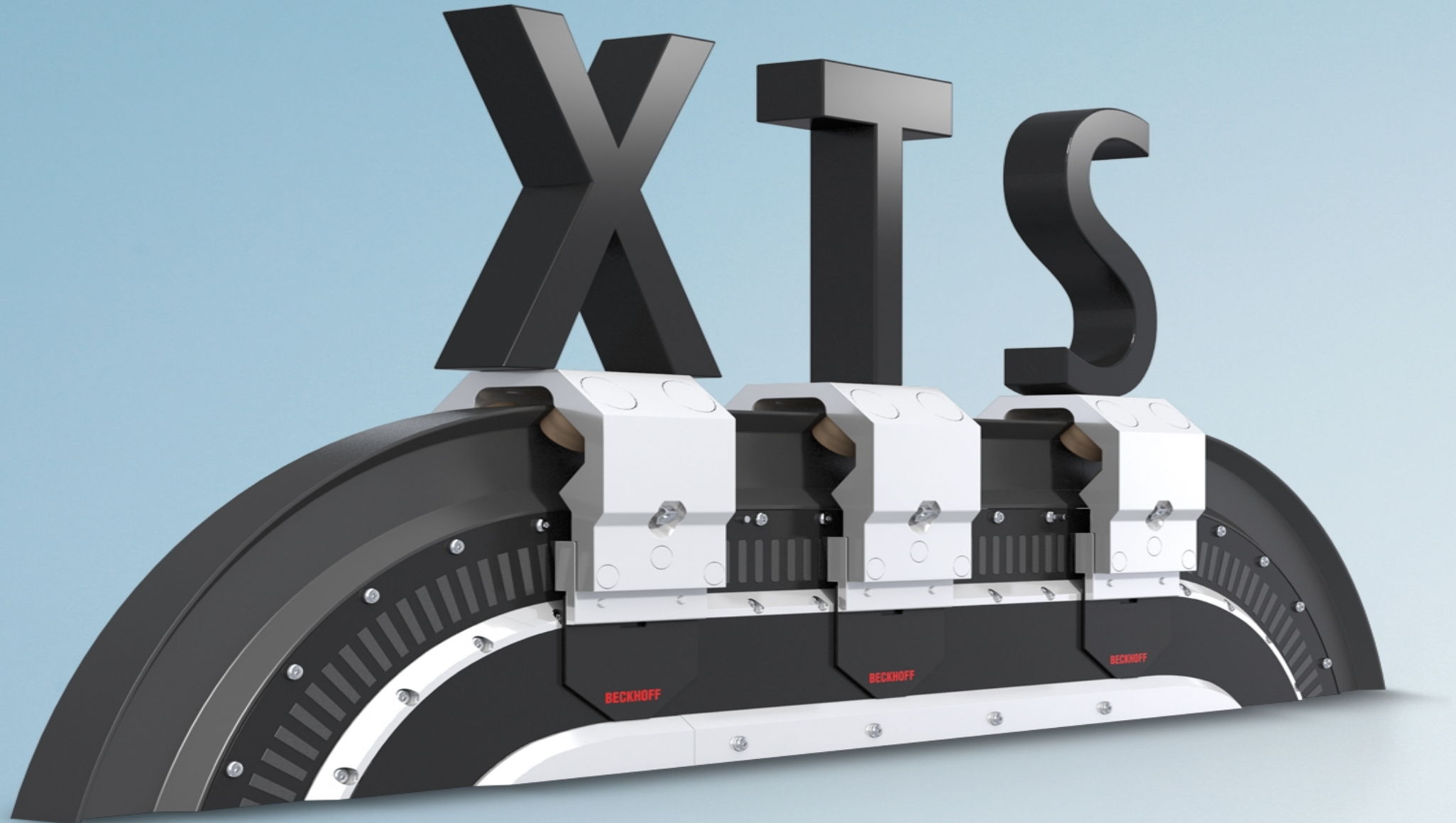


# New Automation Technology

## Beckhoff Automation

**BECKHOFF**





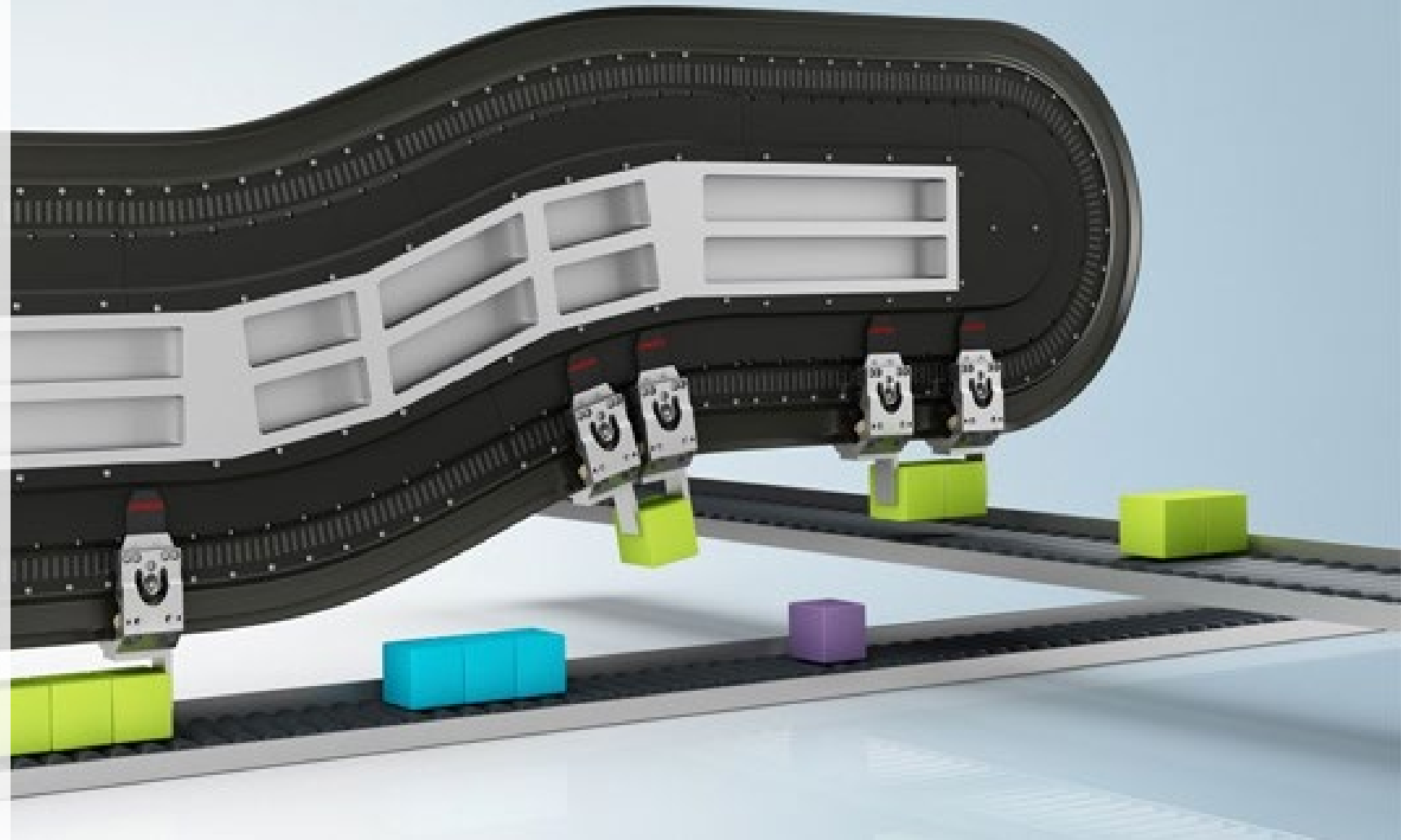
# BECKHOFF

## XTS – PLC

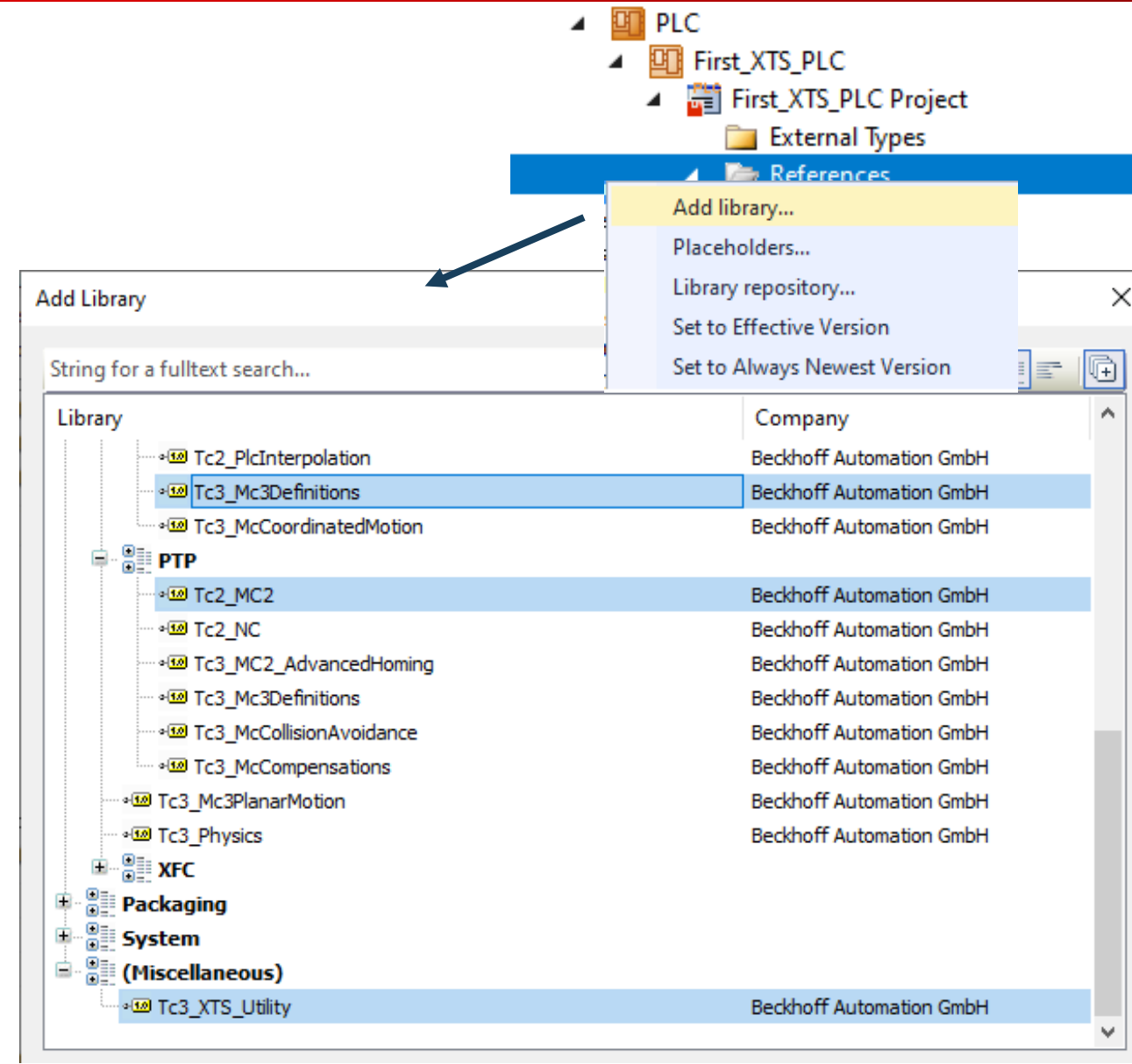




1. **PLC-Library XTS**
2. **AXIS\_REF**
3. **XTS-Utility Library**
4. **PLC StartUp Delay**
5. **Mover1 detection via PLC**
6. **Overview TF5400 Collision Avoidance (CA)**
7. **CA-Group Object**
8. **PLC-Library CA-Group**
9. **AXES\_GROUP\_REF**
10. **CA-Group handling**
11. **CA-Operation**

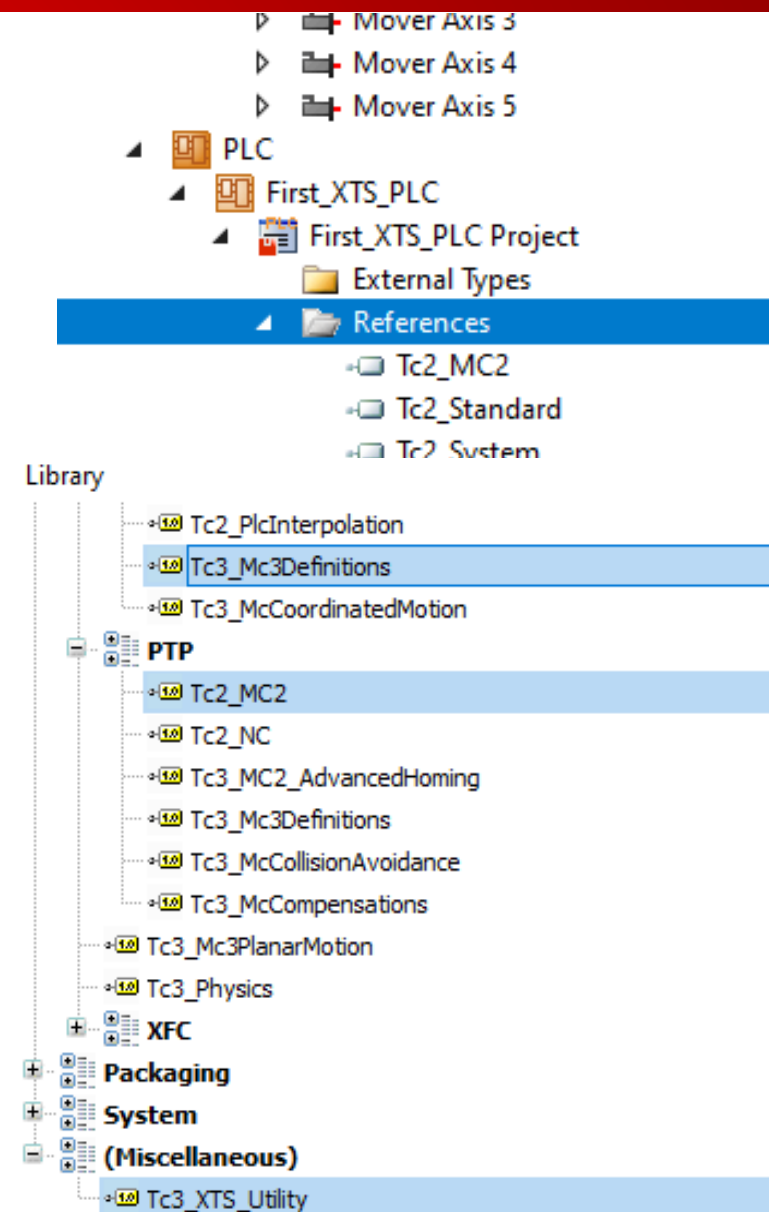


## Necessary PLC-Libraries XTS

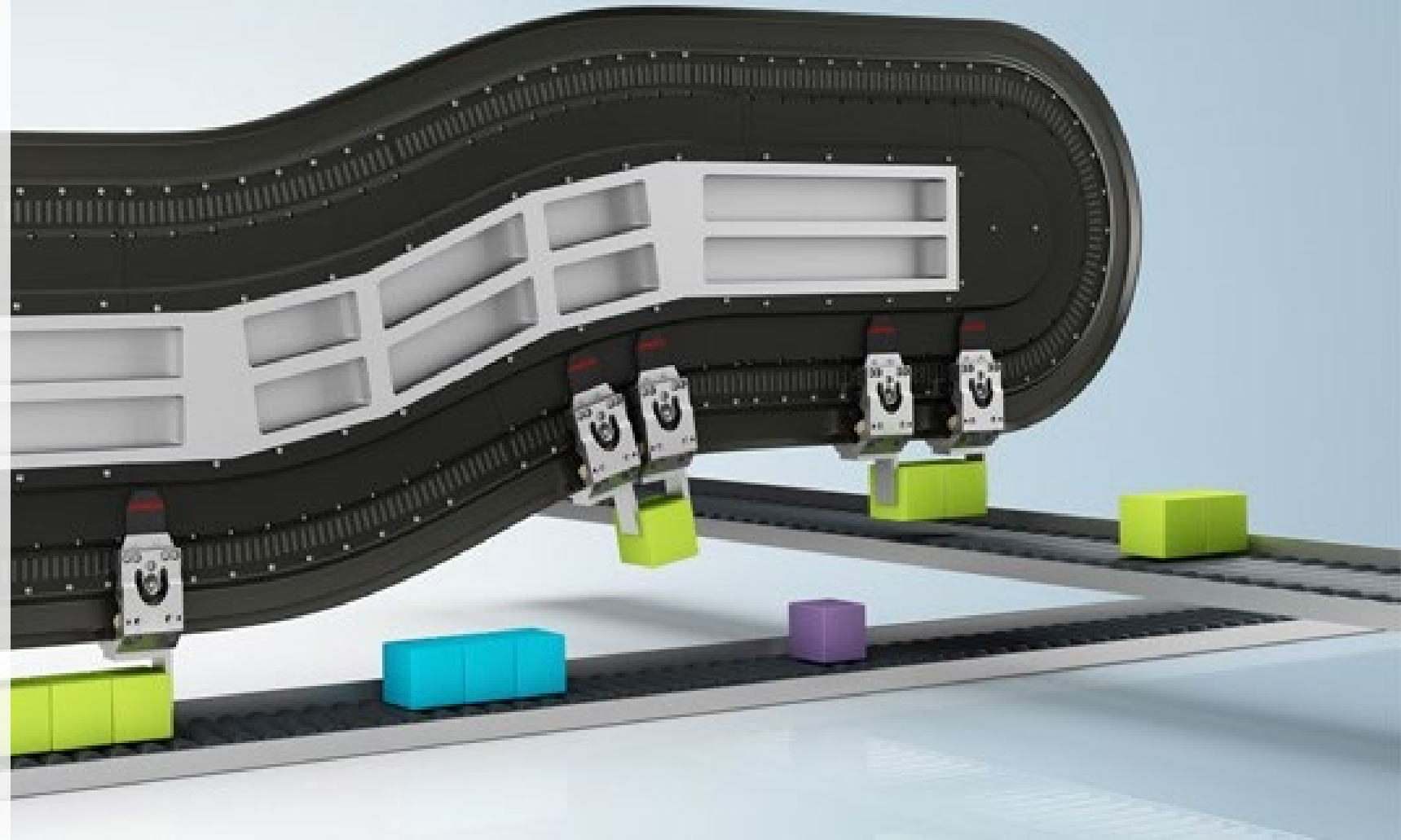


## Necessary PLC-Libraries XTS

- **Tc2\_MC2**  
Library containing PLCOpen standardized motion control function blocks
- **Tc3\_Mc3Definitions**  
Library with definition for the motion functions
- **Tc3\_XTS\_Utility**  
Library containing Diagnosis and Visualization for the XTS-System



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## ■ AXIS\_REF for linking the PLC with the Axis

### – definition of AXIS\_REF

- AXIS\_REF is an interface between the PLC and the NC. It is added to MC function blocks as axis reference.

```
VAR_GLOBAL CONSTANT
```

```
    // Number of Movers (Starting by 1)
```

```
    gciNumMovers      : INT := 5 ;
```

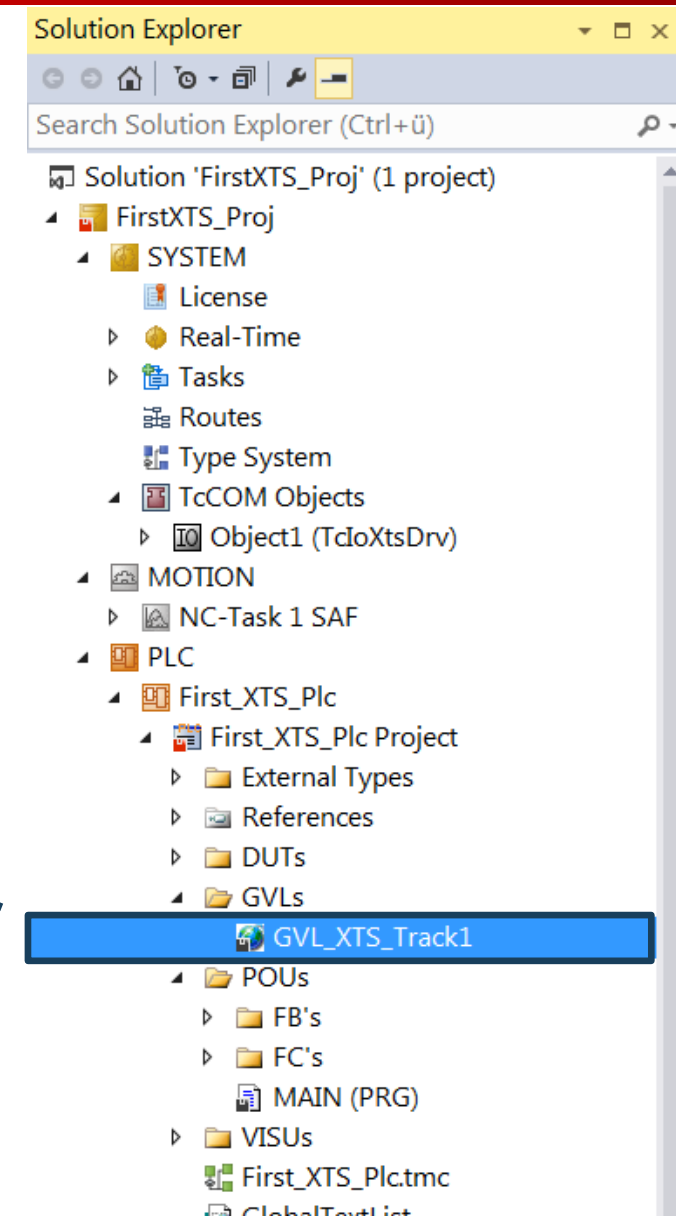
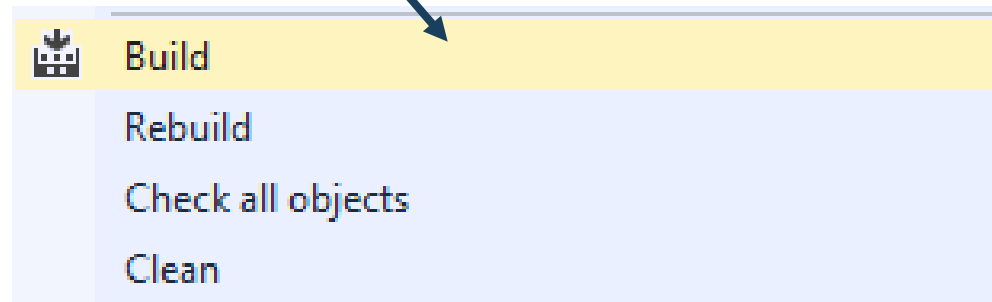
```
END_VAR
```

```
VAR_GLOBAL
```

```
    // IO-Interface to MoverModule
```

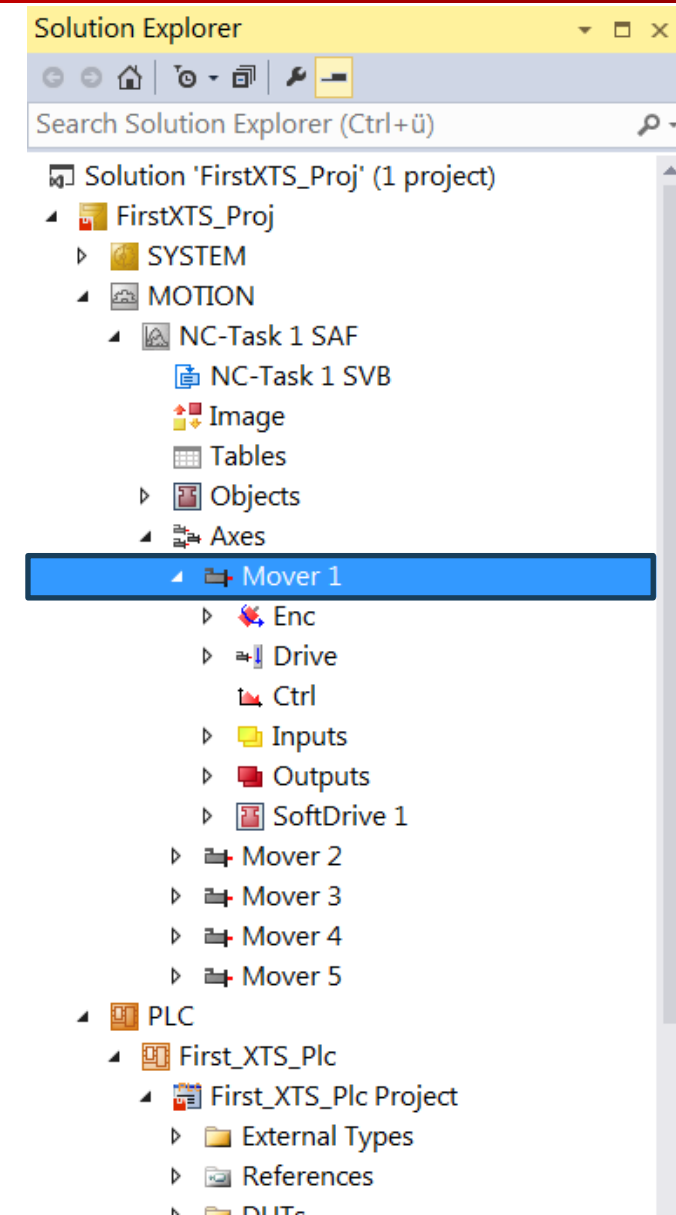
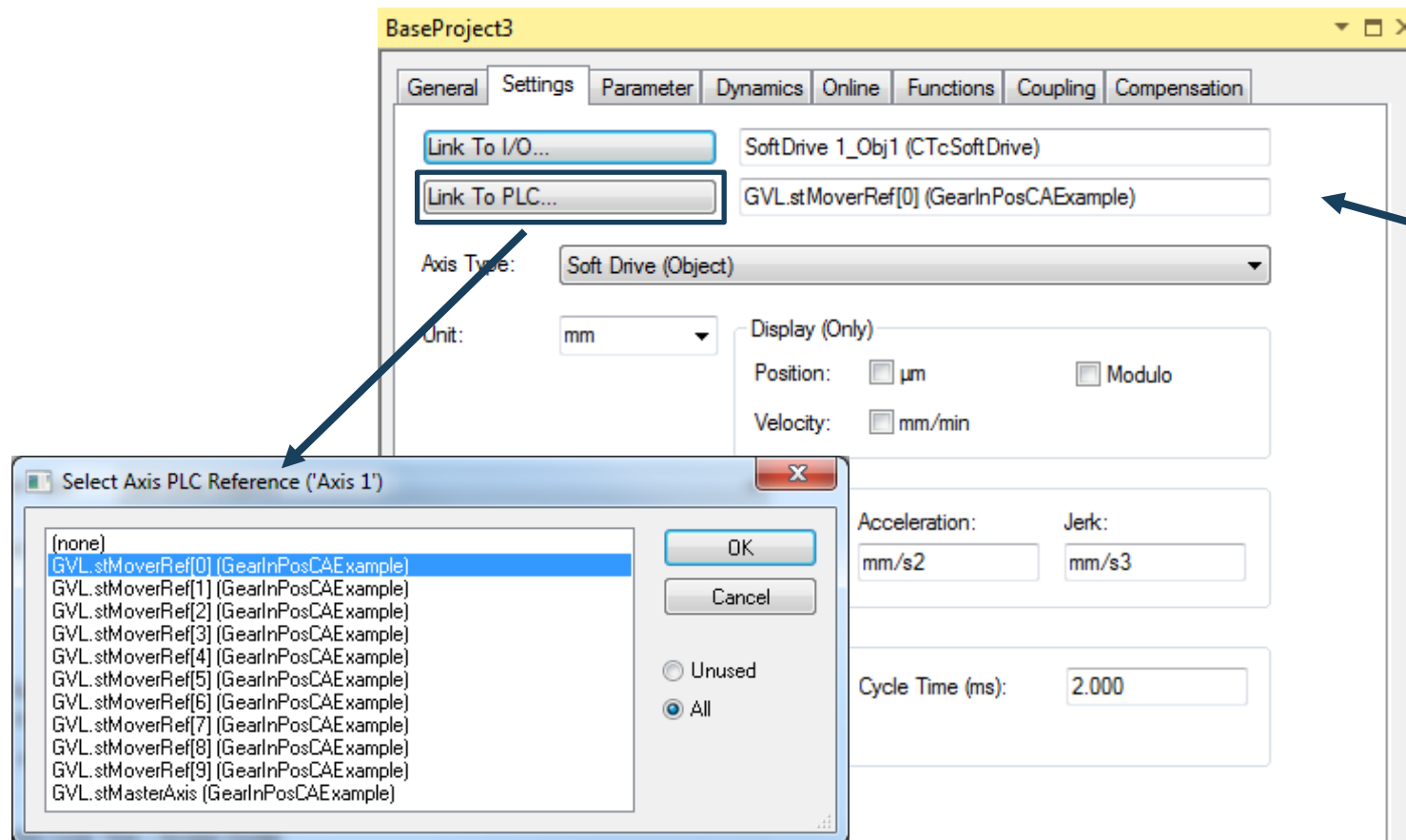
```
    stMoverRef        : ARRAY [1..gciNumMovers] OF AXIS_REF;
```

```
END_VAR
```





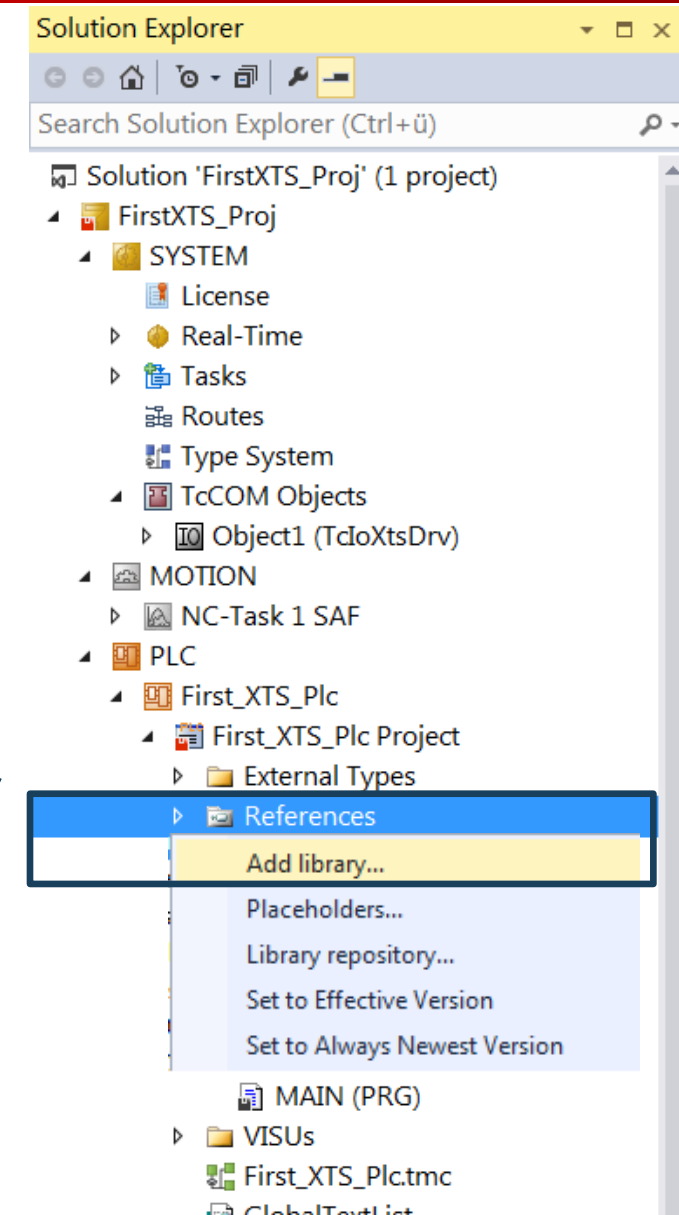
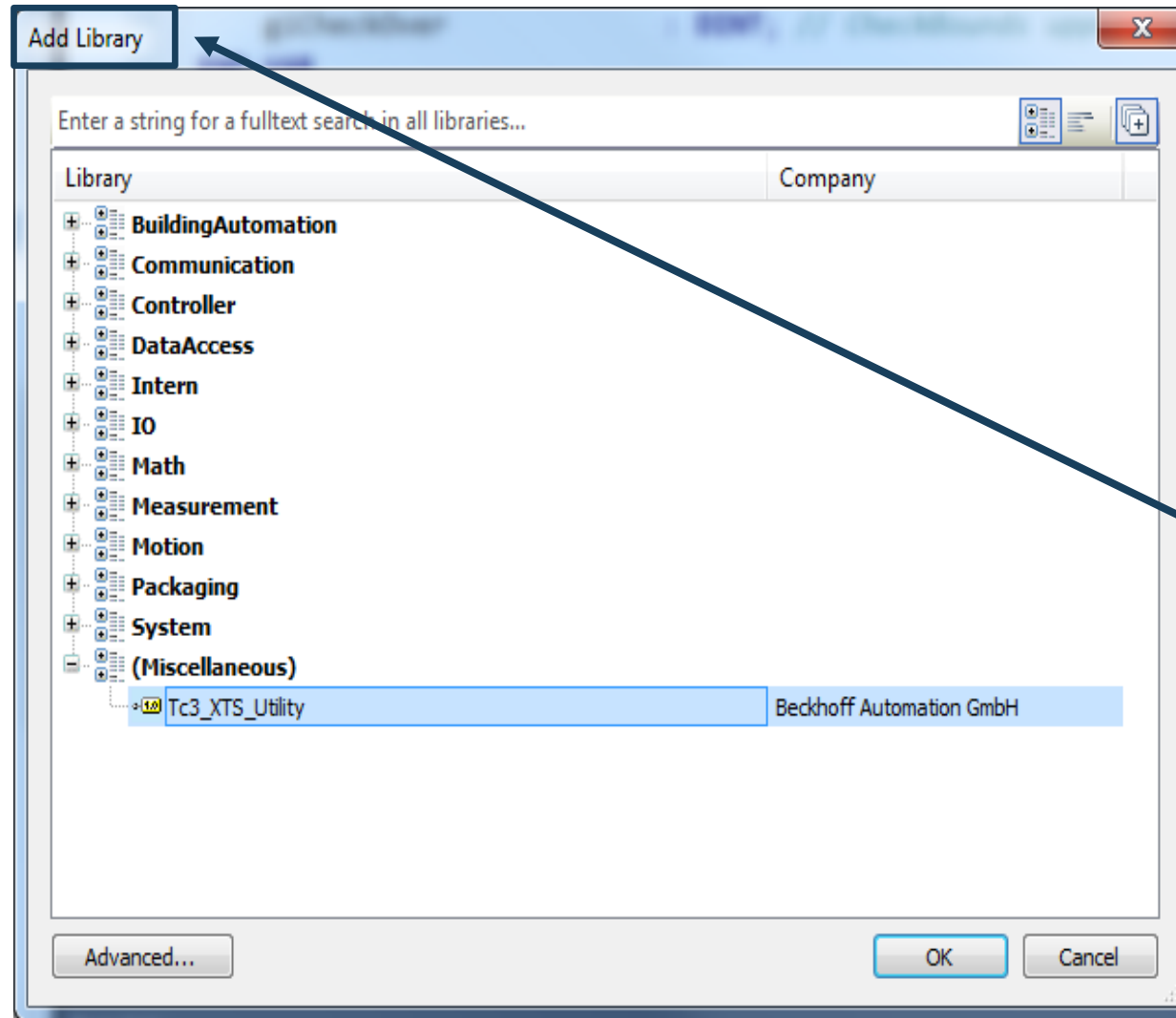
- **AXIS\_REF** for linking the PLC with the Axis
  - link the AXIS\_REF to the Axis (Mover)



1. PLC-Library XTS
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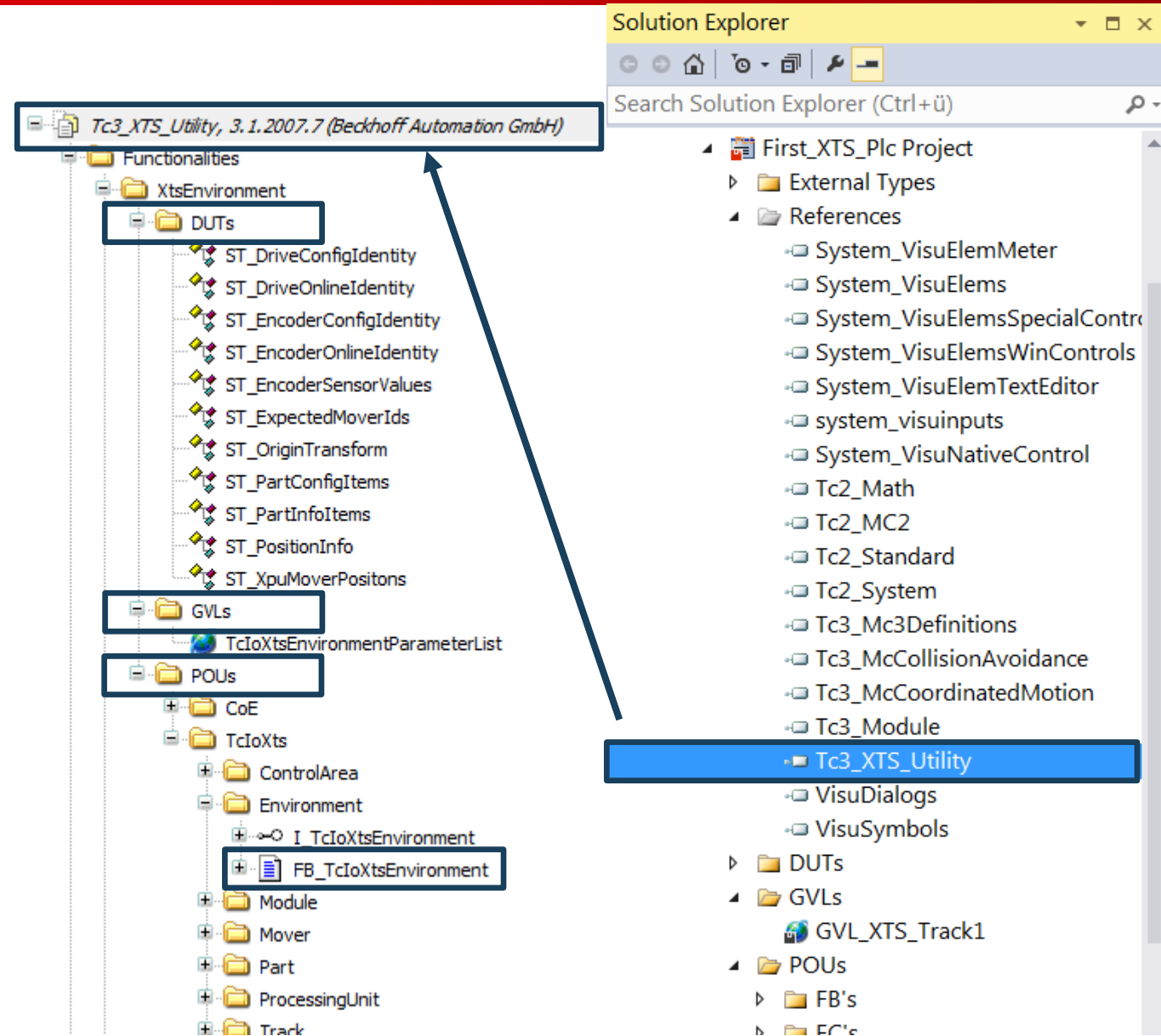


## ■ XTS-Utility PLC-Libraries



## XTS-Utility PLC-Libraries contains

- DUTs
- GVLs
  - TcloXtsEnvironmentParameterList
- POU's
  - FB\_TcloXtsEnvironment



## TcIoXtsEnvironmentParameterList

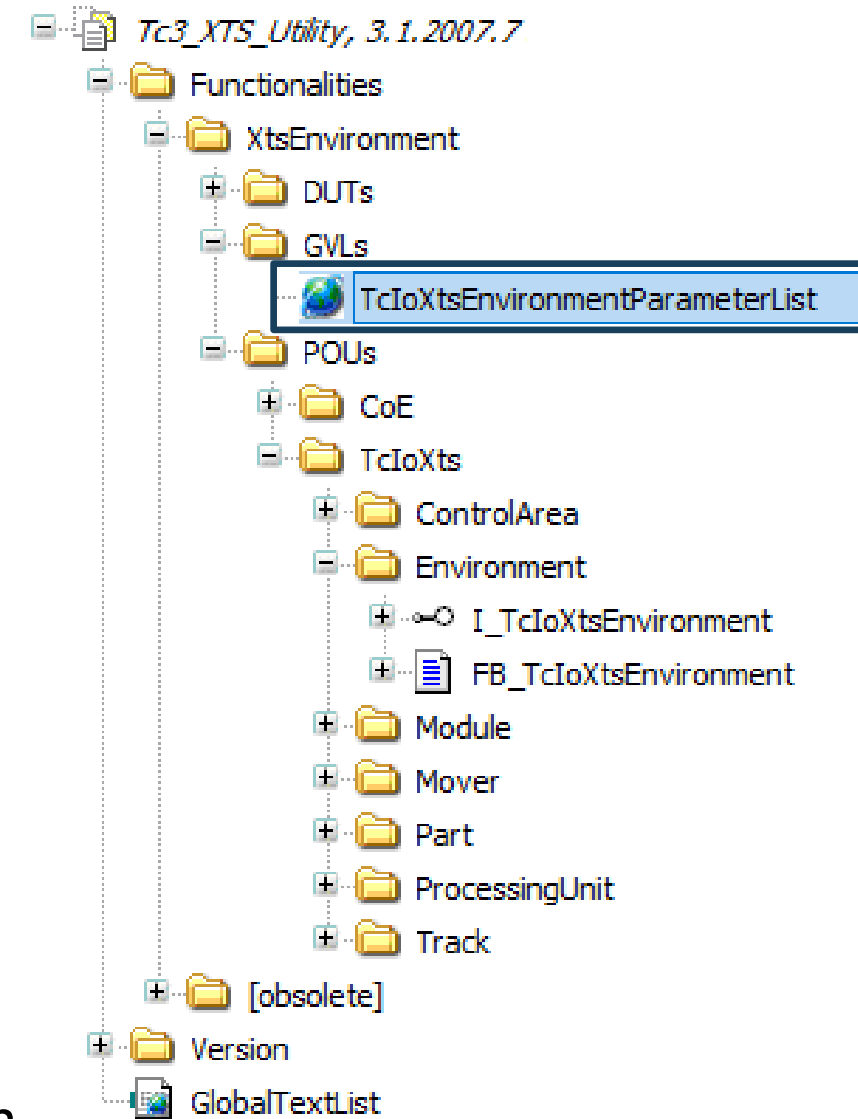
The constant list can be changed in the library.

### TcIoXtsEnvironmentParameterList (PARAMS)

InOut:

Scope	Name	Type	Initial	Comment
Constant	MaxEtherCatMaster	UDINT	32	Maximum EtherCAT Masters used in one XTS
	MaxXtsProcessingUnits	UDINT	5	Number of XtsProcessingUnits used in this project
	MaxXtsPartsPerXpu	UDINT	10	Maximum number of XtsParts used under one XtsProcessingUnit
	MaxModulesPerPart	UDINT	128	Maximum number of XtsModules used for one XtsPart
	MaxAreasPerPart	UDINT	20	Maximum number of XtsAreas used for one XtsPart
	MaxXtsTracksPerXpu	UDINT	100	Maximum number of XtsTracks used under one XtsProcessingUnit
	MaxPartsPerTrack	UDINT	10	Maximum number of XtsParts used for one XtsTrack
	MaxXtsMoversPerXpu	UDINT	120	Number of XtsMovers used under one XtsProcessingUnit
	MaxXtsTasksPerXpu	UDINT	6	Number of XtsTasks used under one XtsProcessingUnit

The parameters must be adapted for the respective system





## TcIoXtsEnvironmentParameterList

To change this Parameters

“Double-click” the entry within the library.

The screenshot shows the 'Bibliotheksverwalter' window for 'XTS\_NewDriverSimulation'. The left pane shows a tree structure with 'TcIoXtsEnvironmentParameterList' selected under 'TcIoXts'. The right pane shows a table of parameters with the 'Wert (editierbar)' column highlighted by a blue box.

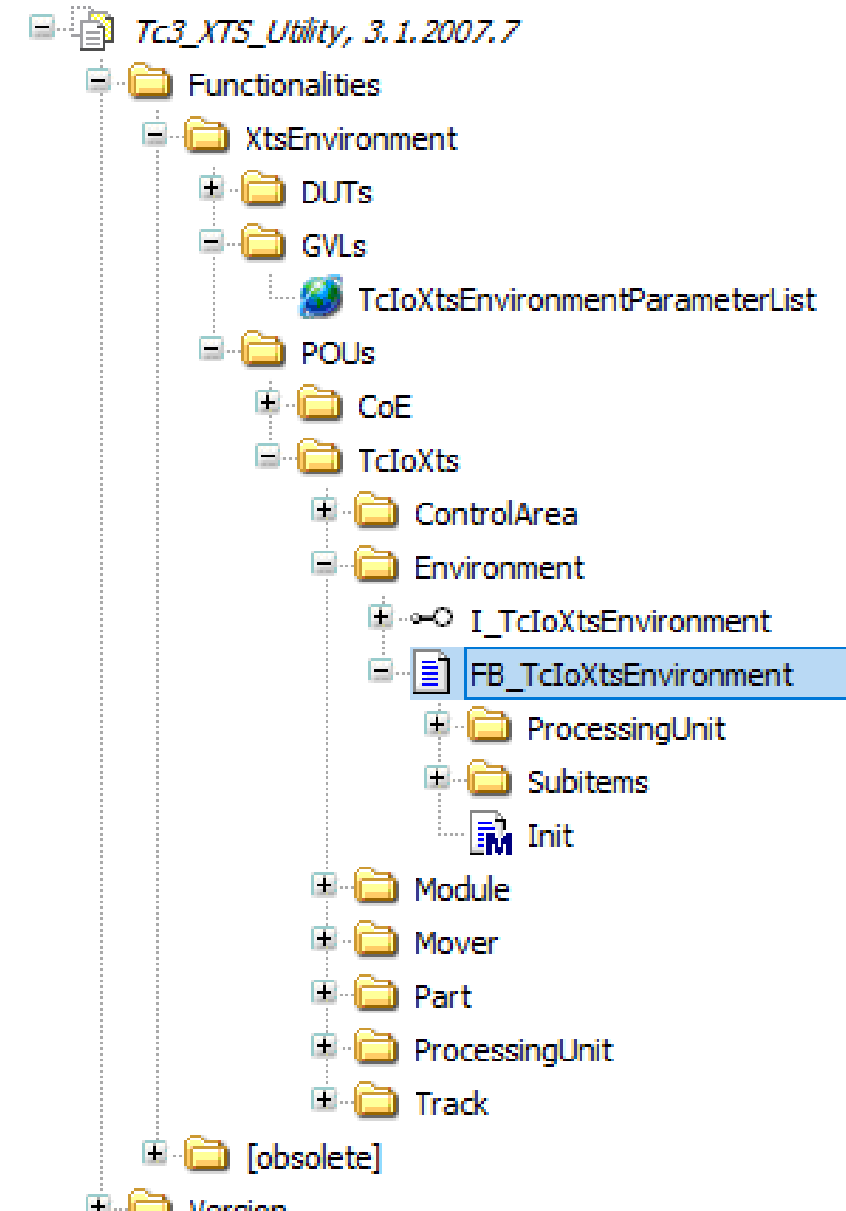
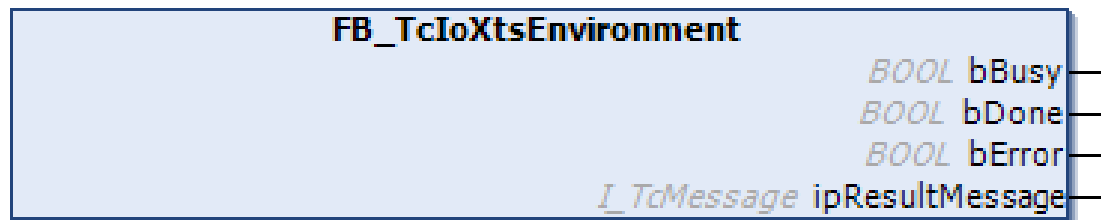
Name	Datentyp	Wert (editierbar)	Kommentar
MaxEtherCatMaster	UDINT	2	Maximum EtherCAT Masters used in one XTS
MaxXtsProcessingUnits	UDINT	1	Number of XtsProcessingUnits used in this project
MaxXtsPartsPerXpu	UDINT	1	Maximum number of XtsParts used under one XtsProcessingUnit
MaxModulesPerPart	UDINT	12	Maximum number of XtsModules used for one XtsPart
MaxAreasPerPart	UDINT	20	Maximum number of XtsAreas used for one XtsPart
MaxXtsTracksPerXpu	UDINT	100	Maximum number of XtsTracks used under one XtsProcessingUnit
MaxPartsPerTrack	UDINT	10	Maximum number of XtsParts used for one XtsTrack
MaxXtsMoversPerXpu	UDINT	120	Number of XtsMovers used under one XtsProcessingUnit
MaxXtsTasksPerXpu	UDINT	6	Number of XtsTasks used under one XtsProcessingUnit

The screenshot shows the 'Solution Explorer' window for 'First\_XTS\_Plc Project'. The tree structure includes 'External Types' and 'References'. The 'Tc3\_XTS\_Utility' entry is highlighted with a blue box, and an arrow points from this box to the 'MaxXtsTracksPerXpu' parameter in the table of the previous screenshot.

- First\_XTS\_Plc Project
  - External Types
  - References
    - System\_VisuElemMeter
    - System\_VisuElems
    - System\_VisuElemsSpecialContr
    - System\_VisuElemsWinControls
    - System\_VisuElemTextEditor
    - system\_visuinputs
    - System\_VisuNativeControl
    - Tc2\_Math
    - Tc2\_MC2
    - Tc2\_Standard
    - Tc2\_System
    - Tc3\_Mc3Definitions
    - Tc3\_McCollisionAvoidance
    - Tc3\_McCoordinatedMotion
    - Tc3\_Module
    - Tc3\_XTS\_Utility**
    - VisuDialogs
    - VisuSymbols
  - DUTs
  - GVLs
    - GVL\_XTS\_Track1
  - POUs
    - FB's
    - FC's

## FB\_TcIoXtsEnvironment

For easy gathering of XTS diagnostic data and accessing object parameters in the PLC.



## FB\_TcloXtsEnvironment

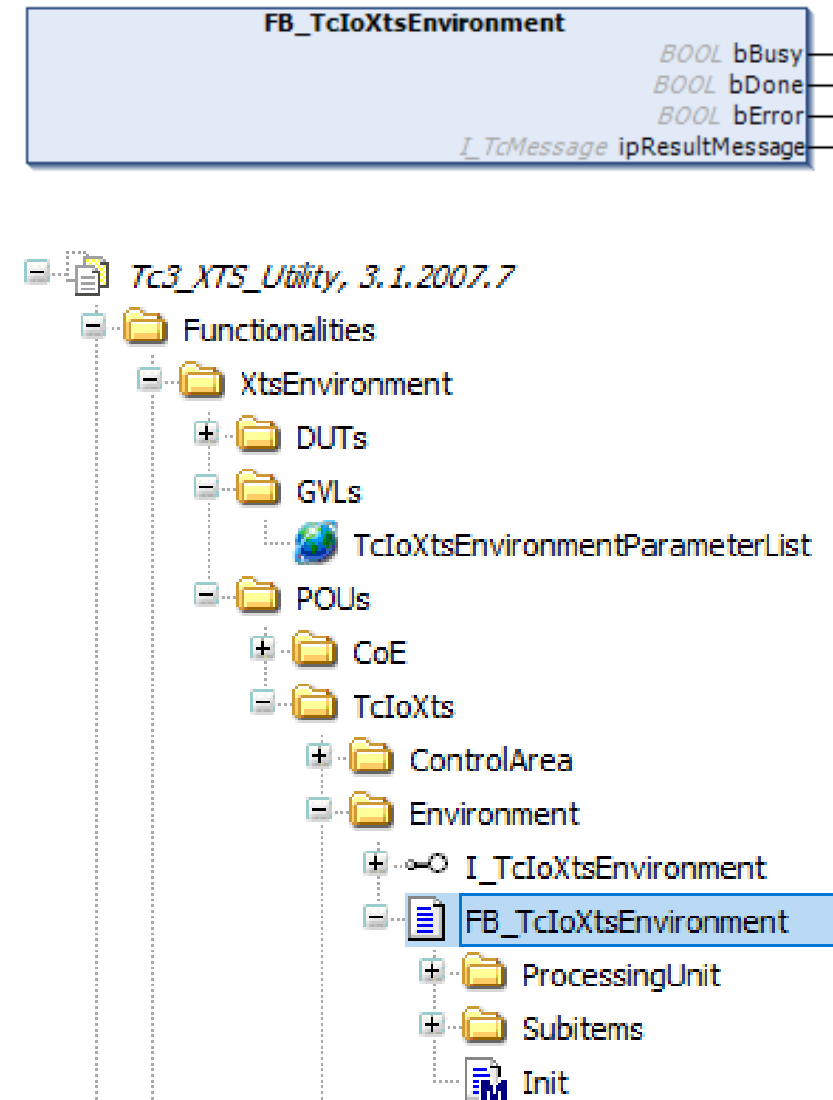
### FB\_TcloXtsEnvironment (FB)

FUNCTION\_BLOCK FB\_TcloXtsEnvironment IMPLEMENTS I\_TcloXtsEnvironment

InOut:

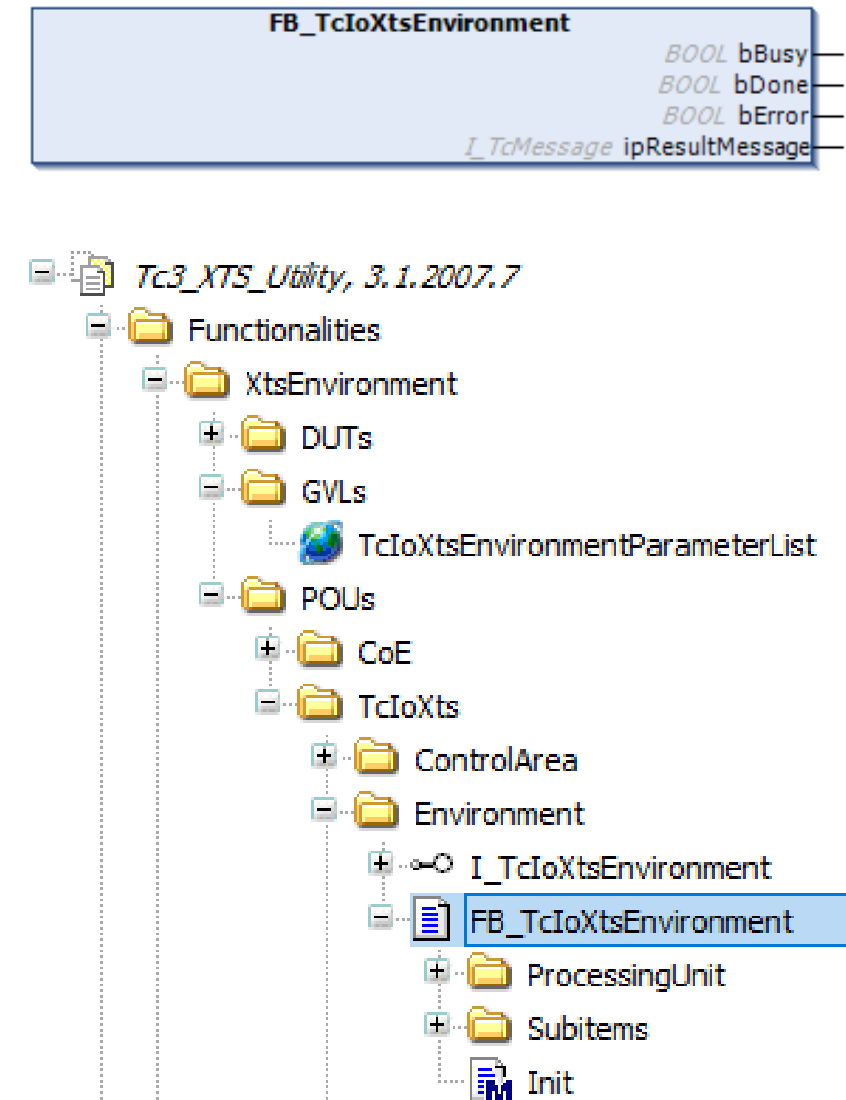
Scope	Name	Type	Initial
Output	bBusy	BOOL	
	bDone	BOOL	
	bError	BOOL	
	ipResultMessage	I_TcMessage	fbResult

- FB\_TcloXtsEnvironment.Init (METH)
- ProcessingUnit
  - FB\_TcloXtsEnvironment.GetXpuCount (METH)
  - FB\_TcloXtsEnvironment.GetXpuOids (METH)
  - FB\_TcloXtsEnvironment.P\_XpuCount (PROP)
  - FB\_TcloXtsEnvironment.P\_XpuOids (PROP)
- Subitems
  - FB\_TcloXtsEnvironment.XpuTclo (METH)

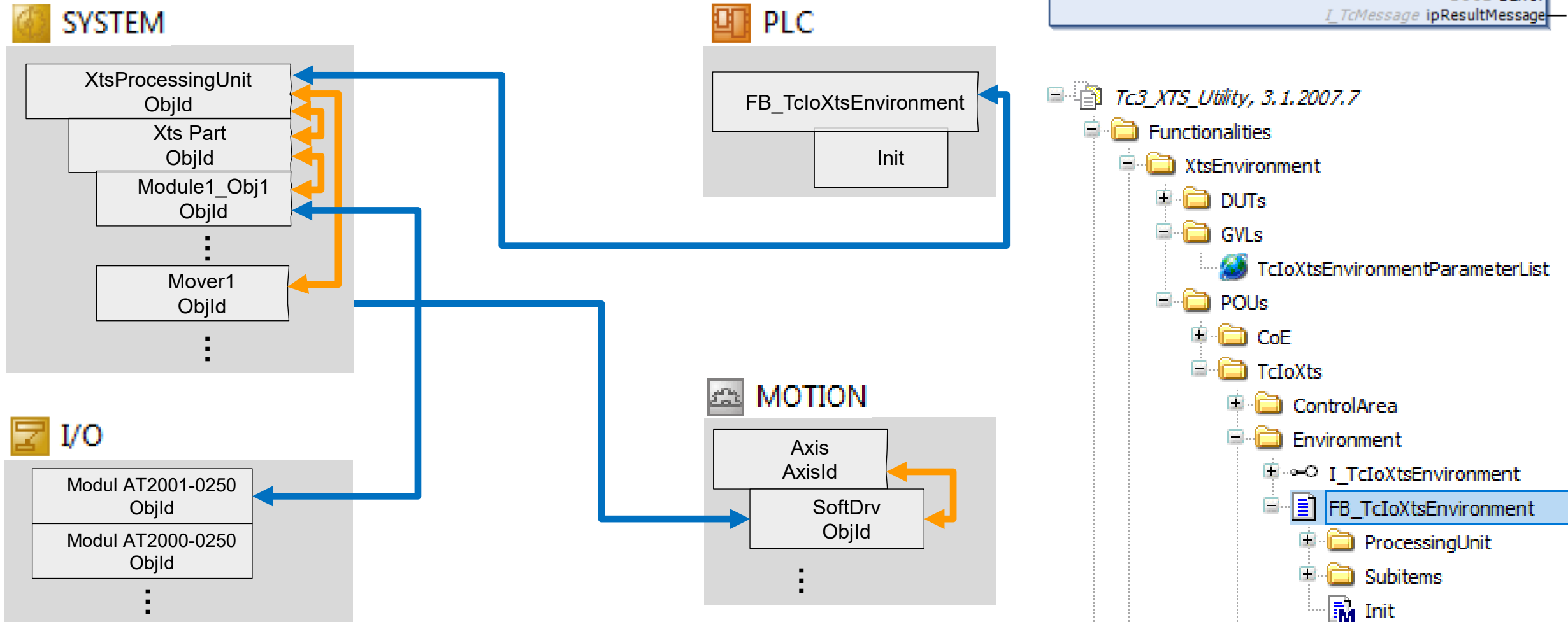


## FB\_TcIoXtsEnvironment

- only one FB\_TcIoXtsEnvironment is needed the XTS project.  
From this FB, all the XtsProcessingUnits and other objects can be accessed
- Once initialized, the Function Block have access to all the connected objects of the XtsEnvironment structure and their methods.
- There is no automatic cyclic update for data!
- The user can use the methods to get the required information if necessary.



## Communication via FB\_TcIoXtsEnvironment





## FB\_TcIoXtsEnvironment

- declaration

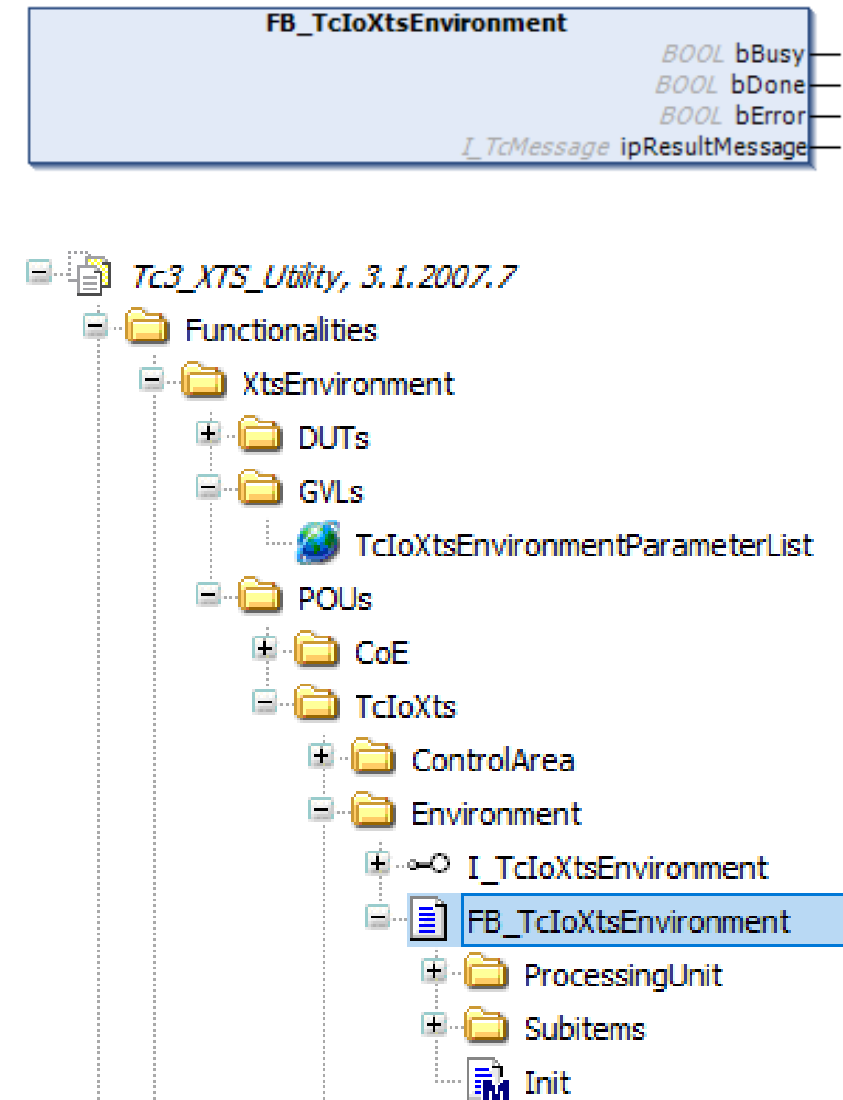
```
// XTS Utility
VAR_GLOBAL
    fbXtsEnvironment      : FB_TcIoXtsEnvironment;

    {attribute 'init_on_onlchange'}
    bInit                  : BOOL := FALSE;
END_VAR
```

- cal in Main()

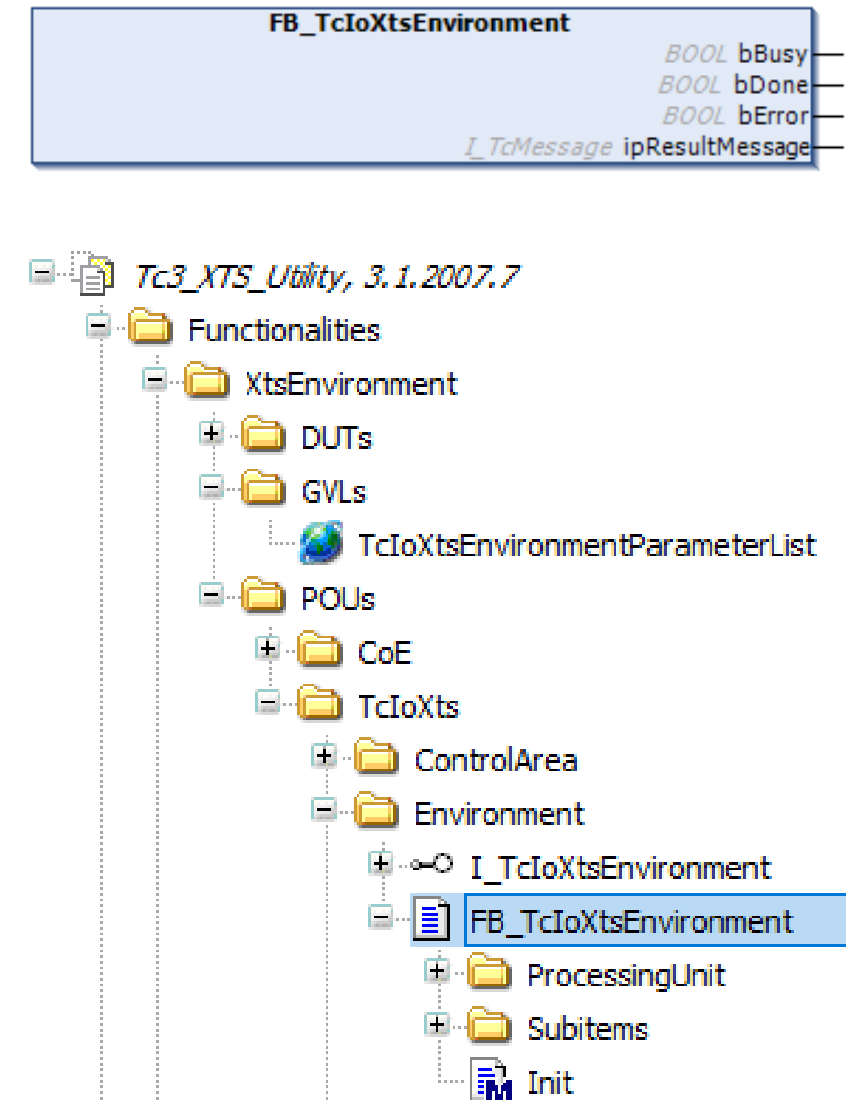
```
// Cal FB_XtsEnvironment
// Trigger only once in init
IF NOT bInit THEN
    IF fbXtsEnvironment.Init(TRUE) THEN
        fbXtsEnvironment.Init(FALSE);
        bInit := TRUE;
    END_IF

    // If not yet initialized, don't execute any of the XtsUtility code
    RETURN;
END_IF
```



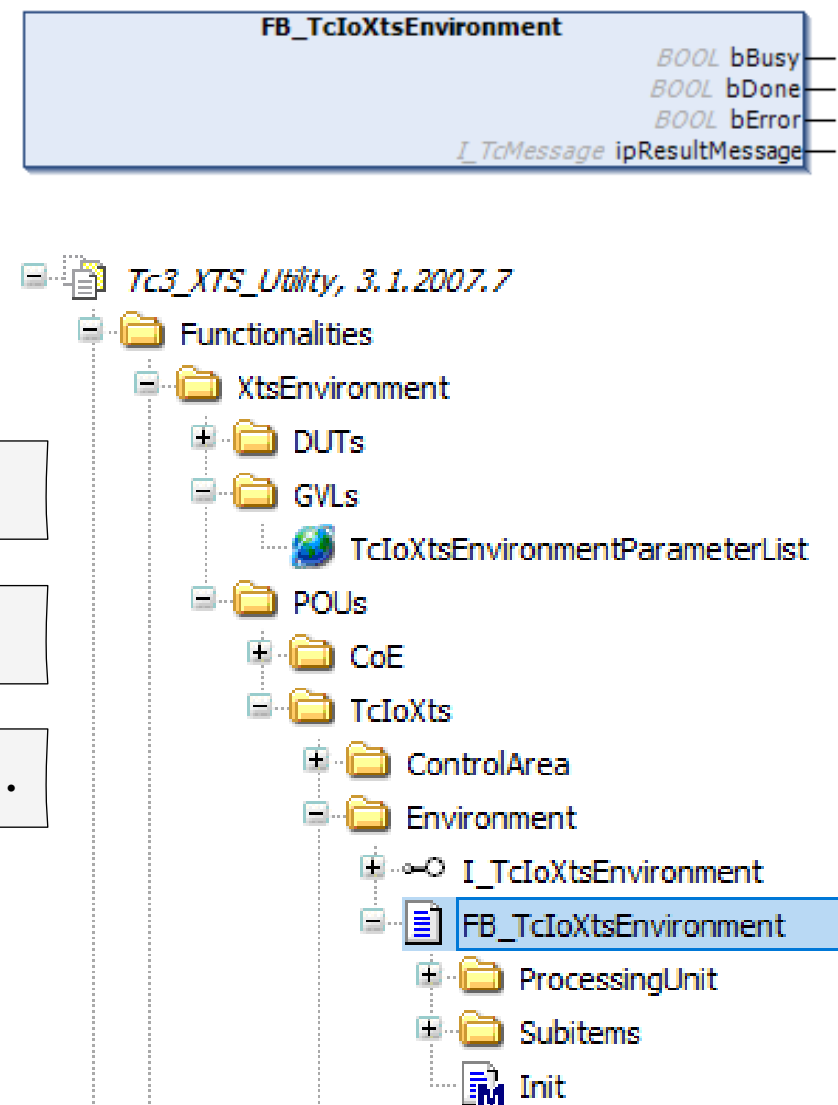
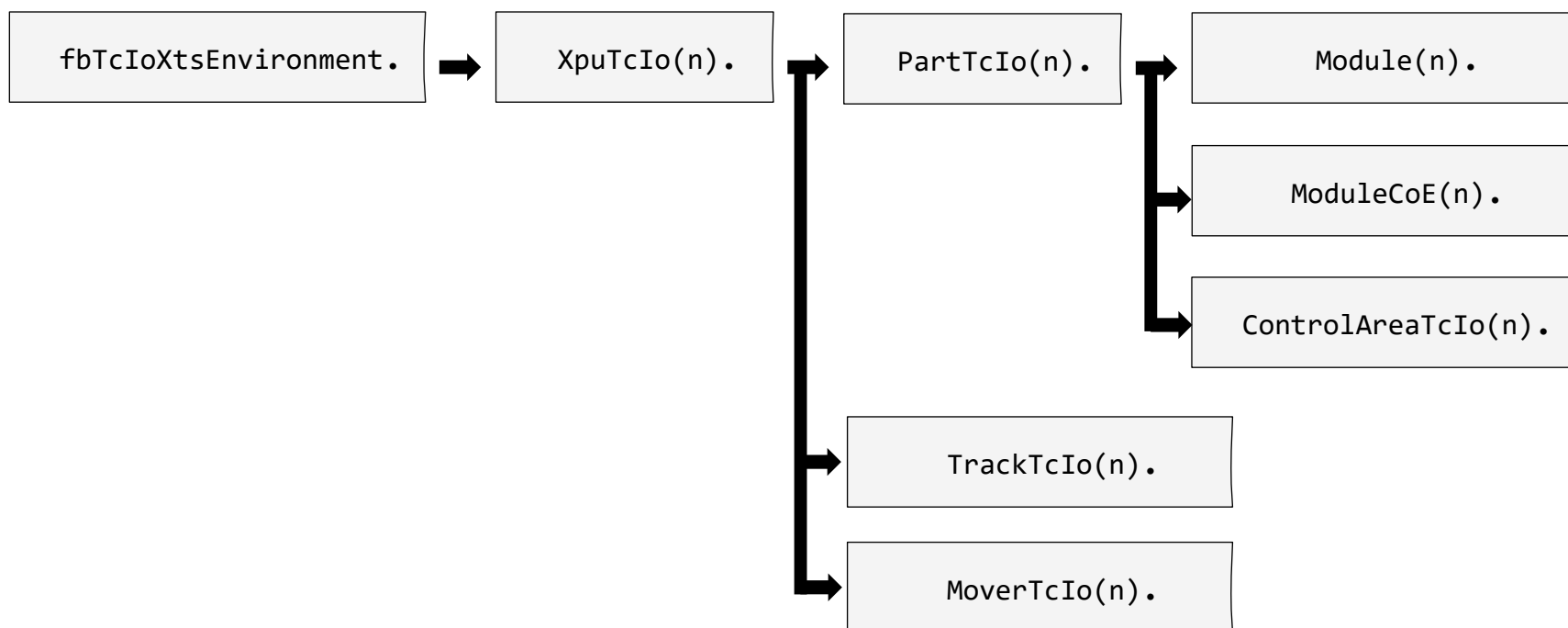
## FB\_TcIoXtsEnvironment

- The FB\_TcIoXtsEnvironment is seen as a hub function block for all XTS related objects within the project.
- Each object has its respective function block (e.g. FB\_TcIoXtsProcessingUnit) in the PLC. They can either be accessed via the FB\_TcIoXtsEnvironment but also can be used standalone.



## FB\_TcIoXtsEnvironment

- To access the methods and gather the data easily, the below call chain can be followed which is very close to the actual object structure within the project:



## Read/Write Parameter via FB\_TcIoXtsEnvironment

## read parameter

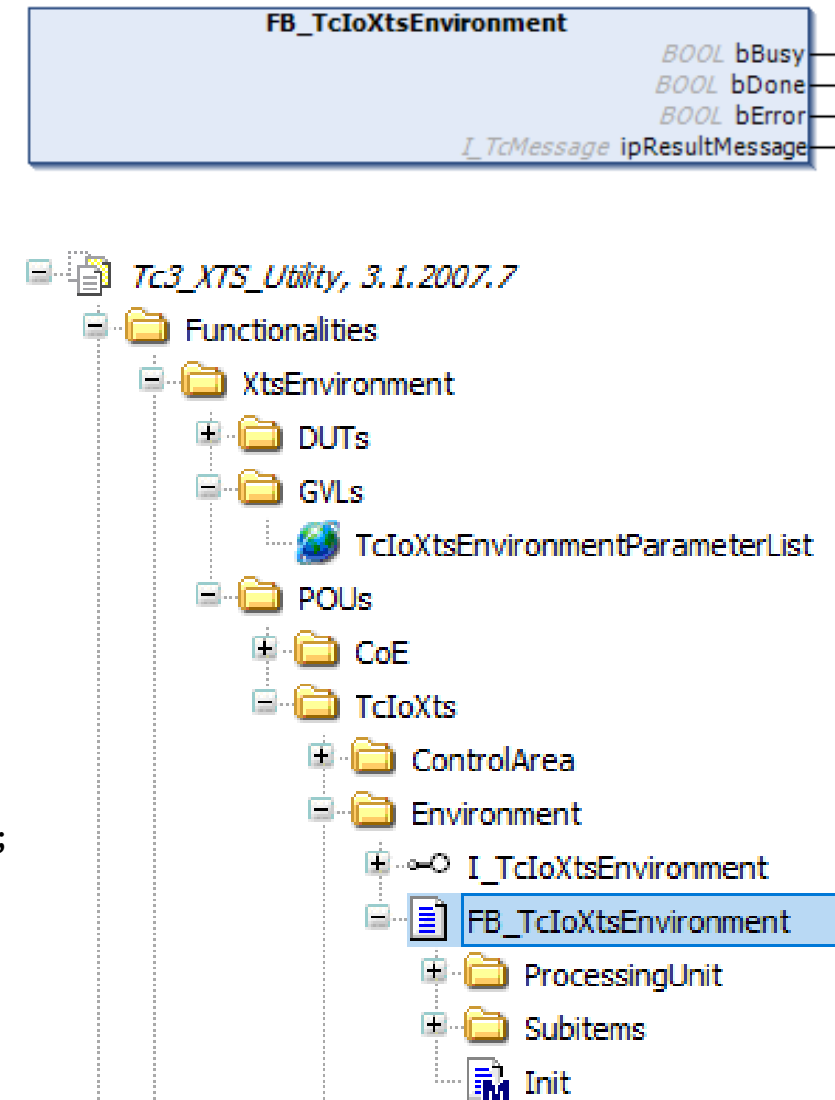
```
// Position valid
bAllPositionsValid :=
    fbXtsEnvironment.XpuTcIo(1).GetAreAllPositionsValid();
```

```
// Position valid
bTeachingValid:=
    fbXtsEnvironment.XpuTcIo(1).GetIsTeachingValid();
```

## write parameter

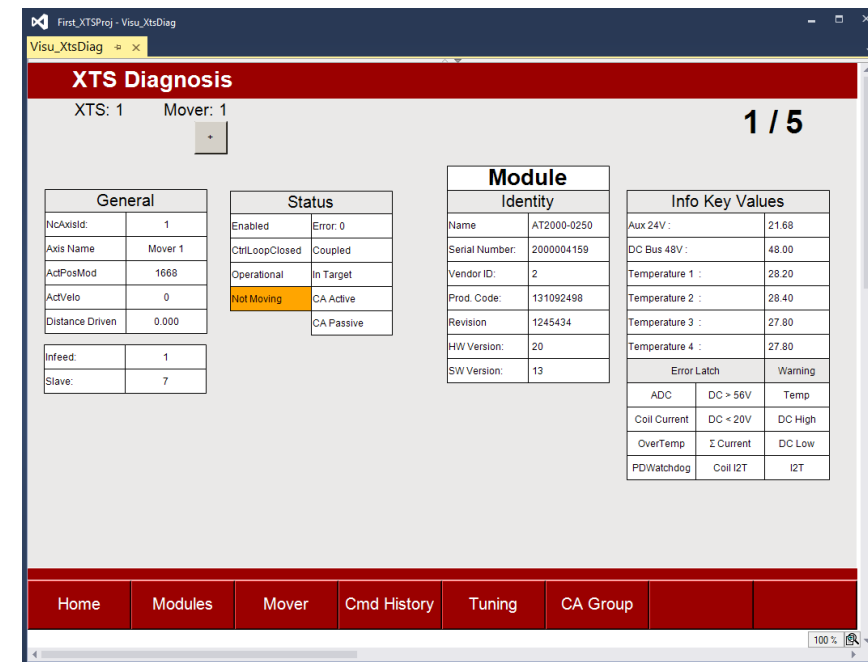
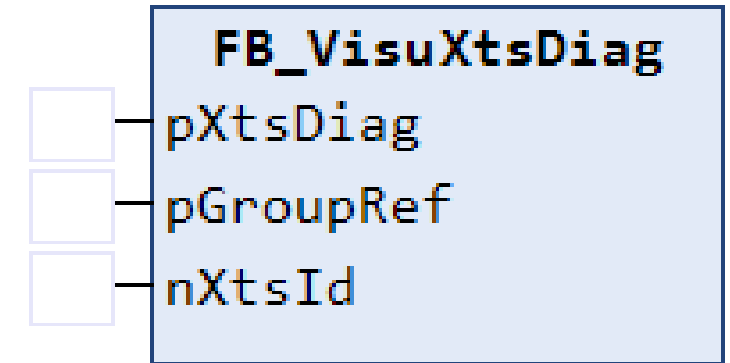
```
// Set ModuleOffset
fbXtsEnvironment.XpuTcIo(1).PartTcIo(1).ModuleTcIo(1).SetOffset(fNewModuleOffset);
```

METHOD SetOffset: BOOL  
tc3\_xts\_utility, 3.1.2007.7 (beckhoff automation gmbh)  
VAR\_INPUT fOffset LREAL



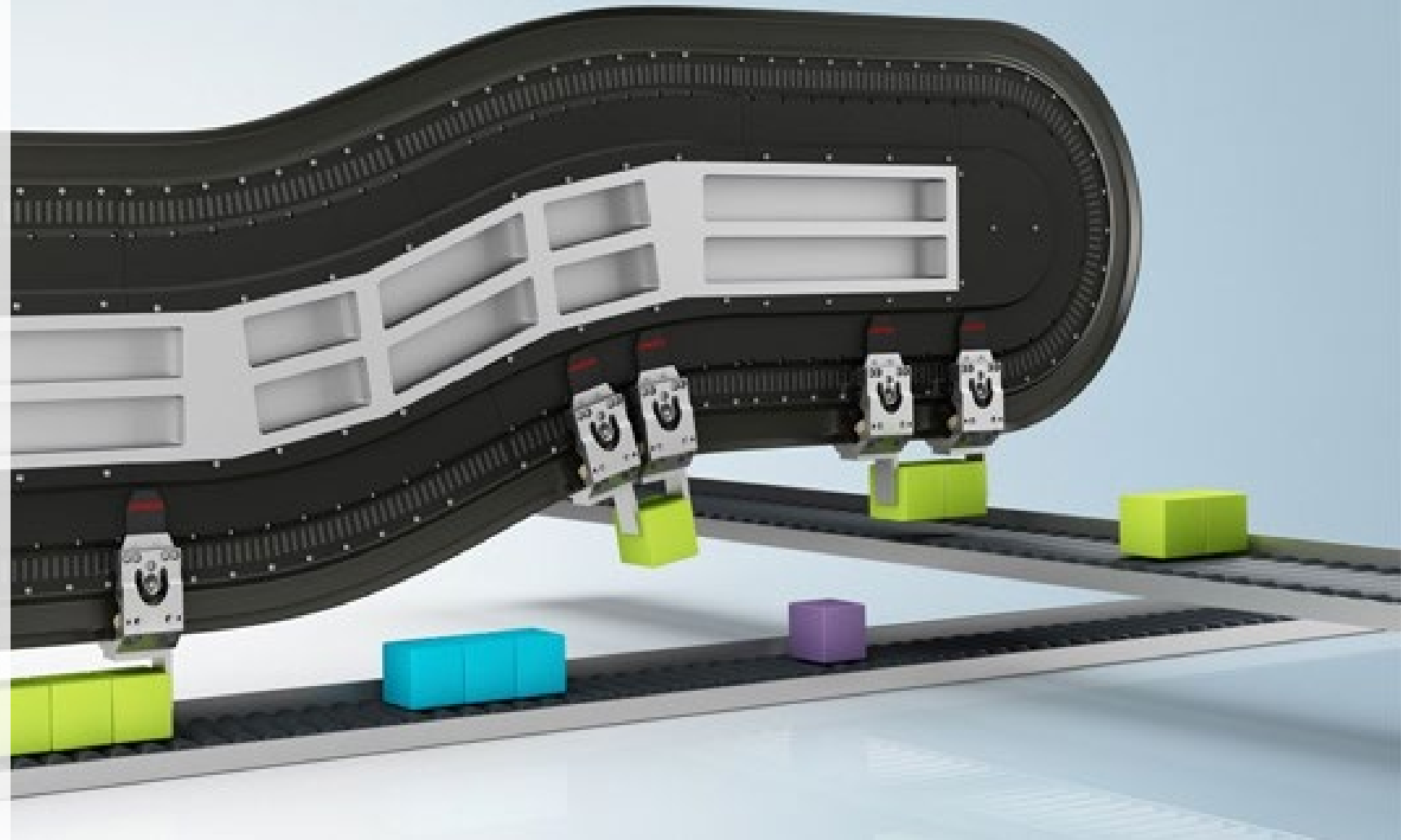
## ▪ FB\_VisuXtsDiag & VI\_XTSLib

- FB\_VisuXtsDiag  
collect all necessary Information  
from the XTS-Track
- VI\_XtsLib  
display all necessary Information  
from the XTS-Track  
inside of a PLC-Visualization (templet)





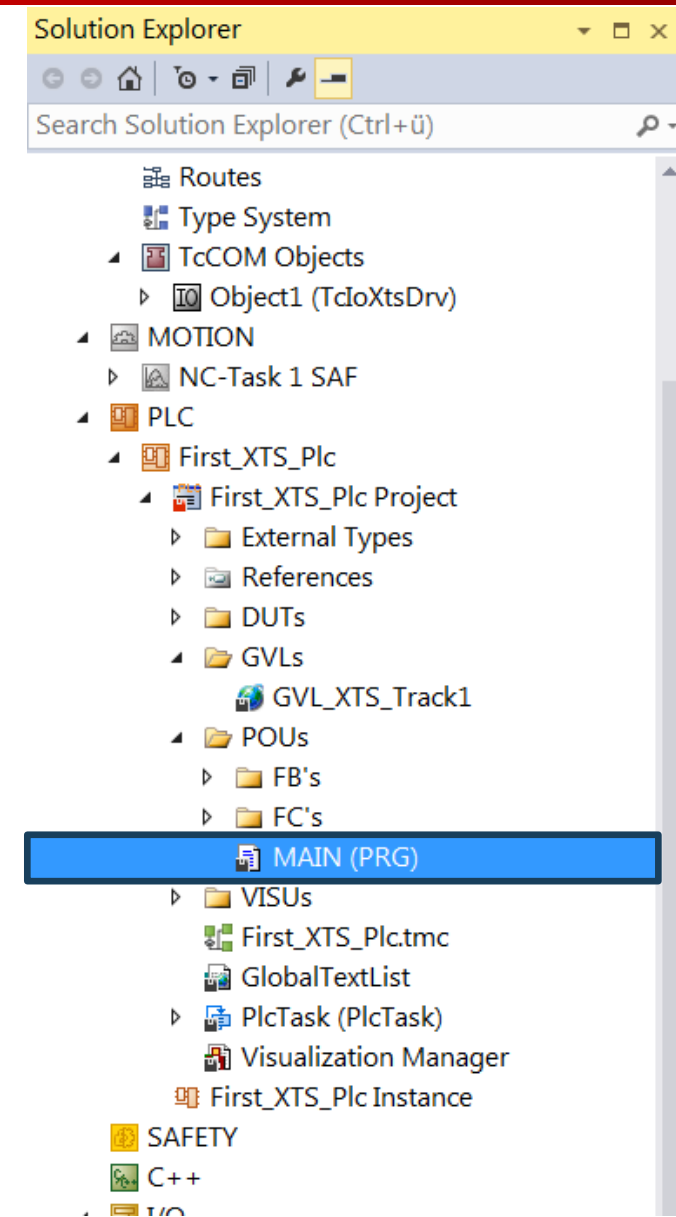
1. PLC-Library XTS
2. AXIS\_REF
3. XTS-Utility Library
4. **PLC StartUp Delay**
5. Mover1 detection via PLC
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## ▪ XTS- Start Up Delay

- The XTS I/O Driver requires time to find all of the movers on the track. During this process the XTS Task will exceed its cycle time, preventing the PLC Task from running normally.
- Therefore, the PLC program should not execute any logic until the XTS Task has successfully located all the configured movers

```
// Check if the position detection of the Movers has been completed.  
IF NOT fbXtsEnvironment.XpuTcIo(1).GetAreAllPositionsValid()  
  OR NOT fbXtsEnvironment.XpuTcIo(1).GetIsTeachingValid()  
  OR NOT ( fbXtsEnvironment.XpuTcIo(1).GetDetectedMoverCount() =  
           fbXtsEnvironment.XpuTcIo(1).GetExpectedMoverCount() ) THEN  
  // If not all Mover positions are valid, do not process any further.  
  RETURN;  
END_IF
```



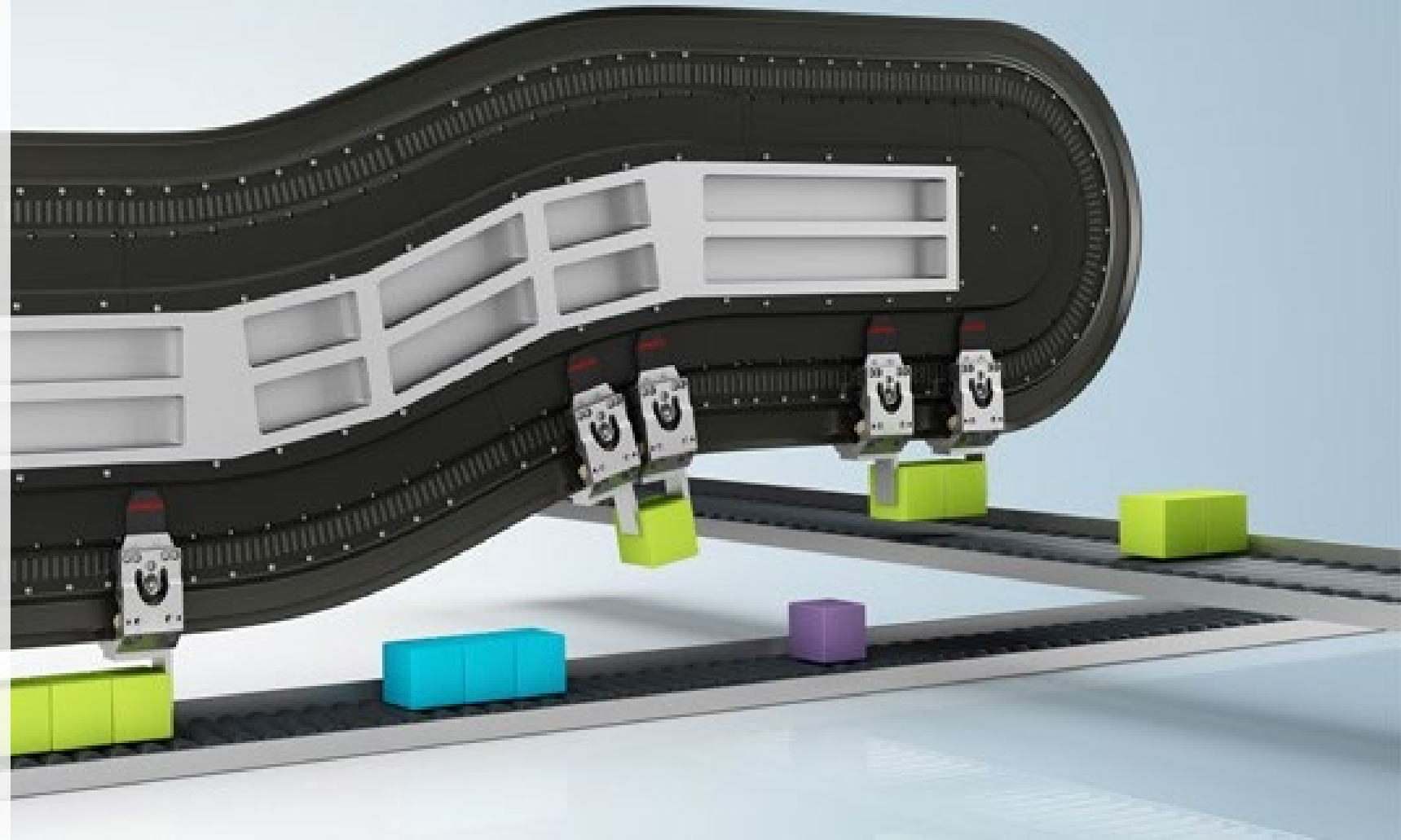
## XTS- StartUp Delay

- The actual state of the XTS-System are shown in “Parameter (Online)” for e.g.:
  - AreAllPositionsValid
  - DetectionCycleCount
  - DetectedMoverCount
  - ExpectedMoverCount
  - ScannedModuleCount

The screenshot displays the Beckhoff XTS software interface. The top right pane shows the 'Solution Explorer' with the project 'XTS\_NewDriverSimulation' expanded. Under 'TcCOM Objects', 'XtsProcessingUnit 1' is selected, and its 'Part 1' sub-tree is expanded, showing 'Module 1', 'Module 2', and 'Module 3'. A blue arrow points from 'XtsProcessingUnit 1' to the 'Parameter (Online)' tab in the main window. The 'Parameter (Online)' tab displays a table of system parameters.

Object	Context	Parameter (Init)	Parameter (Online)	Interfaces	Event Classes	XPU
		Name	Online	CS	Unit	
-		MoverDetection				
		AreAllPositionsValid	TRUE	<input type="checkbox"/>		
		DetectionCycleCount	1	<input type="checkbox"/>		
		DetectedMoverCount	10	<input type="checkbox"/>		
		ExpectedMoverCount	10	<input type="checkbox"/>		
		ScannedModuleCount	0	<input type="checkbox"/>		
+		MoverPositions	[...]	<input type="checkbox"/>		10 (Array Elements)
-		MoverIdDetection				
		HasIdDetectionError	FALSE	<input type="checkbox"/>		
		IsIdDetectionValid	FALSE	<input type="checkbox"/>		
		IsIdDetectionActive	FALSE	<input type="checkbox"/>		
+		MoverIds	[...]	<input type="checkbox"/>		10 (Array Elements)
+		Teaching				
-		Info				

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## Mover1 detection via PLC

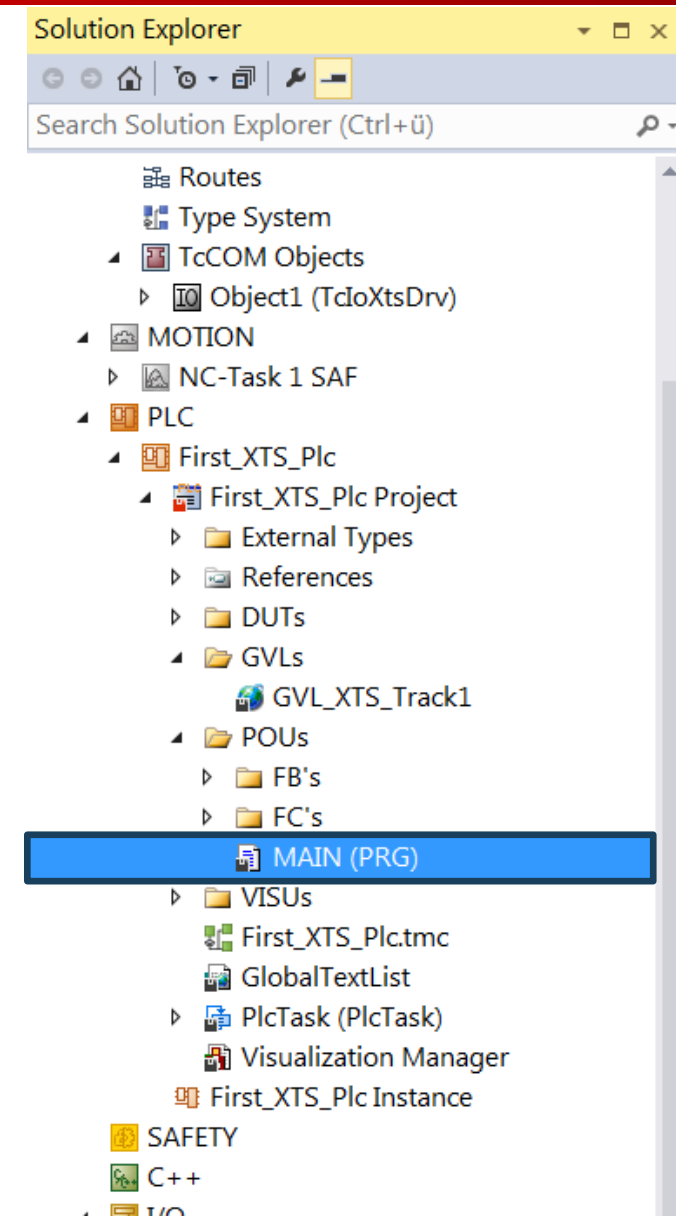
```
// Mover1 detection
// Check if "MoverIdDetectionMode" has been activated under the XtsProcessingUnit object.
IF fbXtsEnvironment.XpuTcIo(1).GetMoverIdDetectionMode() = E_MoverIdDetectionMode.Mover1 THEN

    // Check if the "MoverIdDetection" has already been started or the Mover1 was found.
    IF bStartMoverIdDetection AND NOT (bMoverIdDetectionActive OR bMoverIdDetected) THEN
        bStartMoverIdDetection := FALSE;
        // Trigger the "MoverIdDetection".
        fbXtsEnvironment.XpuTcIo(1).TriggerMoverIdDetection();
    END_IF

    // Check for error or success of "MoverIdDetection".
    // If the detection has an error, check for errors in output and try again.
    IF fbXtsEnvironment.XpuTcIo(1).GetHasMoverIdDetectionError() THEN
        RETURN;
    END_IF

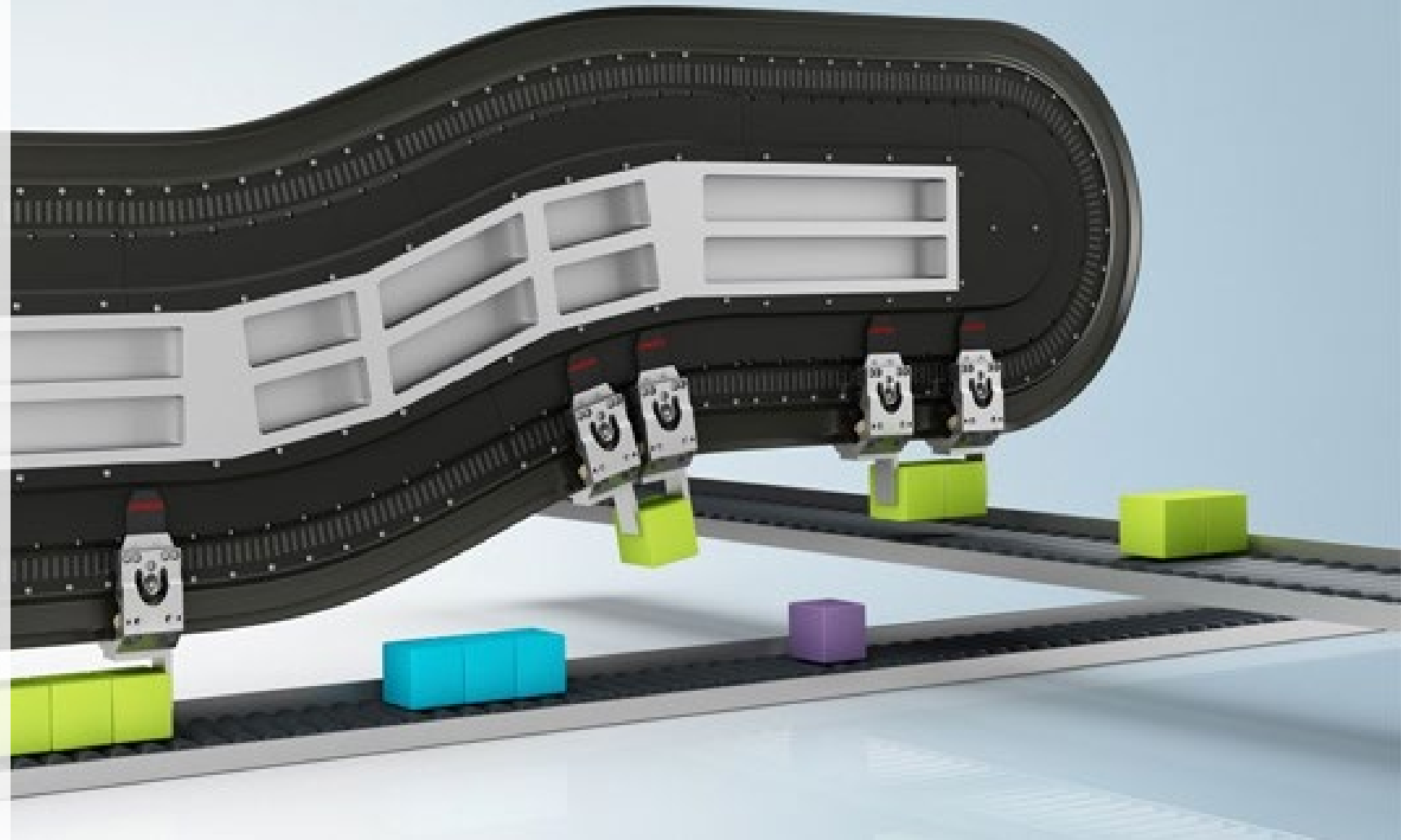
    // Do not process any further until the "MoverId" was detected.
    IF NOT fbXtsEnvironment.XpuTcIo(1).GetIsMoverIdDetectionValid() THEN
        RETURN;
    END_IF

    // If the "MoverIdDetection" was not activated in the XtsProcessingUnit object,
    // then the activation of the "MoverIdDetection" and the search of Mover1 is skipped.
ELSE
    ;
END_IF
```

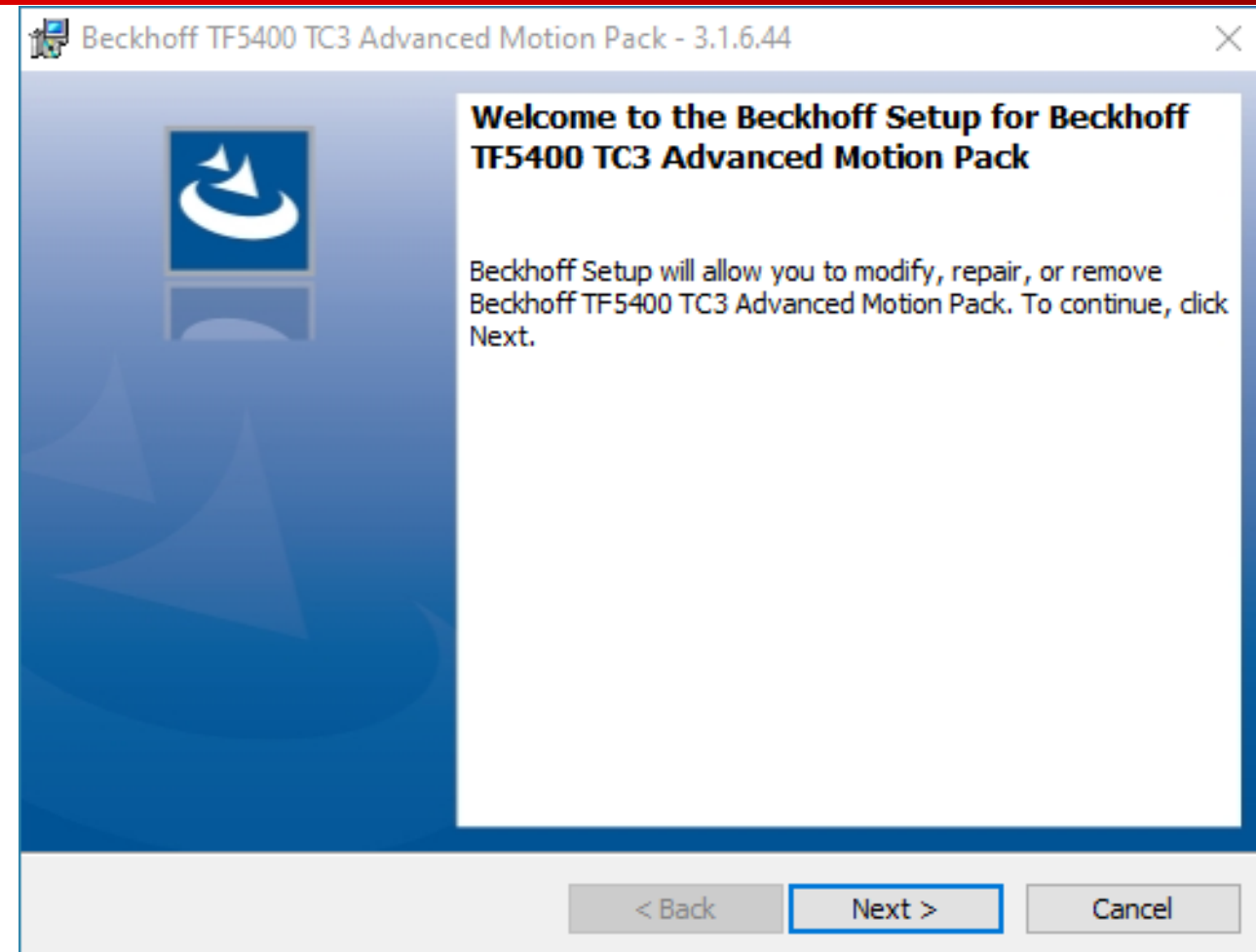




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- TC3 Motion Collision Avoidance as TcCOM Module (TwinCAT Component Object Models)
  - TF5400 | TC3 Advanced Motion Pack
    - Included
      - TC3 Kinematic Transformation
      - TC3 Motion Collision Avoidance
      - TC3 Motion Pick-and-Place
      - TC3 Planar Motion

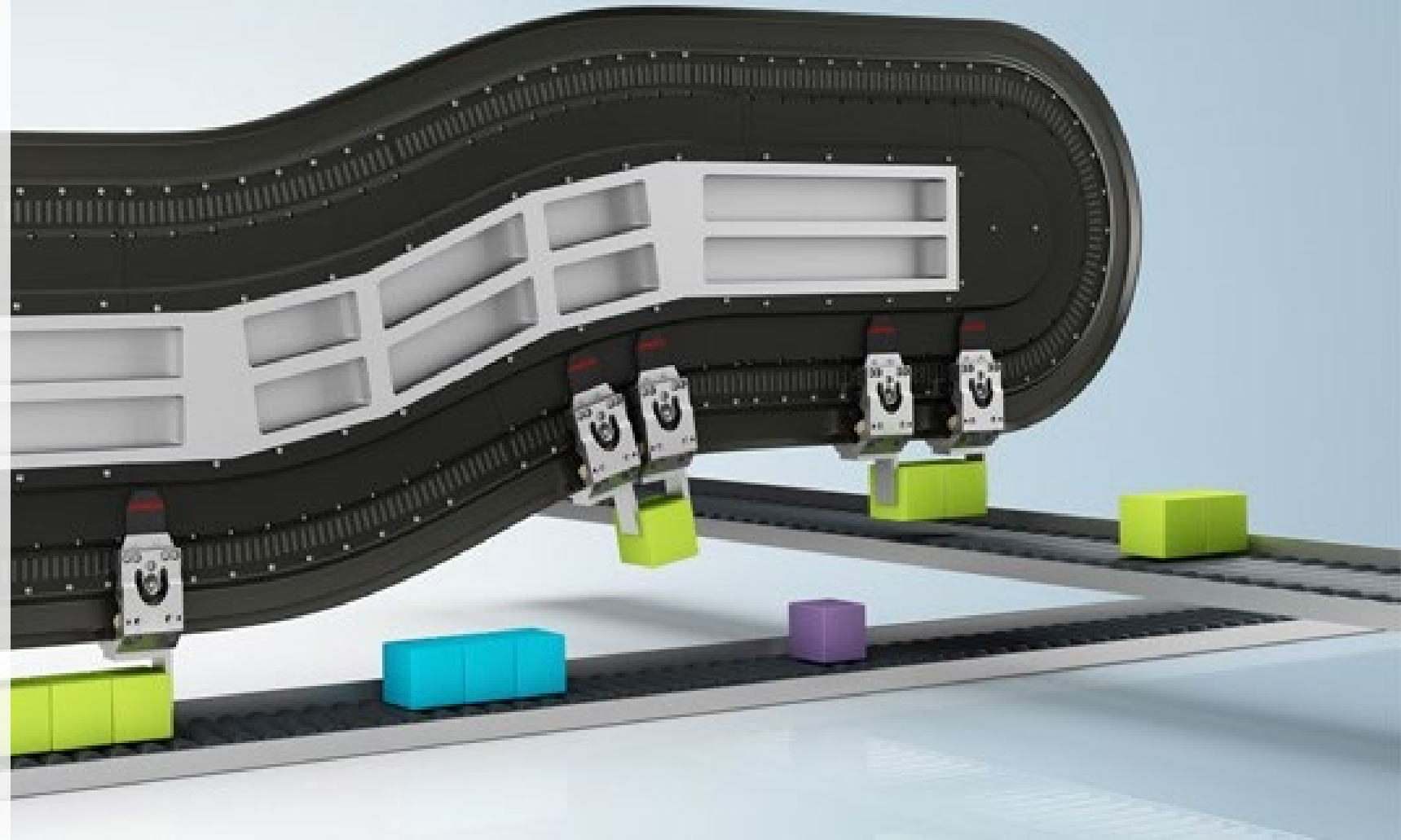


### Collision Avoidance Overview

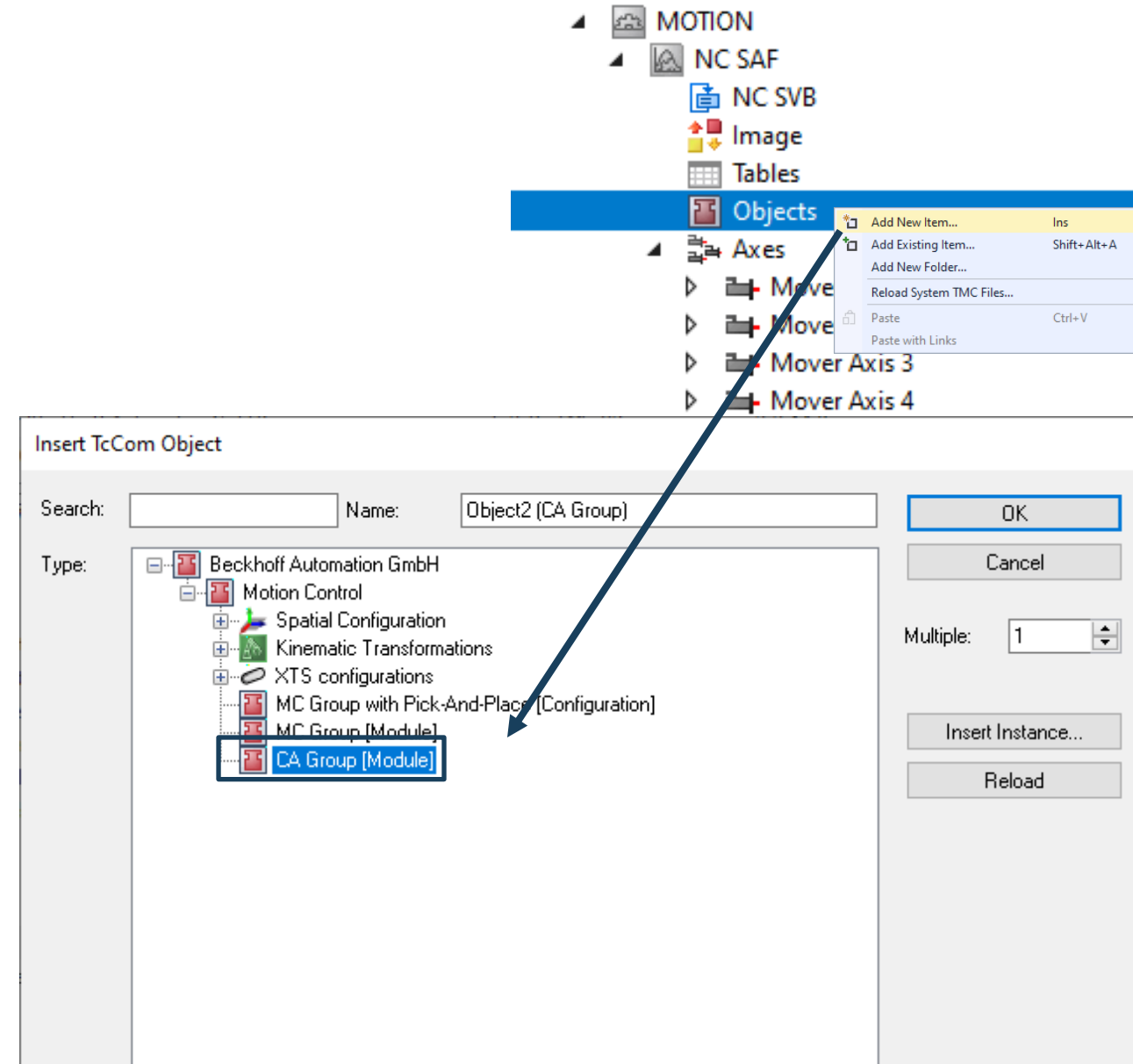
- The purpose of collision avoidance is to prevent collisions between movers, and also to maintain a parameterized “Gap” between any two movers.
- Therefor PTP axes are added to a CA (collision avoidance) group.
- Motion function blocks for collision avoidance are included in library Tc3\_McCollisionAvoidance.
- Administrative function blocks are included in library Tc3\_McCoordinatedMotion.
- For detailed collision avoidance information see the online Beckhoff Information System section on Advanced Motion

[Link](#) to Infosys

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- Adding the CA Group Object



- Set the Context of the Collision Avoidance group to the NC-SAF Task

The screenshot displays the Beckhoff XTS software interface. On the right, a tree view shows the project structure with the following items:

- NC SAF
  - NC SVB
  - Image
  - Tables
  - Objects
    - Object1 (CA Group)** (highlighted in blue)
    - Group Outputs
    - Group Inputs

An arrow points from the 'Object1 (CA Group)' entry in the tree to the 'Context' tab of the configuration window below.

The configuration window has four tabs: 'Object', 'Context', 'Parameter (Init)', and 'Data Area'. The 'Context' tab is active, showing the following settings:

- Context: 0
- Depend On: Parent Object
- ☐ Need Call From Sync Mapping
- Data Areas:
  - ☒ 1 'Group Outputs'
  - ☒ 2 'Group Inputs'
- Interfaces: (empty box)
- Data Pointer: (empty box)
- Interface Pointer: (empty box)

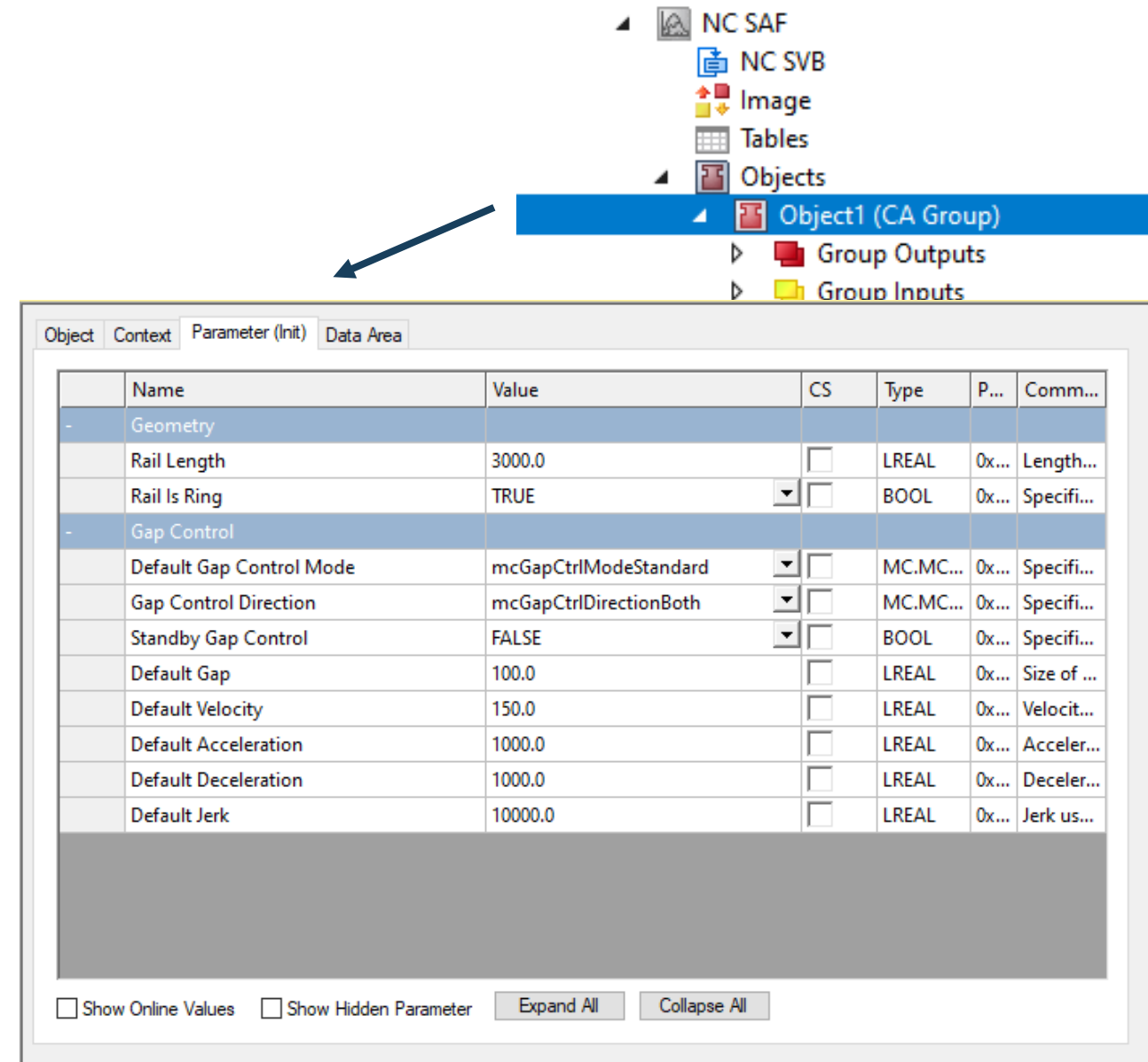
At the bottom, the 'Result' section shows a table with the following data:

Task	Name	P..	C...	Tas...	Sym...	Sort ...
05000010	NC SAF	4	2...	501	501	0 ...

## Collision Avoidance Group Settings

The CA Group has 4 key settings.

- Rail Length  
(Same as the HardwareModulo)
- Rail is a ring
- Gap Control Mode
  - mcGapCtrlModeStandard
  - mcGapCtrlModeFast
- Standby Gap Control



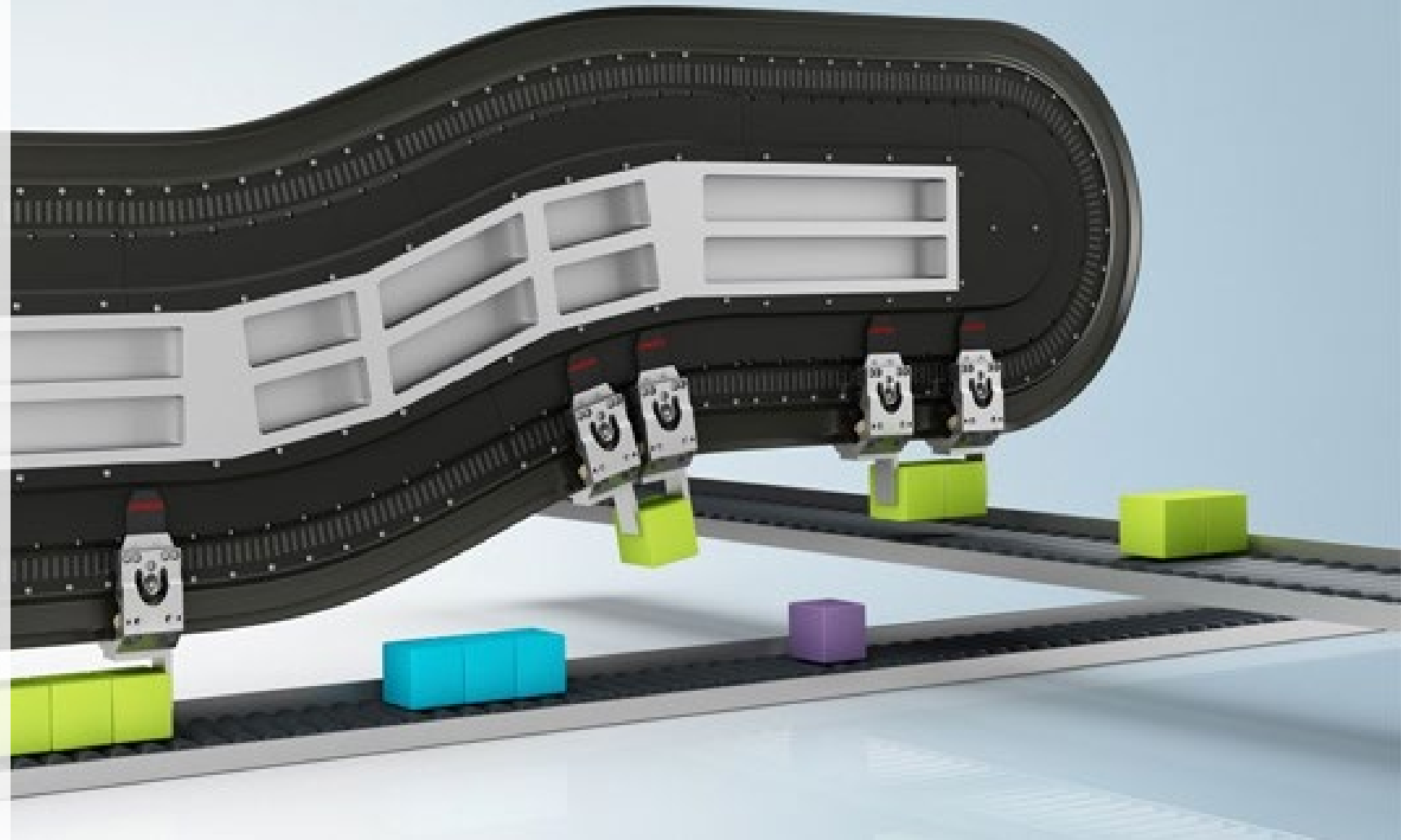
The screenshot shows the Beckhoff XTS software interface. In the top right, a tree view displays the hierarchy: NC SAF, NC SVB, Image, Tables, Objects, and Object1 (CA Group). An arrow points to the 'Object1 (CA Group)' entry. Below the tree, the 'Parameter (Init)' tab is selected, showing a table of parameters for the CA group.

	Name	Value	CS	Type	P...	Comm...
-	Geometry					
	Rail Length	3000.0	<input type="checkbox"/>	LREAL	0x...	Length...
	Rail Is Ring	TRUE	<input type="checkbox"/>	BOOL	0x...	Specifi...
-	Gap Control					
	Default Gap Control Mode	mcGapCtrlModeStandard	<input type="checkbox"/>	MC.MC...	0x...	Specifi...
	Gap Control Direction	mcGapCtrlDirectionBoth	<input type="checkbox"/>	MC.MC...	0x...	Specifi...
	Standby Gap Control	FALSE	<input type="checkbox"/>	BOOL	0x...	Specifi...
	Default Gap	100.0	<input type="checkbox"/>	LREAL	0x...	Size of ...
	Default Velocity	150.0	<input type="checkbox"/>	LREAL	0x...	Velocit...
	Default Acceleration	1000.0	<input type="checkbox"/>	LREAL	0x...	Acceler...
	Default Deceleration	1000.0	<input type="checkbox"/>	LREAL	0x...	Deceler...
	Default Jerk	10000.0	<input type="checkbox"/>	LREAL	0x...	Jerk us...

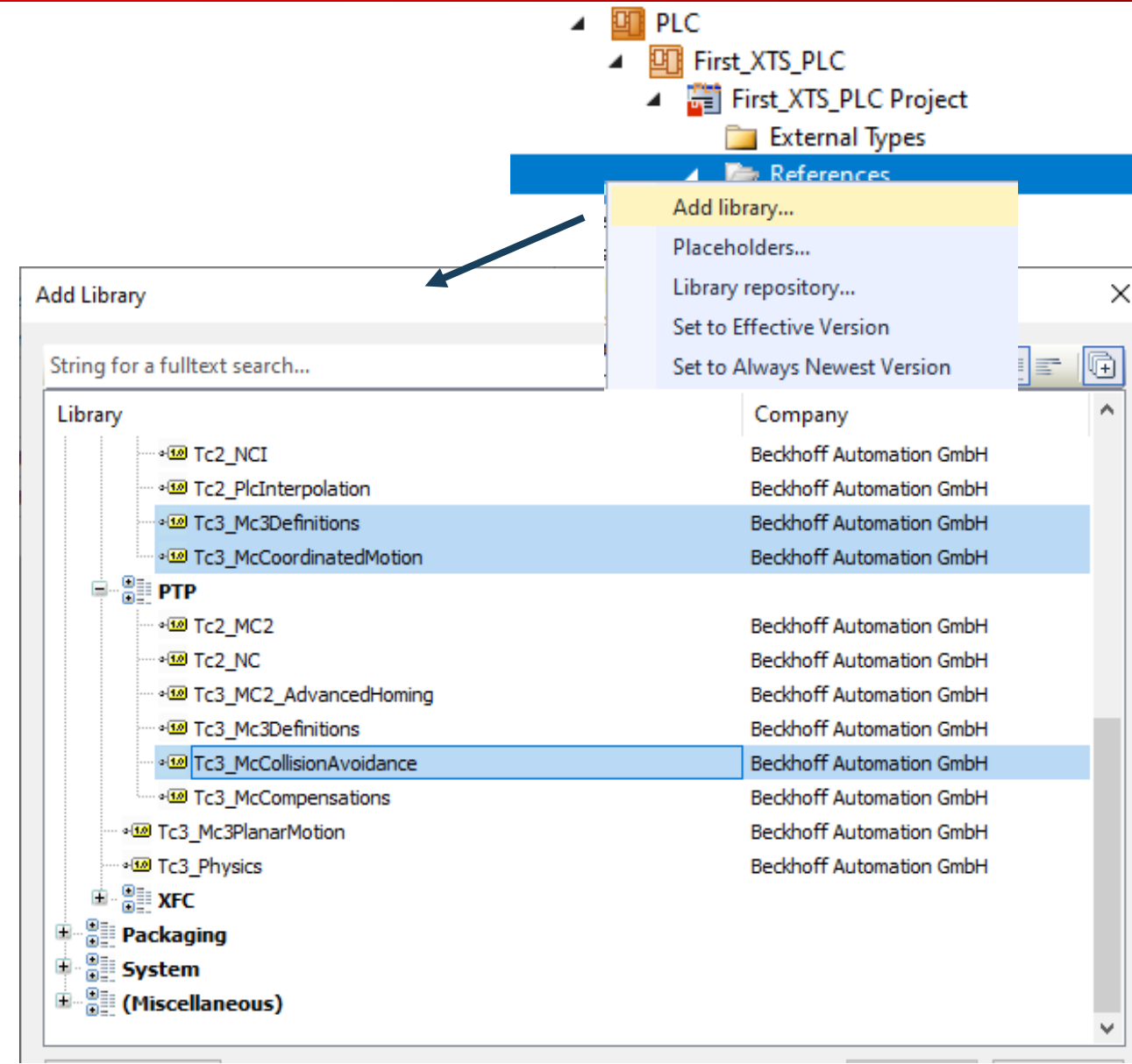
At the bottom of the interface, there are checkboxes for 'Show Online Values' and 'Show Hidden Parameter', and buttons for 'Expand All' and 'Collapse All'.



1. PLC-Library XTS
2. AXIS\_REF
3. XTS-Utility Library
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7. CA-Group Object
8. **PLC-Library CA-Group**
9. AXES\_GROUP\_REF
10. CA-Group handling
11. CA-Operation

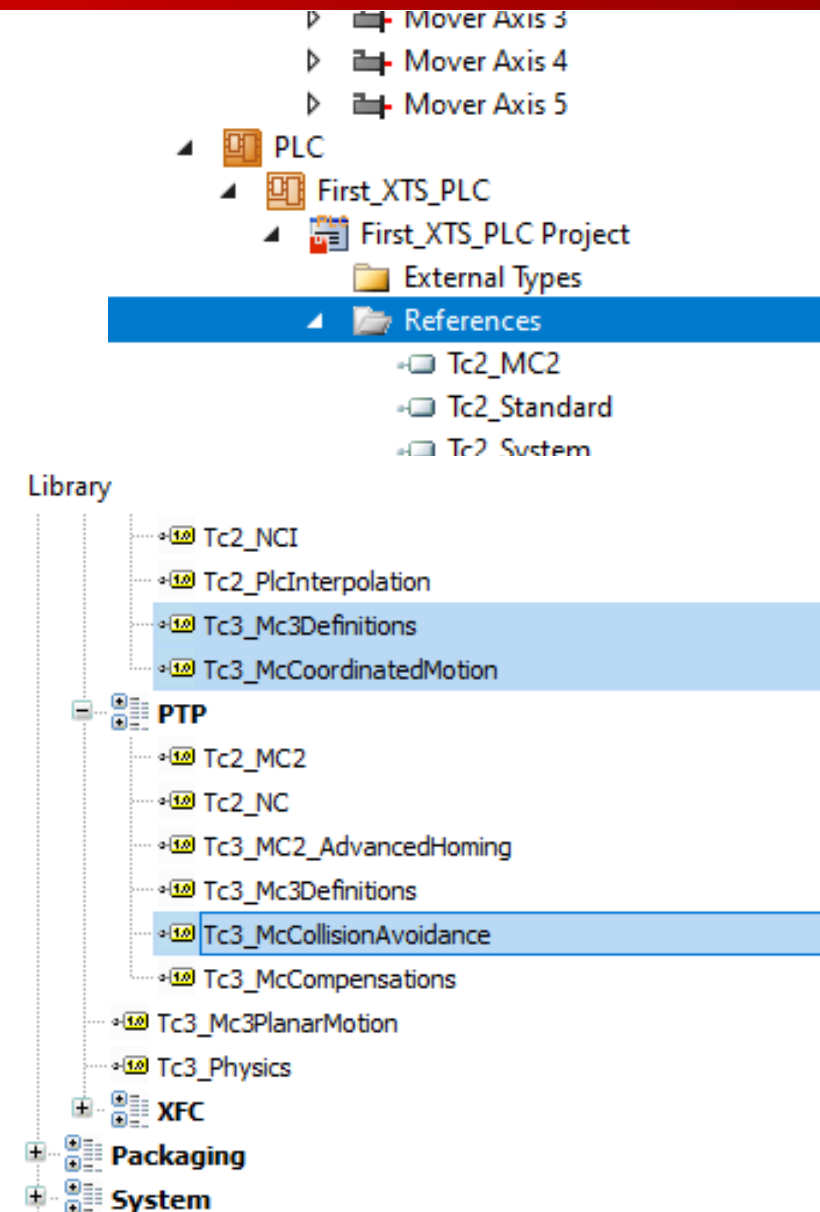


## Necessary PLC-Libraries Collision Avoidance

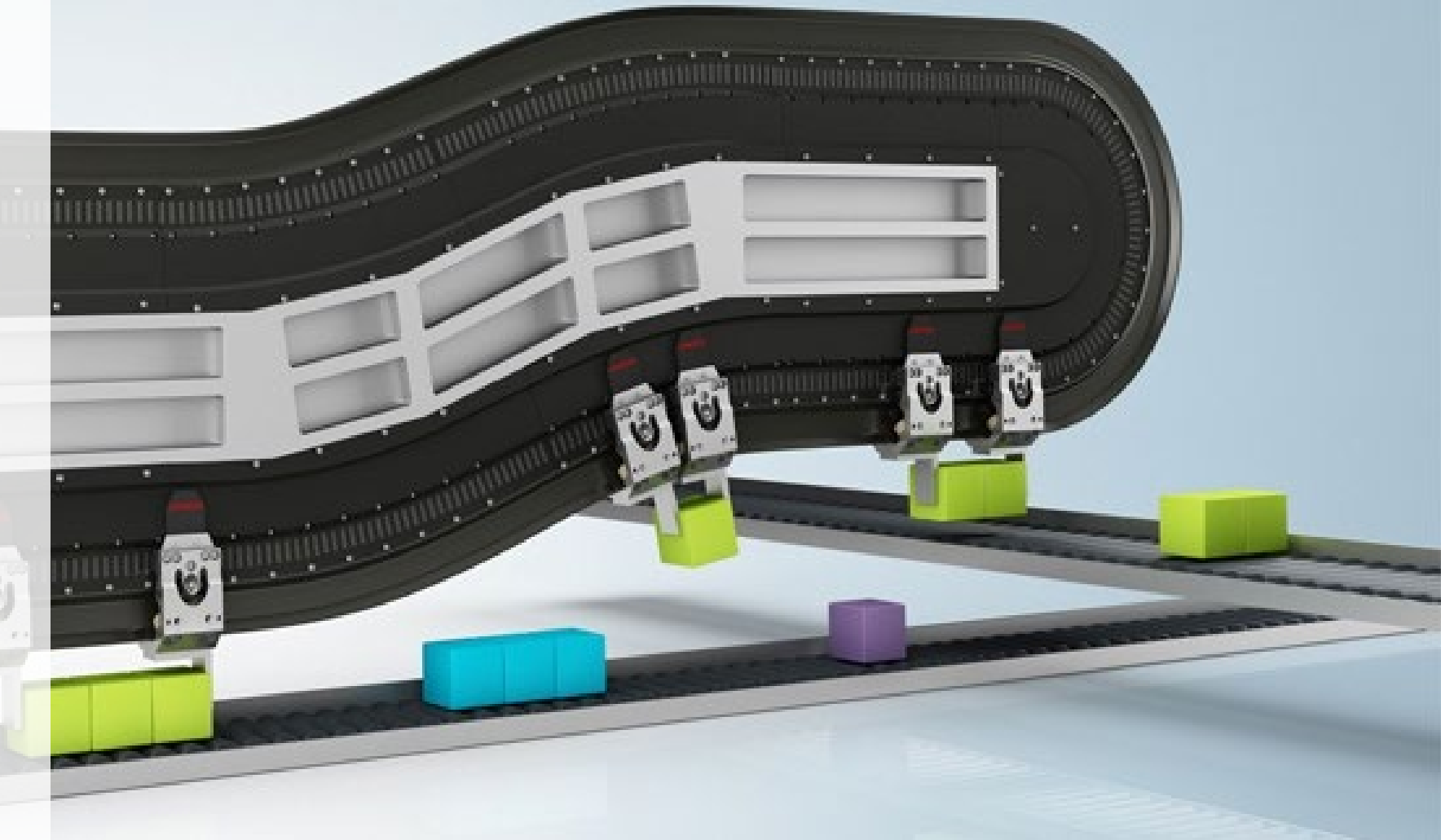


## Necessary PLC-Libraries Collision Avoidance

- Tc3\_McCollisionAvoidance  
Library containing control function blocks for Collision Avoidance
- Tc3\_McCoordinatedMotion  
Library containing control function blocks for Axis Group handling
- Tc3\_Mc3Definitions  
Library with definition for the motion functions



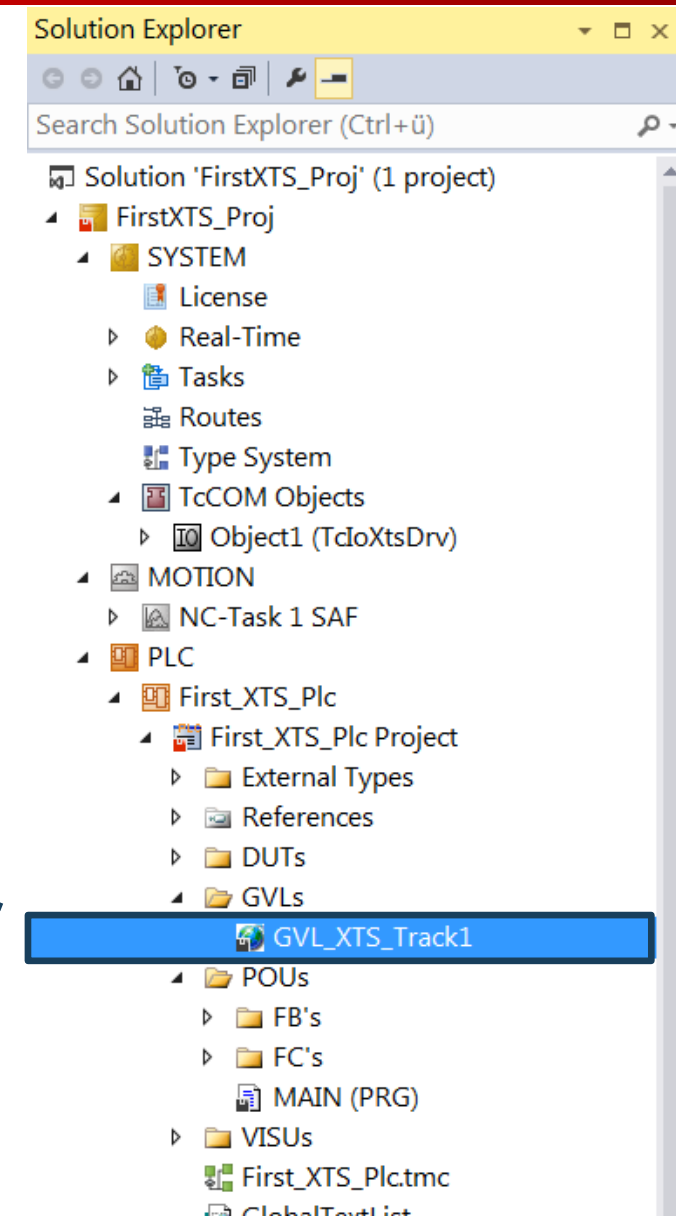
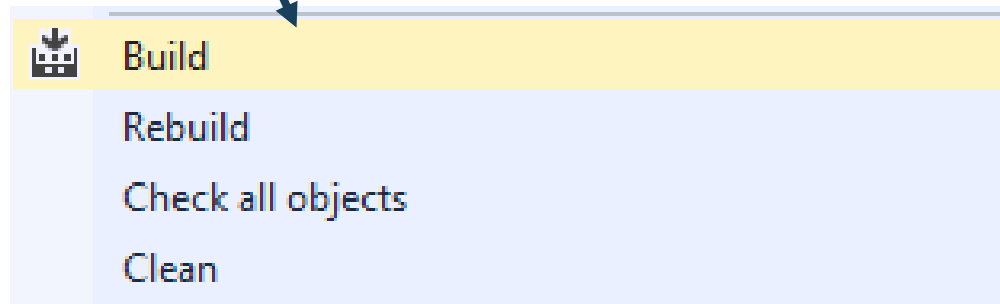
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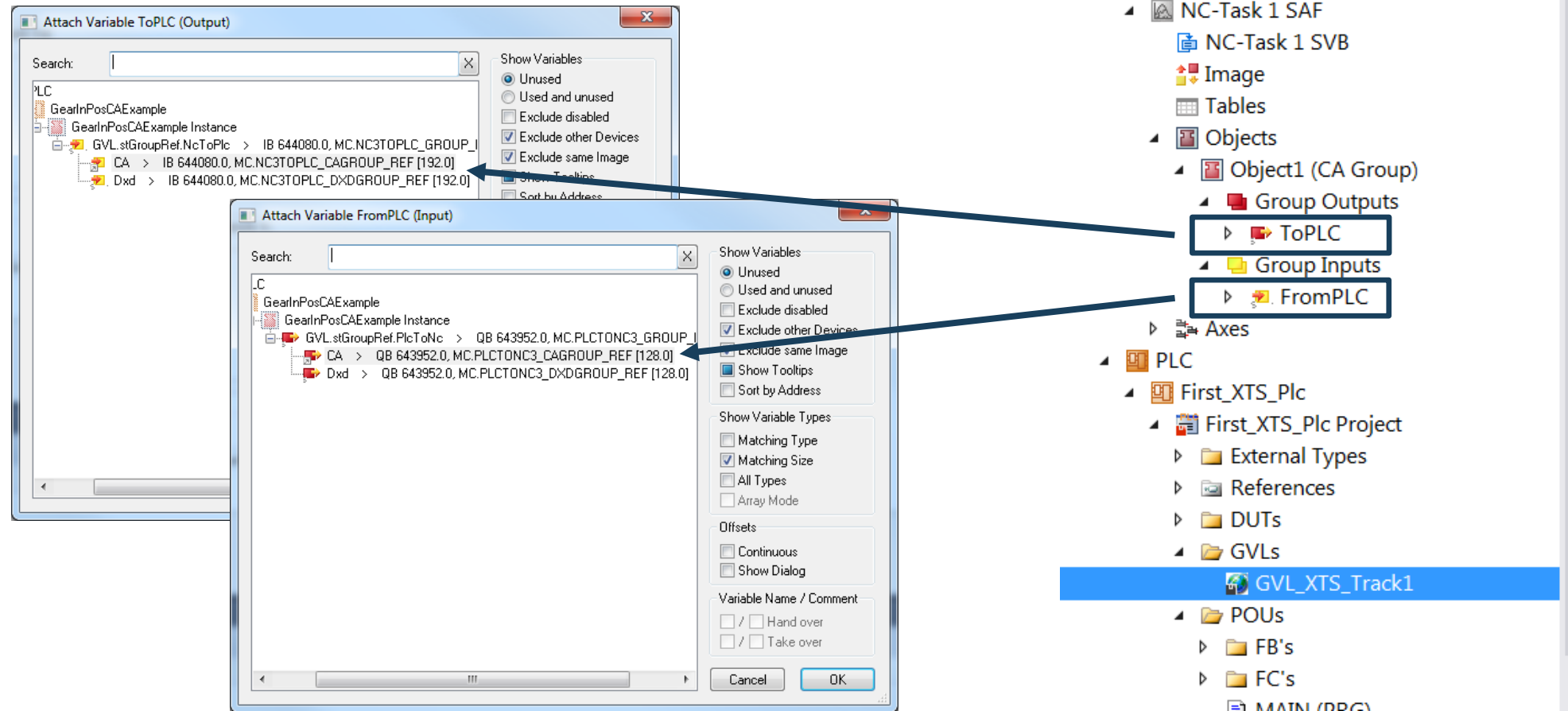
## ■ AXES\_GROUP\_REF for linking to the CA Group Object

- definition of AXES\_GROUP\_REF
  - AXES\_GROUP\_REF interface provides the cyclical data exchange between PLC and a NC group object.

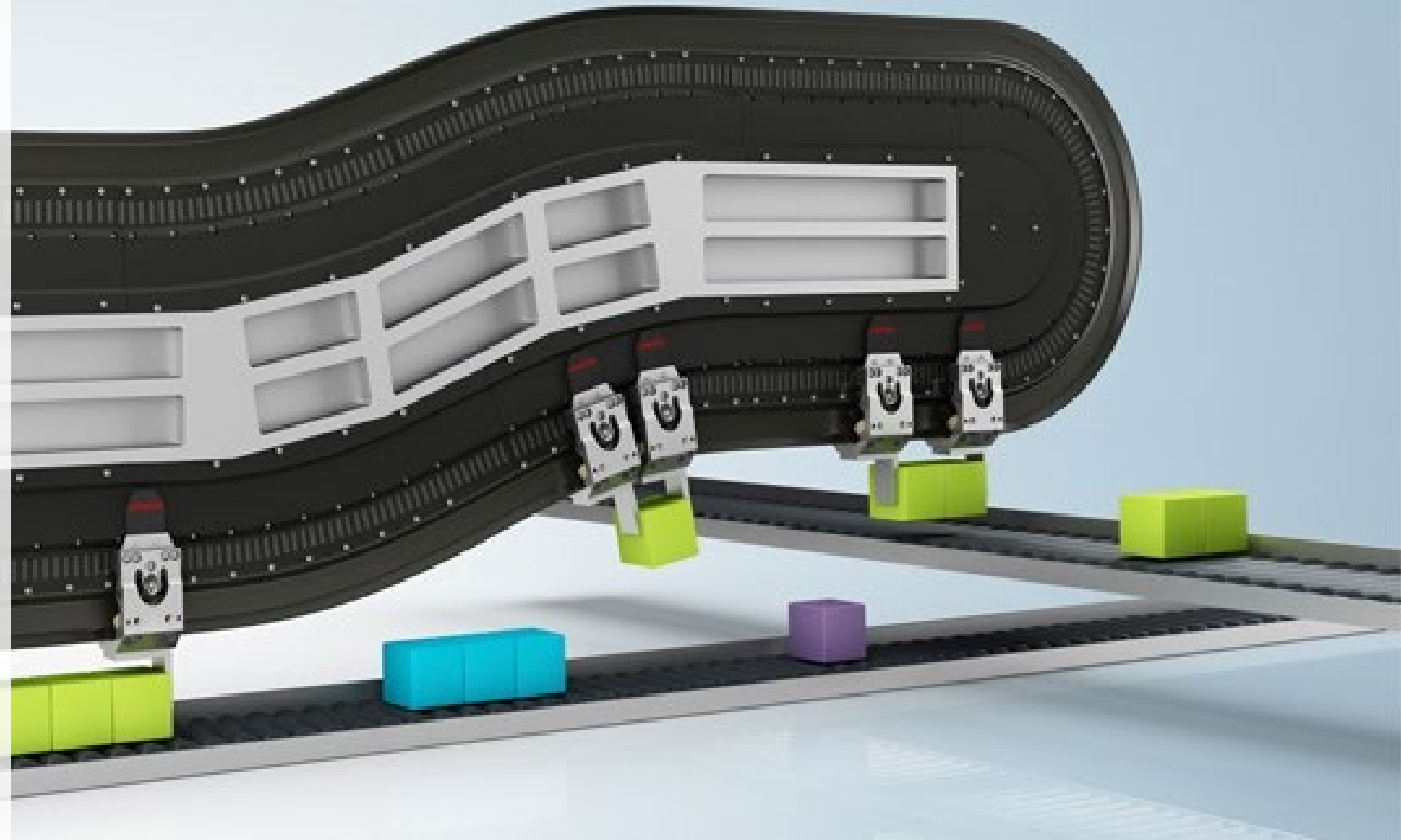
```
VAR_GLOBAL
    // IO-Interface to the CA-Group_object
    stCaGroupRef : AXES_GROUP_REF;
END_VAR
```



- **AXES\_GROUP\_REF** for linking then PLC with the CA Group Object
  - link the AXES\_GROUP\_REF to the CA-Group

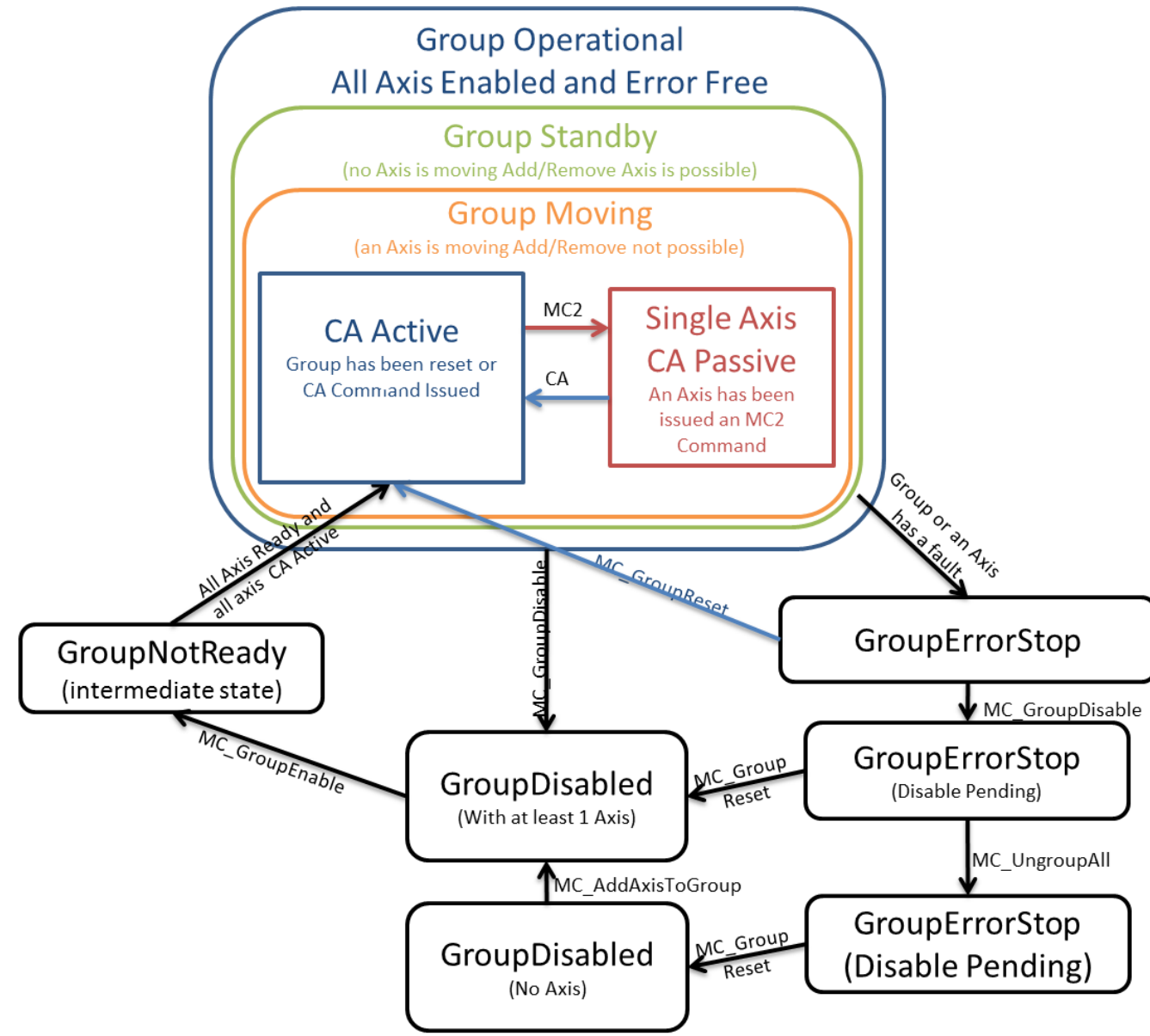


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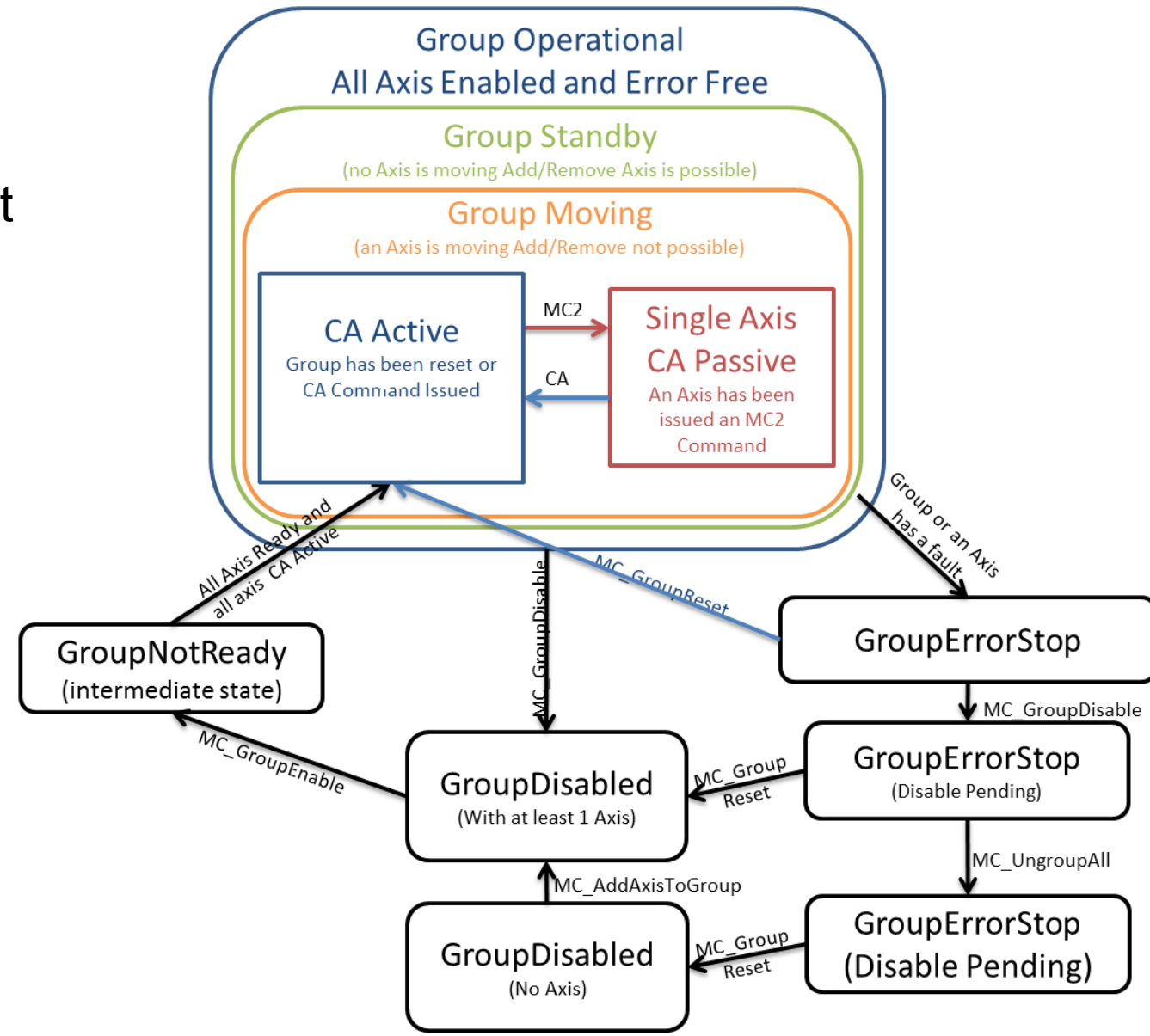
# Collision avoidance State Model



## Collision avoidance State Model

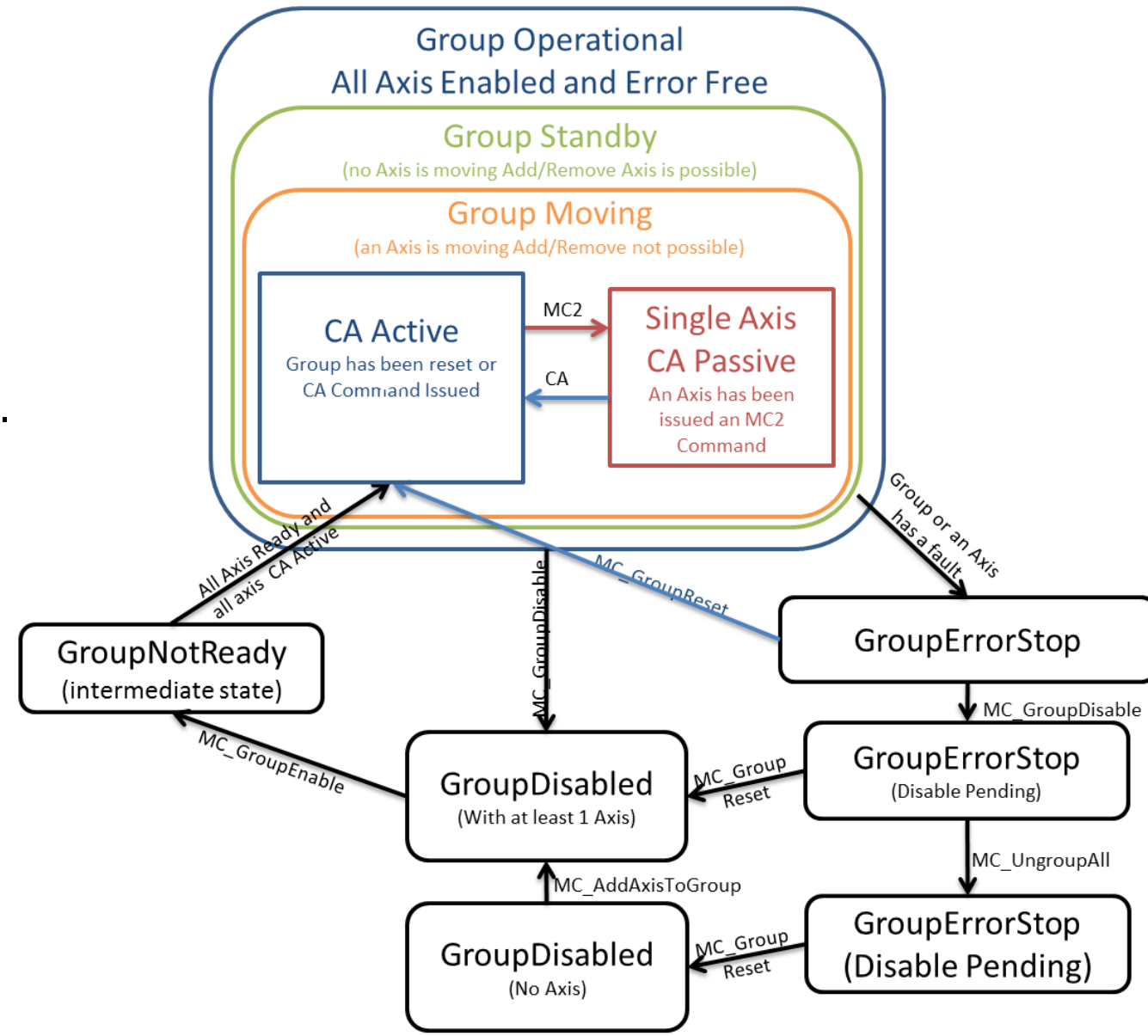
There are effectively 3 Group states that effect a Collision Avoidance axis.

1. Operational (Standby or Moving)
2. GroupErrorState (Faulted and Enabled, Faulted with Disable Pending, Faulted with Ungroup all pending)
3. Group Disabled (with at least 1 Axis or without any axis)



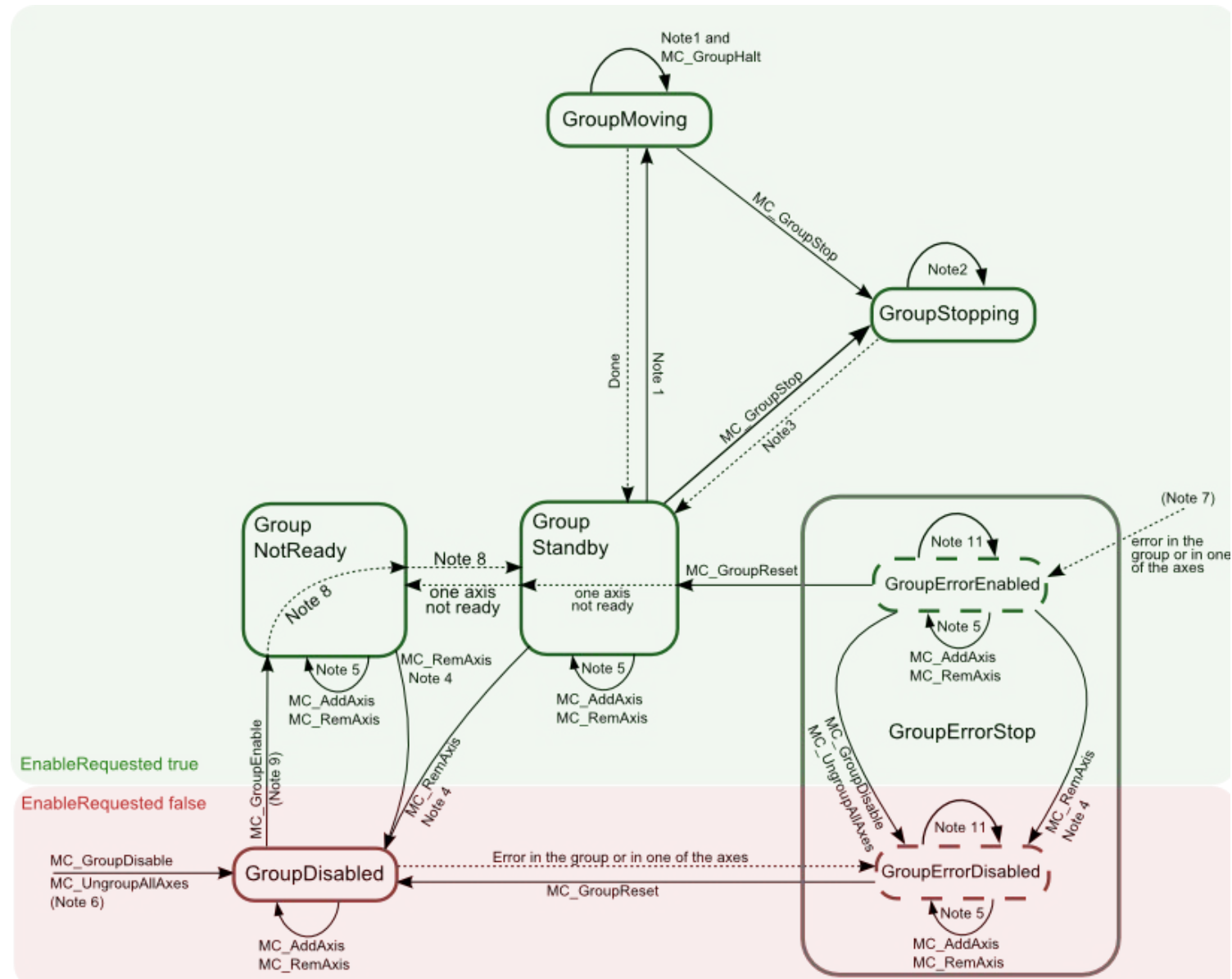
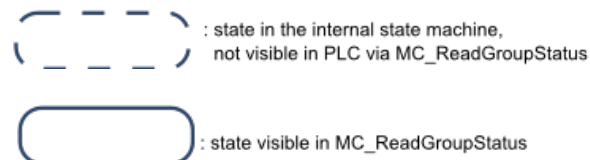
## Collision Avoidance State Model

- A group without any axes is always disabled - it cannot be enabled.
- GroupNotReady is a short transitional state or waiting for axis to be enabled.
- GroupErrorState is a special state. The only method to leave this state is to issue a GroupReset.
- However, Group Reset will have different outcomes depending on the next requested or required state.

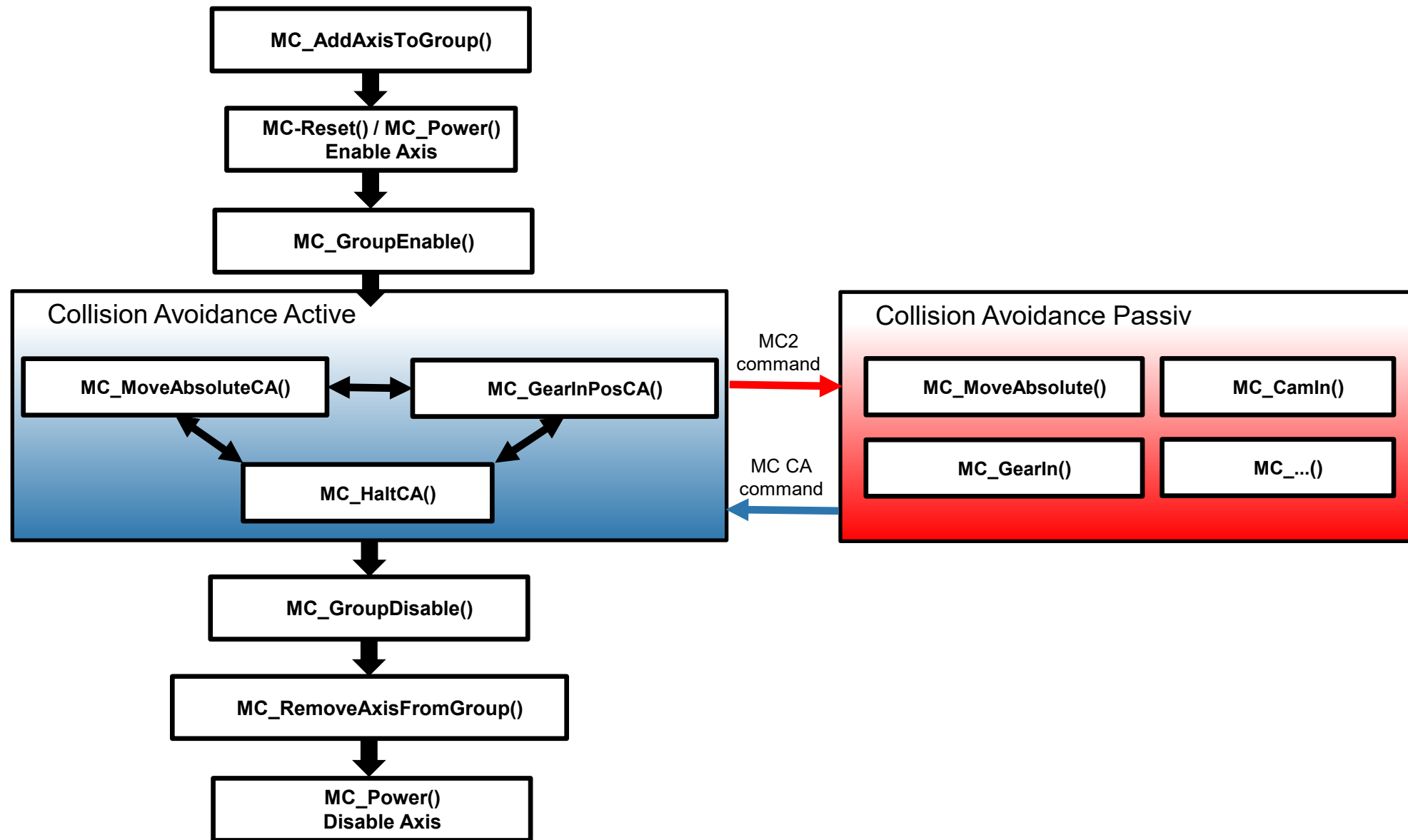


## Collision Avoidance State Model

- simpler presentation



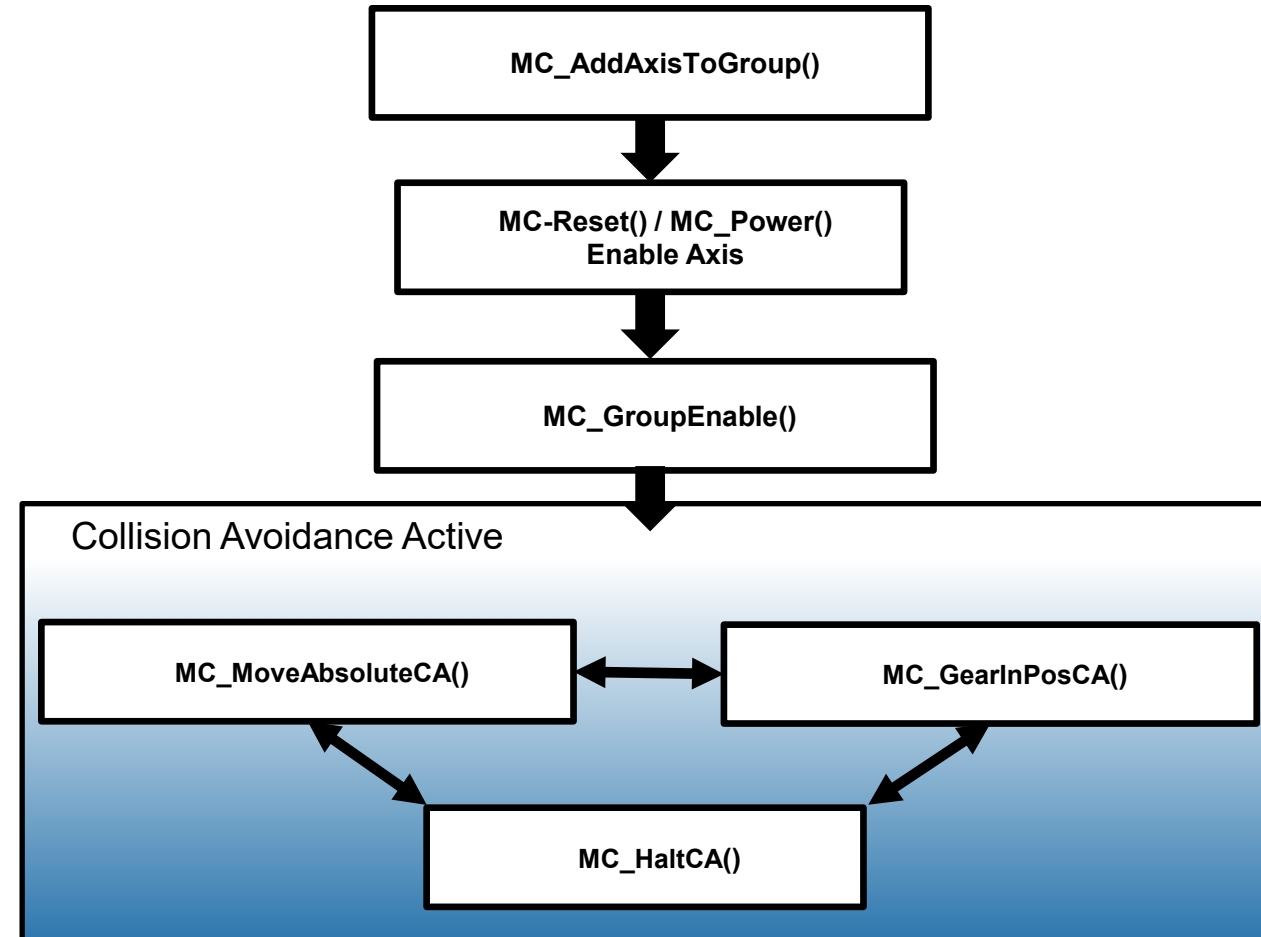
## Full Sequence



## Full Sequence

Startup Sequence:

1. Add All Axes to the group
2. Reset/Enable All axes  
(ensure all axes are enabled  
and error free)
3. Enable the Group

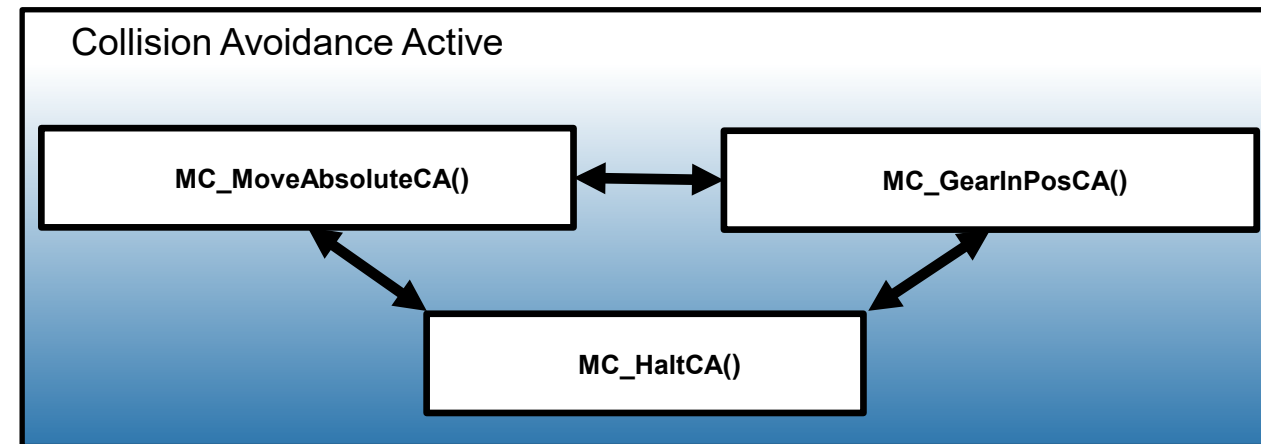


## Full Sequence

Collision avoidance is active :

If Standby Gap is active the movers will separate

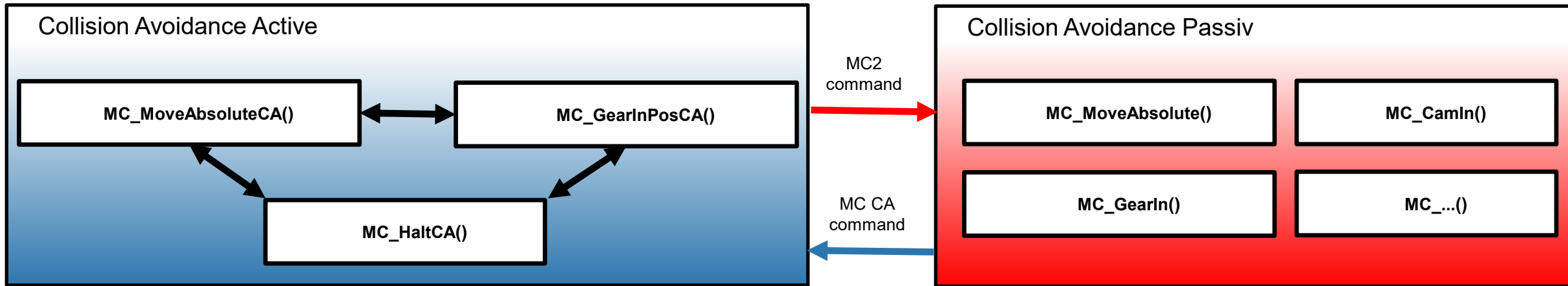
Should a failure occur, GroupReset will return the system to the running state





## Full Sequence

- By using a MC2-Command the axis change in “CA-Passiv”



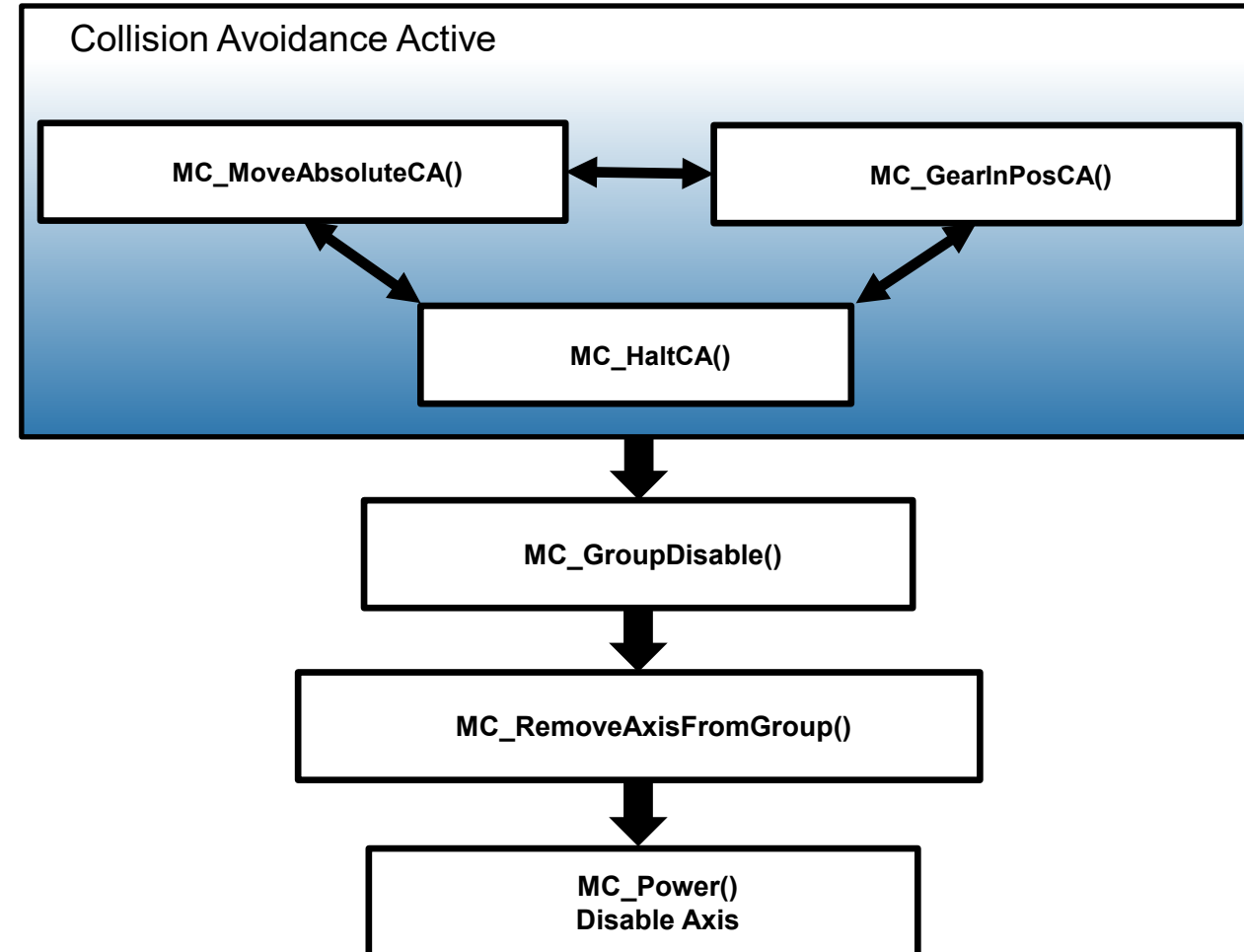
- With using a MC\_CA-Command the Axis change in “CA-Active”

## Full Sequence

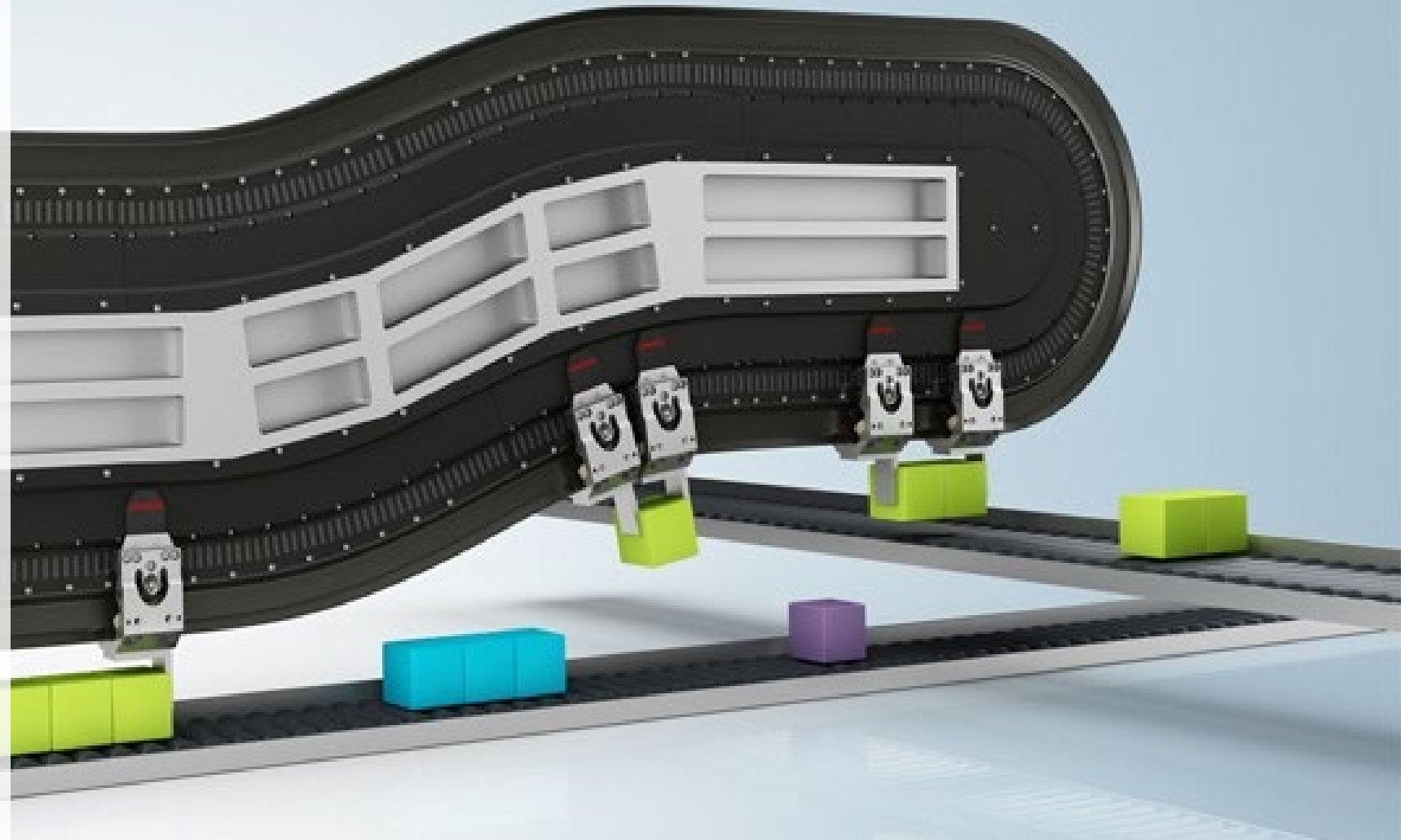
Reset or Shutdown Sequence:

Halt-Command for all Movers

1. Disable Group
2. Remove all Axes from Group
3. Disable Axes



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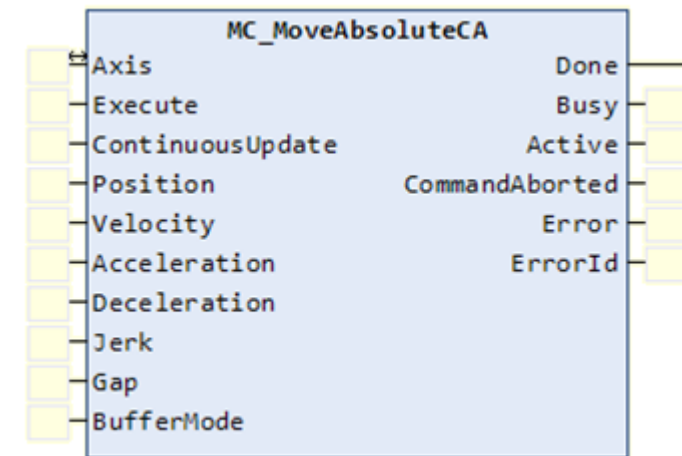
## MC\_MoveAbsoluteCA

This function block commands the specified mover to the specified absolute position according to the parameterized gap of the collision avoidance input.

The collision avoidance functionality has higher priority than the absolute motion command.

During execution of the move, the axis may slow down or stop and wait to avoid a collision. The axis will prioritize maintaining the gap overreaching the destination position. When the path is clear the axis will complete the absolute position command.

The Done output of the function block will become True when the target position has been reached.

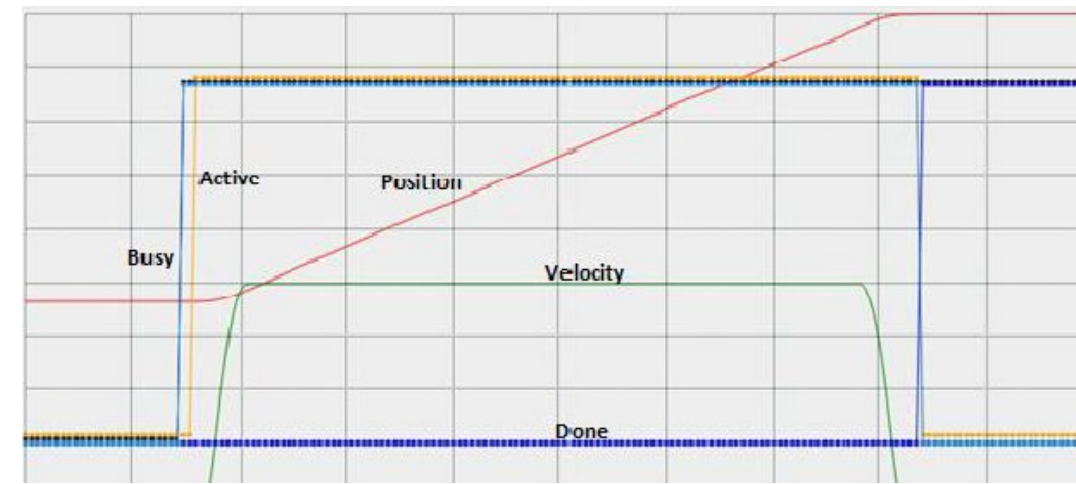
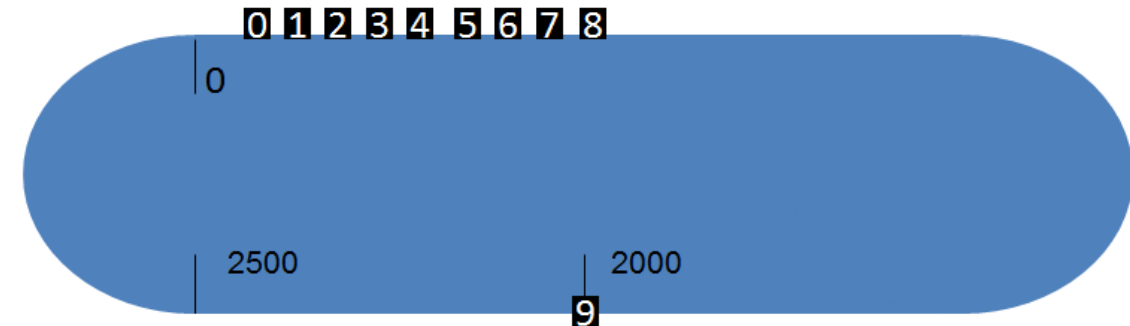
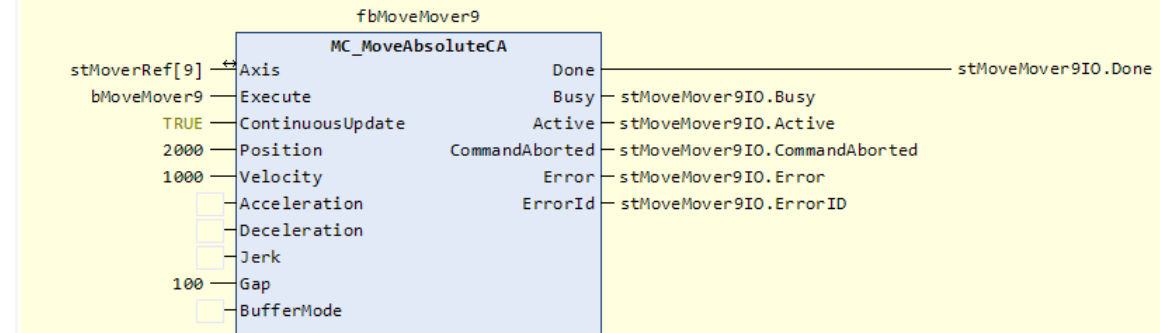


## MC\_MoveAbsoluteCA

Mover 9 is free to move towards the target position of 2000 with a velocity of 1000.

Once the target position is reached, Done becomes True and Busy and Active become False.

The move has been completed successfully and mover 9 is now at position 2000.



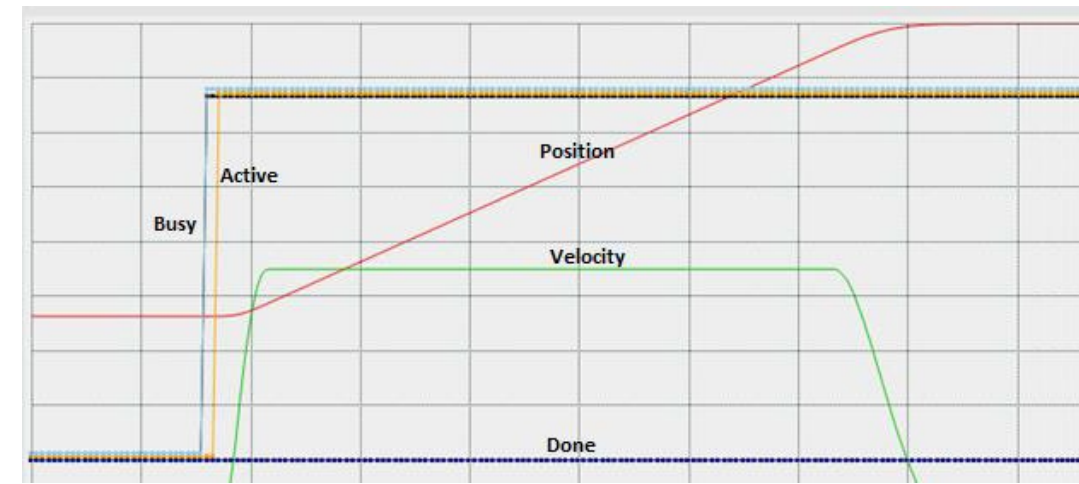
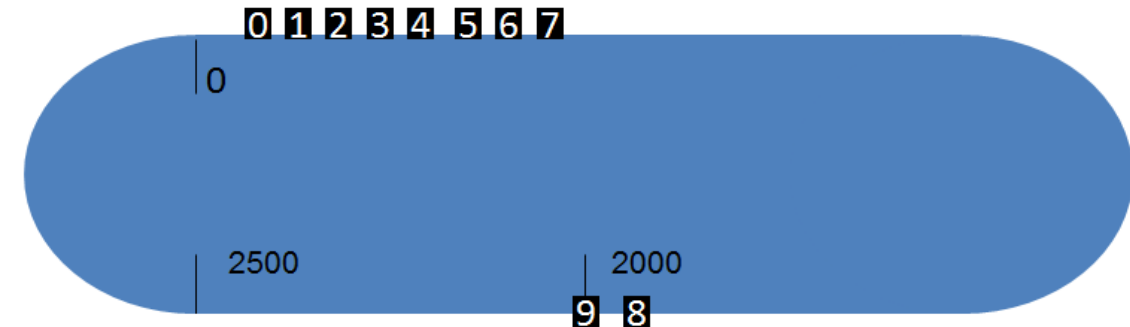
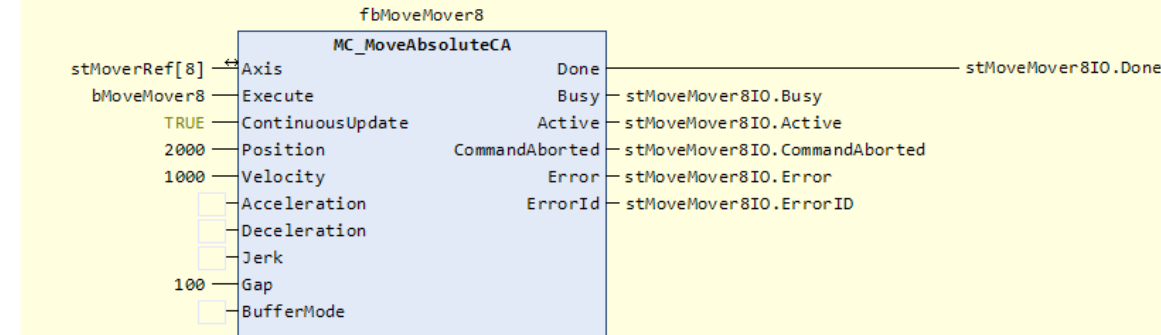
## MC\_MoveAbsoluteCA

Mover 8 is commanded to move to the same position as Mover 9; however, Mover 9 is in the way. Collision Avoidance will prevent Mover 8 from reaching position 2000 but it will also prevent Mover 8 from colliding with Mover 9.

The profile of Mover 8 will look as follows.

Mover 8 stops to maintain the gap spacing but the Active bit and the Busy bit remain true and Done remains false.

This move is not complete.



## MC\_MoveAbsoluteCA

Mover 9 is free to move towards the target position of 2500 with a velocity of 1000.

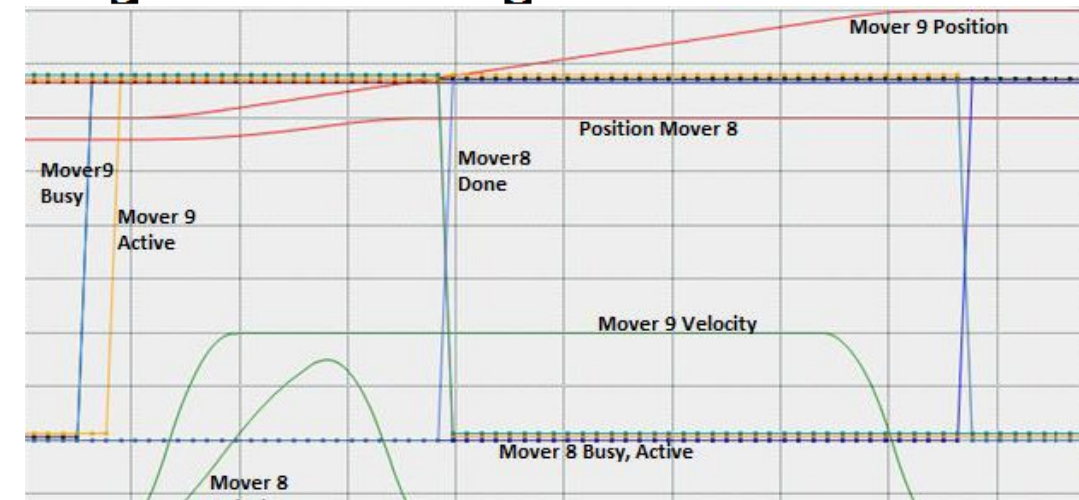
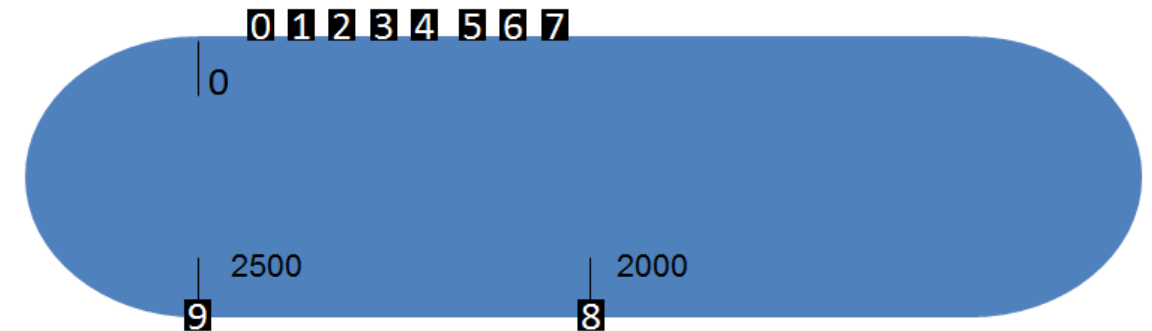
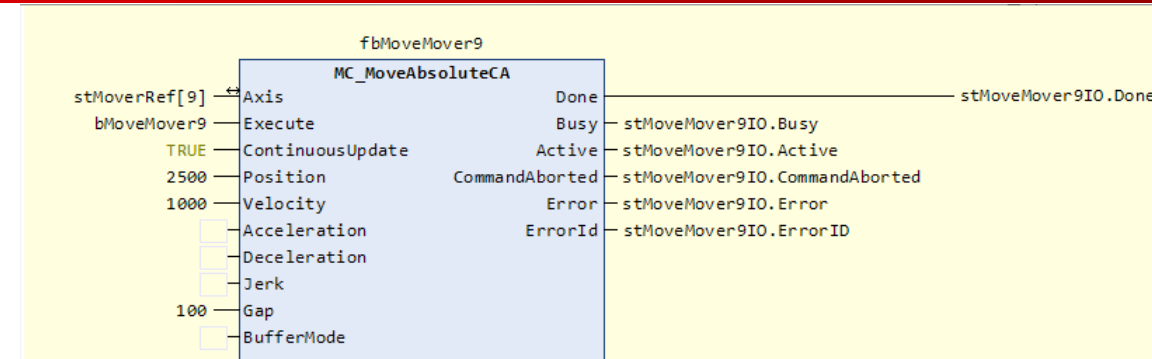
Mover 9 starts to move out of the way.

Mover 8 begins to move, ramps up its velocity and then stops in its final target position, “2000”.

Mover 8’s Busy and Active bits become false and the done bit for Mover 8 is set.

Mover 8’s mover is now complete.

Then finally mover 9 completes its commanded move.





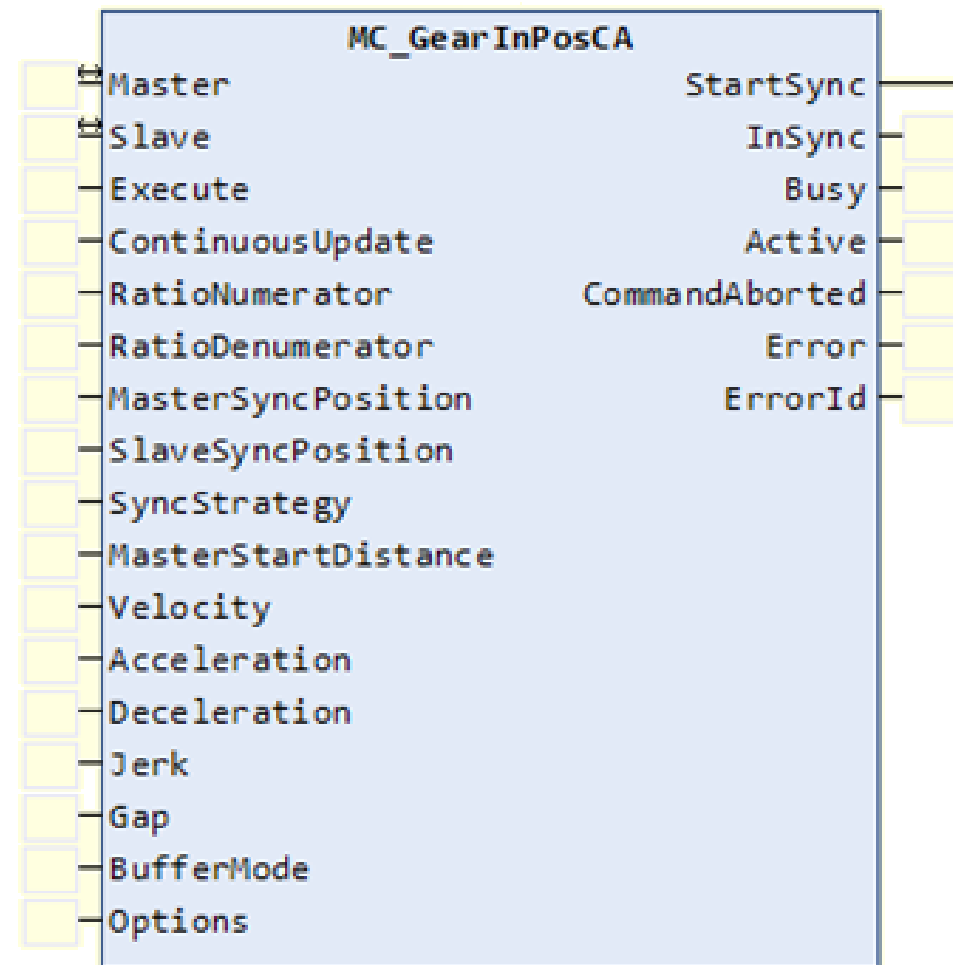
## MC\_GearInPosCA

This function block couples a slave axis to a master axis.

The set values for both axes are calculated based on the master axis set values.

Like all collision avoidance commands, priority is given to satisfying collision avoidance.

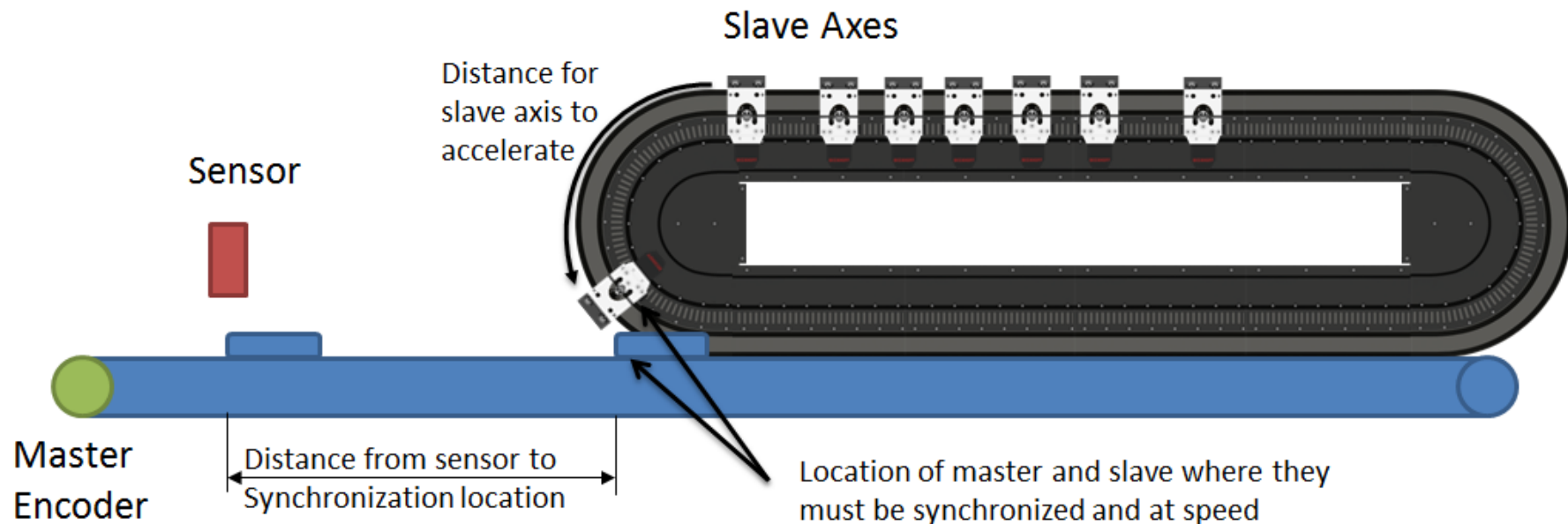
Completion of the commanded move occurs when there is no possibility of striking another axis or violating the collision avoidance gap.



## MC\_GearInPosCA

A typical use for the MC\_GearInPosCA block is to synchronize a mover to a product on a conveyor. To accomplish this, the conveyor is equipped with a servo motor or encoder and a sensor is used to mark positions of products on the conveyor.

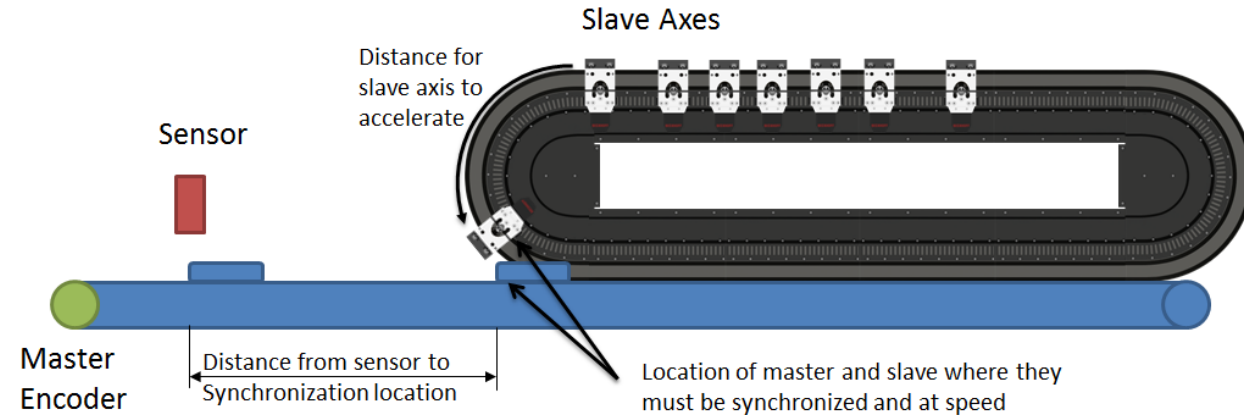
In all cases, Gap control overrides the move command, if the mover would approach another axis, it will slow down regardless of the command issued.



## MC\_GearInPosCA

Input „SyncStrategy“  
from Type MC\_SYNC\_STRATEGY

This data type defines the synchronization  
profile of the slave



### TYPE MC\_SYNC\_STRATEGY

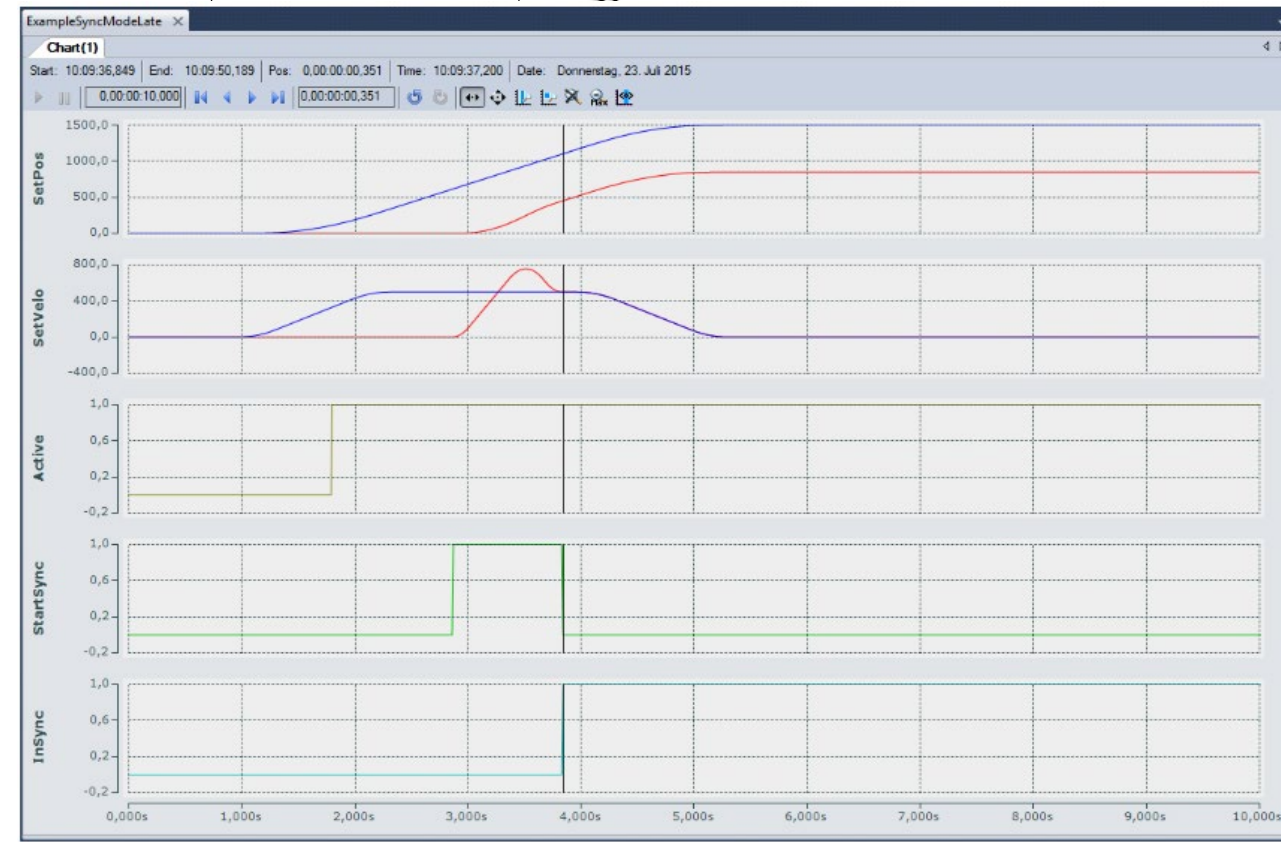
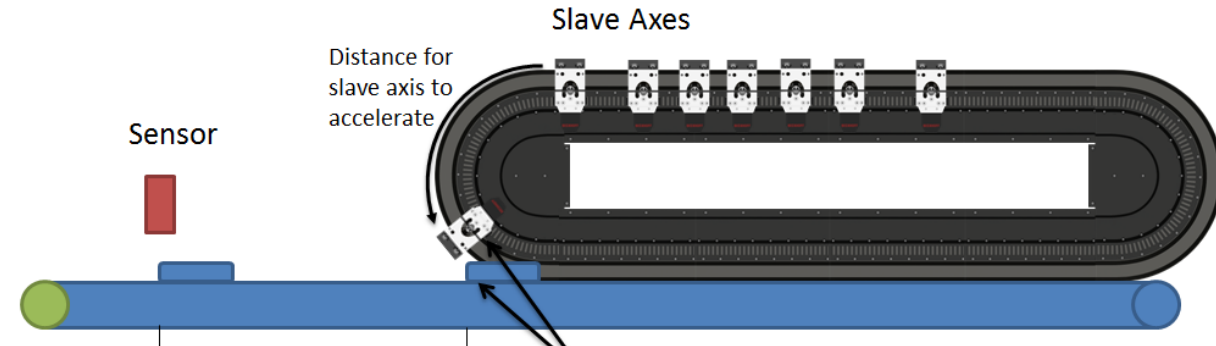
mcSyncStrategyLate	16#1
mcSyncStrategySlow	16#2
mcSyncStrategyEarly	16#3

## MC\_GearInPosCA

mcSyncStrategyLate

The slave starts the synchronization as late as possible and with full dynamics (according to the input values velocity, acceleration, deceleration, jerk).

It reaches the SlaveSyncPosition just in time with the correct gear ratio.

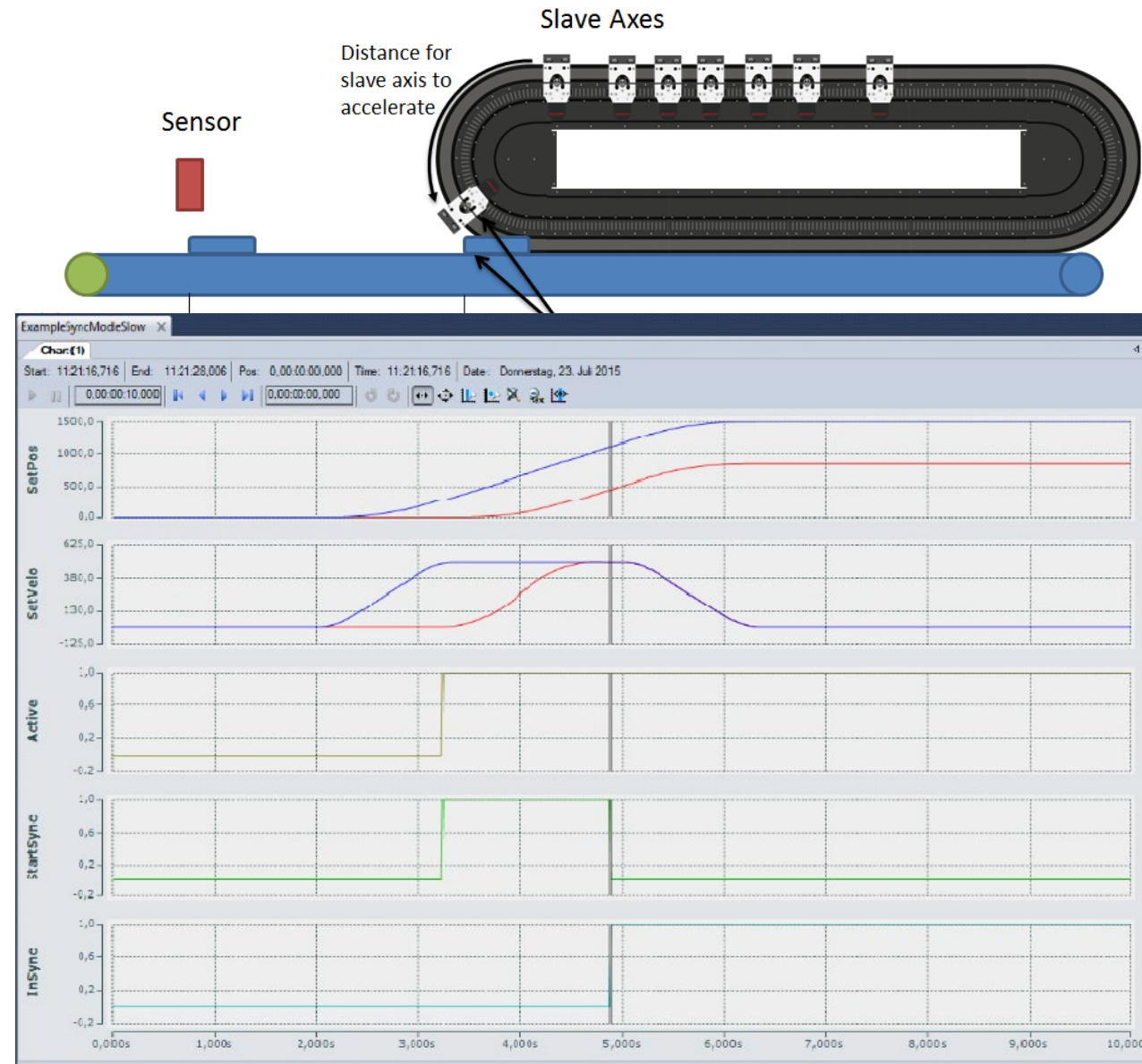


## MC\_GearInPosCA

### mcSyncStrategySlow

The slave starts its sync in motion as soon as the master passes the MasterStartDist (MasterSyncPosition - MasterStartDistance). If the MasterStartDist is not set then the motion begins as soon as the FB is Active.

The dynamics of the slave are reduced such that the slave reaches the SlaveSyncPos with the correct gear ratio just in time when the master reaches the MasterSyncPos.





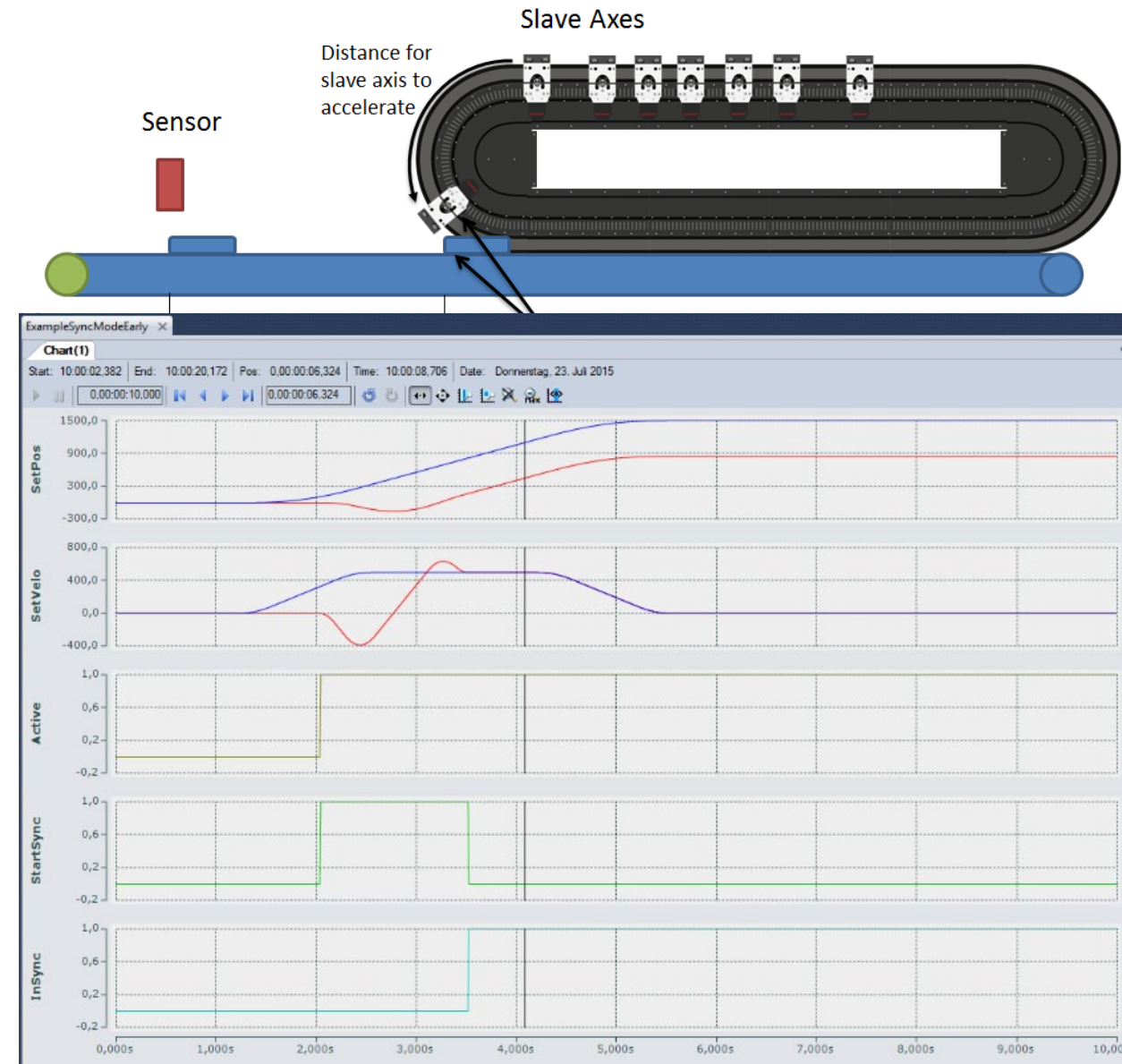
## MC\_GearInPosCA

### mcSyncStrategyEarly

The slave starts its motion as soon as the master passes the MasterStartDist. If the MasterStartDist is not set then the motion begins as soon as the FB is Active.

The dynamics are not reduced.

The slave signals earlier InSync than demanded by the SlaveSyncPosition, but it is still guaranteed that the demanded offset between master and slave ( $\text{MasterSyncPosition} - \text{SlaveSyncPosition}$ ) is reached with the correct gear ratio.





**Complex sequences – simplified solution:  
XTS**

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