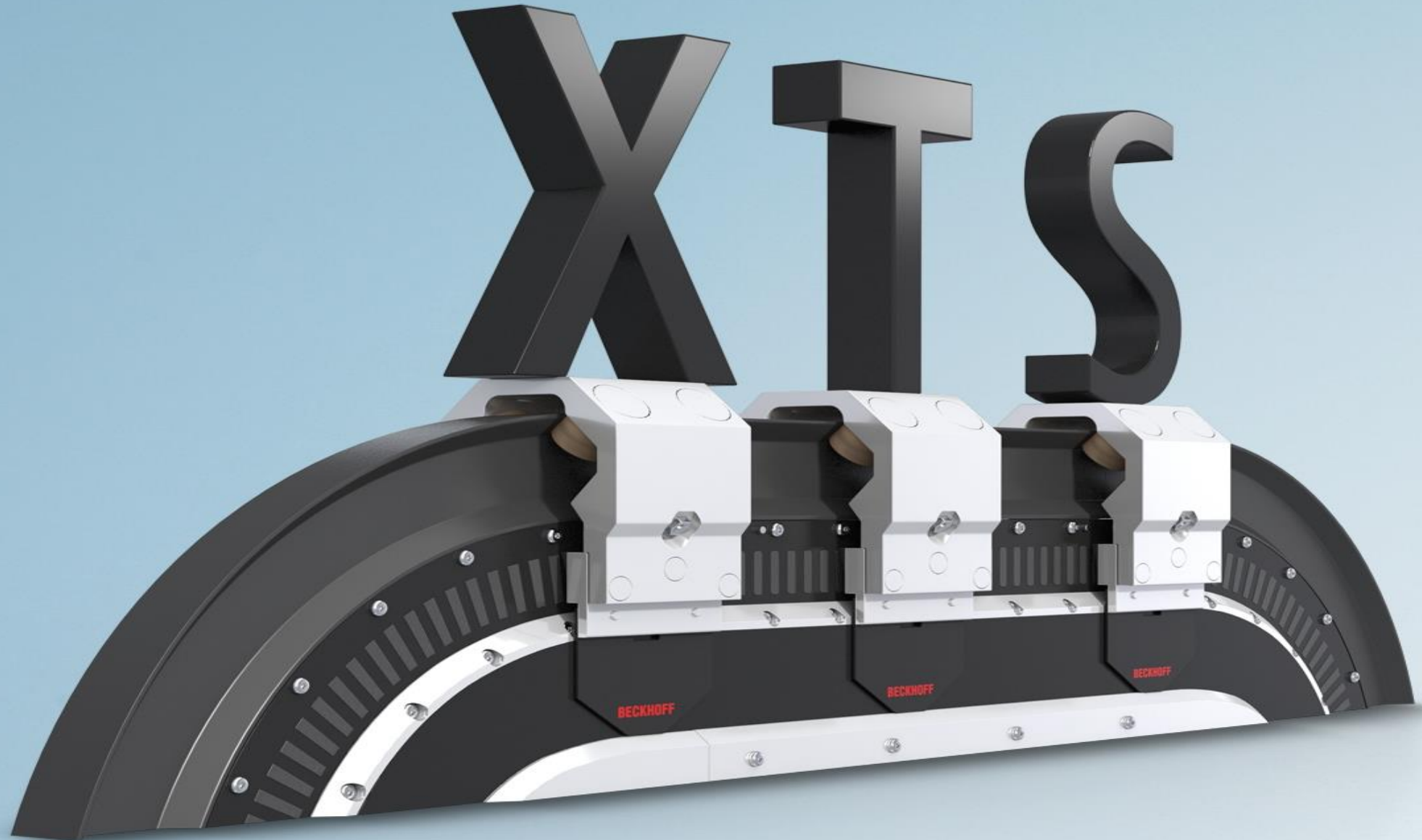


New Automation Technology

Beckhoff Automation

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XTS – TcSoftDrive

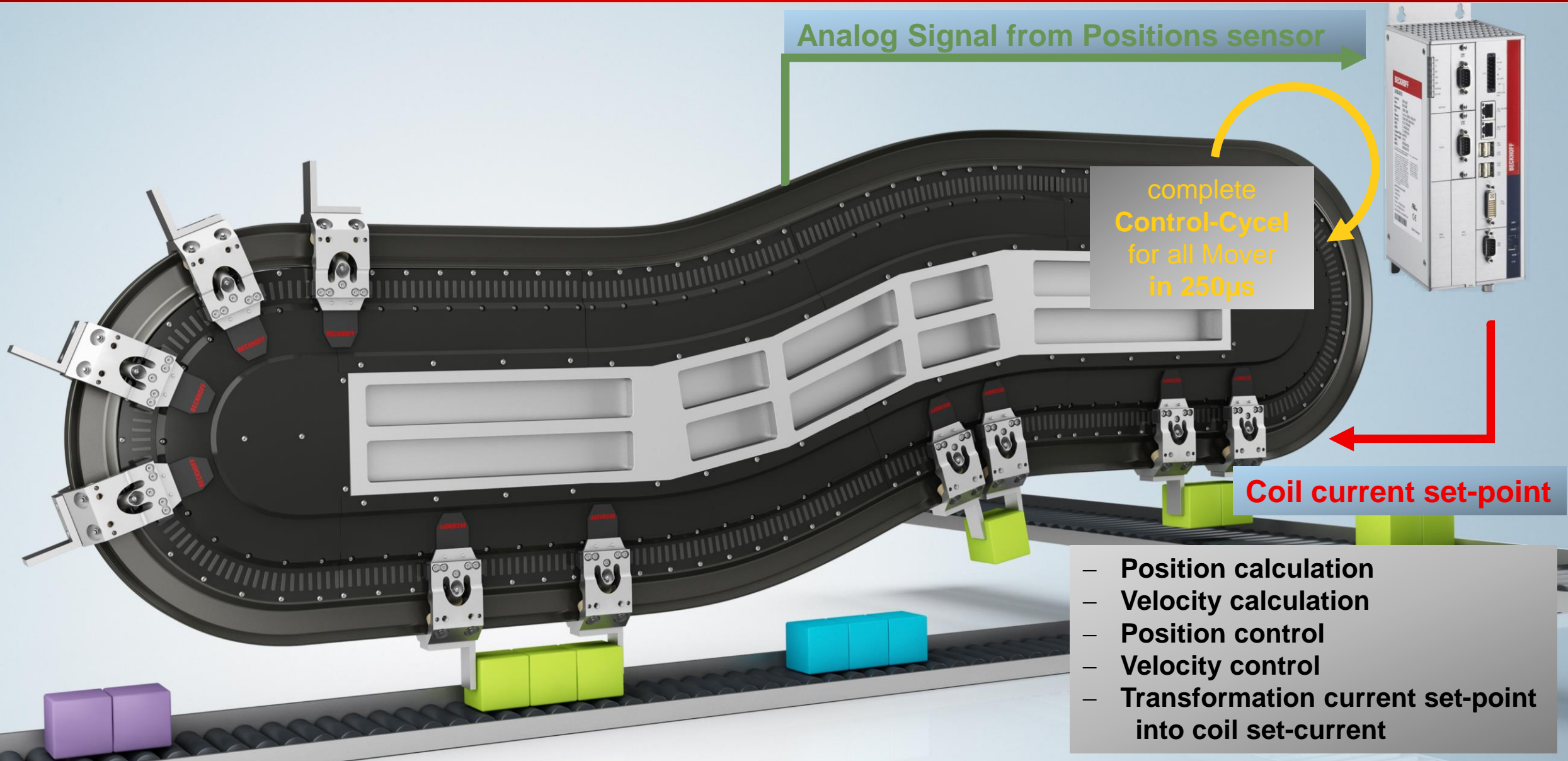


1. **Short XTS basics**
2. XTS Accuracy
3. XTS IPC & capabilities
4. Scope for Mover monitoring
5. TcSoftdrive structure & parameter
6. Tuning



XTS – Overview and timing

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XTS – EtherCAT timing and data size

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each Motor module has

- 15 Coils → 15 current set-values
→ 15 current act-values
- 2 Byte Status & 2 Byte Control
→ 32 Byte Process Image

each Sensor Module has

- 32 Position Sensors
- 2 Byte Status & 2 Byte Control
→ 66 Byte Process Image Input

EtherCAT data size **98 Byte**

XTS_BaseProject

General Adapter EtherCAT Online CoE - Online

NetId: 10.0.28.201.7.1

Advanced Settings...
Export Configuration File...
Sync Unit Assignment...
Topology...

Frame	Cmd	Addr	Len	WC	Sync Unit	Cycle (ms)	Utilization (%)	Size / Duration (µs)	Map Id
0	NOP	0x0000 0x0900	4			0.250			
0	ARMW	0x0000 0x0910	4			0.250			
0	LRD	0x09000000	2			0.250			
0	LRW	0x01000000	1176	72	<default>	0.250			
0	BRD	0x0000 0x0130	2	25		0.250	41.20 41.22	1264 / 103.04	0

0

Number	Box Name	Address	Type	In Size	Out Size	E-Bus (m...
1	Box 1 (CU2508)	1001	CU2508			
2	MotorModule (AT2001-0250)	1002	AT2001-0250	32.0	32.0	
3	SensorModule (AT2001-5250)	1003	AT2001-5250	66.0	2.0	0

XTS – EtherCAT timing and datasize

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per Frame max. data size of 1500 Byte

per Module (Motor & Sensor)

data size of 98 Byte

3m XTS-Track → 12 Modules

12 x 98 Byte = 1176 Byte Data

Full Frame size = 1264 Byte Data

Frame runtime = **103 µs**

XTS_BaseProject

General Adapter EtherCAT Online CoE - Online

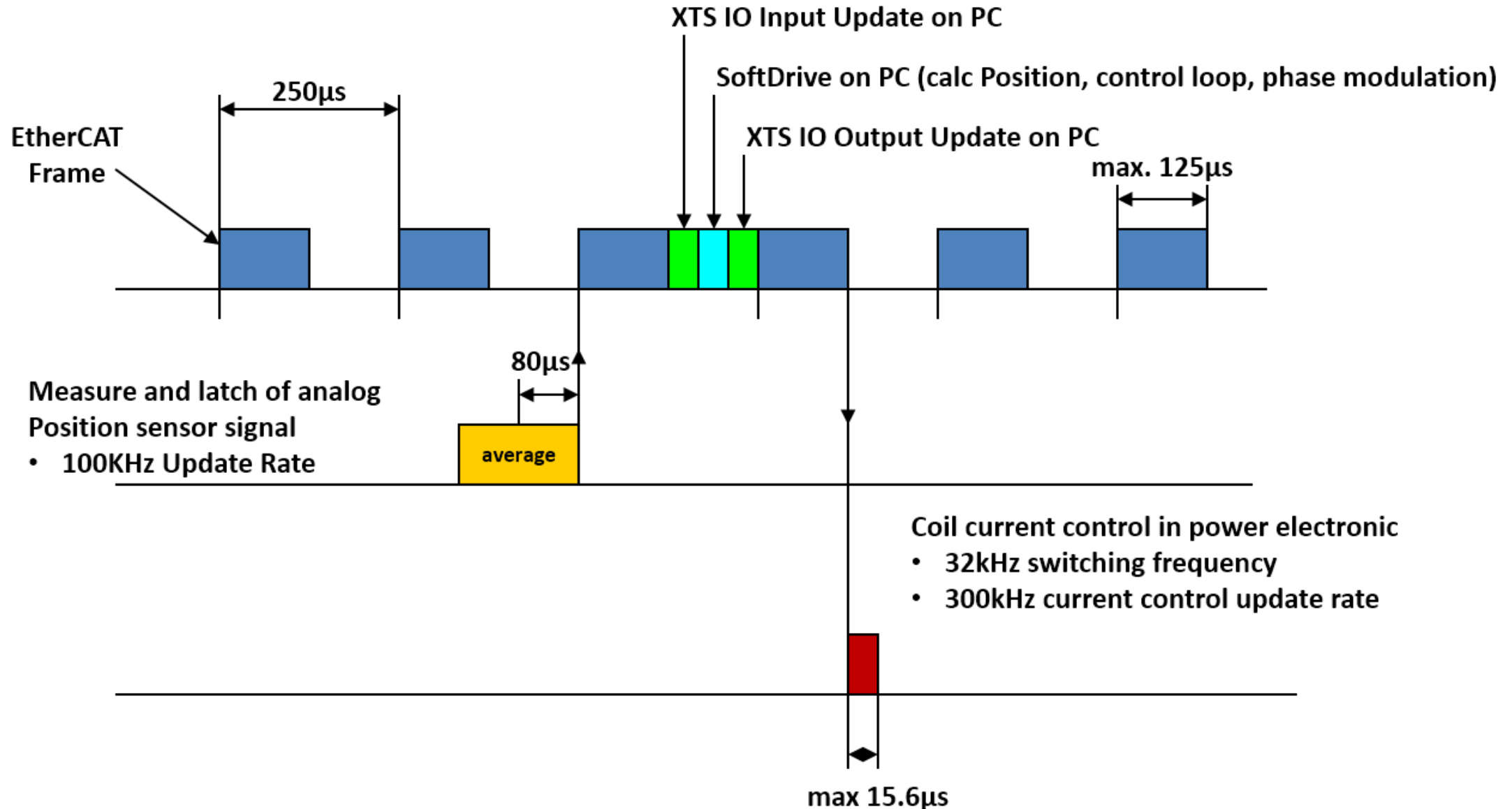
NetId: 10.0.28.201.7.1

Advanced Settings...
Export Configuration File...
Sync Unit Assignment...
Topology...

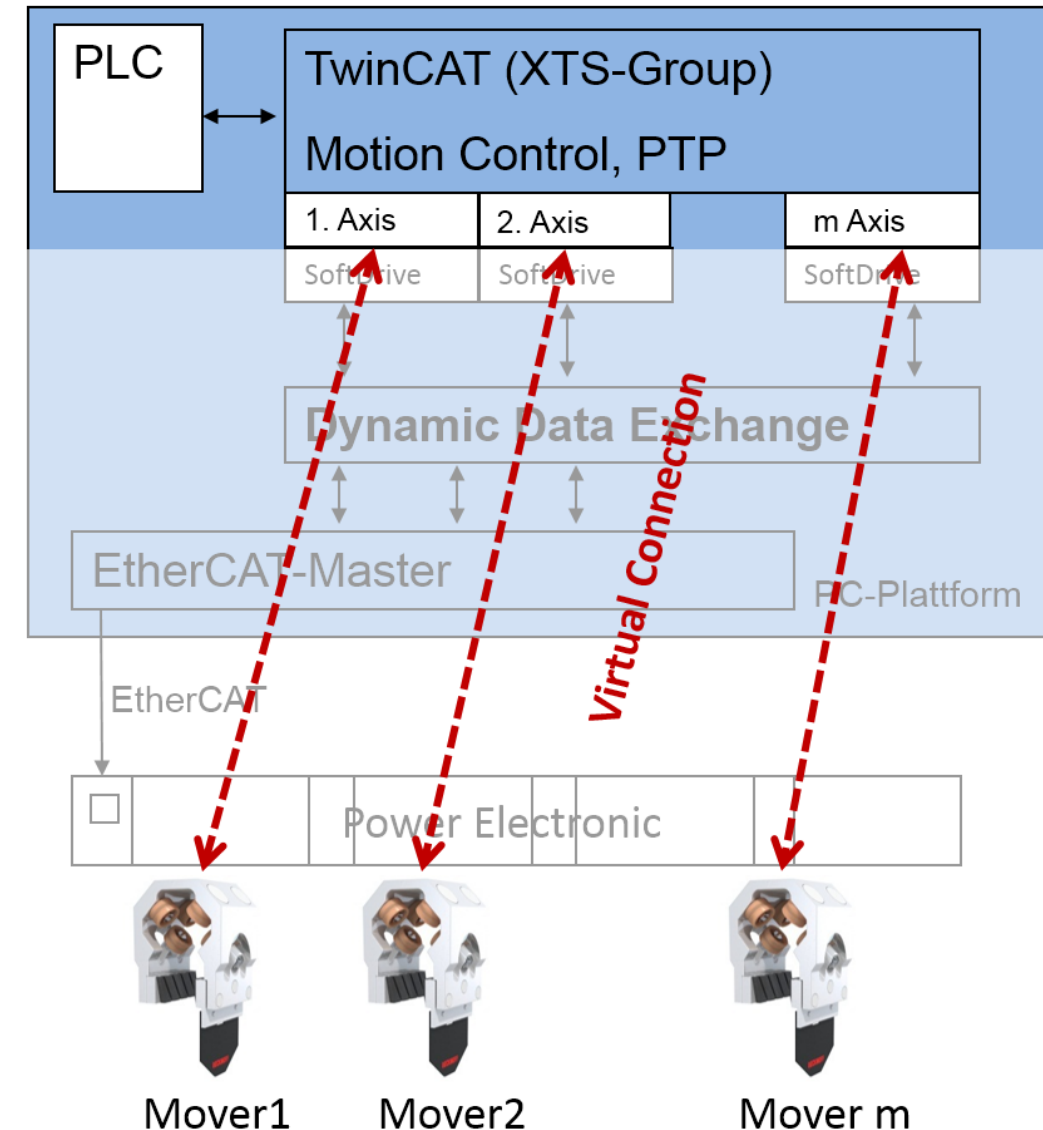
Frame	Cmd	Addr	Len	WC	Sync Unit	Cycle (ms)	Utilization (%)	Size / Duration (µs)	Map Id
0	NOP	0x0000 0x0900	4			0.250			
0	ARMW	0x0000 0x0910	4			0.250			
0	LRD	0x09000000	2			0.250			
0	LRW	0x01000000	1176	72	<default>	0.250			
0	BRD	0x0000 0x0130	2	25		0.250	41.20 41.22	1264 / 103.04	0

10

Number	Box Name	Address	Type	In Size	Out Size	E-Bus (m...
1	Box 1 (CU2508)	1001	CU2508			
2	MotorModule (AT2001-0250)	1002	AT2001-0250	32.0	32.0	
3	SensorModule (AT2001-5250)	1003	AT2001-5250	66.0	2.0	0

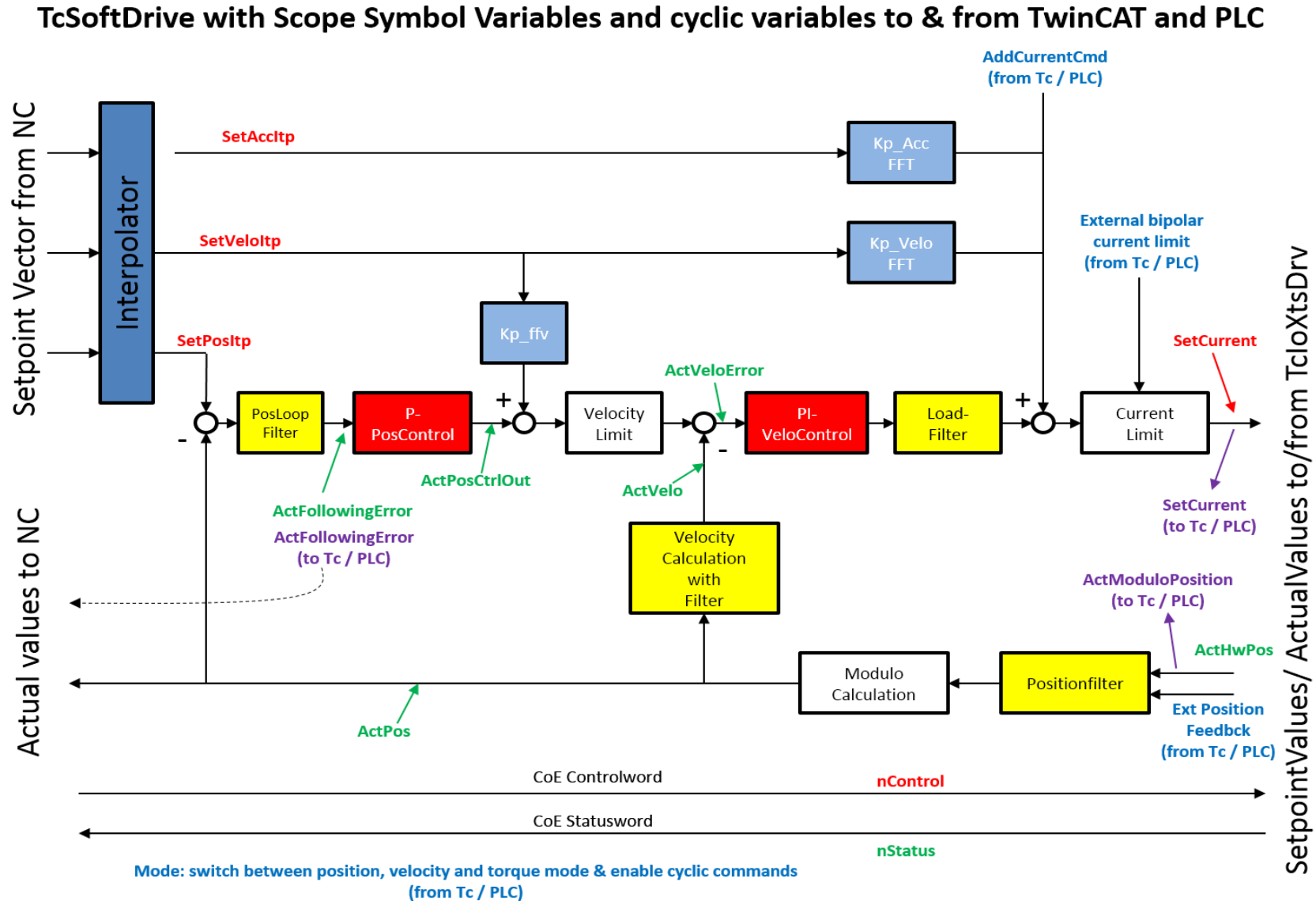


- From the point of view of application programming, a mover looks like a „standard“ servo NC axis.
- New standard tasks are available:
 - Collision avoidance CA
 - Group building
 - Synchronous mechanisms
- Runs on powerful Beckhoff Standard IPCs with EtherCAT-Port
- Simulation mode is possible for TcSoftDrive



XTS – TcSoftDrive control loop structure

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1. Short XTS basics
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Ideal Positioning

Start Position Target Position



High Accuracy
High Repeatability



Low Accuracy
High Repeatability



→ Low accuracy with high repeatability can be compensated.

Low Accuracy
Low Repeatability



→ Low repeatability cannot be compensated

XTS - Position Accuracy (Sensor Rev. 18)

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XTS Datasheet	
Absolute Position Accuracy	$\pm 250\mu\text{m}$ (within one straight Module) *
Tested but not specified Accuracy	
Achievable Position Accuracy	$\pm 150\mu\text{m}$ (within one straight Module) **

* Typical achievable absolute accuracy, this can become larger due to thermal expansion of the module ($\Delta\vartheta \geq 30^\circ\text{C}$) or Parallelism of the flag to the encoder module and the orthogonality of the Encoder Flag to the Motor Module.

** typically achievable accuracy in a straight module between 15 - 235mm (Encoder flag completely in a single module) a parallel and orthogonal Encoder flag and a thermal expansion of while in operation ($\Delta\vartheta \leq 15^\circ\text{C}$)

XTS Datasheet	
Position accuracy while at speed	$\pm 150\mu\text{m}$ @ 1.5m/s (in a straight module) *
Tested but not specified Accuracy	
Position accuracy while at speed in the curve	$\pm 400\mu\text{m}$ @ 1m/s (in a 180° Curve Module) **

* the synchronization accuracy is very dependent on the mechanical stiffness and the load on the mover and the controller settings. The mechanical displacement between the modules also plays an important role

** the deviation in the curve can be much, much worse if the center of gravity is not directly between the magnets of the mover

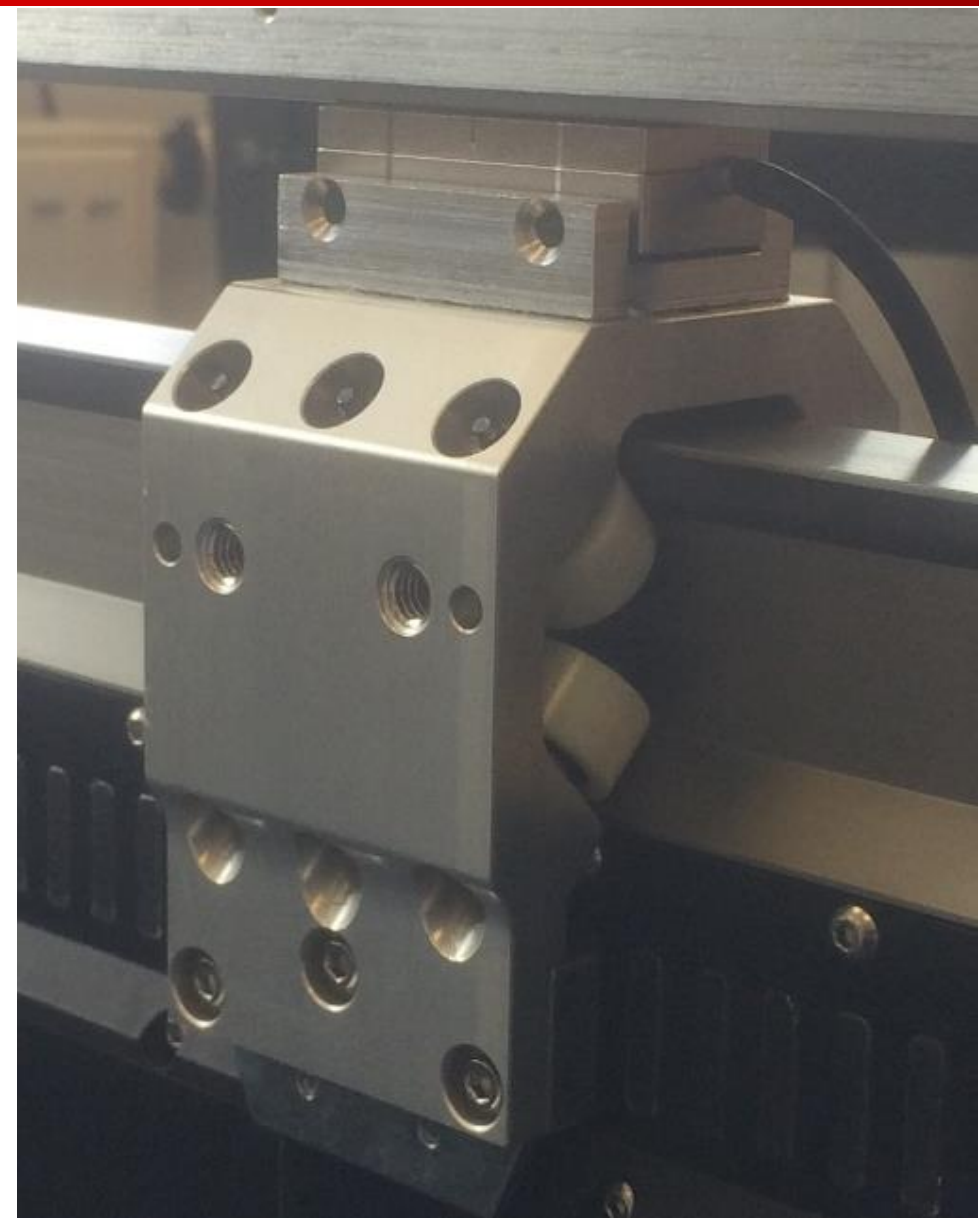
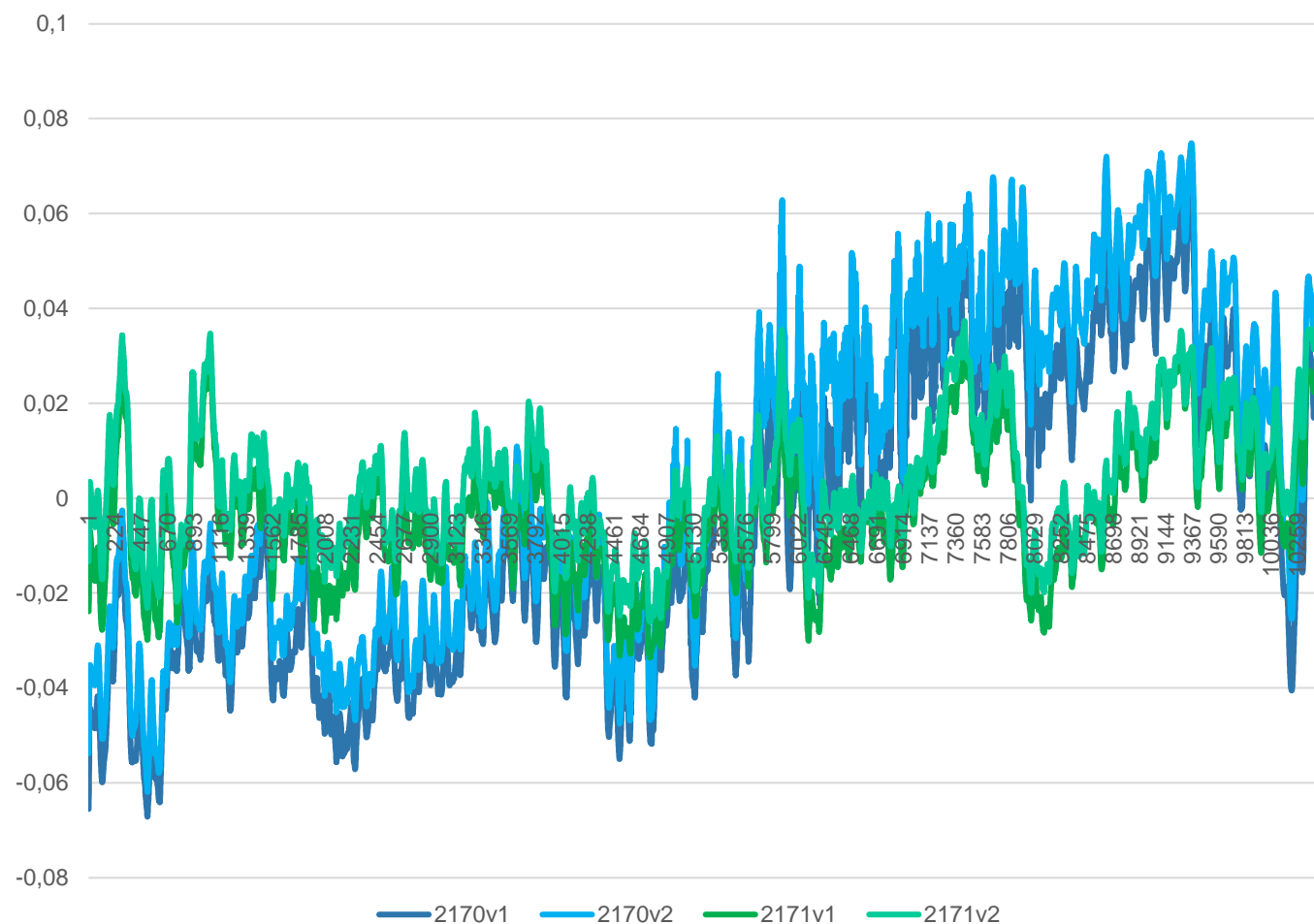
XTS Datasheet	
Stand Still Repeatability	$\pm 10\mu\text{m}$ (unidirectional) *

* repeatability for the encoder flag the stand still repeatability may fail due to the defects in the rail system or a Roller developing a flat spot or bearing failure or thermal extension

XTS - Position Accuracy measurements

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Absolute Position Accuracy measured against an very precise optical encoder

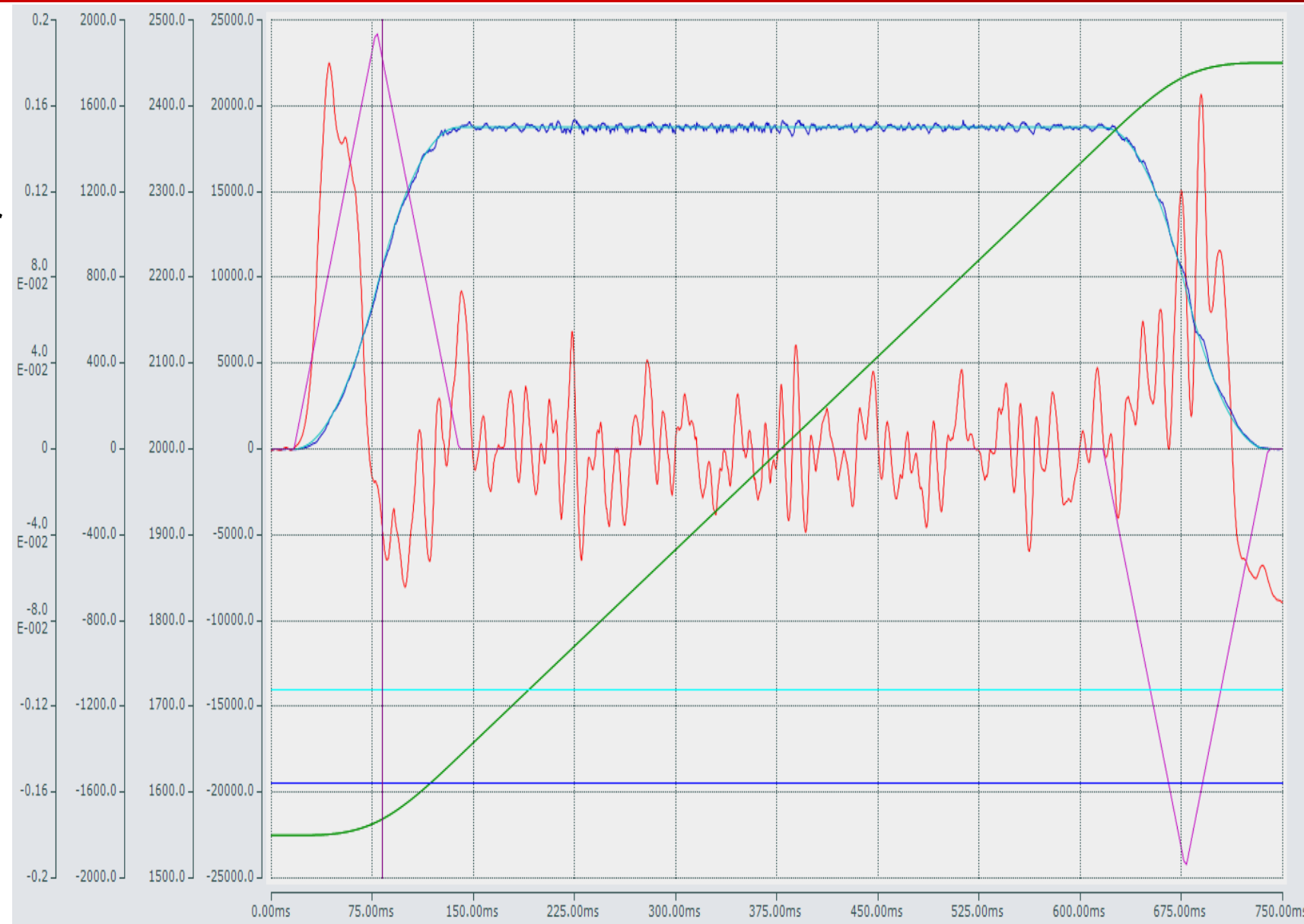


XTS - Position Accuracy while moving

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Measurement in
the straight section
at 1.5m/s
with a tuned 12 Roller mover
and no load

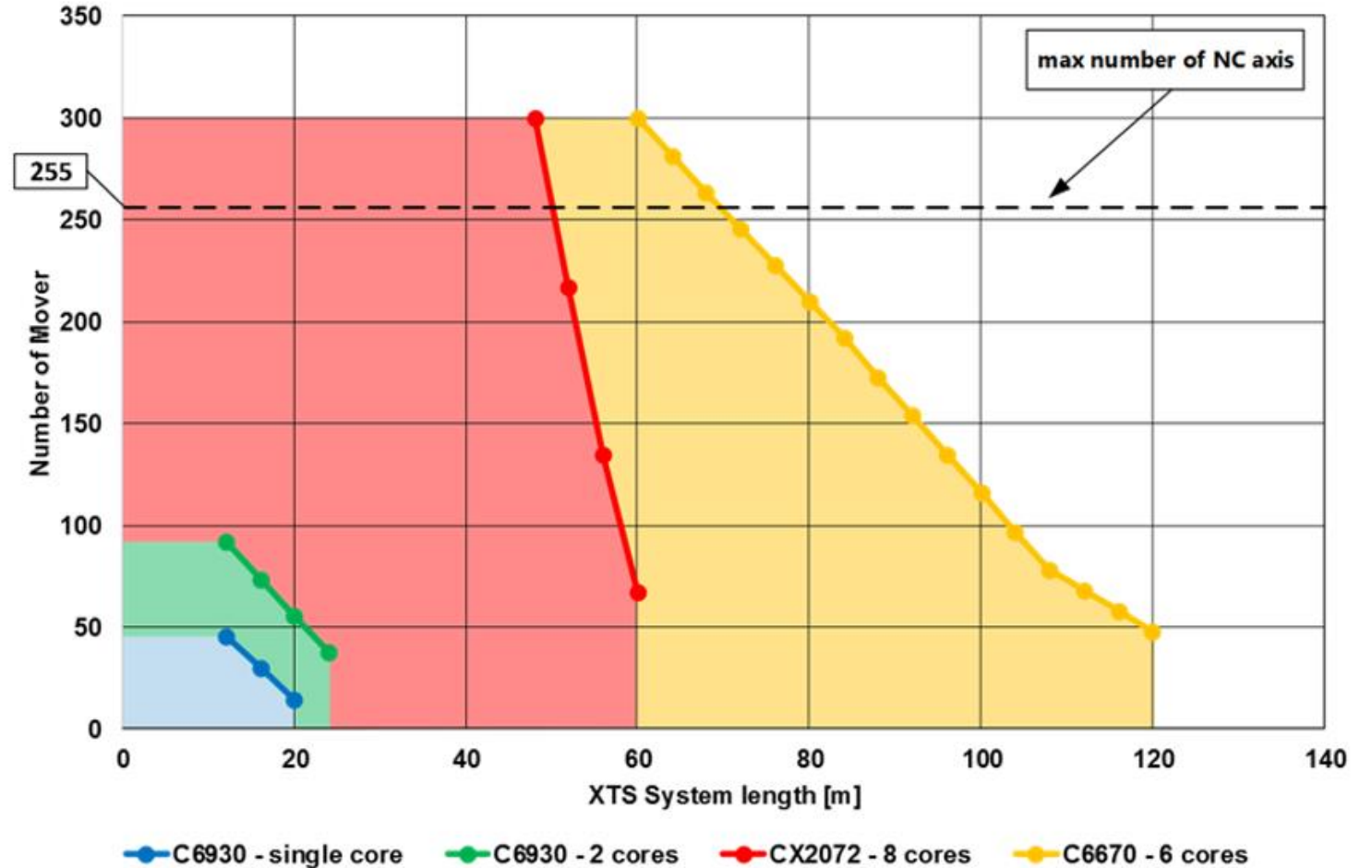
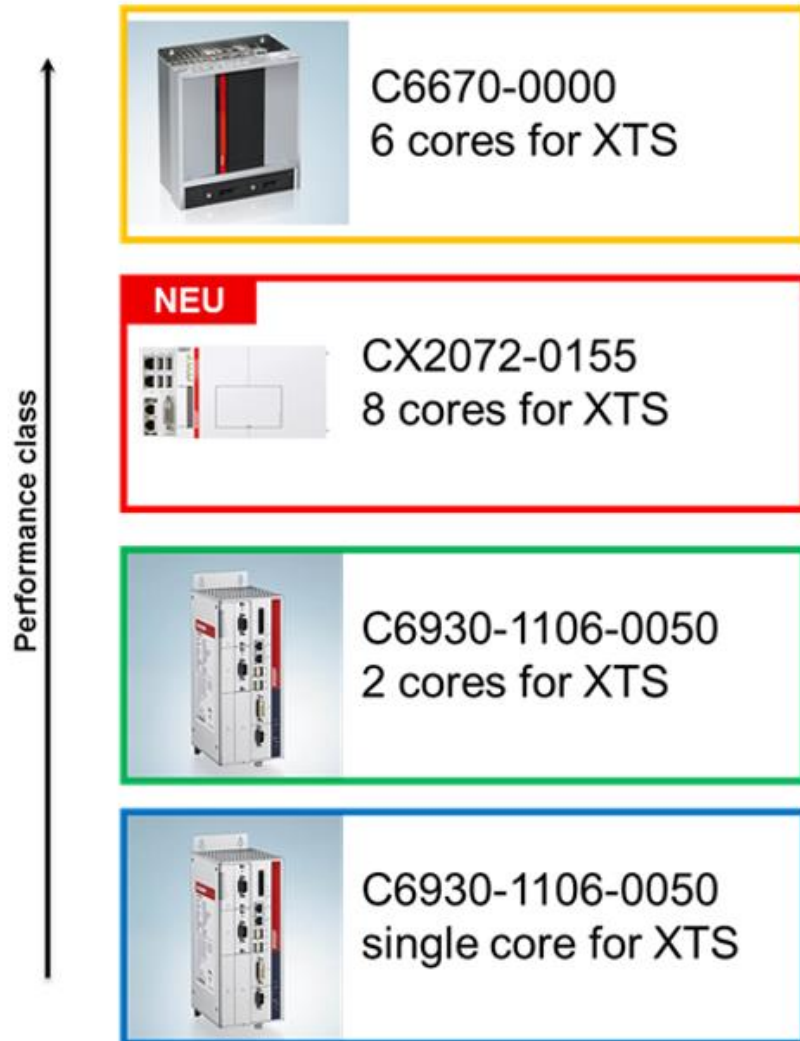
→ Position deviation
in Lag Distance
is less than $\pm 60\mu\text{m}$



Possible solutions if the accuracy is not sufficient	
Absolute accuracy of all Movers	<ul style="list-style-type: none">- Adapt the target position of the commands from the PLC based on previously measured and stored values.- Mechanically position the tooling at the processing station, e.g. a pin to center the tooling.- Use an External encoder feedback such as a laser distance sensor or a highly accurate quick Vision System - a balance during positioning would thereby therefore Possible
Absolute Accuracy between movers	<ul style="list-style-type: none">- Position offset in the NC. Each mover must be taught and a unique identification required- External encoder or a laser distance sensor or a highly accurate quick Vision System - a correction during positioning would thereby also possible
Positional accuracy over several modules / synchronization accuracy	<ul style="list-style-type: none">- Setting a position offset in TcIoXts drivers per module (very time consuming)- Sometimes AREA control parameters in TcSoftDrive can be adjusted to ensure a smoother ride- Sometimes an additional counter-weight mass on the Mover can help bring the center of gravity to the middle of the magnets, thus improving the synchronous accuracy and travel through the curve

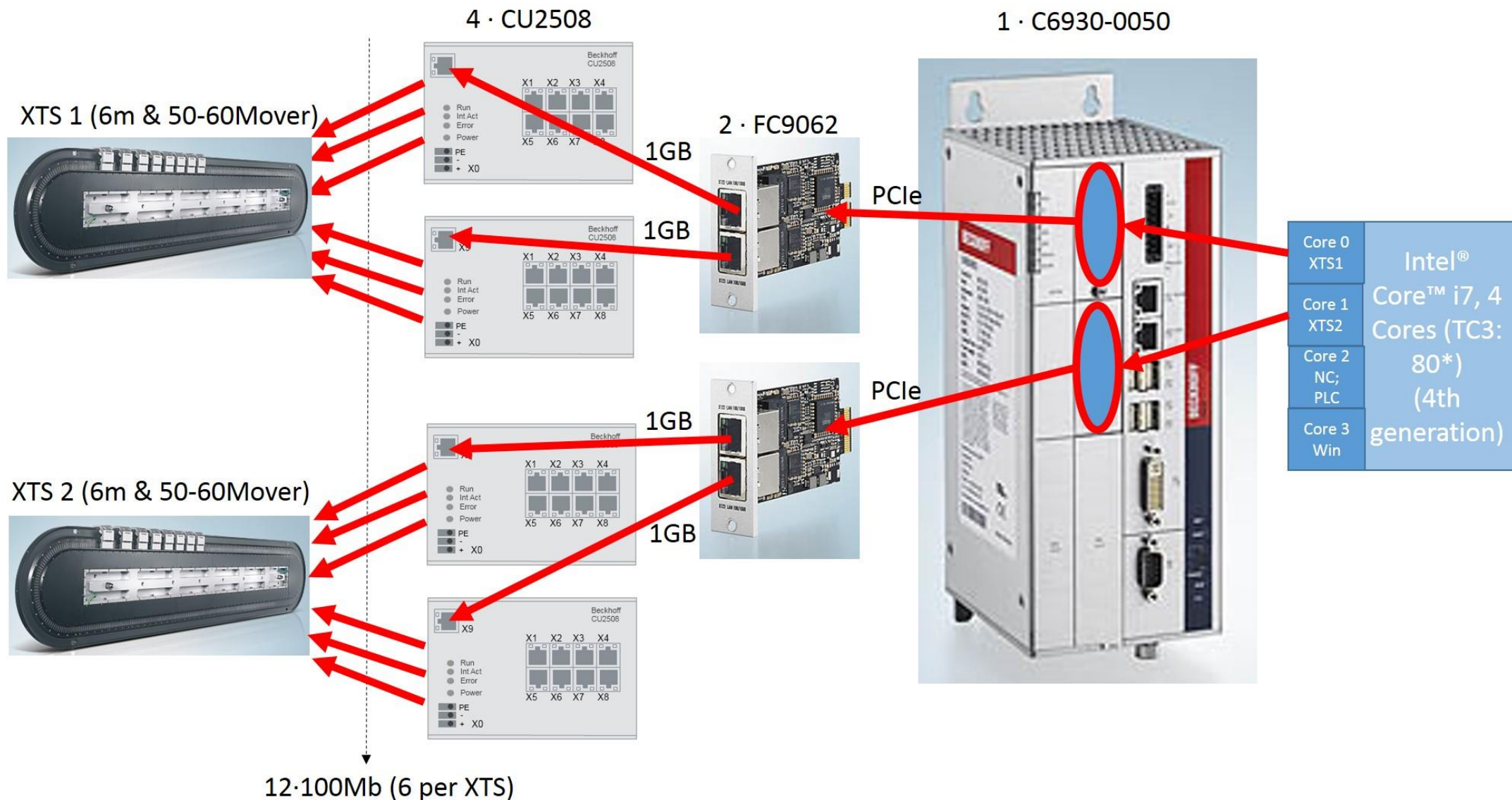
1. Short XTS basics
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4. Scope for Mover monitoring
5. TcSoftdrive structure & parameter
6. Tuning





XTS – IPC C6930 Core™ i7 application examples

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XTS – Capabilities coming soon

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- Maximum circumference of 18 m
- Maximum 80 movers on a track



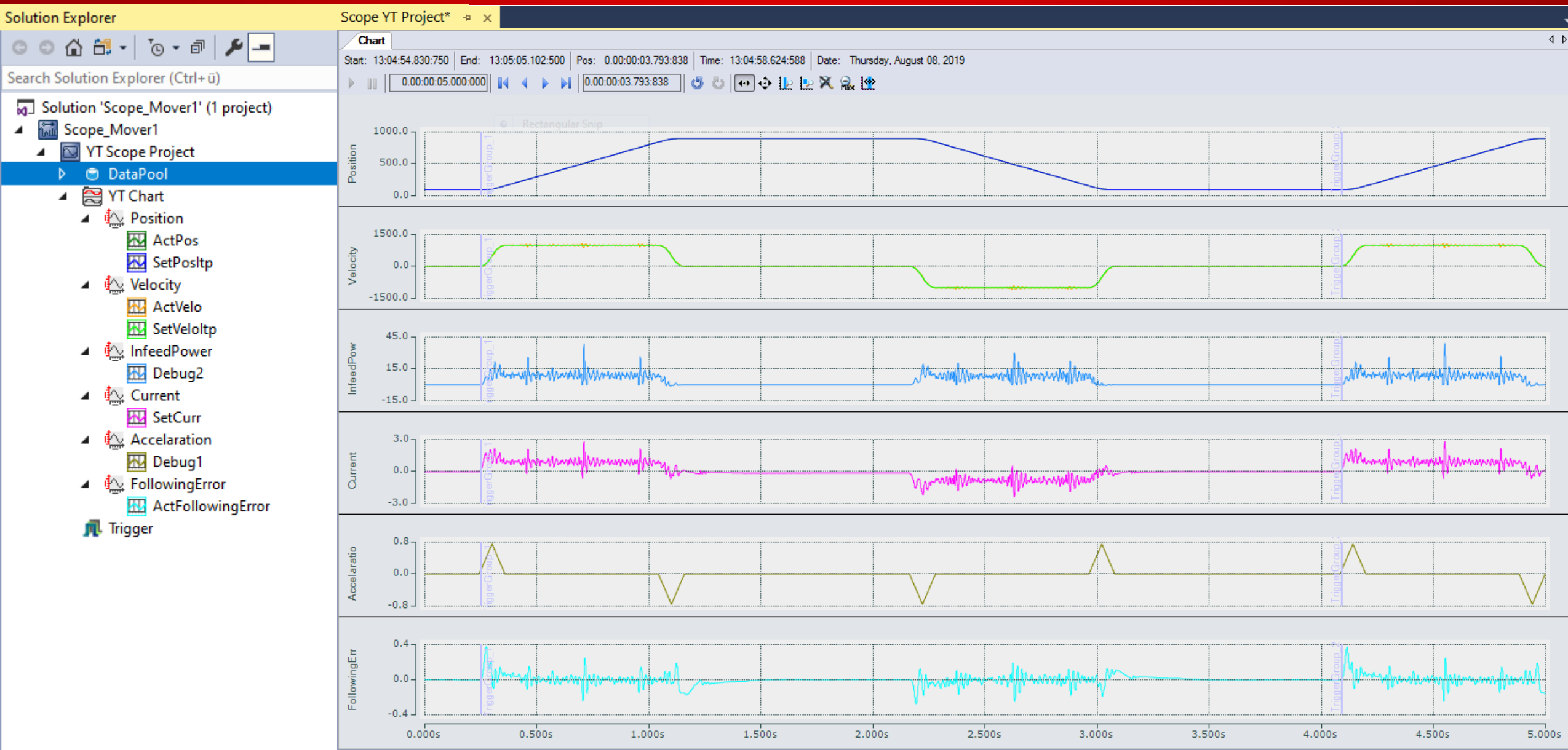
Restrictions are purely due to data gathering and processing requirements
The mover count and circumference will continue to increase in coming years

1. Short XTS basics
2. XTS Accuracy
3. XTS IPC & capabilities
4. **Scope for Mover monitoring**
5. TcSoftdrive structure & parameter
6. Tuning



XTS TcSoftDrive – Scope for Mover monitoring

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XTS TcSoftDrive – Signal selection for monitoring

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The screenshot displays the Beckhoff TcSoftDrive software interface, showing the configuration for monitoring signals in the XTS TcSoftDrive project.

Solution Explorer: The left pane shows the project structure. The 'Scope_Mover1' project is expanded, showing the 'YT Scope Project' and 'DataPool' folders. The 'YT Chart' folder is expanded, showing the 'Position' folder, which contains the 'ActPos' variable. The 'Velocity' folder is also expanded, showing the 'ActVelo' variable. The 'Current' folder is expanded, showing the 'SetCurr' variable. The 'Acceleration' folder is expanded, showing the 'Debug1' variable. The 'FollowingError' folder is expanded, showing the 'ActFollowingError' variable. The 'Trigger' folder is also visible.

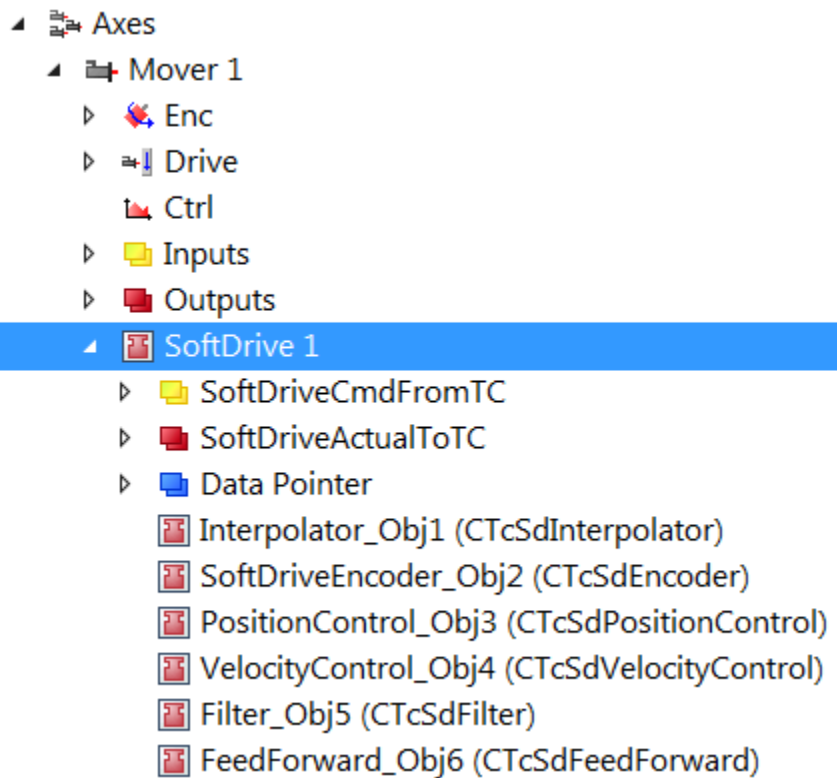
Target Browser: The middle pane shows the 'Target Browser' window. The 'ADS' tab is selected, showing the 'BECK-NB-1294' target. The 'XTS1' through 'XTS5' variables are listed. The 'XTS0' variable is expanded, showing the '350: XTS Task 1' and '501: TCNC.NcTaskSaf' sub-variables.

Variable List: The right pane shows a detailed list of variables. The 'Enter Filter...' search bar is at the top. The list is filtered to show variables under the path 'Mover 1 > SoftDrive 1 > SdScopeVariable > ActFollowingError >'. The variables are listed in a table with columns: Name, Type, Size, Category, Full-Name, Comment, and Subitem.

Name	Type	Size	Category	Full-Name	Comment	Subitem
Mover 1		0	Struct	Mover 1		1
SoftDrive 1		0	Struct	Mover...		3
SdScopeVariable		0	Struct	Mover...		23
ActComPos	LREAL	8	Primitive	Mover...	actual...	0
ActCurr	LREAL	8	Primitive	Mover...	actual...	0
ActFollowingError	LREAL	8	Primitive	Mover...	actual...	0
ActHwPos	LREAL	8	Primitive	Mover...	actual...	0
ActPos	LREAL	8	Primitive	Mover...	actual...	0
ActPosCtrlOut	LREAL	8	Primitive	Mover...	setpoint...	0
ActVelo	LREAL	8	Primitive	Mover...	actual...	0
ActVeloError	LREAL	8	Primitive	Mover...	actual...	0
Debug1	LREAL	8	Primitive	Mover...	debug...	0
Debug2	LREAL	8	Primitive	Mover...	debug...	0
Debug3	LREAL	8	Primitive	Mover...	debug...	0
Debug4	LREAL	8	Primitive	Mover...	debug...	0
Debug5	LREAL	8	Primitive	Mover...	debug...	0
Debug6	LREAL	8	Primitive	Mover...	debug...	0
nControl	DINT	4	Primitive	Mover...	DS402...	0
nError	DINT	4	Primitive	Mover...	actual soft...	0
nStatus	DINT	4	Primitive	Mover...	DS402...	0
nWarning	DINT	4	Primitive	Mover...	actual soft...	0
SetAccItp	LREAL	8	Primitive	Mover...	setpoint...	0
SetCurr	LREAL	8	Primitive	Mover...	setpoint...	0
SetJerkItp	LREAL	8	Primitive	Mover...	setpoint...	0
SetPosItp	LREAL	8	Primitive	Mover...	setpoint...	0
SetVeloItp	LREAL	8	Primitive	Mover...	setpoint...	0
SoftDriveActualToTC		0	Struct	Mover...		7
SoftDriveCmdFromTC		0	Struct	Mover...		6
Mover 2		0	Struct	Mover 2		1

XTS TcSoftDrive – Setup Motor-Parameter for monitoring

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Change Parameter Motor.Type 1 → 2
- Variable Debug2 will be filled
with InfeedPower

set "Show Hidden Parameter" first

XTS

Object	Context	Parameter (Init)	Parameter (Online)	Data Area	Interfaces	Interface Pointer	Data Pointer
Name	Value	Online	CS	Unit	Type		
AdsPort	0x015e	0x015e	<input type="checkbox"/>		WORD		
TraceLevelMax	tlAlways	tlAlways	<input type="checkbox"/>		TcTraceLevel		
HardwareModulo	3000.0	3000.0	<input type="checkbox"/>	mm	LREAL		
OperationMode	8	8	<input type="checkbox"/>		UDINT		
MaxCurrentOutput	12.0	12.0	<input type="checkbox"/>	A	LREAL		
EmergencyRamp	10000.0	10000.0	<input type="checkbox"/>	mm/s^2	LREAL		
EmergencyTimeOut	0.5	0.5	<input type="checkbox"/>	s	LREAL		
StandstillSwitchTime	0.1	0.1	<input type="checkbox"/>	s	LREAL		
+ ControlAreas	[...]	[...]	<input type="checkbox"/>	1 (Array Elements)			
- SoftDriveMotorPara	<input type="checkbox"/>				
.Type	2	1			UDINT		
.Poles	2	2			UDINT		
.TorqueConstant	8.0	8.0		Nm/A	LREAL		
.Inertia	0.35	0.35		kgcm^2	LREAL		
.NominalCurrent	3.7	3.7		A	LREAL		
.ElThermalTimeCon...	33.0	33.0		s	LREAL		
.RatedSpeed	12000.0	12000.0		rpm	LREAL		
.VoltageConstant	0.118	0.118		V/rpm	LREAL		
.WindingResistance...	1.1	1.1		Ohm	LREAL		

☒ Show Online Values ☒ Show Hidden Parameter

XTS TcSoftDrive – Trigger settings for monitoring

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Solution Explorer

Search Solution Explorer (Ctrl+ü)

- Solution 'Scope_Mover1' (1 project)
 - Scope_Mover1
 - YT Scope Project
 - DataPool
 - YT Chart
 - Position
 - ActPos
 - SetPosltp
 - Velocity
 - ActVelo
 - SetVeloltp
 - InfeedPower
 - Debug2
 - Current
 - SetCurr
 - Accelaration
 - Debug1
 - FollowingError
 - ActFollowingError
 - Trigger
 - Triggergroup
 - Channel Triggerset

Properties

Triggergroup TriggerGroup - Properties

Common	
Name	Triggergroup
Trigger Action	
Trigger Action	Stop Display
Trigger Group	
Clear Chart	False
Color	<input type="checkbox"/> Transparent
Enabled	True
Silent	False
Trigger Category	None
Trigger Image Size	0
Trigger Position	7
Trigger Release Capacity	50
Visible	True
Visible Trigger Release Ca	Show All

Properties

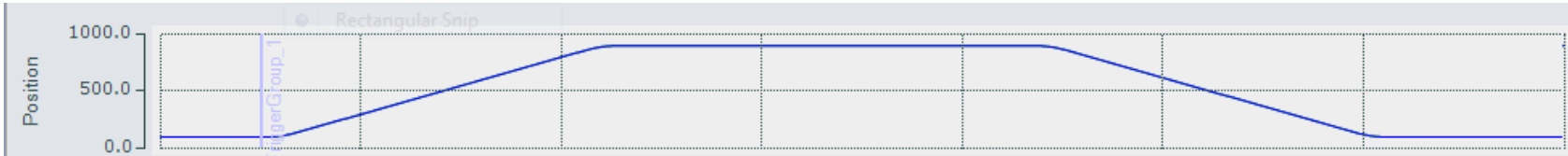
Channel Triggerset ChannelTriggerSet - Properties

Common	
Combine	AND
Name	Channel Triggerset
Release	RisingEdge
Threshold	10
Used Data	Acquisition: SetVeloltp
Modify	
Offset	0
Scalefactor	1
Unit	(None)

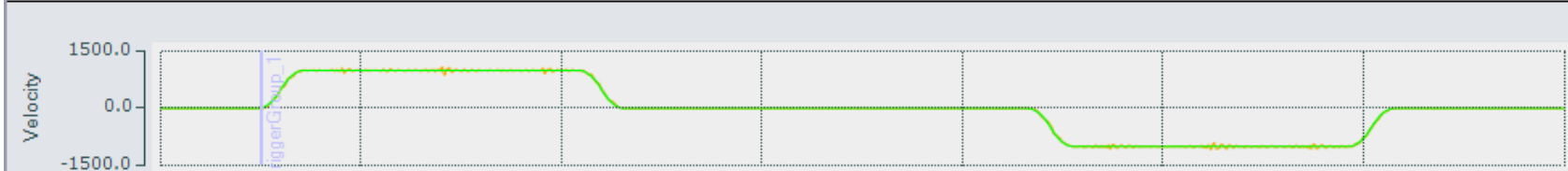
XTS TcSoftDrive – Power monitoring example

BECKHOFF

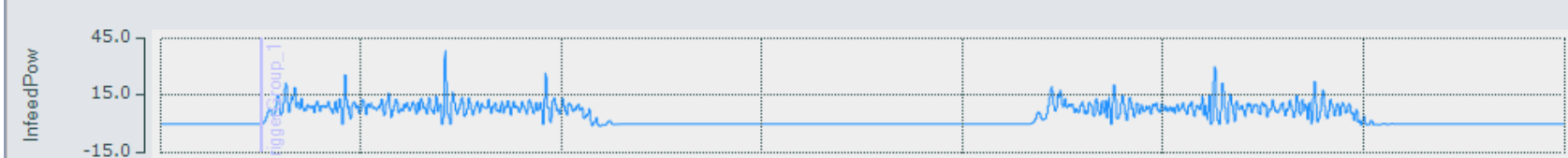
Position [mm]



Velocity [mm/s]

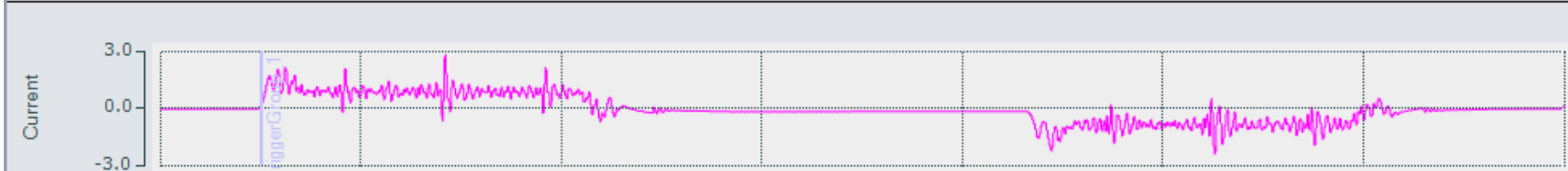


Infeed Power [W]

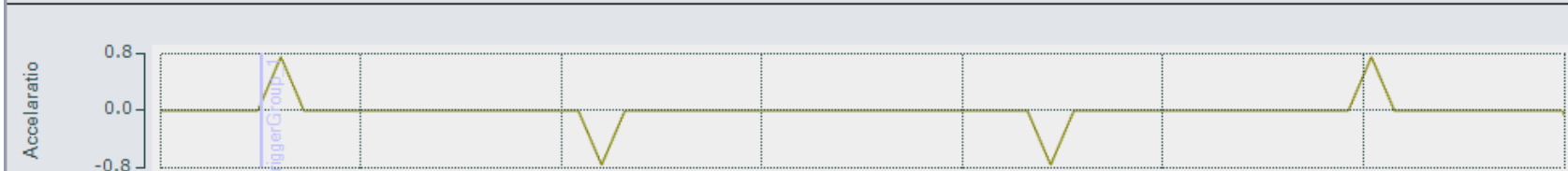


Mover Current [A]

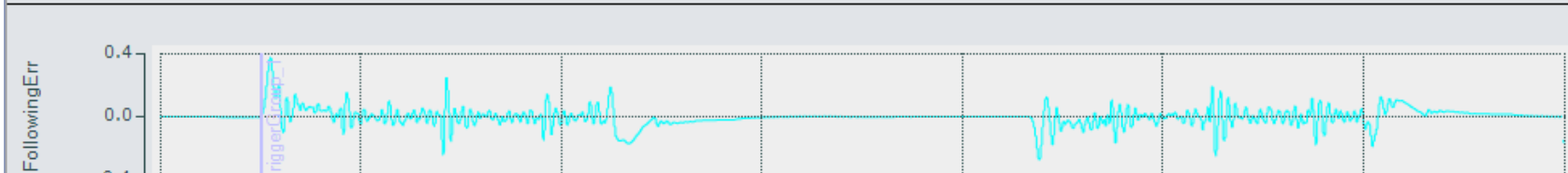
(this is different to the infeed current on the 48V DC!!!)



Acceleration [mm/s²]




















FollowingError [mm]

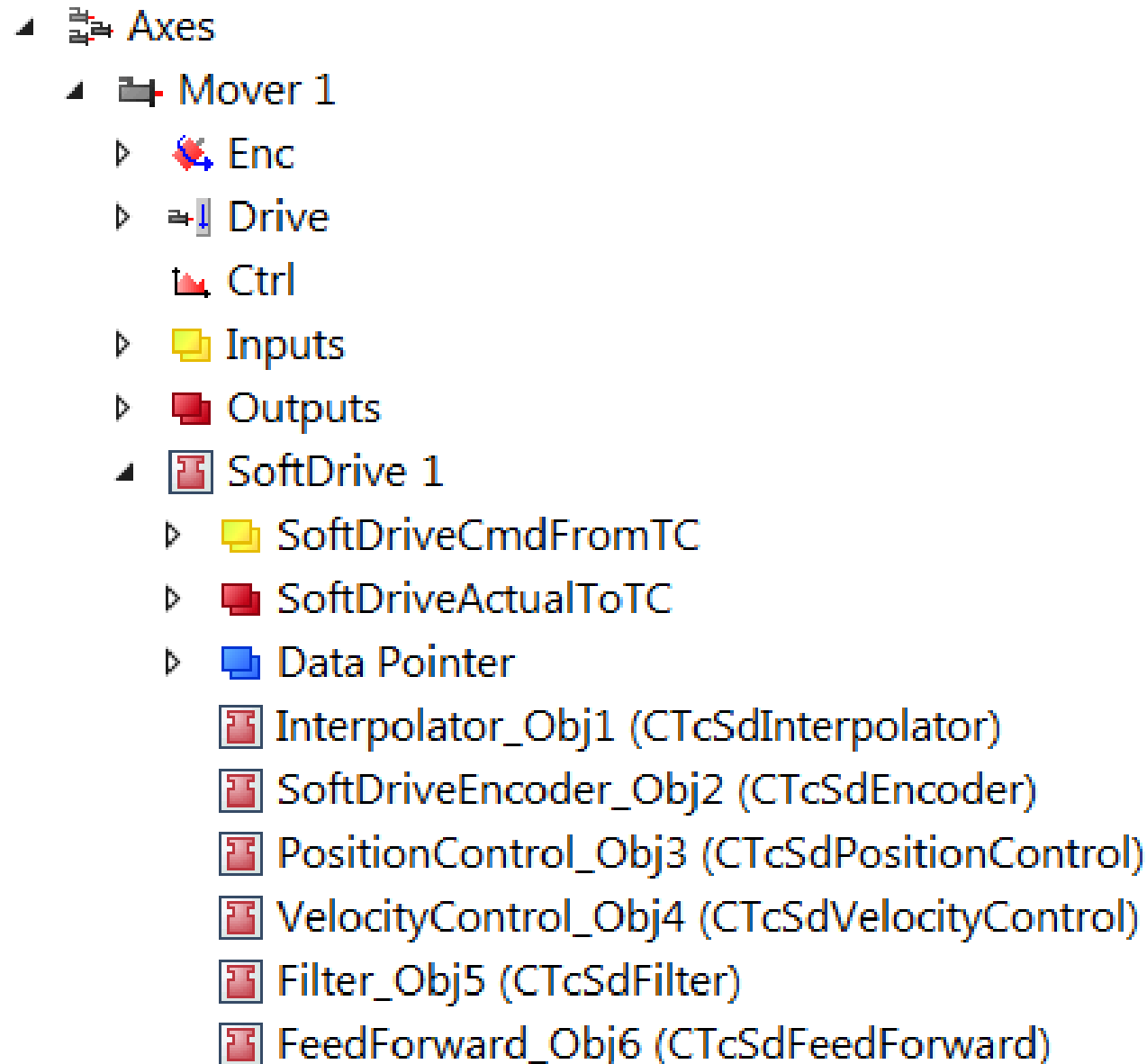


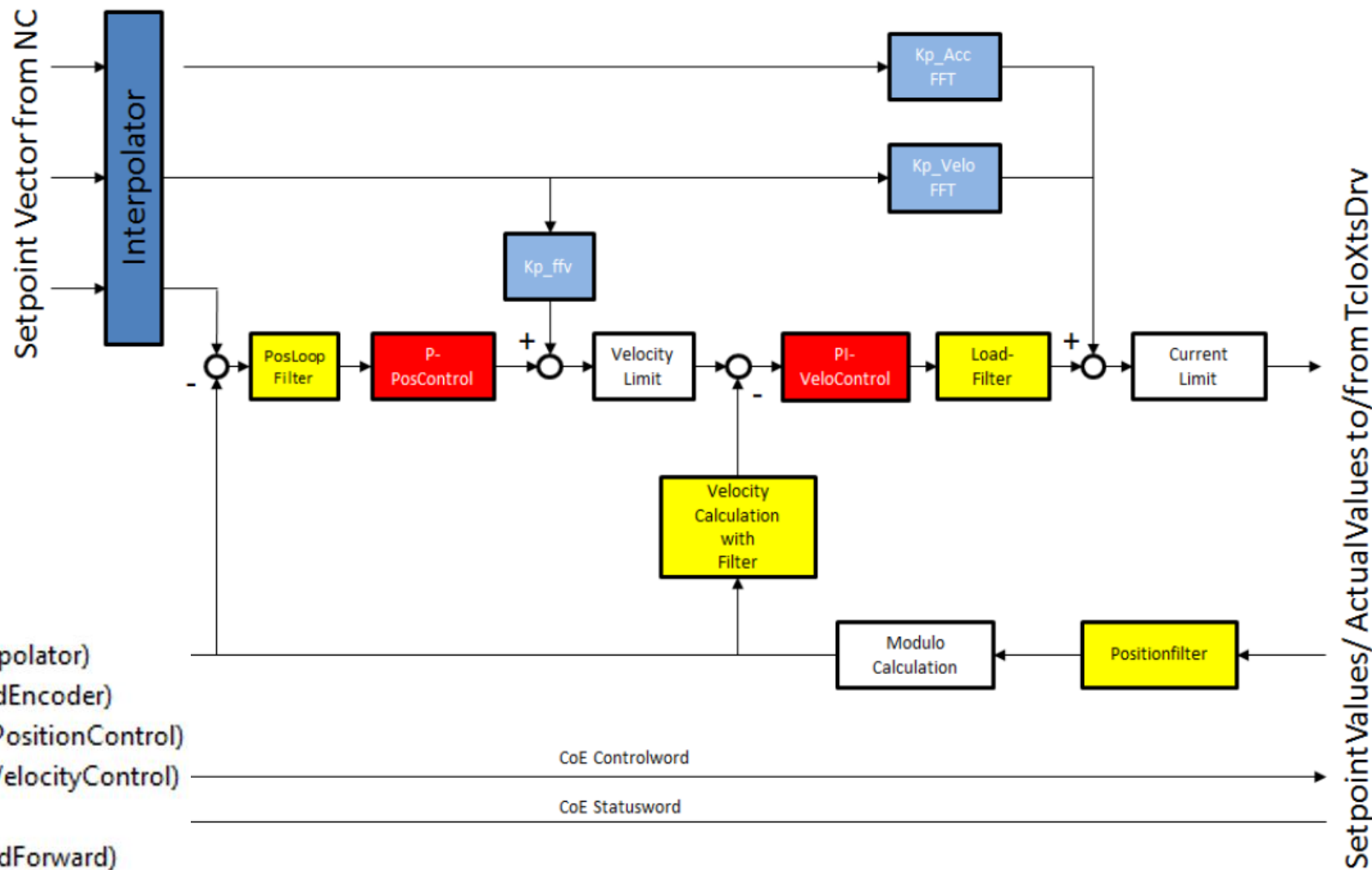
1. Short XTS basics
2. XTS Accuracy
3. XTS IPC & capabilities
4. Scope for Mover monitoring
5. **TcSoftdrive structure & parameter**
6. Tuning



- ▲  Axes
 - ▲  Mover 1
 - ▷  Enc
 - ▷  Drive
 -  Ctrl
 - ▷  Inputs
 - ▷  Outputs
 - ▲  SoftDrive 1
 - ▷  SoftDriveCmdFromTC
 - ▷  SoftDriveActualToTC
 - ▷  Data Pointer
 -  Interpolator_Obj1 (CTcSdInterpolator)
 -  SoftDriveEncoder_Obj2 (CTcSdEncoder)
 -  PositionControl_Obj3 (CTcSdPositionControl)
 -  VelocityControl_Obj4 (CTcSdVelocityControl)
 -  Filter_Obj5 (CTcSdFilter)
 -  FeedForward_Obj6 (CTcSdFeedForward)

- General SoftDrive Parameter
 - Parameter for Interpolator
 - Parameter for Position calculation
 - Parameter for Position Control
 - Parameter for Velocity Control
 - Parameter for Filter settings
 - Parameter for feedforward control





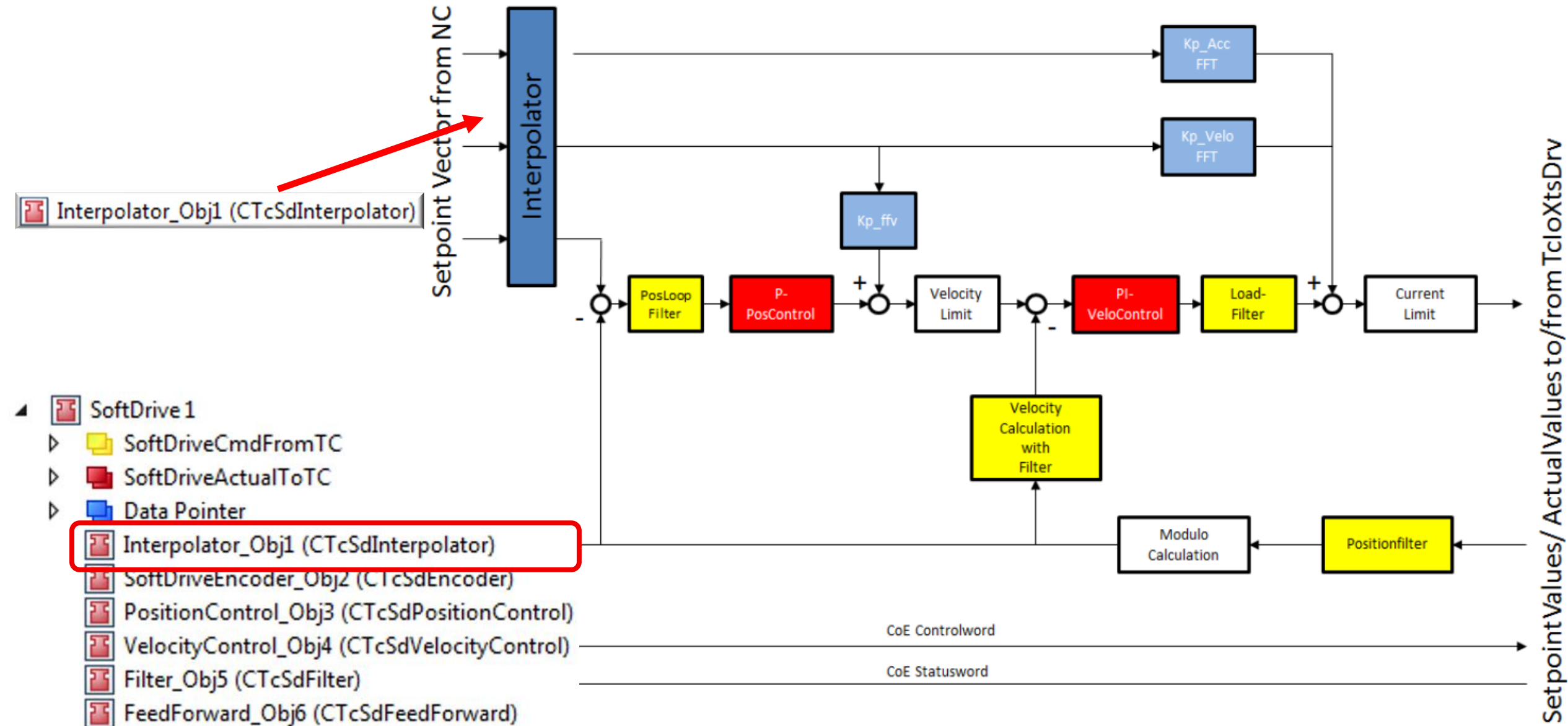
SoftDrive 1

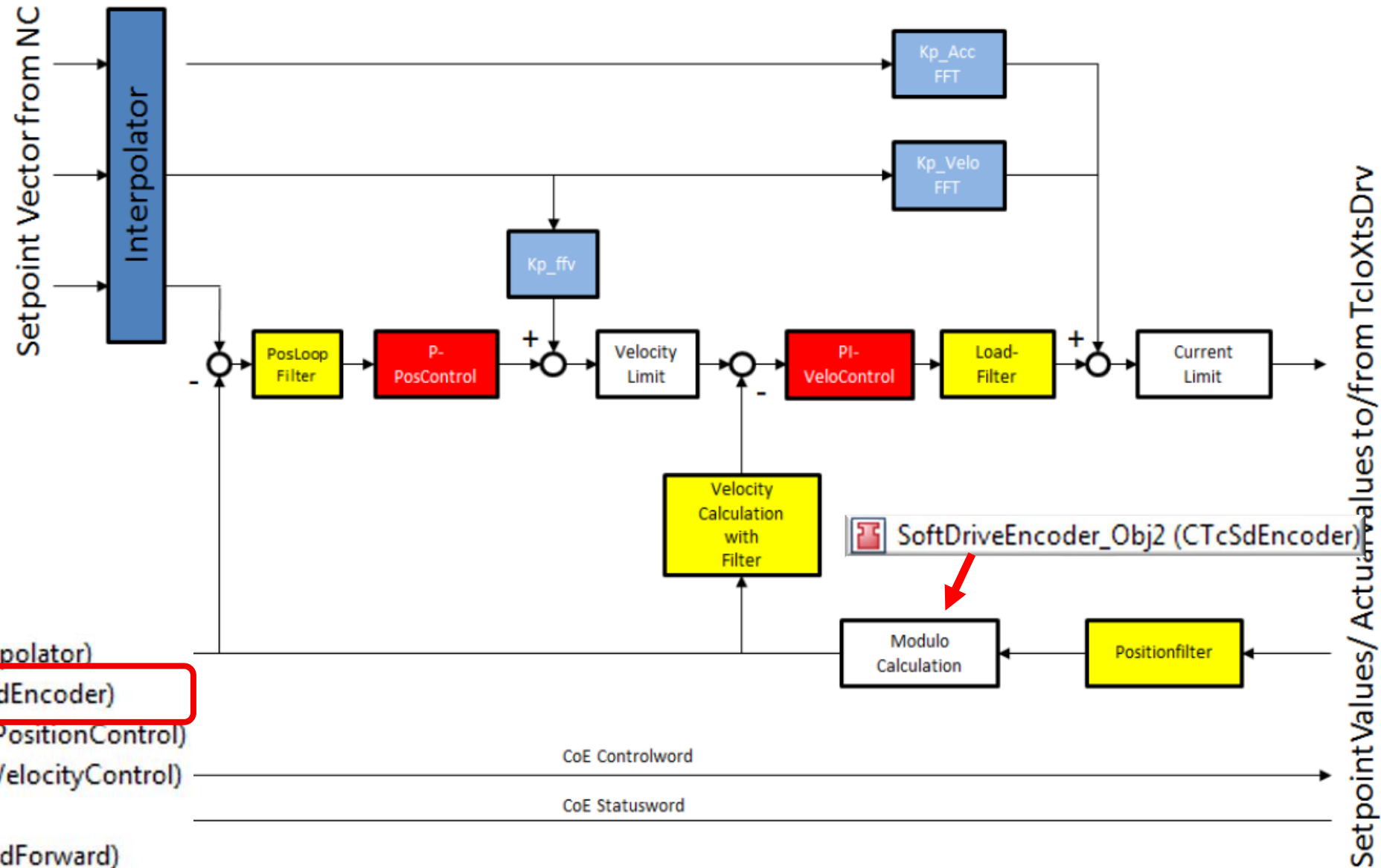
- ▶ SoftDriveCmdFromTC
- ▶ SoftDriveActualToTC
- ▶ Data Pointer

- ▶ Interpolator_Obj1 (CTcSdInterpolator)
- ▶ SoftDriveEncoder_Obj2 (CTcSdEncoder)
- ▶ PositionControl_Obj3 (CTcSdPositionControl)
- ▶ VelocityControl_Obj4 (CTcSdVelocityControl)
- ▶ Filter_Obj5 (CTcSdFilter)
- ▶ FeedForward_Obj6 (CTcSdFeedForward)

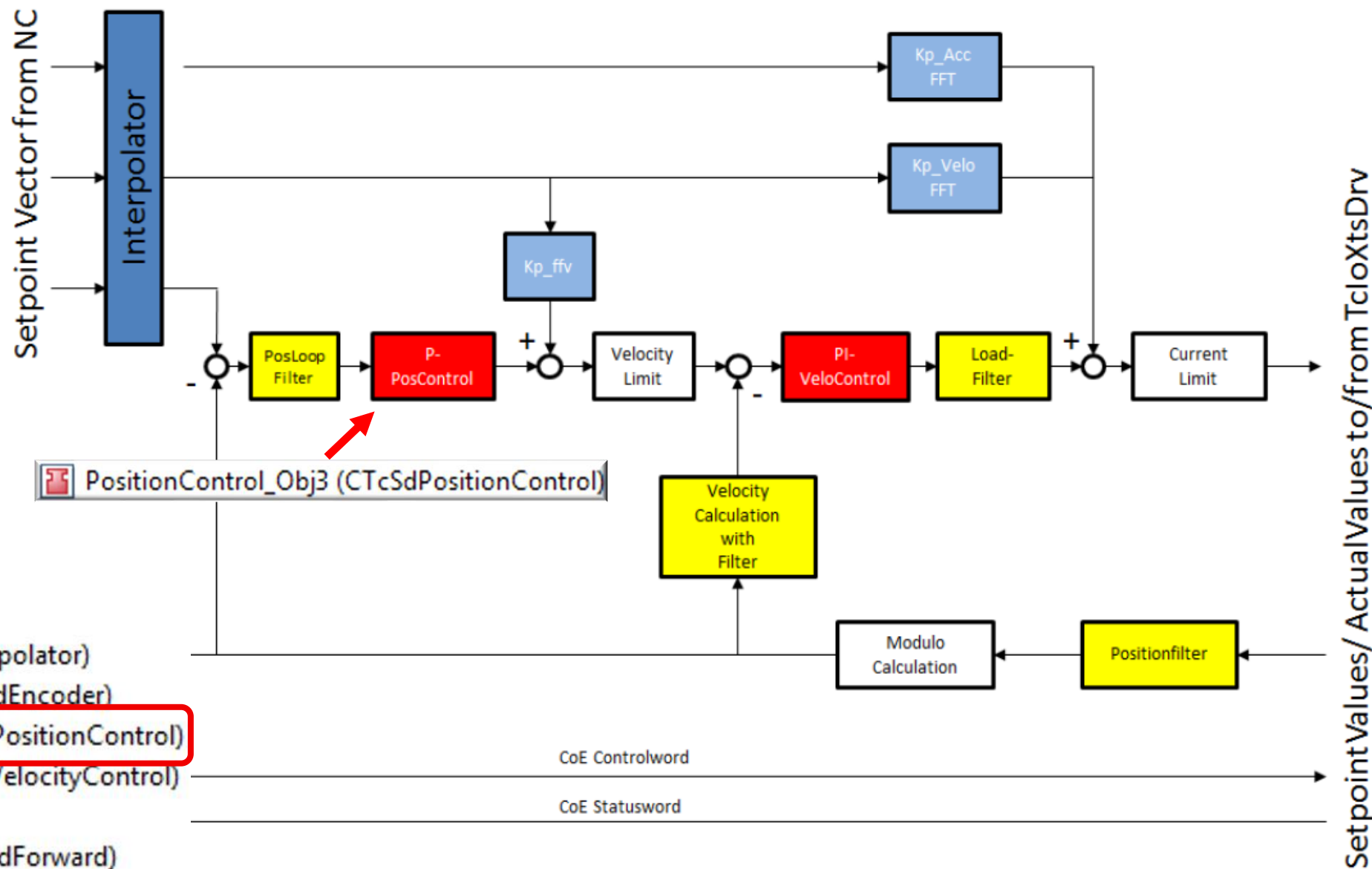
XTS TcSoftDrive - parameter structure

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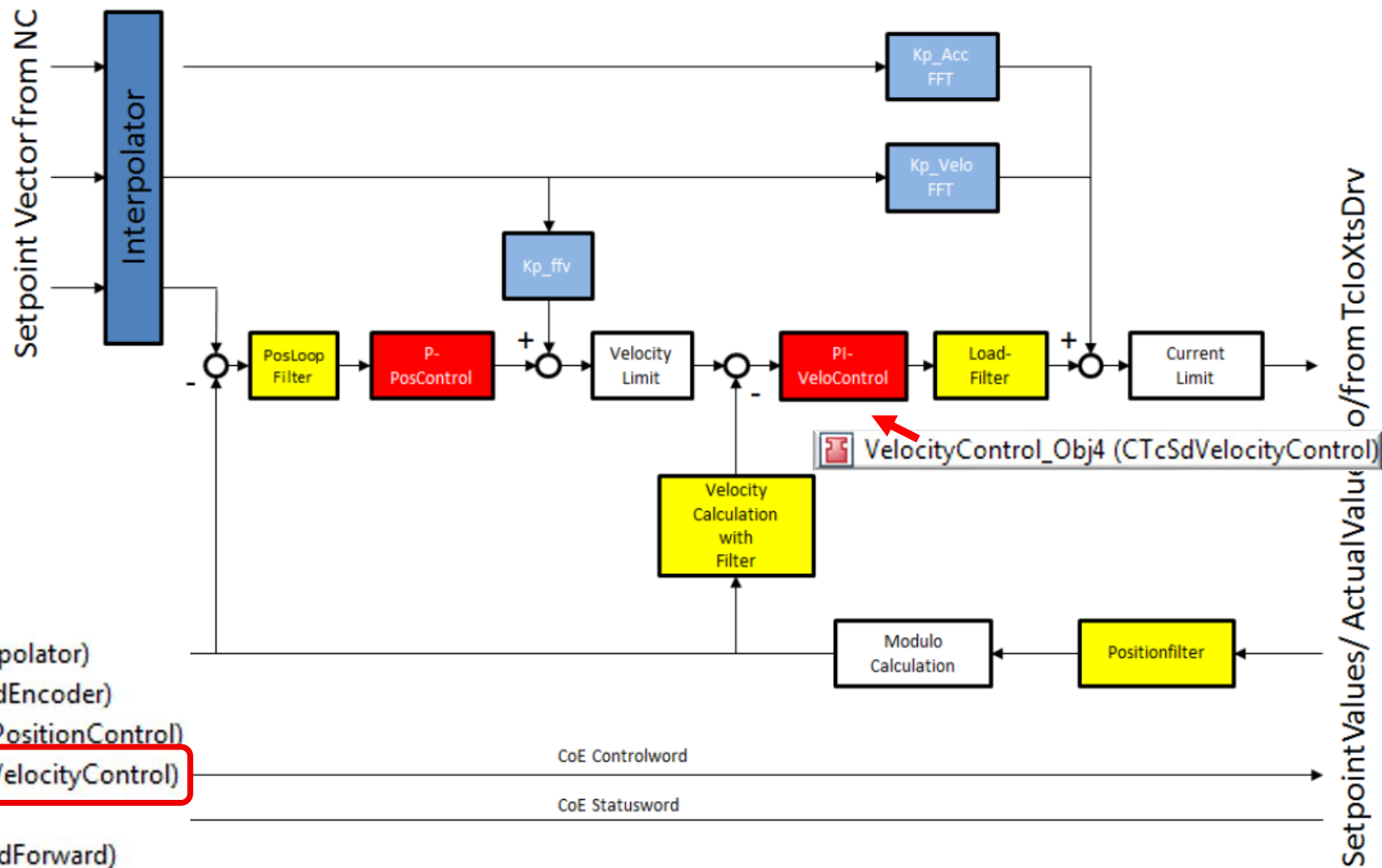
- SoftDrive 1
 - SoftDriveCmdFromTC
 - SoftDriveActualToTC
 - Data Pointer
 - Interpolator_Obj1 (CTcSdInterpolator)
 - SoftDriveEncoder_Obj2 (CTcSdEncoder)**
 - PositionControl_Obj3 (CTcSdPositionControl)
 - VelocityControl_Obj4 (CTcSdVelocityControl)
 - Filter_Obj5 (CTcSdFilter)
 - FeedForward_Obj6 (CTcSdFeedForward)



- SoftDrive 1
 - SoftDriveCmdFromTC
 - SoftDriveActualToTC
 - Data Pointer
 - Interpolator_Obj1 (CTcSdInterpolator)
 - SoftDriveEncoder_Obj2 (CTcSdEncoder)
 - PositionControl_Obj3 (CTcSdPositionControl)**
 - VelocityControl_Obj4 (CTcSdVelocityControl)
 - Filter_Obj5 (CTcSdFilter)
 - FeedForward_Obj6 (CTcSdFeedForward)

XTS TcSoftDrive - parameter structure

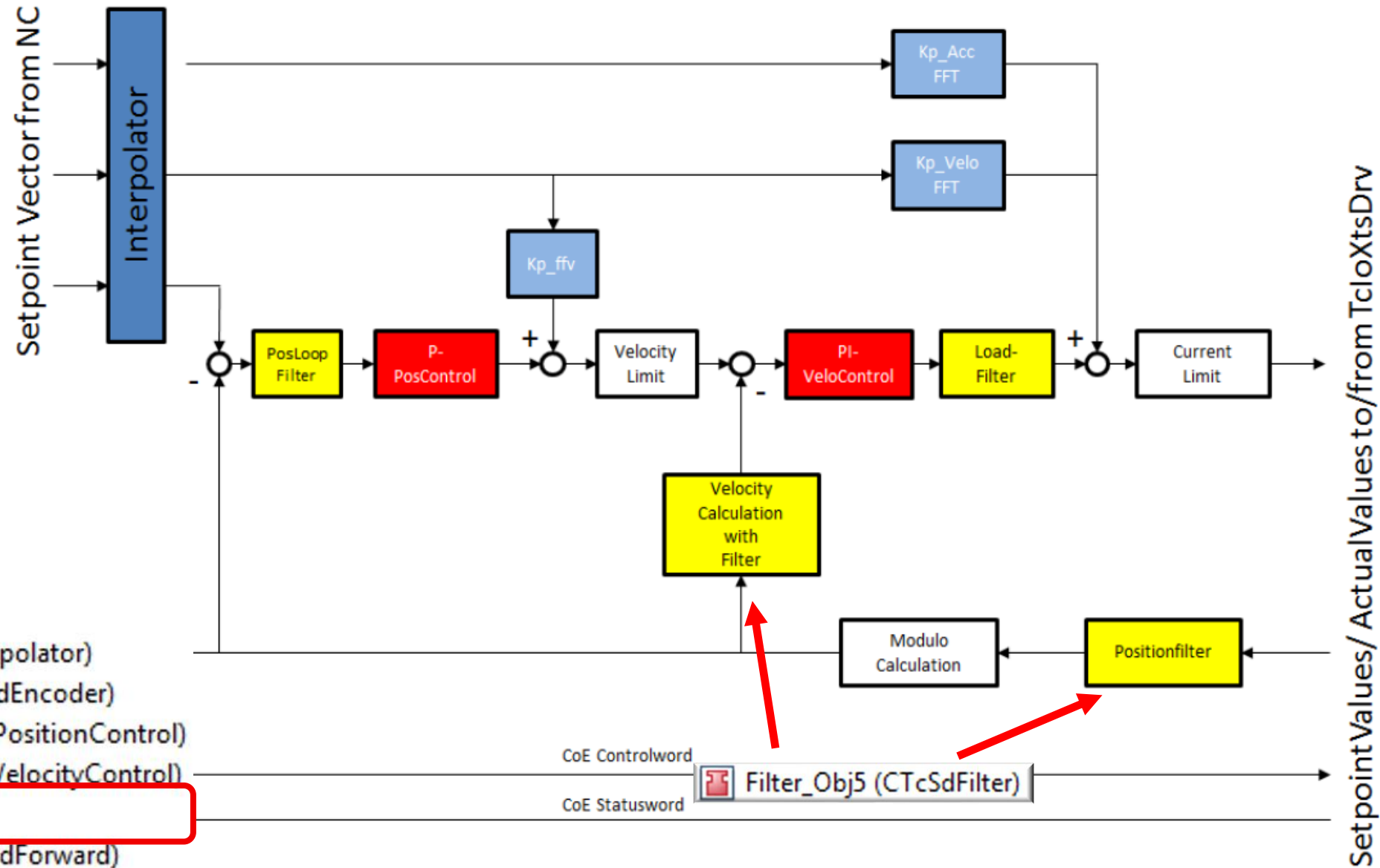
BECKHOFF



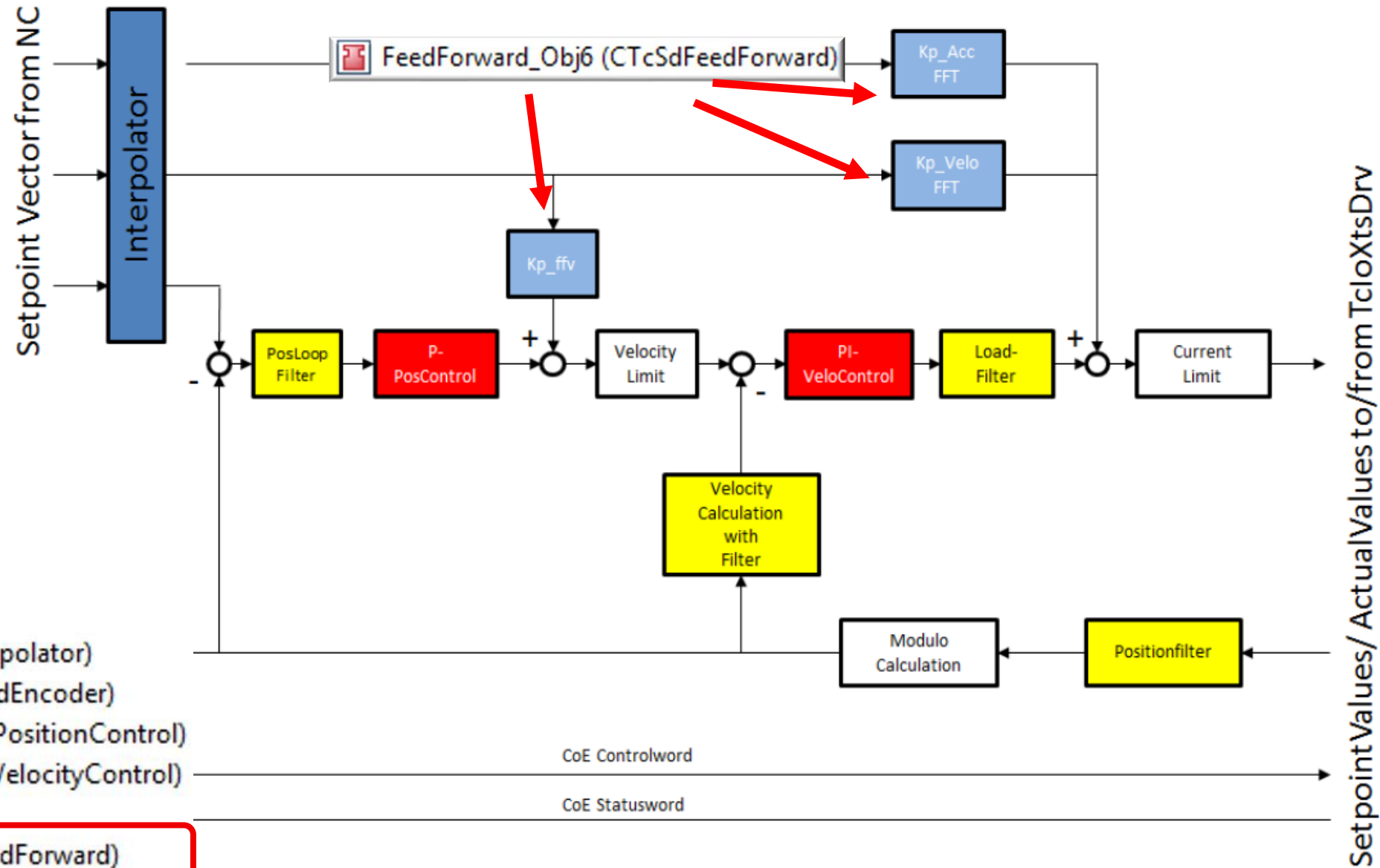
- SoftDrive 1
 - SoftDriveCmdFromTC
 - SoftDriveActualToTC
 - Data Pointer
 - Interpolator_Obj1 (CTcSdInterpolator)
 - SoftDriveEncoder_Obj2 (CTcSdEncoder)
 - PositionControl_Obj3 (CTcSdPositionControl)
 - VelocityControl_Obj4 (CTcSdVelocityControl)**
 - Filter_Obj5 (CTcSdFilter)
 - FeedForward_Obj6 (CTcSdFeedForward)

XTS TcSoftDrive - parameter structure

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- SoftDrive 1
 - SoftDriveCmdFromTC
 - SoftDriveActualToTC
 - Data Pointer
 - Interpolator_Obj1 (CTcSdInterpolator)
 - SoftDriveEncoder_Obj2 (CTcSdEncoder)
 - PositionControl_Obj3 (CTcSdPositionControl)
 - VelocityControl_Obj4 (CTcSdVelocityControl)
 - Filter_Obj5 (CTcSdFilter)
 - FeedForward_Obj6 (CTcSdFeedForward)



- SoftDrive 1
 - SoftDriveCmdFromTC
 - SoftDriveActualToTC
 - Data Pointer
 - Interpolator_Obj1 (CTcSdInterpolator)
 - SoftDriveEncoder_Obj2 (CTcSdEncoder)
 - PositionControl_Obj3 (CTcSdPositionControl)
 - VelocityControl_Obj4 (CTcSdVelocityControl)
 - Filter_Obj5 (CTcSdFilter)
 - FeedForward_Obj6 (CTcSdFeedForward)

XTS TcSoftDrive - General SoftDrive Parameter




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Axis

- Mover 1
 - Enc
 - Drive
 - Ctrl
 - Inputs
 - Outputs
 - SoftDrive 1
 - SoftDriveCmdFromTC
 - SoftDriveActualToTC
 - Data Pointer
 - Interpolator_Obj1 (CTcSdInterpolator)
 - SoftDriveEncoder_Obj2 (CTcSdEncoder)
 - PositionControl_Obj3 (CTcSdPositionControl)
 - VelocityControl_Obj4 (CTcSdVelocityControl)
 - Filter_Obj5 (CTcSdFilter)
 - FeedForward_Obj6 (CTcSdFeedForward)

First_XTS_Project

Object	Context	Parameter (Init)	Parameter (Online)	Data Area	Interfaces	Interface Pointer	Data Pointer
-	General						
	AdsPort	0x015e	<input type="checkbox"/>		WORD	0..	
	HardwareModulo	3000.0	<input type="checkbox"/>		LREAL	0..	
	OperationMode	8	<input type="checkbox"/>		UDINT	0..	
	MaxCurrentOutput	12.0	<input type="checkbox"/>		LREAL	0..	
	EmergencyRamp	10000.0	<input type="checkbox"/>		LREAL	0..	
	EmergencyTimeOut	0.5	<input type="checkbox"/>		LREAL	0..	
	StandstillSwitchTime	0.1	<input type="checkbox"/>		LREAL	0..	
	StandstillSwitchMode	DIRECT_AT_SWIT...	<input type="checkbox"/>		Stand...	0..	
-	ControlAreas						
-	ControlAreas	[...]	<input type="checkbox"/>	1 (Array ...			
	[0].IsEnabled	FALSE	<input type="checkbox"/>				
	[0].reserved	0					
	[0].StartPosition	0.0					
	[0].EndPosition	0.0			LREAL		
	[0].TransitionLength	0.0			LREAL		
+	ExternalIO						
-	Advanced						
	TraceLevelMax	tlAlways	<input type="checkbox"/>		TcTrac...	0..	
-	SoftDriveMotorPara	...	<input type="checkbox"/>			0..	
	.Type	1			UDINT		defin...
	.Poles	2			UDINT		set m...
	.TorqueConstant	8.0		N/A	LREAL		set th...
	.Location	0.25		h...	LREAL		set th...

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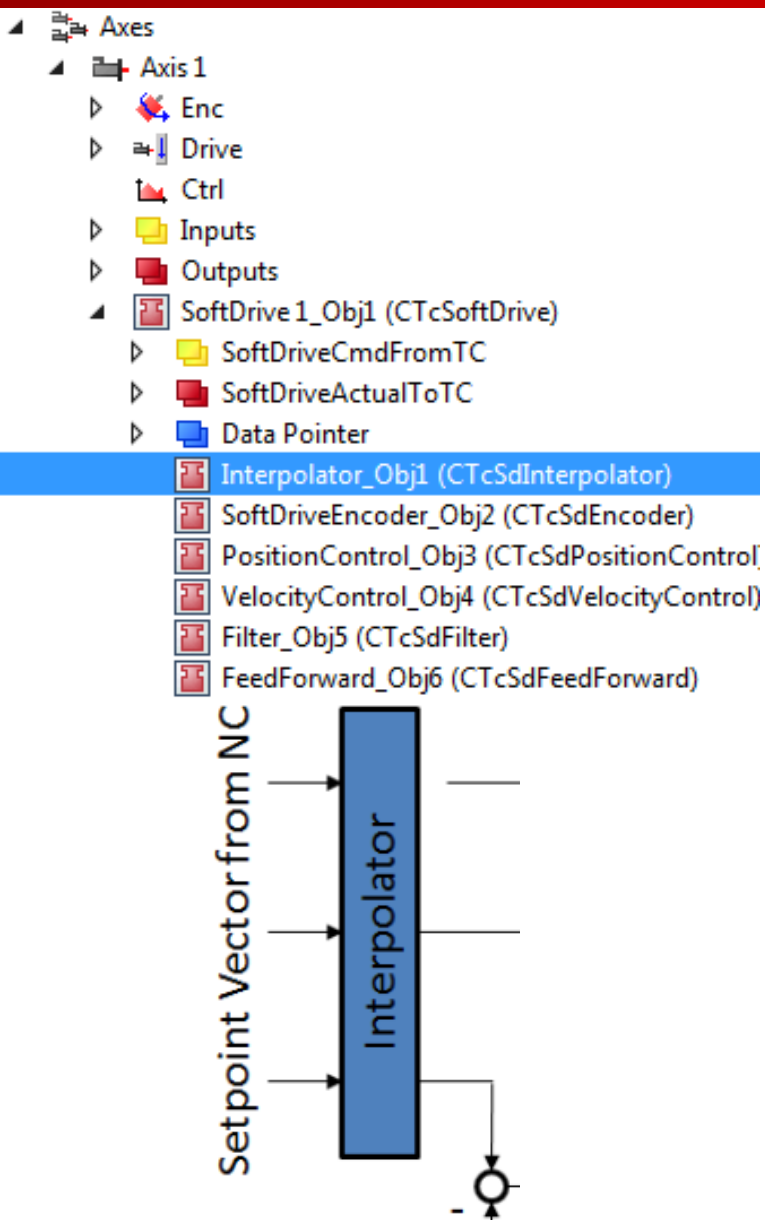
- 1 up to 32 different control areas
- Different parameter for position and velocity control
- Different current limit could be set in Feedforward module
- To use a certain control area [X].IsEnabled must be set to TRUE and Activate Configuration



Name	Value	Online
HardwareModulo	3000.0	3000.0
OperationMode	8	8
MaxCurrentOutput	120.0	12.0
EmergencyRamp	40000.0	40000.0
EmergencyTimeOut	0.5	0.5
StandstillSwitchTime	0.1	0.1
ControlAreas	[...]	[...]
[0].IsEnabled	TRUE	TRUE
[0].reserved	0	0
[0].StartPosition	1000.0	1000.0
[0].EndPosition	1500.0	1500.0
[0].TransitionLength	40.0	40.0

XTS TcSoftDrive - Interpolator

BECKHOFF



First_XTS_Project

Object Context Parameter (Init) Interfaces

	Name	Value	CS	Type	P..
-	General				
	InterpolatorType	INTERPOLATION_POLYN...	<input type="checkbox"/>	Inter...	0...
-	Advanced				
	TraceLevelMax	tlAlways	<input type="checkbox"/>	TcTra...	0...

☐ Show Online Values

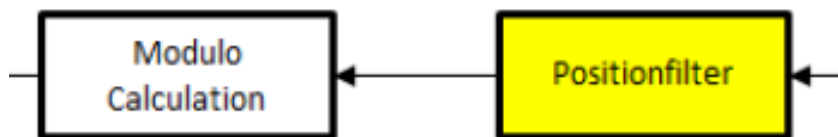
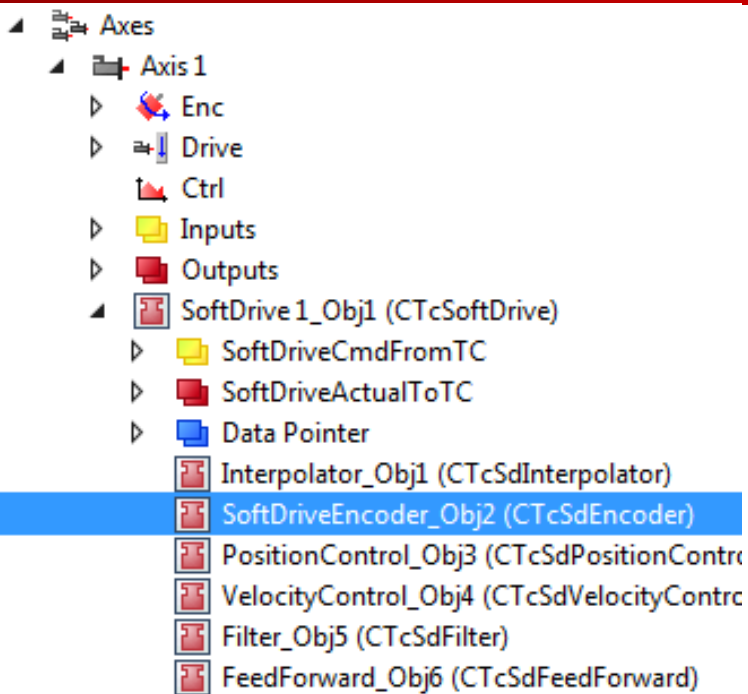
☒ Show Hidden Parameter

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XTS TcSoftDrive - Encoder

BECKHOFF



First_XTS_Project

Object Context Parameter (Init) Interfaces Interface Pointer

	Name	Value	CS	Unit	Type	P..
-	General					
	VelocityFeedbackMode	OBSERVER	<input type="checkbox"/>		Velo...	0...
	PositionFeedbackMode	MODULO_START	<input type="checkbox"/>		Posit...	0...
	PositionLowPassFilter	500.0	<input type="checkbox"/>	Hz	LREAL	0...
	VelocityFilterBandwidth	160.0	<input type="checkbox"/>	Hz	LREAL	0...
	StartUpPositionType	PART	<input type="checkbox"/>		Start...	0...
-	Advanced					
	TraceLevelMax	tlAlways	<input type="checkbox"/>		TcTra...	0...
	CorrectionFactor	0.5	<input type="checkbox"/>		LREAL	0...
	SimulationOffset	10.0	<input type="checkbox"/>	mm	LREAL	0...
	CommutationErrorVelocity	1000.0	<input type="checkbox"/>	mm/s	LREAL	0...

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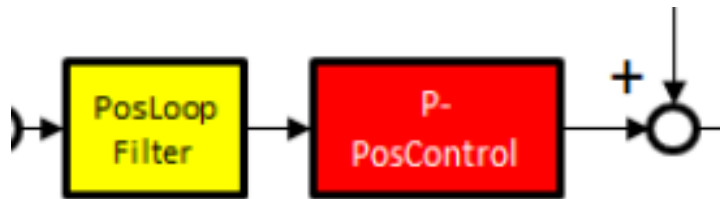
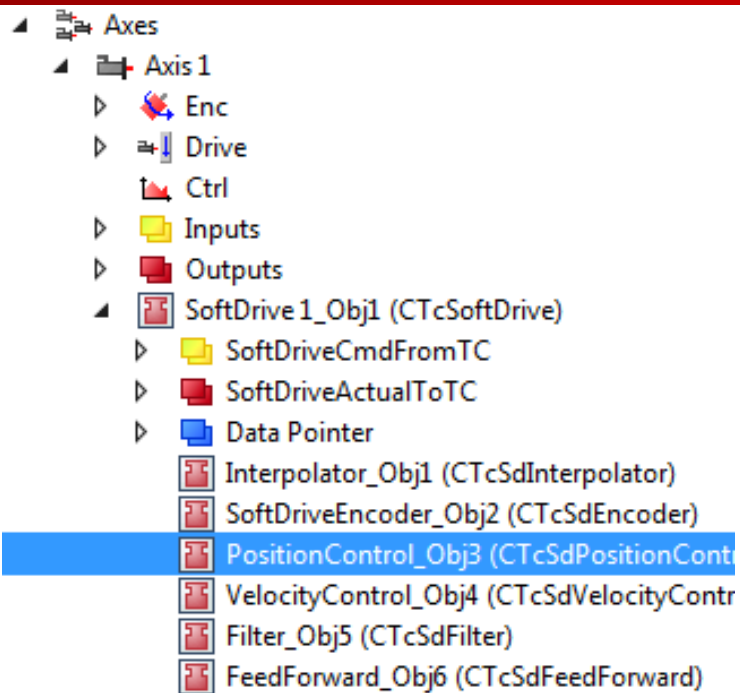
☒ Show Hidden Parameter

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XTS TcSoftDrive - position control

BECKHOFF



First_XTS_Project

Object	Context	Parameter (Init)	Interfaces	Interface Pointer			
	Name	Value	CS	Unit	Type	P...	
-	General						
	PositionLoopType	P_POSITION_STAND... ▾	<input type="checkbox"/>		Positi...	0...	
	Kp	0.03	<input type="checkbox"/>	1/s	LREAL	0...	
	Kp_standstill	0.02	<input type="checkbox"/>	1/s	LREAL	0...	
	Kp_area	0.02	<input type="checkbox"/>	1/s	LREAL	0...	
	Kp_area_standstill	0.02	<input type="checkbox"/>	1/s	LREAL	0...	
-	Advanced						
	TraceLevelMax	tlAlways ▾	<input type="checkbox"/>		TcTrac...	0...	
	Kp_ffv	1.0	<input type="checkbox"/>	100%	LREAL	0...	
	PosLoopFilter	75.0	<input type="checkbox"/>	Hz	LREAL	0...	
	PosLoopFilter_area	75.0	<input type="checkbox"/>	Hz	LREAL	0...	
	InpositionTn	0.05	<input type="checkbox"/>	s	LREAL	0...	

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XTS TcSoftDrive - parameter for position control

BECKHOFF

- Type: P_Position
only Kp is used
- Type: P_Position_Standstill
Kp &
Kp_standstill is used
- Type: P_Position_Standstill_Area
all parameter are used

First_XTS_Project

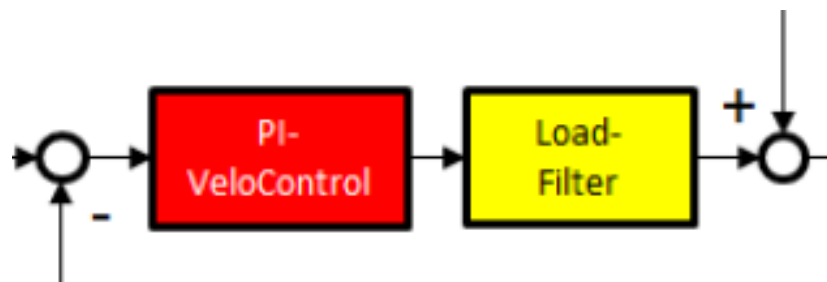
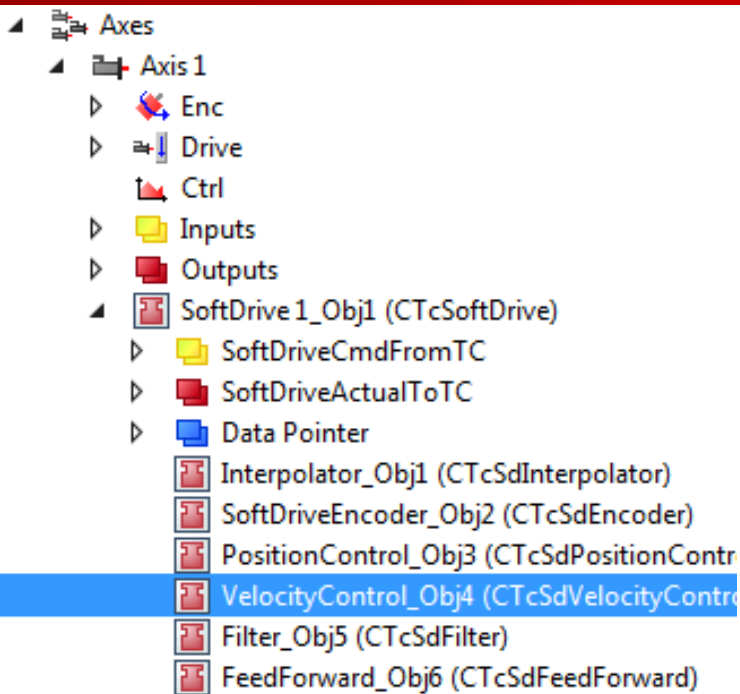
Object Context Parameter (Init) Interfaces Interface Pointer

	Name	Value	CS	Unit	Type	P...
-	General					
	PositionLoopType	P_POSITION_STAND...	<input type="checkbox"/>		Positi...	0...
	Kp	0.03	<input type="checkbox"/>	1/s	LREAL	0...
	Kp_standstill	0.02	<input type="checkbox"/>	1/s	LREAL	0...
	Kp_area	0.02	<input type="checkbox"/>	1/s	LREAL	0...
	Kp_area_standstill	0.02	<input type="checkbox"/>	1/s	LREAL	0...
-	Advanced					
	TraceLevelMax	tlAlways	<input type="checkbox"/>		TcTrac...	0...
	Kp_ffv	1.0	<input type="checkbox"/>	100%	LREAL	0...
	PosLoopFilter	75.0	<input type="checkbox"/>	Hz	LREAL	0...
	PosLoopFilter_area	75.0	<input type="checkbox"/>	Hz	LREAL	0...
	InpositionTn	0.05	<input type="checkbox"/>	s	LREAL	0...



















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XTS TcSoftDrive - velocity control

BECKHOFF



First_XTS_Project

Object	Context	Parameter (Init)	Interfaces	Interface Pointer			
	Name	Value	CS	Unit	Type	P.	^
-	General						
	VelocityLoopType	PI_VELOCITY_STAN... 			Velo...	0..	
	Kp	0.05		As/r...	LREAL	0..	
	Kp_standstill	0.033		As/r...	LREAL	0..	
	Kp_area	0.04		As/r...	LREAL	0..	
	Kp_area_standstill	0.03		As/r...	LREAL	0..	
	Tn	0.05		s	LREAL	0..	
	Tn_standstill	0.05		s	LREAL	0..	
	Tn_area	0.05		s	LREAL	0..	
	Tn_area_standstill	0.05		s	LREAL	0..	
	Kd	0.0		As^...	LREAL	0..	
	Kd_standstill	0.0		As^...	LREAL	0..	
	Kd_area	0.0		As^...	LREAL	0..	
	Kd_area_standstill	0.0		As^...	LREAL	0..	
-	Optimization						
	ResetlPartAtMotionStart	OFF 			Rese...	0..	
-	Advanced						
	TraceLevelMax	tlAlways 			TcTr...	0..	

☐ Show Online Values

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XTS TcSoftDrive - parameter for velocity control

BECKHOFF

- Type: PI_Position
only Kp & Tn is used
- Type: PI_Velocity_Standstill
Kp/Kp_standstill &
Tn/Tn_standstill is used
- Type: PI_Velocity_Standstill_Area
all Kp and Tn are used
(standstill & area)

First_XTS_Project

Object Context Parameter (Init) Interfaces Interface Pointer

	Name	Value	CS	Unit	Type	P.	^
-	General						
	VelocityLoopType	PI_VELOCITY_STAN...	<input type="checkbox"/>		Vel...	0..	
	Kp	0.05	<input type="checkbox"/>	As/r...	LREAL	0..	
	Kp_standstill	0.033	<input type="checkbox"/>	As/r...	LREAL	0..	
	Kp_area	0.04	<input type="checkbox"/>	As/r...	LREAL	0..	
	Kp_area_standstill	0.03	<input type="checkbox"/>	As/r...	LREAL	0..	
	Tn	0.05	<input type="checkbox"/>	s	LREAL	0..	
	Tn_standstill	0.05	<input type="checkbox"/>	s	LREAL	0..	
	Tn_area	0.05	<input type="checkbox"/>	s	LREAL	0..	
	Tn_area_standstill	0.05	<input type="checkbox"/>	s	LREAL	0..	
	Kd	0.0	<input type="checkbox"/>	As^...	LREAL	0..	
	Kd_standstill	0.0	<input type="checkbox"/>	As^...	LREAL	0..	
	Kd_area	0.0	<input type="checkbox"/>	As^...	LREAL	0..	
	Kd_area_standstill	0.0	<input type="checkbox"/>	As^...	LREAL	0..	
-	Optimization						
	ResetIPartAtMotionStart	OFF	<input type="checkbox"/>		Rese...	0..	
-	Advanced						
	TraceLevelMax	tlAlways	<input type="checkbox"/>		TcTr...	0..	

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XTS TcSoftDrive - parameter for velocity control

BECKHOFF

- If one integral parameter is set to zero then the calculated value is also reset to zero.
- If an old tmc is used the functionality is backward compatible

First_XTS_Project

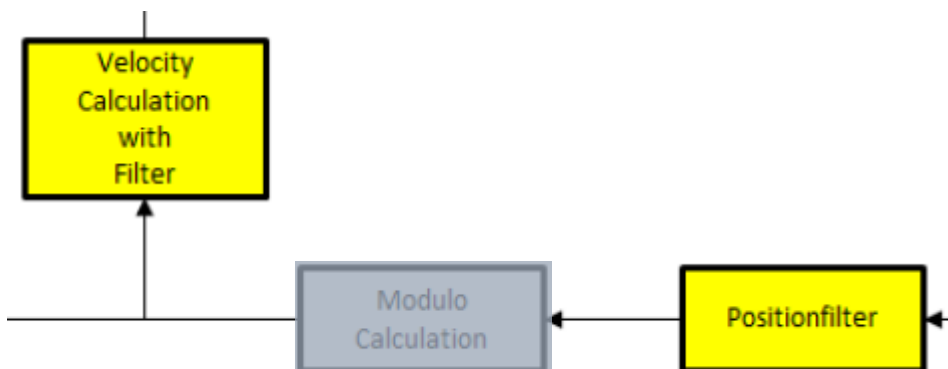
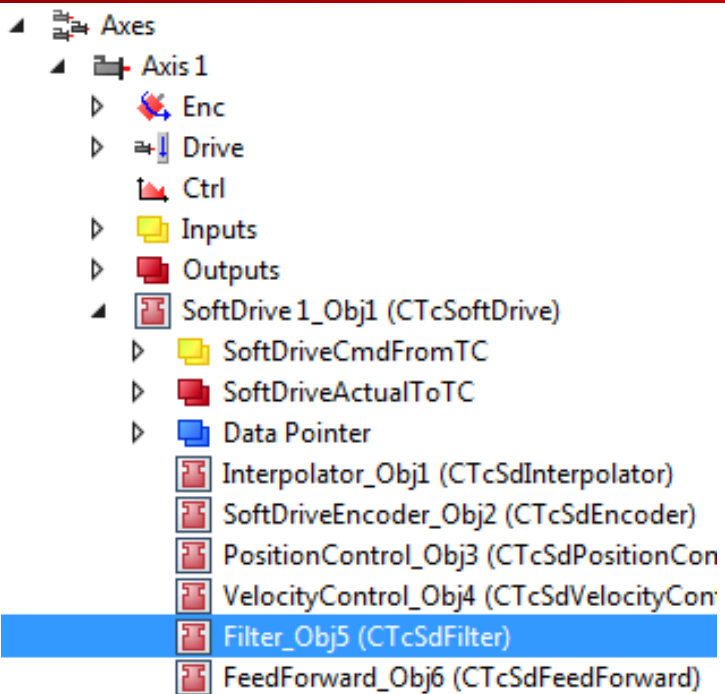
Object Context Parameter (Init) Interfaces Interface Pointer

	Name	Value	CS	Unit	Type	P.	^
-	General						
	VelocityLoopType	PI_VELOCITY_STAN...	<input type="checkbox"/>		Vel...	0..	
	Kp	0.05	<input type="checkbox"/>	As/r...	LREAL	0..	
	Kp_standstill	0.033	<input type="checkbox"/>	As/r...	LREAL	0..	
	Kp_area	0.04	<input type="checkbox"/>	As/r...	LREAL	0..	
	Kp_area_standstill	0.03	<input type="checkbox"/>	As/r...	LREAL	0..	
	Tn	0.05	<input type="checkbox"/>	s	LREAL	0..	
	Tn_standstill	0.05	<input type="checkbox"/>	s	LREAL	0..	
	Tn_area	0.05	<input type="checkbox"/>	s	LREAL	0..	
	Tn_area_standstill	0.05	<input type="checkbox"/>	s	LREAL	0..	
	Kd	0.0	<input type="checkbox"/>	As^...	LREAL	0..	
	Kd_standstill	0.0	<input type="checkbox"/>	As^...	LREAL	0..	
	Kd_area	0.0	<input type="checkbox"/>	As^...	LREAL	0..	
	Kd_area_standstill	0.0	<input type="checkbox"/>	As^...	LREAL	0..	
-	Optimization						
	ResetIPartAtMotionStart	OFF	<input type="checkbox"/>		Rese...	0..	
-	Advanced						
	TraceLevelMax	tlAlways	<input type="checkbox"/>		TcTr...	0..	

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XTS TcSoftDrive - filter parameter

BECKHOFF



First_XTS_Project

Object Context Parameter (Init) Interfaces Interface Pointer

	Name	Value	CS	Unit	Type	P.	Co...
-	General						
-	ConfigurationFilter	...	<input type="checkbox"/>			0..	
	.Type	LOWPASS2			DINT		
	.Usage	ALWAYS			DINT		
	.LowPassFrequency	250.0		Hz	LRE...		set t...
	.LowPassDamping	0.8			LRE...		set t...
	.HighPassFrequency	0.0		Hz	LRE...		set t...
	.HighPassDamping	0.0			LRE...		set t...
-	Advanced						
	TraceLevelMax	tIAlways	<input type="checkbox"/>		TcTr...	0..	

☐ Show Online Values

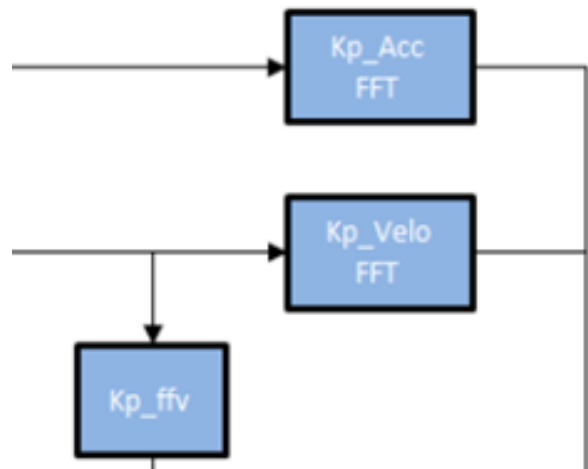
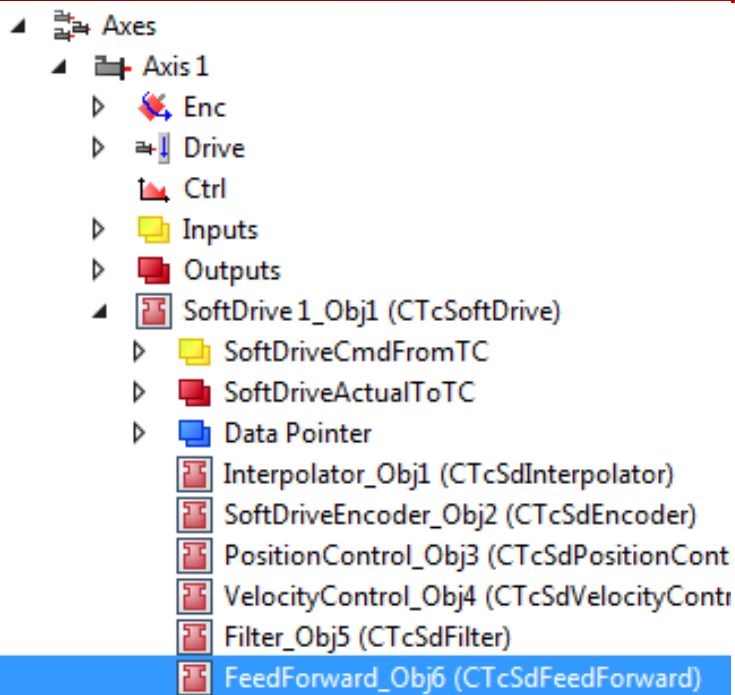
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XTS TcSoftDrive - Feed Forward

BECKHOFF



First_XTS_Project

Object	Context	Parameter (Init)	Parameter (Online)	Interfaces	Interface Pointer
-	General				
	FeedforwardType	FFT_ON	<input type="checkbox"/>		Fee... 0..
	KpAccFFT	1.0	<input type="checkbox"/>	As^...	LREAL 0..
	KpAccFFT_area	1.0	<input type="checkbox"/>	As^...	LREAL 0..
	FrictionCompensation	0.0	<input type="checkbox"/>	A	LREAL 0..
	FrictionCompensation_area	0.0	<input type="checkbox"/>	A	LREAL 0..
	AreaCurrentLimit	0.0	<input type="checkbox"/>	A	LREAL 0..
-	MoverIdDetection				
	DetectionMinMovement	0.1	<input type="checkbox"/>	mm	LREAL 0..
	DetectionFilter	250.0	<input type="checkbox"/>	Hz	LREAL 0..
	DetectionCurrentRamp	25.0	<input type="checkbox"/>	mA/...	LREAL 0..
	DetectionMaxCurrent	12.0	<input type="checkbox"/>	A	LREAL 0..
	DetectionStandstillVelocity...	15.0	<input type="checkbox"/>	mm/s	LREAL 0..
	DetectionStandstillSwitchTi...	0.015	<input type="checkbox"/>	s	LREAL 0..
	DetectionTimeOut	2.0	<input type="checkbox"/>	s	LREAL 0..
	DetectionInfoMessage	FALSE	<input type="checkbox"/>		BO... 0..
-	Optimization				
	CyclicCurrentFeedforward...	OFF	<input type="checkbox"/>		Cycl... 0..

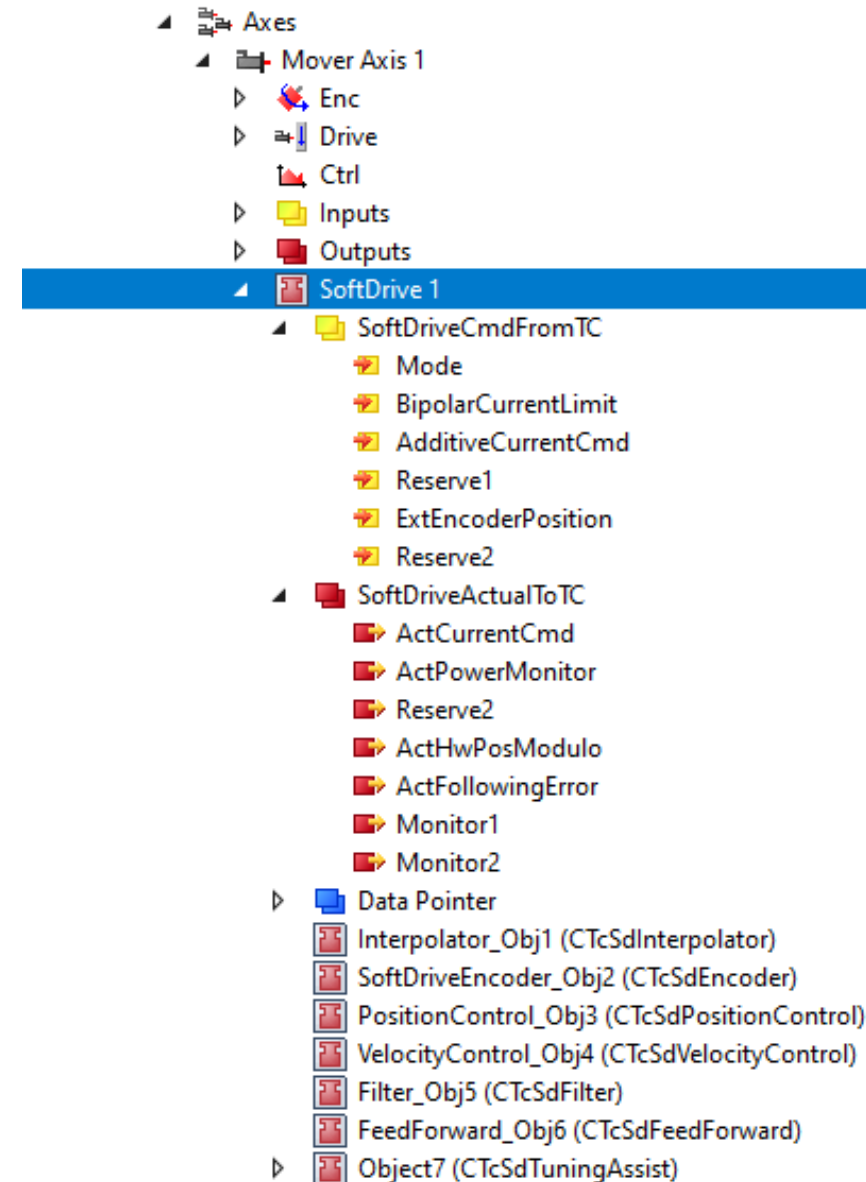
☐ Show Online Values ☒ Show Hidden Parameter

Expand All

Collapse All

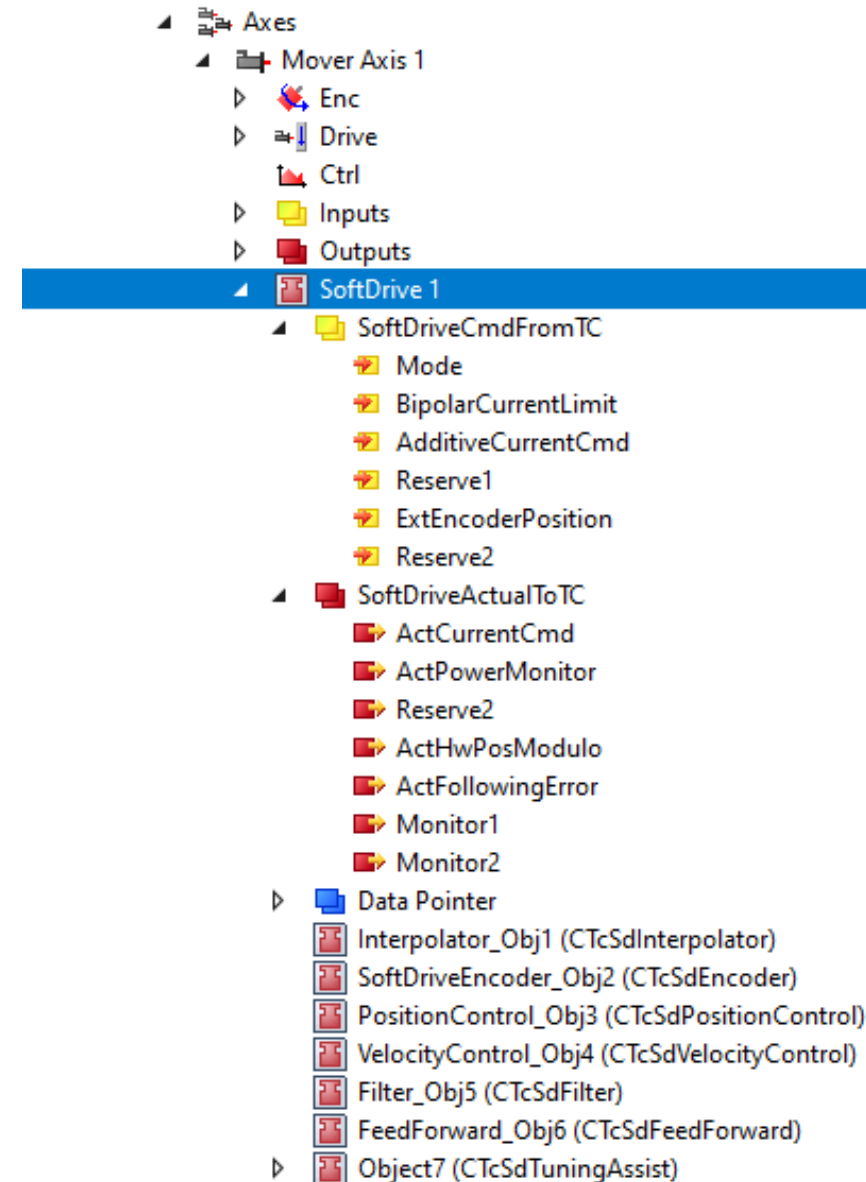
From NC / PLC → TcSoftDrive

- Mode: change TcSoftDrive operation mode & the use of the other cmd values
- BipolarCurrentLimit: add the cyclic current limit value
- AdditiveCurrentCmd: set an additional cyclic FFT current value. Functionality depends on the actual Operation mode used for real torque control
- AdditiveCurrentCmd: add an additional cyclic FFT current value
- ExtEncoderPosition: use position data from another source



From TcSoftDrive → NC / PLC

- ActCurrentCmd: actual current command
- ActHwPosModule: actual HW Position
- ActFollowingError: actual Following Error

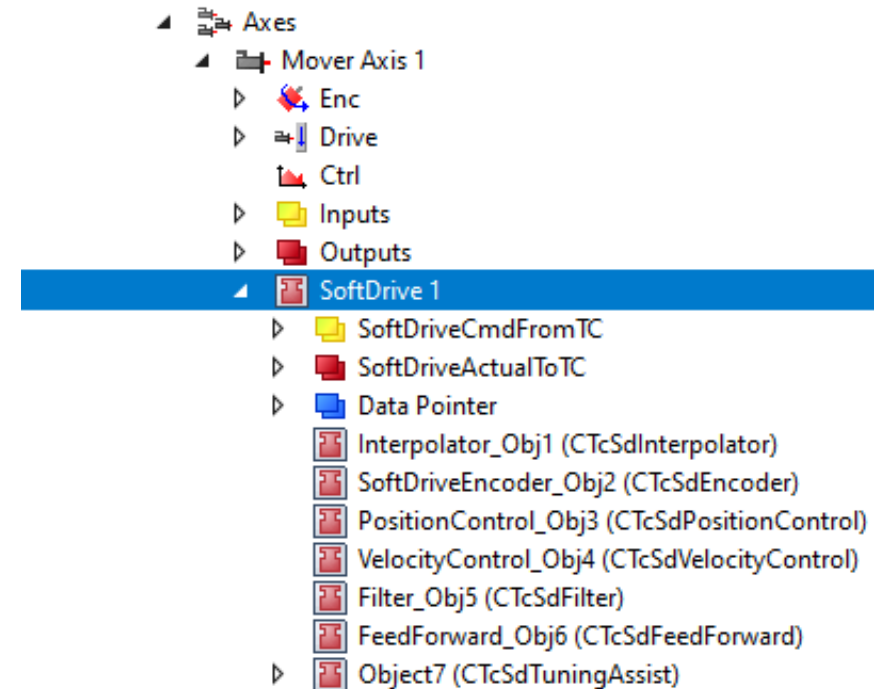
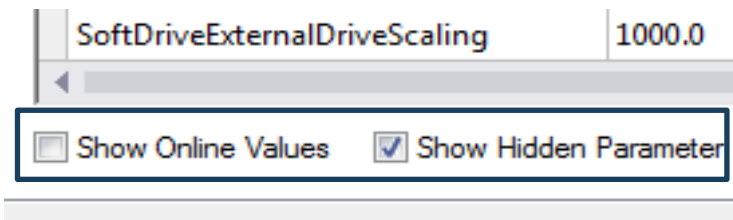


■ SoftDriveExternalEncoder

These parameters set the encoder counting direction, the scaling and offset for the external encoder feedback. This external encoder position could also be the position from another XTS mover.

■ SoftDriveExternalDriveScale

This parameter sets the scaling for the output of the actual SoftDrive current command e.g. for use with another drive HW



-	ExternalIO				
-	SoftDriveExternalEncoder	...	<input type="checkbox"/>		
	.InvertExtEncoder	OFF	<input type="checkbox"/>		UDINT
	.Reserved	0	<input type="checkbox"/>		UDINT
	.ExtEncoderScale	0.0	<input type="checkbox"/>	mm/Inc	LREAL
	.ExtEncoderOffset	0.0	<input type="checkbox"/>	mm	LREAL
	SoftDriveExternalDriveScaling	1000.0	<input type="checkbox"/>		LREAL
+	IoChildAreaLocation	[..., ...]	<input type="checkbox"/>	2 (Array ...	
	AreaOwner	00000000	<input type="checkbox"/>		OTCID

1. Short XTS basics
2. XTS Accuracy
3. XTS IPC & capabilities
4. Scope for Mover monitoring
5. TcSoftdrive structure & parameter
6. **Tuning**

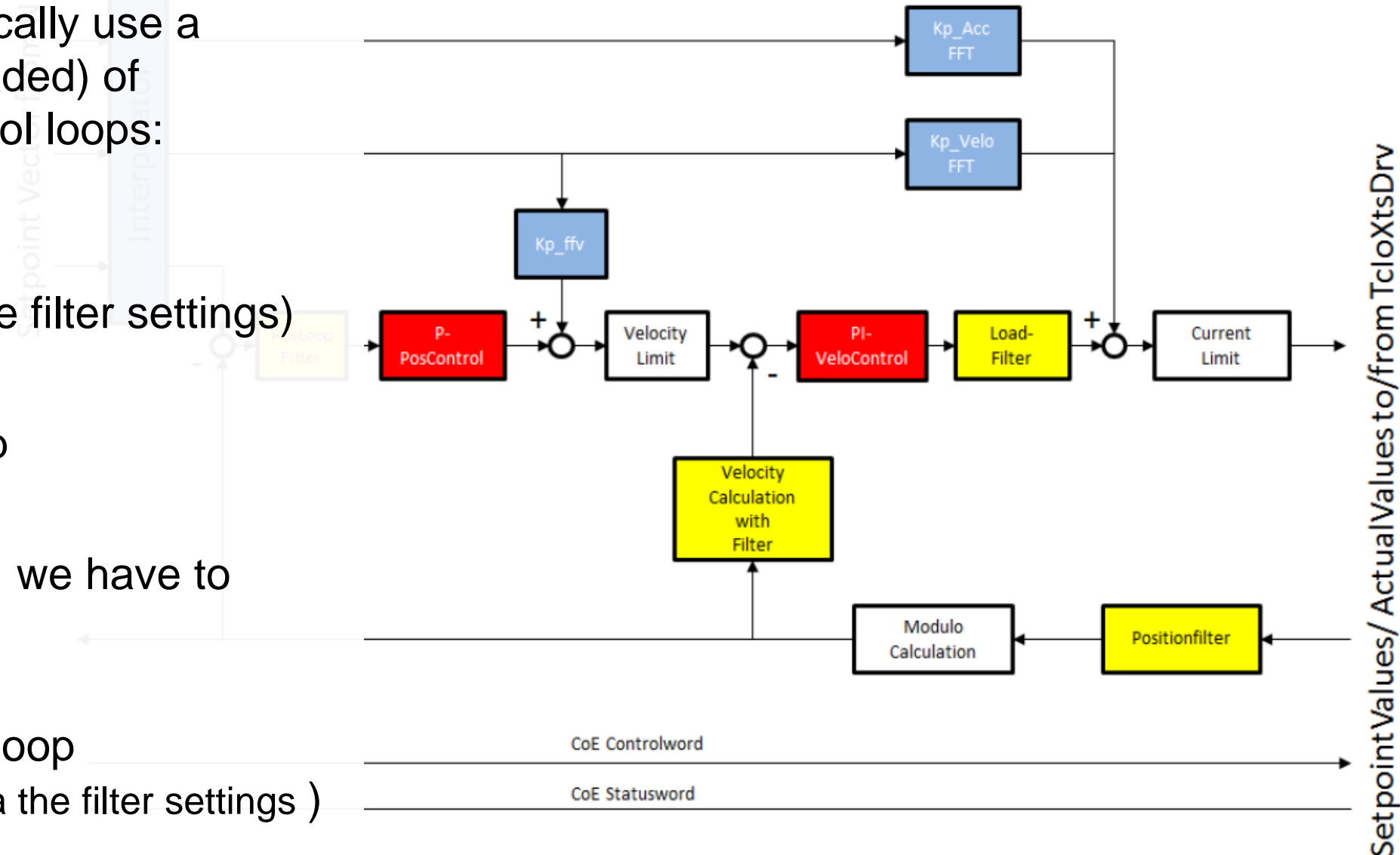


Servo systems typically use a combination (cascaded) of three types of control loops:

- current loop
(indirectly via the filter settings)
- velocity loop
- and position loop

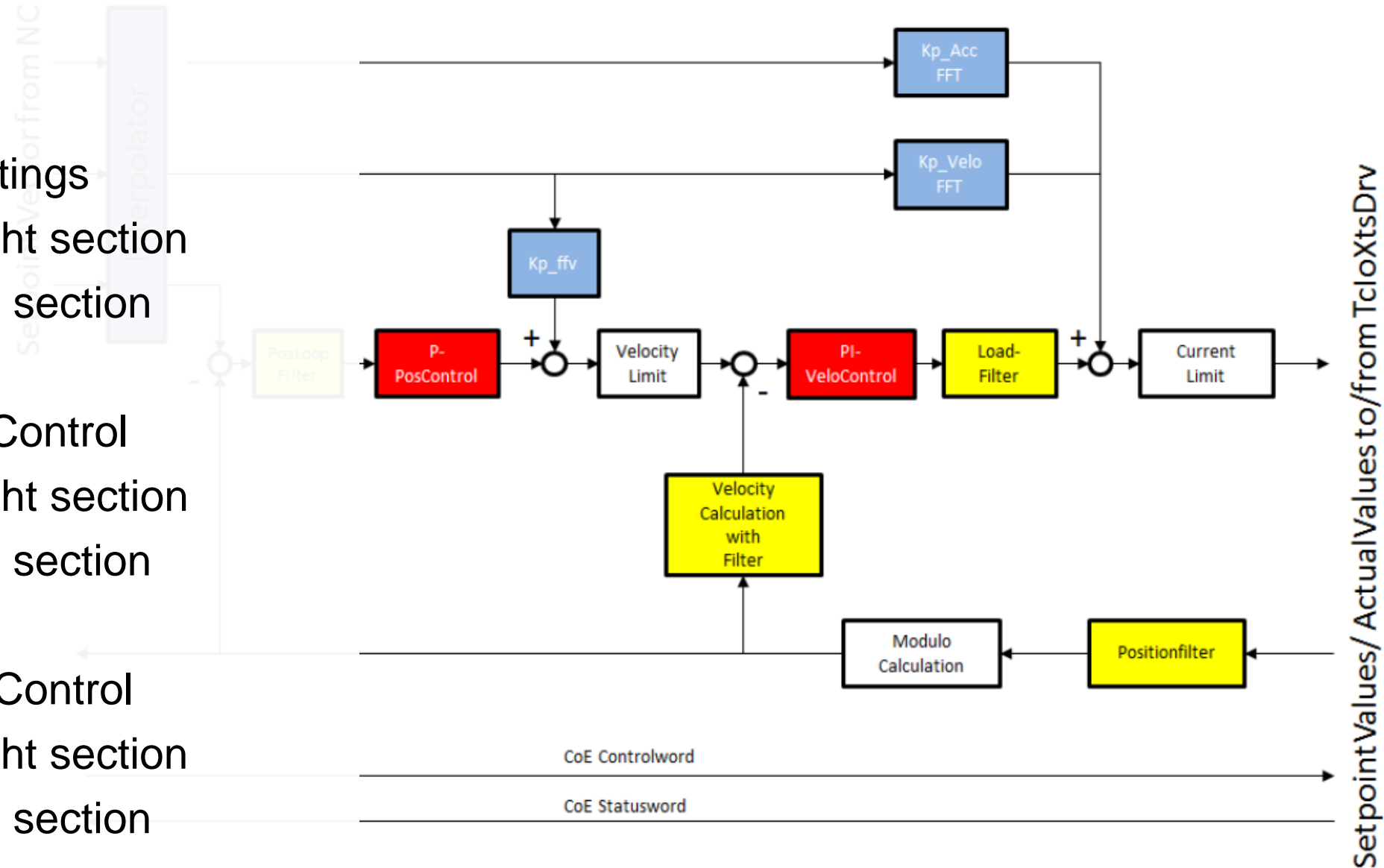
To tune the system, we have to tune each loop.

Starting at the first loop
(current indirectly via the filter settings)



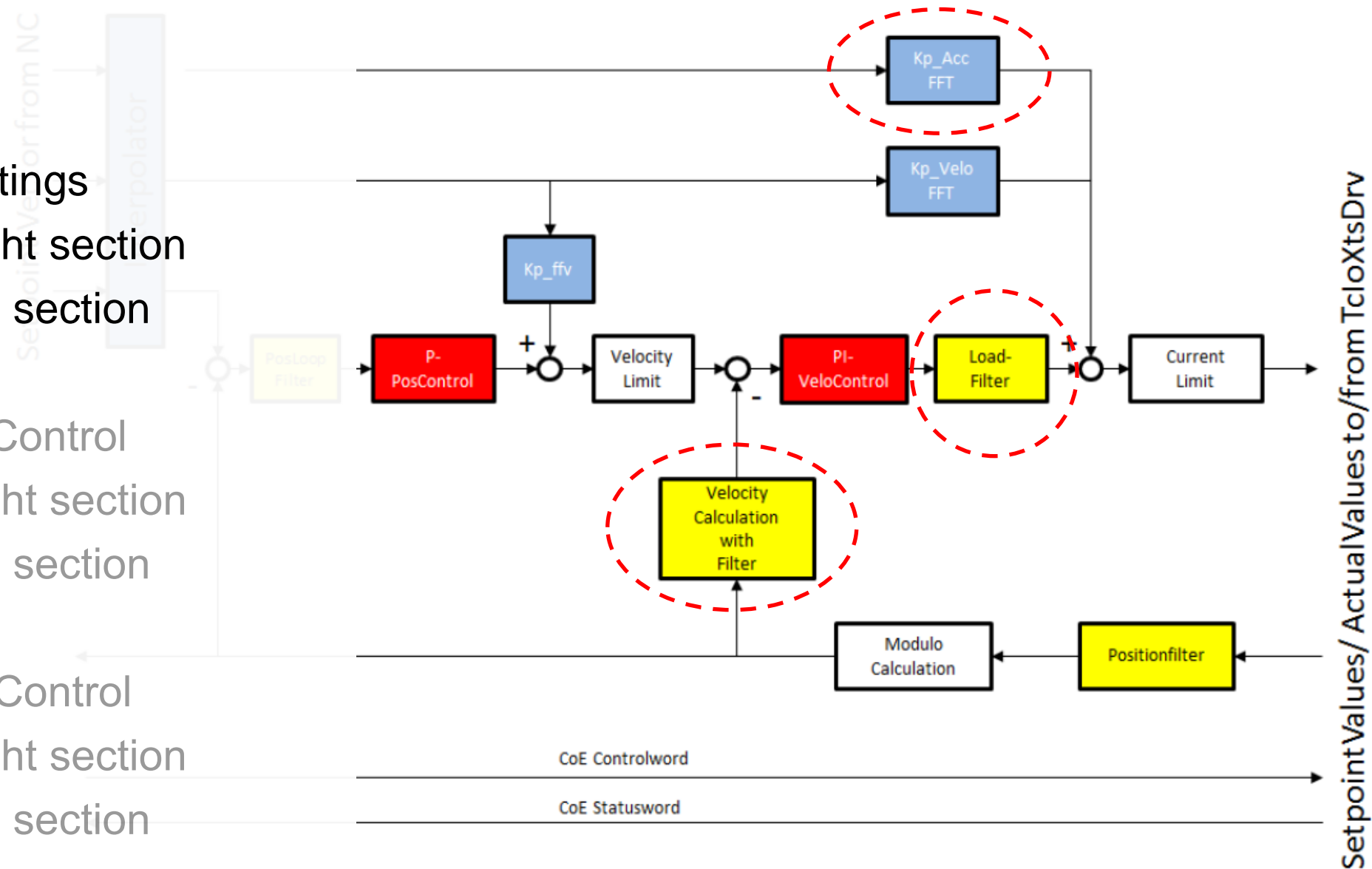
Tuning Sequence

1. Setup Filter Settings
 - I. on the straight section
 - II. on the curve section
2. Setup Velocity-Control
 - I. on the straight section
 - II. on the curve section
3. Setup Position-Control
 - I. on the straight section
 - II. on the curve section



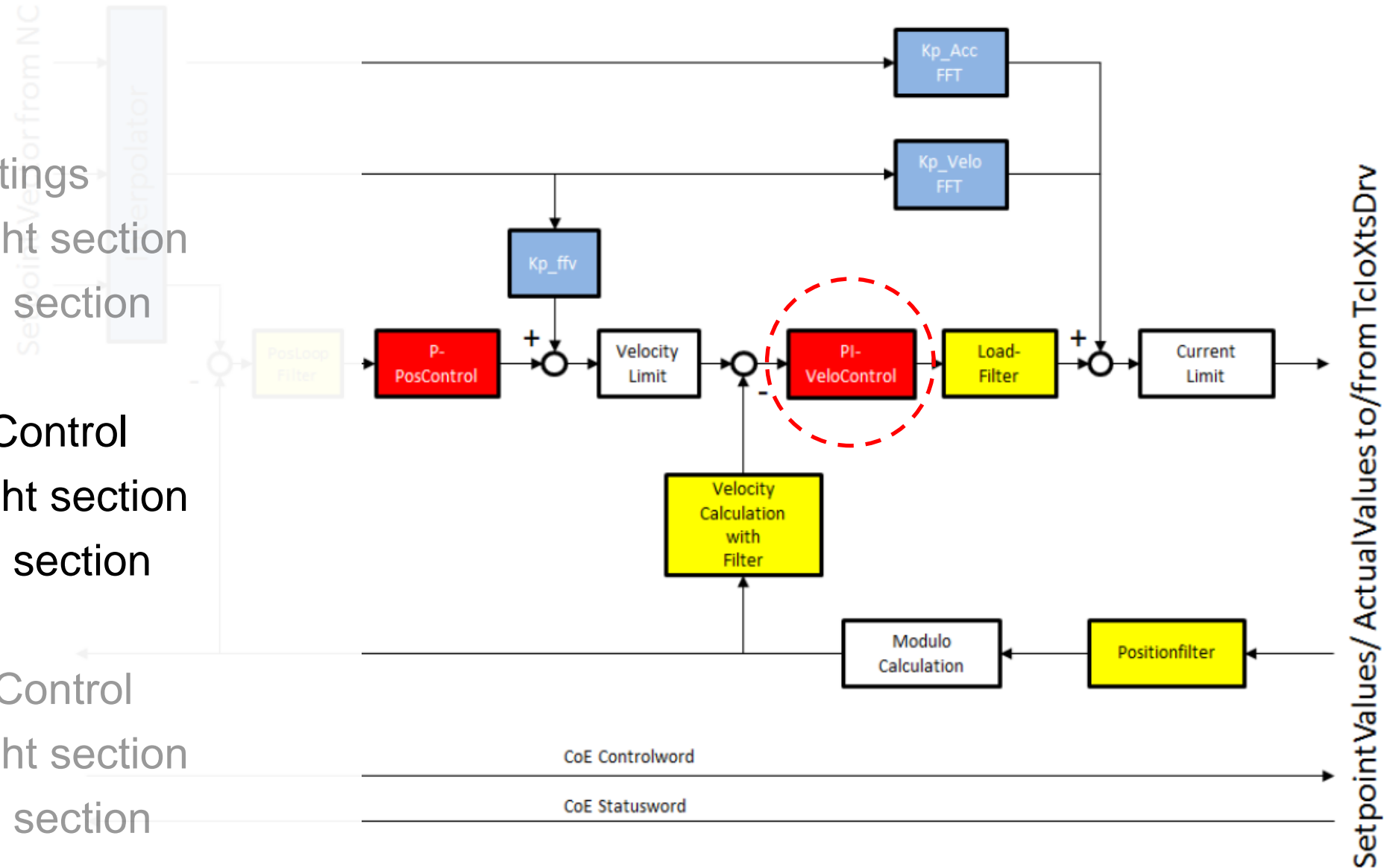
Tuning Sequence

1. Setup Filter Settings
 - I. on the straight section
 - II. on the curve section
2. Setup Velocity-Control
 - I. on the straight section
 - II. on the curve section
3. Setup Position-Control
 - I. on the straight section
 - II. on the curve section



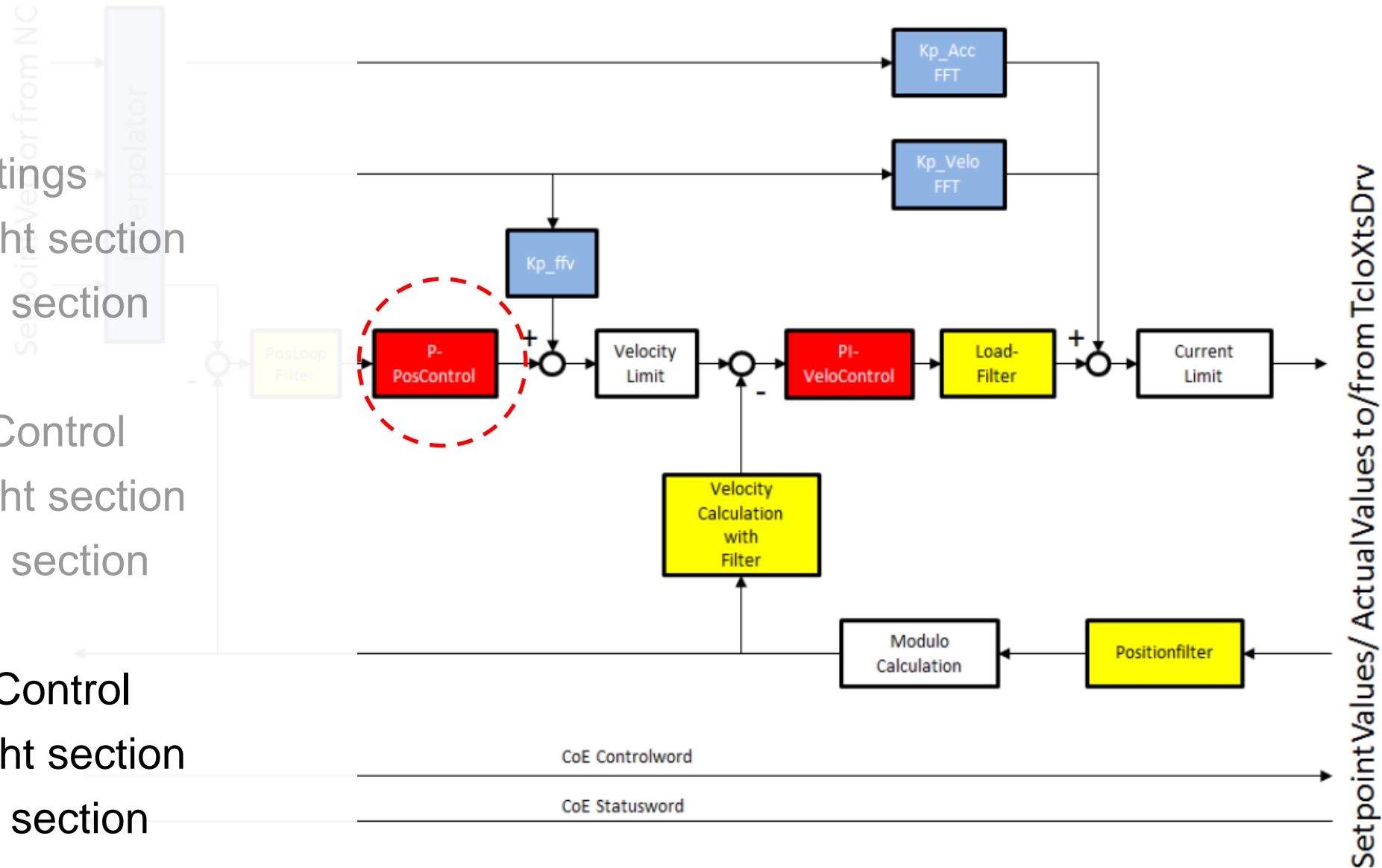
Tuning Sequence

1. Setup Filter Settings
 - I. on the straight section
 - II. on the curve section
2. Setup Velocity-Control
 - I. on the straight section
 - II. on the curve section
3. Setup Position-Control
 - I. on the straight section
 - II. on the curve section



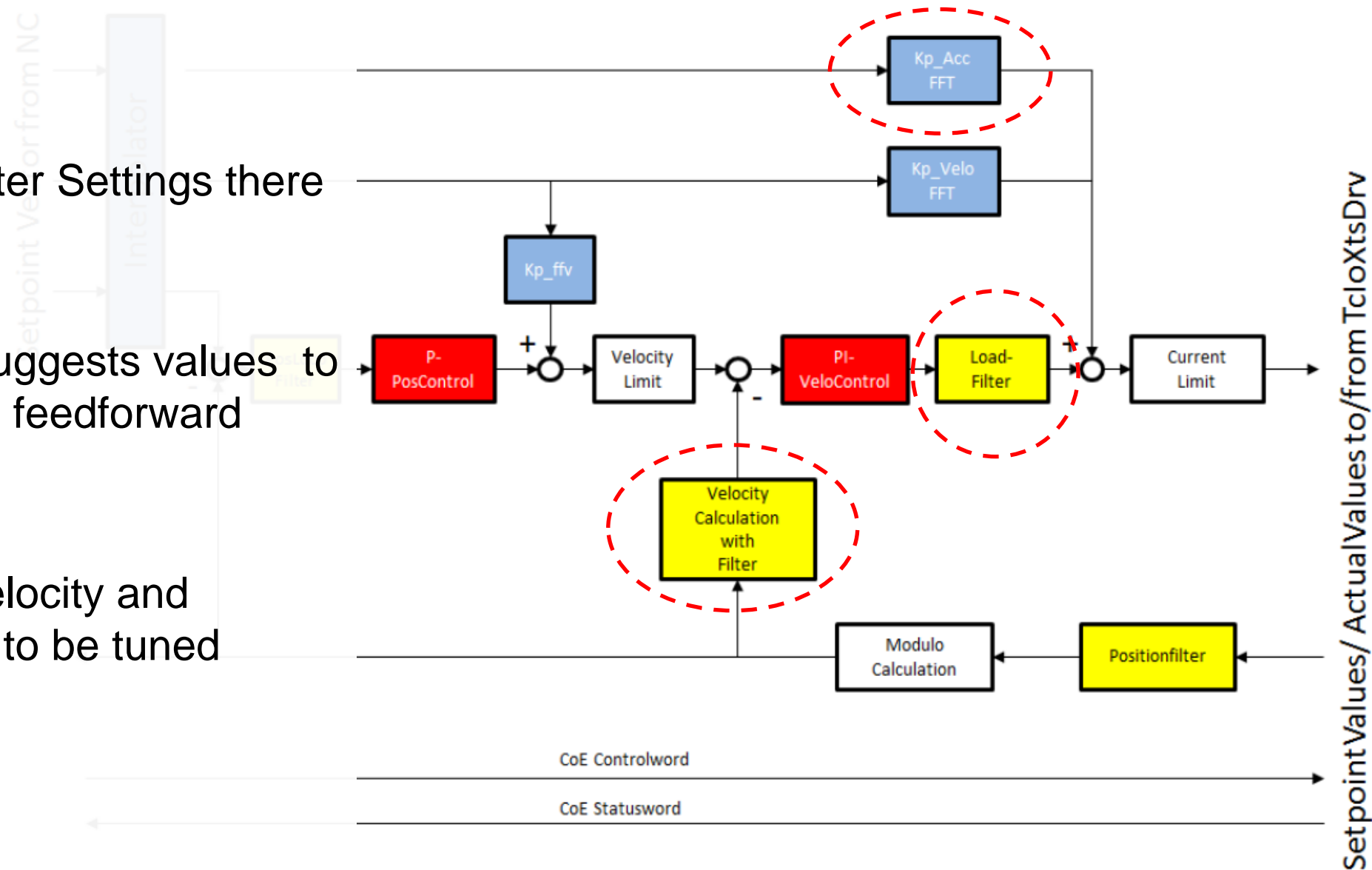
■ Tuning Sequence

1. Setup Filter Settings
 - I. on the straight section
 - II. on the curve section
2. Setup Velocity-Control
 - I. on the straight section
 - II. on the curve section
3. Setup Position-Control
 - I. on the straight section
 - II. on the curve section



Setup Filter Settings

- To determine the Filter Settings there is a Tuning Assist
- The Tuning Assist suggests values to adjust the filters and feedforward parameters
- Typically only the Velocity and Position loops need to be tuned afterwards



Determining Filter Settings using Tuning Assist

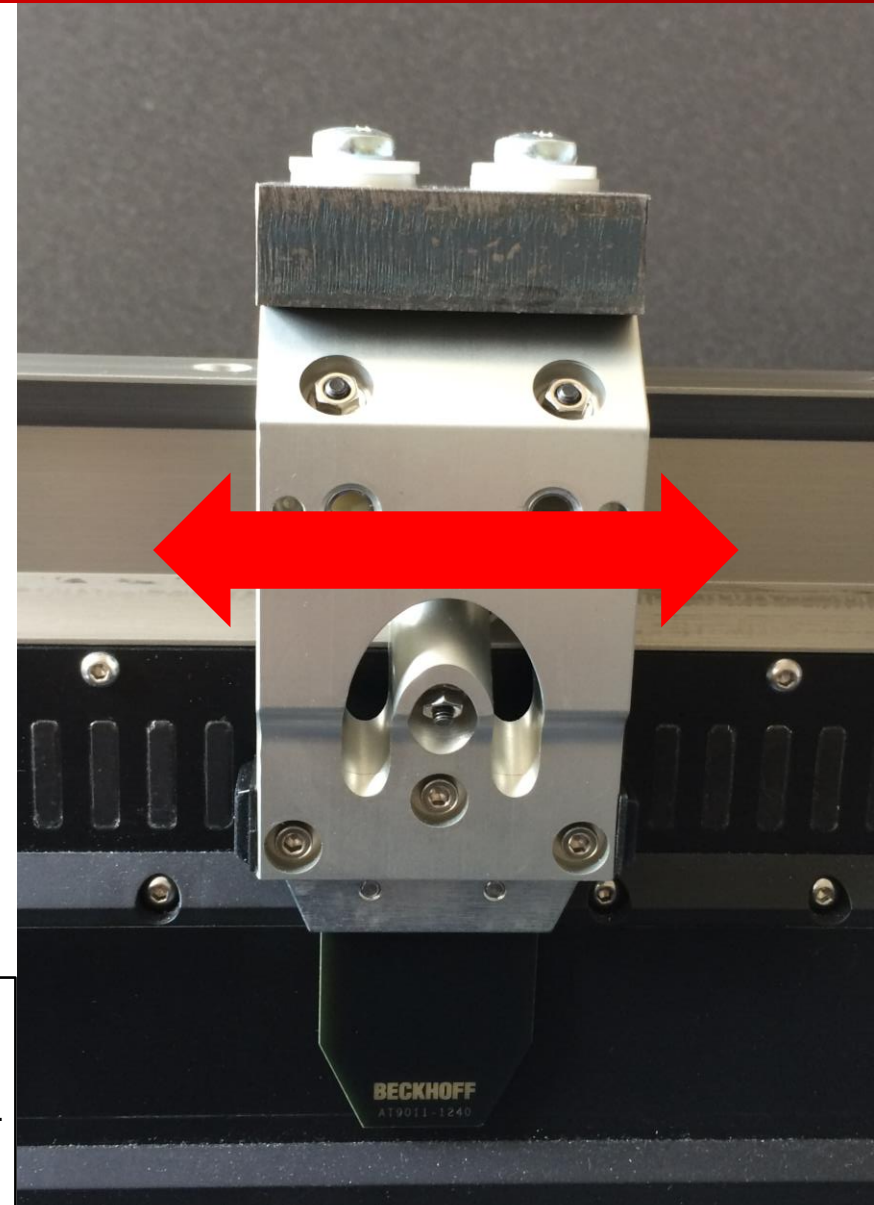
- The Tuning Assist (TA) TcCom object is added to the existing TcSoftDrive module (Version $\geq 3.10.43.0$)
- The TA function operates in torque mode and generates a short current to the mover, followed by coasting to a stop. The Mover will be driven in both positive and negative directions and two measurements will be taken.



WARNING

Risk of injury from moving movers

When the Tuning Assist function is started the mover starts to move open loop with a jump. There is a risk of injury to body parts. Keep an appropriate safety distance, and stay clear outside of the operating space.



Determining Filter Settings using Tuning Assist

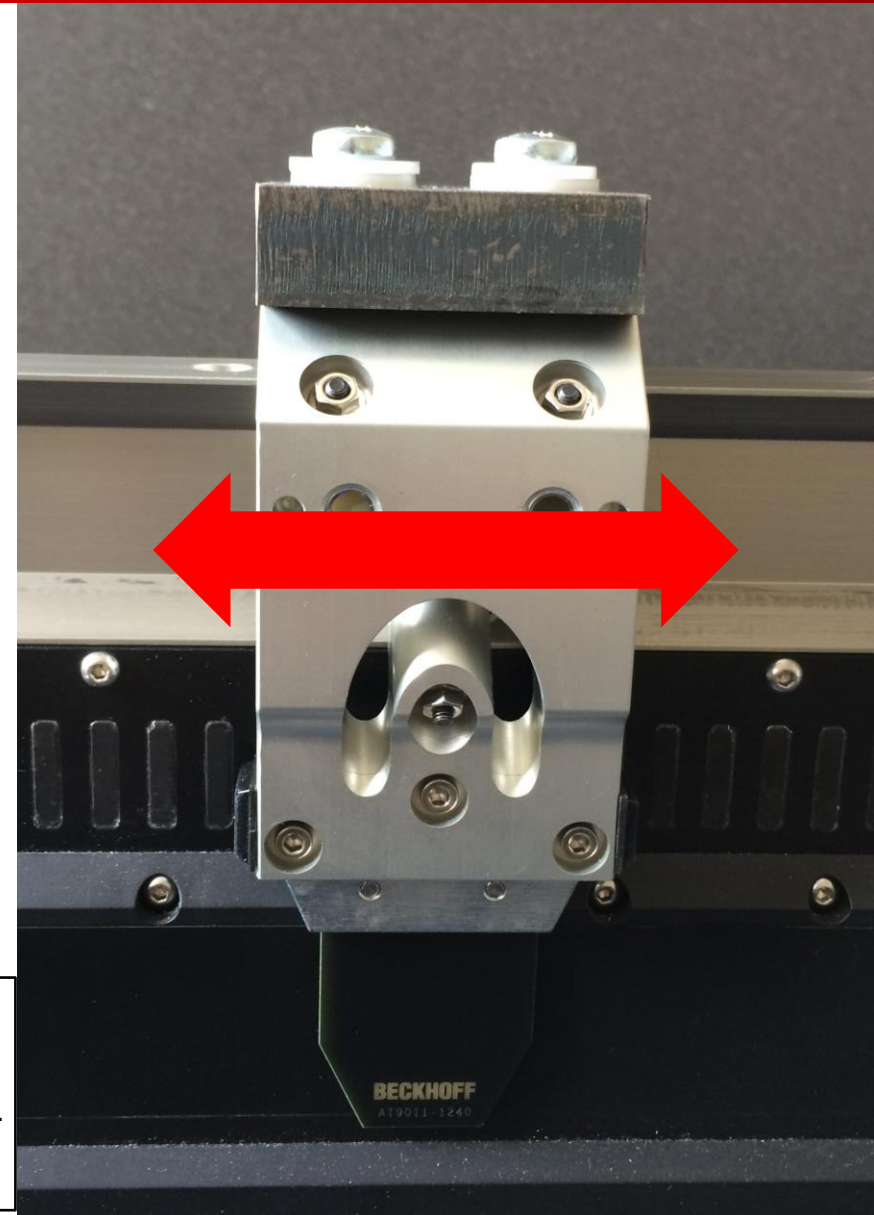
- The response of the system (Mover with tooling) will be measured and a Fast Fourier Transformation (FFT) is used to determine the frequency components
- The result could be visualized with the array bar chart functionality of TwinCAT 3 Scope Views (Version $\geq 3.2.3136$ starting with TwinCAT 3.1.4020.14)



WARNING

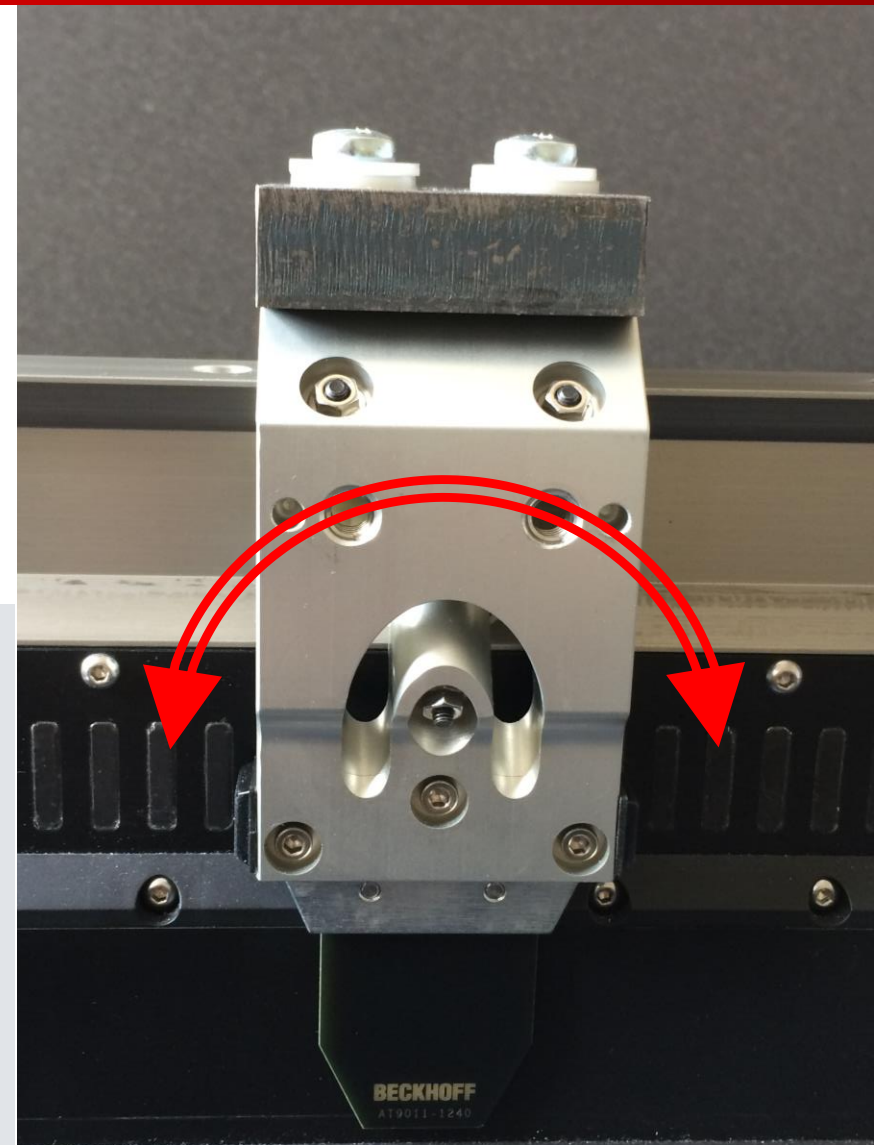
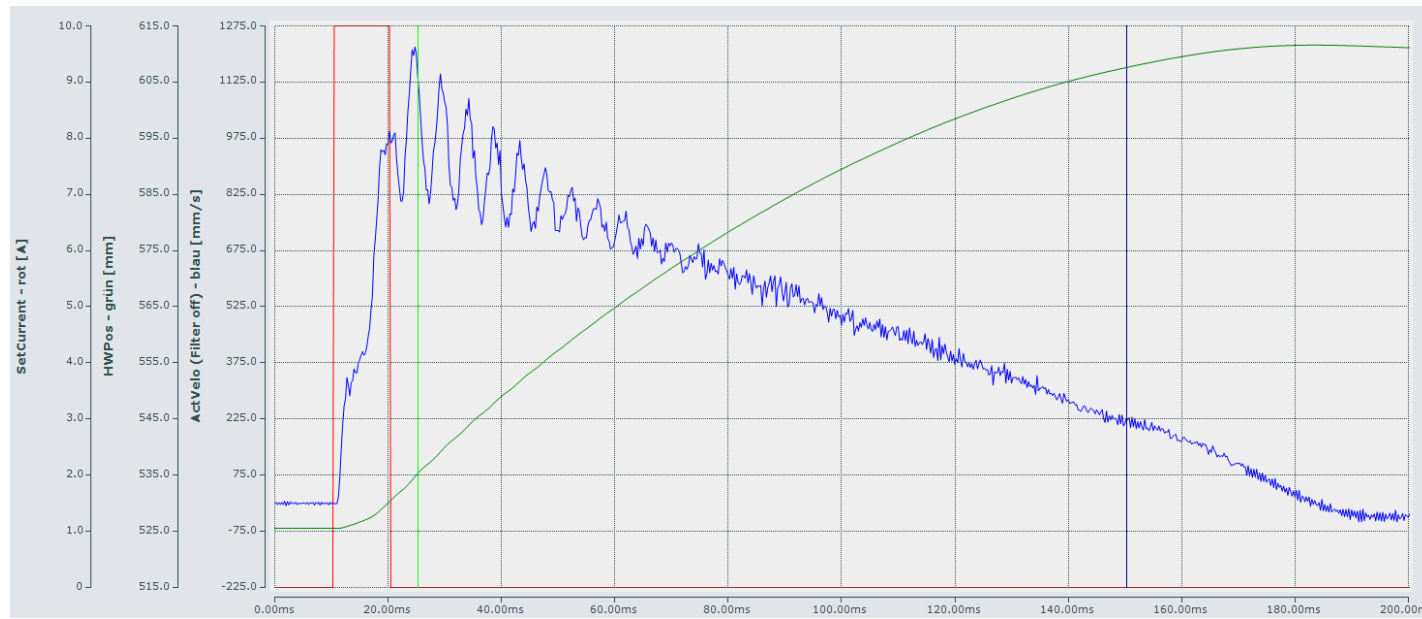
Risk of injury from moving movers

When the Tuning Assist function is started the mover starts to move open loop with a jump. There is a risk of injury to body parts. Keep an appropriate safety distance, and stay clear outside of the operating space.



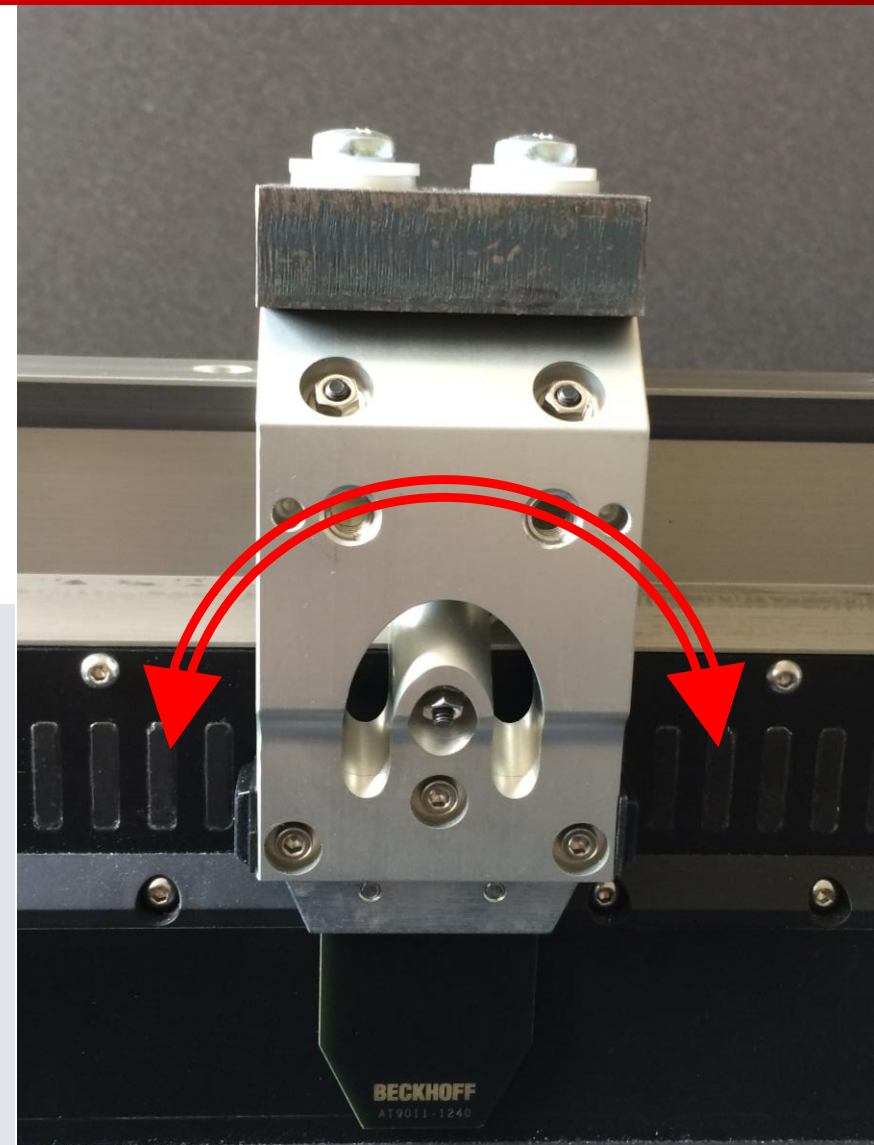
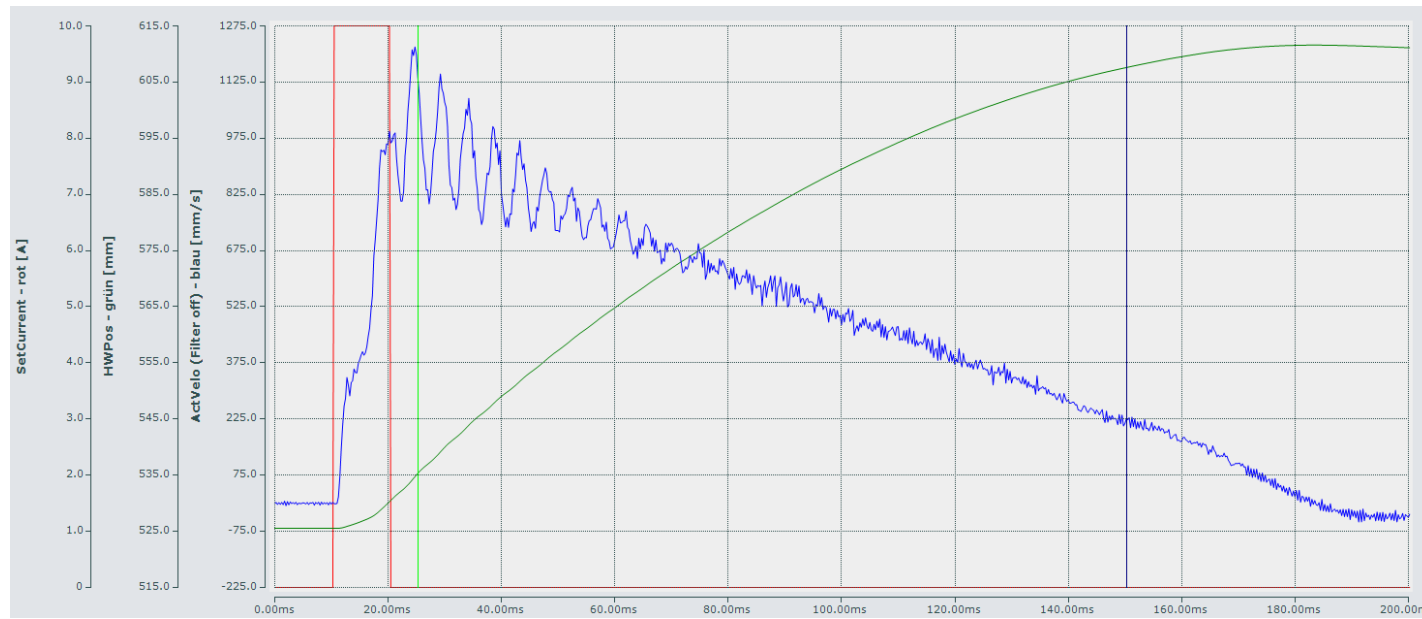
Determining Filter Settings using Tuning Assist

- The behaviour (torsional oscillation) of the mechanical system is analyzed. The normal direction of motion for the application should be used to ensure the best parameterization of the control loops for optimal motion performance.



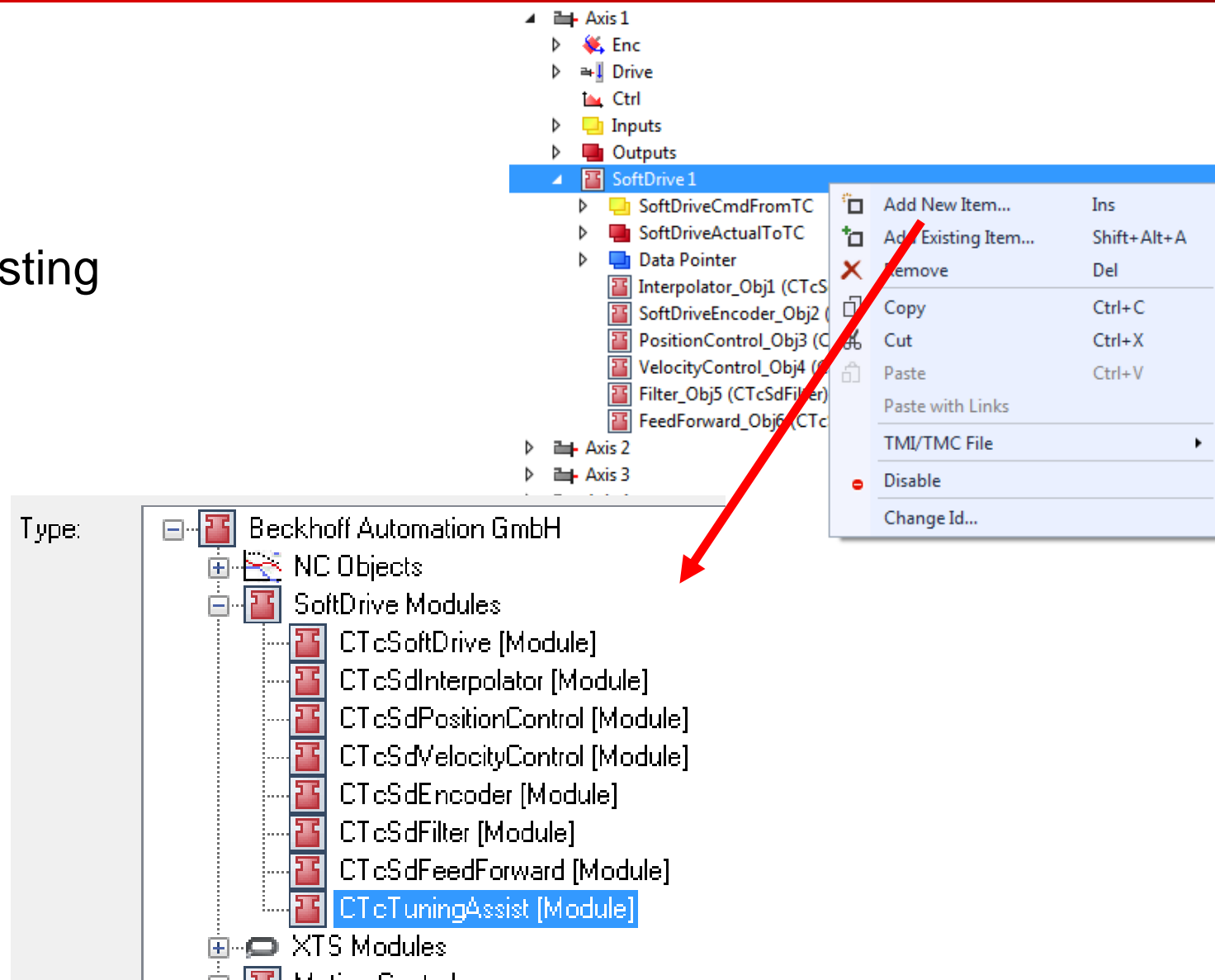
Determining Filter Settings using Tuning Assist

- The direction of torsional oscillations is shown in the picture on the right by the red double arrow
- The scope view example shows the oscillation response over time when a current is applied to the mover.



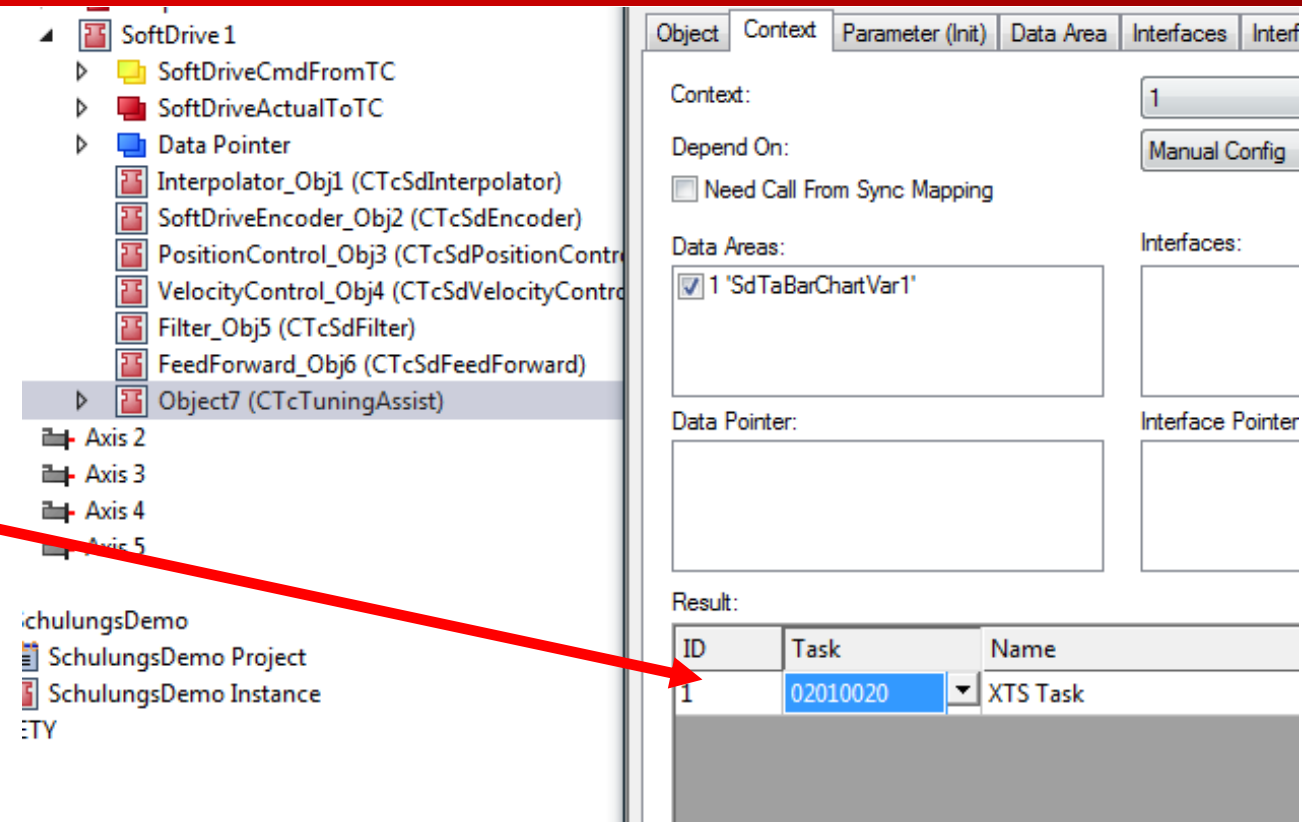
Determining Filter Settings using Tuning Assist

- Add a TuningAssist object to an existing TcSoftDrive



Determining Filter Settings using Tuning Assist

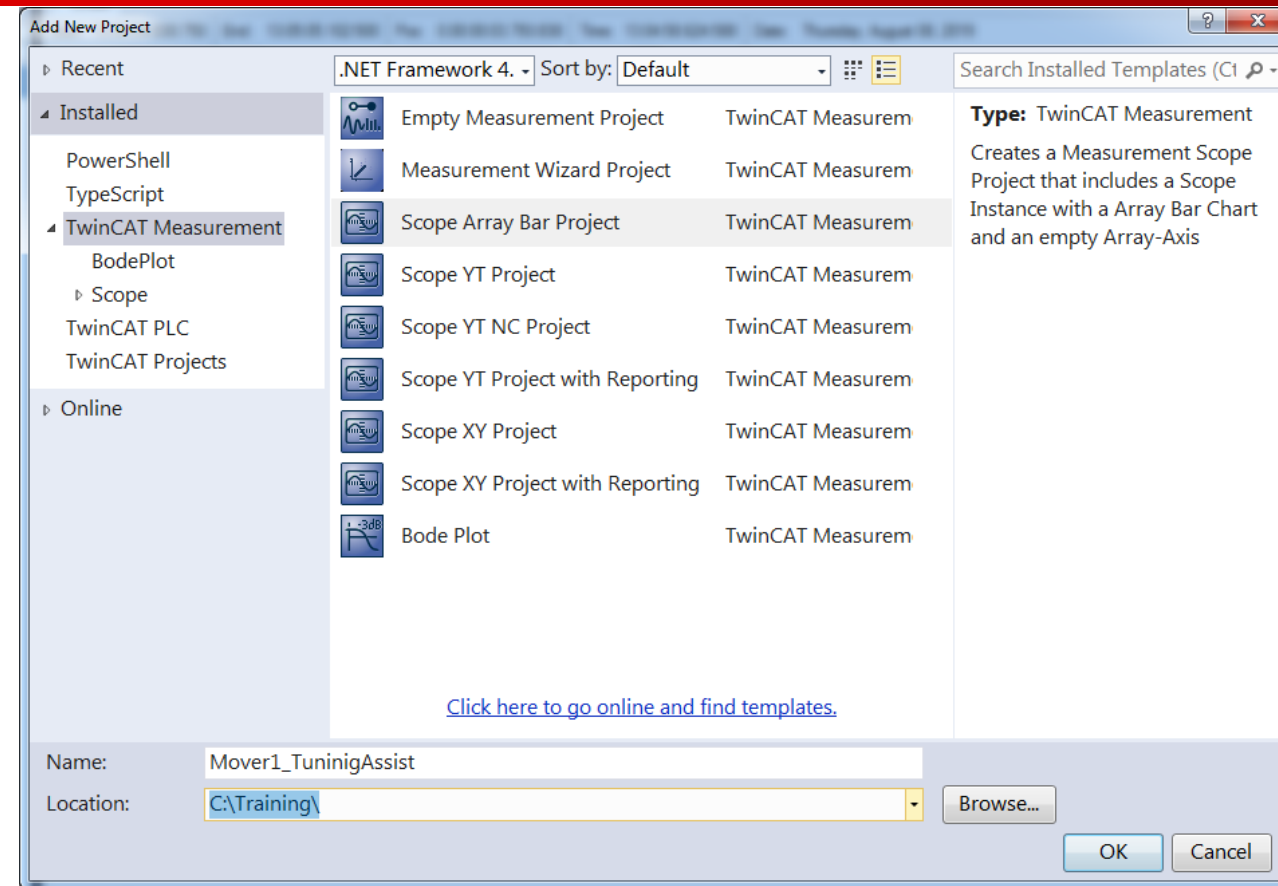
- Set the context task of the TuningAssist object to the same XTS task the TcSoftDrive is using
- Activate the configuration and restart TwinCAT



In the Tuning Assist Obj. set the TcSoftDrive automatic parameter to Mode 10 (force mode)

Determining Filter Settings using Tuning Assist

- Create a new measurement project and choose “Scope Array Bar Project” as the type



Determining Filter Settings using Tuning Assist

- Add the array variable “SdTaBarChartVar2” to the Scope Axis

The screenshot displays the Beckhoff Tuning Assist software interface. The top window shows the 'Solution Explorer' with the project 'Scope Array Project' selected. A context menu is open over the 'Axis' element, with the 'Add to Scope' option highlighted. The bottom window shows the 'Target Browser' with the 'Enter Filter...' dialog box. The filter path is set to 'SoftDrive 1 > Object7 (CTcSdTuningAssist) > SdTaBarChartVar1 > SdTaBarChartVar2'. The table below lists the variables found in the filter.

Name	Type	Size	Category	Full-Nam	Comment	Subiten
Mover 1	Struct	0	Mover 1			1
Mover 10	Struct	0	Mover...			1
Mover 2	Struct	0	Mover 2			1
Mover 3	Struct	0	Mover 3			1
Mover 4	Struct	0	Mover 4			1
Mover 5	Struct	0	Mover 5			1
Mover 6	Struct	0	Mover 6			1
Mover 7	Struct	0	Mover 7			1
Mover 8	Struct	0	Mover 8			1
Mover 9	Struct	0	Mover 9			1
Object1 (TdoXtsDrv)	Struct	0	Object...			11
SoftDrive 1	Struct	0	SoftDr...			1
Object7 (CTcSdTuningAssist)	Struct	0	SoftDr...			1
SdTaBarChartVar1	Struct	0	SoftDr...			1
SdTaBarChartVar2	ARRAY...	110	Array	SoftDr...	FFT spectrum	55

The 'Add to Scope' button is highlighted in the bottom right corner of the table.

Determining Filter Settings using Tuning Assist

- Set the properties of the variable “SdTaBarChartVar2”:
 - X Offset is set to 60 and
 - X Scale Factor is set to 10

The calculated frequency spectrum by the FFT is always calculated from 60 Hz to 600 Hz in 10 Hz steps

The screenshot displays the Beckhoff TcSoft interface. On the left, the **Solution Explorer** shows a project structure for 'Scope_Mover1'. The 'SdTaBarChartVar2' variable is highlighted under the 'Array Bar Chart' node. On the right, the **Properties** window for 'SdTaBarChartVar2' is open, showing various configuration settings. The 'Common' section includes 'Enabled' (True), 'Name' (SdTaBarChartVar2), and 'Visible' (True). The 'Index-Scaling' section shows 'Display Index Max' (600), 'Display Index Min' (60), 'Offset' (60), and 'Scalefactor' (10). The 'Line' section includes 'Antialias' (True), 'Graph Type' (Bar), and 'Line Color' (0, 128, 0). The 'Marks' section includes 'Mark Color' (0, 128, 0), 'Mark Size' (2), and 'Mark State' (Auto). The 'Min/Max' section includes 'Show Max' (False) and 'Show Min' (False). The 'Y-Data' section includes 'Acquisition' (SdTaBarChartVar2) and 'Bitmask' (0xFFFFFFFFFFFFFFFF).

Section	Property	Value
Common	Enabled	True
	Name	SdTaBarChartVar2
	Visible	True
Index-Scaling	Display Index Max	600
	Display Index Min	60
	Offset	60
	Scalefactor	10
Line	Antialias	True
	Graph Type	Bar
	Line Color	0, 128, 0
Marks	Mark Color	0, 128, 0
	Mark Size	2
	Mark State	Auto
Min/Max	Show Max	False
	Show Min	False
Y-Data	Acquisition	SdTaBarChartVar2
	Bitmask	0xFFFFFFFFFFFFFFFF

Setup Position Lag Monitoring

- Set the following error monitoring to a high value e.g. 500mm (or disable it)

The screenshot displays the Beckhoff XTS Tuning Assist software interface. At the top, a tree view shows the project structure under 'Axes' > 'Mover Axis 1', including components like Enc, Drive, Ctrl, Inputs, Outputs, SoftDrive 1, and Data Pointer. Below this, the 'First_XTS_Project' window is open, showing the 'Parameter' tab. A table lists various parameters with their offline and online values. The 'Monitoring' section is expanded, showing 'Position Lag Monitoring' set to 'TRUE' and 'Maximum Position Lag Value' set to '500.0'.

Parameter	Offline Value	Online Value
Maximum Dynamics:		
Default Dynamics:		
Manual Motion and Homing:		
Fast Axis Stop:		
Limit Switches:		
Monitoring:		
Position Lag Monitoring	TRUE	TRUE
Maximum Position Lag Value	500.0	500.0
Maximum Position Lag Filter Time	0.02	0.02

Determining Filter Settings using Tuning Assist

- Process control is done by OnlineWrite and OnlineRead to the parameter “TuningProcess”
- The Online-Value shows the actual state of the “TuningProcess”

First_XTS_Project

Object Context Parameter (Init) Data Area Interfaces Interface Pointer

	Name	Value	PV	CS	Unit	Type	P...	C
-	General							
	TuningType	METHODE1		<input type="checkbox"/>		Tunin...	0...	
	TuningProcess	START_MEASURE		<input type="checkbox"/>		Tunin...	0...	
	Suggested_KpAccFFT	0.0			As^2...	LREAL	0...	
	Suggested_VeloFilterBandwidth	0.0			Hz	LREAL	0...	
-	Suggested_LoadFilter	...					0...	
	.Type	BIQUAD				DINT		
	.Usage	ALWAYS				DINT		
	.LowPassFrequency	0.0						
	.LowPassDamping	0.0						
	.HighPassFrequency	0.0						
	.HighPassDamping	0.0						
	Suggested_Friction_Compensati...	0.0						

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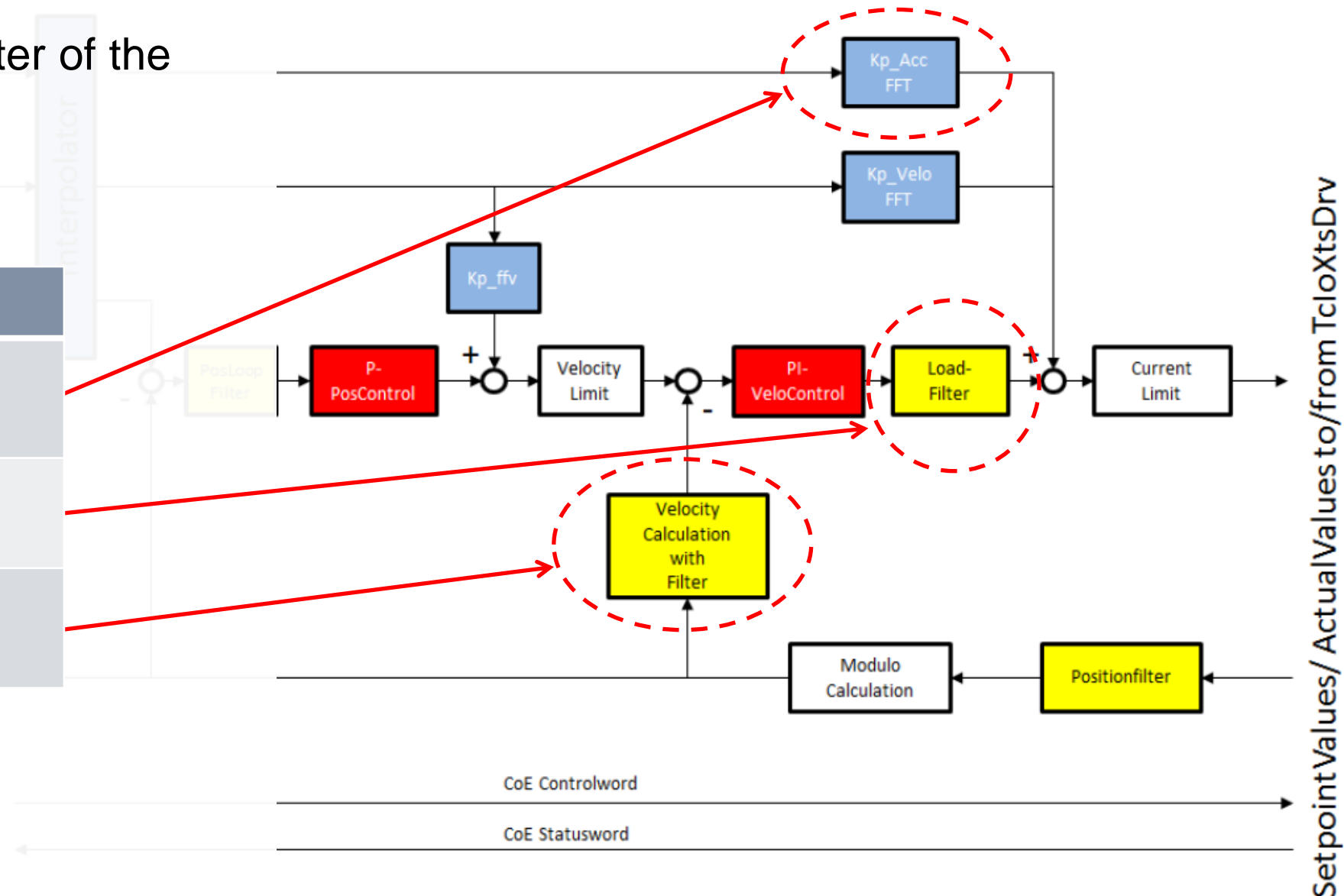
TuningProcess Settings:
 TUNING_ASSIST_OFF
 START_MEASURE
 TUNING_ASSIST_ERROR
 BUSY_MEASURE
 DONE_MEASURE
 BUSY_SPEC_CALC1
 BUSY_SPEC_CALC2
 DONE_SPEC_CALC
 DONE_FILTER_CALC
 DONE_FRICTION_CALC
 ERROR_FRICTION_CALC

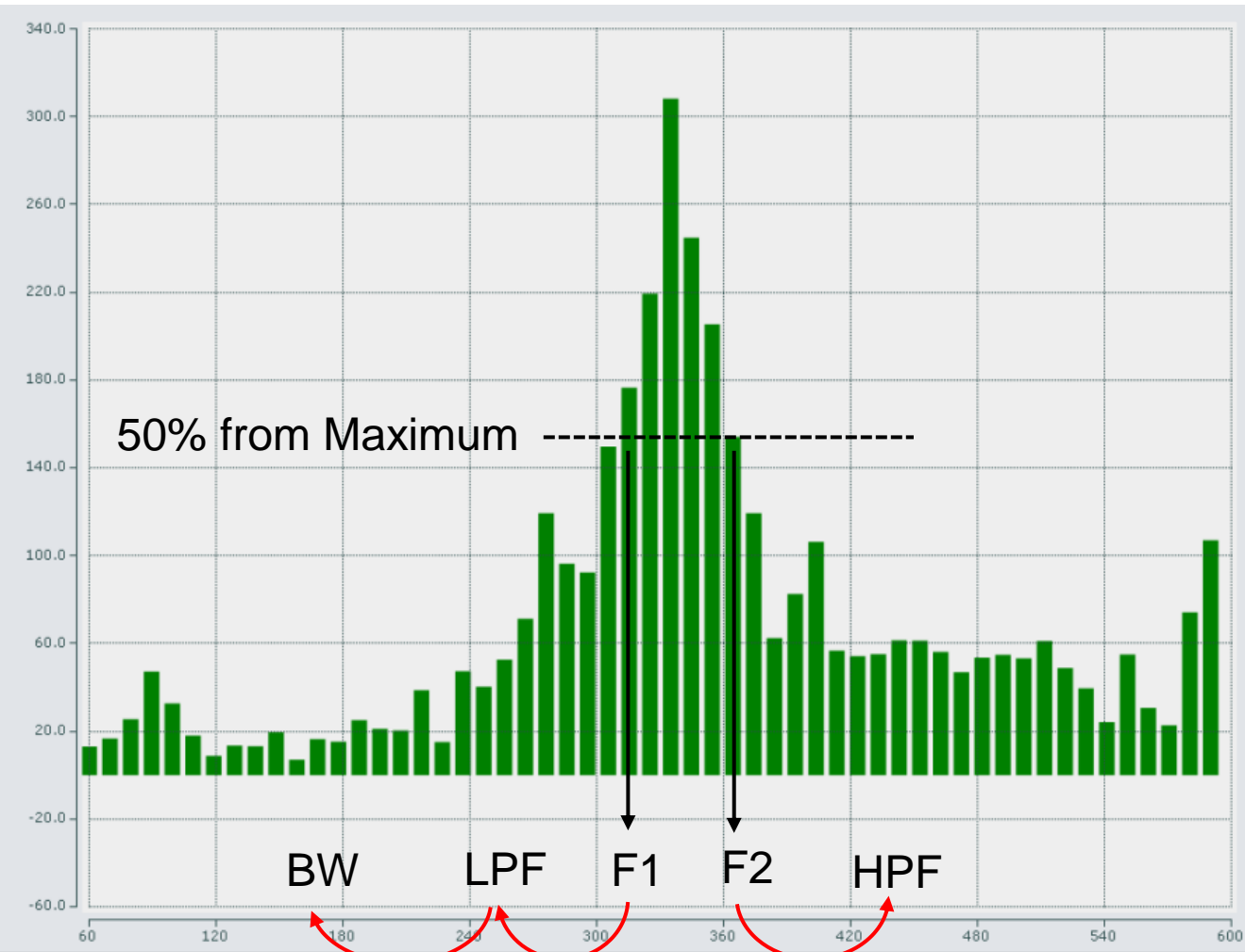
- The Tuning Assist object contain seven parameter

Parameter	Description
Tuning Type	Set the type of calculation – “Method1” measurement in move direction “Source2” measurement across move direction
Tuning Process	Status and control of the tuning assist procedure; set a new state with an “Online Write” access on this parameter and get the current state with an “Online Read” access on this parameter
Suggested_KpAccFFT	Suggestion for the acceleration feedforward gain “KpAccFFT” inside FeedForward_Obj6 after the complete tuning assist procedure was successful executed
Suggested_VeloFilterBandwidth	Suggestion for the “VelocityFilterBandwidth” inside the SoftDriveEncoder_Obj2 after the complete tuning assist procedure was successful executed
Suggested_LoadFilter	Suggestion for the load filter configuration inside the Filter_Obj5 after the complete tuning assist procedure was successful executed and this parameter was requested with an online read on this parameter
Suggested_Friction_Compensation	Suggestion for the parameter “FrictionCompensation” in Ampere, within the Feedforward object of the TcSoftDrive. To avoid following error, when changing the velocity, due to static friction
CurrentPulseTime	Set the time for the current pulse in ms. The default is 10ms but with higher load or more friction it is may necessary to increase it. The maximum possible time is 25 ms

- The Suggested parameter of the Tuning Assist

Parameter
Suggested_KpAccFFT
Suggested_LoadFilter
Suggested_VeloFilterBandwidth



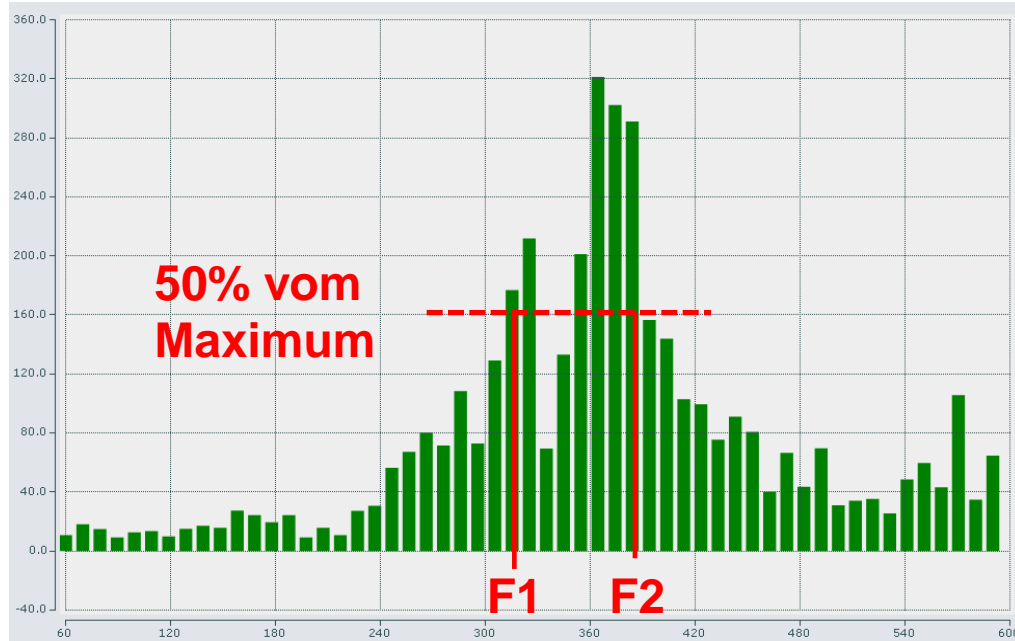


Name	Value
TraceLevelMax	tlAlways
TuningType	METHODE1
TuningProcess	DONE_FILTER_CALC
Suggested_KpAccFFT	1.6
Suggested_VeloFilterBandwidth	146.0
Suggested_LoadFilter	...
.Type	BIQUAD
.Usage	ALWAYS
.LowPassFrequency	256.0
.LowPassDamping	0.6
.HighPassFrequency	437.0
.HighPassDamping	0.3

Result of calculation

This graphic shows how the calculation for the filter suggestion is done with one FFT result

- LPF: LowPassFrequency
- HPF: HighPassFrequency
- BW: VelocityFilterBandwidth

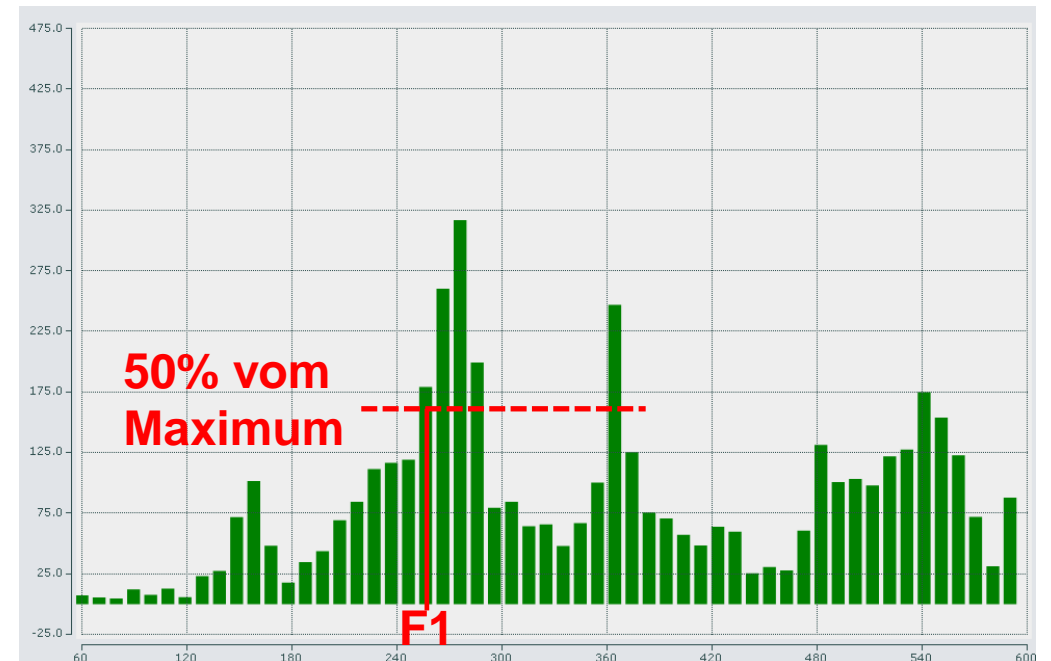


Example 1:

If the two maxima are close to each other then one Bi-Quad Filter may be used

Example 2:

If the maxima are too far apart, then a second order low pass filter is suggested

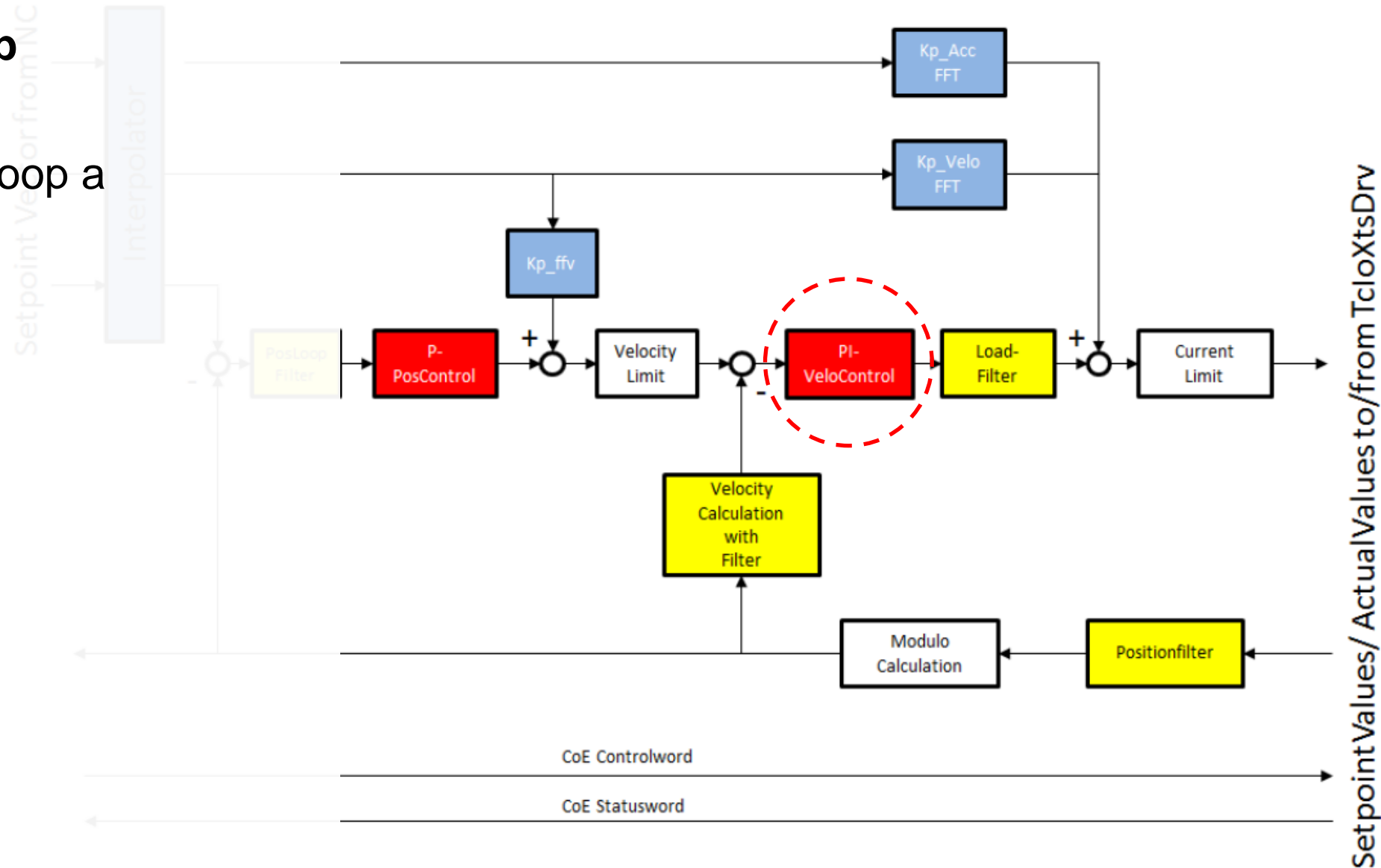


■ Steps / Tips for Tuning Assist

- Enable the NC axis first and set the following error monitoring in the corresponding NC axis to a high value e.g. 500mm (or disable it)
- Execute some more measurements e.g. three on the straight and three on the curve and maybe also with / without product on the mover
- Analyze the spectrum manually as well and try to categorize the FFT with the given examples by yourself
- Notice the parameter suggestions and try to combine the filter settings
 - Use lowest value for “Suggested_VeloFilterBandwidth
 - Use lowest value for “Suggested_KpAccFFT” from a straight measurement
 - Use LowpassFilter2 if both filter types are suggested (Lowpass2 & Biquad)
 - Use lowest value for suggested “LowPassFrequency”
 - Use highest value for suggested “HighPassFrequency”

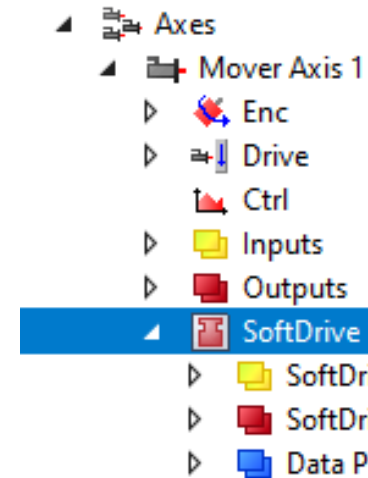
Velocity Control Loop

- For velocity control loop a “PI” – Loop is used.
- Setup Kp
- Setup Tn



Velocity Control Loop

- Disable or remove the Tuning assist object (if not already done)
- Set the SoftDrive “OperationMode” parameter in the main object to 9 (cyclic synchronous velocity mode)



First_XTS_Project

Data Area	Interfaces	Interface Pointer	Data Pointer
Object	Context	Parameter (Init)	Parameter (Online)

	Name	Value	CS	Unit	Type	P	Co...	^
-	General							
	AdsPort	0x015e	<input type="checkbox"/>		W...	0.		
	HardwareModulo	3000.0	<input type="checkbox"/>		LR...	0.		
	OperationMode	9	<input type="checkbox"/>		UD...	0.		
	MaxCurrentOutput	12.0	<input type="checkbox"/>		LR...	0.		
	EmergencyRamp	10000.0	<input type="checkbox"/>		LR...	0.		
	EmergencyTimeOut	0.5	<input type="checkbox"/>		LR...	0.		
	StandstillSwitchTime	0.1	<input type="checkbox"/>		LR...	0.		

Velocity Control Loop

- Set the following error monitoring to a high value e.g. 500mm (or disable it)

The screenshot displays the Beckhoff TcSoftDrive software interface. The top panel shows a tree view of the project structure under 'Axes' > 'Mover Axis 1'. The bottom panel shows the 'Parameter' tab for 'First_XTS_Project'. The 'Monitoring' section is expanded, showing the 'Maximum Position Lag Value' set to 500.0.

Tree View:

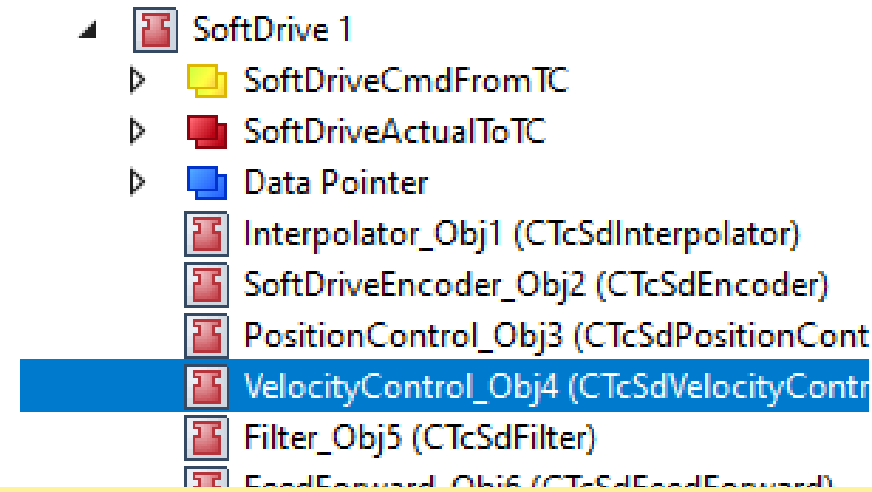
- Axes
 - Mover Axis 1
 - Enc
 - Drive
 - Ctrl
 - Inputs
 - Outputs
 - SoftDrive 1
 - SoftDriveCmdFromTC
 - SoftDriveActualToTC
 - Data Pointer

Parameter Table:

Parameter	Offline Value	Online Value
Maximum Dynamics:		
Default Dynamics:		
Manual Motion and Homing:		
Fast Axis Stop:		
Limit Switches:		
Monitoring:		
Position Lag Monitoring	TRUE	TRUE
Maximum Position Lag Value	500.0	500.0
Maximum Position Lag Filter Time	0.02	0.02












Velocity Control Loop

- Switch off the integral part of the velocity control
 - all Tn parameter set to zero



First_XTS_Project

Object	Context	Parameter (Init)	Interfaces	Interface Pointer
--------	---------	------------------	------------	-------------------

	Name	Value	CS	Unit	Type	P.	^
-	General						
	VelocityLoopType	PI_VELOCITY_STAN... 			Velo...	0..	
	Kp	0.05		As/r...	LREAL	0..	
	Kp_standstill	0.033		As/r...	LREAL	0..	
	Kp_area	0.04		As/r...	LREAL	0..	
	Kp_area_standstill	0.03		As/r...	LREAL	0..	
	Tn	0.05		s	LREAL	0..	
	Tn_standstill	0.05		s	LREAL	0..	
	Tn_area	0.05		s	LREAL	0..	
	Tn_area_standstill	0.05		s	LREAL	0..	
	Ki	0.0		s	LREAL	0..	

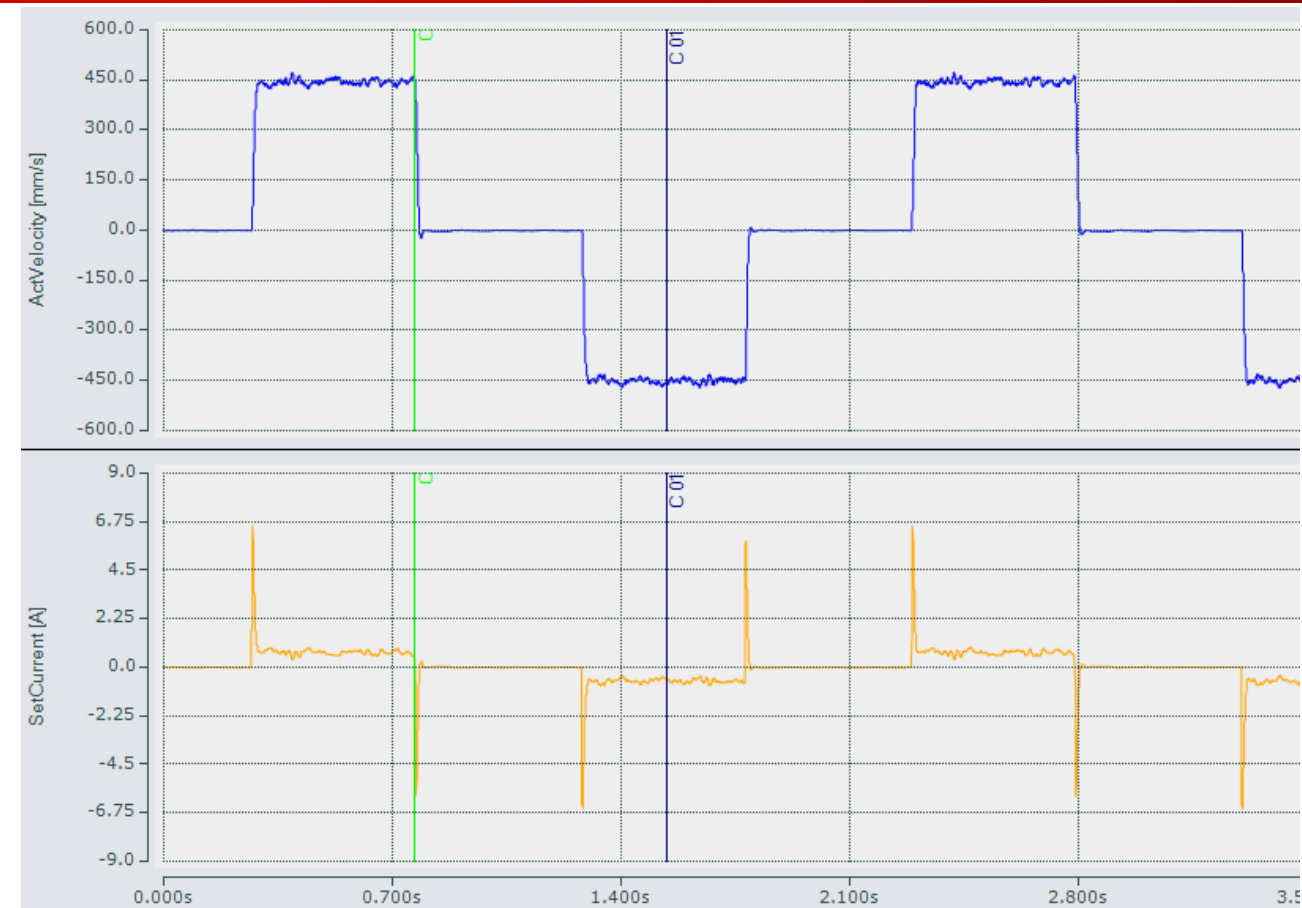
Velocity Control Loop

- Enable the NC axis and start the service mode “Velo Step Sequence”
- Scope as minimum from the corresponding SoftDrive
 - Act Velocity
 - Set Velocity
 - Set Current
- May reduce the target velocity to avoid current saturation reaching the “MaxCurrentOutput” value (12A default)

The screenshot displays the Beckhoff TcSoftDrive software interface for the 'First_XTS_Project'. The 'Axes' tree on the left shows 'Mover Axis 1' expanded, with sub-items: Enc, Drive, Ctrl, Inputs, and Outputs. The main window has tabs for General, Settings, Parameter, Dynamics, Online, Functions, Coupling, and Compensation. The 'Functions' tab is active, showing the 'Velo Step Sequence' function. A large numerical display shows '702.3531'. To the right, 'Setpoint Position: [mm]' is set to '306.8673'. The 'Extended Start' section includes fields for 'Start Mode' (set to 'Velo Step Sequence'), 'Target Velocity1' (500 mm/s), 'Target Velocity2' (-500 mm/s), 'Driving Time' (0.5 s), 'Idle Time' (0.5 s), and 'No Of Cycles' (0). 'Start' and 'Stop' buttons are present. A 'Last Time: [s]' field shows '0.00000'. A warning box at the bottom left contains a yellow triangle with an exclamation mark and the text 'WARNING'. A larger warning box on the right states: 'Risk of injury from moving movers. When the Velo Step Sequence function is started the mover starts to move open loop. There is a risk of injury to body parts. Keep an appropriate safety distance, and stay clear outside of the operating space.'

Velocity Control Loop

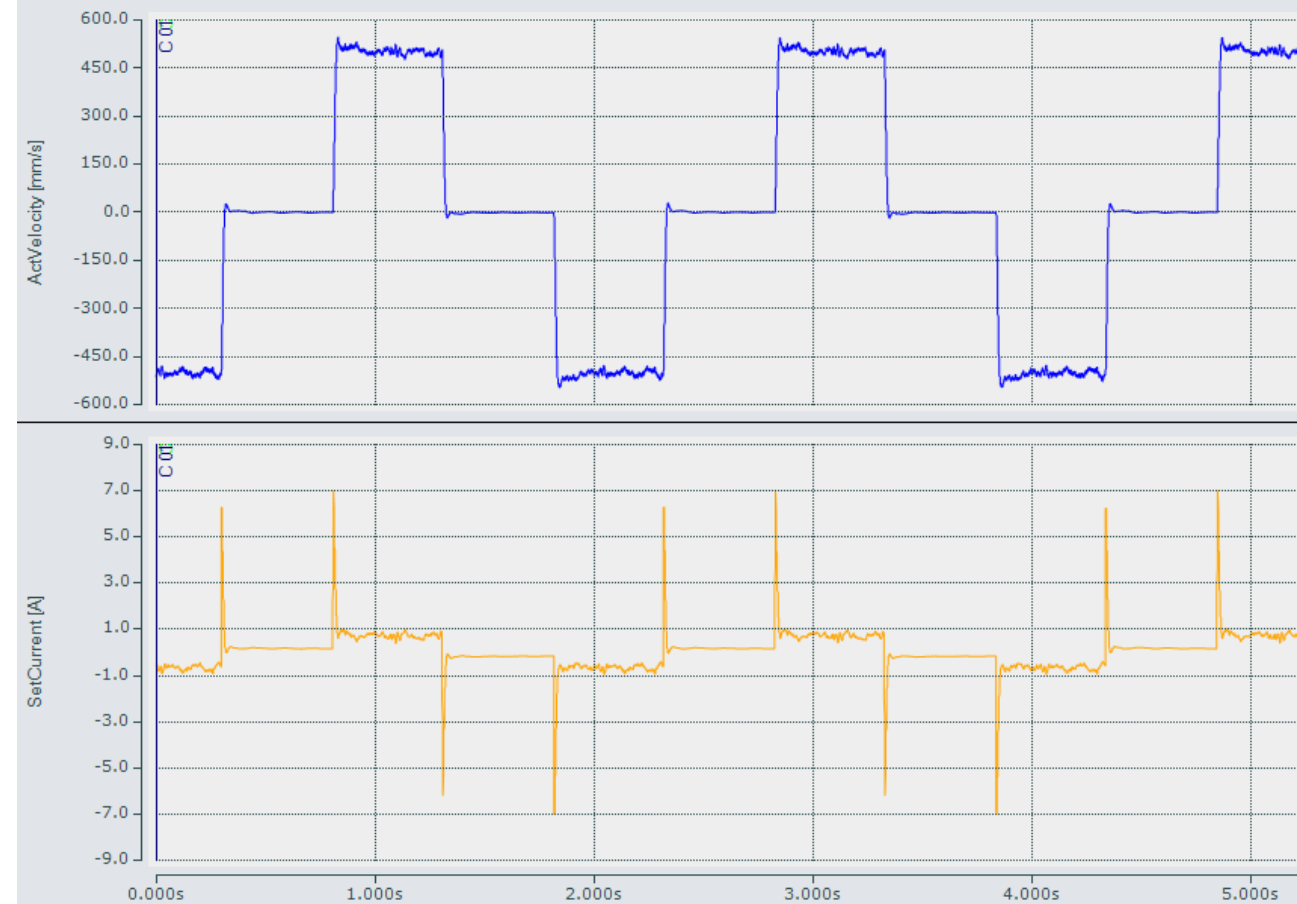
- Increase (or decrease) the velocity loop gain K_p until the actual velocity reaches
85 – 90 %
of the commanded velocity (e.g. here 500 mm/s)
- Set $K_{p_standstill}$ parameter to the same value or a bit less e.g. 75%



Set K_p to reach 90% of command velocity

Velocity Control Loop

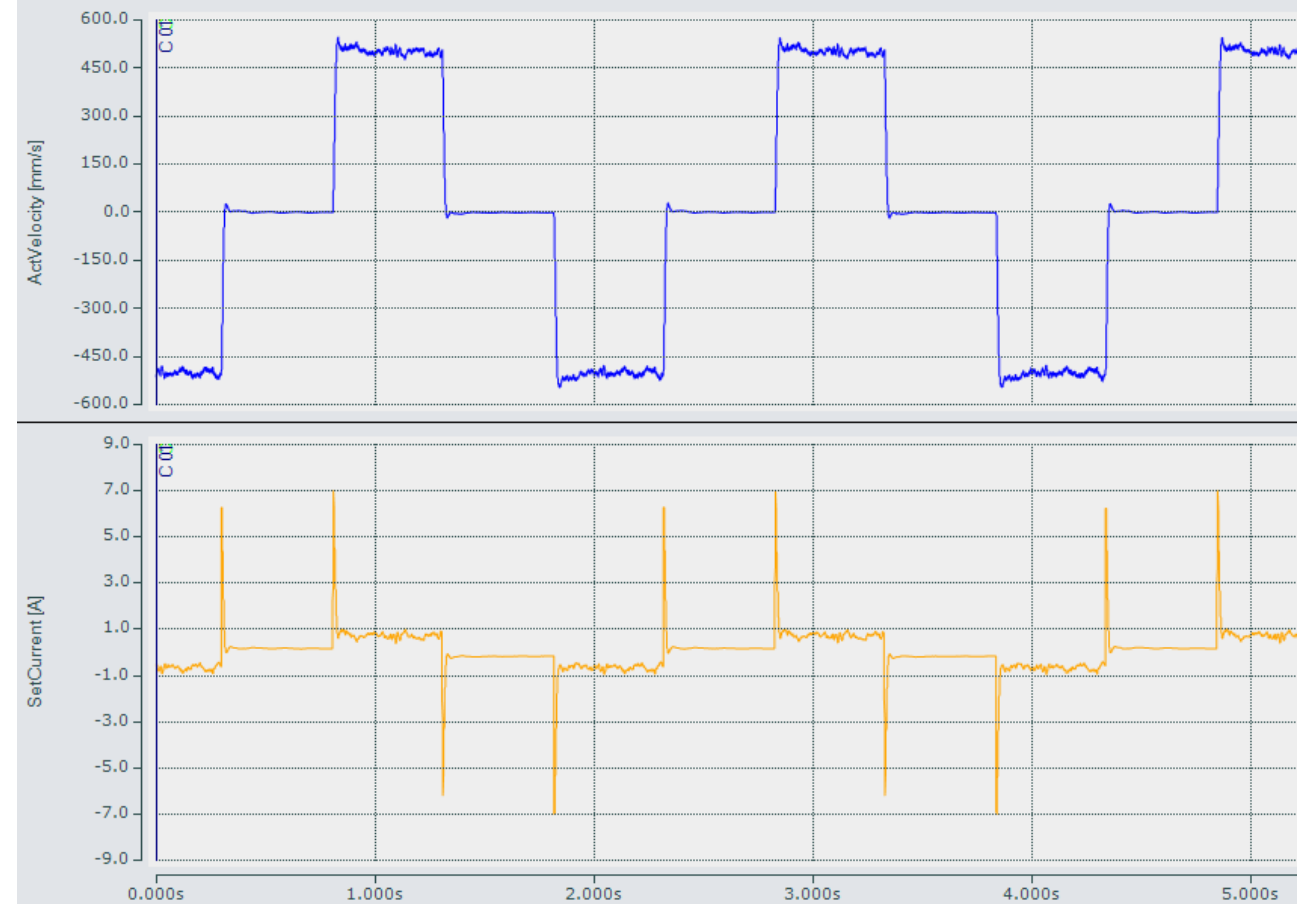
- Switch on Tn with a large time value e.g. 0.2 s and reduce this incrementally until the actual velocity has a small overshoot of 5 – 10% of the command
- Repeat procedure for the curve and use area parameters in case of differences in the straight and curve sections
- Avoid saturating the current output



Set Tn to reach 5 -10 % overshoot

Velocity Control Loop

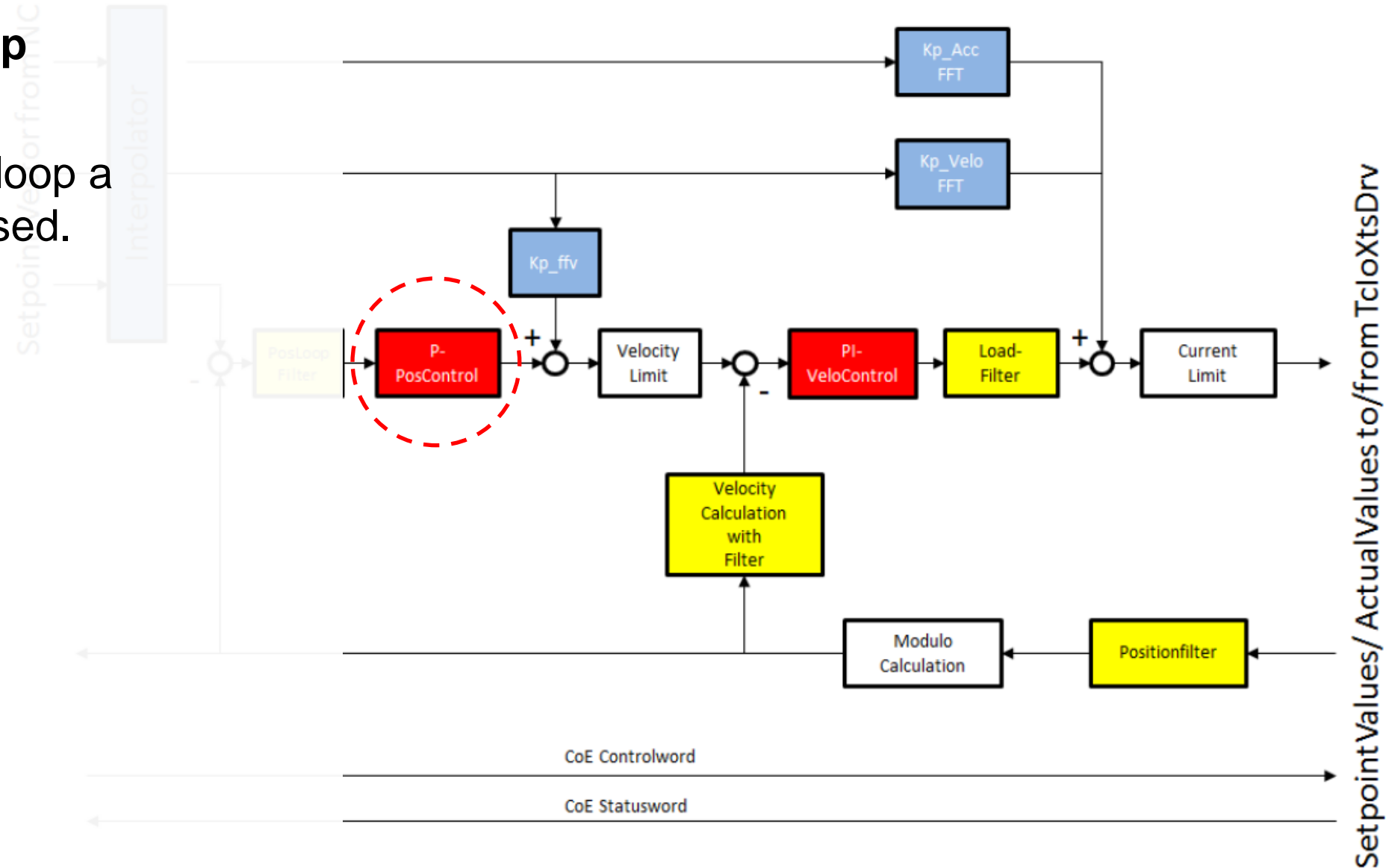
- Repeat procedure for the curve and use area parameters in case of differences in the straight and curve sections
- Avoid saturating the current output



Set Tn to reach 5 -10 % overshoot

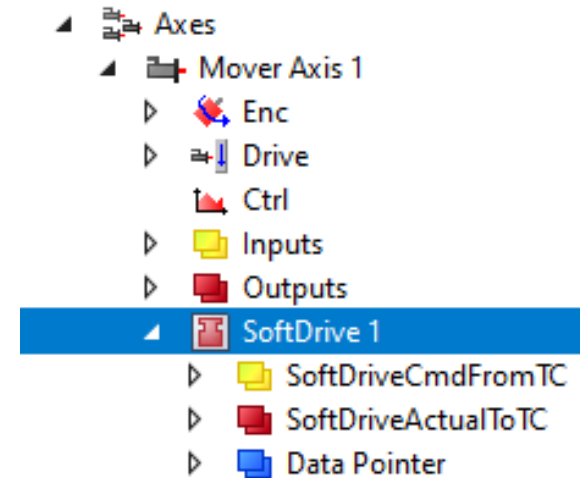
Position Control Loop

- For position control loop a “P” – Controller is used.
- Setup Kp



Position Control Loop

- Set the SoftDrive “OperationMode” parameter in the main object to 8 (cyclic synchronous position mode)



First_XTS_Project

Data Area	Interfaces	Interface Pointer	Data Pointer
Object	Context	Parameter (Init)	Parameter (Online)

	Name	Value	CS	Unit	Type	P	Co...	^
-	General							
	AdsPort	0x015e	<input type="checkbox"/>		W...	0.		
	HardwareModulo	3000.0	<input type="checkbox"/>		LR...	0.		
	OperationMode	8	<input type="checkbox"/>		UD...	0.		
	MaxCurrentOutput	12.0	<input type="checkbox"/>		LR...	0.		
	EmergencyRamp	10000.0	<input type="checkbox"/>		LR...	0.		
	EmergencyTimeOut	0.5	<input type="checkbox"/>		LR...	0.		
	StandstillSwitchTime	0.1	<input type="checkbox"/>		LR...	0.		

Position Control Loop

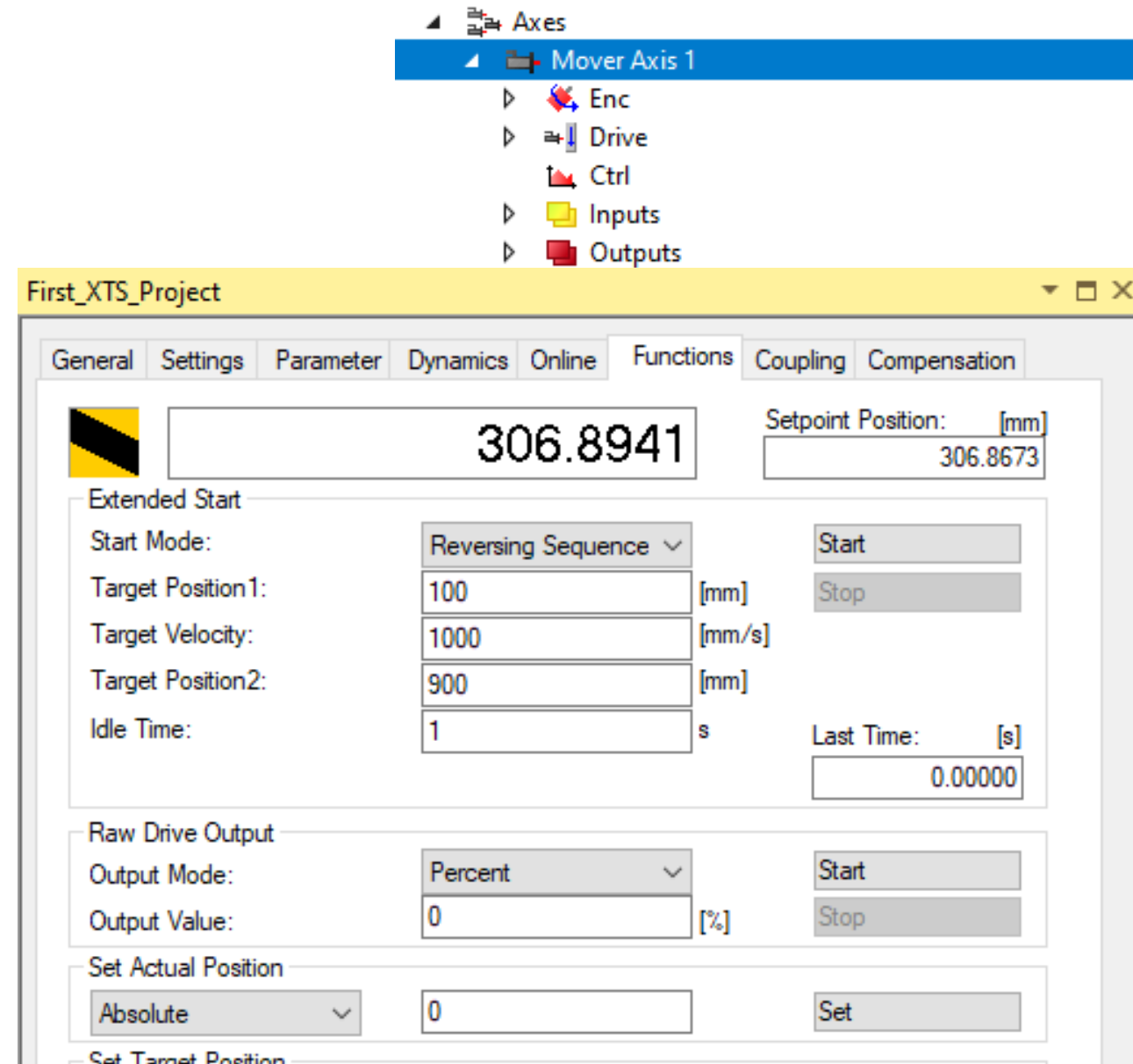
- Set the following error monitoring back to “normal” values

The screenshot displays the Beckhoff TcSoftDrive software interface. The top panel shows a tree view of the project structure, with 'Mover Axis 1' selected. Below this, the 'First_XTS_Project' window is open, showing the 'Parameter' tab. The 'Monitoring' section is expanded, and the 'Position Lag Monitoring' parameter is set to 'TRUE'. The 'Maximum Position Lag Value' is set to 10.0, and the 'Maximum Position Lag Filter Time' is set to 0.02.

Parameter	Offline Value	Online Value
Maximum Dynamics:		
Default Dynamics:		
Manual Motion and Homing:		
Fast Axis Stop:		
Limit Switches:		
Monitoring:		
Position Lag Monitoring	TRUE	TRUE
Maximum Position Lag Value	10.0	10.0
Maximum Position Lag Filter Time	0.02	0.02

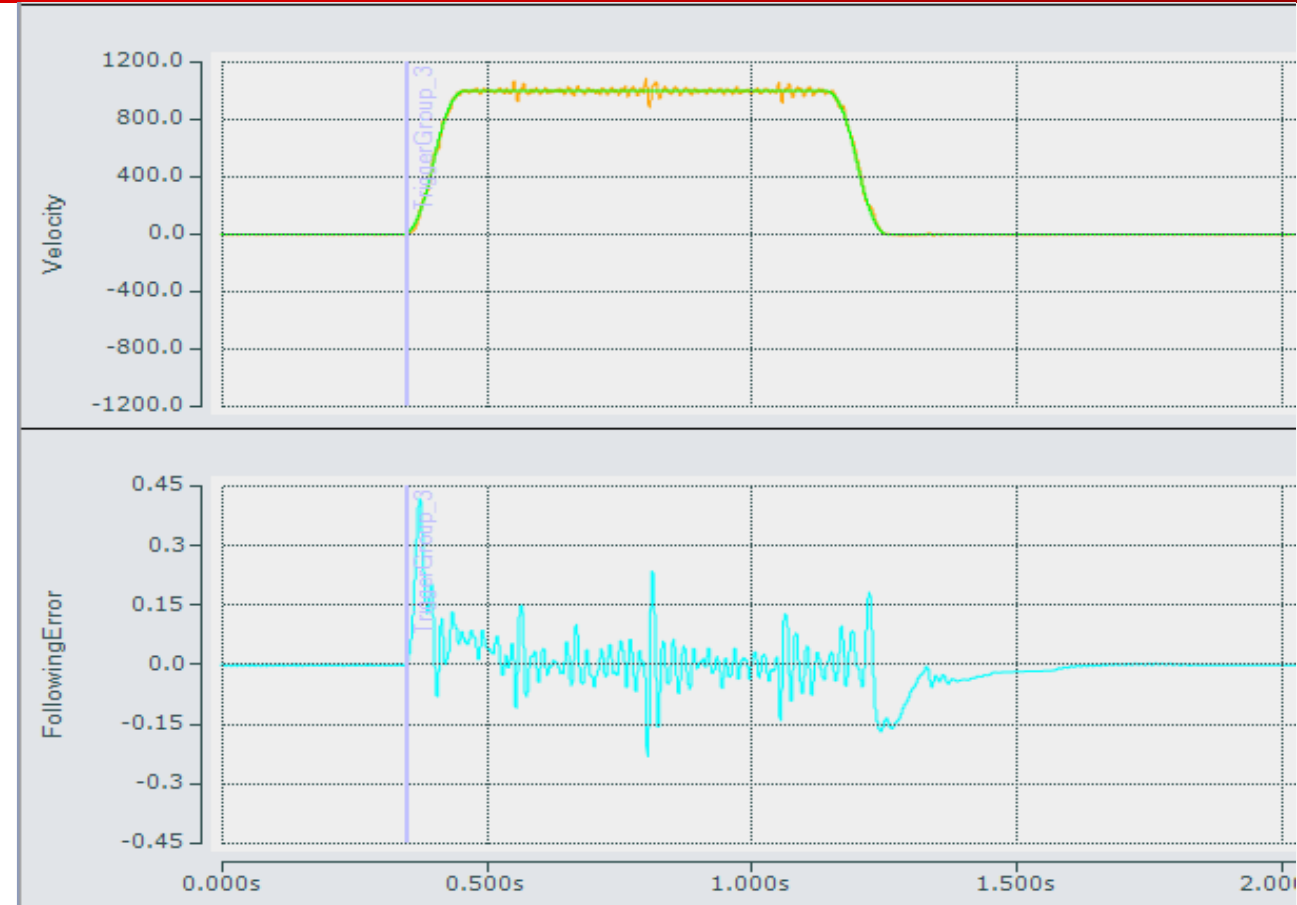
Position Control Loop

- Enable the NC axis and start the service mode “Reversing Sequence” with achievable (or necessary) values for velocity, acceleration and jerk
- Also scope the following error parameter of the SoftDrive



Position Control Loop

- Increase Kp of position loop to reduce following error as much as possible but stop before getting more noise or oscillation
- Set Kp_standstill parameter to the same value or maybe a bit less e.g. 75%
- Repeat procedure for the curve and use area parameter in case of differences in the straight and curve





**Complex sequences – simplified solution:
XTS**

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