FAST Application Software

Technology module

Cross Cutter ________________________________

Reference Manual EN

13531710

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 • New: Structure of the access points L_TT1P_scAP_CrossCutter[Base/State] (📖 36)
3.0	11/2015	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	**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

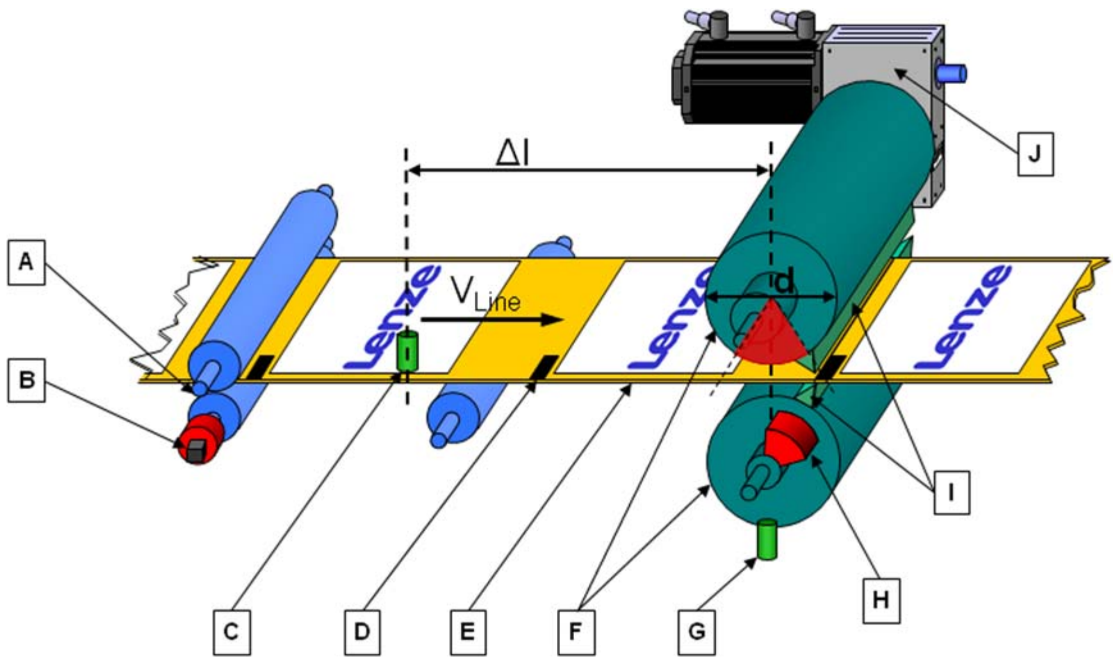
Stop!

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 "Cross Cutter"



- A Feeding rollers
- B Detection of the master speed
- C Cutting mark sensor (touch probe sensor) mounted in a distance Δl in front of the sealing rollers
- D Cutting mark
- E Web
- F Sealing rollers with an adjustable number of sealing jaws
- G Reference sensor of the sealing roller
- H Reference cam of the sealing roller
- I Sealing jaws
- J Motor and gearbox

[3-1] Typical mechanics of the technology module

The "Cross Cutter" technology module calculates the cam for the synchronous motion of a cross sealing roller and synchronises it with a master axis.

- In the "Base" version, the technology module works in a purely length-controlled way. The profiles are calculated in real time allowing to flexibly respond to product gaps or process data changes (cutting lengths, cutting asynchronicities and sealing area). The motion profile is calculated via a polynomial of the fifth degree.
- The "State" version provides an extended function range of the "Base" version:

  The State version provides process modes in addition to length-cutting by allowing for cuts via the detection of marks. In this way constant lengths are cut and corrected by detected marks. In another mode, the cut is effected on a detected mark (event-controlled cut).

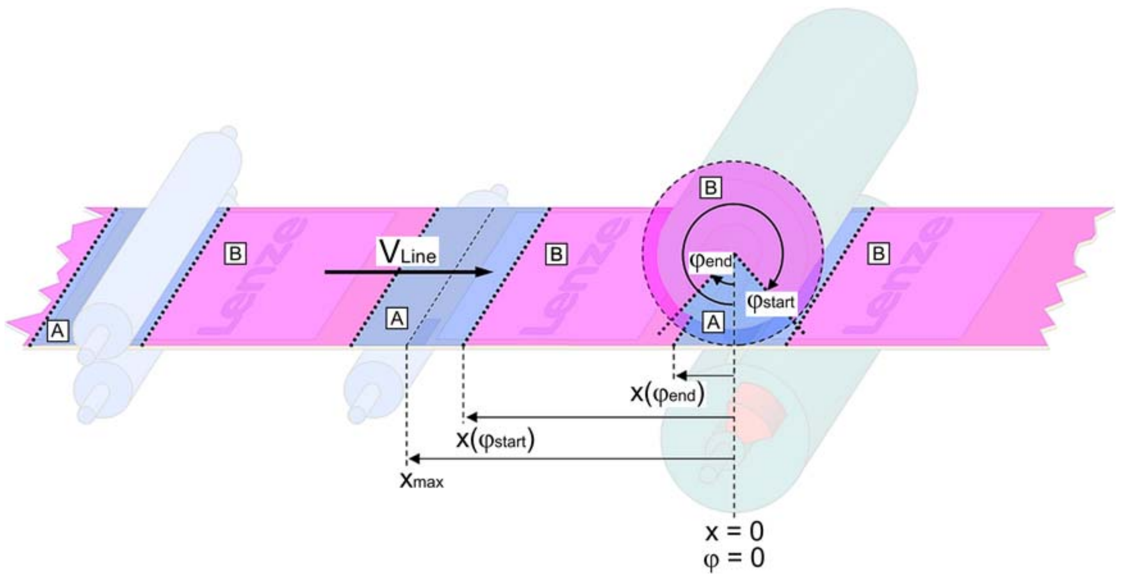
▸ Overview of the functions (📖 12)

Different parameters and process data are required for calculating the seal motion:

- Number of tools (mechanic parameter)
- Diameter of the sealing roller (mechanical parameter)
- Sealing area (synchronous area)
- Product length (process factor)
- Cutting asynchronicity (process factor)

The motion profile of the technology module is determined by these factors and is thus divided into two phases:

- Synchronous phase (cutting phase)
- Asynchronous phase



A Synchronous phase
B Asynchronous phase

[3-2] Phases of the motion profile

Synchronous phase (cutting phase)

In this phase of motion, the material processing or the cut is effected. The sealing jaw of the sealing roller follows the motion of the material in order to ensure a high cutting accuracy. In this phase, the speed of the sealing roller mainly depends on the cutting circle diameter of the sealing roller and the material web speed. An asynchronous motion of the sealing jaws to the material would result in damage to the material web.

Asynchronous phase

In this section, the sealing roller is asynchronous to the material flow. Depending on the required seal length, the sealing roller must be undersynchronous or oversynchronous to the material speed in order to let pass the respective material length below the sealing roller or to make the sealing jaw position catch up with the material, respectively. Depending on the speed difference between material and sealing roller and the duration of the asynchronous section, the required seal length is achieved.

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
Parameterisation of the sealing roller (🕮 37)	●	●
Positioning to the parking position (🕮 38)	●	●
Manual jog (jogging) (🕮 40)	●	●
Homing (🕮 41)	●	●
"Length cutting" operating mode (🕮 42) • Top cut (🕮 44)	●	●
"Flow packer" operating mode (🕮 45)	●	●
Positioning the cross cutter to static material (🕮 49)	●	●
Clutching the cross cutter to moving material (🕮 51)	●	●
Declutching the cross cutter (🕮 53)	●	●
Positive opening operation / Emergency opening operation (🕮 55)	●	●
Trimming and offset of the cutting position (🕮 57) • Position cut trimming (🕮 58) • Speed cut trimming (Tip trimming) (🕮 60) • Absolute positioning of the cutting position via master offset (🕮 62)	●	●
Method of elimination (🕮 64)	●	●
Increasing/decreasing the speed (overspeed) (🕮 66)	●	●
Calculating extreme values of a cam (🕮 68)	●	●
Calculating the cutting length (🕮 68)	●	●
"Length cutting with mark correction" operating mode (🕮 69)		●
Partial cutting lengths in product length (print/cut format) (🕮 71)		●
Cutting mark register (🕮 72)		●
Selecting the touch probe source (🕮 74)		●
Referencing the mark position (🕮 75)		●
Speed sychronism of master and register axis (🕮 76)		●
Gearbox factor correction (🕮 77)		●
"Cutting on a mark (event-controlled)" operating mode (🕮 80)		●
Torque feedforward control (🕮 83)		●

»PLC Designer« Online help

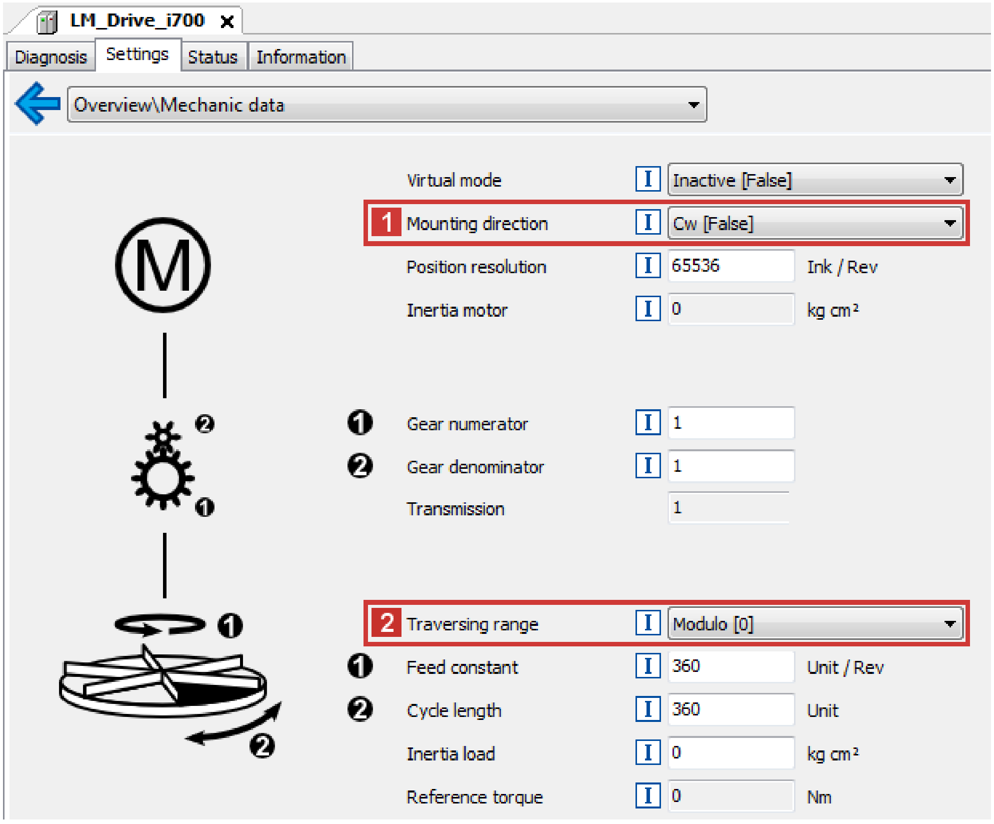
Here you will find detailed information on the **L_MC1P_AxisBasicControl** function block, the **stop function** and the **holding function**.

3.2 Important notes on how to operate the technology module

The "Cross Cutter" 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 2 :



During the cutting process the master axis must only move in positive direction.

In the application, the mounting direction 1 must also be set so that the master axis only moves in positive direction.

Setting of the operating mode

The operating mode for the cross cutter 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) (📖 40)**:**

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_CrossCutter[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_CrossCutter[Base/State]

Type	Input	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_CrossCutter[Base/State]	scPar	xAxisEnabled	BOOL
AXIS_REF	MasterAxis	scSignalFlow	L_TT1P_scSF_CrossCutter[Base/State]
AXIS_REF	SlaveAxis	xDone	BOOL
L_TT1P_scAP_CrossCutter[Base/State]	scAccessPoints	xBusy	BOOL
BOOL	xJogPos	xIsHomed	BOOL
BOOL	xJogNeg	xInParkPos	BOOL
BOOL	xHomeExecute	xSynchronised	BOOL
BOOL	xHomeAbsSwitch	xAccDecSync	BOOL
LREAL	xExecuteMoveToParkPos	xHoldInParkPosActive	BOOL
BOOL	xSyncCrossCutter	xCuttingActive	BOOL
BOOL	xSyncOutInstant	xCutDone	BOOL
BOOL	xHoldInParkPos	lrActCutLength	LREAL
BOOL	lrProductLength	bySetToolNoOut	BYTE
LREAL	lrSetOverspeedScaled	bySetAreaOut	BYTE
LREAL	lrSetOffsetMaster	lrOffset	LREAL
BOOL	xTrimPos	lrOffsetTrim	LREAL
BOOL	xTrimNeg	lrOffsetTotal	LREAL
BOOL	xResetTrimOffset	lrSetXPosOut	LREAL
		lrSetXVelOut	LREAL
		lrSetXAccOut	LREAL
		lrActSlaveFollowingError	LREAL
		lrActSlavePos	LREAL
		lrActSlaveVel	LREAL
		lrSlaveMaxVel	LREAL
		lrSlaveMaxAcc	LREAL
State			
BOOL	xTeachMarkWindow	xTrqCtrlActive	BOOL
BOOL	xMarkReceive	lrSetMotorPreCtrlTrqOut	LREAL
LREAL	lrActMarkPosIn	xRegisterCtrlActive	BOOL

L_TT1P_CrossCutter[Base/State]

Input type	Input	Output	Output type
LREAL	lrCycPosExtEncoder	xTeachMarkWindowActive	BOOL
BOOL	xGearFactorCorr	lrSetRegPosOut	LREAL
BOOL	xGearFactorCorrHold	lrMarkSensorPos	LREAL
		lrRegMarkPos	LREAL
		lrActMarkError	LREAL
		lrActMarkDist	LREAL
		xMarkReceived	BOOL
		xCorrActive	BOOL
		xCorrLimited	BOOL
		xMarkWindowOpen	BOOL
		xMarkOutOfWindow	BOOL
		xMarkNotDetected	BOOL
		xMarkWindowTeached	BOOL
		lrAverageGearFactorCorr	LREAL
		xGearFactorCorrLimited	BOOL

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	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_CrossCutter[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_CrossCutter[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.	●	●
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.	●	●
xExecuteMoveToParkPos BOOL	The input is edge-controlled and evaluates the rising edge.		●	●
	FALSE↗TRUE	Execute positioning of the slave axis to the parking position.		

Designator / Data type	Description		Available in version: Base	Available in version: State
xSyncCrossCutter BOOL	FALSE↗TRUE	Clutching in to the cam	●	●
	TRUE↘FALSE	Declutching to the parking position		
xSyncOutInstant BOOL	TRUE	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.	●	●
xHoldInParkPos BOOL	Rejects process (leaving out cuts)		●	●
	TRUE	After the synchronous phase, the slave axis is declutched to the parking position. • The cutting process is not continued. • The product position (position of the X axis) at the lrSetXPosOut output, however, is still calculated.		
	FALSE	After the next synchronous phase, the slave axis is clutched in to the subsequent synchronous phase. The cutting process is continued.		
lrProductLength LREAL	The length of the product or material, depending on the operating mode in the cutting process (eCuttingMode parameter): • 0: Length cutting The product length corresponds to the cutting length. • 1: Flow packer The product length is only used to calculate the speed in the synchronous phase. The cut is always effected at the cycle end of the master axis. • 2: Length cutting with mark correction The product length corresponds to the register length and is taken over once before the cutting process. The cutting length is set once within the product length via the array alrCutLength[1..10] in the parameter structure L_TT1P_scPar_CrossCutter[Base/State] (📖 23). • 3: Cutting on a mark (event-controlled) The product length is not evaluated in this mode. • Unit: Unit of the master axis (e.g. mm)		●	●
lrSetOverspeedScaled LREAL	Factor for speeding during the synchronous phase The scaled value refers to the current material speed (master speed). • Example: lrSetOverspeedScaled = 1.0 means that the tool (e.g. cutting blade) has twice the circumferential speed than the material speed. • Initial value = 0.0 • Value range: -0.9 ... 2.0		●	●
lrSetOffsetMaster LREAL	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		●	●
xTrimPos BOOL	TRUE	Trim position profile or speed profile of the axis in positive direction. • The trimming type (position profile/speed profile) can be set via the eTrimMode parameter. • If xTrimNeg is also TRUE, the traversing direction selected first remains set.	●	●

Designator Data type	Description		Available in version Base	Available in version State
xTrimNeg BOOL	TRUE	Trim position profile or speed profile of the axis in negative direction. • The trimming type (position profile/speed profile) can be set via the eTrimMode parameter. • If xTrimPos is also TRUE, the traversing direction selected first remains set.	●	●
xResetTrimOffset BOOL	TRUE	The offset of the trimming function (lrOffsetTrim output) is set to zero.	●	●
xTeachMarkWindow BOOL	TRUE	The mark position (touch probe window) is referenced. (Teaching function for setting-up operation) • Behaviour in declutched 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 clutched-in 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.		●
xMarkReceive BOOL	TRUE	A touch probe mark has been detected in the connected touch probe sensor.		●
lrActMarkPosIn LREAL	Current position of the touch probe mark with regard to the axis reference used. • Unit: units			●
lrCycPosExtEncoder LREAL	Cyclic position of the external encoder in case the touch probe from the encoder axis is used. (eTpMode parameter = 2: External encoder) • Unit: units			●
xGearFactorCorr BOOL	TRUE	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.		●
xGearFactorCorrHold BOOL	TRUE	The current gearbox factor correction value is held.		●

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 (📖 28)		●	●
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_CrossCutter[Base/State]	Structure of the signal flow The data type depends on the version used (Base/State). ▸ Signal flow diagrams (📖 30)		●	●
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).	●	●
xInParkPos BOOL	TRUE	The axis is in the parking position. This output can be set by different functions: • Positioning into the parking position; • Holding the axis in the parking position during the cutting process; • The cutting length in the cutting process is so long that the axis comes to a stop in the parking position; • Declutching to the parking position with the input xSyncCrossCutter = FALSE.	●	●
xSynchronised BOOL	TRUE	The axis is synchronised to the cam.	●	●
xAccDecSync BOOL	TRUE	The synchronisation function is active. The axis is synchronised or desynchronised (clutch opens or closes).	●	●
xHoldInParkPosActive BOOL	TRUE	During the rejects process (xHoldInParkPos input = TRUE), the slave axis is in the parking position.	●	●
xCuttingActive BOOL	TRUE	The tool (e.g. cutting blade) at the axis is in the cutting area.	●	●
xCutDone BOOL	TRUE	The cut has been effected. The rising edge at the xCutDone output (FALSE↗TRUE), the cut length of the material is calculated and provided at the lrActCutLength output.	●	●

Designator Data type	Description		Available in version	
			Base	State
lrActCutLength LREAL	Cut length of the material The cut length results from the difference between the current position of the master axis and the current cutting position of the sealing roller. • Unit: mm		●	●
bySetToolNoOut BYTE	The number of the tool (e.g. cutting blade) used for cutting when the synchronisation function is active (xAccDecSync output = TRUE). The first tool is in the zero position of the axis. Further tools on the circumference of the axis are numbered consecutively in positive direction of rotation.		●	●
bySetAreaOut BYTE	The number of the area between two tools on the circumference of the axis The first area is between the first and second tool.		●	●
lrOffset LREAL	Position offset of the master axis from the lrSetOffsetMaster input The resulting X position of the cam is produced by addition of the master axis position to the "lrSetOffsetMaster" offset. • Unit: units		●	●
lrOffsetTrim LREAL	Position offset from the trimming function between the master axis and the X axis from the cam • Unit: units		●	●
lrOffsetTotal LREAL	Total position offset between the master axis and the X axis from the cam • Unit: units		●	●
lrSetXPosOut LREAL	Position of the X axis from the cam The X axis always runs from 0 to the cutting length. • 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		●	●
lrActSlaveFollowingError LREAL	Current following error of the slave axis • 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		●	●
lrSlaveVelMax 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		●	●
lrSlaveAccMax 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		●	●
xTrqCtrlActive BOOL	TRUE	The torque feedforward control is activated.		●
lrSetMotorPreCtrlTrqOut LREAL	Setting of the torque feedfoward control value The torque refers to the output end of the gearbox (gearbox output). • Unit: Nm			●

Designator Data type	Description		Available in version: Base	Available in version: State
xRegisterCtrlActive BOOL	TRUE	The register control is activated.		●
xTeachMarkWindowActive BOOL	TRUE	The homing of the mark position (touch probe window) is activated.		●
lrSetRegPosOut LREAL	Output setpoint position of the register control The register position is always within a rotary modulo cycle with the cycle length of the lrProductLength input.			●
lrMarkSensorPos LREAL	The internally calculated position within the register cycle on which the touch probe mark is expected. • Unit: units			●
lrRegMarkPos LREAL	The converted actual position of the current touch probe mark within the register cycle • Unit: units			●
lrActMarkError LREAL	Current deviation between the real position of the touch probe mark and the expected position of the touch probe mark • Unit: units			●
lrActMarkDist LREAL	Register length between the last two touch probe marks • Unit: units			●
xMarkReceived BOOL	TRUE	A touch probe mark has been detected. If the mark register is used in the State version, xMarkReceived is always set when the mark register has been corrected.		●
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_CrossCutter[Base/State]

The **L_TT1P_scPar_CrossCutter[Base/State]** structure contains the parameters of the technology module.

<table>
<tr><th rowspan="2">Designator
Data type</th><th rowspan="2">Description</th><th colspan="2">Available in version</th></tr>
<tr><th>Base</th><th>State</th></tr>
<tr><td>lrStopDec
LREAL</td><td>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</td><td>●</td><td>●</td></tr>
<tr><td>lrStopJerk
LREAL</td><td>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</td><td>●</td><td>●</td></tr>
<tr><td>lrHaltDec
LREAL</td><td>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.</td><td>●</td><td>●</td></tr>
<tr><td>lrJerk
LREAL</td><td>Jerk for compensating an offset value, trimming, clutch, or holding function
• Unit: units/s^3
• Initial value: 100000</td><td>●</td><td>●</td></tr>
<tr><td>lrJogJerk
LREAL</td><td>Jerk for manual jog
• Unit: units/s^3
• Initial value: 10000</td><td>●</td><td>●</td></tr>
<tr><td>lrJogVel
LREAL</td><td>Maximum speed to be used for manual jog.
• Unit: units/s
• Initial value: 10</td><td>●</td><td>●</td></tr>
<tr><td>lrJogAcc
LREAL</td><td>Acceleration for manual jog
Specification of the maximum speed variation which is to be used for acceleration.
• Unit: units/s^2
• Initial value: 100</td><td>●</td><td>●</td></tr>
<tr><td>lrJogDec
LREAL</td><td>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</td><td>●</td><td>●</td></tr>
<tr><td>lrHomePosition
LREAL</td><td>Home position for a reference run (homing)
• Unit: units
• Initial value: 0</td><td>●</td><td>●</td></tr>
<tr><td>xUseHomeExtParameter
BOOL</td><td>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.</td><td>●</td><td>●</td></tr>
<tr><td>scHomeExtParameter
L_MC1P_HomeParameter</td><td>Homing parameters from the application
• Only relevant if xUseHomeExtParameter = TRUE.</td><td>●</td><td>●</td></tr>
</table>

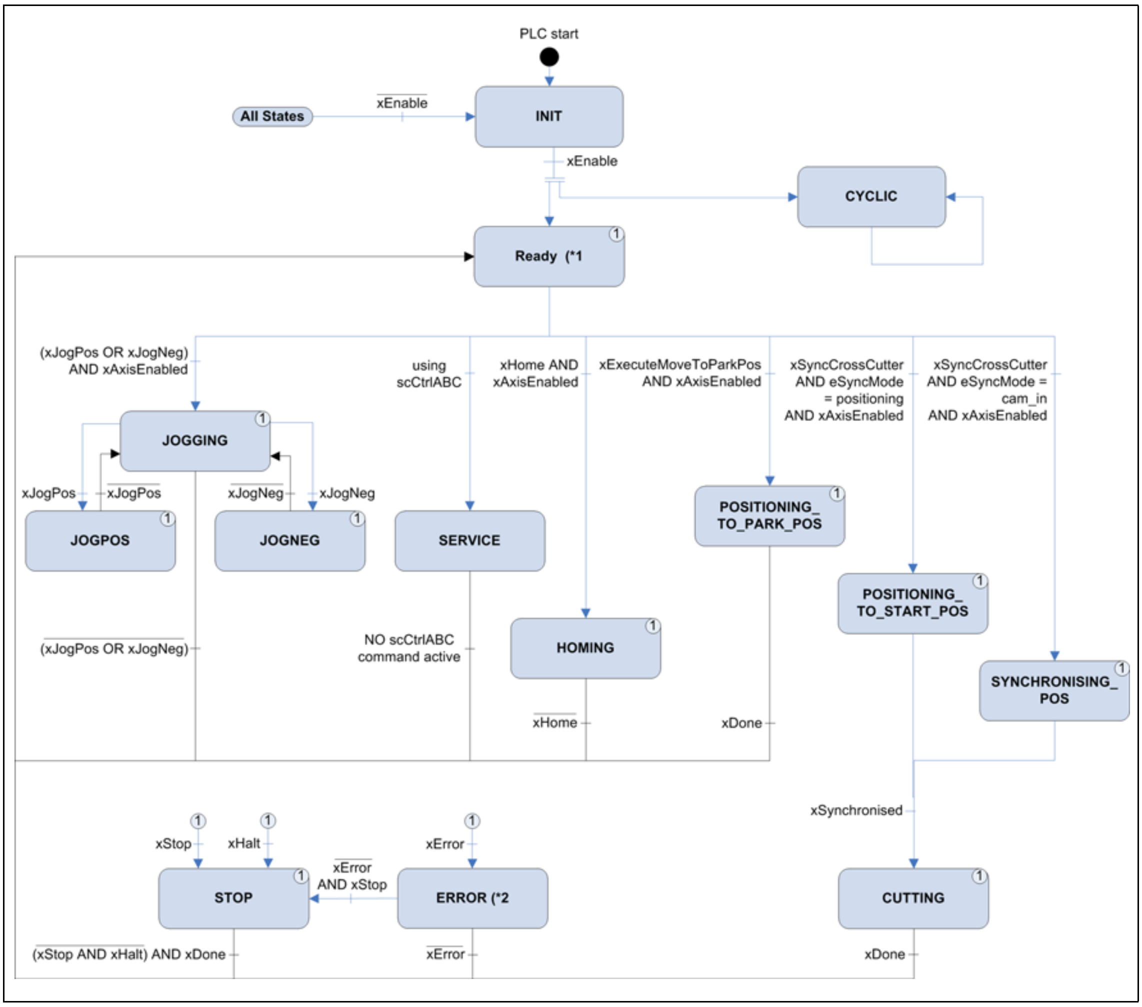
Designator Data type	Description		Available in version: Base	Available in version: State
scHomeExtTP MC_TRIGGER_REF	Transfer of an external touch probe event • Only relevant for "external encoder" touch probe configuration. • For describing the MC_TRIGGER_REF structure, see the **MC_TouchProbe** function block.		●	●
eTrimMode L_TT1P_TrimMode	Type of trimming for positive or negative direction (inputs xTrimPos or xTrimNeg) • Initial value: 0		●	●
	0	Trimming via positioning profile (with increment in lrTrimDist parameter)		
	1	Trimming via velocity profile (with velocity in lrOffsetTrimVel parameter)		
lrTrimDist LREAL	Increment for trimming via positioning profile (eTrimMode = 0) • Unit: mm • Initial value: 3		●	●
lrOffsetTrimVel LREAL	Velocity offset for compensating an offset change (lrSetOffsetMaster input) or the increment for trimming via the positioning profile (lrTrimDist parameter) • Unit: units/s • Initial value: 10		●	●
lrOffsetTrimAcc LREAL	Acceleration offset for compensating an offset change (lrSetOffsetMaster input) or the increment for trimming via the positioning profile (lrTrimDist parameter) • Unit: units/s^2 • Initial value: 100		●	●
lrOffsetTrimDec LREAL	Deceleration offset for compensating an offset change (lrSetOffsetMaster input) or the increment for trimming via the positioning profile (lrTrimDist parameter) • Unit: units/s^2 • Initial value: 100		●	●
ePositioningDirection MC_DIRECTION	Direction of rotation for positioning the sealing roller Use for positioning into the parking position or onto the cam. • Initial value: MC_DIRECTION.positive		●	●
lrPositioningVel LREAL	Velocity for positioning the sealing roller Use for positioning into the parking position or onto the cam. • Unit: units/s • Initial value: 10		●	●
lrPositioningAcc LREAL	Acceleration for positioning the sealing roller Use for positioning into the parking position or onto the cam. • Unit: units/s^2 • Initial value: 100		●	●
lrPositioningDec LREAL	Deceleration for positioning the sealing roller Use for positioning into the parking position or onto the cam. • Unit: units/s^2 • Initial value: 100		●	●
eSyncMode L_TT1P_SyncModeCrossCutter	Synchronisation of the cross cutter		●	●
	0	Cam_in: Clutch in cross cutter to moving material.		
	1	Positioning: Position the cross cutter to the stationary material.		

Designator Data type	Description		Available in version	
			Base	State
lrMasterSyncInDist LREAL	Clutch-in distance of the master axis in the "length cutting" operating mode (eCuttingMode parameter = 0) for the synchronisation mode "Cam_in" (eSyncMode parameter = 0) For the *lrMasterSyncInDist* setting = 0, an optimum clutch-in distance is calculated. • Initial value: 0		●	●
lrMasterSyncOutDist LREAL	Declutch distance of the master axis in the "length cutting" operating mode (eCuttingMode parameter = 0) for the synchronisation mode "Cam_in" (eSyncMode parameter = 0) For the setting *lrMasterSyncOutDist* = 0, an optimum declutch distance is calculated. • Initial value: 0		●	●
lrSyncOutInstantDec LREAL	Deceleration for declutching from the cam when the xSyncOutInstant input is set to TRUE. • Unit: units/s^2 • Initial value: 1000		●	●
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 X axis of the cam		
	FALSE	Relative reference: The X starting position is loaded from the lrStarttXPosRelative parameter.		
lrStartXPosRelative REAL	Starting position for the X axis of the cam when setting the xMasterAbsolute = FALSE • Unit: units • Initial value: 0		●	●
byStartToolNo BYTE	Number of the tool (e.g. cutting blade) on the sealing roller which executes the first cut. • Initial value: 0 (automatic tool selection)		●	●
byNumOfTools BYTE	Number of the tools on the sealing roller The tools are spread symmetrically on the circumference of the roller. • Initial value: 1		●	●
lrCuttingAngle LREAL	Angle of the synchronous area of the sealing roller • Unit: Degree • Value range: from '0' to 360 / number of tools (byNumOfTools) • Initial value: 10		●	●
lrCrossCutterCircumference LREAL	Circumference of the sealing roller • Unit: Unit of the master axis (e.g. mm) • Initial value: 75.55555		●	●
lrScalingMaster LREAL	X extension/compression factor (scaling factor) of the master axis Thus, the X position of the cam results from the multiplication of the master position by lrScalingMaster • The scaling factor is taken over in the "Ready" state. • Negative values are not permitted. • Initial value: 1		●	●
xCalcCamBounds BOOL	TRUE	Extreme values of the slave axis (lrSlaveMaxVel, lrSlaveMaxAcc) are calculated as a function of the parameters lrMasterMaxVel and lrMasterMaxAcc. • Initial value: FALSE	●	●
lrMasterMaxVel LREAL	Maximum speed of the master axis for checking the cams • Unit: units/s • Initial value: 100		●	●

<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>lrMasterMaxAcc
LREAL</td><td colspan="2">Maximum acceleration of the master axis for checking the cams
• Unit: units/s^2
• Initial value: 1000</td><td>●</td><td>●</td></tr>
<tr><td rowspan="5">eCuttingMode
L_TT1P_CuttingMode [Base/State]</td><td colspan="2">Selection of the operating mode in the cutting process
• Initial value: 0 (length cutting)</td><td rowspan="5">●</td><td rowspan="5">●</td></tr>
<tr><td>0</td><td>Length cutting (initial value)</td></tr>
<tr><td>1</td><td>Flow packer</td></tr>
<tr><td>2</td><td>Length cutting with mark correction</td></tr>
<tr><td>3</td><td>Cutting on a mark (event-controlled)</td></tr>
<tr><td>alrCutLengthInProduct
(ARRAY[1..10] OF LREAL)</td><td colspan="2">Cutting lengths within the product length (lrProductLength input)
Use only in the "length cutting operating mode with mark correction": eCuttingMode parameter = 2
• Initial value: 0 (cutting lengths deactivated)</td><td></td><td>●</td></tr>
<tr><td>lrMinProductLength
LREAL</td><td colspan="2">Minimum cutting length and therefore the minimum distance between two (touch probe) marks
Use only in the "cutting on a mark (event-controlled)": eCuttingMode parameter = 3
• Unit: units
• Initial value: 50</td><td></td><td>●</td></tr>
<tr><td>lrTrqCtrlGain
LREAL</td><td colspan="2">Gain factor for the torque feedforward control
• Initial value: 0 (torque feedforward control deactivated)</td><td></td><td>●</td></tr>
<tr><td>lrTrqCtrlRateTime
LREAL</td><td colspan="2">Rate time for the torque feedforward control
• Unit: s
• Initial value: 0</td><td></td><td>●</td></tr>
<tr><td>lrMInertia
LREAL</td><td colspan="2">Moment of inertia for the torque feedforward control with regard to the sealing rollers at the gearbox output of the motor.
• Unit: kg/cm^2
• Initial value: 0 (torque feedforward control deactivated)</td><td></td><td>●</td></tr>
<tr><td>lrSensorToolDistance
LREAL</td><td colspan="2">Distance of the touch probe sensor to the attack position of the tool (e.g. cutting blade) 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</td><td></td><td>●</td></tr>
<tr><td>xMarkCorrection
BOOL</td><td>TRUE</td><td>Activate correction of the touch probe deviation.
• Initial value: TRUE</td><td></td><td>●</td></tr>
<tr><td>lrMarkWindowSize
LREAL</td><td colspan="2">Size of the touch probe window with regard to the X axis of the cam.
The touch probe window is put symmetrically around the expected touch probe position.
• Unit: units
• Initial value: 20</td><td></td><td>●</td></tr>
<tr><td rowspan="4">eTPMode
L_TT1P_TpMode</td><td colspan="2">Touch probe source
• Initial value: 0 (master axis)</td><td rowspan="4"></td><td rowspan="4">●</td></tr>
<tr><td>0</td><td>Master axis</td></tr>
<tr><td>1</td><td>Slave axis</td></tr>
<tr><td>2</td><td>External encoder</td></tr>
<tr><td>lrCycleLengthExtEncoder
LREAL</td><td colspan="2">Cycle time for the external encoder
(Only relevant if eTpMode parameter is set = "2: External encoder")
• Unit: s
• Initial value: 360</td><td></td><td>●</td></tr>
</table>

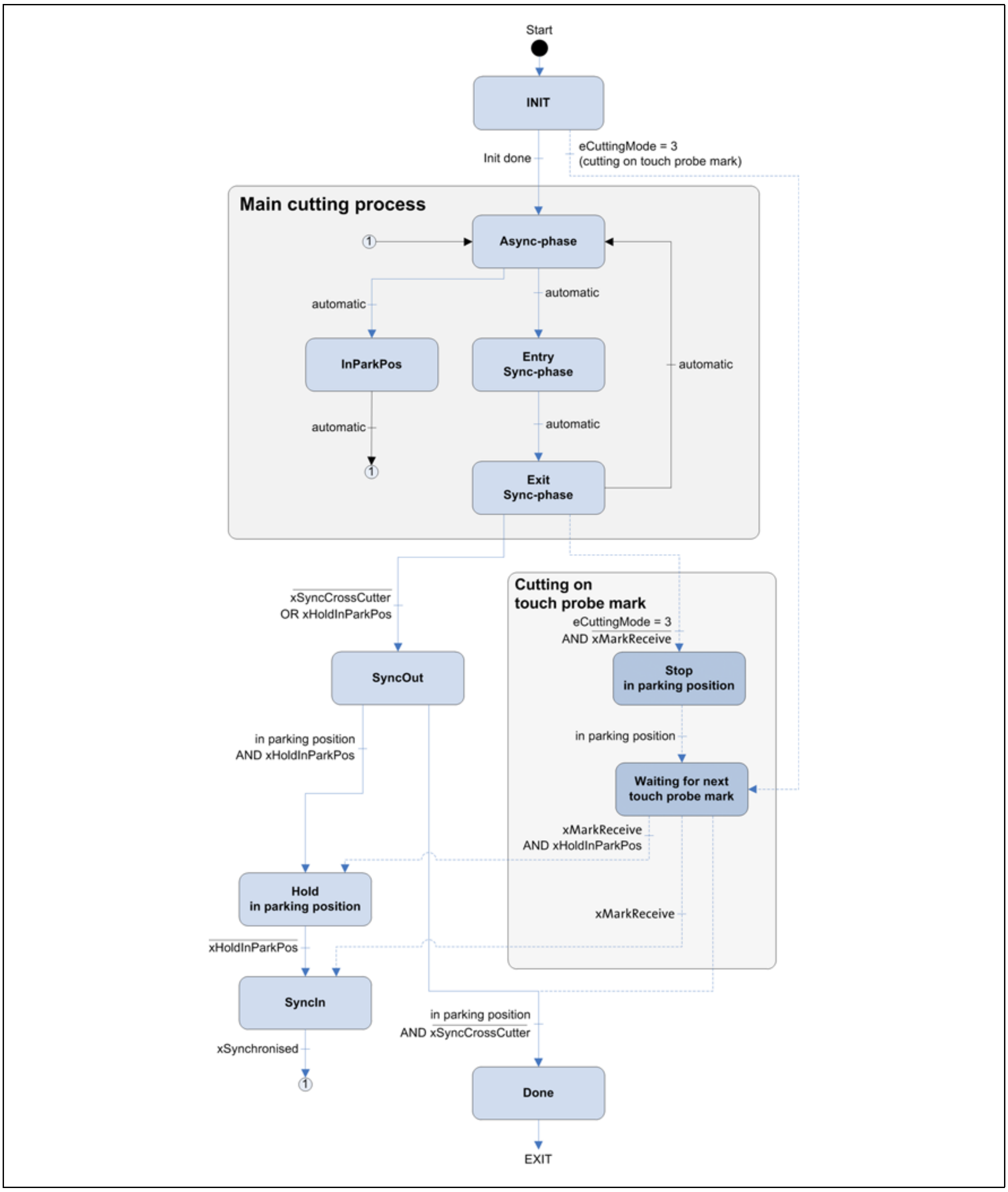
Designator Data type	Description	Available in version	
		Base	State
lrMaxCorrPos LREAL	Maximum positive correction distance per register cycle (X units) • Unit: units • Initial value: 30.0		●
lrMaxCorrNeg LREAL	Maximum negative correction distance per register cycle (X units) • Unit: units • Initial value: -30.0		●
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		●
dwMaxMissedMarks 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



[3-3] 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.

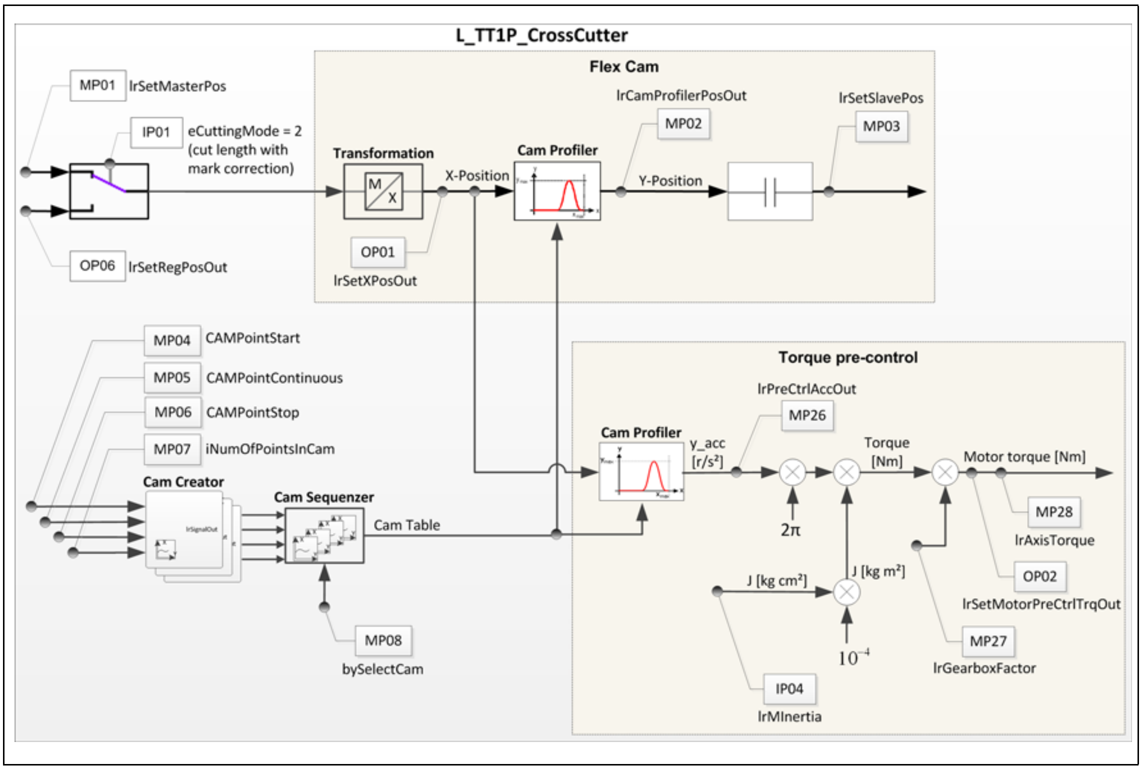


[3-4] State machine for the cutting process

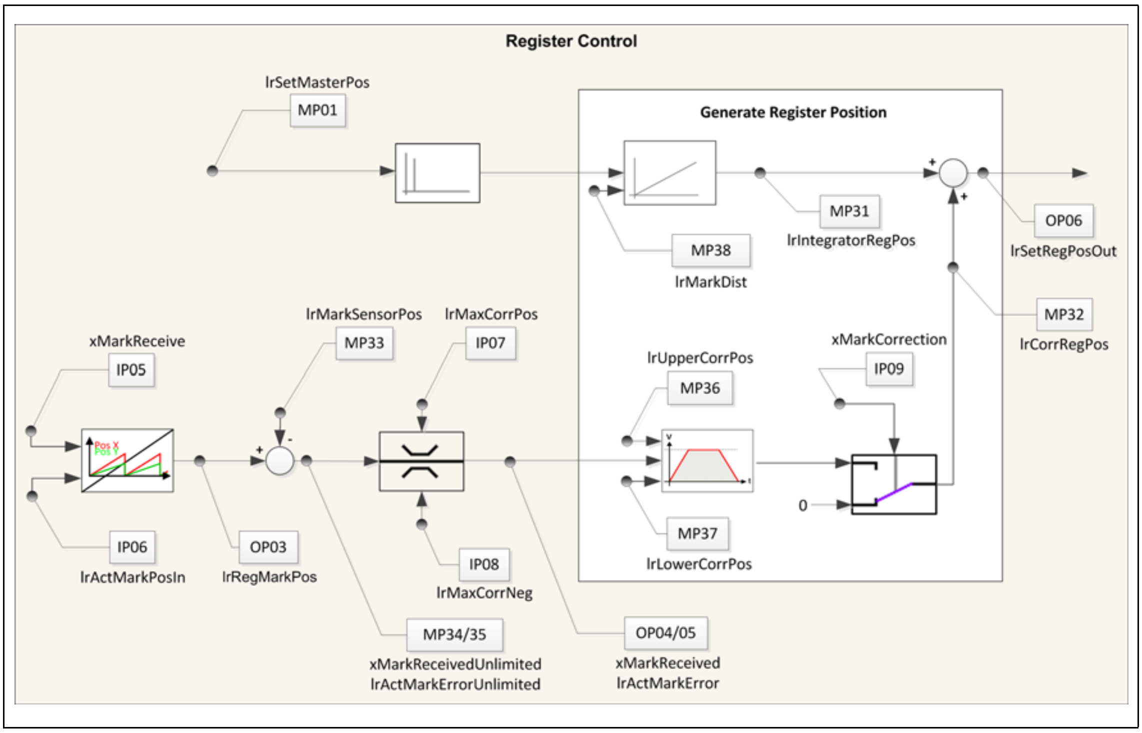
3.5 Signal flow diagrams

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

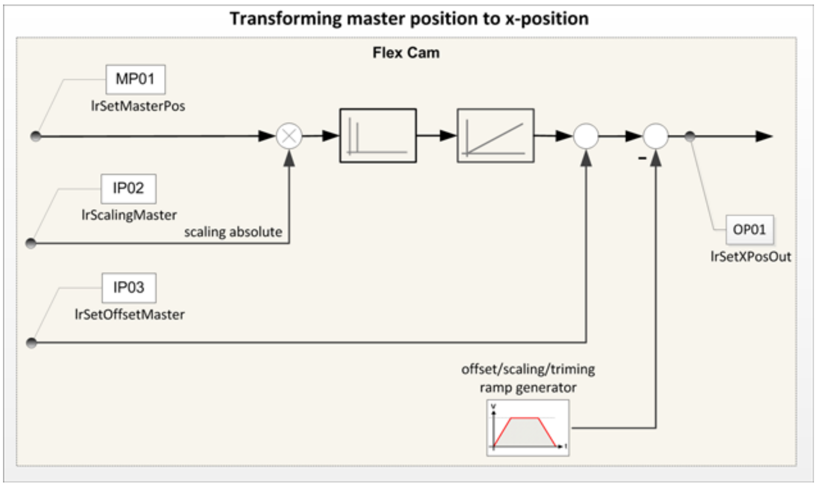
The signal flow of the additional functions such as "manual jog" is not displayed here.



[3-5] Signal flow: Cross Cutter - cam and torque feedforward control



[3-6] Partial signal flow: Register Control



[3-7] Partial signal flow: Transform position of the master axis to X position

3.5.1 Structure of the signal flow

L_TT1P_scSF_CrossCutter[Base/State]

The contents of the **L_TT1P_scSF_CrossCutter[Base/State]** structure is read-only and offer a practical diagnostics option within the signal flow (Signal flow diagrams (📖 30)).

Designator Data type	Description	Available in version Base	 State
IP01_eCuttingMode L_TT1P_CuttingMode [...]	Selection of the operating mode in the cutting process • Initial value: 0 (length cutting) 0 – Length cutting 1 – Flow packer 2 – Length cutting with mark correction 3 – Cutting on a mark (event-controlled)	●	●
IP02_lrScalingMaster LREAL	X extension/compression factor (scaling factor) of the master axis Thus, the X position of the cam results from the multiplication of the master position by lrScalingMaster • The scaling factor is taken over in the "Ready" state. • Negative values are not permitted. • Initial value: 1	●	●
IP03_lrSetOffsetMaster LREAL	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	●	●
IP04_lrMInertia LREAL	Moment of inertia for the torque feedforward control with regard to the sealing rollers at the gearbox output of the motor. • Unit: kg/cm^2 • Initial value: 0 (torque feedforward control deactivated)		●
IP05_xMarkReceived BOOL	TRUE – A touch probe mark has been detected in the connected touch probe sensor.		●
IP06_lrActMarkPosIn LREAL	Current touch probe position with regard to the axis reference used. • Unit: units		●
IP07_lrMaxCorrPos LREAL	Maximum positive correction distance per register cycle (X units) • Unit: units • Initial value: 30.0		●
IP08_lrMaxCorrNeg LREAL	Maximum negative correction distance per register cycle (X units) • Unit: units • Initial value: -30.0		●
IP09_xMarkCorrection BOOL	TRUE – Activate correction of the touch probe deviation. • Initial value: TRUE		●
MP01_lrSetMasterPos LREAL	Set position of the master axis • Unit: units	●	●
MP02_lrCamProfilerPosOut LREAL	The Y position directly from the cam generator • Unit: units	●	●
MP03_lrSetSlavePosOut LREAL	Set position of the slave axis • Unit: units	●	●
MP04_CAMPointStart ARRAY[0...3] OF SMC_CAMXYVA	The interpolation points of the start cam	●	●
MP05_CAMPointContinuous ARRAY[0...5] OF SMC_CAMXYVA	The interpolation points of the cutting cam	●	●

Designator / Data type	Description		Available in version: Base	Available in version: State
MP06_CAMPointStop ARRAY[0...3] OF SMC_CAMXYVA	The interpolation points of the stop cam		●	●
MP07_iNumOfPointsInCam INT	Number of points in the current cam		●	●
MP08_bySelectCam BYTE	Cam used		●	●
	1	Cutting curve		
	2	Cutting curve		
	3	Starting curve		
	4	Stop curve		
MP09_eCuttingProcessState L_TT1P_States	State of the cutting process in the technology module (output eTMState = CUTTING) ▸ State machine (📖 28)		●	●
MP10_lrYStart LREAL	Internally calculated starting position of the Y axis for the cam		●	●
MP11_lrYPark LREAL	Internally calculated parking position of the Y axis for the cam		●	●
MP12_lrYEnd LREAL	Internally calculated target position of the Y axis for the cam		●	●
MP13_lrXStart LREAL	Internally calculated starting position of the X axis for the cam		●	●
MP14_lrXEndSyncPos LREAL	Internally calculated position of the X axis for the cam in the transition to the asynchronous area		●	●
MP15_lrXStartParkPos LREAL	Internally calculated starting position of the X axis for the parking position of the Y axis for the cam		●	●
MP16_lrXEndParkPos LREAL	Internally calculated target position of the X axis for the parking position of the Y axis for the cam		●	●
MP17_lrXStartSyncPos LREAL	Internally calculated position of the X axis for the cam in the transition to the synchronous area		●	●
MP18_lrXEnd LREAL	Internally calculated target position of the X axis for the cam		●	●
MP19_xXAbsolute BOOL	TRUE	The absolute reference between X axis and master axis is activated or already active.	●	●
MP20_xSlaveAbsolute BOOL	TRUE	The absolute reference between X axis and slave axis is activated or already active.	●	●
MP21_xEndOfProfile BOOL	TRUE	The last cycle in the current profile of the cam is reached/ active. • The current values are extrapolated for detection. • The signal is applied for one clock cycle.	●	●
MP22_xEndOfXCycle BOOL	TRUE	The last position on the X axis is reached. • For the identification, the current values are extrapolated. The signal is applied for one clock cycle.	●	●
MP23_xEnablePosition Follower BOOL	TRUE	Enable position follower for the setpoint positions of the slave axis from "Flex Cam".	●	●
MP25_xEnableTorque Follower BOOL	TRUE	Enable torque follower for the torque feedforward control of the slave axis.		●
MP26_lrPreCtrlAccOut LREAL	Internally calculated acceleration from the cam for the next setpoint			●

Designator / Data type	Description		Available in version: Base	Available in version: State
MP27_lrGearboxFactor LREAL	Transmission factor of torque from cross-cutter axis to motor axis			●
MP28_lrAxisTorque LREAL	Setpoint torque of the slave axis • Unit: Nm			●
MP30_lrSetVelocityRegister LREAL	Input velocity of the integrator for creating the register position			●
MP31_lrIntegratorRegPos LREAL	Position value of the integrator for generating the register position without correction • Unit: units			●
MP32_lrCorrRegPos LREAL	Position profile of the correction motion (is added to the integrator position of the register) • Unit: units			●
MP33_lrMarkSensorPos LREAL	Internally calculated position of the touch probe sensor within the register cycle • Unit: units			●
MP34_xMarkReceived Unlimited BOOL	TRUE	A touch probe signal has been detected <u>before</u> the mark error limitation.		●
MP35_lrActMarkError Unlimited LREAL	Deviation (touch probe error) <u>before</u> the mark error limitation			●
MP36_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			●
MP37_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			●
MP38_lrMarkDist LREAL	Register length in units of the measuring system of the master axis • Initial value: 360.0			●
OP01_lrSetXPosOut LREAL	Position of the X axis from the cam • Unit: units			●
OP02_lrSetMotorPreCtrlTrq Out LREAL	Torque feedforward control value • Unit: Nm			●
OP03_lrRegMarkPos LREAL	The converted actual position of the current touch probe mark within the register cycle • Unit: units			●
OP04_xMarkReceived BOOL	TRUE	A touch probe mark has been detected. **Base version:** • xMarkReceived corresponds to the output at the limitation module. **State version:** • xMarkReceived corresponds to the output at the touch probe module.		●

Designator Data type	Description	Available in version	
		Base	State
OP05_lrActMarkError LREAL	Current deviation between detected touch probe mark and expected touch probe position • Unit: mm **Base version:** • lrActMarkError corresponds to the touch probe error at the output of the limitation module. **State version:** • lrActMarkError corresponds to the touch probe error at the output of the touch probe module.		●
OP06_lrSetRegPosOut LREAL	Output setpoint position of the register control The register position is always within a rotary modulo cycle with the cycle length of the lrProductLength input.		●

3.5.2 Structure of the access points

L_TT1P_scAP_CrossCutter[Base/State]

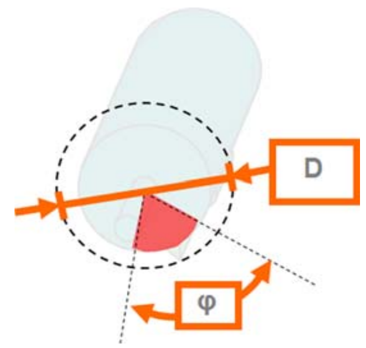
The access points (AP) can be used to influence signals. In the initial state, the access points do not have any effect.

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

<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">AP01_xEndOfProfileWindow Size
BOOL</td><td colspan="2">Enable of the AP01_lrEndOfProfileWindowSize access point</td><td rowspan="3">●</td><td rowspan="3">●</td></tr>
<tr><td>TRUE</td><td>The access point overwrites the values at the access point in the signal flow.</td></tr>
<tr><td>AP01_lrEndOfProfileWindow Size
LREAL</td><td colspan="2">Tolerance window for a stable/safe detection of the last cycle in the current profile of the cam (MP21: xEndOfProfile)
• Within the window, xEndOfProfile = TRUE can only occur once.
• Only after the window has been left (after xEndOfProfile = TRUE), the technology module is able to detect the last cycle in the sequence profile.
• Unit: units (with reference to the master axis)</td></tr>
<tr><td rowspan="2">AP02_xOverspeedUpper Limit
BOOL</td><td colspan="2">Enable of the AP02_lrOverspeedUpperLimit access point</td><td rowspan="3">●</td><td rowspan="3">●</td></tr>
<tr><td>TRUE</td><td>The access point overwrites the values at the access point in the signal flow.</td></tr>
<tr><td>AP02_lrOverspeedUpper Limit
LREAL</td><td colspan="2">The lrSetOverspeedScaled input serves to define the factor for speeding during the synchronous phase. The factor has the value range -0.9 ... 2.0.
With the AP02_lrOverspeedUpperLimit access point, the upper limit can be defined to a value greater than '2.0'.</td></tr>
<tr><td rowspan="2">AP05_xUpperCorrPos
BOOL</td><td colspan="2">Enable of the AP05_lrUpperCorrPos access point</td><td rowspan="3"></td><td rowspan="3">●</td></tr>
<tr><td>TRUE</td><td>The access point overwrites the values at the access point in the signal flow.</td></tr>
<tr><td>AP05_lrUpperCorrPos
LREAL</td><td colspan="2">Upper limit value of the correction window with regard to the register position for the compensating movement of the touch probe correction
• The window must not amount to the entire cycle length.
• Unit for register position: mm</td></tr>
<tr><td rowspan="2">AP06_xLowerCorrPos
BOOL</td><td colspan="2">Enable of the AP06_lrLowerCorrPos access point</td><td rowspan="3"></td><td rowspan="3">●</td></tr>
<tr><td>TRUE</td><td>The access point overwrites the values at the access point in the signal flow.</td></tr>
<tr><td>AP06
lrLowerCorrPos
LREAL</td><td colspan="2">Lower limit value of the correction window with regard to the register position for the compensating movement of the touch probe correction
• The window must not amount to the entire cycle length.
• Unit for register position: mm</td></tr>
</table>

3.6 Parameterisation of the sealing roller

The technology module calculates the cam for synchronous motion of a cross sealing axis and synchronises it with a master axis.



D: Diameter of the sealing roller
φ: Sealing area, angle of the synchronous area of the sealing roller (parameter lrCuttingAngle)

[3-8] Definition of the sealing roller diameter and the sealing area

In order to calculate the seal motion, the circumference (= diameter x π) of the sealing roller is specified using the *lrCrossCutterCircumference* parameter, in the master axis unit (e.g. mm). The value cannot be changed during the cutting operation.

The sealing area is parameterised via the *lrCuttingAngle* parameter in the unit (angular) degrees. The sealing area can be changed at any time during operation and thus adapted to the cutting process. New values are always accepted after the synchronous phase.

The permissible value range for the *lrCuttingAngle* parameter goes from a minimum of '0' to a maximum of
360 / number of tools (*byNumOfTools* parameter).

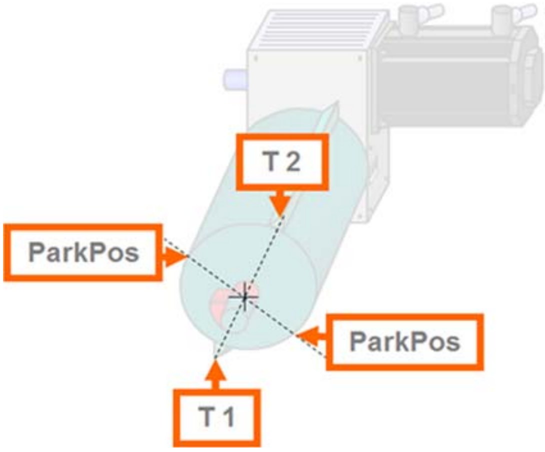
Parameters to be set

The parameters for the sealing roller are located in the L_TT1P_scPar_CrossCutter[Base/State] (📖 23) parameter structure.

```
lrCrossCutterCircumference : LREAL := 360;
lrCuttingAngle : LREAL := 10;
```

3.7 Positioning to the parking position

The technology module supports the calculation of the profiles of several tools (e.g. cutting blades) on the sealing roller. The number of tools per sealing roller is specified by the *byNumOfTools* parameter. The first tool is always on the zero coordinate of the sealing roller and is defined as tool number 1. Any further tools are distributed symmetrically on the roller circumference in positive cutting direction. The parking positions are exactly in the middle between two neighbouring tools.



T1: Tool number 1
T2: Tool number 2
ParkPos: Parking positions

[3-9] Distribution of two tools and parking positions on the sealing roller

The *byStartToolNo* parameter serves to select the tool with the corresponding number which will make the first cut in the material. It also specifies the associated parking position before the selected tool.

If the tools on the sealing roller are not different, set the automatic tool selection using parameter *byStartToolNo* = 0. Then the next possible parking position will be used as target parking position.

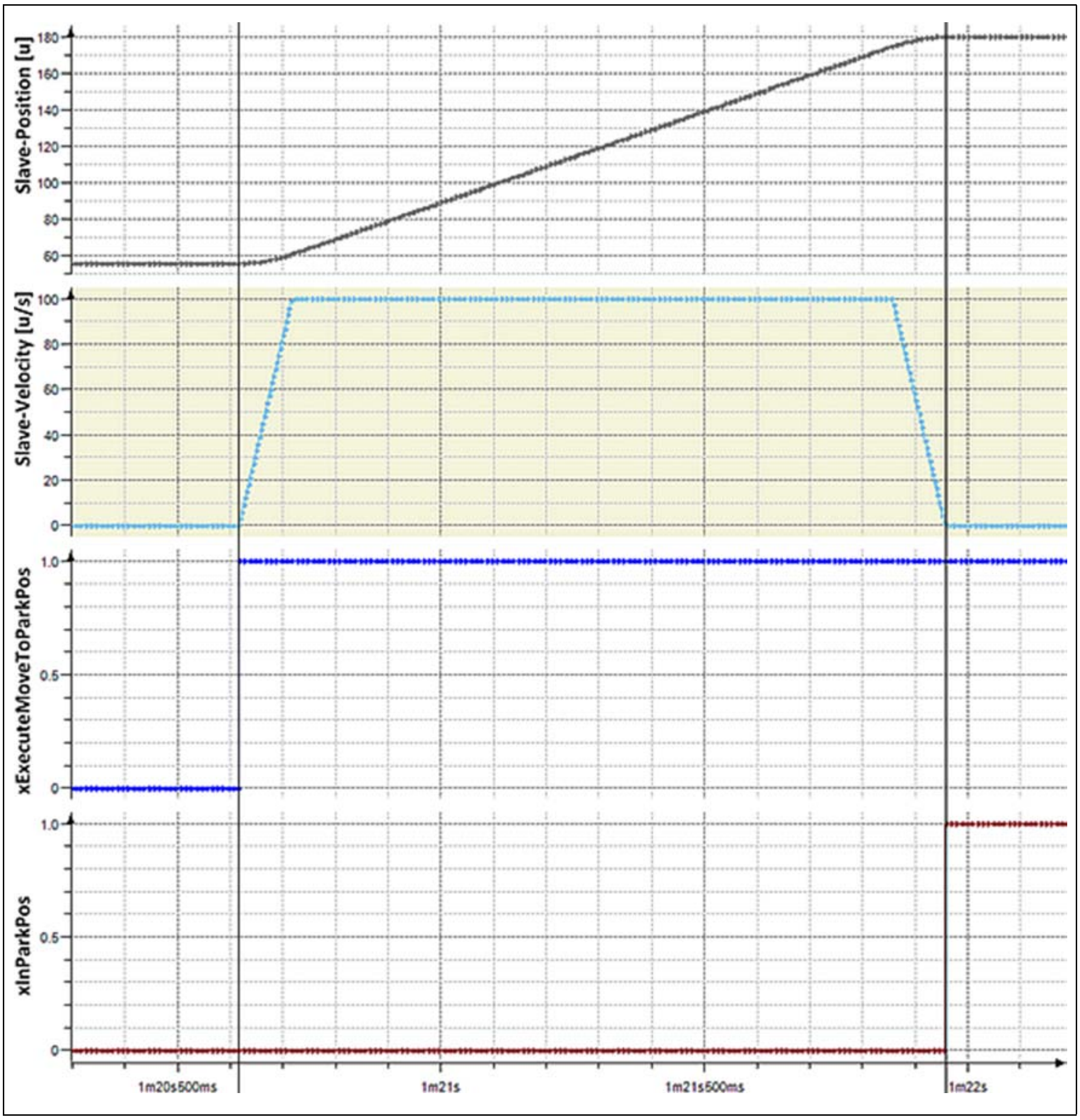
With a rising edge (FALSE↗TRUE) at the *xExecuteMoveToParkPos* input, the slave axis is positioned to the parking position.

The slave axis is then moved to the parking position using the motion parameters *ePositioningDirection*, *lrPositioningVel*, *lrPositioningAcc* and *lrPositioningDec*.

Parameters to be set

The parameters for positioning are located in the L_TT1P_scPar_CrossCutter[Base/State] (📖 23) parameter structure.

```
byNumOfTools : BYTE := 1;
byStartToolNo : BYTE := 0;
ePositioningDirection : MC_DIRECTION := MC_DIRECTION.positive;
lrPositioningVel : LREAL  := 10;
lrPositioningAcc : LREAL  := 100;
lrPositioningDec : LREAL  := 100;
```



[3-10] History: Positioning to the parking position for a tool

3.8 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 (📖 28) changes to the "Ready" state again.

Parameters to be set

The parameters for the manual jog are located in the L_TT1P_scPar_CrossCutter[Base/State] (📖 23) 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.

3.9 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 (📖 28) changes back again to the "Ready" state.

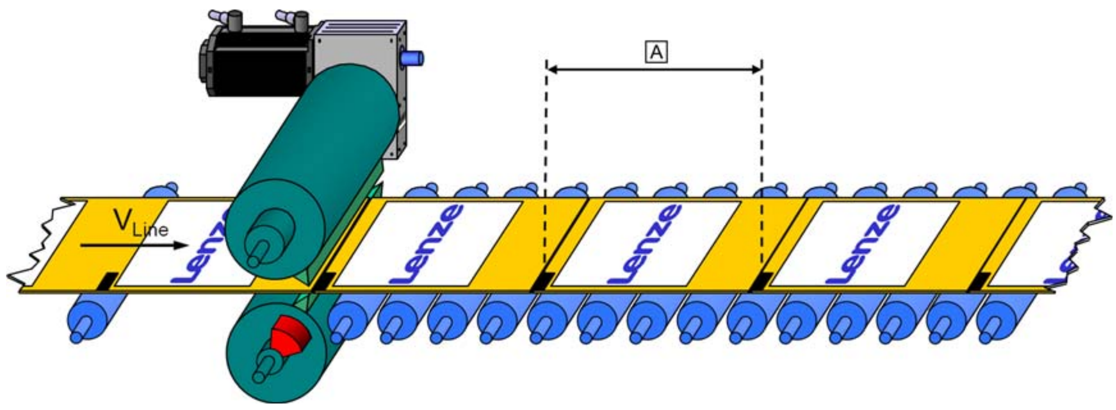
The homing process is not interrupted if the *xHomeExecute* input is set to FALSE too early. The function is aborted via the *xStop* input.

Parameters to be set

The parameters for homing are located in the L_TT1P_scPar_CrossCutter[Base/State] (📖 23) parameter structure.

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

3.10 "Length cutting" operating mode



A Cutting length = product length (input lrProductLength)

[3-11] Cutting length in the "Length cutting" operating mode

In the "Length cutting" operating mode, the profiles are calculated in real time which provides the possibility to carry out flexible changes to the cutting lengths and the synchronous phase during the cutting process. Any changes are accepted after the synchronous phase and effective for the next cut. The synchronous speed of the sealing roller is calculated as a function of the roller circumference in the *lrCrossCutterCircumference* parameter, the speed of the master axis and the cycle length of the sealing roller.

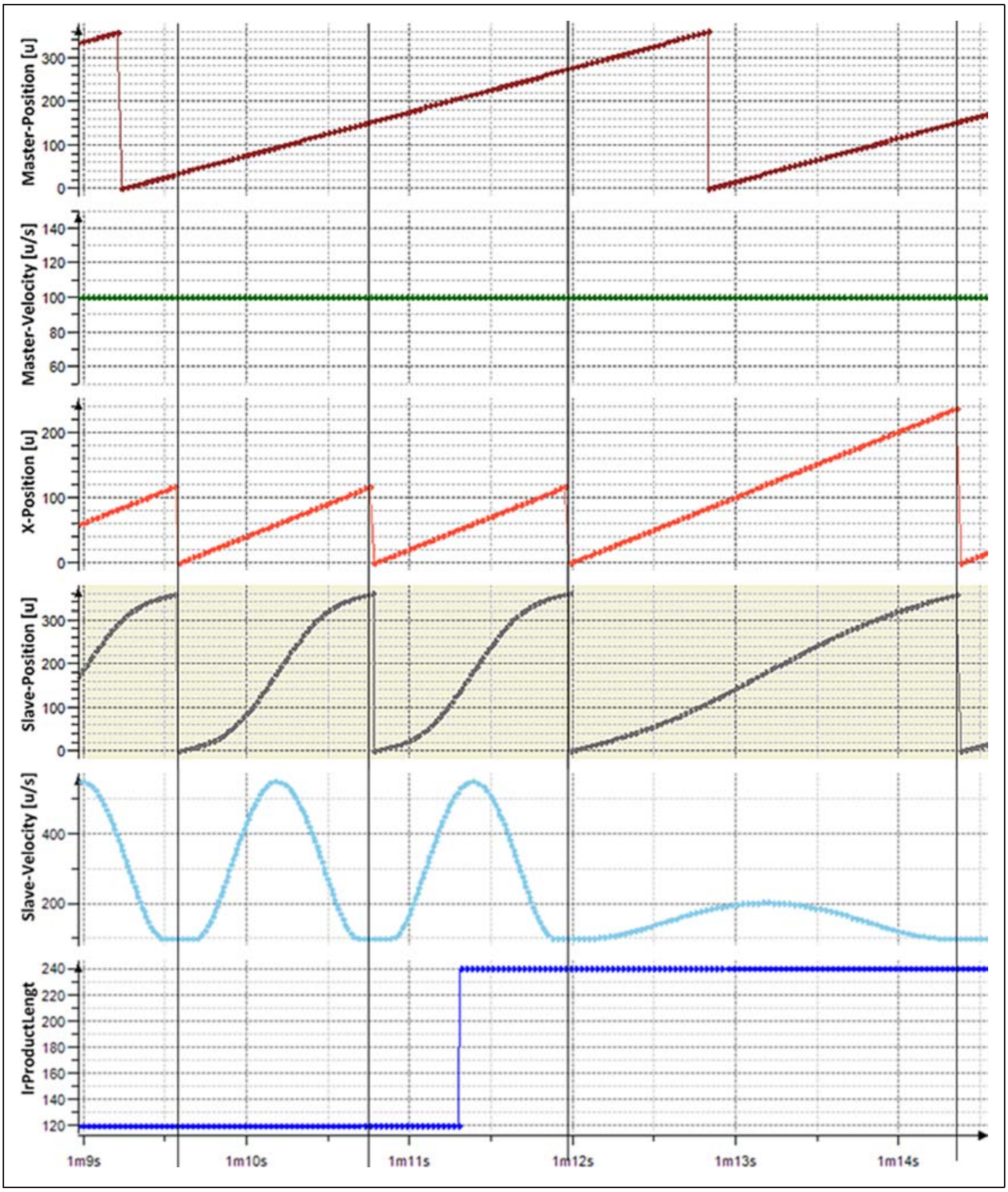
The "Length cutting" operating mode is selected via parameter *eCuttingMode* = 0.

The product/material is cut to the length defined in the *lrProductLength* input. The length is defined in the unit of the master axis (e.g. mm).

Parameters to be set

The parameters for the "length cutting" operating mode are located in the L_TT1P_scPar_CrossCutter[Base/State] (📖 23) parameter structure.

```
xMasterAbsolute : BOOL := FALSE;
lrStartXPosRelative : LREAL := 0;
eCuttingMode : L_TT1P_CuttingMode[Base/State] := 0;
lrCrossCutterCircumference : LREAL := 360;
lrCuttingAngle : LREAL := 10;
byNumOfTools : BYTE := 1;
byStartToolNo : BYTE := 0;
```



[3-12] History: Length-controlled cutting process

3.11 Top cut

Note!

This function is only supported in the "Length cutting" operating mode (📖 42) (parameter *eCuttingMode* = 0).

The frist cutting length of the material is called top cut. The top cutting length can be defined in the technology module via the parameterisation.

Input *xSyncCrossCutter* = TRUE serves to integrate the material speed and thus to calculate the resulting position of the material which is depicted as position on the X axis (output *lrSetXPosOut*).

The end position on the X axis and thus the cutting position of the material results from the sum of the starting position for the X axis (parameter *lrStartXPosRelative)* and half of the path of the synchronous phase. Therefore the X axis will cover the following distance after the FALSE↗TRUE edge at the *xSyncCrossCutter* input until the cut:

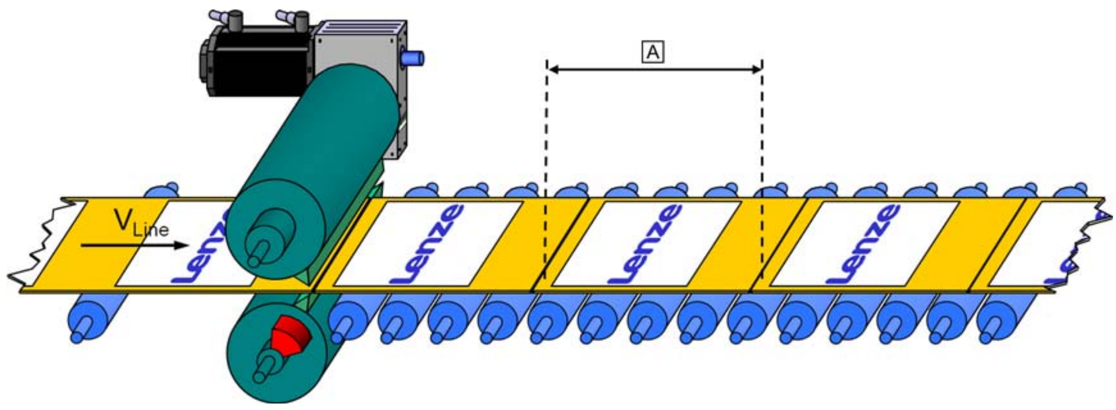
$$\text{lrXDist} = \text{lrMasterSyncInDist} + \frac{\text{lrCuttingAngle}}{2} \cdot \frac{\text{lrCrossCutterCircumference}}{360} + \text{lrSetOffsettMaster}$$

Parameters to be set

The parameters to be set are located in the L_TT1P_scPar_CrossCutter[Base/State] (📖 23) parameter structure.

```
lrStartXPosRelative : LREAL := 0;
lrMasterSyncInDist : LREAL := 0;
lrCrossCutterCircumference : LREAL := 360;
lrCuttingAngle : LREAL := 10;
```

3.12 "Flow packer" operating mode



A cutting length ≡ cycle length of the master axis

[3-13] Cutting length in the "Flow packer" operating mode

In the "Flow packer" operating mode, the cycle length of the master axis is decisive for the cut. In this case, the cross cutter is coupled to the master axis via the cycle length. The technology module always effects a cut at the end of the cycle of the master axis, independent of the product length set in the *lrProductLength* input.

The product length is required to calculate the synchronous speed. The synchronous speed of the sealing roller is calculated as a function of the roller circumference in the *lrCrossCutterCircumference* parameter (in units), the speed of the master axis, the cycle length of the master axis and the cycle length of the sealing roller.

The profiles are calculated in real time which provides the possibility to carry out flexible changes to the cutting lengths and the synchronous phase during the cutting process. Any changes are accepted after the synchronous phase and effective for the next cut. The synchronous speed of the sealing roller is calculated as a function of the roller circumference in the *lrCrossCutterCircumference* parameter, the speed of the master axis and the cycle length of the sealing roller.

The product/material is cut to the length defined in the *lrProductLength* input. The length is defined in the unit of the master axis (e.g. mm).

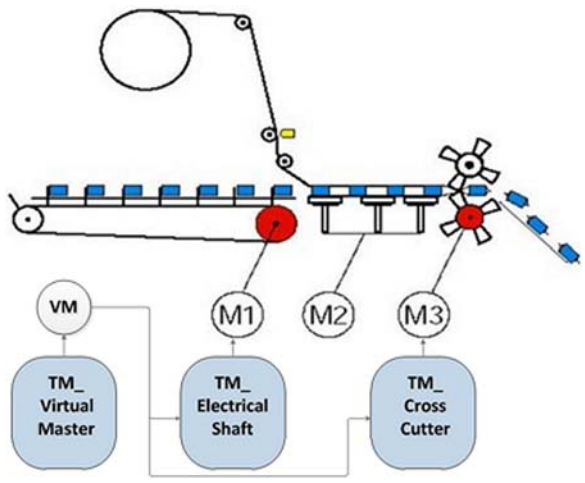
The "Flow packer" operating mode is selected via parameter *eCuttingMode* = 1.

Parameters to be set

The parameters for the "flow packer" operating mode are located in the L_TT1P_scPar_CrossCutter[Base/State] (📖 23) parameter structure.

```
xMasterAbsolute : BOOL := FALSE;
lrStartXPosRelative : LREAL := 0;
eCuttingMode : L_TT1P_CuttingMode[Base/State] := 1;
lrCrossCutterCircumference : LREAL := 360;
lrCuttingAngle : LREAL := 10;
byNumOfTools : BYTE := 1;
byStartToolNo : BYTE := 0;
```

Example: "Flow packer"



[3-14] Sample structure: "Flow packer"

The "Virtual Master" technology module controls a virtual axis with the modulo cycle 0 ... 360°. The virtual axis is the virtual master for all processing stations in the "Flow packer".

The M1 conveying belt is controlled by the "Electrical Shaft Position" technology module (Base variant). The cycle length of M1 is specified equal to the compartment length of 100 mm in which the product is transported. While the master effects a cycle rotation of 360°, the conveying belt covers a distance of 100 mm, i.e. exactly one compartment length.

The M3 cross cutter is operated by the "Cross Cutter" technology module in the "Flow packer" operating mode. The product length of 100 mm is transferred to the "Cross Cutter" technology module. Thus the technology module also specifies the correct synchronous speed for the cut. The cross cutter makes a cut at the end of the cycle of the virtual master, i.e. at position 360.

The virtual master controls the entire cutting process in this way. With each cycle of the virtual master, the conveying belt covers another 100 mm and the cross cutter makes a cut.

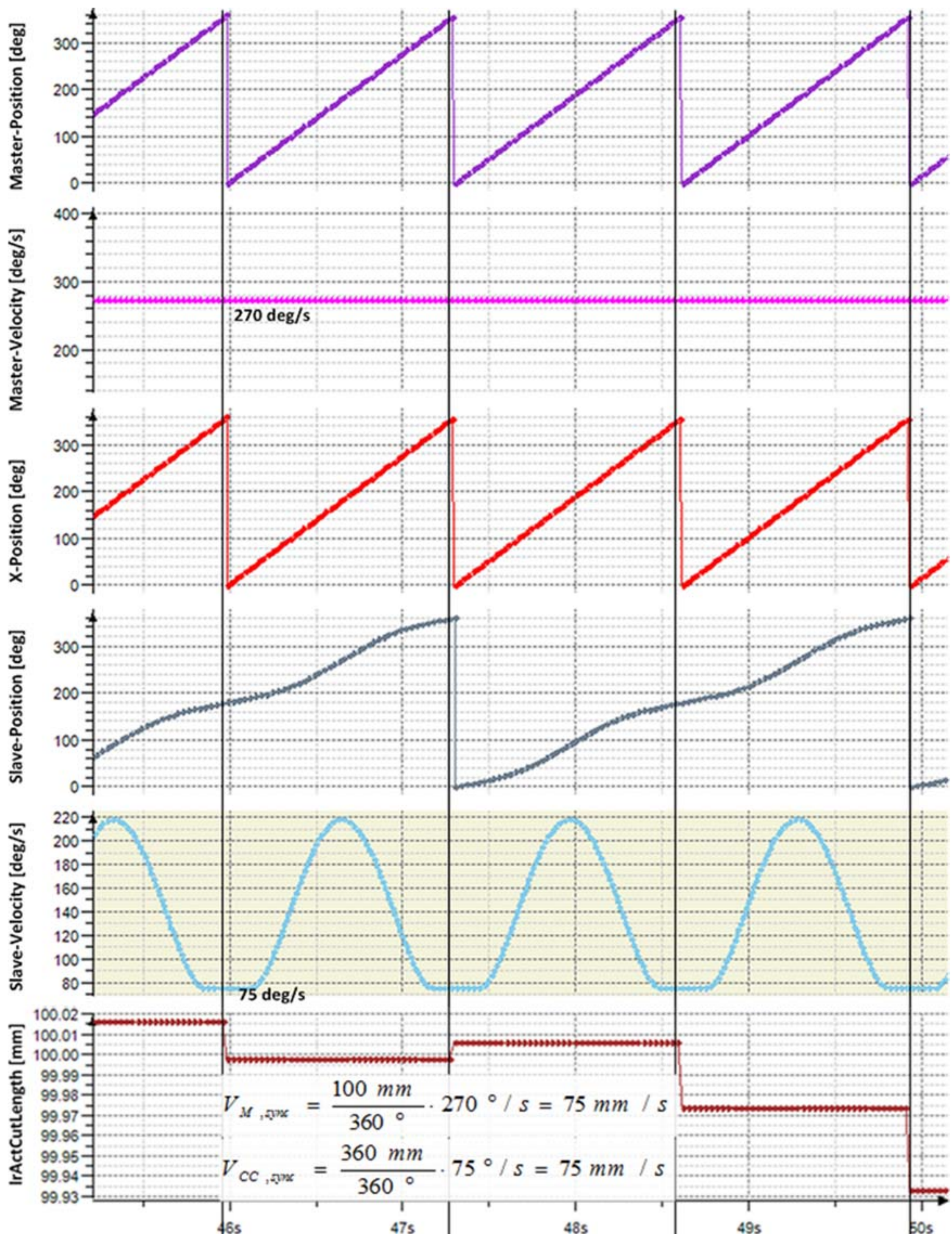
Calculation of the synchronous speed

The synchronous speed (in mm/s) can be derived from the cycle speed of the master axis in the unit [deg/s]:

Calculation of the synchronous speed from the cycle speed of the master axis		
$$V_{M,\ sync} = \frac{L_{Prod}}{L_{MCycle}} \cdot V_{\delta M,\ sync}$$		
Symbol	Description	Dimension unit
$V_{M,sync}$	Cycle speed of the master axis	mm/s
L_{Prod}	Product length	mm
L_{MCycle}	Length of the master cycle	deg
$V_{\delta M,sync}$	Cycle speed of the master axis	deg/s

The synchronous speed can equally be derived from the angular velocity of the cross cutter axis (in deg/s):

Calculation of the synchronous speed from the angular velocity of the cross cutter axis		
$$V_{CC,\ sync} = \frac{Circ_{CC}}{L_{SCycle}} \cdot V_{\delta CC,\ sync}$$		
Symbol	Description	Dimension unit
$V_{CC,sync}$	Angular velocity of the cross cutter axis	mm/s
$Circ_{CC}$	Circumference of the cross cutter axis	mm
L_{SCycle}	Length of the slave cycle	deg
$V_{\delta CC,sync}$	Angular velocity of the cross cutter axis	deg/s



Input lrProductLength = 100 mm
Parameter lrCrossCutterCircumference = 360 mm

[3-15] History: "Flow packer" cutting process

3.13 Positioning the cross cutter to static material

Note!

During the positioning process the master axis and thus the material must not move.

The "Positioning to static material" clutching type is selected via parameter *eSyncMode* = 1 (positioning).

The cross cutter is synchronised with the material position (X position and resulting Y position from the cam) using the input *xSyncCrossCutter* = TRUE.

There are two possibilities to specify the current material position:

- Specify the material position via the *lrStartXPosRelative* parameter.
  For this purpose, the parameter *xMasterAbsolute* must be set to FALSE.
- Set the parameter *xMasterAbsolute* = TRUE.
  This serves to set the current material position to the master axis position and thus to define an absolute reference between these two positions to position the slave axis.

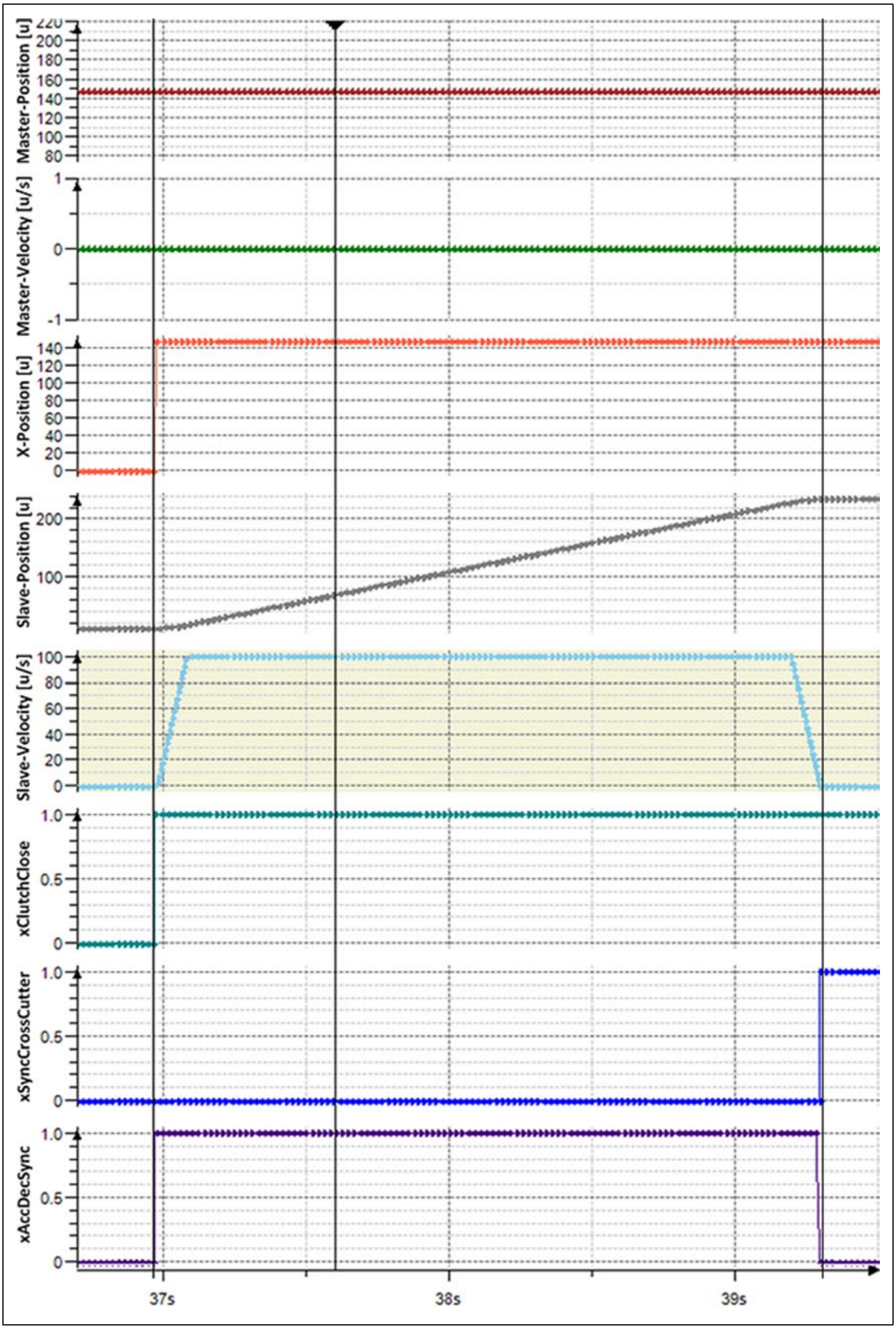
The slave axis is positioned from its current position via the parameters *ePositioningDirection*, *lrPositioningVel*, *lrPositioningAcc* and *lrPositioningDec* to the resulting Y position from the cam.

The positioning process is carried out in the "POSITIONING_TO_START_POS" status. After successful clutch-in, the output *xSynchronised* = TRUE and the "CUTTING" status is set.

Parameters to be set

The parameters for positioning the cross cutter to the static material are located in the L_TT1P_scPar_CrossCutter[Base/State] (📖 23) parameter structure.

```
xMasterAbsolute : BOOL := FALSE;
lrStartXPosRelative : LREAL := 0;
eSyncMode : L_TT1P_SyncModeCrossCutter := 0;
ePositioningDirection : MC_DIRECTION := MC_DIRECTION.positive;
lrPositioningVel : LREAL  := 10;
lrPositioningAcc : LREAL  := 100;
lrPositioningDec : LREAL  := 100;
```



[3-16] History: Positioning to the cam

3.14 Clutching the cross cutter to moving material

Note!

For the clutch-in process to moving material, the cross cutter must be in the parking position (set input *xExecuteMoveToParkPos* = TRUE).

▶ Positioning to the parking position (📖 38)

The clutching type "Clutching to moving material" is selected via parameter *eSyncMode* = 1 (Cam_in).

The cross cutter is synchronised with the material position (X position and resulting Y position from the cam) using the input *xSyncCrossCutter* = TRUE.

There are two possibilities to specify the current material position:

- Specify the material position via the *lrStartXPosRelative* parameter.
  For this purpose, the parameter *xMasterAbsolute* must be set to FALSE.
- Set the parameter *xMasterAbsolute* = TRUE.
  This serves to set the current material position to the master axis position and thus to define an absolute reference between these two positions to position the slave axis.

Starting from the parking position, the slave axis is clutched into the synchronous phase using the calculated cam.

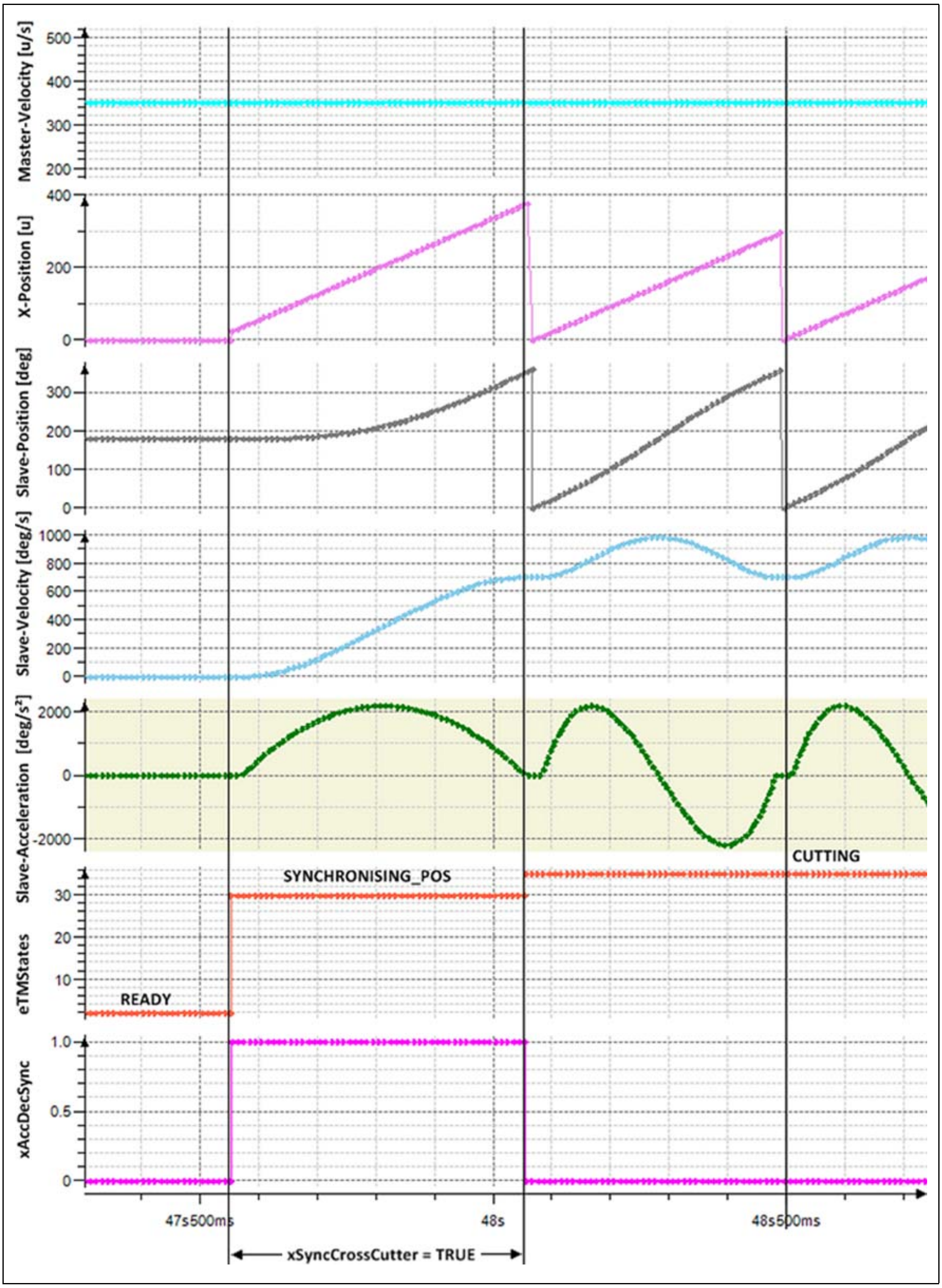
In the "Length cutting" operating mode (parameter eCuttingMode = 0) you can set the clutch-in distance of the master axis using the *lrMasterSyncInDist* parameter. Then the first cutting length is defined. Setting *lrMasterSyncInDist* = 0 serves to calculate the optimal clutch-in distance.

The clutch-in process is carried out in the "SYNCHRONISING_POS" status and the *xAccDecSync* output is set to TRUE. After successful clutch-in, the output *xSynchronised* = TRUE and the "CUTTING" status is set.

Parameters to be set

The parameters for clutching the cross cutter to moving material can be found in the L_TT1P_scPar_CrossCutter[Base/State] (📖 23) parameter structure.

```
xMasterAbsolute : BOOL := FALSE;
lrStartXPosRelative : LREAL := 0;
eSyncMode : L_TT1P_SyncModeCrossCutter := 1;
lrMasterSyncInDist : LREAL := 0;
```



[3-17] History: Clutching to moving material.

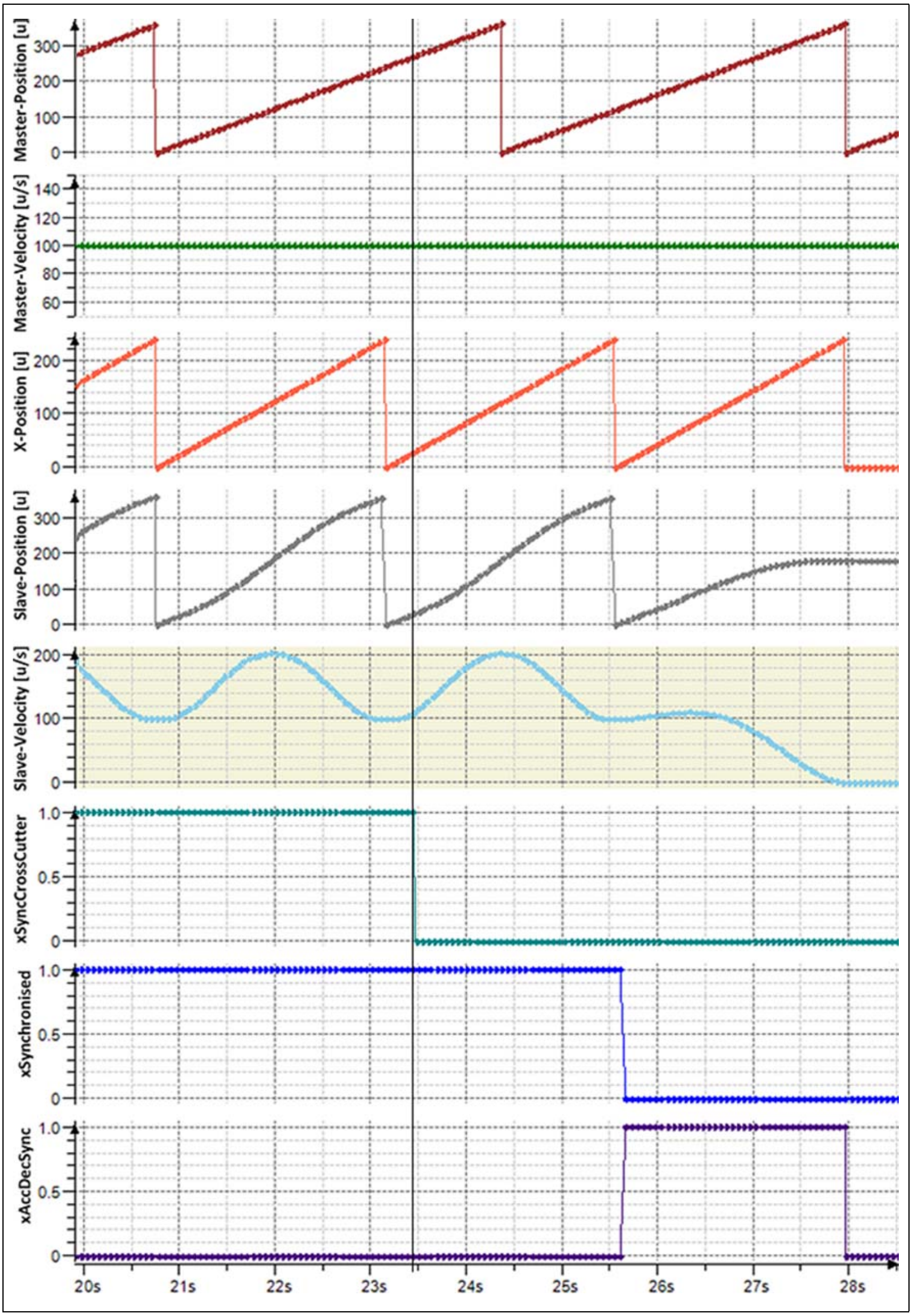
3.15 Declutching the cross cutter

The declutch process can only be carried out if the master axis is moving. It is effected via the input *xSyncCrossCutter* = FALSE.

The declutch process starts after the synchronous phase and can take several cutting cycles. The cross cutter is stopped in the parking position.

Position-controlled declutching from the current cam is carried out by a 5th degree polynomial.

The declutch process is indicated by the output *xAccDecSync* = TRUE. After successfull declutching, the outputs *xDone* = TRUE and *xAccDecSync* = FALSE are set.



[3-18] History: Declutching from the cutting process

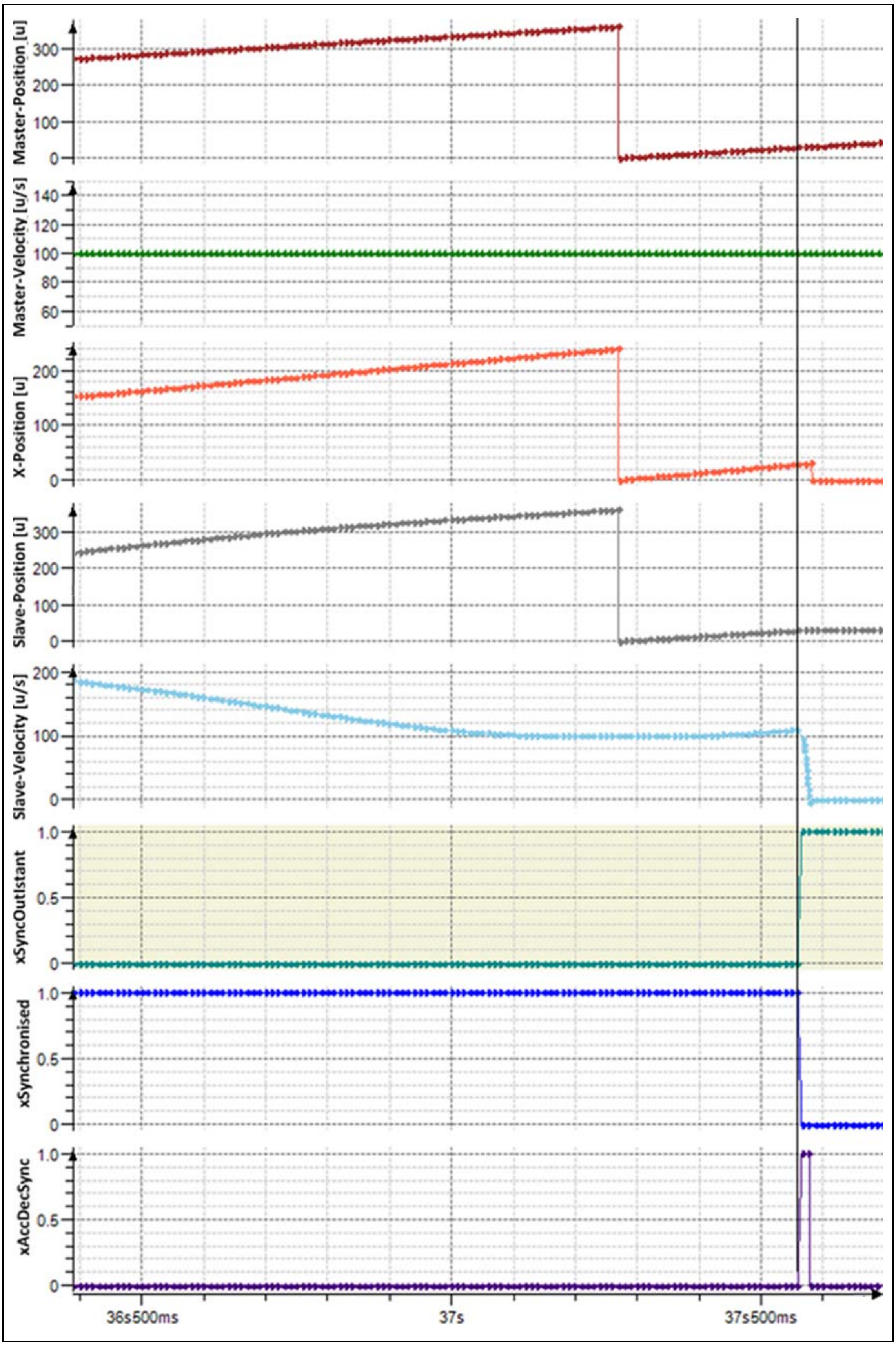
3.16 Positive opening operation / Emergency opening operation

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 opened as long as the input *xSyncOutInstant* is set to TRUE. The *xSyncOutInstant* input has higher priority than the *xSyncCrossCutter* input.

The declutch process is indicated by the output *xCuttingActive* = TRUE. After successful declutching, the outputs *xDone* = TRUE and *xCuttingActive* = FALSE are set.

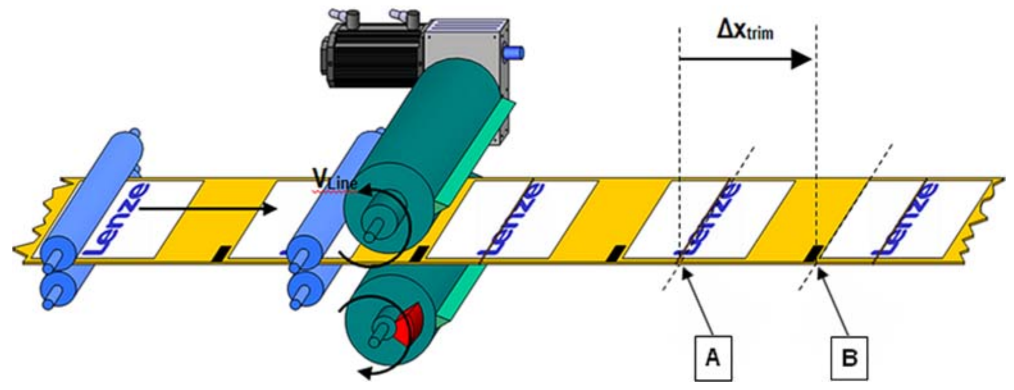
The *lrSyncOutInstantDec* parameter can be found in the L_TT1P_scPar_CrossCutter[Base/State] (📖 23) parameter structure.



[3-19] History: Positive opening operation / Emergency opening operation

3.17 Trimming and offset of the cutting position

The trimming and offset functions provide a possibility to shift the cut in relation to the product cycle.

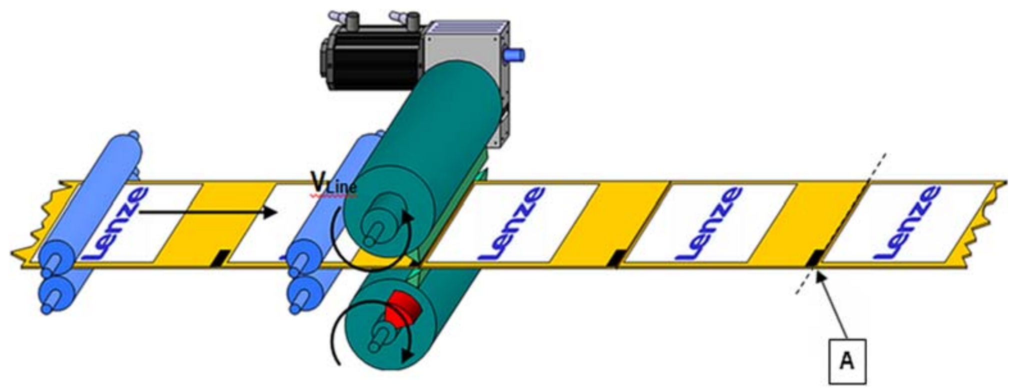


A Actual cutting position
B Setpoint cutting position
Δx_{trim}: Offset of the cutting position

[3-20] Cutting position: the cut is in the middle of the print image

In fig. [3-20] the cut is in the middle of the print image. In order to get the cut into the required position, the cross cutter drive must be trimmed by the corresponding differential travel Δx_{trim} with respect to the current cutting position.

After completing the trimming, the cut - with reference to the product cycle - is shifted and in the ideal case it is placed correctly (fig. [3-21]: setpoint cutting position = actual cutting position).



A setpoint cutting position = actual cutting position

[3-21] Optimal cutting position: the cut is exactly at the cycle transition

The technology module provides the following functions for cut trimming and cut offset:

- Position cut trimming (📖 58)
- Speed cut trimming (Tip trimming) (📖 60)
- Absolute positioning of the cutting position via master offset (📖 62)

3.17.1 Position cut trimming

The position cut trimming is enabled when *eTrimMode* parameter = 0.

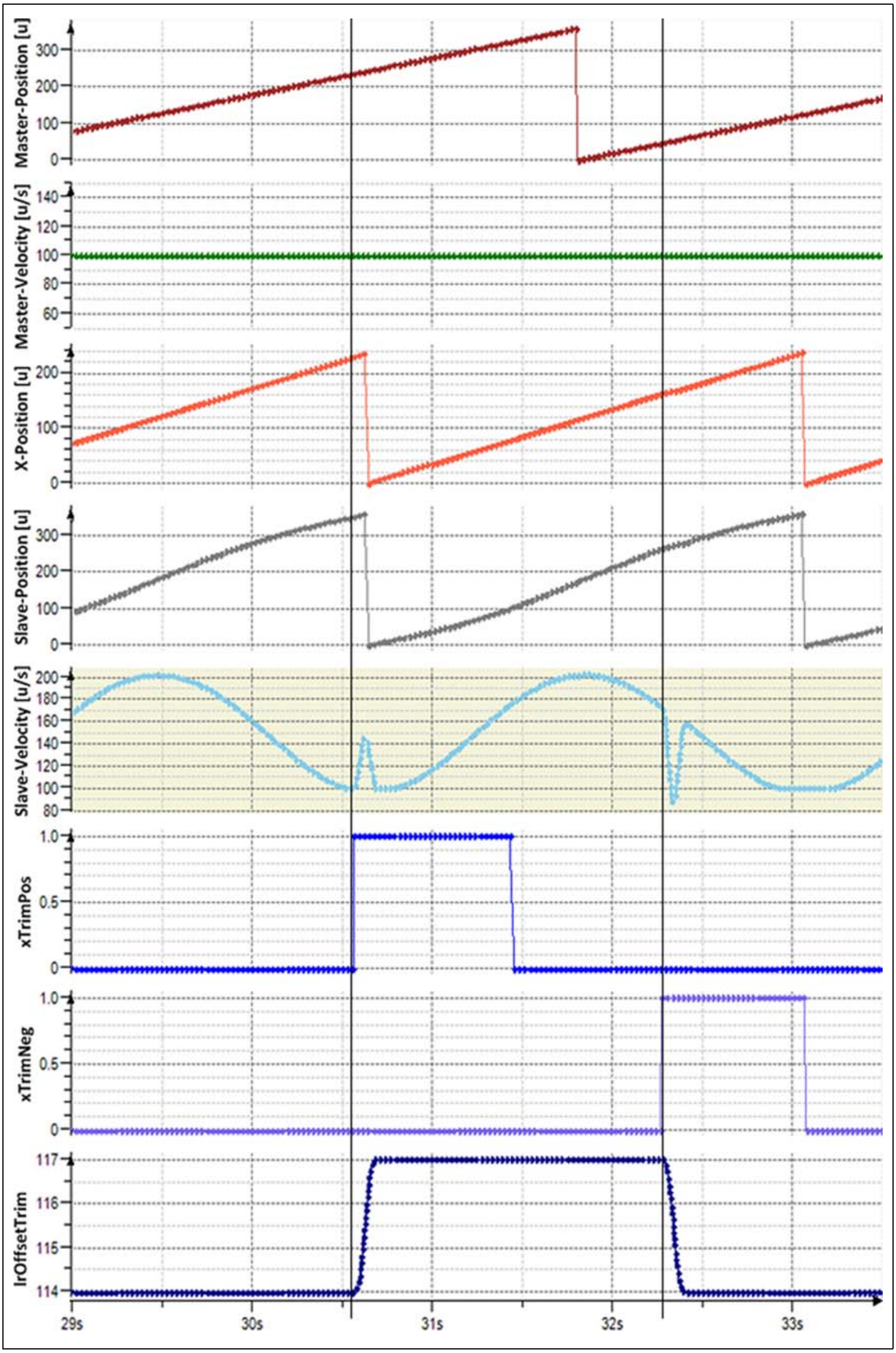
In the position cut trimming, the cut is trimmed via a defined increment.

The cutting position is shifted using the inputs *xTrimPos* = TRUE (in positive direction) or *xTrimNeg* = TRUE (in negative direction) by the increment specified in the *lrTrimDist* parameter.

Parameters to be set

The parameters for position cut trimming are located in the L_TT1P_scPar_CrossCutter[Base/State] (📖 23) parameter structure.

```
eTrimMode : L_TT1A_TrimMode := 0;
lrTrimDist : LREAL := 3;
lrOffsetTrimVel : LREAL := 10;
lrOffsetTrimAcc : LREAL := 100;
lrOffsetTrimDec : LREAL := 100;
```



[3-22] Progression: Position cut trimming

3.17.2 Speed cut trimming (Tip trimming)

The speed cut trimming is enabled when *eTrimMode* parameter = 1.

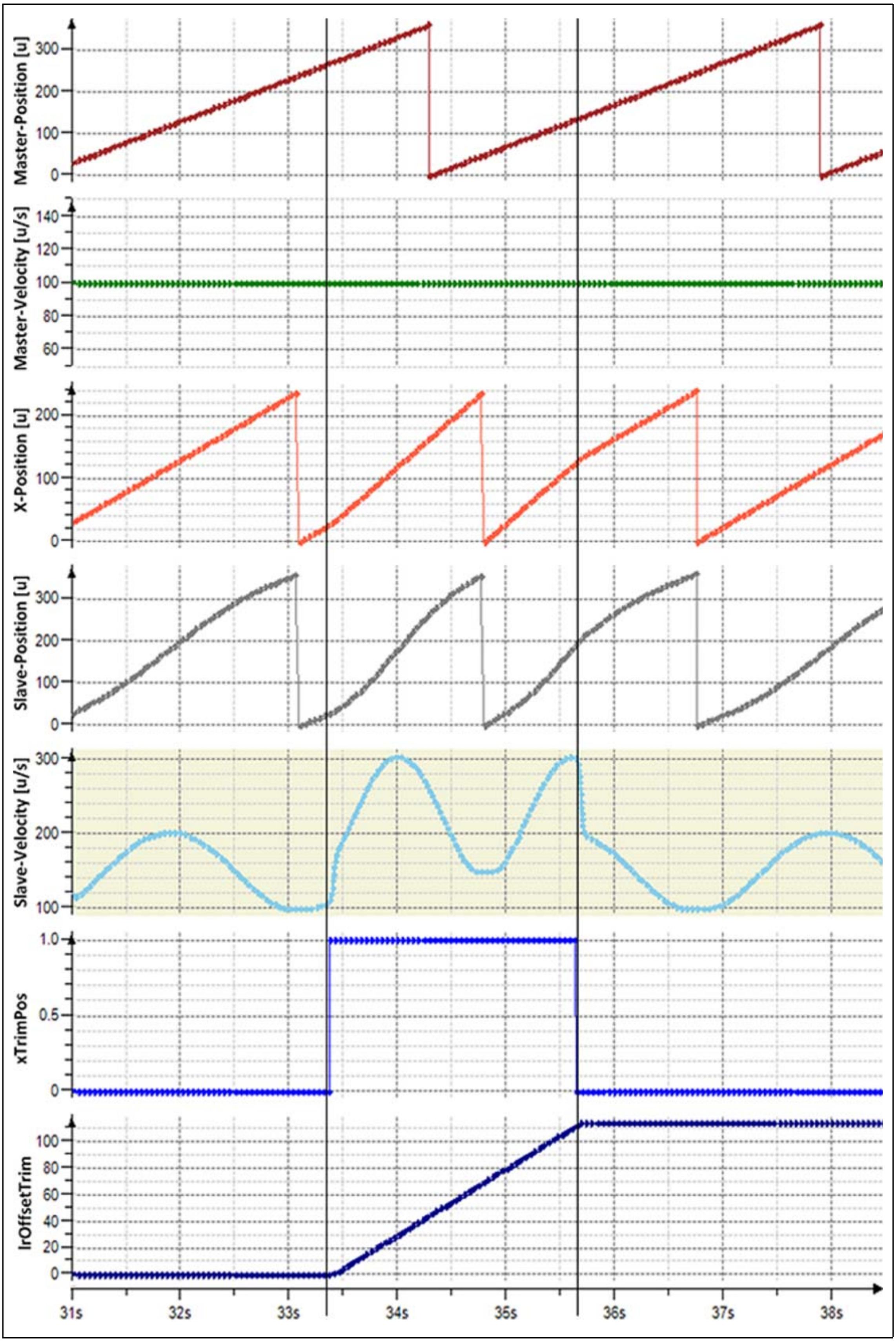
With speed cut trimming, the cutting position is shifted using the *xTrimPos* (in positive direction) or *xTrimNeg* (in negative direction) inputs. The offset per time unit is specified by the trimming velocity (*lrOffsetTrimVel* parameter).

Similar to Manual jog (jogging) (📖 40) the setpoint cutting position is shifted back or forth at constant speed until one of the inputs *xTrimPos* or *xTrimNeg* is TRUE.

Parameters to be set

The parameters for speed cut trimming are located in the L_TT1P_scPar_CrossCutter[Base/State] (📖 23) parameter structure.

```
eTrimMode : L_TT1A_TrimMode := 1;
lrOffsetTrimVel : LREAL := 10;
lrOffsetTrimAcc : LREAL := 100;
lrOffsetTrimDec : LREAL := 100;
```



[3-23] Progression: Speed cut trimming

3.17.3 Absolute positioning of the cutting position via master offset

In this mode, the cutting position is shifted by an offset already known before the start of the cut trimming. The offset must be specified as master offset via the *lrSetOffsetMaster* input. The offset is applied by a profile generator.

The *lrOffset* output serves to indicate the absolute offset resulting from the sum of trimming and master offset. In the synchronous phases, the profile generator for the offset adjustment is stopped in order to maintain the synchronous speed. After the synchronous phase, the offset adjustment is resumed by the profile generator.

In order to restore the initial reference, the offset must be set to '0'. The application of the offset is started automatically as soon as a new value different from the previous setpoint is set.

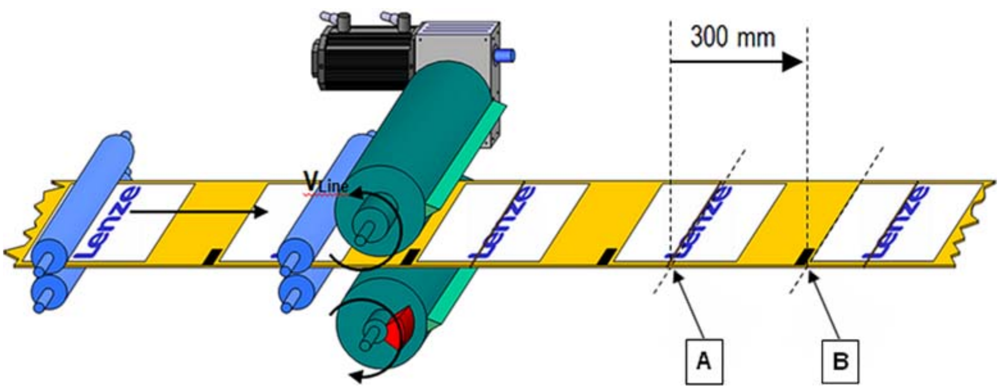
Parameters to be set

The parameters for the absolute positioning of the cutting position are located in the L_TT1P_scPar_CrossCutter[Base/State] (23) parameter structure.

```
eTrimMode : L_TT1A_TrimMode := 0;
lrOffsetTrimVel : LREAL := 10;
lrOffsetTrimAcc : LREAL := 100;
lrOffsetTrimDec : LREAL := 100;
```

Example

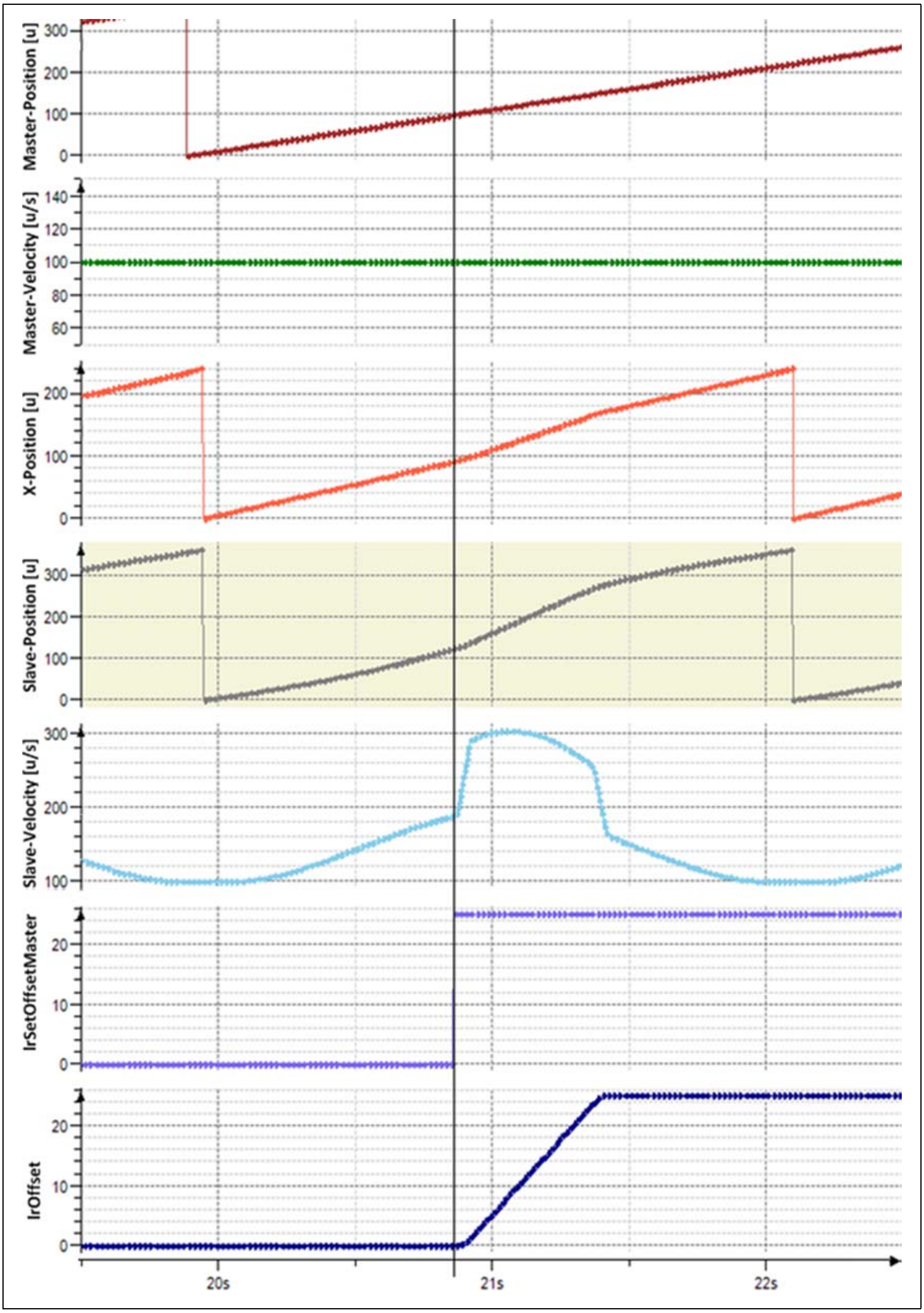
In a current actual cutting position (X position), the cut is 300 mm before the setpoint cutting position.



A Actual cutting position
B Setpoint cutting position

[3-24] Compensation of a known cutting offset

By means of the cut trimming, the cut is shifted by 300 mm in material flow direction to the required position (offset in positive direction). For this purpose, the required offset of +300 mm is specified for the current actual cutting position. The offset is automatically applied immediately.



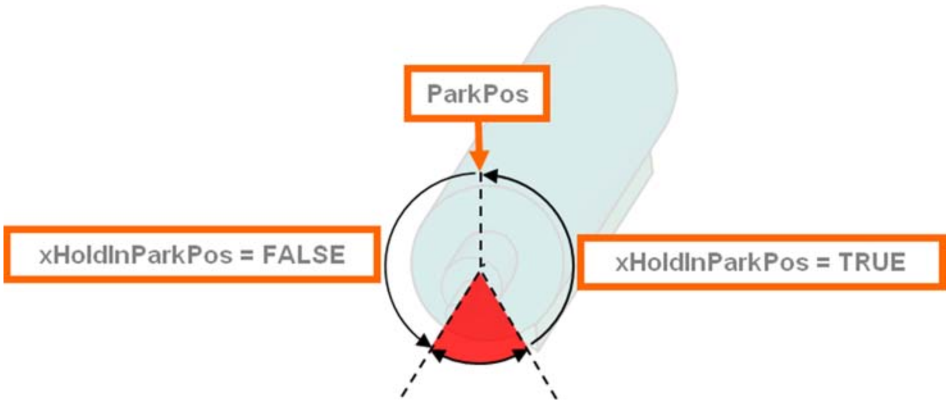
[3-25] History: Acceptance of the offset by the profile generator

3.18 Method of elimination

The eliminiation function serves to leave out cuts in the material. For this purpose the cross cutter is brought to the parking postion in order not to carry out the cutting process.

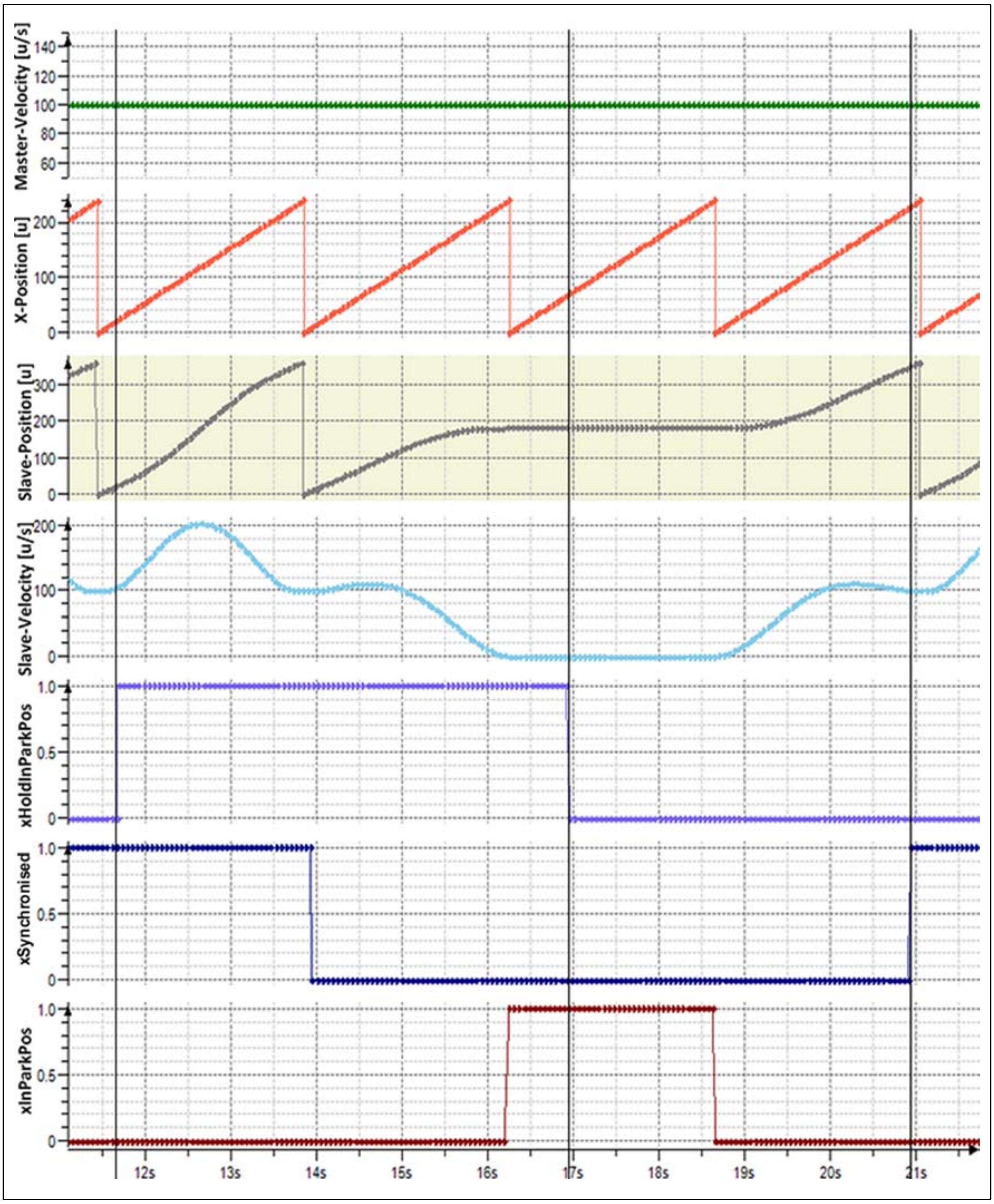
The input *xHoldInParkPos* = TRUE serves to declutch the cross cutter after the synchronous phase into the parking position. As soon as the parking position is reached, the output *xInParkPos* is set to TRUE. The position of the material is still determined. The cross cutter remains in the parking position until the input *xHoldInParkPos* is set to FALSE.

The cutting process is resumed after the synchronous phase, i.e. the cross cutter is clutched into the next synchronous phase.



ParkPos: parking position

[3-26] Parking position in the elimination function

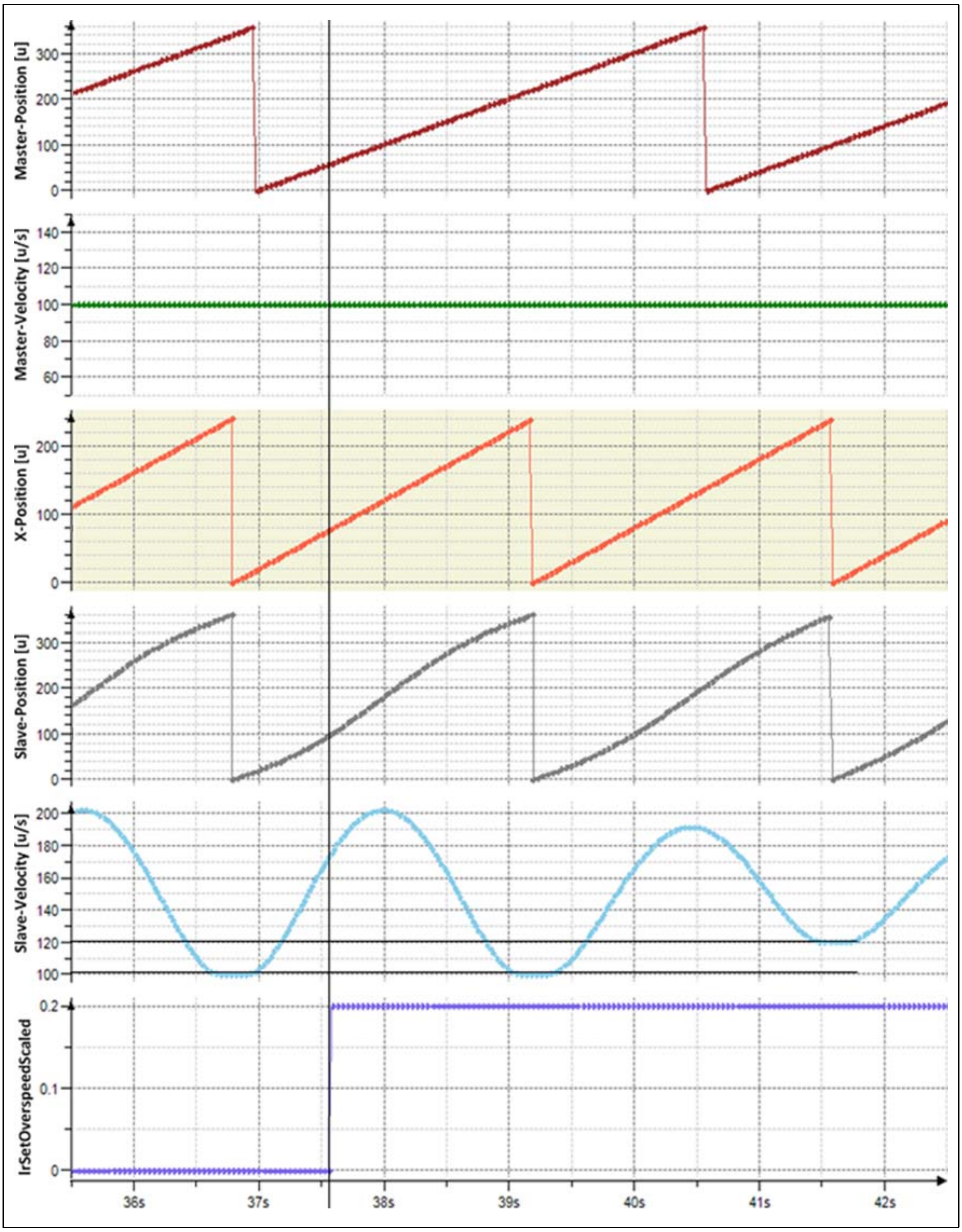


[3-27] History: Stopping the cross cutter in the cutting process

3.19 Increasing/decreasing the speed (overspeed)

In certain applications, the motion in the cutting phase must be undersynchronous or oversynchronous with the material speed by an adjustable factor. Increasing or decreasing the speed is made possible by the *lrSetOverspeedScaled* input. A scaled value with reference to the current material speed is expected here.

If, for example, the synchronous speed of the sealing roller is to be decreased by 20%, the input *lrSetOverspeedScaled* must be set to -0.2. The setting '0.5' results in an increase in the synchronous speed by 50%. The valid value range of the *lrSetOverspeedScaled* input is from -0.9 to 2.0. Any change to the value is accepted after the synchronous phase and is effective for the next step.



[3-28] History: Oversynchronous cutting process

3.20 Calculating extreme values of a cam

The technology module provides the possibility to examine the profiles for the slave axis for maxima of speed and acceleration. The maxima are calculated using 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* serve to put out the maximum velocity and the maximum acceleration of the slave axis. These values are updated automatically.

Parameters to be set

The parameters to be set are located in the L_TT1P_scPar_CrossCutter[Base/State] (📖 23) parameter structure.

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

3.21 Calculating the cutting length

After each cut, the technology module calculates the material length cut (output *xCutDone* = TRUE).

The cut length results from the difference between the current position of the master axis and the current cutting position of the sealing roller.

The current cutting length is put out at the *lrActCutLength* output.

3.22 "Length cutting with mark correction" operating mode

In the "Length cutting with mark correction" operating mode, the integrated register controller as higher-level control loop controls the position relative to a mark detected on the material (touch probe). For this purpose the technology module creates a register axis which contains the corrected position. This register position is used as master value for the cutting formats.

The "Length cutting with mark correction" operating mode is selected using parameter *eCuttingMode* = 2.

Note!

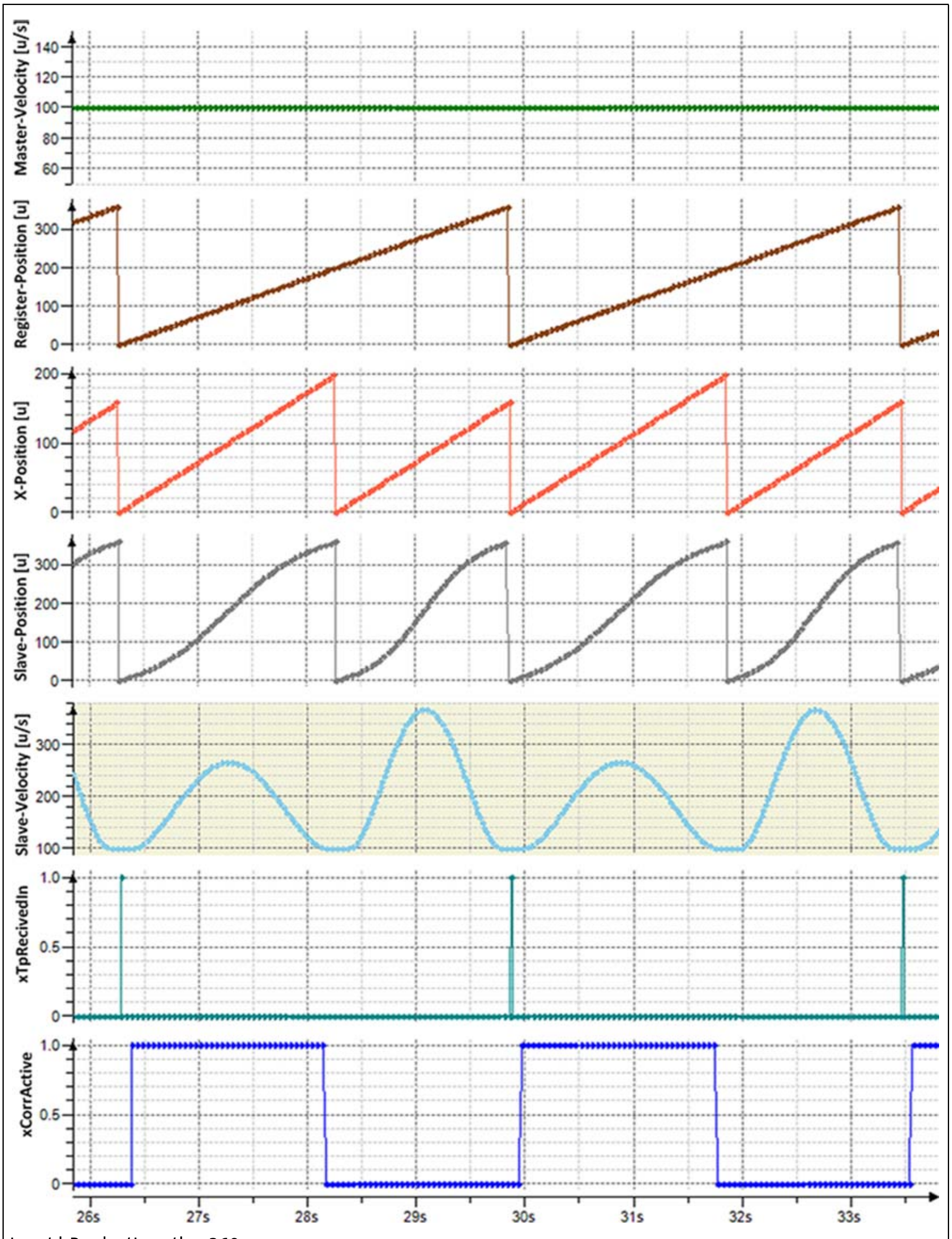
Before the cutting process ...

- you must select a touch probe source.
  - Selecting the touch probe source (74)
- you must reference the mark position (touch probe) for register control;
  - Referencing the mark position (75)

Parameters to be set

The parameters for the "length cutting with mark correction" operating mode are located in the L_TT1P_scPar_CrossCutter[Base/State] (23) parameter structure.

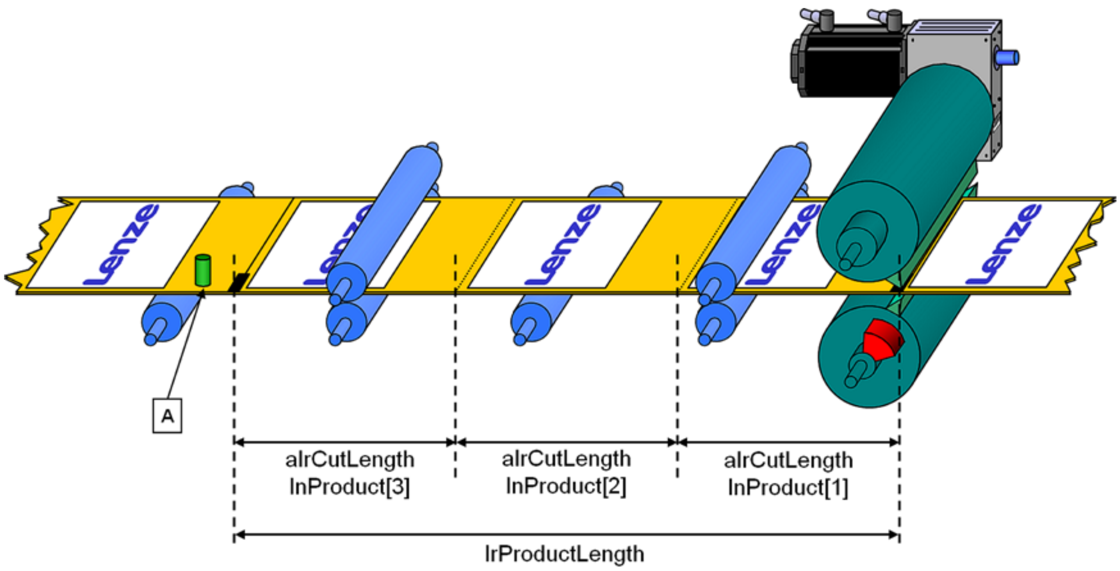
```
xMasterAbsolute : BOOL := FALSE;
lrStartXPosRelative : LREAL := 0;
eCuttingMode : L_TT1P_CuttingModeState := 2;
eTpMode : L_TT1P_TpMode := 0;
lrSensorToolDistance : LREAL := 0;
lrCrossCutterCircumference : LREAL := 360;
lrCuttingAngle : LREAL := 10;
byNumOfTools : BYTE := 1;
byStartToolNo : BYTE := 0;
xMarkCorrection : BOOL := TRUE;
lrMarkWindowSize : LREAL := 90;
lrMaxCorrPos : LREAL := 30.0;
lrMaxCorrNeg : LREAL := -30.0;
```



Input lrProductLength = 360
Parameter alrCutLengthInProduct[1] = 200
Parameter alrCutLengthInProduct[2] = 160

[3-29] History: Cutting process with mark correction via register control

3.23 Partial cutting lengths in product length (print/cut format)



A Cutting mark sensor (touch probe sensor)

[3-30] Cutting lenghts in product length (print/cut format)

The product length is defined by the *lrProductLength* input. In this way you also define the cycle length of the register. This value is always constant for the cutting process and cannot be changed. Cuts are always expected at the interval of the product length.

The parameter (array) *alrCutLengthInProduct[1..10]* serves to defined up to 10 partial cuts with different cutting lengths within in the product length (or the register cycle). The first cut *alrCutLengthInProduct[1]* is made at the beginning of the product, the second cut *alrCutLengthInProduct[2]* subsequently, etc. The sum of all cutting lengths in the array must correspond to the product length (the register cycle).

All partial cutting lengths defined with the value '0' are deactivated. In the event that all partial cutting lengths are defined with the value '0', the cutting length is equal to the product length (input *lrProductLength*).

Parameters to be set

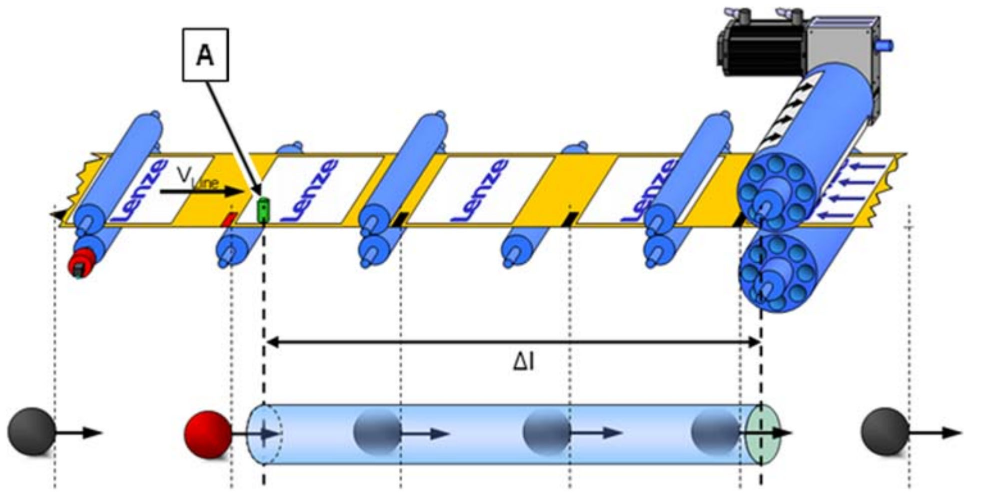
The parameters to be set are located in the L_TT1P_scPar_CrossCutter[Base/State] (23) parameter structure.

```
eCuttingMode : L_TT1P_CuttingMode[Base/State] := 0;
eTpMode : L_TT1P_TpMode := 0;
lrMarkWindowSize : LREAL := 90;
```

3.24 Cutting mark register

The cutting mark register allows for the installation of the cutting mark sensor further away from the axis with the tool (e.g. cutting blade) than one register cycle.

Fig. [3-31] shows the use of a cutting mark register. Here the distance (Δl) from the cutting mark sensor to the tool is larger than the specified register cycle.

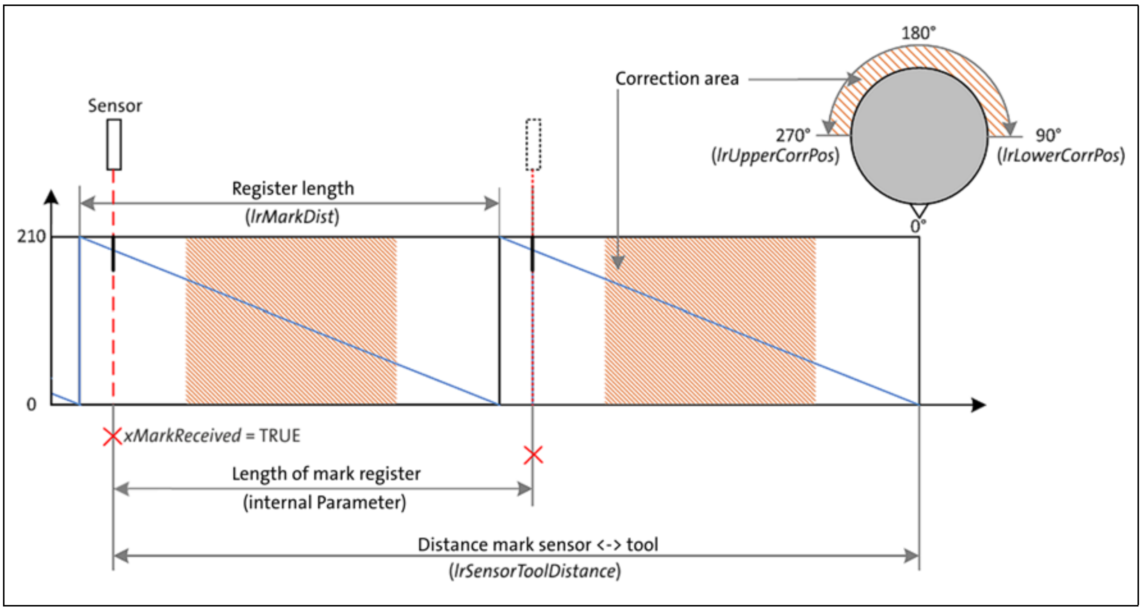


A Cutting mark sensor (touch probe sensor)

[3-31] Systematic representation of the cutting mark register

The aim should always be to mount the cutting mark sensor as close to the axis as possible. The further away from the axis the sensor is mounted, the more changes to the material flow will remain undetected and result in cutting inaccuracies.

Up to 100 mark signals can be managed in the mark register. They are available for the system at the right time – delayed by the mark register length. In this way, a cut can always be made on the right cutting mark signal, for instance.



[3-32] Cutting 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.

3.25 Selecting the 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.

Parameters to be set

The parameters to be set are located in the L_TT1P_scPar_CrossCutter[Base/State] (📖 23) parameter structure.

```
eTpMode : L_TT1P_TpMode := 0;
lrCycleLengthExtEncoder : LREAL := 0;
```

3.26 Referencing the mark position

The mark position must be referenced before the cutting process can be started in the "Length cutting with mark correction" operating mode (parameter *eCuttingMode* = 2).

Preconditions for referencing the mark position (touch probe) are the selection of the operating mode (parameter *eCuttingMode)*, the determination of the product length (input *lrProductLength*) and no active cutting process. The product length corresponds to the length of one register cycle of the register axis.

During homing, the axis is moved from the touch probe source (parameter *eTpMode*) and a valid touch probe mark is transferred via inputs *xMarkReceive* and *lrActMarkPosIn*. The next valid touch probe mark serves to set the register position. The position where the mark is expected is determined internally and is indicated via output *lrMarkSensorPos*. A touch probe window with the width specified in parameter *lrMarkWindowSize* is symmetrically (± *lrMarkWindowSize* / 2) put around the current touch probe mark.

The register axis is coupled with the master axis using a synchronism. The output *xMarkWindowTeached* is set to TRUE if the home position of the mark is known. The product length must then not be changed any more. If you want to change the product length and thus the register register cycle, you must re-reference the mark.

Referencing the mark position is started using input *xTeachMarkWindow* = TRUE. During the referencing, the output *xTeachMarkWindowActive* is set to TRUE.

The *lrActMarkDist* output contains the register length between the last two touch probe marks.

Parameters to be set

The parameters to be set are located in the L_TT1P_scPar_CrossCutter[Base/State] (📖 23) parameter structure.

```
eCuttingMode : L_TT1P_CuttingModeState := 2;
eTpMode : L_TT1P_TpMode := 0;
lrMarkWindowSize : LREAL := 90;
```

3.27 Speed sychronism of master and register axis

For the synchronism of the register axis with the master axis, a register position is created within the technology module which is used by the cross cutter (slave axis) as master position.

The register position is created by integrating the setpoint speed of the master axis into the register cycle (input *lrProductLength*). The calculated register position is put out at the *lrSetRegPosOut* output.

By coupling the input *xSyncCrossCutter* = TRUE, the slave axis is connected with the register axis without jerking.

3.28 Gearbox factor correction

Changing register features (e.g. within a paper reel) will result in a changed real register length. The difference to the parameterised register length results in turn in corrections in always the same direction (positive/negative). This is inefficient and contributes to higher energy consumption as well as increased mechanic 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 by input *xGearFactorCorr* = TRUE and is active until the input *xSyncCrossCutter* is set to TRUE.

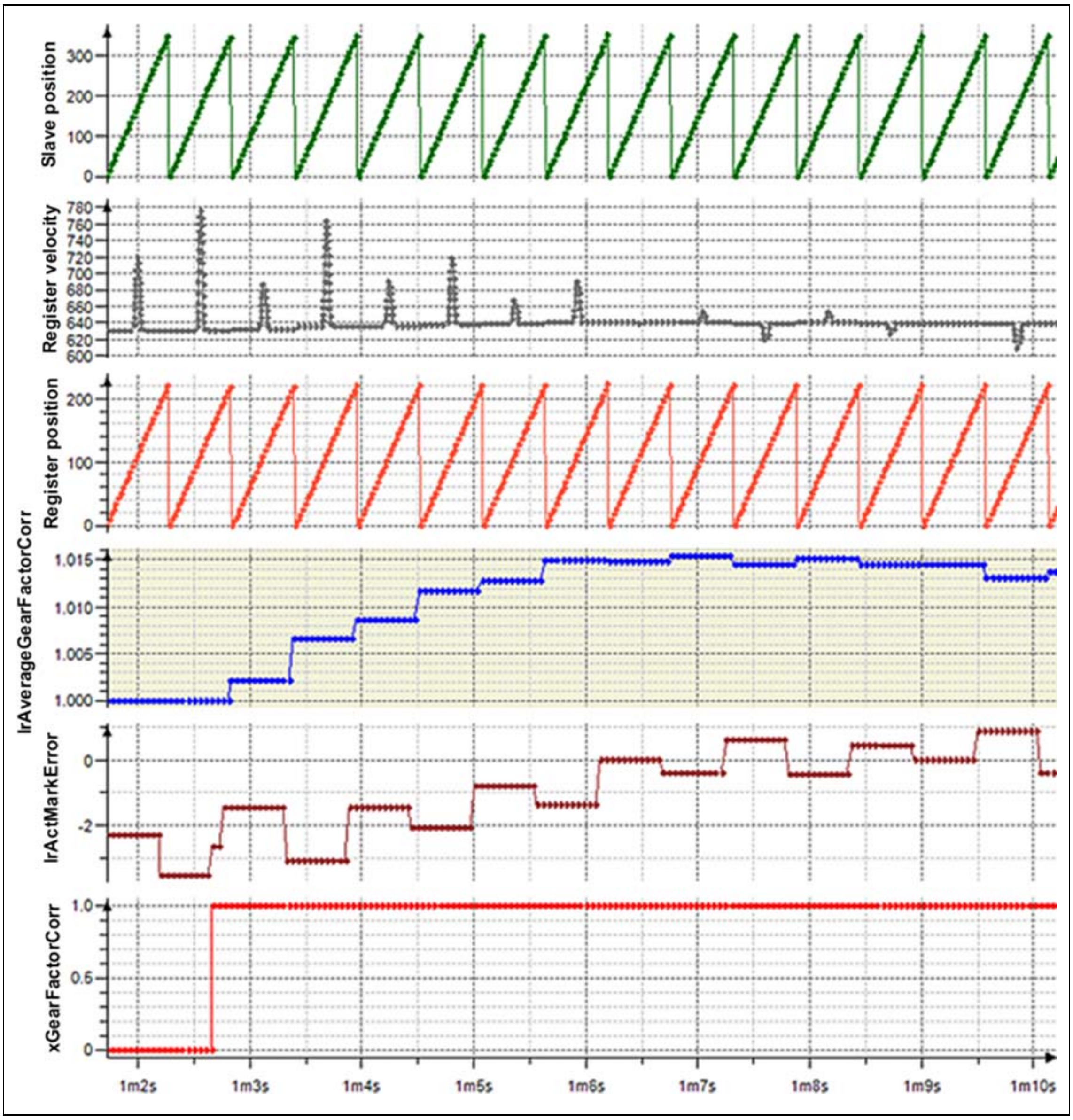
The gain of the gearbox factor correction is set via the gain factor in the *lrGearFactorCorrGain* parameter. When the gearbox factor correction is activated, the current value of the corrected gearbox factor is provided via the *lrAverageGearFactorCorr* output.

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

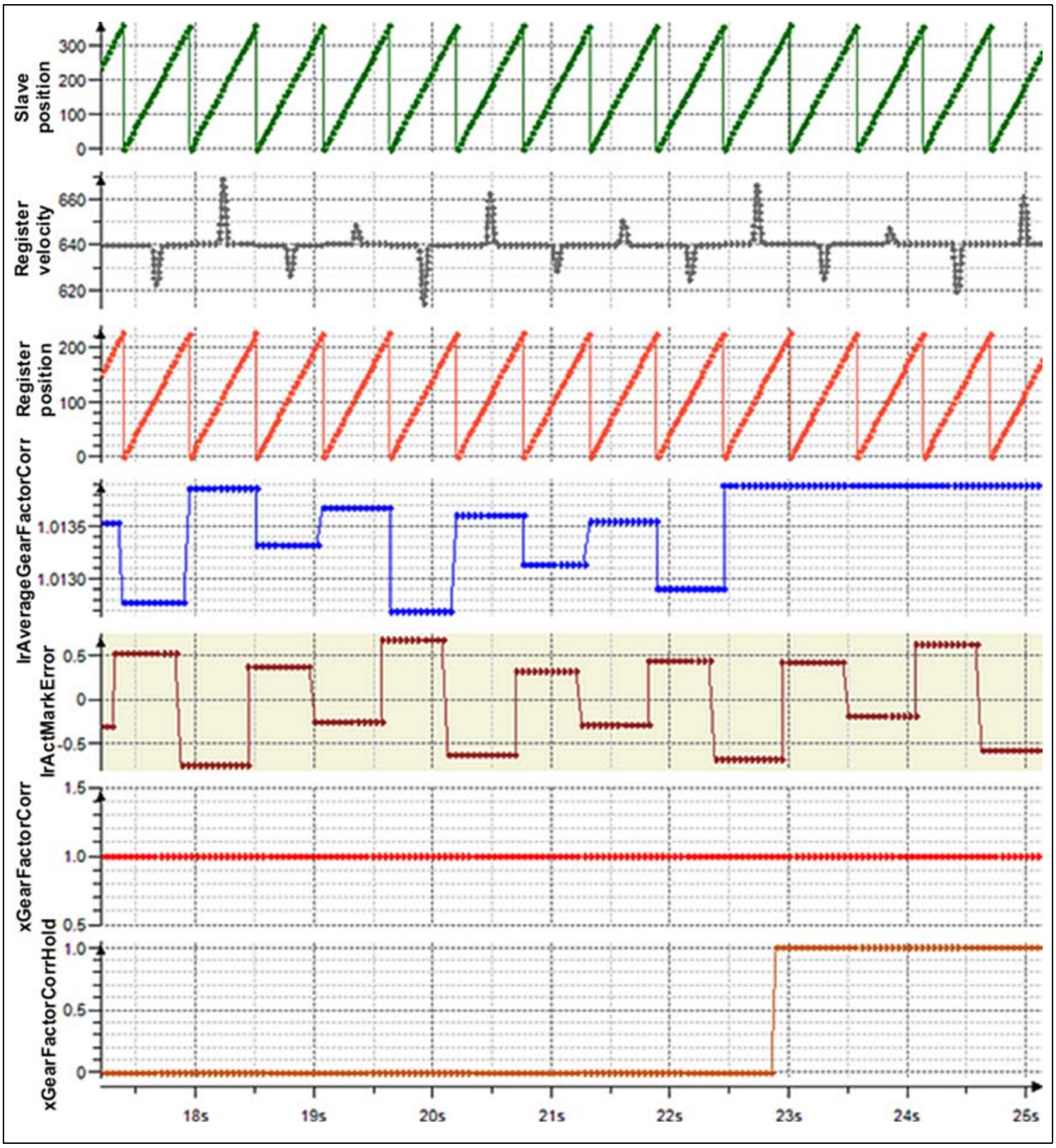
The parameters to be set for the gearbox factor correction are located in the L_TT1P_scPar_CrossCutter[Base/State] (📖 23) parameter structure.

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



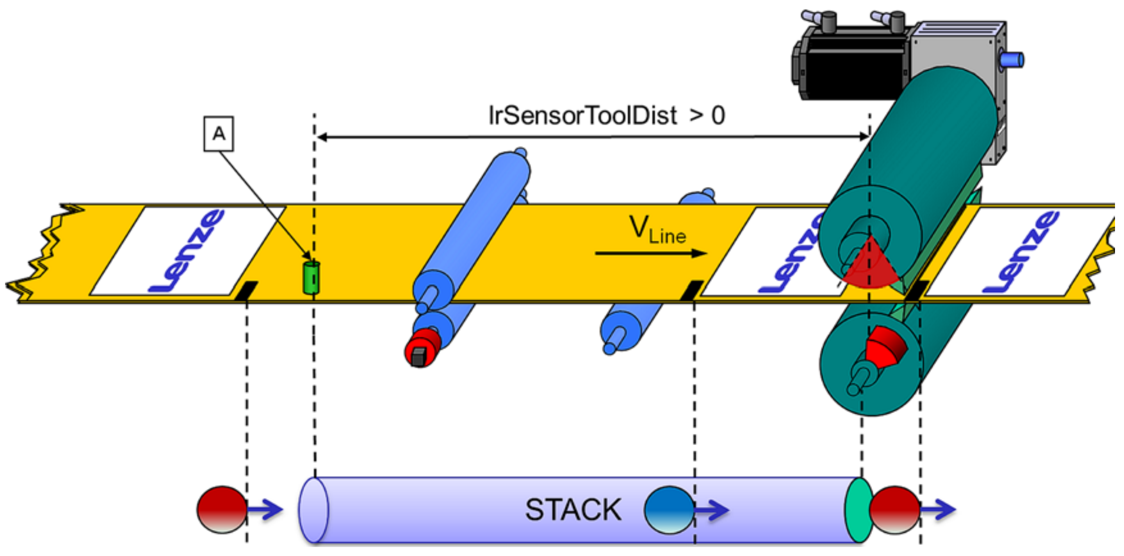
[3-33] Signal characteristic with active gearbox factor correction

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.



[3-34] Hold signal characteristic with optimised gearbox factor

3.29 "Cutting on a mark (event-controlled)" operating mode



A Cutting mark sensor (touch probe sensor)

[3-35] "Cutting on a mark (event-controlled)" operating mode

The "Cutting on a mark (event-controlled)" operating mode is selected using parameter *eCuttingMode* = 3. Using this operating mode is only possible, if the cutting mark sensor is installed in front of the cross cutter. The distance between cross cutter and cutting mark sensor is set using parameter *lrSensorToolDistance* > 0.

The profiles are calculated in real time in this operating mode which provides the possibility to make flexible changes to the cutting lengths and the synchronous phase during the cutting process. Any changes are accepted after the synchronous phase and effective for the next step. The synchronous speed of the sealing roller is calculated as a function of the roller circumference in parameter *lrCrossCutterCircumference*, the speed of the master axis and the cycle length of the sealing roller.

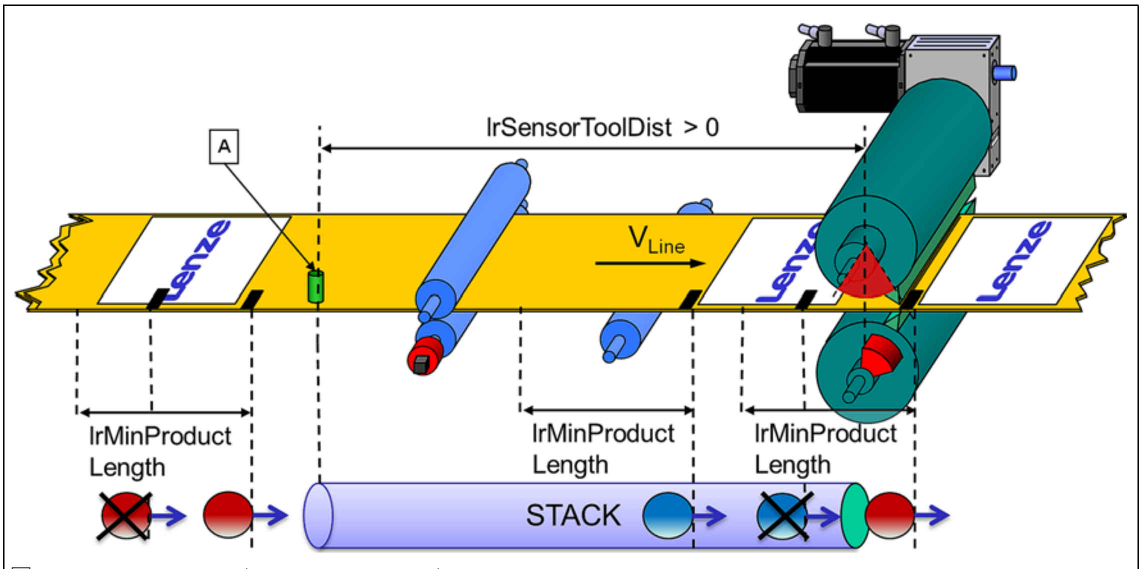
Select the touch probe source used to detect the marks via parameter *eTpMode*.

▸ Selecting the touch probe source (📖 74)

The input *xSyncCrossCutter* = TRUE serves to calculate the start cam from the current position in the synchronous phase. The cutting process starts as soon as a valid mark (detected touch probe with the current position) is present. The cross cutter makes the cuts on the detected marks. If no other valid marks are detected, the cross cutter is moved to the parking position. The cross cutter remains at standstill until another valid mark is detected. A valid mark serves to re-initiate the cutting process.

All valid marks are stored in a register. The register can keep a maximum of 100 marks. After each cut, the next mark from the register is processed for the next step.

Several marks can be stored and processed consecutively during the cutting process. In order to hide marks, you must set a minimum distance between two marks using parameter *lrMinProductLength*. After a valid mark, the following marks within the minimum distance are masked out by the technology module.



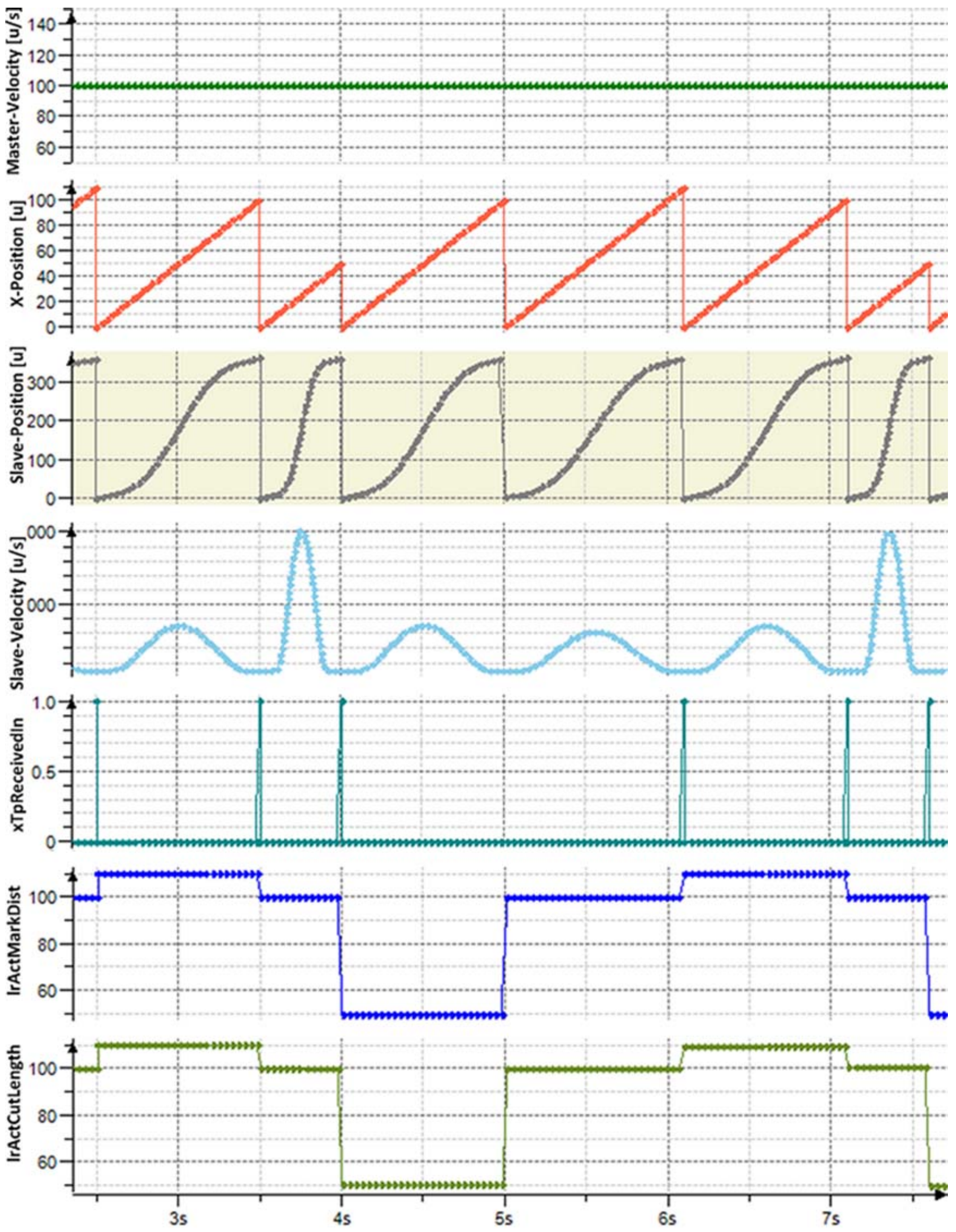
A Cutting mark sensor (touch probe sensor)

[3-36] Cutting on a mark with the minimum product length (parameter lrMinProductLength)

Parameters to be set

The parameters for the "cutting on a mark (event-controlled) operating mode are located in the L_TT1P_scPar_CrossCutter[Base/State] (📖 23) parameter structure.

```
xMasterAbsolute : BOOL := FALSE;
lrStartXPosRelative : LREAL := 0;
eCuttingMode : L_TT1P_CuttingModeState := 3;
eTpMode : L_TT1P_TpMode := 0;
lrSensorToolDistance : LREAL := 0;
lrMinProductLength : LREAL := 50;
lrCrossCutterCircumference : LREAL := 360;
lrCuttingAngle : LREAL := 10;
byNumOfTools : BYTE := 1;
byStartToolNo : BYTE := 0;
```



Parameter lrSensorToolDistance = 360

[3-37] History: Event-controlled cutting process on a detected mark

3.30 Torque feedforward control

The torque feedforward control is activated by parameter *lrTrqCtrlGain* > 0 and the output *xTrqCtrlActive* is set to TRUE. The *lrTrqCtrlGain* parameter is the multiplicative gain factor of the feedforward control value. The feedforward control value is calculated in the axis by multiplying the mass inertia with the acceleration/deceleration of the sealing roller. The mass inertia of the sealing roller is defined by the *lrMInertia* parameter in kg/cm². The feedforward control value is put out via the *lrSetMotorPreCtrlTrqOut* output.

The acceleration/deceleration of the sealing roller is pre-estimated from the cam information. The time difference at which the acceleration/deceleration is pre-estimated is defined by the *lrTrqCtrlRateTime* parameter in seconds. If the parameter *lrTrqCtrlRateTime* is set to 0, the current acceleration/deceleration setpoints of the sealing roller are used.

As the feedforward control values are calculated in real time there is the possibility to make flexible changes to the parameters for the torque feedforward control during the cutting process. Any changes are immediately effective. In this way, the feedforward control values can be adapted and optimised during the cutting process.

Parameters to be set

The parameters to be set for torque feedforward control are located in the L_TT1P_scPar_CrossCutter[Base/State] (📖 23) parameter structure.

```
lrTrqCtrlGain : LREAL := 0;
lrTrqCtrlRateTime : LREAL := 0;
lrMInertia : LREAL := 0;          // Constant MInertia J [kg/cm^2]
```

3.31 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;
	xSyncCrossCutter := TRUE;
		90 µs	155 µs

State	xEnable := TRUE;
	xRegulatorOn := TRUE;
	xSyncCrossCutter := TRUE;
		120 µs	172 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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