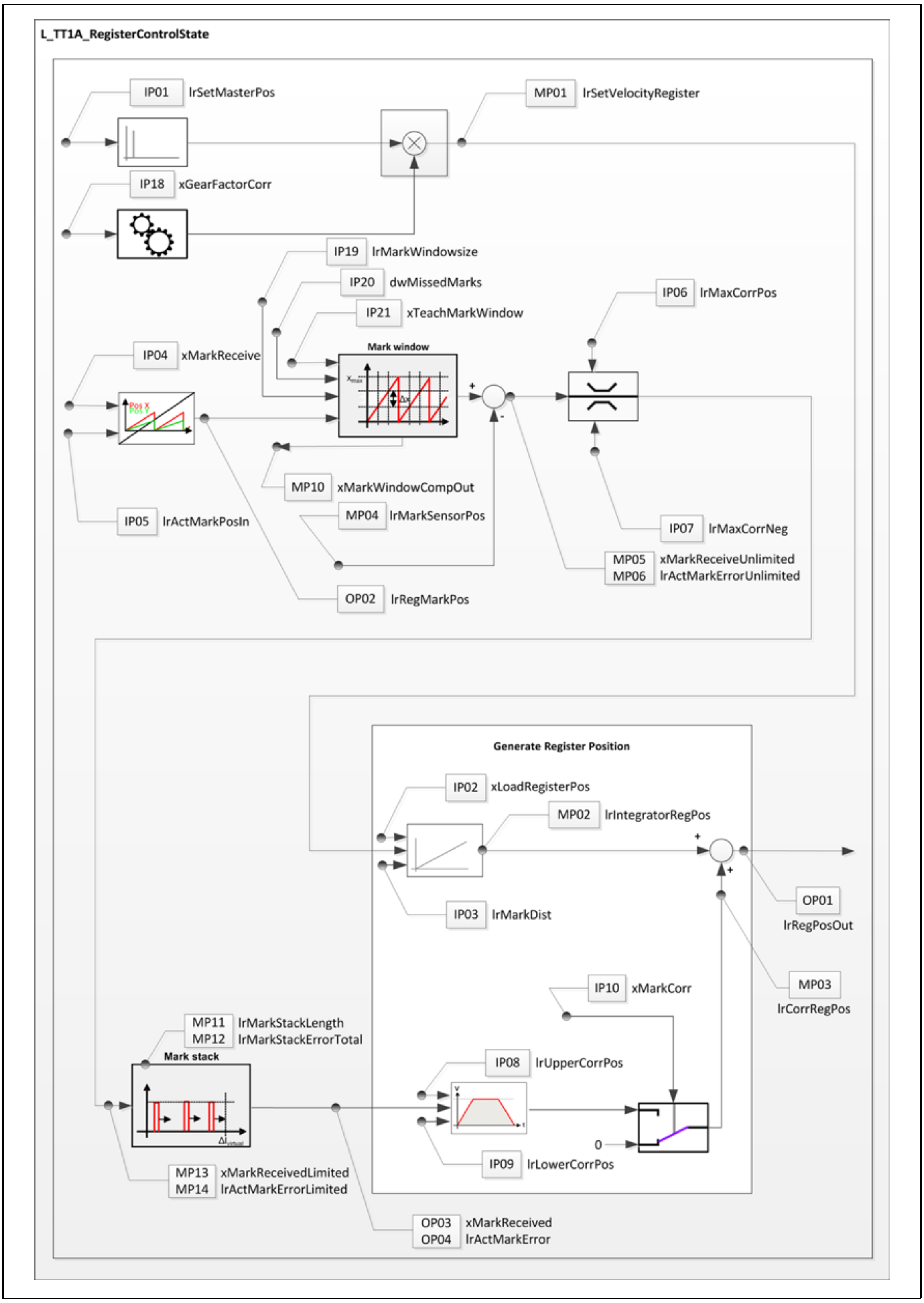


[3-3] Signal flow diagram: Register Control Base version - generation of the register position

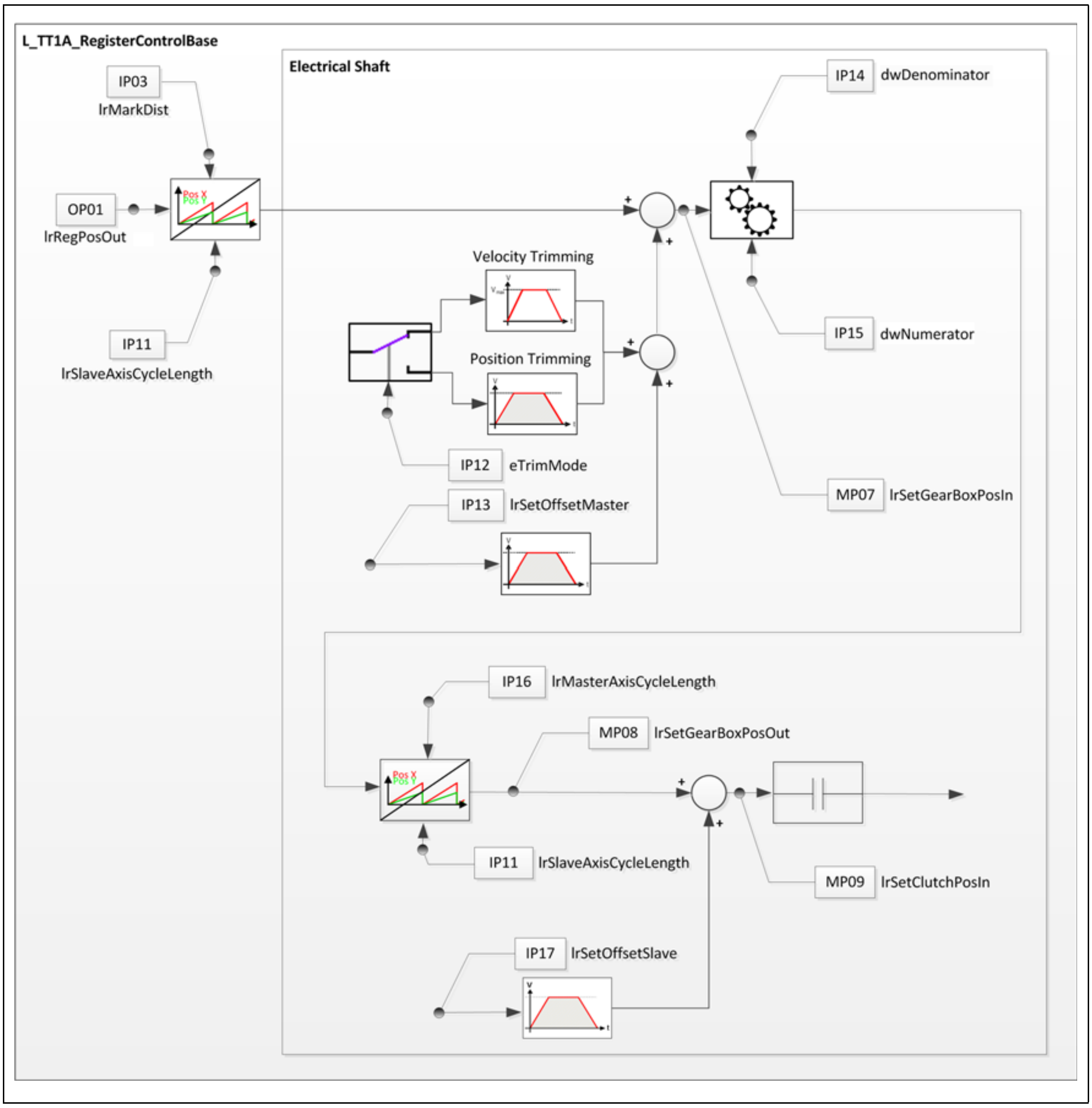


[3-4] Signal flow diagram: Register Control Base version - Electrical Shaft

3.5.2 Register Control State version



[3-5] Signal flow diagram: Register Control State version - generation of the register position



[3-6] Signal flow diagram: Register Control State version - Electrical Shaft

3.5.3 Structure of the signal flow

L_TT1P_scSF_RegisterControl[Base/State]

The contents of the **L_TT1P_scSF_RegisterControl[Base/State]** structure are read-only and offer a practical diagnostics option within the signal flow (Signal flow diagrams (📖 26)).

Designator / Data type	Description		Available in version: Base	Available in version: State
IP01_lrSetMasterPos LREAL	Set position of the master axis • Unit: units		●	●
IP02_xLoadRegisterPos BOOL	TRUE	Select the register position manually: The register position is evaluated using the position at the lrSetRegisterPos input. The input is only evaluated in the declutched state.	●	●
IP03_lrMarkDist LREAL	Register length in units of the measuring system of the master axis • Unit: units • Initial value: 360.0		●	●
IP04_xMarkReceive BOOL	TRUE	A touch probe mark has been detected in the connected touch probe sensor.	●	●
IP05_lrActMarkPosIn LREAL	Current touch probe position with regard to the axis reference used. • Unit: units		●	●
IP06_lrMaxCorrPos LREAL	Maximum positive correction distance per register cycle • Unit for axis: units • Unit for register: mm • Initial value: 30.0		●	●
IP07_lrMaxCorrNeg LREAL	Maximum negative correction distance per register cycle • Unit for axis: units • Unit for register: mm • Initial value: -30.0		●	●
IP08_lrUpperCorrPos LREAL	Upper limit value of the correction window for the compensating movement of the touch probe correction The window must not amount to the entire cycle length. • Unit for axis: units • Unit for register: mm • Initial value: 180		●	●
IP09_lrLowerCorrPos LREAL	Lower limit value of the correction window for the compensating movement of the touch probe correction • Unit for axis: units • Unit for register: mm • Initial value: 90		●	●
IP10_xMarkCorr BOOL	TRUE	Activate touch probe correction. • Initial value: TRUE	●	●
IP11_lrSlaveAxisCycleLength LREAL	Cycle length of the slave axis • Unit: units		●	●
IP12_eTrimMode L_TT1P_TrimMode	Type of trimming • Initial value: 0		●	●
	0	Trimming via speed profile		
	1	Trimming via positioning profile (with lrTrimDist increment)		

<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>IP13_lrSetOffsetMaster
LREAL</td><td colspan="2">Position offset of the master axis
• When xLoadOffsetMaster = TRUE. the offset is loaded cyclically.
• When xLoadOffsetMaster = FALSE, the offset is run via the profile generator.
• The position is approached in the "POS_IS_SYNCHRONISED" state (slave is clutched in) when the value changes.
• Unit: units (unit of the register)</td><td>●</td><td>●</td></tr>
<tr><td>IP14_dwDenominator
DWORD</td><td colspan="2">This value is included in the resulting synchronous factor as denominator term.</td><td>●</td><td>●</td></tr>
<tr><td>IP15_dwNumerator
DWORD</td><td colspan="2">This value is included in the resulting synchronous factor as numerator term.</td><td>●</td><td>●</td></tr>
<tr><td>IP16_lrMasterAxisCycle Length
LREAL</td><td colspan="2">Cycle length of the master axis
• Unit: units</td><td>●</td><td>●</td></tr>
<tr><td>IP17_lrSetOffsetSlave
LREAL</td><td colspan="2">Position offset of the slave axis
• When xLoadOffsetSlave = TRUE, the offset is loaded cyclically.
• When xLoadOffsetSlave = FALSE, the offset is run via the profile generator.
• The position is approached in the "POS_IS_SYNCHRONISED" state (slave is clutched in) when the value changes.
• Unit: units</td><td>●</td><td>●</td></tr>
<tr><td>IP18_xGearFactorCorr
BOOL</td><td>TRUE</td><td>Activation of the gearbox factor correction (compensation of deviating register lengths)
• The speed setpoint is corrected by the medium difference of the touch probe correction values.
• The correction is active as long as the register control is activated (xSyncPos input = TRUE).</td><td></td><td>●</td></tr>
<tr><td>IP19_lrMarkWindowSize
LREAL</td><td colspan="2">Size of the touch probe window with regard to the register measuring system.
The touch probe window is put symmetrically around the expected touch probe position.
• Unit: mm
• Initial value: 90</td><td></td><td>●</td></tr>
<tr><td>IP20_dwMissedMarks
DWORD</td><td colspan="2">Maximum number of permitted touch probe failures
If no touch probe is detected within the touch probe window, an artificial mark is generated.
This happens as long as the number of marks set here is not exceeded.
If the number of marks was exceeded, the xError output is set to TRUE.
• Initial value: 3</td><td></td><td>●</td></tr>
<tr><td>IP21_xTeachMarkWindow
BOOL</td><td>TRUE</td><td>The touch probe window is saved. (teaching function for setting-up operation)
• Behaviour in <u>declutched</u> state:
When a touch probe mark has been detected, the touch probe window is adjusted to the position of the detected mark and activated. In addition, the register position is set to the value of the internally calculated setpoint position of the sensor.
• Behaviour in <u>clutched-in</u> state:
When a touch probe mark has been detected, the touch probe window is adjusted to the position of the detected mark and activated.
After successful execution, the xMarkWindowTeached output is set to TRUE.</td><td></td><td>●</td></tr>
<tr><td>MP01_lrSetVelocityRegister
LREAL</td><td colspan="2">Input velocity of the integrator for creating the register position
• Unit: units/s</td><td>●</td><td>●</td></tr>
</table>

Designator Data type	Description		Available in version	
			Base	State
MP02_lrIntegratorRegPos LREAL	Integrator position of the register • Unit: units		●	●
MP03_lrCorrRegPos LREAL	Position profile of the correction motion (is added to the integrator position of the register) • Unit: units		●	●
MP04_lrMarkSensorPos LREAL	The internally calculated position within the register cycle on which the touch probe mark is expected. • Unit: units		●	●
MP05_xMarkReceived Unlimited BOOL	TRUE	A touch probe signal has been detected before the mark error limitation.	●	●
MP06_lrActMarkError Unlimited LREAL	Deviation (touch probe error) before the mark error limitation • Unit: mm		●	●
MP07_lrSetGearBoxPosIn LREAL	Position setpoint at the input of the gearbox in units of the measuring system of the master axis • Unit: units		●	●
MP08_lrSetGearBoxPosOut LREAL	Position setpoint at the output of the gearbox in units of the measuring system of the slave axis • Unit: units		●	●
MP09_lrSetClutchPosIn LREAL	Position value at the clutch input In order to enable a "hard" clutching-in, the declutched slave first has to be driven to this position. Afterwards, hard clutching-in is possible without causing a position jump of the slave axis setpoint position.		●	●
MP10_xMarkWindowComp Out BOOL	Velocity-compensated touch probe window This signal can be used, for instance, to display whether a detected touch probe mark is within or outside the touch probe window.			●
	TRUE	The detected touch probe signal is valid (within the touch probe window).		
MP11_lrMarkStackLength LREAL	Number of fields for saving the mark positions • Example: 2 = two mark positions are saved.			●
MP12_lrMarkStackErrorTotal LREAL	Sum of the touch probe error saved in the mark error memory			●
MP13_xMarkReceived Limited BOOL	TRUE	A touch probe signal has been detected after the mark error limitation.		●
MP14_lrActMarkError Limited LREAL	Deviation (touch probe error) at the output of the mark error limitation • Unit: mm			●
OP01_lrRegPosOut LREAL	Setpoint position of the register for register control The setpoint position is always within a rotary modulo cycle with the cycle length of the lrMarkDist parameter. • Unit: units		●	●
OP02_lrRegMarkPos LREAL	The converted actual position of the current touch probe mark within the register cycle • Unit: units		●	●

Designator Data type	Description		Available in version: Base	Available in version: State
OP03_xMarkReceived BOOL	TRUE	A touch probe signal has been detected. • **Base:** xMarkReceived corresponds to the output at the limitation module. • **State:** xMarkReceived corresponds to the output at the touch probe module.	●	●
OP04_lrActMarkError LREAL	Current deviation between detected touch probe mark and expected touch probe position • **Base:** lrActMarkError corresponds to the touch probe error at the output of the limitation module. • **State:** lrActMarkError corresponds to the touch probe error at the output of the touch probe module. • Unit: mm		●	●

3.5.4 Structure of the access points

L_TT1P_scAP_RegisterControl[Base/State]

The access points (AP) can be used to influence signals. In the initial state, the access points do not have any effect.

Each access point acts as an alternative branch and is activated via an OR operation or a switch.

Designator Data type	Description		Available in version: Base	Available in version: State
AP01_xLoadGearBoxPosOut BOOL	Enable of the AP01_lrLoadGearBoxPosOut access point		●	●
	TRUE	The access point overwrites the values at the access point in the signal flow.		
AP01_lrLoadGearBoxPosOut LREAL	Loading of the resulting position from the gearbox • Unit: units			
AP02_xLoadTrimOffset BOOL	Enable of the AP02_lrLoadTrimOffset access point		●	●
	TRUE	The access point overwrites the values at the access point in the signal flow.		
AP02_lrLoadTrimOffset LREAL	Loading of the resulting distance from the trimming function • Unit: units			
AP05_xLoadOffsetSync BOOL	Enable of the AP05_lrLoadOffsetSync access point		●	●
	TRUE	The access point overwrites the values of the synchronisation offset.		
AP05_lrLoadOffsetSync LREAL	Loading the synchronisation offset			

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 (📖 25) changes to the "Ready" state again.

Parameters to be set

The parameters for the manual jog are located in the L_TT1P_scPar_RegisterControl[Base/State] (📖 20) 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 (📖 25) 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_RegisterControl[Base/State] (📖 20) parameter structure.

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

3.8 Synchronism (SyncPos) with clutch-in/declutch mechanism

Execution

In order to obtain synchronism of the register and the slave axis, a register position is created within the technology module which serves as master position for the slave axis. The register position (*lrSetRegPosOut* output) is created by integrating the setpoint speed of the master axis within the register cycle (*lrMarkDist* parameter).

The clutch function synchronises the register position (master position) to the slave axis. Here, the positioning takes place without any position jump. Clutching-in starts at any position by setting the *xSyncPos* input = TRUE.

When declutching with *xSyncPos* = FALSE, the drive is braked to a standstill at the *lrSlaveSyncOutPos* position and changed to the "Ready" state.

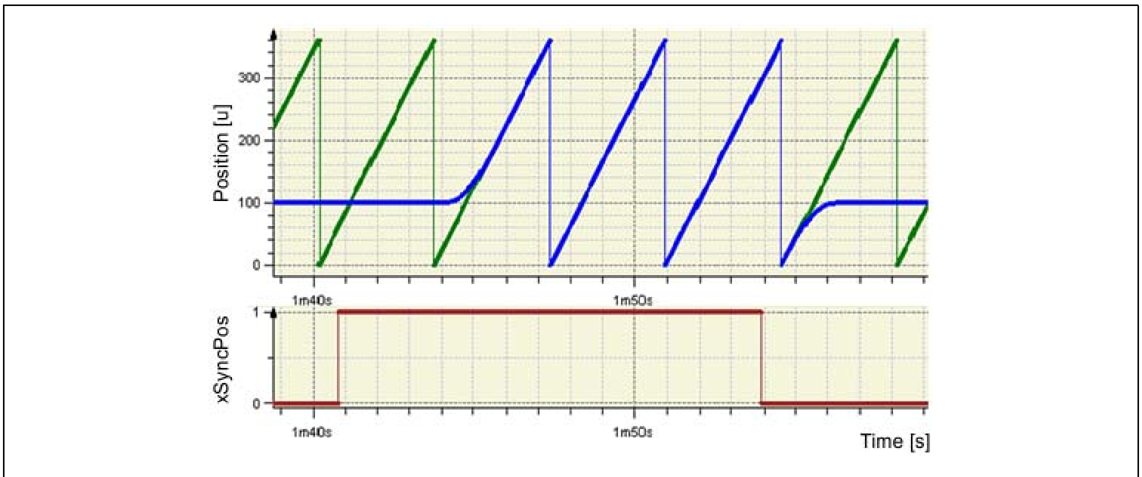
The *lrSlaveSyncInDist* parameters (for clutch-in) and *lrSlaveSyncOutDist* (for declutch) describe the path of the slave axis via which the clutch process shall take place. For the initial values of the parameters, the clutch process has to be completed after 90 units.

Parameters to be set

The parameters for the clutch function are located in the L_TT1P_scPar_RegisterControl[Base/State] (20) parameter structure.

```
lrSlaveSyncOutPos : LREAL := 0.0;
lrSlaveSyncInDist : LREAL := 90.0;
lrSlaveSyncOutDist : LREAL := 90.0;
```

Example



[3-7] Clutching-in/declutching with lrSlaveSyncOutPos = 100

The [3-7] figure shows the clutch-in process on position 100.0 which is completed within 90 units. After declutching, it ends again on position 100.0 after 90 units.

3.8.1 Direct clutching-in/declutching

The clutch function also provides for a direct clutching-in/declutching. For this purpose, set the parameters *lrSlaveSyncInDist* and *lrSlaveSyncOutDist* to the value 0.0. Clutching-in is then executed directly and abruptly.

In order to prevent a jump of the position at the clutch output and thus at the slave axis, the following options are available:

- Positioning of the slave axis to the input position of the clutch (*MP09:lrSetClutchPosIn*) before clutching-in hard.
  This version offers a position synchronism without position offset between register and slave axis.
  More information on *MP09:lrSetClutchPos* can be found here:
  L_TT1P_scSF_RegisterControl[Base/State] (📖 30).
- Automatic calculation and definition of the gearbox position for direct clutch-in with *xLoadSyncPos parameter = TRUE*.
  This version offers a position synchronism with position offset between the register and slave axis. The resulting position offset can be eliminated afterwards by applying an offset.

3.8.2 Relative clutching-in/declutching

These functions are selected via inputs and not via selecting a coupling mode. The selection of the general coupling mode is not affected by this function.

When the *xSyncInstant* input = TRUE, the synchronisation is carried out with relative position coupling.

- If the master axis is at standstill, the slave axis directly (abruptly) clutches in to its current position.
- When the master axis is in motion, the slave axis immediately clutches in via the clutching distance in the *lrSlaveSyncInDist* parameter (by analogy with a velocity coupling).
- For declutching, the *xSyncInstant* input has no function.

When the *xSyncOutInstant* input = TRUE, it is declutched with relative position coupling.

- If the master axis is at standstill, the slave axis directly (abruptly) declutches from its current position.
- When the master axis is in motion, the slave axis immediately declutches via the clutching distance in the *lrSlaveSyncOutDist* parameter (by analogy with a velocity coupling or MC_Halt).
- For declutching, the *xSyncOutInstant* input has no function.

A position offset caused by relative clutching-in is displayed at the *lrOffsetSyncPos* output (in units).

Coupling behaviour if the inputs are stimulated at different times

Clutching-in via the *xSyncInstant* input:

Combinations of the inputs		Coupling behaviour
xSyncPos	**xSyncInstant**	
FALSE↗TRUE	FALSE	Coupling behaviour as before
FALSE	FALSE↗TRUE	No response
TRUE	FALSE↗TRUE	No response
FALSE↗TRUE	FALSE↗TRUE	Relative clutching-in
FALSE↗TRUE	TRUE	Relative clutching-in

Declutching via the *xSyncOutInstant* input:

Combinations of the inputs		Coupling behaviour
xSyncPos	**xSyncOutInstant**	
TRUE↘FALSE	FALSE	Coupling behaviour as before
TRUE↘FALSE	FALSE↗TRUE	Relative declutching
TRUE	FALSE↗TRUE	Relative declutching

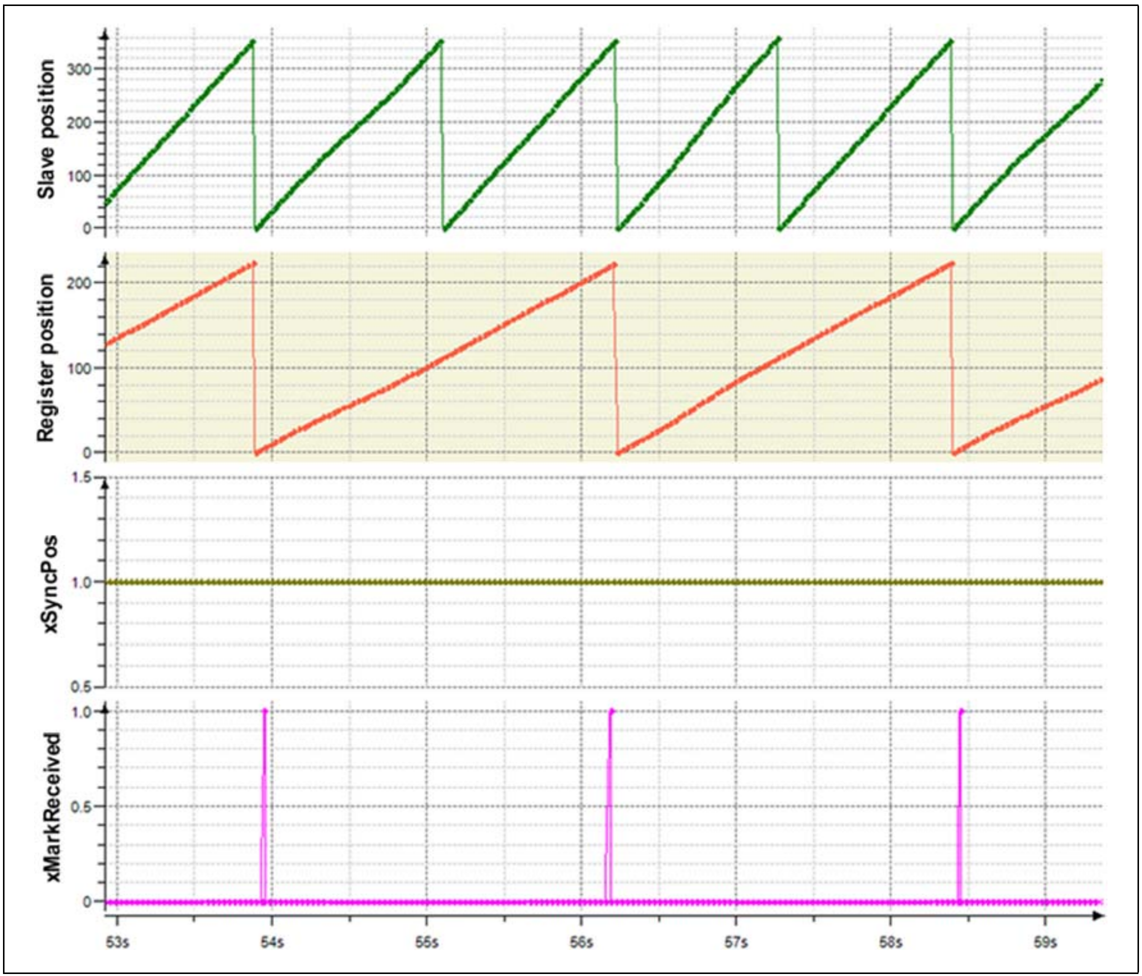
Parameters to be set

The parameters for the clutch function are located in the L_TT1P_scPar_RegisterControl[Base/State] (🕮 20) parameter structure.

```
lrSlaveSyncInDist : LREAL := 90.0;
lrSlaveSyncOutDist : LREAL := 90.0;
eOffsetSlaveDirection : L_TT1P_Direction := 1;
eOffsetSlaveProfileType : L_TT1P_ProfileType := 2;
lrOffsetSlaveVelPos : LREAL := 100;
lrOffsetSlaveVelNeg : LREAL := 100;
lrOffsetSlaveAccDec : LREAL := 1000;
```

3.9 Gearbox factor for different clock cycles

The technology module has a freely adjustable gearbox which can be used for parameter setting of different clock cycles between register and slave axis.



[3-8] Example: Gearbox factor (2 slave cycles / 1 register cycle)

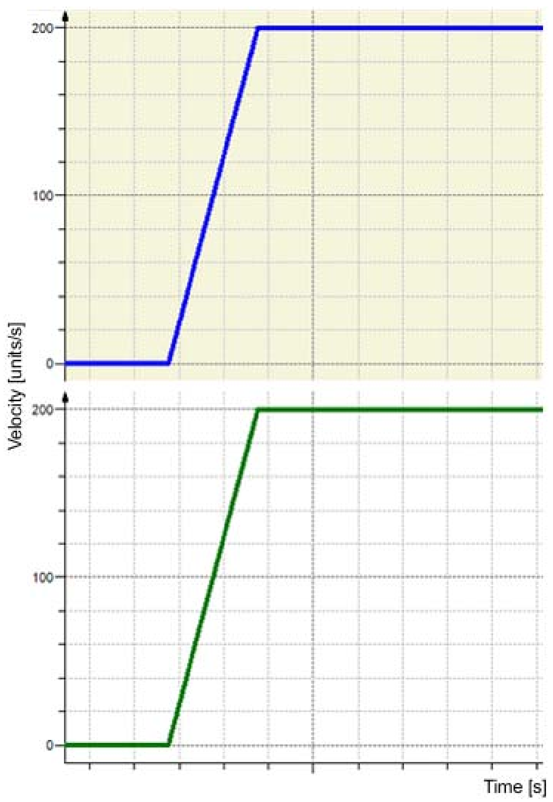
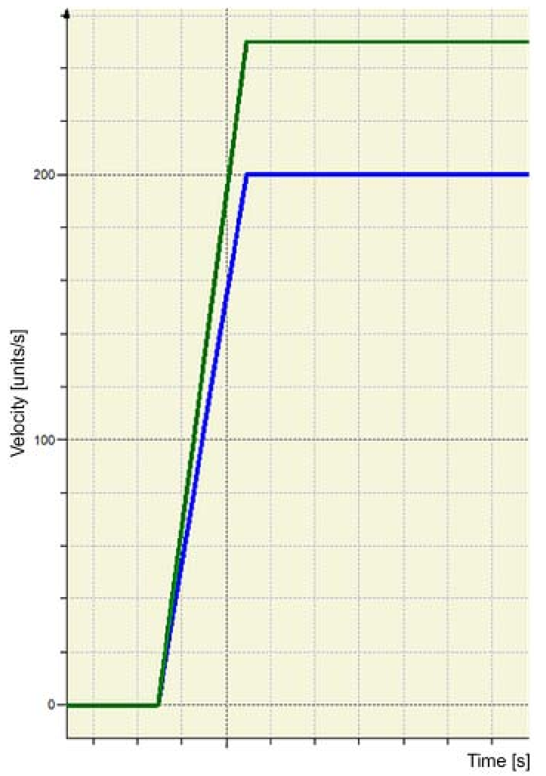
Parameters to be set

The parameters for the gearbox factor are located in the L_TT1P_scPar_RegisterControl[Base/State] (20) parameter structure.

```
dwNumerator : DWORD := 1;
dwDenominator : DWORD := 1;
```

Examples

Clutching the register and the slave axis results in a velocity synchronism.

Synchronism with identical cycle (360/360)	Synchronism with different cycle (360/450)
	

3.10 Position offset during synchronism

Note!

A position offset is set with a position jump.

Precondition

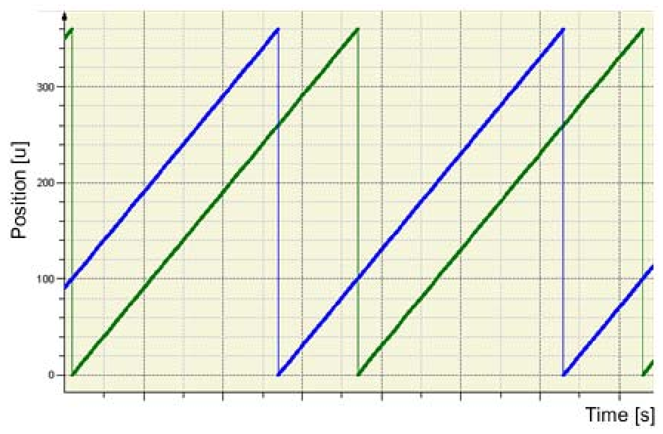
Setting a position offset is only possible in the "POS_IS_SYCHRONISED" state.

Execution

A variable position offset between master axis and slave axis is defined using the inputs *lrSetOffsetMaster* and *lrSetOffsetSlave*. Here, *lrSetOffsetMaster* is given in units of the register, *lrSetOffsetSlave* in units of the slave axis. Thus, it is possible, for instance, to trim an offset of the axes both in millimetres and degrees, depending on which selection is more appropriate in the respective application.

When being in the "POS_IS_SYNCHRONISED" state and the value changes, the offset is switched immediately to the setpoint position of the axis.

Example



[3-9] Position offset lrSetOffsetSlave = 100

3.11 Trimming

Precondition

Trimming is only possible in the "POS_IS_SYCHRONISED" state.

Execution

Trimming enables the position of the slave axis to be adjusted towards the master axis by "tipping" – as in case of Manual jog (jogging) (📖 34).

The *eTrimMode* parameter serves to change over between an "increment trimming" and a "speed trimming":

- For "increment trimming", the *lrTrimDist* parameter is used to define the increment to be trimmed.
- Velocity trimming is started by setting the input *xTrimPos* or *xTrimNeg* to TRUE. The "POS_IS_SYCHRONISED" state then changes to "TRIM_POS_PLUS" or "TRIM_POS_MINUS", depending on the direction, and only leaves it when the respective input *xTrimPos* or *xTrimNeg* is reset to FALSE.

Offsets adjusted by trimming can be detected via the *lrOffsetTrim* output. The value of *lrOffsetTrim* can be reset to zero by switching of the technology module.

Parameters to be set

The parameters for position trimming are located in the L_TT1P_scPar_RegisterControl[Base/State] (📖 20) parameter structure.

```
eTrimMode   : L_TT1P_TrimMode := 0;
lrTrimDist : LREAL := 1.0;
lrJerk     : LREAL := 10000;
lrTrimAcc  : LREAL := 100;
lrTrimDec  : LREAL := 100;
lrTrimVel  : LREAL := 50;
```

The acceleration and velocity of the trimming superimpose the ones of the master axis. Hence, the results for the axis to be trimmed are as follows:

- Resulting velocity of: $\mathbf{v_{AxisRes} = v_{MasterAxis} + lrTrimVel}$
- Resulting acceleration of: $\mathbf{a_{AxisRes} = a_{MasterAxis} + lrTrimAcc}$

3.12 Register control

As a higher-level control loop, the integrated register controller controls the position relatively to the mark detected on the material (touch probe). This serves to compensate mark deviations on the material with regard to the master position.

Touch probe source

The touch probe source for detecting the mark on the material is selected via the *eTPMode* parameter.

If an external encoder is used (*eTPMode* = 2), the *lrCycPosExtEncoder* input (cyclic position of the encoder) has to be interconnected and the *lrCycleLengthExtEncoder* parameter (cycle length of the encoder) has to be set. This information is required to convert the axis-side touch probe event to the internal register format.

The *lrCycleLengthExtEncoder* parameter is located in the L_TT1P_scPar_RegisterControl[Base/State] (📖 20) parameter structure.

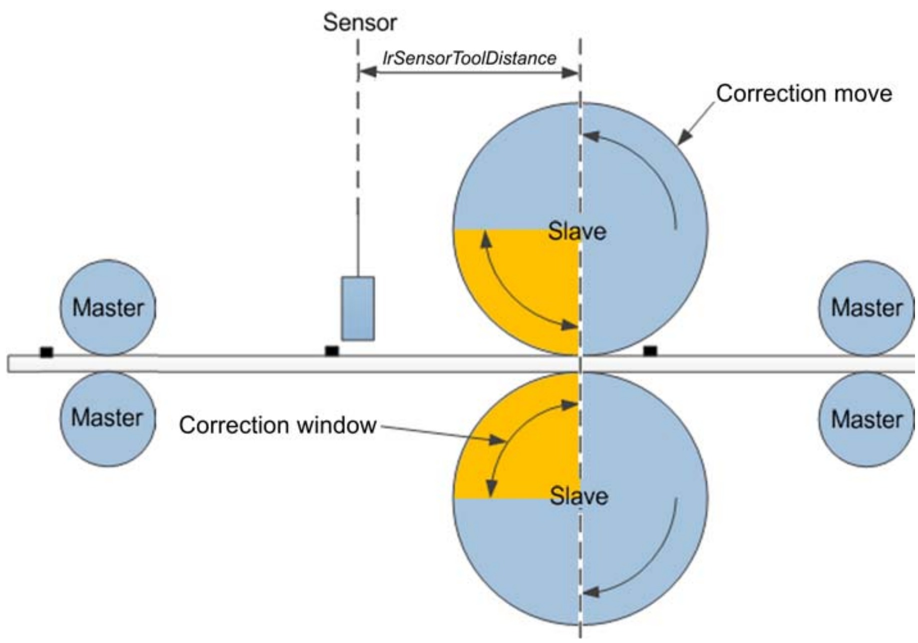
Correction window for the position of the register or axis

The *eSourceForCorrWindow* parameter serves to specify whether the position of the correction window is to refer to the position of the register, the master axis or the slave axis.

The position of the correction window is specified via the parameters *lrUpperCorrPos* and *lrLowerCorrPos*. These parameters are parameterised in the unit of the measuring system used (e.g. register in mm, master/slave axis in units).

In the *lrSensorToolDistance* parameter, the distance between the touch probe sensor and the attack position of the tool (e. g. cutting blade, printheads) on the material is set in units.

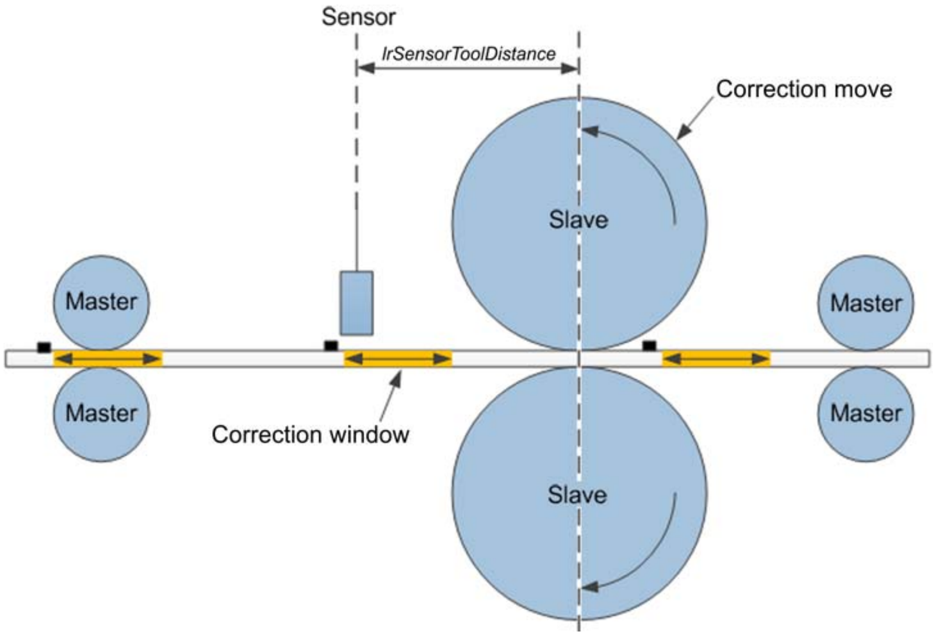
In the standard setting, the correction window refers to the position and the units of the slave axis (fig. [3-10]).



eSourceForCorrWindow = slave

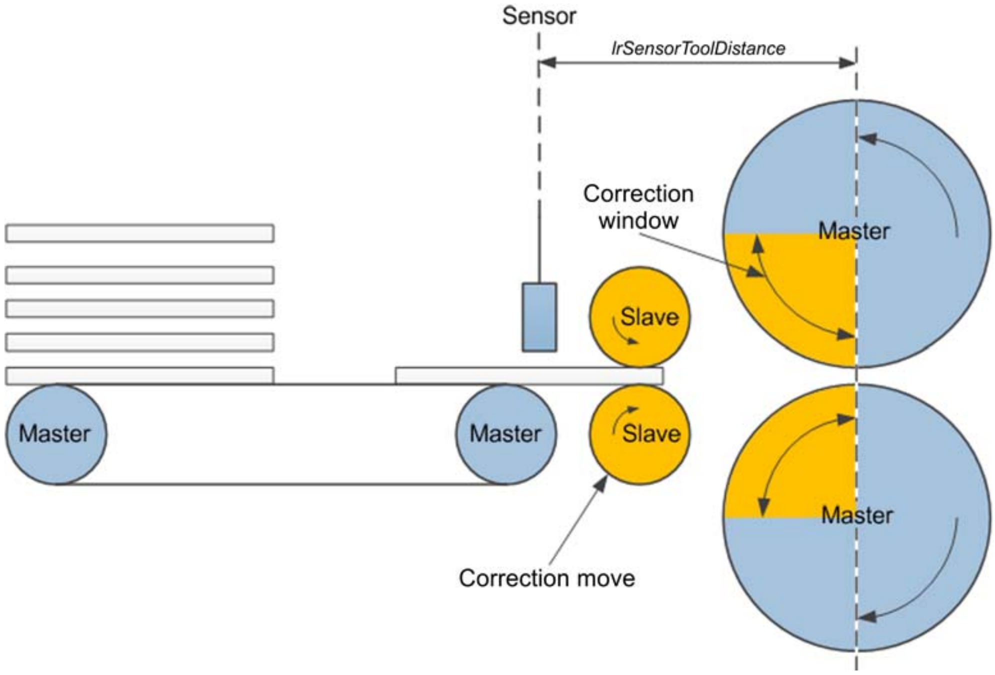
[3-10] Correction window to slave axis

If the correction window is not to be parameterised to the position and the units of the slave axis, select via the *eSourceForCorrWindow* whether the correction window refers to the position and the units of the register (Fig. [3-11]) or the master axis (Fig. [3-12]).



eSourceForCorrWindow = register

[3-11] Correction window to register



eSourceForCorrWindow = master

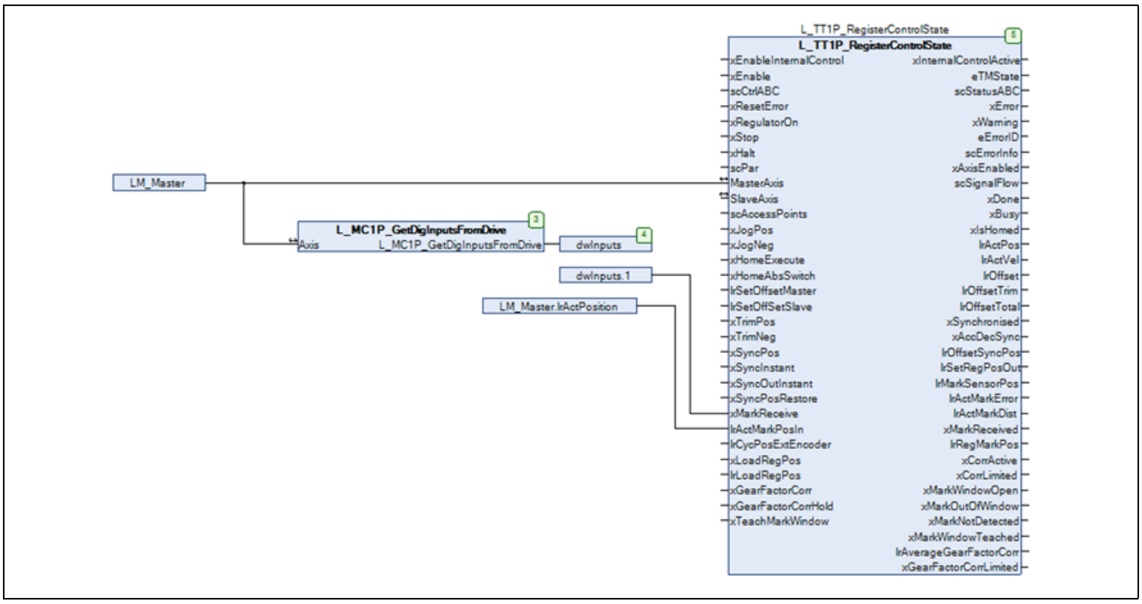
[3-12] Correction window to master axis

Sensor connection

For detecting the product error, the mark sensor must be connected logically to the technology module.

Interconnection example 1: Digital input without touch probe

Can be used if no touch probe accuracy is required (position error is detected with the accuracy of the used task cycle time).



Inputs:

```
xMarkReceive = digital input to which the sensor is connected.
lrActMarkPosIn = SlaveAxis.lrActPosition
```

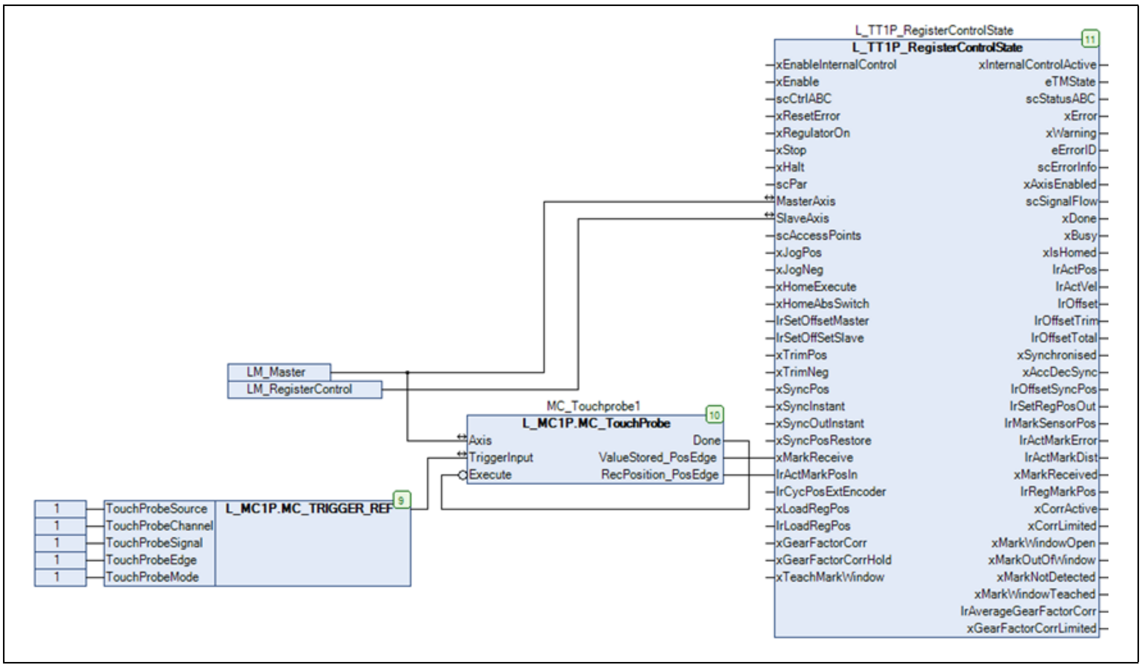
Parameters to be set:

```
eTpMode = L_TT1P_TpMode.TpFromMaster;
```

Interconnection example 2: Touch probe of the master axis

Can be used if ...

- a touch probe accuracy is required and ...
- a digital input of the master axis is used.



Inputs:

```
xMarkReceive = MC_Touchprobe.ValueStored_PosEdge;
lrActMarkPosIn = MC_Touchprobe.RecPosition_PosEdge
```

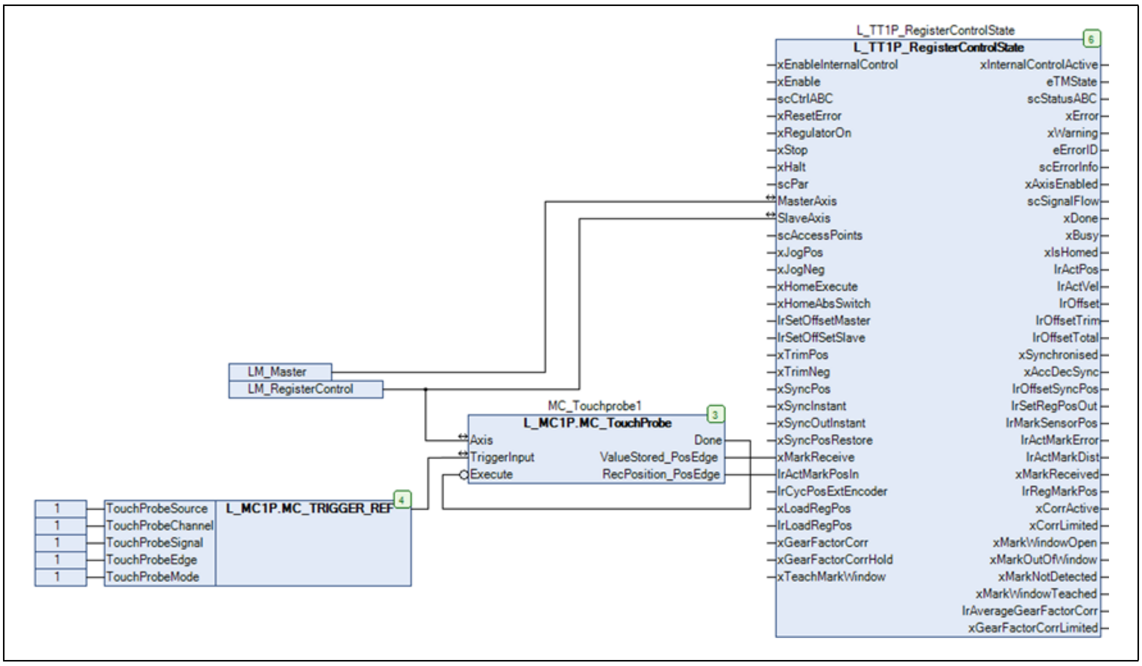
Parameters to be set:

```
eTpMode = L_TT1P_TpMode.TpFromMaster;
```

Interconnection example 3: Touch probe of the slave axis

Can be used if ...

- a touch probe accuracy is required and ...
- a digital input of the slave axis is used.



Inputs:

```
xMarkReceive = MC_Touchprobe.ValueStored_PosEdge;
lrActMarkPosIn = MC_Touchprobe.RecPosition_PosEdge
```

Parameters to be set:

```
eTpMode = L_TT1P_TpMode.TpFromSlave;
```

3.13 Teaching function

The teaching function is executed by setting the *xTeachMarkWindow* input = TRUE.

Here, the touch probe window is put with the width in *lrMarkWindowSize* parameter symmetrically (+/- *lrMarkWindowSize* / 2) around the current touch probe mark.

The current register position is set to the internally calculated value of the sensor position.

The *lrActMarkDist* output contains the register length between the last two touch probe marks in units (units of the master axis).

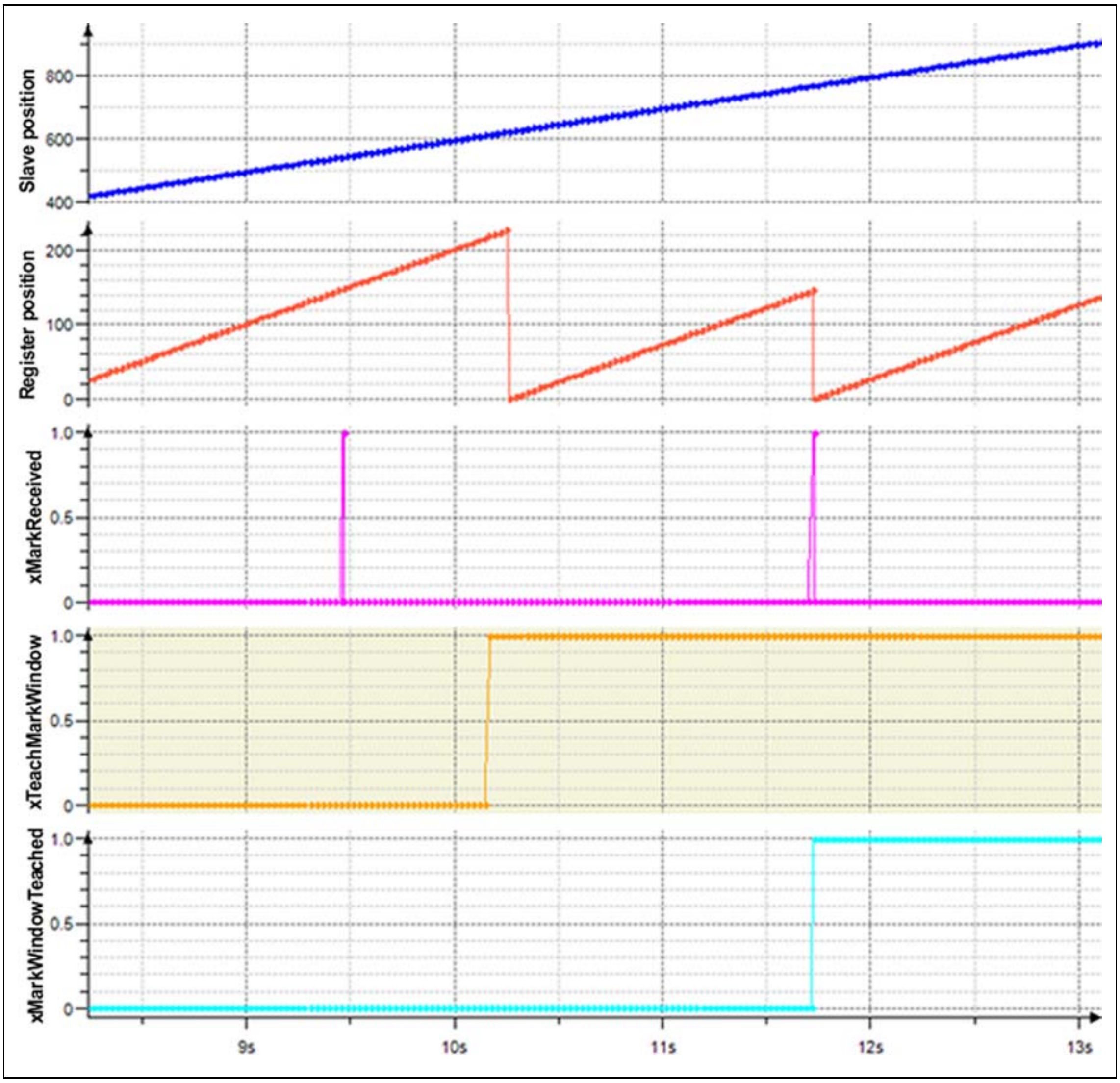
The *lrMarkDist* parameter corresponds to the register length in units.

Alternatively to teaching, you can also enter the width of the touch probe window manually into the *lrMarkWindowSize* parameter.

Parameters to be set

The parameters for the teaching function are located in the L_TT1P_scPar_RegisterControl[Base/State] (📖 20) parameter structure.

```
lrMarkWindowSize : LREAL := 90;   // [mm]
lrMarkDist : LREAL := 360.0;      // [units]
```



[3-13] Signal characteristic when the teaching function is executed (xTeachMarkWindow = TRUE)

3.14 Touch probe failure detection

When the *xMarkNotDetected* output is set to TRUE, no touch probe is detected within the parameterised touch probe window. In this case, an ideal virtual mark is created for the system in order that downstream functions can continued to be executed.

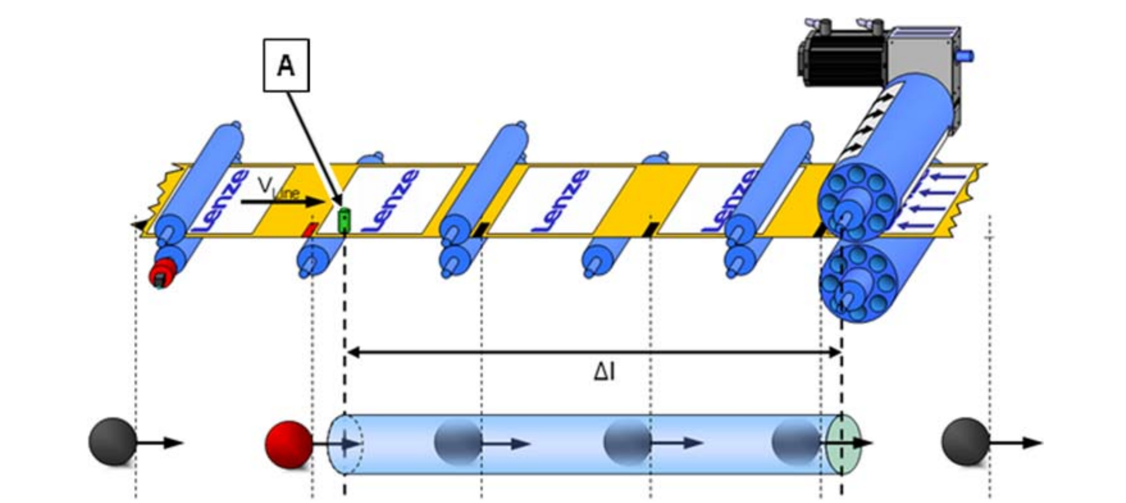
The *dwMaxMissedMarks* parameter serves to define the maximum number of virtual marks that may occur successively. The current actual position of the touch probe is assumed on the exact position of the touch probe sensor. Thus, there is no compensating movement for the register cycles in which virtual marks occur.

If the number of successively occurring virtual marks is exceeded, the technology module is set to the "ERROR" state and an error message is output.

3.15 Mark register

The mark register enables the mark sensor to be mounted more than one register cycle away from the axis with the tool (e.g. cutting blade, printheads).

Figure [3-14] shows the use of a mark register. Here, the distance of the mark sensor to the tool is greater than the set register cycle.

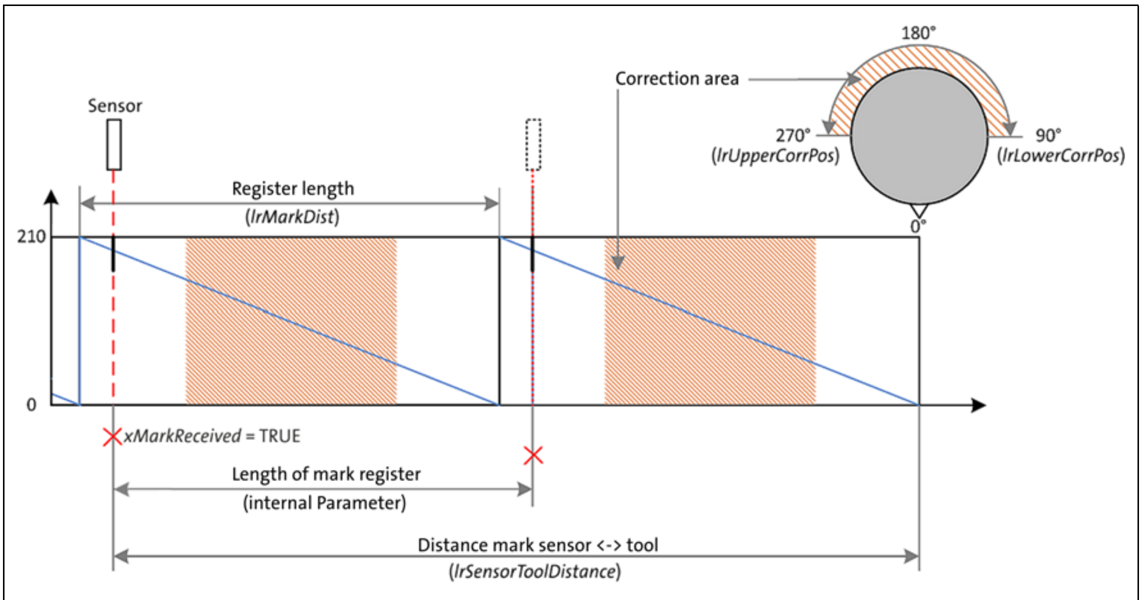


A Mark sensor (touch probe sensor)

[3-14] Systematic representation of the mark register

The target should always be to mount the mark sensor as close as possible to the axis. The farther away the mark sensor is mounted from the axis, the more changes in the material flow remain undetected and cause cutting inaccuracy.

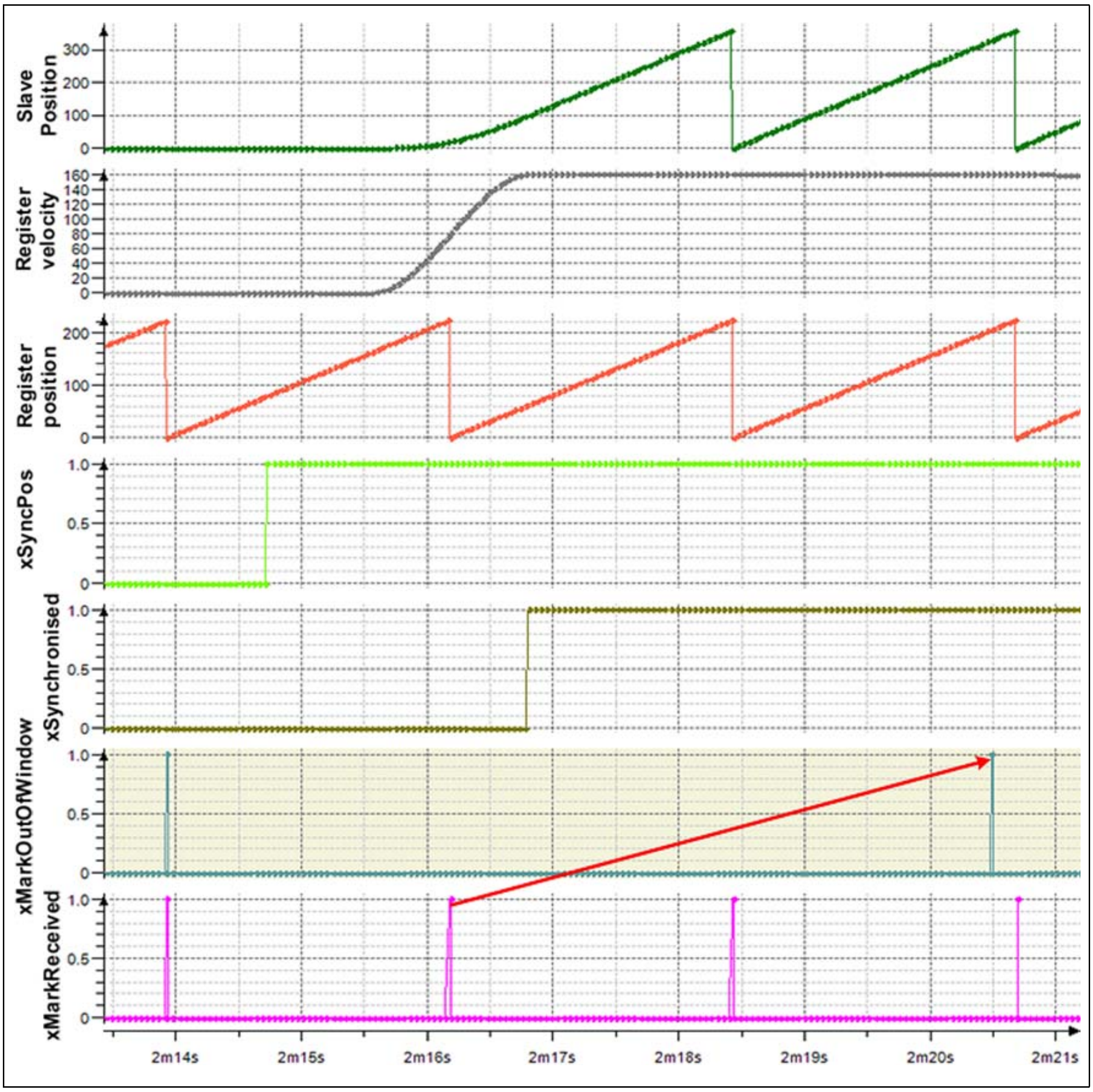
In the mark register, up to 64 mark signals can be managed. These are available for the system at the right time delayed by the mark register length. Thus, for instance, a cut can always be triggered by the correct mark signal.



[3-15] Mark register with correction areas

The distance of the touch probe sensor to the attack position of the tool on the material is defined via the *lrSensorToolDistance* parameter.

After a mark has been detected, the value of the mark deviation will only be enabled after the position in the register cycle has covered the distance of the mark register.

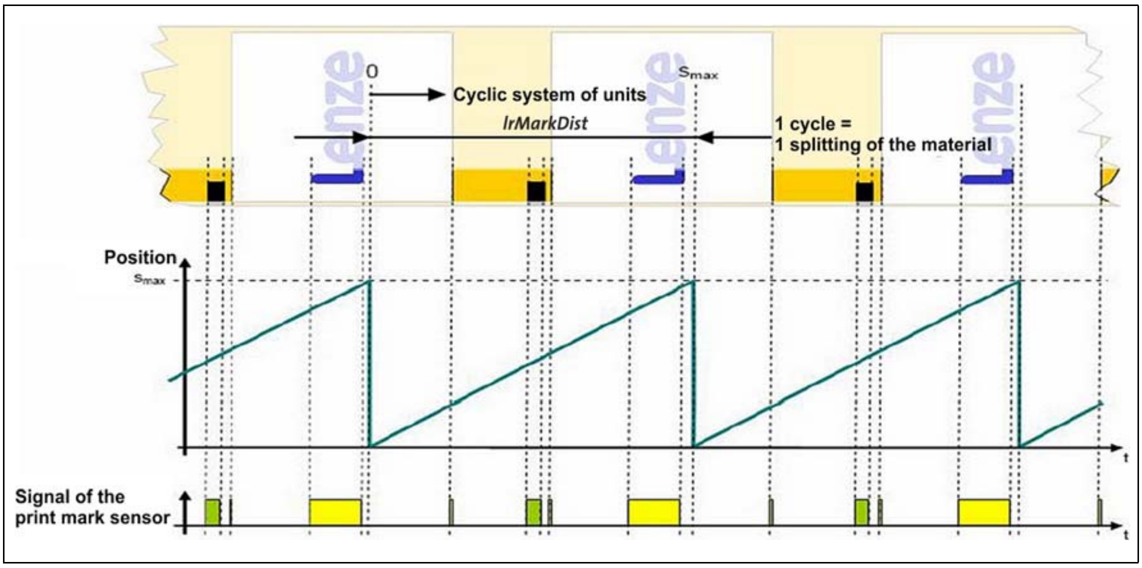


[3-16] Signal characteristic when the mark register is used

3.16 Hiding marks

In case of print images, not only the print marks themselves may be located in the scanning field of the print-mark sensor but also parts of the print image or other interfering signals.

Figure [3-17] shows how the signal characteristic of the print marks is filtered.



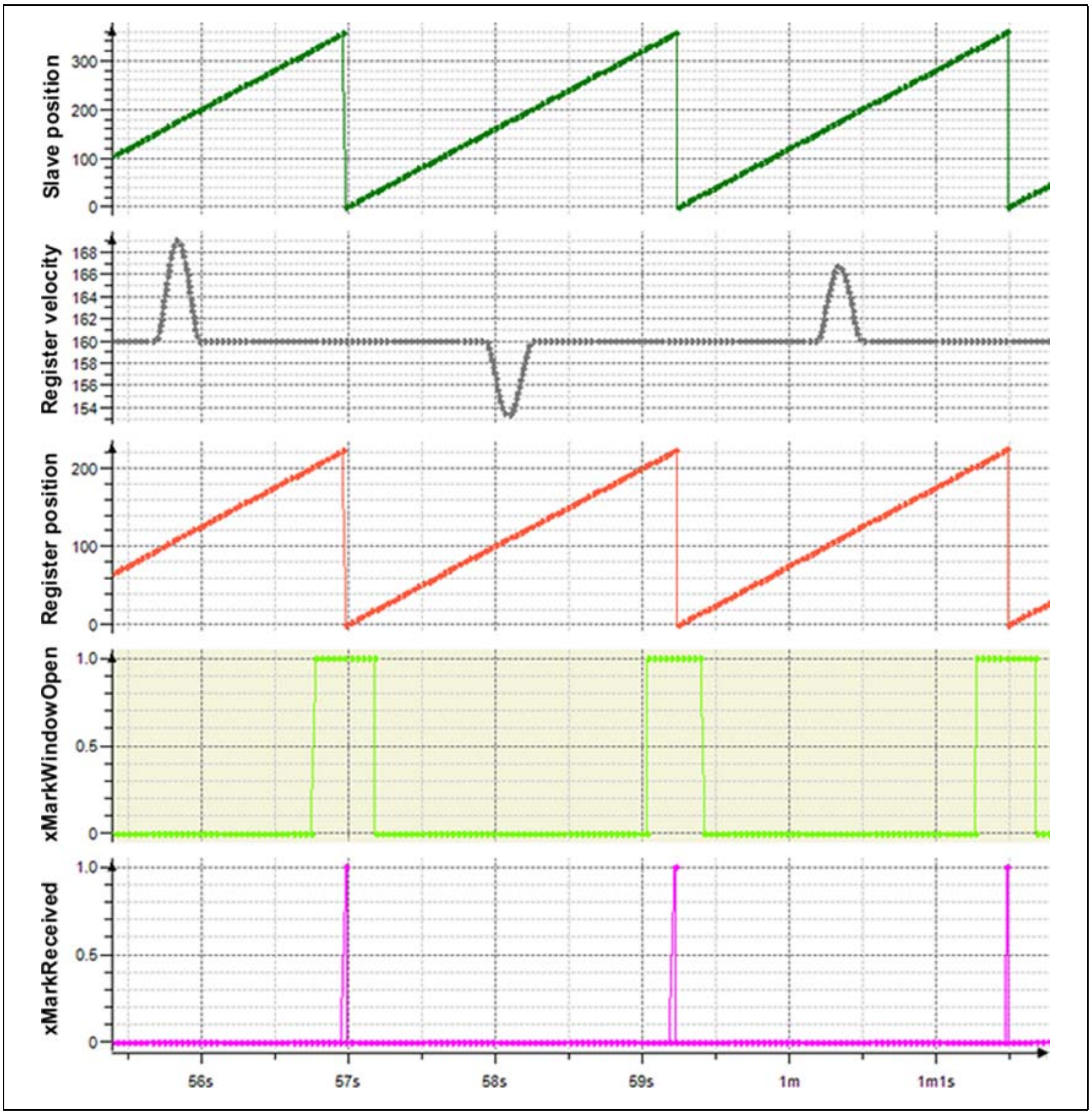
[3-17] Signal characteristic of the print marks

Figure [3-17] shows that in addition to the valid print-mark signals (highlighted in green) resulting from the print marks, invalid signals (highlighted in yellow) occur as well.

The *IrMarkDist* parameter corresponds to the register length in units.

The *lrMarkWindowSize* parameter defines the window around the touch probe setpoint position (setpoint position of the mark). As long as the *xMarkWindowOpen* output remains set to TRUE, the window is active. Touch probe signals (marks) outside of this window are hidden.

The *lrSetOffsetMarkWindow* parameter serves to define an offset for shifting the window (with regard to the register measuring system).



[3-18] Signal characteristic for a defined touch probe window (lrMarkWindowSize)

Parameters to be set

The parameters to be set are located in the L_TT1P_scPar_RegisterControl[Base/State] (📖 20) parameter structure.

```
lrMarkWindowSize : LREAL := 90;   // [mm]
lrSetOffsetMarkWindow : LREAL := 0  // [mm]
lrMarkDist : LREAL := 360.0;      // [units]
```

3.17 Gearbox factor correction

Changing register properties (e.g. within a paper roll) leads to a changed real register length. The difference with respect to the parameterised register length (*lrMarkDist*) in turn causes corrections in always the same direction (positive/negative). This is inefficient and causes increased energy consumption and an increased mechanical load.

For this case, the gearbox factor correction calculates the optimal speed setpoint of the master axis. This optimisation causes the corrections to be carried out equally in the positive and negative direction.

The correction value is calculated from the mean value of the touch probe deviations. It multiplicatively affects the setpoint speed of the master axis via an additional correction gearbox factor.

The gearbox factor correction is activated when the *xGearFactorCorr* input = TRUE and remains active until the *xSyncPos* input is set to TRUE.

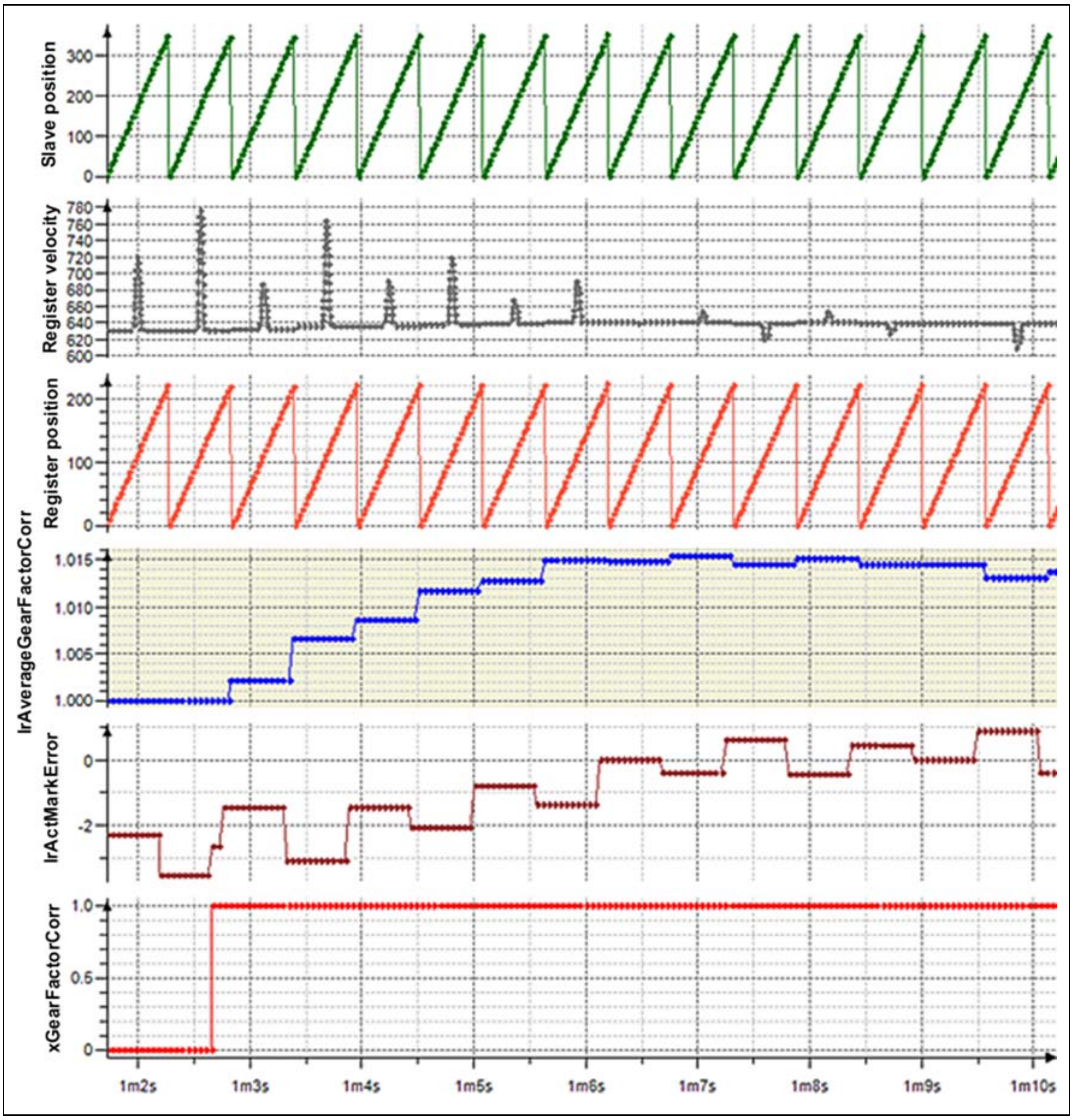
The gain of the gearbox factor correction is set via the gain factor in the *lrGearFactorCorrGain* parameter. When the gearbox factor correction is activated, the current value of the corrected gearbox factor is provided via the *lrAverageGearFactorCorr* output.

The maximum value of the gearbox factor correction is defined using the *lrMaxGearFactorCorr* parameter. If the gearbox factor correction operates at the positive or negative limit, this will be displayed via the *xGearFactorCorrLimited* output.

Parameters to be set

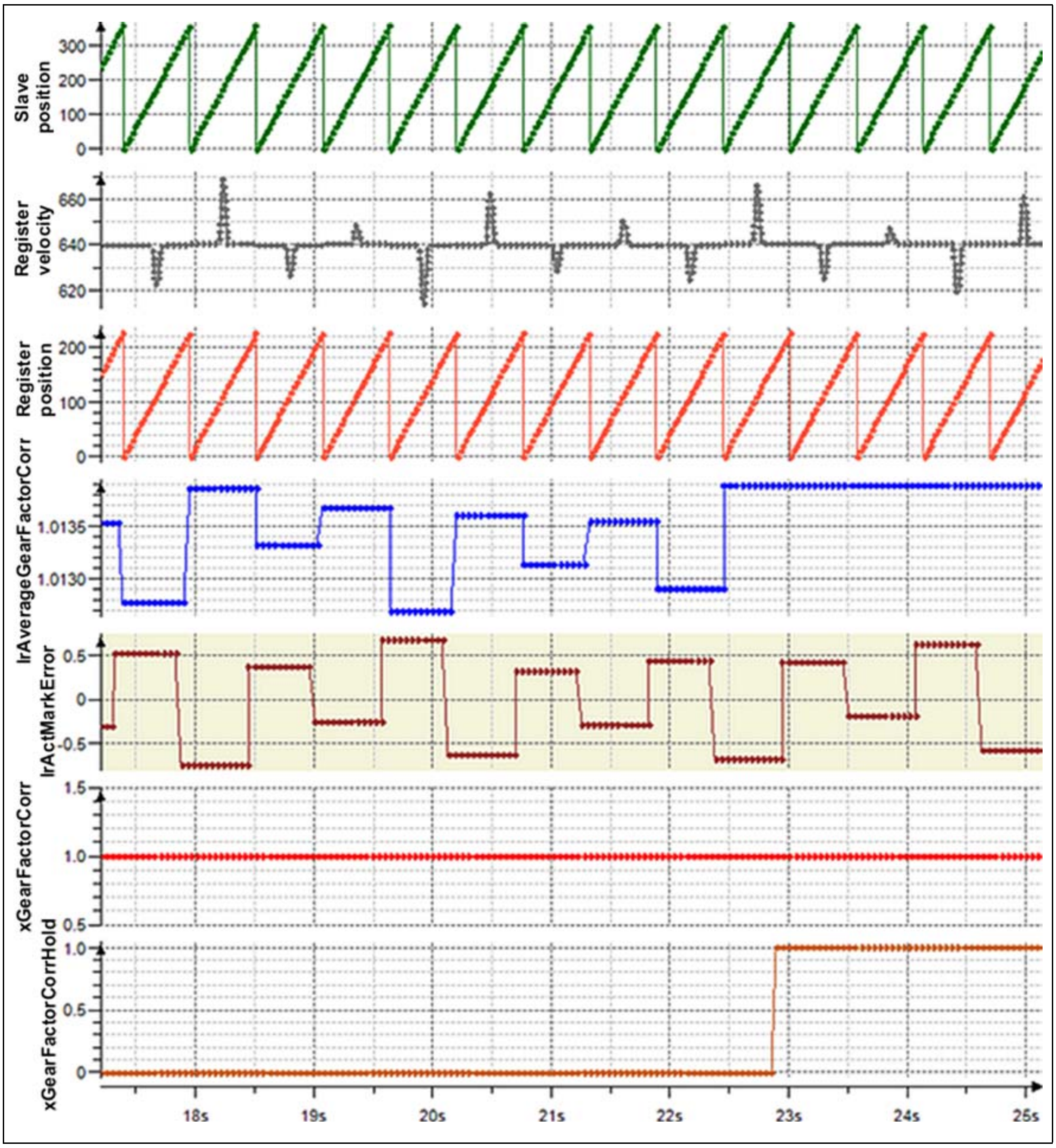
The parameters to be set for the gearbox factor correction are located in the L_TT1P_scPar_RegisterControl[Base/State] (📖 20) parameter structure.

```
lrGearFactorCorrGain : LREAL := 0.1;
lrMaxGearFactorCorr : LREAL := 10;   // [units]
```



[3-19] Signal characteristic with active gearbox factor correction

As soon as the optimum corrected gearbox factor has been detected, correction movements occur both in positive and negative direction. The detected gearbox factor value can be permanently accepted when the *xGearFactorCorrHold* input = TRUE. The value will only be changed when *xGearFactorCorrHold* is set to FALSE.



[3-20] Hold signal characteristic with optimised gearbox factor

3.18 Setting up register control (Base version)

When the register control is activated, it is expected that the first touch probe mark is detected when the register has reached the position of the touch probe sensor.

If the detected touch probe mark is located at a different position within the register cycle, the detected deviation (touch probe error) is compensated in the correction window of the current register cycle.

Example: Setting up register control (Base version)

1. Detect the distance between the touch probe sensor and the attack position of the tool (e.g. cutting blade, printheads) on the material and set it in the *lrSensorToolDistance* parameter.
2. Reference the slave axis.

   At the position where the material meets the first touch probe mark, the position of the slave axis is set as zero position in the *lrHomePosition* parameter.

   ▶ Homing (📖 35)
3. Move the slave axis for the machine start to a position outside the material access. This means that a tool attached to the axis does not touch the material.
4. Move the material until the second touch probe mark is below the sensor.

   ▶ Manual jog (jogging) (📖 34)
5. Load the register position:
   - Set the *lrLoadRegPos* input = *lrMarkSensorPos* output.
   - Set the *xLoadRegpos* input = TRUE.
   - Set the *xLoadRegpos* input = FALSE.
6. Clutch in the slave axis to the register axis and activate the register control.

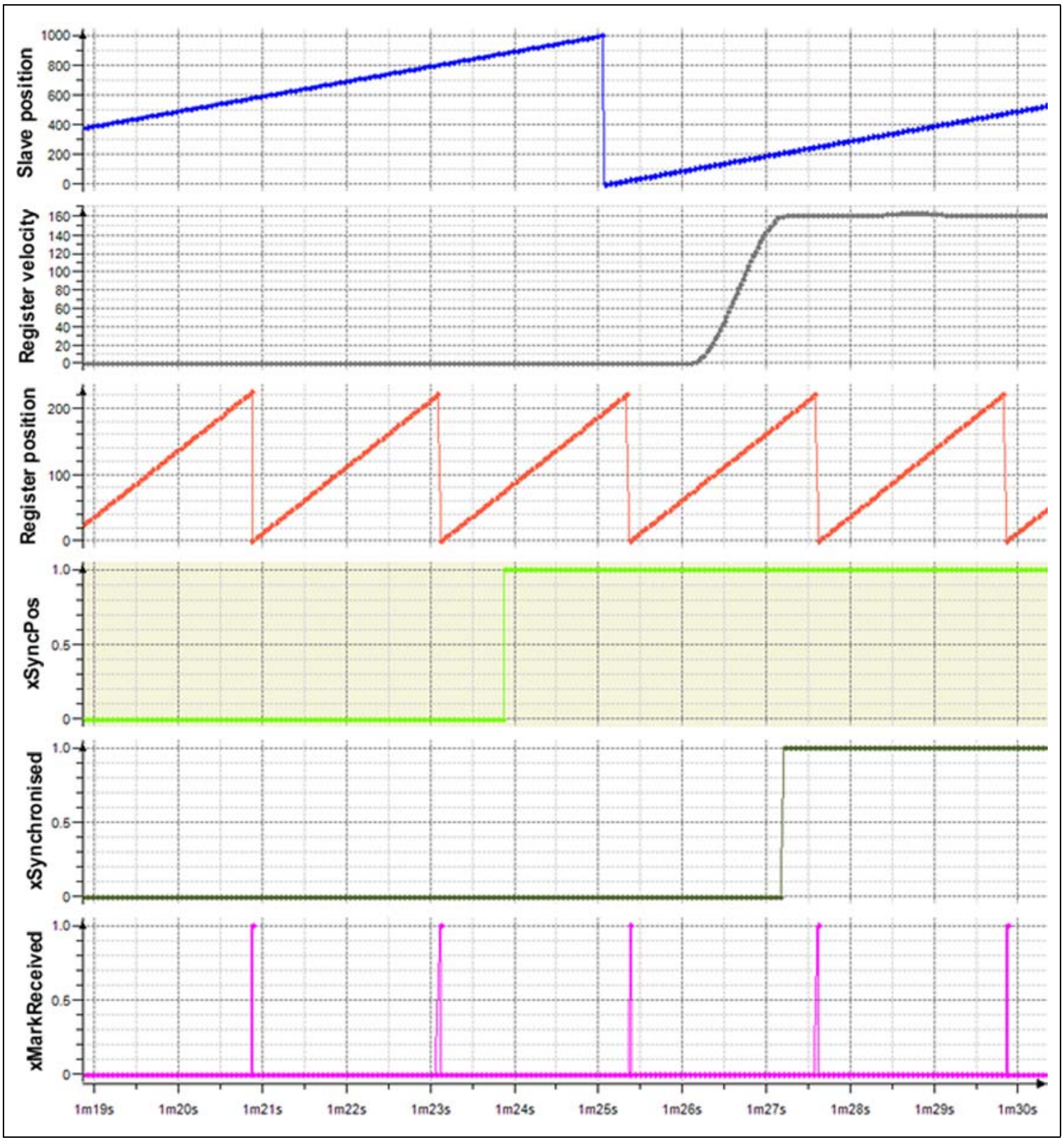
   Set the *xSyncPos* input = TRUE.

   ▶ Synchronism (SyncPos) with clutch-in/declutch mechanism (📖 36)
7. When the next touch probe mark is reached (FALSE/TRUE edge at the *xMarkReceived* output), the calculation of the touch probe deviation starts.

   At the *lrActMarkError* output, the current deviation between the position of the detected touch probe mark and the expected touch probe position is displayed.
8. Set the *xMarkCorrection* parameter = TRUE to correct the detected deviation (touch probe correction).
9. Specify position offset.

   Possibly, the positioning of the touch probe sensor cannot be executed exactly in the run-up (errors of measurement). In this case, a static deviation for the tool attached to the axis can be compensated via the specification of an offset.

   ▶ Position offset during synchronism (📖 41)



[3-21] Synchronisation of the slave axis (xSyncPos = TRUE) using the touch probe correction (xMarkCorrection = TRUE)

3.19 Setting up register control (State version)

When the register control is activated, it is expected that the first touch probe mark is detected when the register has reached the position of the touch probe sensor.

If the detected touch probe mark is located at a different position within the register cycle, the detected position difference (touch probe error) is compensated in the correction window of the current register cycle.

Example: Setting up register control (Base version)

1. Detect the distance between the touch probe sensor and the attack position of the tool (e.g. cutting blade, printheads) on the material and set it in the *lrSensorToolDistance* parameter.
2. Reference the slave axis.

   At the position where the material meets the first touch probe mark, the position of the slave axis is set as zero position in the *lrHomePosition* parameter.

   ▶ Homing (📖 35)
3. Move the slave axis for the machine start to a position outside the material access. This means that a tool attached to the axis does not touch the material.
4. Move the material until the second touch probe mark is located approximately 10 mm in front of the detection position of the touch probe sensor.

   ▶ Manual jog (jogging) (📖 34)
5. Execute the teaching function.

   Set the *xTeachMarkWindow* input = TRUE.

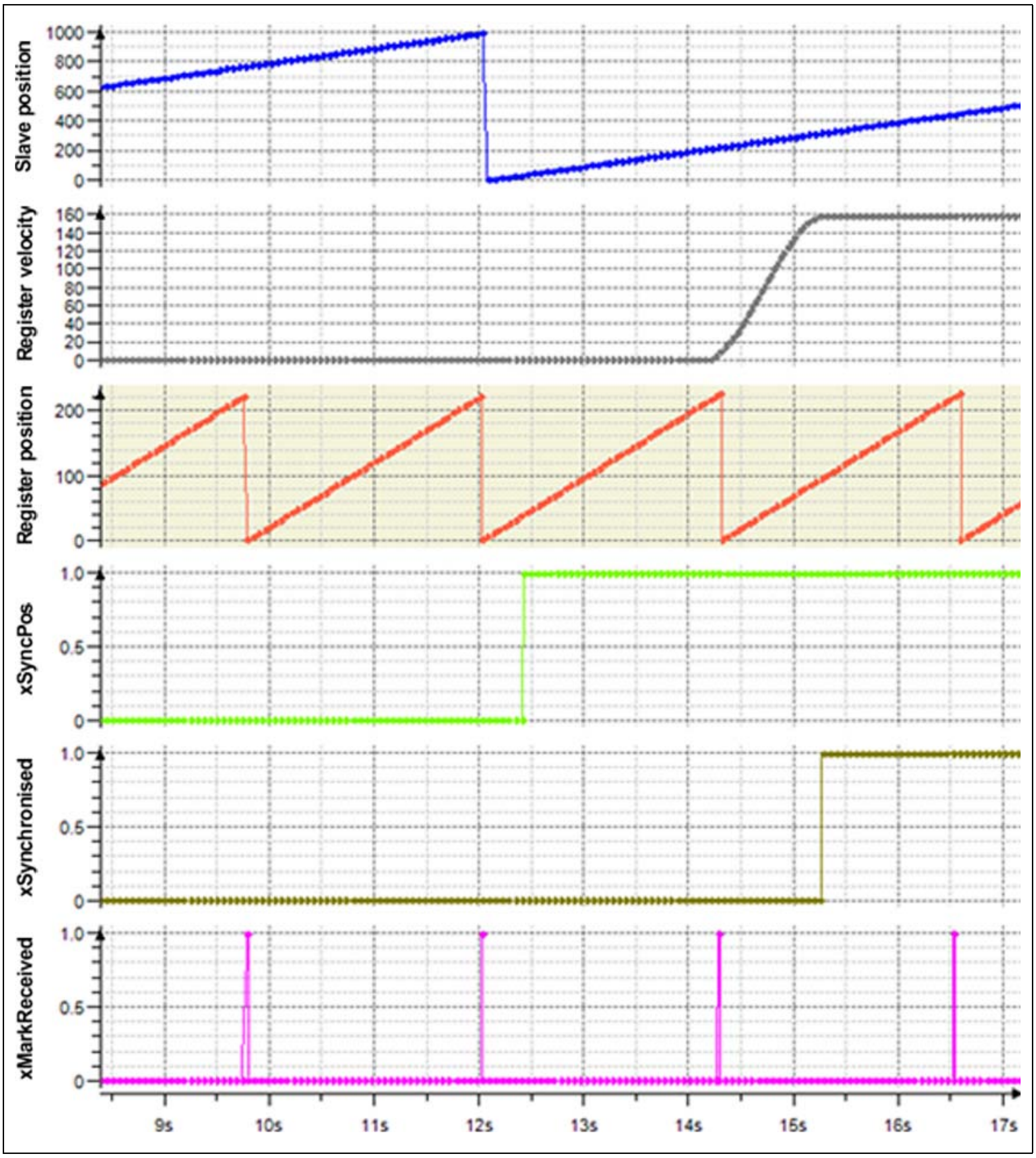
   ▶ Teaching function (📖 48)
6. Clutch in the slave axis to the register axis and activate the register control.

   Set *xSyncPos* parameter = TRUE.
   ▶ Synchronism (SyncPos) with clutch-in/declutch mechanism (📖 36)
7. When the next touch probe mark is reached (FALSE/TRUE edge at the *xMarkReceived* output), the calculation of the touch probe deviation starts.

   At the *lrActMarkError* output, the current deviation between the position of the detected touch probe mark and the expected touch probe position is displayed.
8. Set the *xMarkCorrection* parameter = TRUE to correct the detected deviation (touch probe correction).
9. Specify position offset.

   Possibly, the positioning of the touch probe sensor cannot be executed exactly in the run-up (errors of measurement). In this case, a static deviation for the tool attached to the axis can be compensated via the specification of an offset.

   ▶ Position offset during synchronism (📖 41)



[3-22] Synchronisation of the slave axis (xSyncPos = TRUE) using the touch probe correction (xMarkCorrection = TRUE)

3.20 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;
	xSyncPos := TRUE;
		95 µs	124 µs

State	xEnable := TRUE;
	xRegulatorOn := TRUE;
	xSyncPos := TRUE;
		110 µs	134 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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