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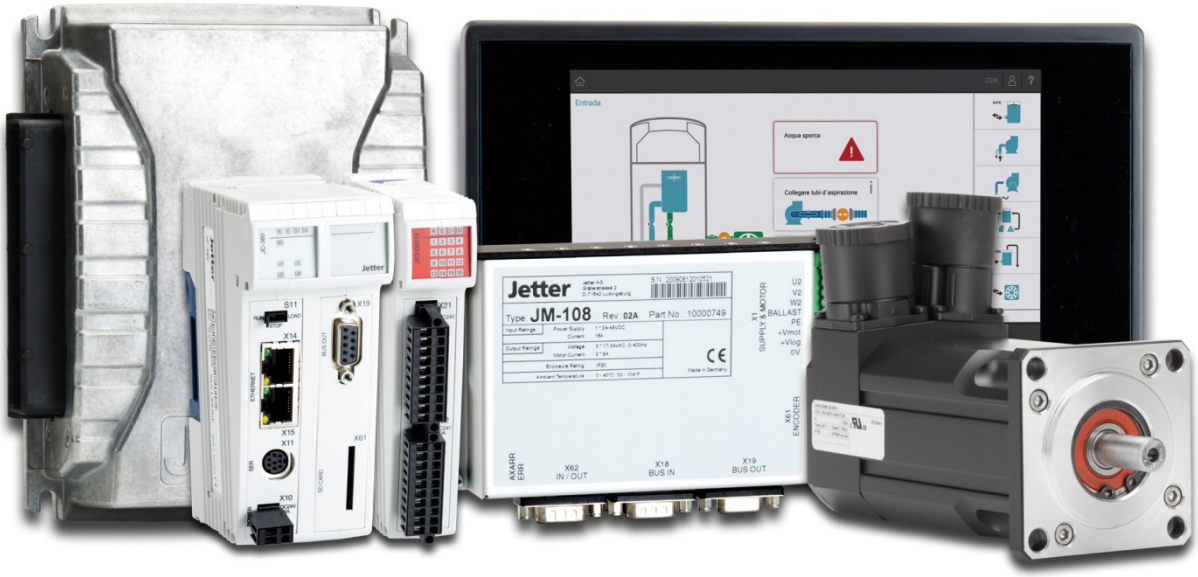

Motion Control - Electrical Gearbox in a Technology Group

Application Note 050

608 847 53_00

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Table of Contents

1 Introduction

1.1 Purpose

This application note shows how an "electrical gearbox" can be used in a technology group. The aim here is to show

- what options the Motion Setup offers;
- how it is programmed in an application using MotionAPI.

In particular, it will be shown what options the MCX kernel offers for coupling and decoupling axes and where the differences between the modes lie.
Practical examples are used to illustrate the different application scenarios.

1.2 Prerequisites

- The following versions were used for the code and project examples as well as screenshots:
  - JetSym 5.60

• JC-440MC, OS 1.08.0.00 • Motion API 2.0.0.4	• JC-365MC, OS 1.33.0.00 • Motion API 1.0.0.16

INFO

The differences in the application of Motion Control, in particular the application within a technology network, are minimal, so for simplicity, the procedure for JC365MC is not explicitly mentioned. However, if there are important differences, they are mentioned.

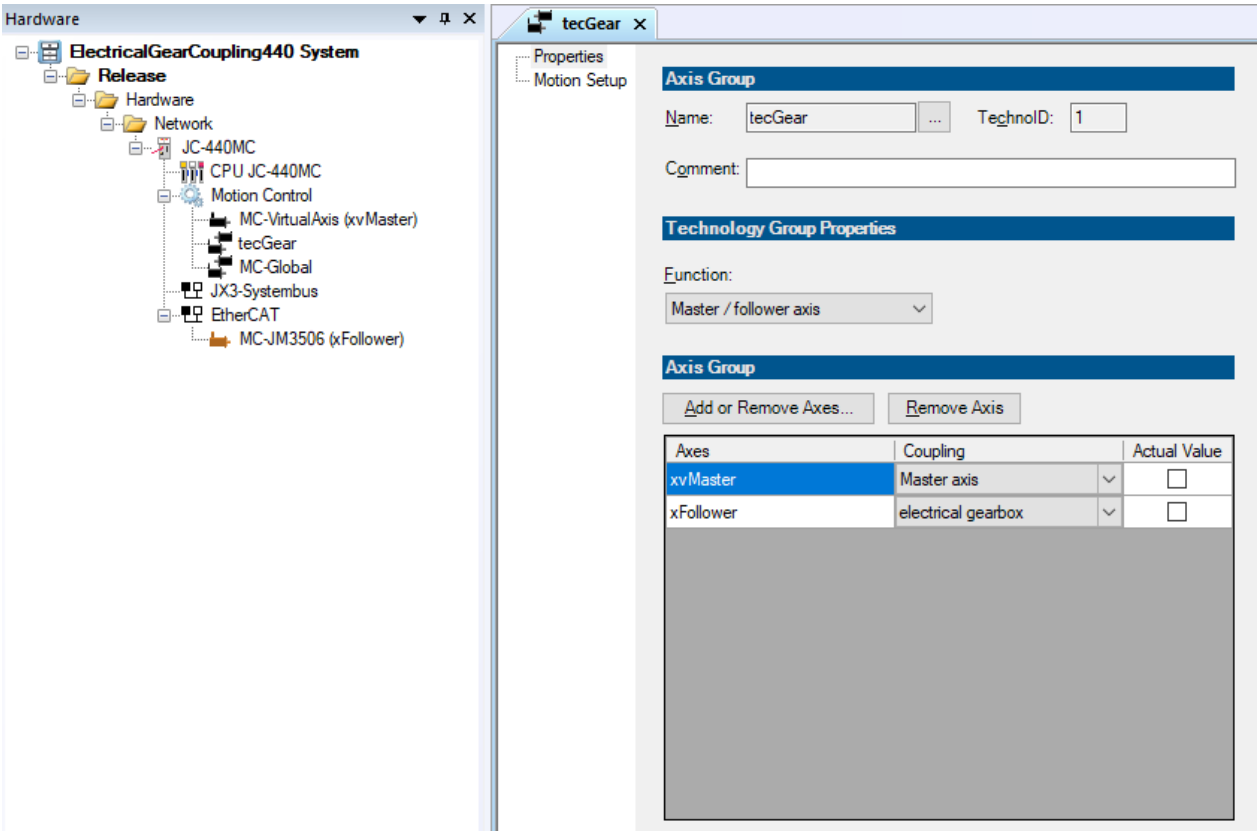
- Application Note "motion_control_apn049_100_technology_group.pdf"

2 Setting up an electrical gearbox in a technology group

In order to set up an electrical gearbox in a group, refer to the Application Note "motion_control_apn049_100_technology_group.pdf".

The following hardware configuration is required for the following chapters:

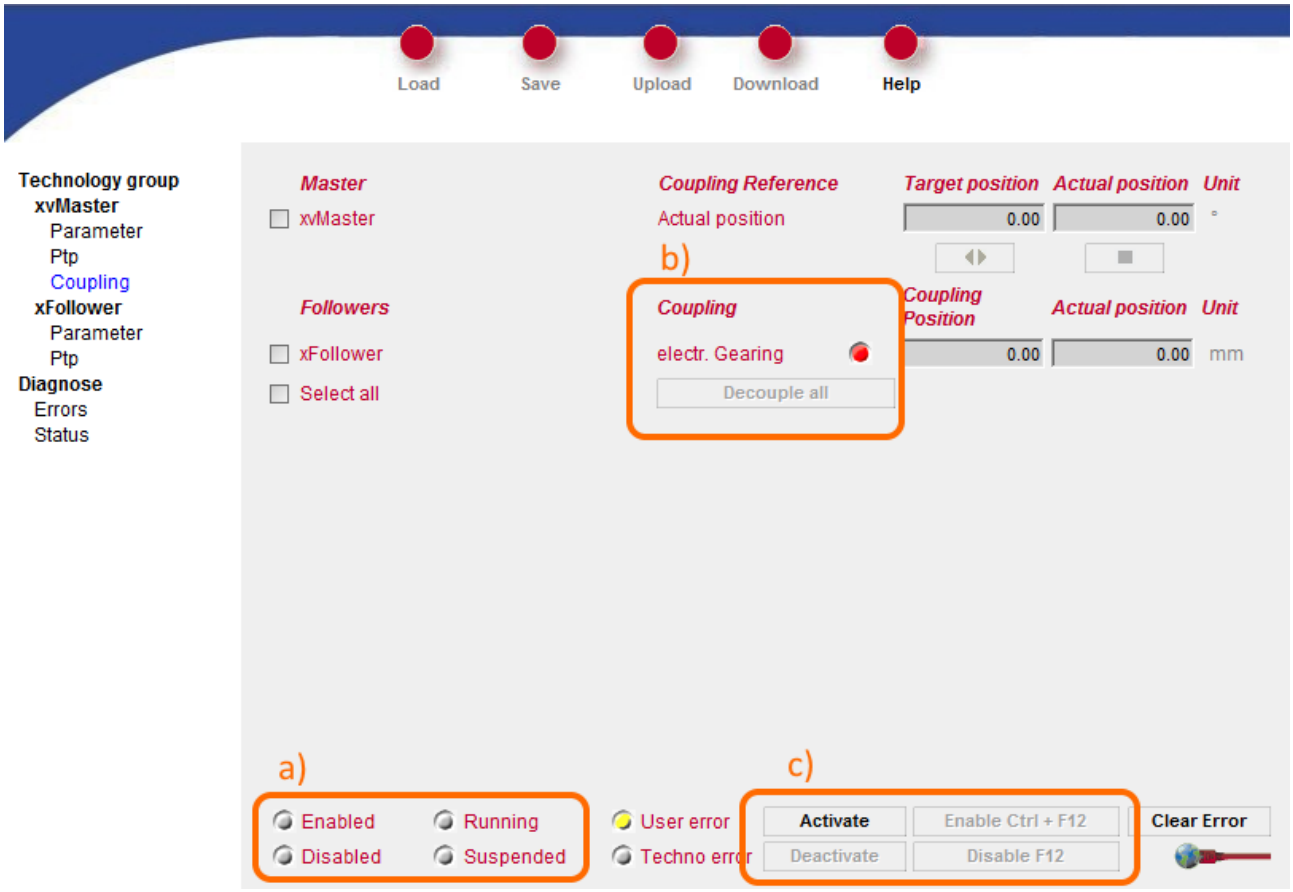
- Master axis "xvMaster": virtual axis, rotatory modulo
- Follower axis "xFollower": Simulation axis, rotatory modulo
- Technology group "tecGear":



Use the "Compare and Download" command to update the configuration on the controller and re-boot it.
After the controller has been restarted, the configuration is ready for use.

3 Operating the electrical gearbox via Motion Setup

The “Technology group/coupling” page in Motion Setup lets you activate/deactivate the electrical gearbox.
xvMaster: Master Axis
xFollower: Follower axis

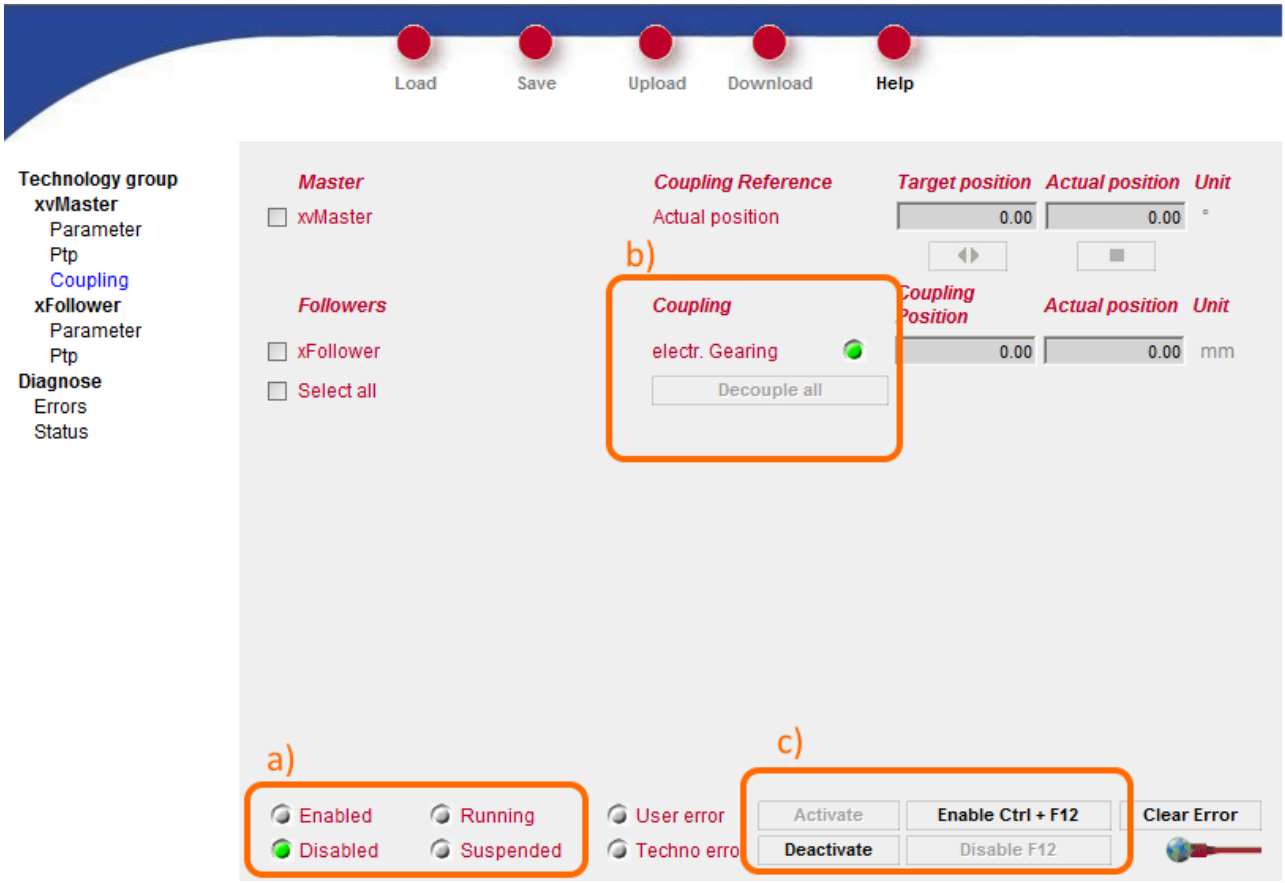


Status after restarting the controller:

a) Displays the operating status of the group. The group is "Deactivated". Therefore, the status indicators are grayed out.
b) The coupling state of the follower axis is displayed here. Member axes coupling states can be seen here as red (uncoupled) and green (coupled).
c) You can either “Activate”, or “Deactivate” the group. Since the group is in the deactivated state, you can only click on the “Activate” button.

3.1 Activating

Click the "Activate" button to activate the group.

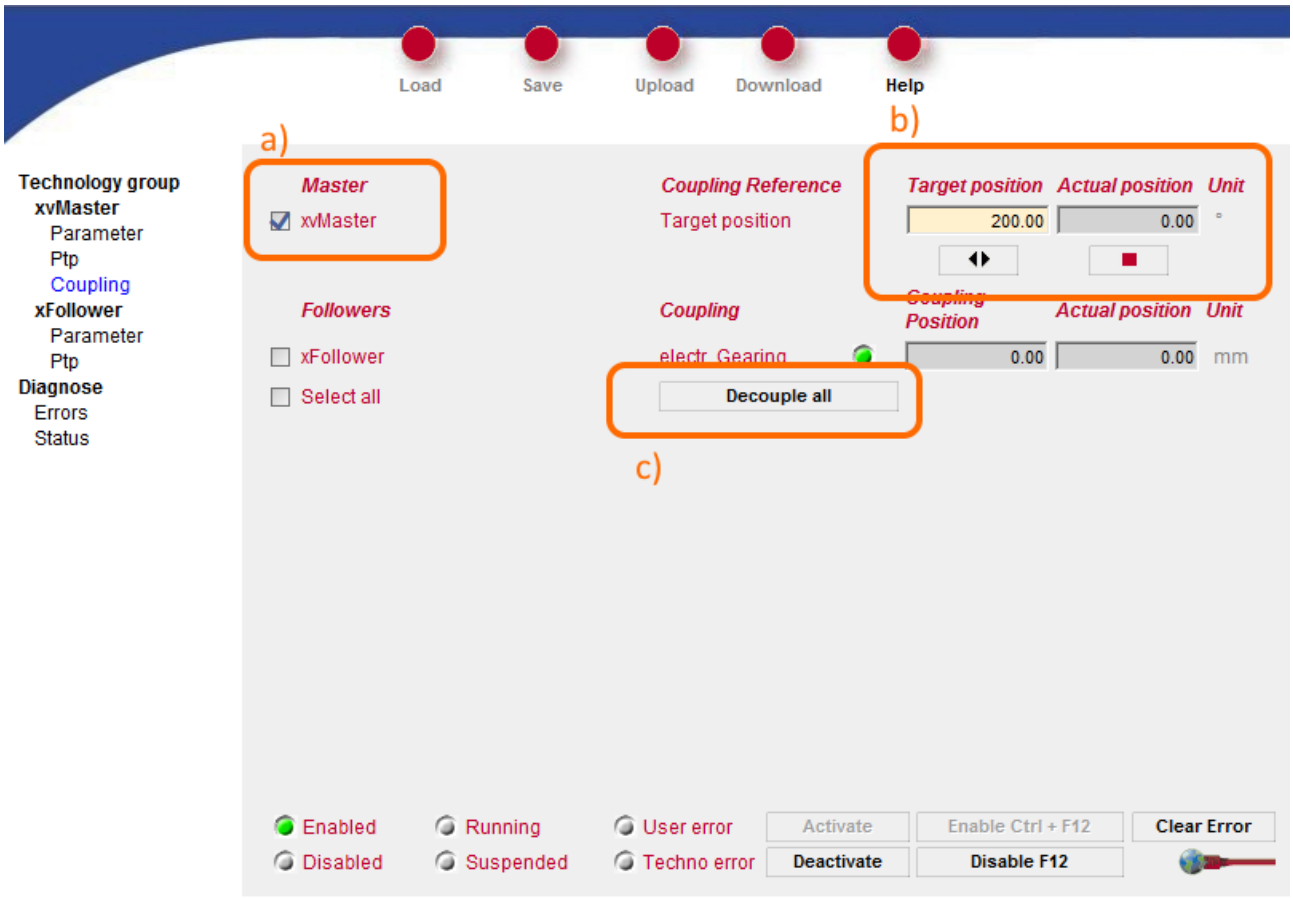


a) By clicking the "Activate" button, the group adopts the axes' previous state, in this case, "Disabled" as indicated in the status display.
b) The default coupling setting for a follower axis of the type "electrical gearbox" is "Coupled" (green) after activating the group.
c) With the group state now activated, the Enable/Disable functionality is now usable. It is also possible to deactivate the group using the "Deactivate" button.

3.2 Manual positioning of the electrical gearbox

For testing, the axis can be moved on the "Coupling" page. On this page, you can not only monitor the movement of the coupled follower axis by positioning the master axis, but also move all axes to a position from which they can start moving together in a coupled motion.

3.2.1 Moving the master axis

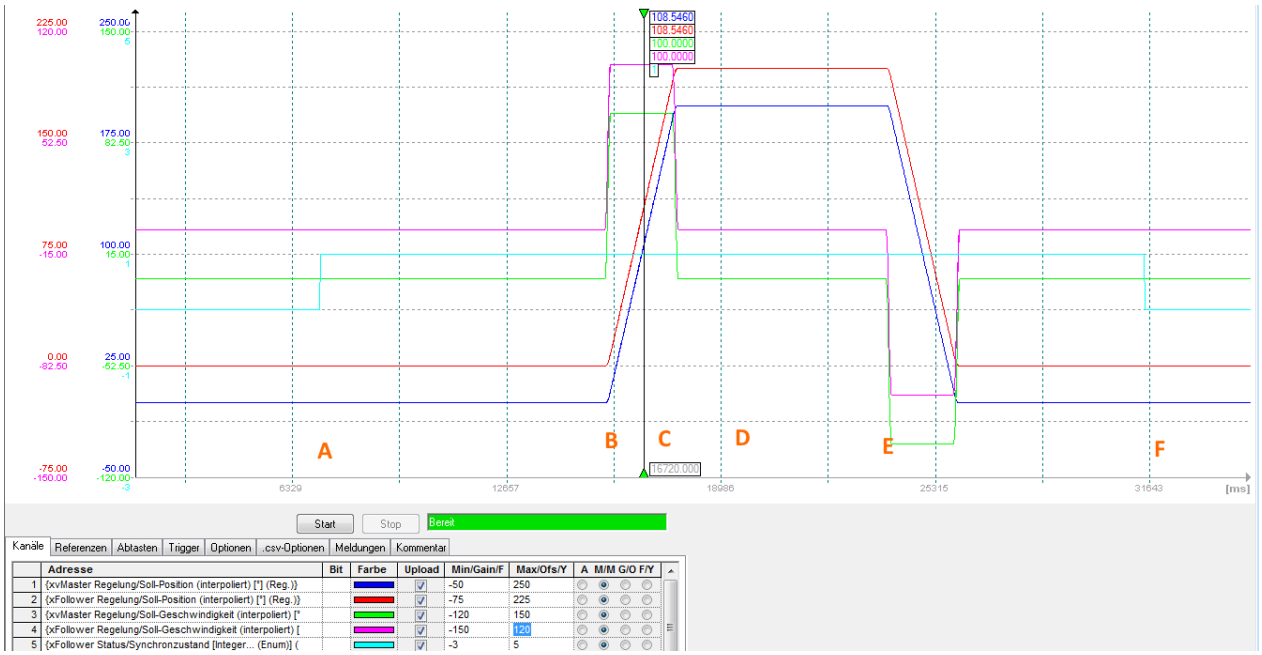


a) If you check the "xvMaster" box, the edit box and the associated controls are enabled.

b) Now you can enter a target position here, e.g. 200°. Press ◆▶ to start positioning, and ■ to stop it. In the Actual position display you can monitor the change in position of the master and follower axes.

c) With "Decouple all" all follower axes are decoupled so that they no longer follow the movement of the master axis.

3.2.1.1 Display of a motion sequence in the oscilloscope



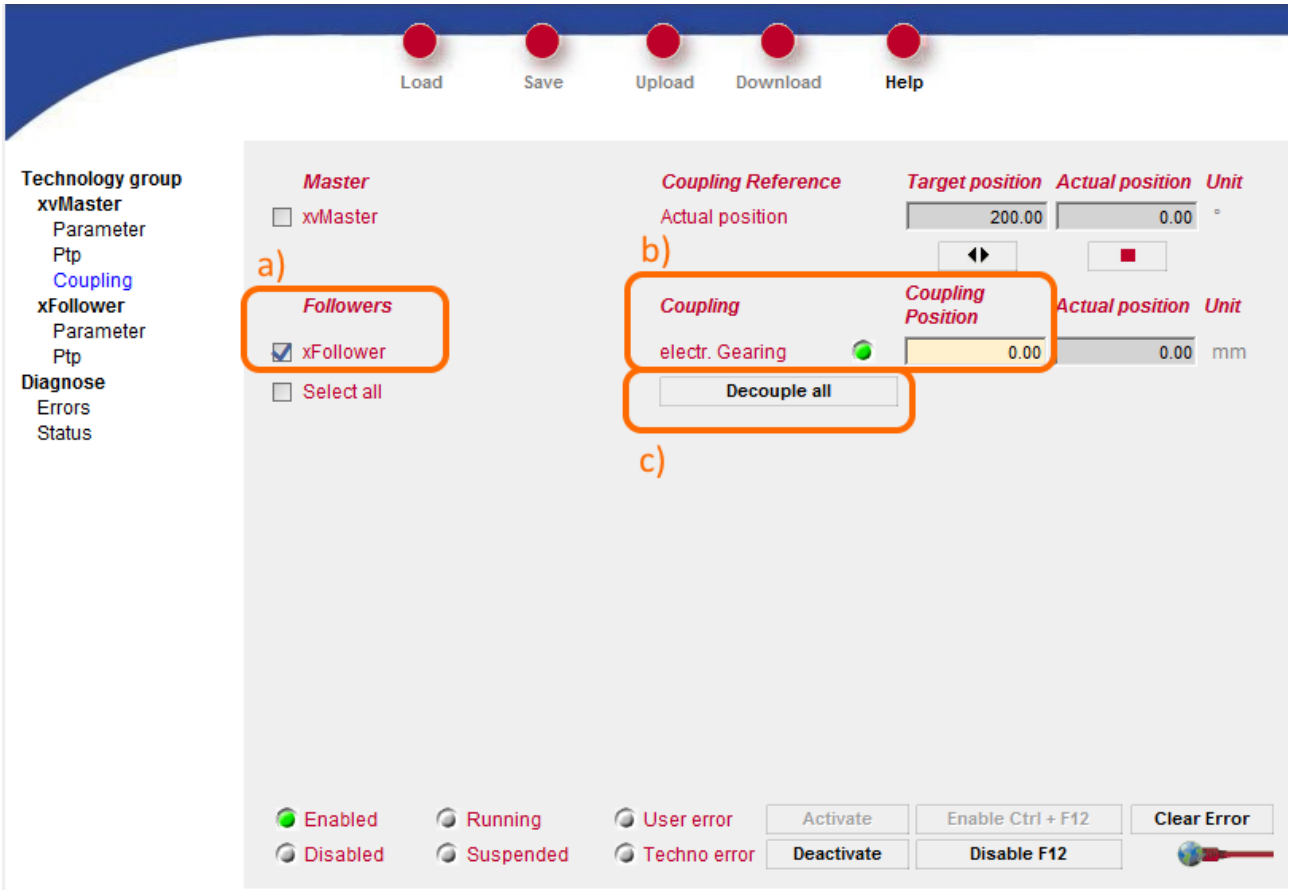
Color	Description
Blue	Master axis target position
Red	Follower axis target position
Green	Master axis target velocity
Pink	Follower axis target velocity
Light blue	Follower axis synchronous status

To display all curves, the position and velocity curves of master and follower axes are shown slightly offset.
The following sequence can be observed:

A) The group is activated and enabled: The synchronous status changes to 1: Coupled.
B) A positioning of the master axis is started to 200° at the target velocity 100°/s.
C) The master and follower axes move synchronously towards the target at the same velocity. Individual points can also be queried using the cursor.
D) Master and follower axes arrive synchronously at the target position, the velocity is now 0°/s.
E) The reverse movement by positioning the master axis to 0° is also synchronous. Both axes reach the target with the same position and velocity.
F) The group is disabled and deactivated. The synchronous status changes to 0: Decoupled.

3.2.1.2 Positioning the follower axis manually

This function can be used to move the follower axis to a new target position where it is coupled with the master axis.



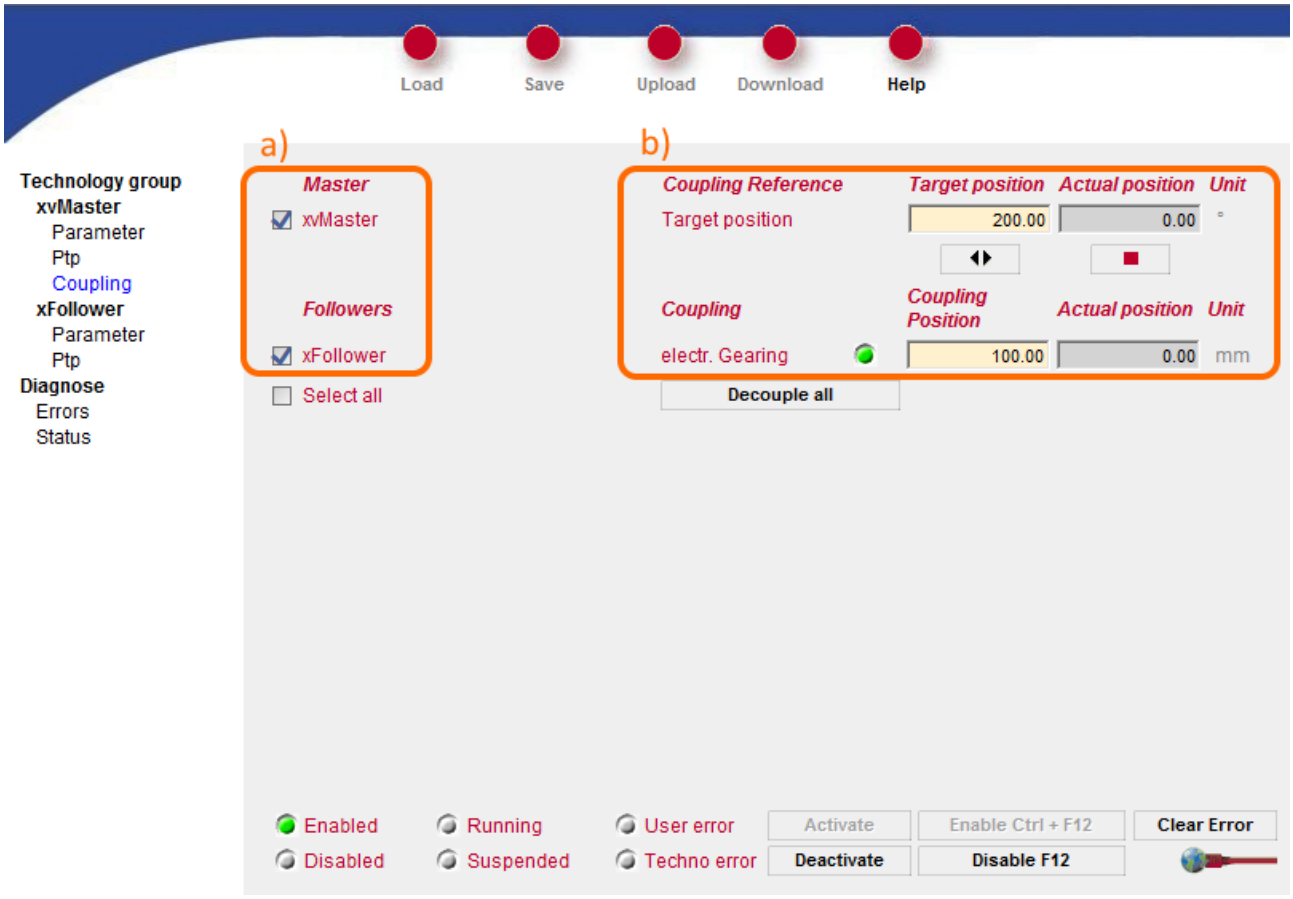
a) To move the follower axis, check the box for the respective follower axis.

b) After the box has been checked, the "Coupling Position" box for the follower axis is enabled. This Coupling Position is also the target position. Once a coupling position has been entered, the positioning process can be started as with the leading axis by clicking  and stopped by clicking  . During positioning, the follower axis is decoupled and is coupled after all active positioning processes has been completed.

c) With "Decouple all" *all follower axes are decoupled* so that they no longer follow the movement of the master axis.
"*Decouple all*" does not have to be given before positioning one or more axes. If the group consists, for example, of several follower axes, it can be quite useful to decouple all follower axes before positioning, especially if only individual follower axes are to be considered.

On the other hand, it may be desired that individual axes remain coupled during positioning. In this case "*Decouple all*" should not be clicked.

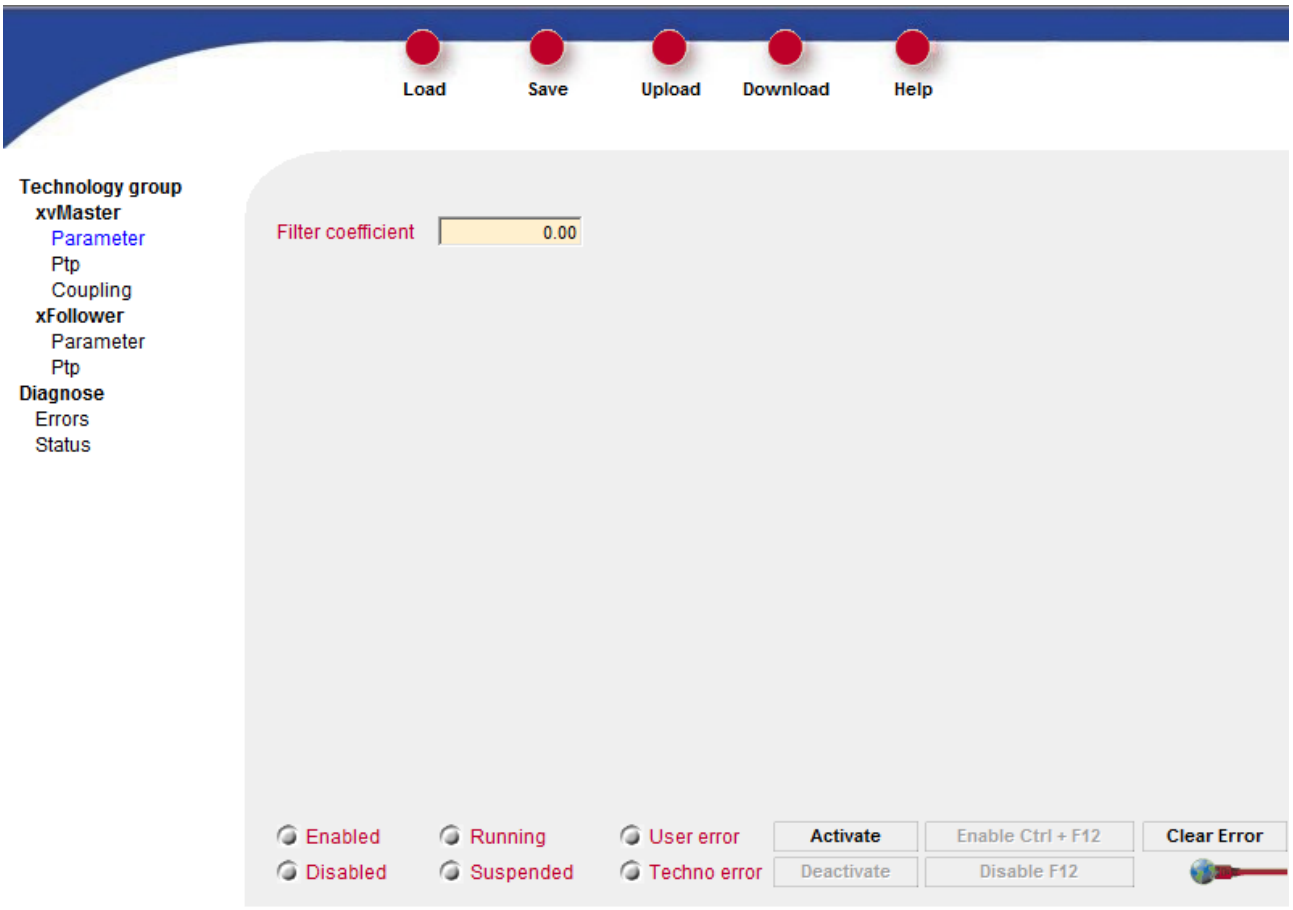
3.2.2 Positioning master and follower axis manually



a) To position the master and follower axes, tick the check box next to the respective axis.

b) After the checkmark for the axis has been set, the "Target position" box is enabled. Once a target position has been entered, the positioning process, as described above, can be started by clicking  and stopped by clicking  . During positioning, the follower axis is decoupled and is coupled after all active positioning processes has been completed.

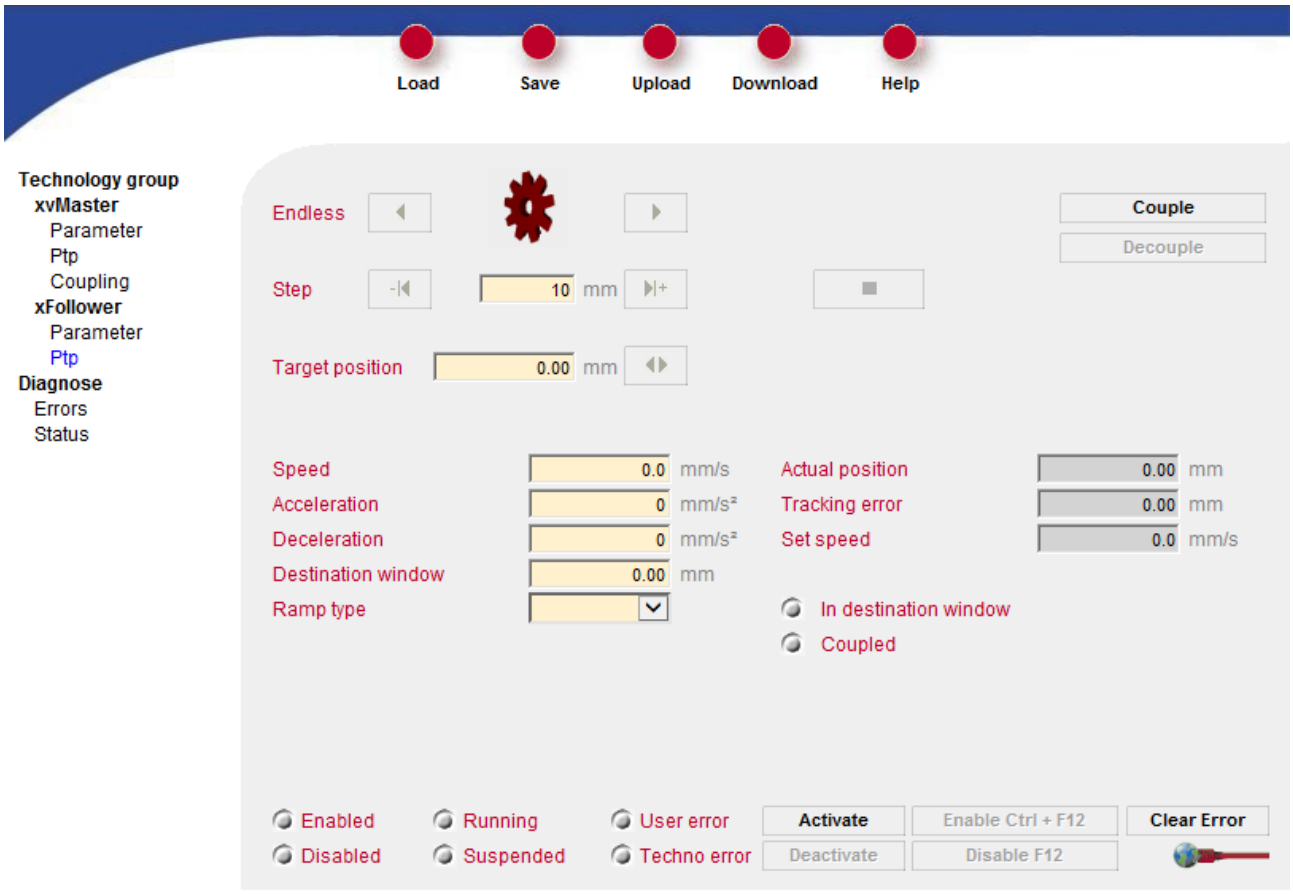
Setting the Filter



The filter coefficient in the active group can be set via the "Parameter" screen of the axes involved. The value range is between 0.0 and 99.9. A 5th degree polynomial filter is used, whose effect is determined by the filter coefficient. The settings for master and follower axes are made in the same way.

➢ Further information on the use of the filter can be found in the Application Note 053 "*Filters in Technology Groups*".

3.2.2.1 Positioning an axis involved in the group (member axis)

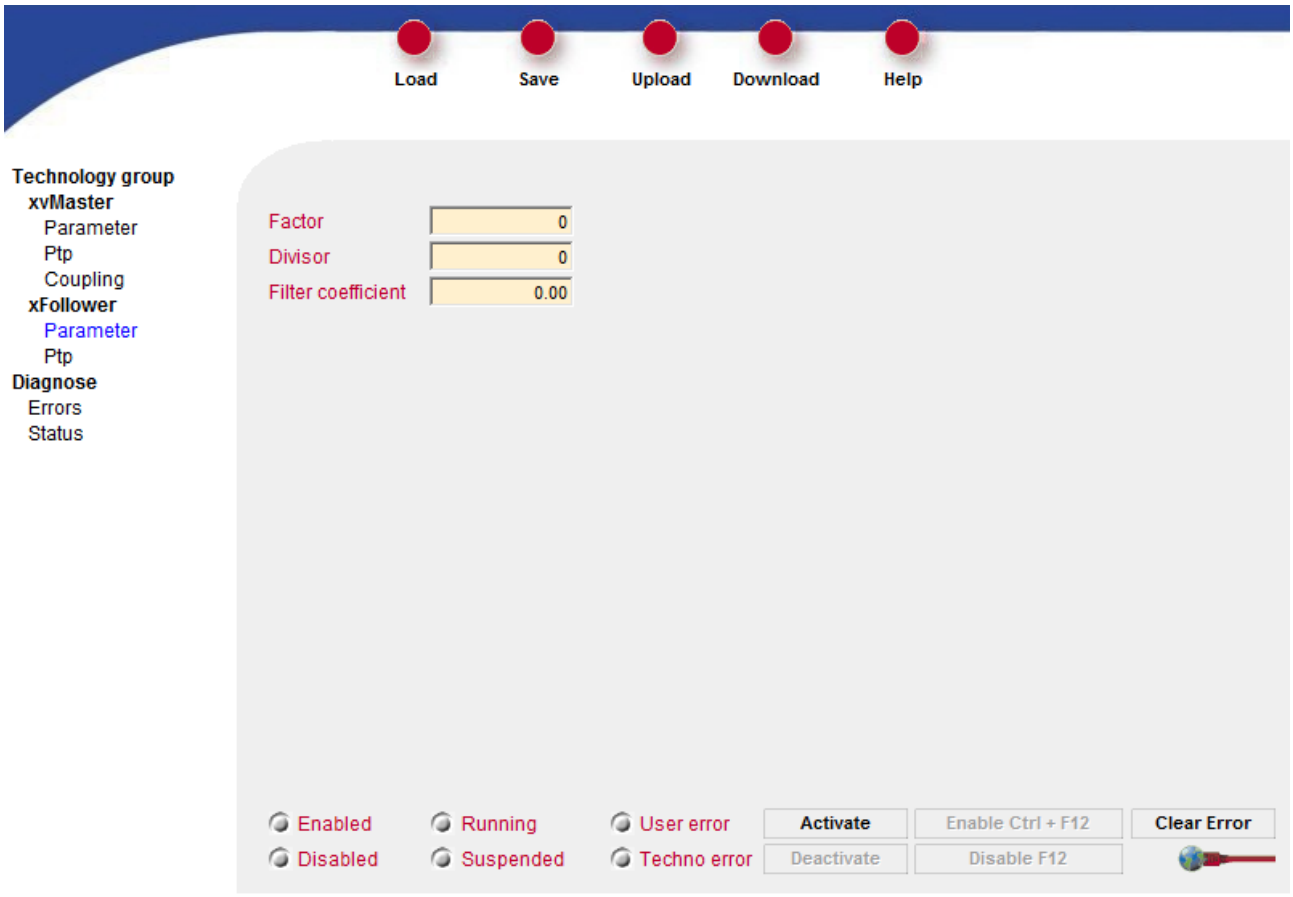


Similar to "Point-to-Point" commissioning pages for individual axes, individual positioning jobs can be carried out on the"PtP" pages for commissioning a group. To do this, you can set the appropriate parameters for the following positioning methods: Endless, Step, and Target Positioning. The synchronous status is also displayed.

INFO

When positioning a coupled electrical gear follower axis, the axis will be decoupled. There is no automatic recoupling as on the "Coupling" page!

3.2.2.2 Setting the gear ratio between follower and master axis



3.2.2.3 Gear ratio

The gear ratio is entered by specifying the factor and divisor.
Where:

$$\Delta x_{Follower} = \Delta x_{Master} * \frac{\text{Factor}}{\text{Divisor}}$$

Both are integer values. The factor may only become negative to generate a counter-coupling.

	Value range
Factor	-1000 … 1000
Division factor	0 … 1000

The gear ratio can be changed in the operating states "*Disabled*" "*Enabled*" and "*Running*". The new value will be taken over immediately.

INFO

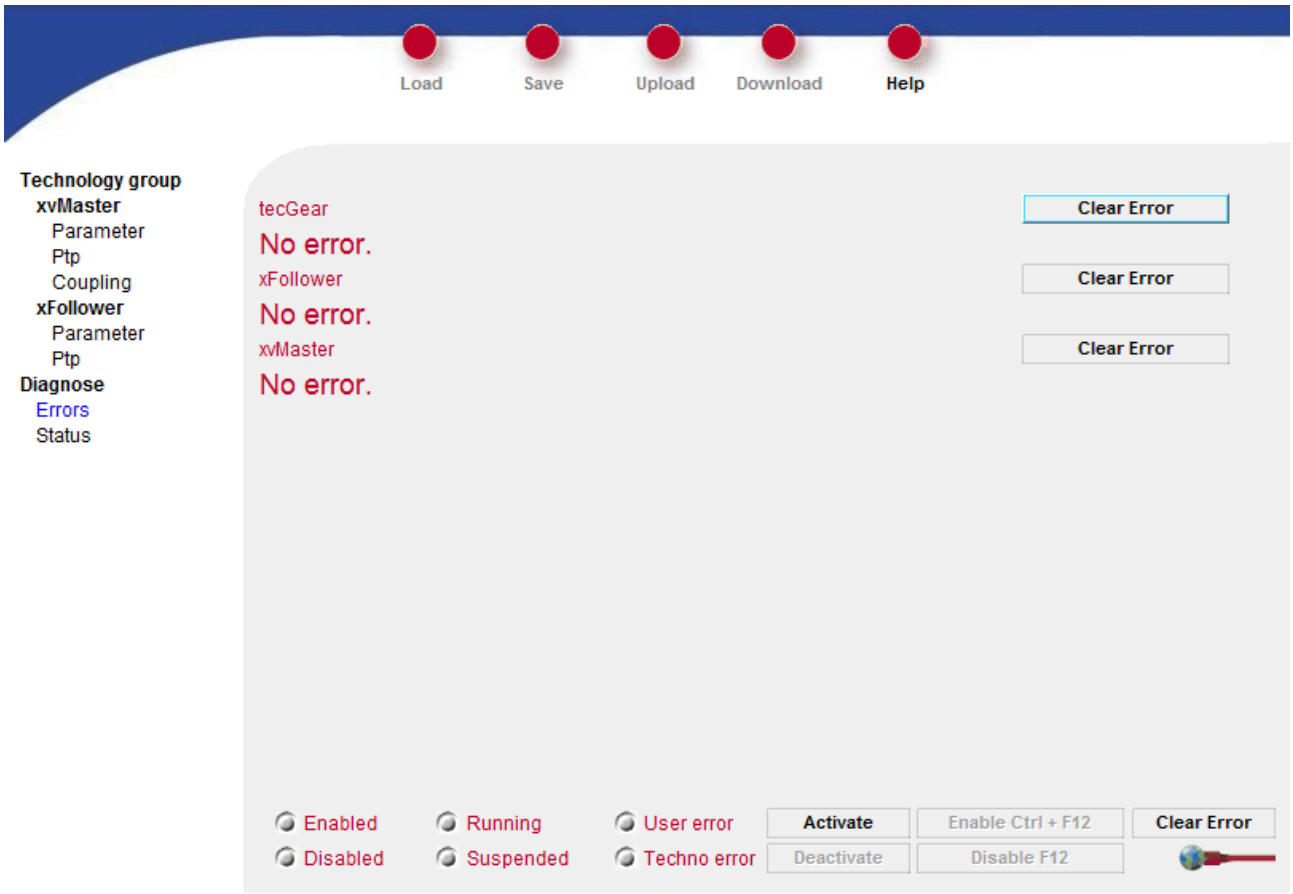
If a follower axis is coupled and the master axis is running, the gear ratio is also taken over immediately even during synchronous operation. As soon as the value is changed, the follower axis moves at a new velocity. A velocity jump occurs here! A position jump does not occur!

The filter coefficient in the active group can be set via the "Parameter" page of the axes involved. The value range is between 0.0 and 99.9. A 5th degree polynomial filter is used, whose effect is determined by the filter coefficient. The settings for master and follower axes are made in the same way.

➢ For more information on the use of the filter, refer to Application Note 049 "motion_control_apn049_100_technologyverbund.pdf", section "Actual value coupling/Filter".

3.2.2.4 Diagnostic functions

Errors

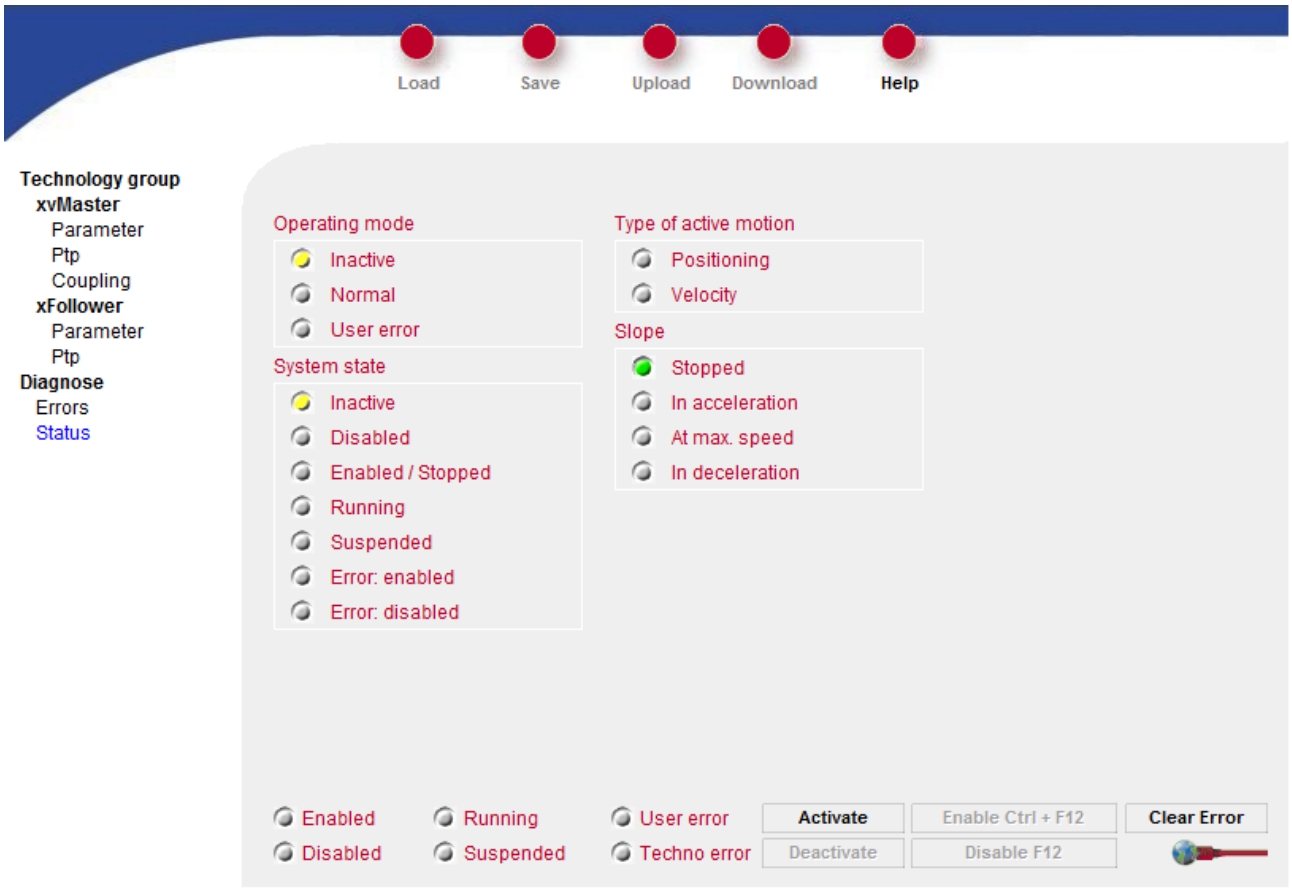


The "Errors" page shows a summary of the currently active errors of the group and its member axes. Each axis can be individually cleared using its respective "Clear Error". The "Clear error" button on the bottom control bar lets you clear all errors related to the group.

INFO

If the error of a group is cleared, the errors of its member axes are also cleared!

Status



The "Status" page shows an overview of the status of the group axes.

- The slope parameter pertains to the speed of the master axis. In the active group, the ramp status of the axis object of the master axis remains at "Stopped". Follower axis slopes may be accessed via the respective axis object.

4 Using the electrical gearbox in the application program

4.1 Configuring the electrical gear box

The configuration lets you define **the gear ratio** and **the activation mode.**
TechnoObject.Coupling.Gearing.Configure(Axis, Factor, Divisor) up to Motion API 1.0.0.13
TechnoObject.Coupling.Gearing.Configure(Axis, Factor, Divisor, ActivationMode) from Motion API 1.0.0.14

```
tecGear.Activate();
when tecGear.State.IsDisabled or tecGear.State.IsEnabled continue;
tecGear.Coupling.Gearing.Configure(xFollower, nFactor, nDivisor, MCTechnoGearingActivationModes.Decoupled);
tecGear.Deactivate();
when tecGear.State.IsInactive continue;
```

- The configuration function can only be used in the "Disabled", "Enabled" or "Running" operating states. In the example above, this is ensured by "<TechnoObject.Activate()" with subsequent query of the operating state.
- The gear ratio is specified by factor and divisor.
    - The parameters are integers.
    - Factor: Can be a positive or negative integer.
    - Divisor: Can only be a positive integer!
- The activation mode determines whether the follower axis should already be coupled or still uncoupled when the group is activated.
    - The default setting is "Coupled on activation".
    - If no parameter is specified, "Coupled on activation" is set!
    - MCTechnoGearingActivationModes.Coupled = "Coupled on activation": When the group is activated, the follower axis is already coupled.
    - MCTechnoGearingActivationModes.Decoupled = "Decoupled on activation When the group is activated, the follower axis is not coupled.
- Configuration can be carried out in the coupled and decoupled state of the follower axis. The parameters become valid immediately. A transitional movement will not be performed.
- The settings you have made are retained when the group is deactivated.
- After a reboot of the controller, the MC initialization file parameters are reloaded so any manual or code change is lost.

4.2 Coupling

In principle, there are 2 different ways of coupling the follower axis of an electrical gearbox:

- By activating the *TechnoObject* technology group. Activate():
  If the activation mode is configured as "Coupled", the follower axis is automatically coupled when the group is activated and follows the movement of the master axis according to the set gear ratio.
- By using the *<Technology group>.Coupling.Couple() coupling function:*
  In the "Couple" function, 4 different coupling modes (MCTechnoCoupleModes) can be selected.

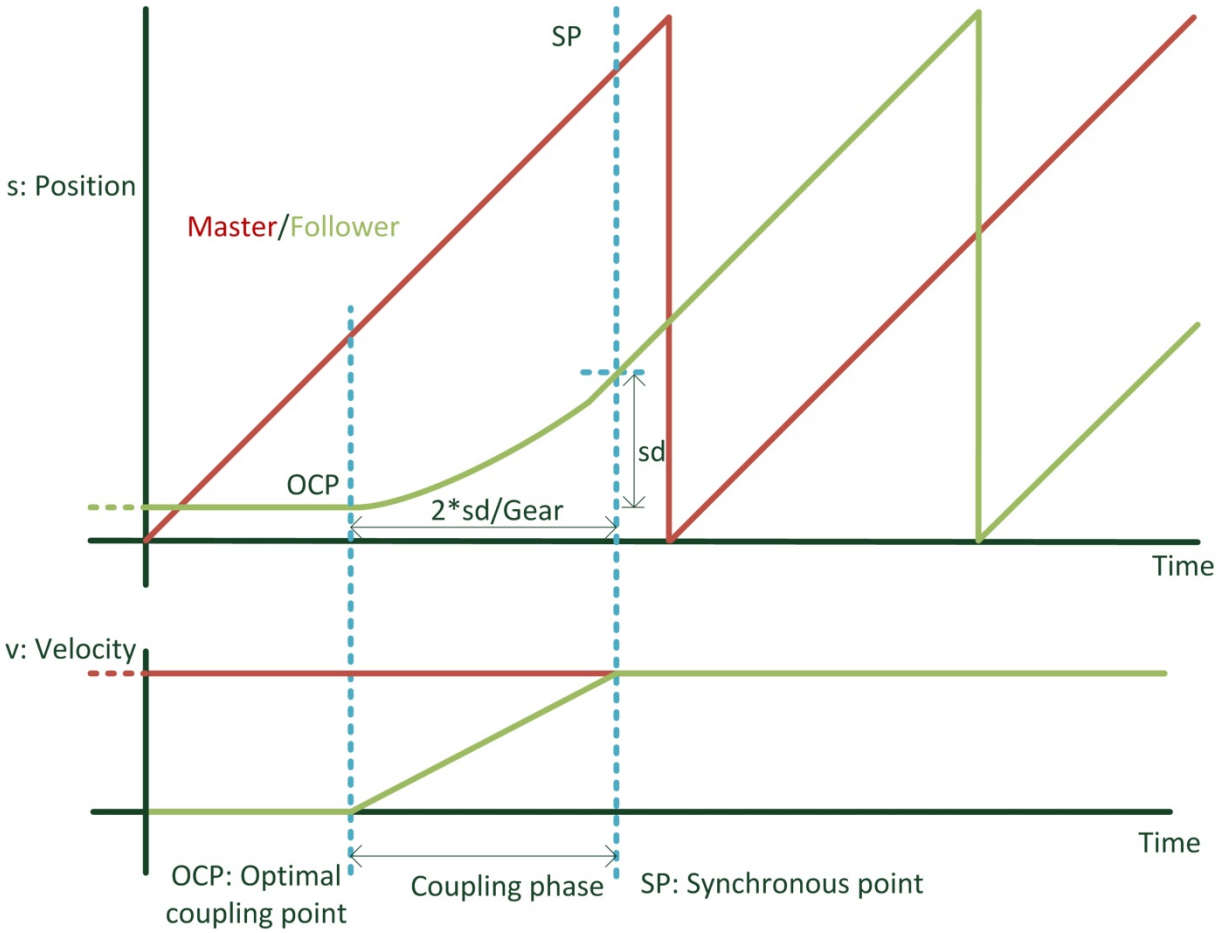
4.2.1 Use Cases:

The use cases are located in the project "*ElectricalGearCoupling440*" and *"ElectricalGearCoupling365"*.
The following configuration is used in the use cases:

- xvMaster: Virtual axis, rotary modulo bidirectional, traversing range 0° … 360° is set in the STX project.
- xFollower: MC-JM203 as simulated axis, rotary modulo bidirectional, traversing range 0° … 360° is set in the STX project.
- tecGear: Technology group:
  - Master axis: xvMaster,
  - Follower axis: XFollower, coupling mode: Electrical gearbox, setpoint coupled

4.2.2 Optimum coupling point

When using the "Fast" and "Wait" coupling modes, the synchronous point (SP) is passed as a parameter. A coupling polynomial for the coupling motion is calculated for this synchronous point. As a result of this coupling polynomial, a point can be calculated at which a purely linear speed increase takes place up to the synchronous speed. This is the optimal coupling point (OCP). Using the OCP, there is neither overspeed nor overshoot in reaching synchronization.



Name	Description
M	Master: Master Axis
F	Follower: Follower axis
Gear	Gear ratio: In the diagram 1:1
SP	Synchronous point
OCP	Optimal coupling point
sd	Synchronization position difference between SP and actual follower position
Act	Actual value

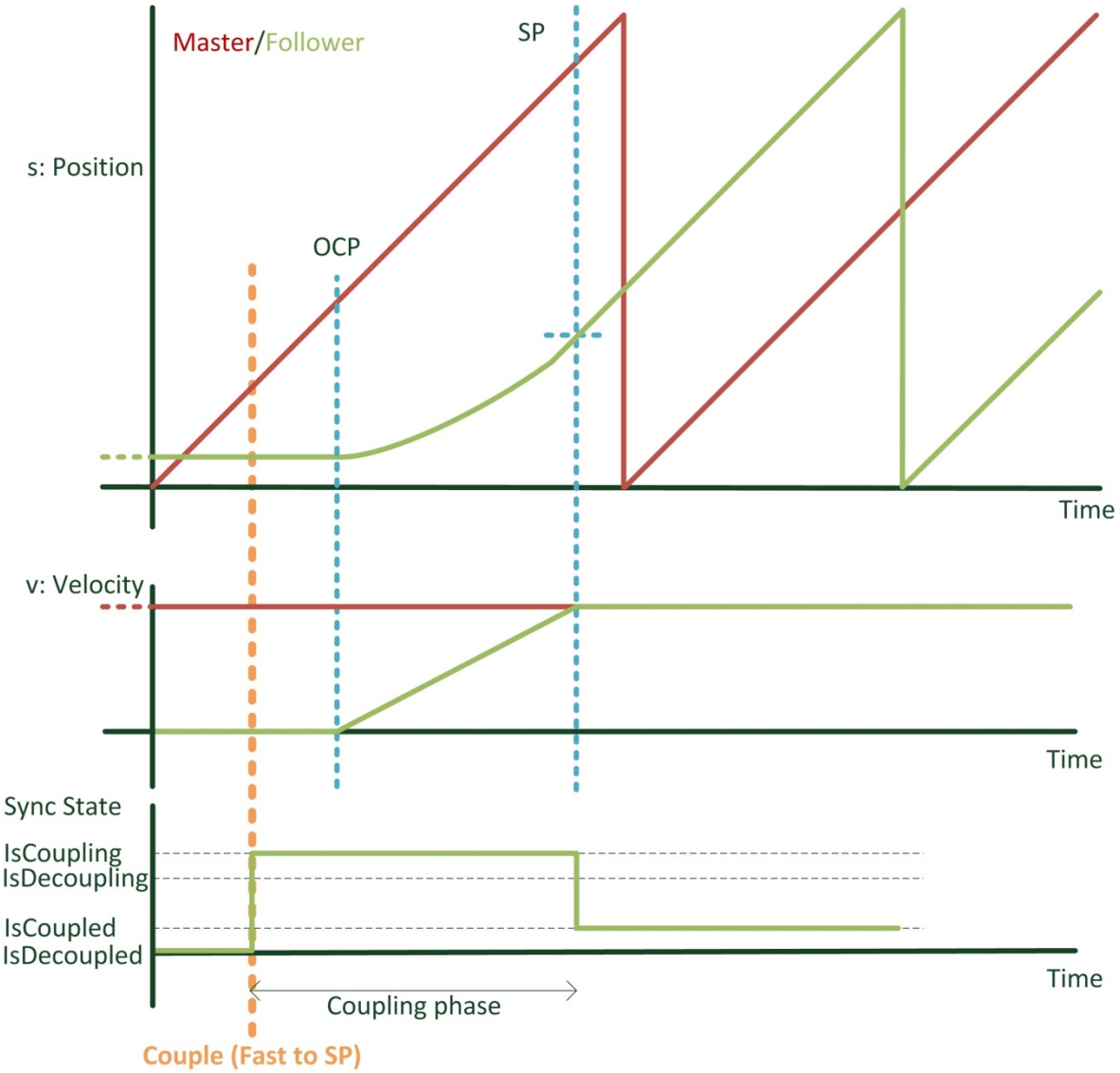
Coupling phase
The velocity increase up to synchronous velocity is linear. The velocity during the coupling phase does not exceed the synchronous velocity.
The optimum coupling point is determined from the synchronous point minus 2* coupling distance/gear factor

$$sd = s_{SP\_F} - s_{ACT\_F}$$

$$\begin{bmatrix} s_M \\ s_F \end{bmatrix}_{OCP} = \begin{bmatrix} s_{SP_L} \\ s_{Act_F} \end{bmatrix} - \begin{bmatrix} 2 * \frac{sd}{ratio} \\ 0 \end{bmatrix}$$

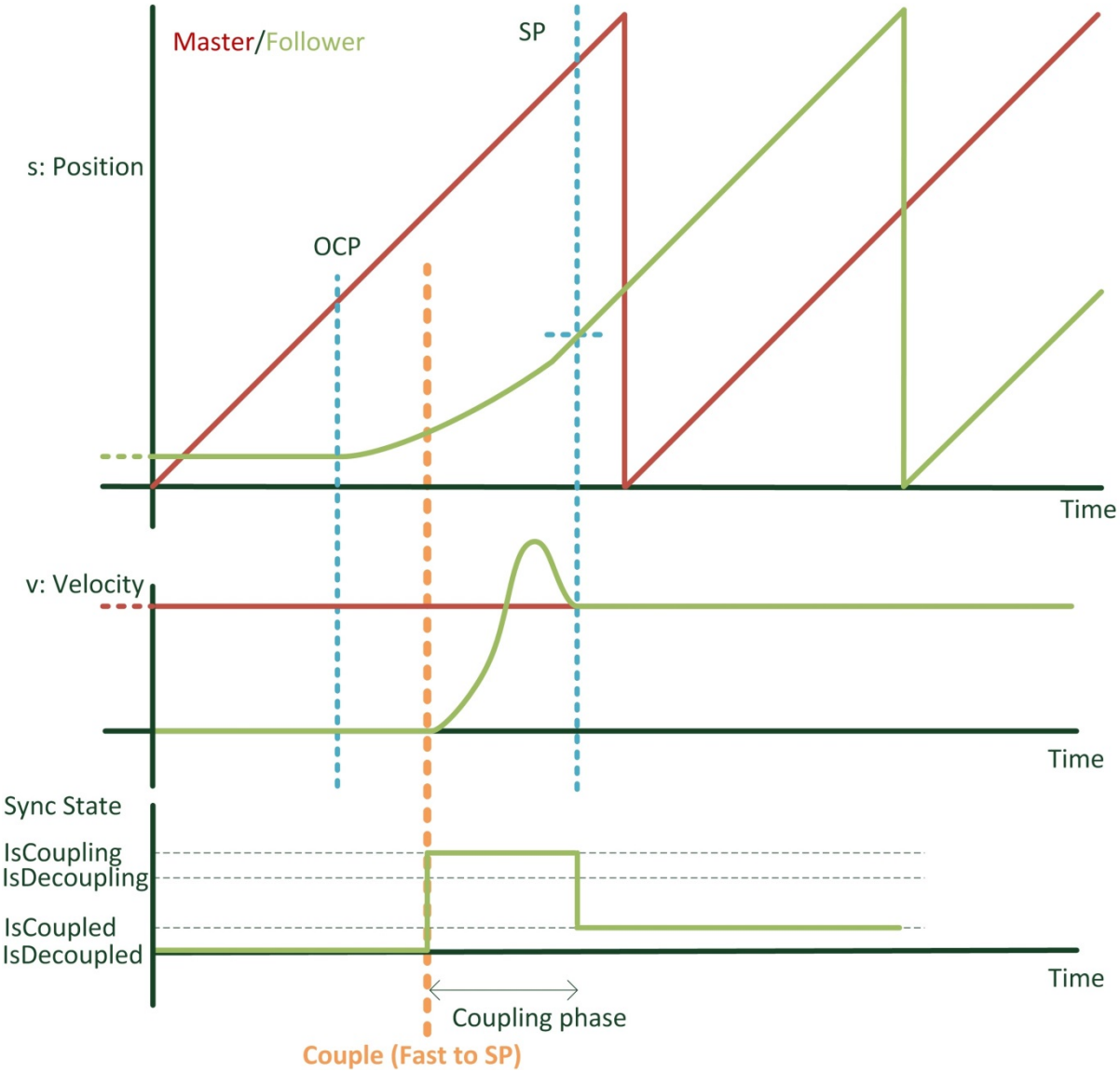
4.2.3 "Fast" mode

If the coupling command is issued before this time, the follower axis waits until this point is reached. When this point is reached, the coupling movement starts in such a way that the follower axis starts following the master axis synchronously at the selected coupling point.
As required parameters, the master and follower axis position at which the axis is to be synchronous is specified here.



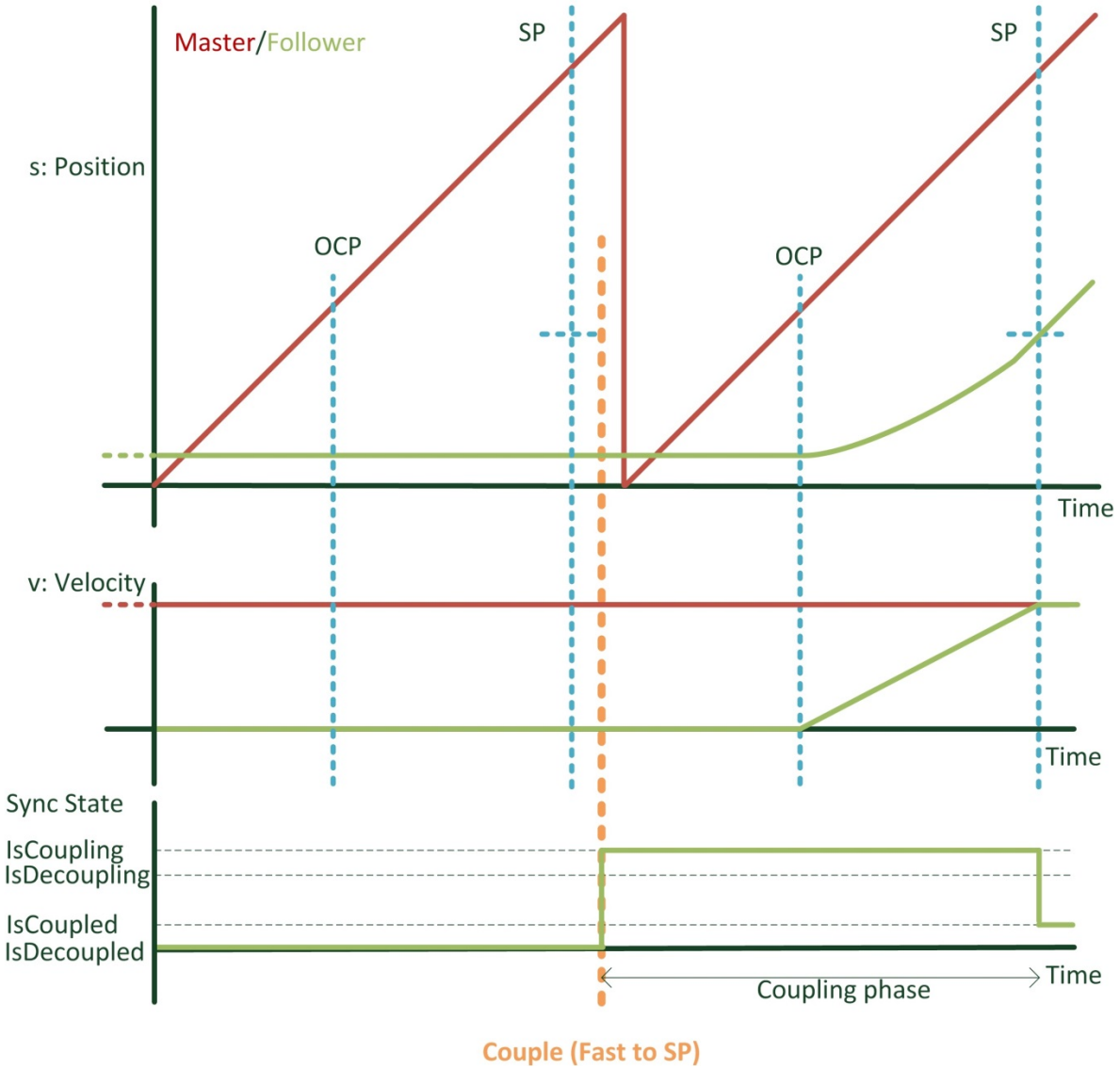
From the time the command is given until the synchronization point is reached, the synchronous status of the follower axis is "Coupling" (AxisObject.State.Techno.IsCoupling). When the coupling is successful, the state changes to "Coupled" (AxisObject.State.Techno.IsCoupled)".

If the coupling command is issued between the optimum coupling point (OCP) and the synchronous point, the coupling movement is started immediately. The velocity of the coupling movement may be higher than synchronous velocity to reach the OCP in time.



- The closer the coupling point comes to the synchronous point, the higher the coupling velocity. The MCX does not evaluate the maximum acceleration or velocity of the follower axis. Therefore sudden jumps may occur which may lead to errors or mechanical issues.

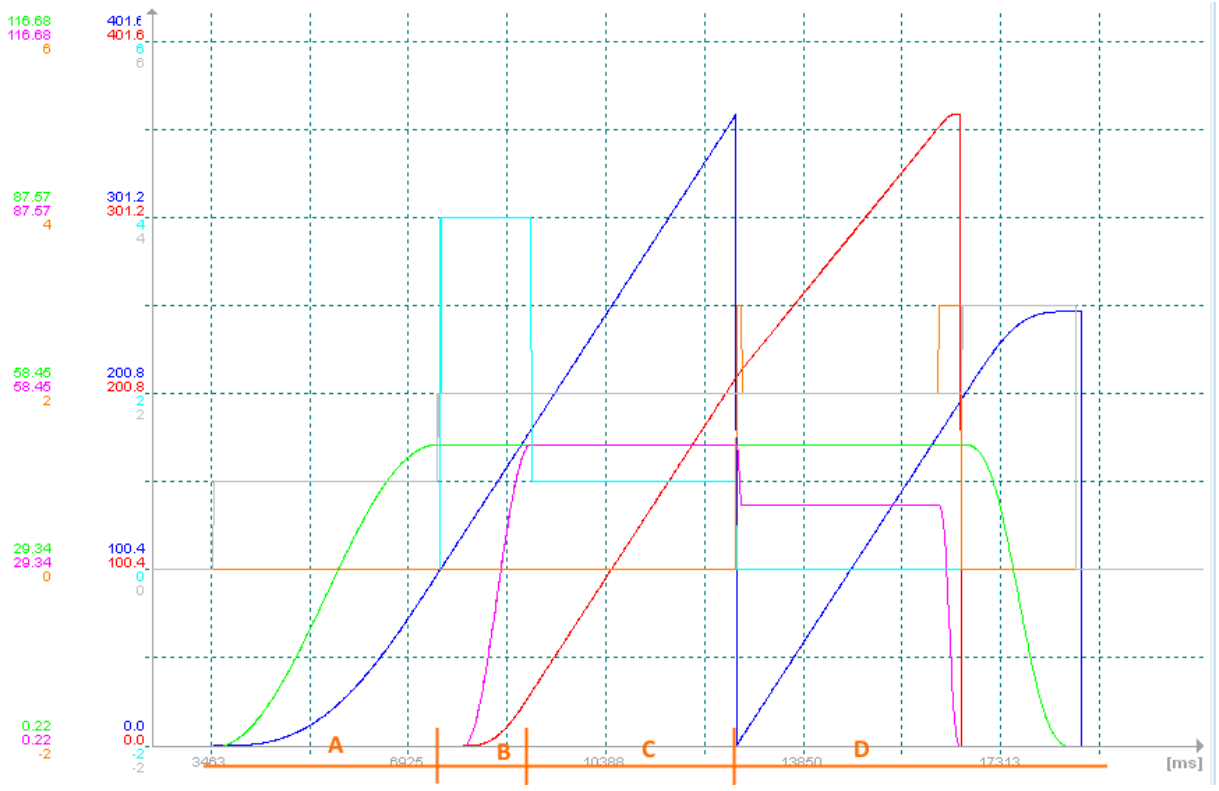
If the coupling command is issued after the synchronization point, the follower axis waits until the next modulo cycle of the master axis (by analogy to the first case). The coupling movement starts at the next OCP.



4.2.3.1 Use Case 01: Coupling command "Fast" before optimum coupling point

See also:

```
//-----------------------------------------------------------------
// Use case 01: Couple with mode "Fast" before OCP
//-----------------------------------------------------------------
function runCoupleFastBeforeOCP()

        tecGear.MoveVelocity.Start(xvMaster, Directions.Positive, 50.0, 20.0, 20.0);
        when xvMaster.Position.Setpoint > 100.0 continue;
        tecGear.Coupling.Couple(xFollower, MCTechnoCoupleModes.Fast, 180.0, Directions.Positive, 30.0);
        when xFollower.State.Techno.IsCoupled continue;

        // Just let it run to the next modulo turn
        when xvMaster.Position.Setpoint < 100.0 continue;
        tecGear.MovePtp.Start(xFollower, MCTechnoPositioningModes.AbsModuloAuto, 0.0, 40.0, 200.0, 200.0);
        when xFollower.Mechanism.Slope.IsStopped continue;
        tecGear.MoveHalt.Start(xvMaster, MCTechnoHaltModes.Normal, 50.0);
        when tecGear.State.IsEnabled continue;

end_function;
```



Color	Description
Blue:	Target position of the master axis
Red:	Target position of the follower axis
Green	Target velocity of the master axis
Pink	Target velocity of the follower axis
Light blue	Follower axis synchronous status
Orange:	Ramp status of the follower axis
Gray	Ramp state of the technology group

A) Preparation phase:
- Master axis starts an endless movement.
- The synchronous status is "Decoupled" (IsDecoupled / synchronous status = 0)

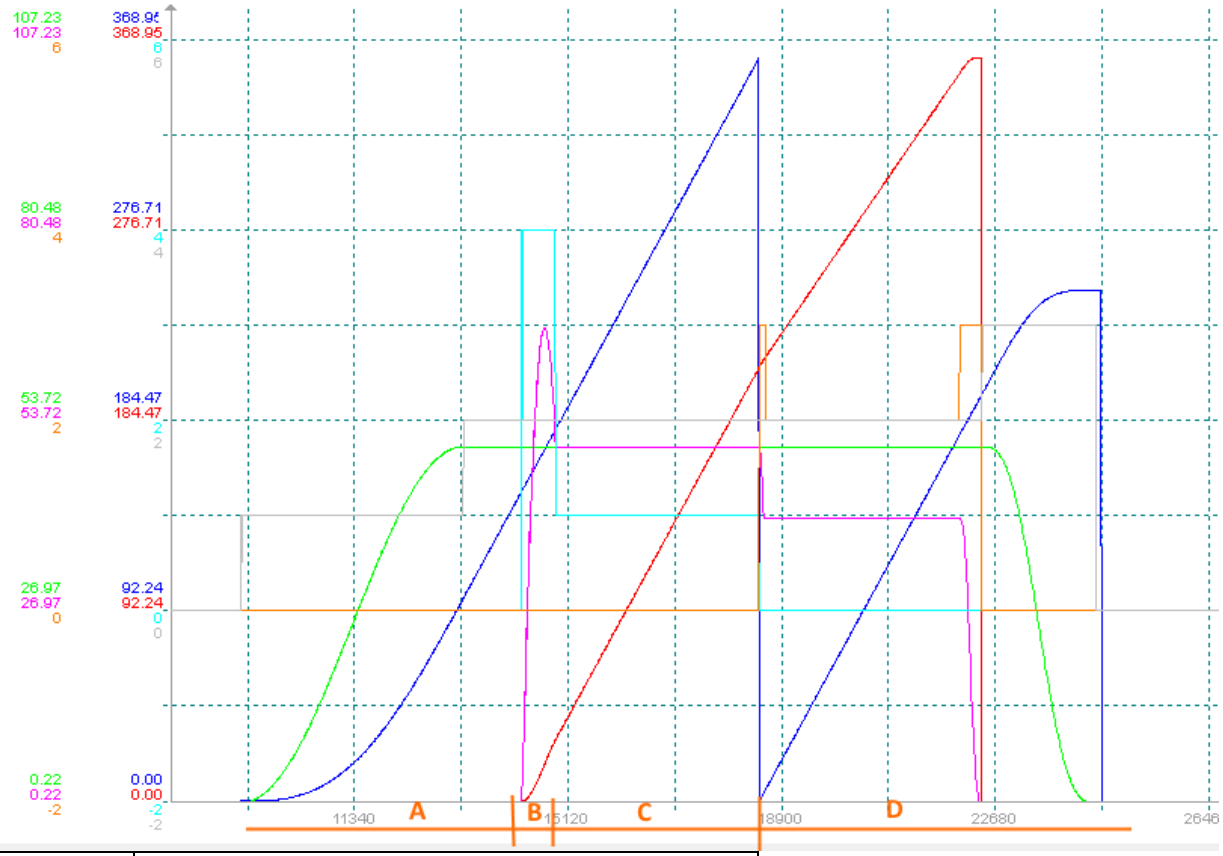
B) Coupling:
- The coupling command is issued in accordance with the code when the master axis position of 100° is crossed.
- The synchronous point should be at 180° for the master axis and 30° for the follower axis.
- The optimum coupling point thus starts at the master axis position 120°.
- Since the coupling command is issued before this position, the follower axis waits and starts the synchronization motion when the master axis reaches 120°.
- From the time when the coupling command is issued until the synchronous point is reached, the synchronous status is "Coupling" (IsCoupling / synchronous status = 4).

C) - When the synchronous point is reached, the follower axis is in synchronism with the master axis and follows it at the same velocity.
- Now, the synchronous status is "Coupled" (IsCoupled / synchronous status = 1).

D) - According to the code example, a point-to-point positioning is used to decouple and stop the master axis.
- The synchronous status is "Decoupled" (IsDecoupled / synchronous status = 0)

4.2.3.2 Use Case 02: Coupling command "Fast" between optimum coupling point and synchronous point

```
//-----------------------------------------------------------------
// Use case 02: Couple with mode "Fast" after OCP and before SP
//-----------------------------------------------------------------
function runCoupleFastAfterOCP()

        tecGear.MoveVelocity.Start(xvMaster, Directions.Positive, 50.0, 20.0, 20.0);
        when xvMaster.Position.Setpoint > 150.0 continue;
        tecGear.Coupling.Couple(xFollower, MCTechnoCoupleModes.Fast, 180.0, Directions.Positive, 30.0);
        when xFollower.State.Techno.IsCoupled continue;

        // Just let it run to the next modulo turn
        when xvMaster.Position.Setpoint < 100.0 continue;
        tecGear.MovePtp.Start(xFollower, MCTechnoPositioningModes.AbsModuloAuto, 0.0, 40.0, 200.0, 200.0);
        when xFollower.Mechanism.Slope.IsStopped continue;
        tecGear.MoveHalt.Start(xvMaster, MCTechnoHaltModes.Normal, 50.0);
        when tecGear.State.IsEnabled continue;

end_function;
```



Color	Description
Blue:	Target position of the master axis
Red:	Target position of the follower axis
Green	Target velocity of the master axis
Pink	Target velocity of the follower axis
Light blue	Follower axis synchronous status
Orange:	Ramp status of the follower axis
Gray	Ramp status of the technology group

A) Preparation phase:
- Master axis starts an endless movement.
- The synchronous status is "Decoupled" (IsDecoupled / synchronous status = 0).

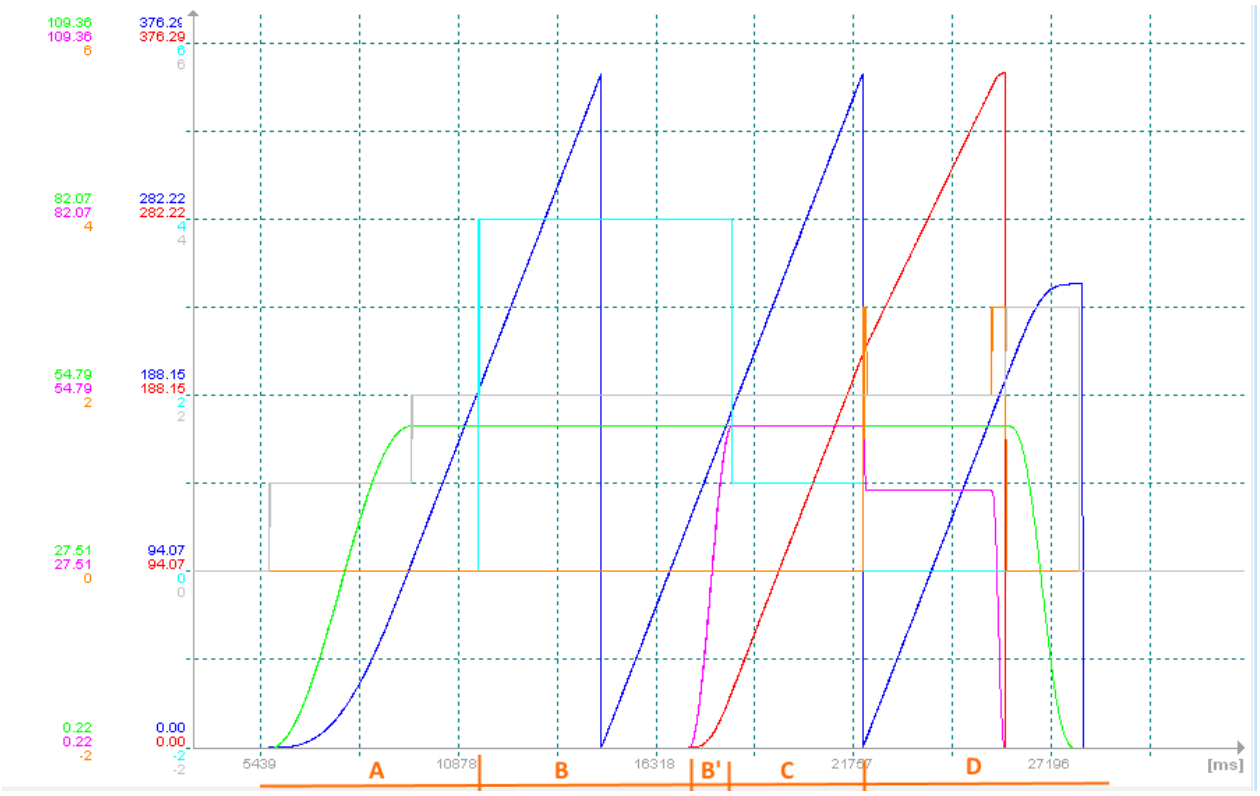
B) Coupling:
- The coupling command is issued in accordance with the code when the master axis position of 150° is crossed.
- The synchronous point should be at 180° for the master axis and 30° for the follower axis.
- The optimum coupling point thus starts at the master axis position 120°.
- Since the coupling command is only issued after this position, the follower axis starts immediately with the synchronization motion. As can be seen in the diagram, the follower axis must now travel faster than the synchronous velocity in order to reach the synchronous point in time.
- From the time when the coupling command is issued until the synchronous point is reached, the synchronous status is "Coupling" (IsCoupling / synchronous status = 4).

C) - When the synchronous point is reached, the follower axis is in synchronism with the master axis and follows it at the same velocity.
- Now, the synchronous status is "Coupled" (IsCoupled / synchronous status = 1).

D) - According to the code example, a point-to-point positioning is used to decouple and stop the master axis.
- The synchronous status is "Decoupled" (IsDecoupled / synchronous status = 0).

4.2.3.3 Use Case 03: Coupling command "Fast" after synchronous point

```
//-----------------------------------------------------------
// Use case 03: Couple with mode "Fast" after SP
//-----------------------------------------------------------
function runCoupleFastAfterSP()

        tecGear.MoveVelocity.Start(xvMaster, Directions.Positive, 50.0, 20.0, 20.0);
        when xvMaster.Position.Setpoint > 190.0 continue;
        tecGear.Coupling.Couple(xFollower, MCTechnoCoupleModes.Fast, 180.0, Directions.Positive, 30.0);
        when xFollower.State.Techno.IsCoupled continue;

        // Just let it run to the next modulo turn
        when xvMaster.Position.Setpoint < 100.0 continue;
        tecGear.MovePtp.Start(xFollower, MCTechnoPositioningModes.AbsModuloAuto, 0.0, 40.0, 200.0, 200.0);
        when xFollower.Mechanism.Slope.IsStopped continue;
        tecGear.MoveHalt.Start(xvMaster, MCTechnoHaltModes.Normal, 50.0);
        when tecGear.State.IsEnabled continue;

end_function;
```



Color	Description
Blue:	Target position of the master axis
Red:	Target position of the follower axis
Green	Target velocity of the master axis
Pink	Target velocity of the follower axis
Light blue	Follower axis synchronous status
Orange:	Ramp status of the follower axis
Gray	Ramp status of the technology group

A) Preparation phase:
- Master axis starts an endless movement.
- The synchronous status is "Decoupled" (IsDecoupled / synchronous status = 0).

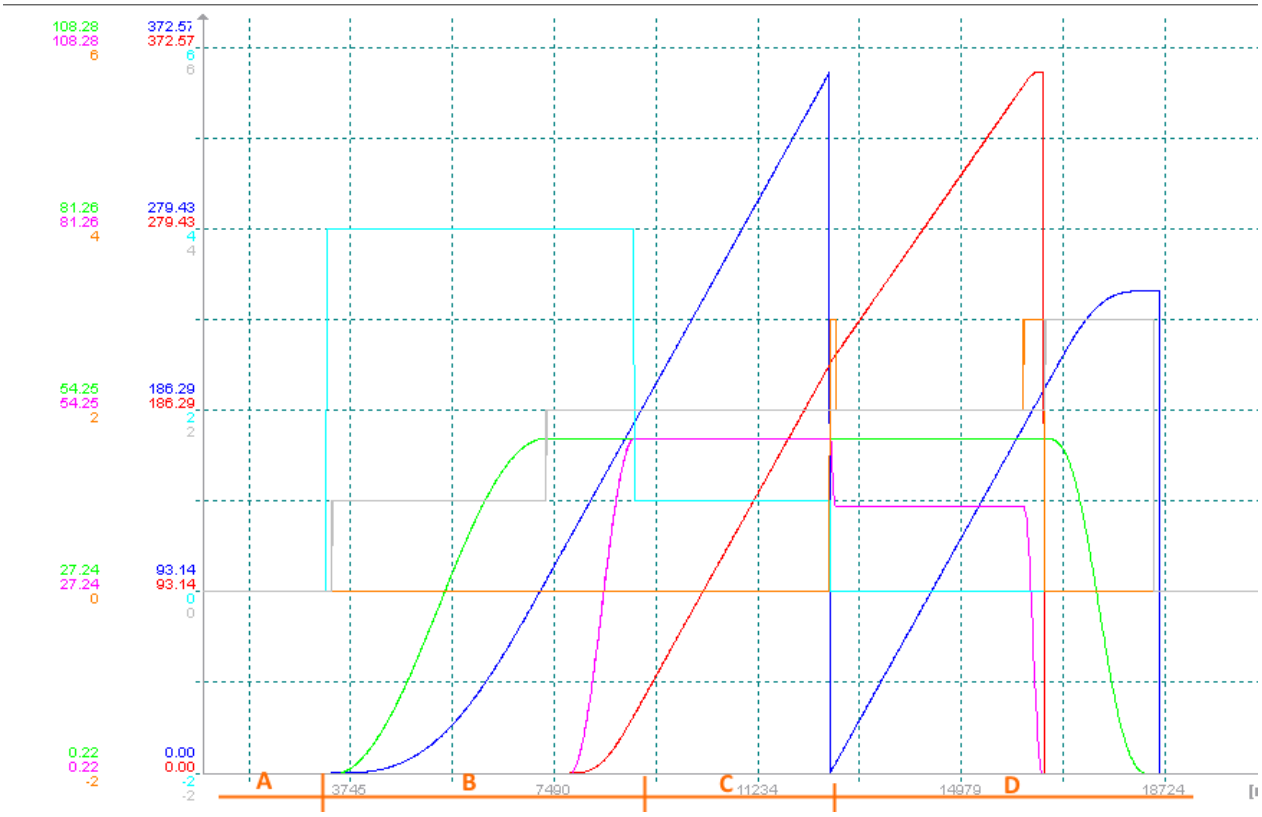
B) Coupling:
- The coupling command is issued in accordance with the code when the master axis position of 190° is crossed.
- The synchronous point should be at 180° for the master axis and 30° for the follower axis.
- The optimum coupling point thus starts at the master axis position 120°.
- Since the coupling command is issued after the synchronization point has been crossed, the follower axis waits until the next modulo cycle of the master axis and starts with the synchronization motion at the optimum coupling point in this modulo cycle. A velocity increase does not take place.
- From the time when the coupling command is issued until the synchronous point is reached, the synchronous status is "Coupling" (IsCoupling / synchronous status = 4).

C) - When the synchronous point is reached, the follower axis is in synchronism with the master axis and follows it at the same velocity.
- Now, the synchronous status is "Coupled" (IsCoupled / synchronous status = 1).

D) - According to the code example, a point-to-point positioning is used to decouple and stop the master axis.
- The synchronous status is "Decoupled" (IsDecoupled / synchronous status = 0).

4.2.3.4 Use Case 04: Coupling command "Fast" before optimum coupling point with stationary master axis

```
//-----------------------------------------------------------------
// Use case 04: Couple with mode "Fast" before SP but master is stopped
//-----------------------------------------------------------------
function runCoupleFastBeforeOCPStoppedMaster()

        tecGear.Coupling.Couple(xFollower, MCTechnoCoupleModes.Fast, 180.0, Directions.Positive, 30.0);
        when xFollower.State.Techno.IsCoupling continue;
        delay(t#100ms);     // delay acutally not necessary, only to see a short time gap in the scope

        tecGear.MoveVelocity.Start(xvMaster, Directions.Positive, 50.0, 20.0, 20.0);
        when xFollower.State.Techno.IsCoupled continue;

        // Just let it run to the next modulo turn
        when xvMaster.Position.Setpoint < 100.0 continue;
        tecGear.MovePtp.Start(xFollower, MCTechnoPositioningModes.AbsModuloAuto, 0.0, 40.0, 200.0, 200.0);
        when xFollower.Mechanism.Slope.IsStopped continue;
        tecGear.MoveHalt.Start(xvMaster, MCTechnoHaltModes.Normal, 50.0);
        when tecGear.State.IsEnabled continue;

end_function;
```



Color	Description
Blue:	Target position of the master axis
Red:	Target position of the follower axis
Green	Target velocity of the master axis
Pink	Target velocity of the follower axis
Light blue	Follower axis synchronous status
Orange:	Ramp status of the follower axis
Gray	Ramp status of the technology group

A) Preparation phase:
- Master axis and follower axis are at standstill.
- The synchronous status is "Decoupled" (IsDecoupled / synchronous status = 0).

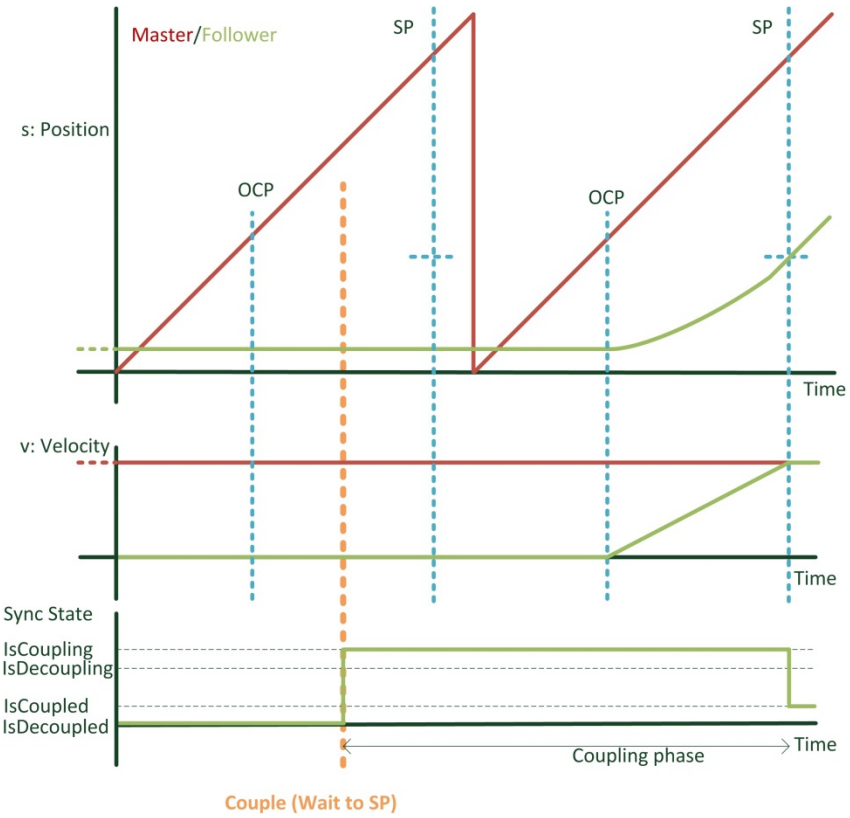
B) Coupling:
- The coupling command is issued first. Only then does the master axis start endless positioning.
- The synchronous point should be at 180° for the master axis and 30° for the follower axis.
- The optimum coupling point thus starts at the master axis position 120°.
- Since the coupling command is issued before the optimum coupling point is reached, the follower axis waits first and starts with the synchronization motion at the optimum coupling point. A velocity increase does not take place.
- From the time when the coupling command is issued until the synchronous point is reached, the synchronous status is "Coupling" (IsCoupling / synchronous status = 4).

C) - When the synchronous point is reached, the follower axis is in synchronism with the master axis and follows it at the same velocity.
- Now, the synchronous status is "Coupled" (IsCoupled / synchronous status = 1).

D) - According to the code example, a point-to-point positioning is used to decouple and stop the master axis.
- The synchronous status is "Decoupled" (IsDecoupled / synchronous status = 0).

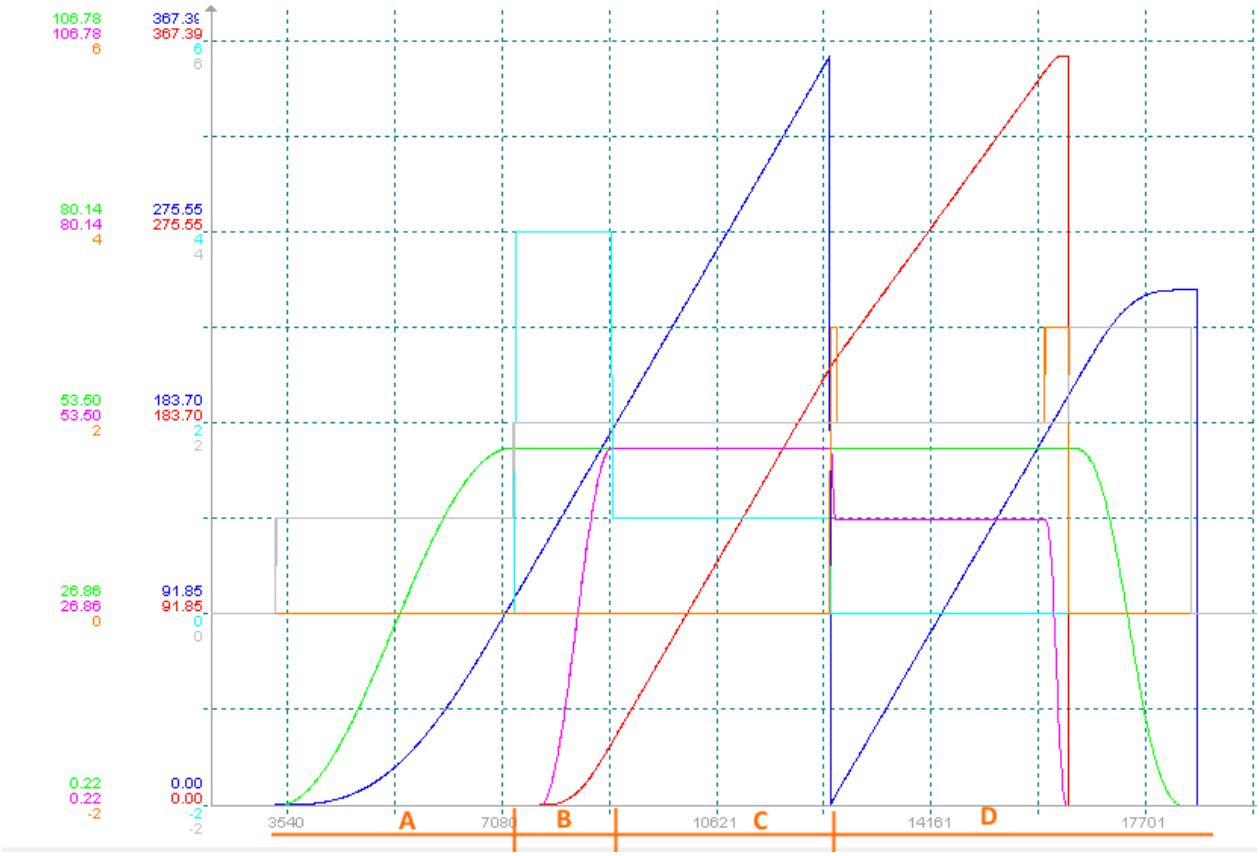
4.2.4 "Wait" mode

In the "waiting" (wait) mode, the synchronization movement is always started at the optimum coupling point (OCP). If the coupling command is issued between the OCP and the synchronous point (SP), the system waits until the next OCP is reached in the following modulo cycle.
After sending the coupling command the synchronous status changes to *"AxisObject.Status.Techno.IsCoupling*" followed by *"AxisObject.Status.Techno.IsCoupled"* when the synchronous point is reached.
The position where master and follower axis must be synchronized is to be specified as required parameter.



4.2.4.1 Use Case 05: Coupling command "Wait" before optimum coupling point

```
//-------------------------------------------------------------
// Use case 05: Couple with mode "Wait" before OCP
//-------------------------------------------------------------
function runCoupleWaitBeforeOCP()

        tecGear.MoveVelocity.Start(xvMaster, Directions.Positive, 50.0, 20.0, 20.0);
        when xvMaster.Position.Setpoint > 100.0 continue;
        tecGear.Coupling.Couple(xFollower, MCTechnoCoupleModes.Wait, 180.0, Directions.Positive, 30.0);
        when xFollower.State.Techno.IsCoupled continue;

        // Just let it run to the next modulo turn
        when xvMaster.Position.Setpoint < 100.0 continue;
        tecGear.MovePtp.Start(xFollower, MCTechnoPositioningModes.AbsModuloAuto, 0.0, 40.0, 200.0, 200.0);
        when xFollower.Mechanism.Slope.IsStopped continue;
        tecGear.MoveHalt.Start(xvMaster, MCTechnoHaltModes.Normal, 50.0);
        when tecGear.State.IsEnabled continue;

end_function;
```



Color	Description
Blue:	Target position of the master axis
Red:	Target position of the follower axis
Green	Target velocity of the master axis
Pink	Target velocity of the follower axis
Light blue	Follower axis synchronous status
Orange:	Ramp status of the follower axis
Gray	Ramp state of the technology group

A) Preparation phase:
- Master axis starts an endless movement.
- The synchronous status is "Decoupled" (IsDecoupled / synchronous status = 0)

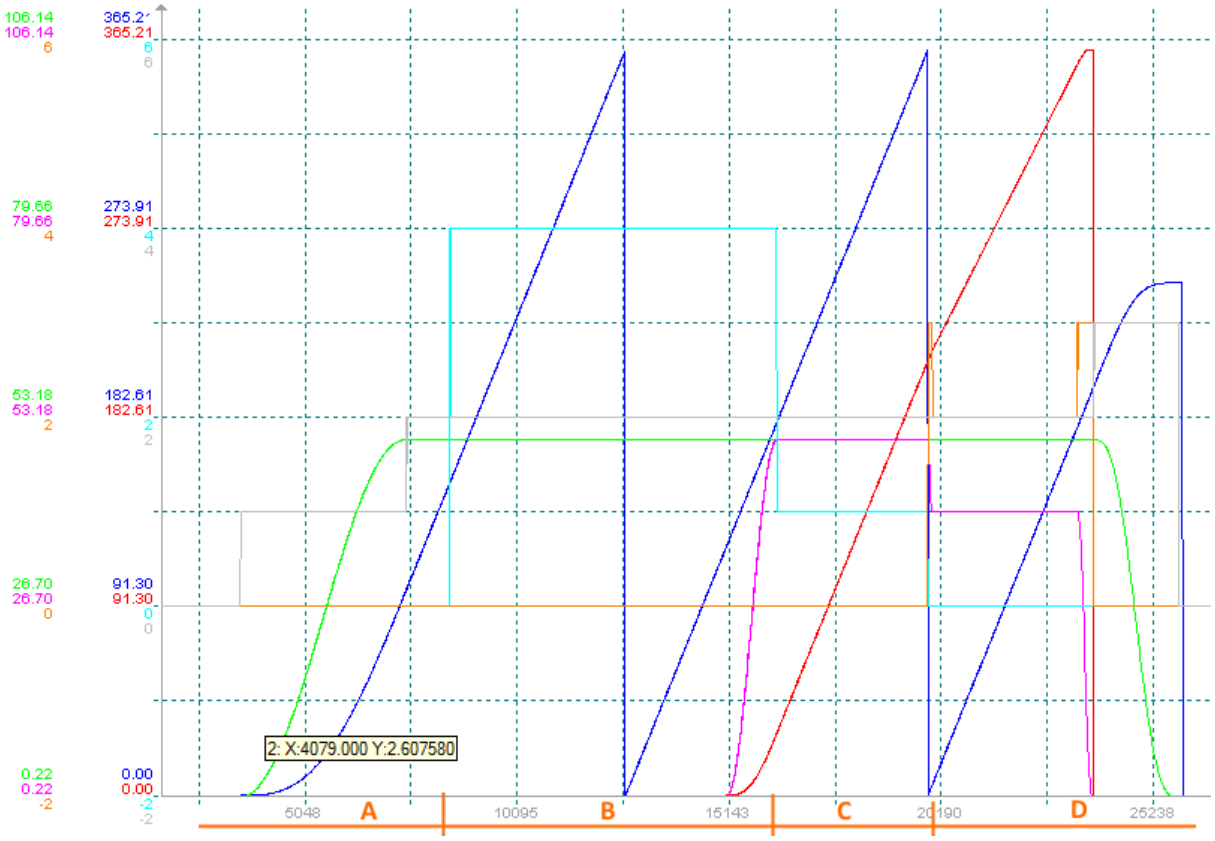
B) Coupling:
- The coupling command is issued in accordance with the code when the master axis position of 100° is crossed.
- The synchronous point should be at 180° for the master axis and 30° for the follower axis.
- The optimum coupling point thus starts at the master axis position 120°.
- Since the coupling command is issued before this position, the follower axis waits and starts the synchronization motion when the master axis reaches 120°.
- From the time when the coupling command is issued until the synchronous point is reached, the synchronous status is "Coupling" (IsCoupling / synchronous status = 4).

C) - When the synchronous point is reached, the follower axis is in synchronism with the master axis and follows it at the same velocity.
- Now, the synchronous status is "Coupled" (IsCoupled / synchronous status = 1).

D) - According to the code example, a point-to-point positioning is used to decouple and stop the master axis.
- The synchronous status is "Decoupled" (IsDecoupled / synchronous status = 0).

4.2.4.2 Use Case 06: Coupling command "Wait" between optimum coupling point and synchronous point

```
//-----------------------------------------------------------------
// Use case 06: Couple with mode "Wait" after OCP and before SP
//-----------------------------------------------------------------
function runCoupleWaitAfterOCP()

        tecGear.MoveVelocity.Start(xvMaster, Directions.Positive, 50.0, 20.0, 20.0);
        when xvMaster.Position.Setpoint > 150.0 continue;
        tecGear.Coupling.Couple(xFollower, MCTechnoCoupleModes.Wait, 180.0, Directions.Positive, 30.0);
        when xFollower.State.Techno.IsCoupled continue;

        // Just let it run to the next modulo turn
        when xvMaster.Position.Setpoint < 100.0 continue;
        tecGear.MovePtp.Start(xFollower, MCTechnoPositioningModes.AbsModuloAuto, 0.0, 40.0, 200.0, 200.0);
        when xFollower.Mechanism.Slope.IsStopped continue;
        tecGear.MoveHalt.Start(xvMaster, MCTechnoHaltModes.Normal, 50.0);
        when tecGear.State.IsEnabled continue;

end_function;
```



Color	Description
Blue:	Target position of the master axis
Red:	Target position of the follower axis
Green	Target velocity of the master axis
Pink	Target velocity of the follower axis
Light blue	Follower axis synchronous status
Orange:	Ramp status of the follower axis
Gray	Ramp state of the technology group

A) Preparation phase:
- Master axis starts an endless movement.
- The synchronous status is "Decoupled" (IsDecoupled / synchronous status = 0).

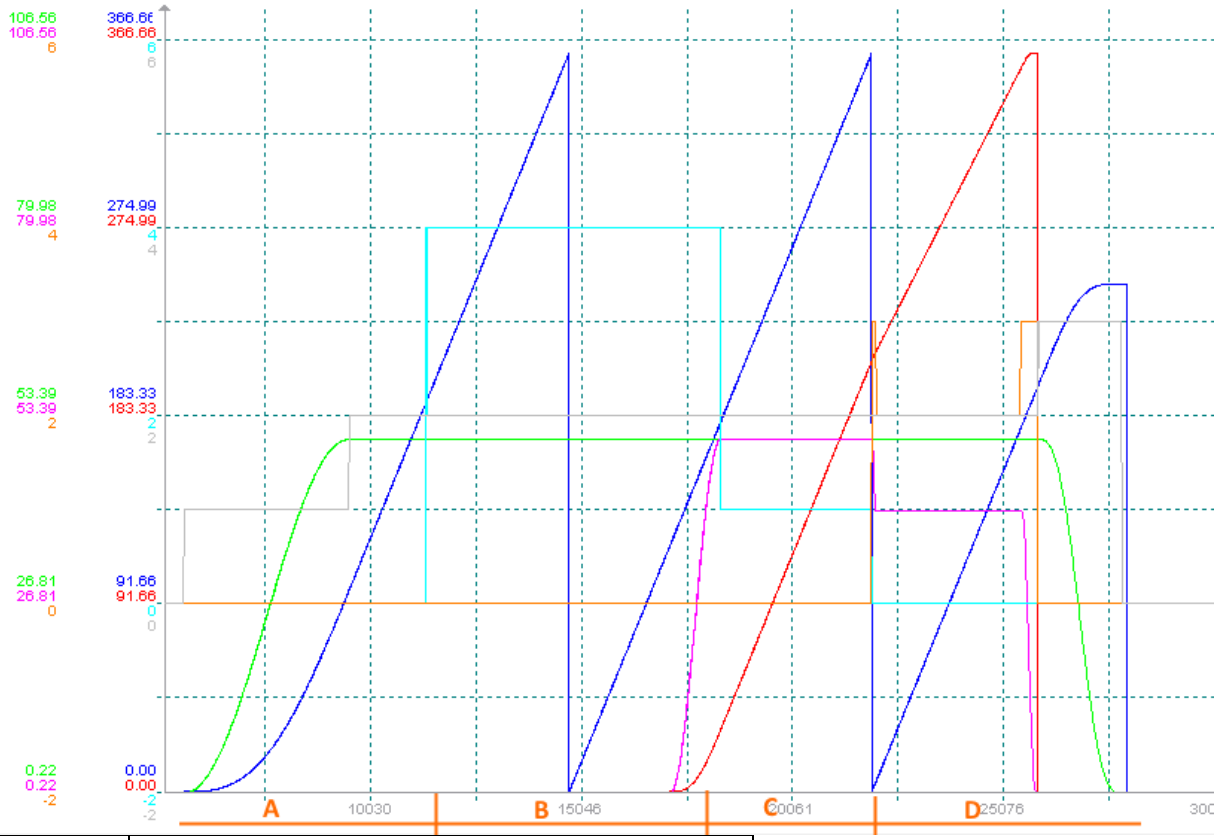
B) Coupling:
- The coupling command is issued in accordance with the code when the master axis position of 150° is crossed.
- The synchronous point should be at 180° for the master axis and 30° for the follower axis.
- The optimum coupling point thus starts at the master axis position 120°.
- Since the coupling command is issued after the coupling point has been crossed, the follower axis waits until the next modulo cycle of the master axis and starts with the synchronization motion at the optimum coupling point in this modulo cycle.
- There is not increase in velocity.
- From the time when the coupling command is issued until the synchronous point is reached, the synchronous status is "Coupling" (IsCoupling / synchronous status = 4).

C) - When the synchronous point is reached, the follower axis is in synchronism with the master axis and follows it at the same velocity.
- Now, the synchronous status is "Coupled" (IsCoupled / synchronous status = 1).

D) - According to the code example, a point-to-point positioning is used to decouple and stop the master axis.
- The synchronous status is "Decoupled" (IsDecoupled / synchronous status = 0).

4.2.4.3 Use Case 07: Coupling command "Wait" after synchronous point

```
//-------------------------------------------------------------
// Use case 07: Couple with mode "Wait" after SP
//-------------------------------------------------------------
function runCoupleWaitAfterSP()

        tecGear.MoveVelocity.Start(xvMaster, Directions.Positive, 50.0, 20.0, 20.0);
        when xvMaster.Position.Setpoint > 190.0 continue;
        tecGear.Coupling.Couple(xFollower, MCTechnoCoupleModes.Wait, 180.0, Directions.Positive, 30.0);
        when xFollower.State.Techno.IsCoupled continue;

        // Just let it run to the next modulo turn
        when xvMaster.Position.Setpoint < 100.0 continue;
        tecGear.MovePtp.Start(xFollower, MCTechnoPositioningModes.AbsModuloAuto, 0.0, 40.0, 200.0, 200.0);
        when xFollower.Mechanism.Slope.IsStopped continue;
        tecGear.MoveHalt.Start(xvMaster, MCTechnoHaltModes.Normal, 50.0);
        when tecGear.State.IsEnabled continue;

end_function;
```



Color	Description
Blue:	Target position of the master axis
Red:	Target position of the follower axis
Green	Target velocity of the master axis
Pink	Target velocity of the follower axis
Light blue	Follower axis synchronous status
Orange:	Ramp status of the follower axis
Gray	Ramp state of the technology group

A) Preparation phase:
- Master axis starts an endless movement.
- The synchronous status is "Decoupled" (IsDecoupled / synchronous status = 0).

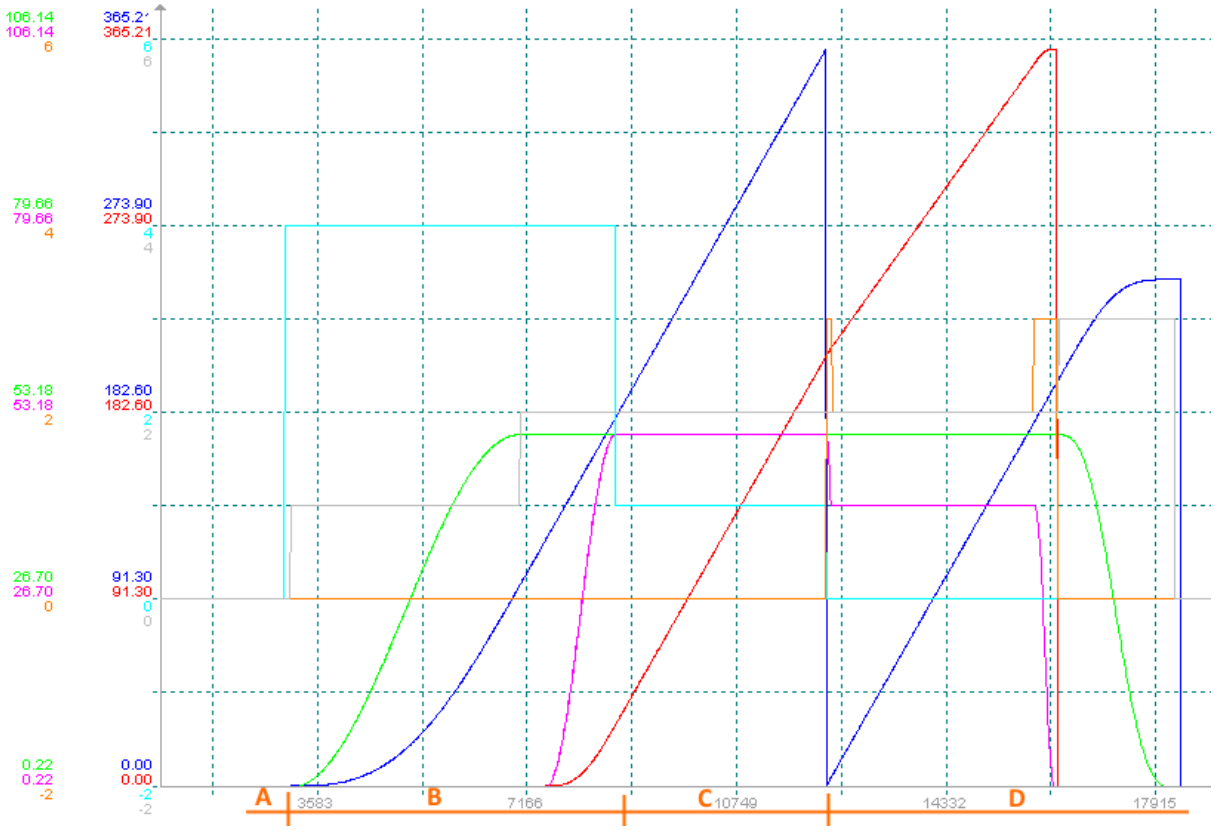
B) Coupling:
- The coupling command is issued in accordance with the code when the master axis position of 190° is crossed.
- The synchronous point should be at 180° for the master axis and 30° for the follower axis.
- The optimum coupling point thus starts at the master axis position 120°.
- Since the coupling command is issued after the synchronization point has been crossed, the follower axis waits until the next modulo cycle of the master axis and starts with the synchronization motion at the optimum coupling point in this modulo cycle. A velocity increase does not take place.
- From the time when the coupling command is issued until the synchronous point is reached, the synchronous status is "Coupling" (IsCoupling / synchronous status = 4).

C) - When the synchronous point is reached, the follower axis is in synchronism with the master axis and follows it at the same velocity.
- Now, the synchronous status is "Coupled" (IsCoupled / synchronous status = 1).

D) - According to the code example, a point-to-point positioning is used to decouple and stop the master axis.
- The synchronous status is "Decoupled" (IsDecoupled / synchronous status = 0).

4.2.4.4 Use Case 08: Coupling command "Wait" before optimum coupling point with stationary master axis

```
//-----------------------------------------------------------------
// Use case 08: Couple with mode "Wait" before SP but master is stopped
//-----------------------------------------------------------------
function runCoupleWaitBeforeOCPStoppedMaster()

        tecGear.Coupling.Couple(xFollower, MCTechnoCoupleModes.Wait, 180.0, Directions.Positive, 30.0);
        when xFollower.State.Techno.IsCoupling continue;
        delay(t#100ms);     // Delay actually not necessary, only to see a short time gap in the scope

        tecGear.MoveVelocity.Start(xvMaster, Directions.Positive, 50.0, 20.0, 20.0);
        when xFollower.State.Techno.IsCoupled continue;

        // Just let it run to the next modulo turn
        when xvMaster.Position.Setpoint < 100.0 continue;
        tecGear.MovePtp.Start(xFollower, MCTechnoPositioningModes.AbsModuloAuto, 0.0, 40.0, 200.0, 200.0);
        when xFollower.Mechanism.Slope.IsStopped continue;
        tecGear.MoveHalt.Start(xvMaster, MCTechnoHaltModes.Normal, 50.0);
        when tecGear.State.IsEnabled continue;

end_function;
```



Color	Description
Blue:	Target position of the master axis
Red:	Target position of the follower axis
Green	Target velocity of the master axis
Pink	Target velocity of the follower axis
Light blue	Follower axis synchronous status
Orange:	Ramp status of the follower axis
Gray	Ramp state of the technology group

A) Preparation phase:
- Master axis and follower axis are at standstill.
- The synchronous status is "Decoupled" (IsDecoupled / synchronous status = 0).

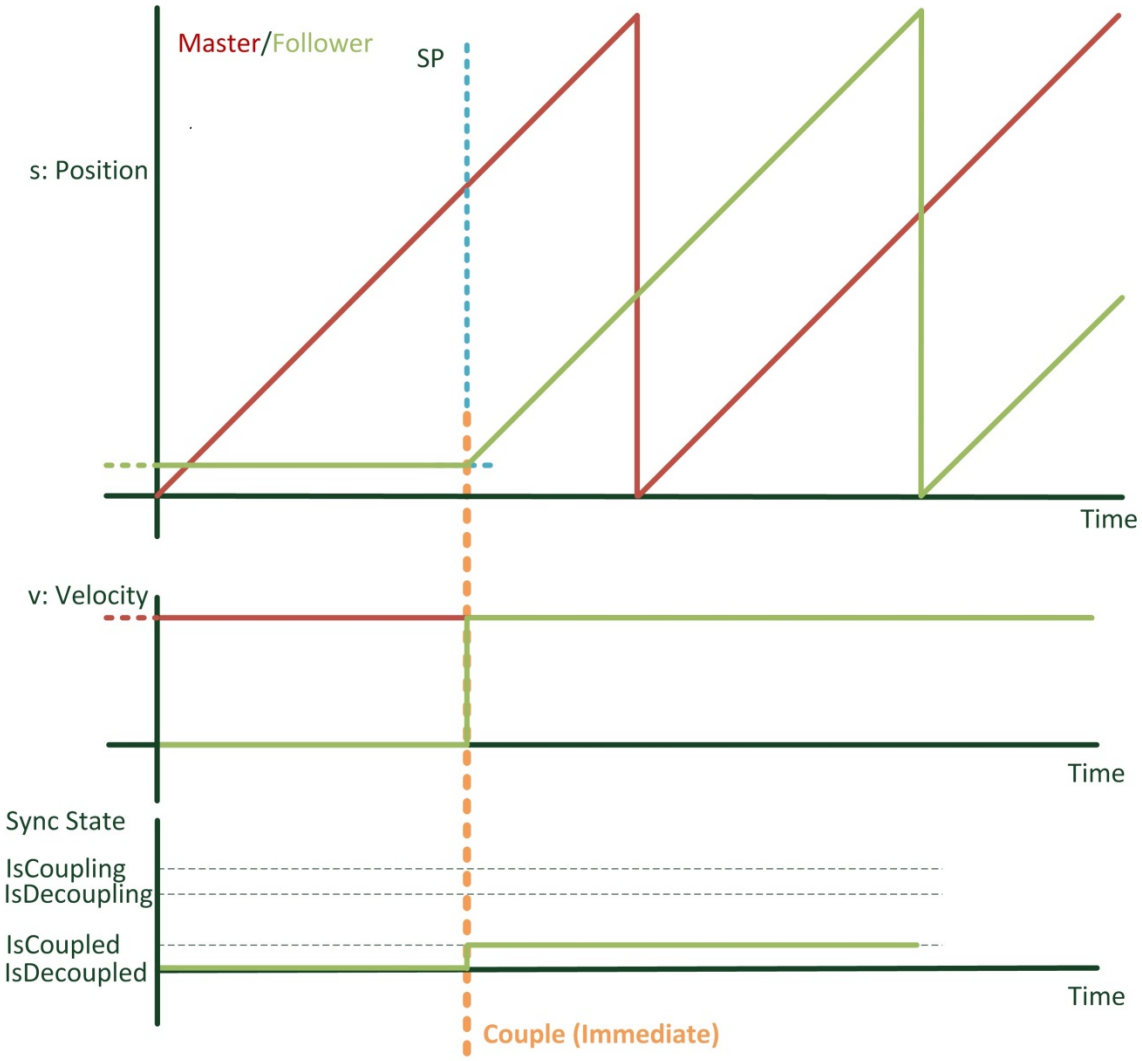
B) Coupling:
- The coupling command is issued first. Only then does the master axis start endless positioning.
- The synchronous point should be at 180° for the master axis and 30° for the follower axis.
- The optimum coupling point thus starts at the master axis position 120°.
- Since the coupling command is issued before the optimum coupling point is reached, the follower axis waits first and starts with the synchronization motion at the optimum coupling point. A velocity increase does not take place.
- From the time when the coupling command is issued until the synchronous point is reached, the synchronous status is "Coupling" (IsCoupling / synchronous status = 4).

C) - When the synchronous point is reached, the follower axis is in synchronism with the master axis and follows it at the same velocity.
- Now, the synchronous status is "Coupled" (IsCoupled / synchronous status = 1).

D) - According to the code example, a point-to-point positioning is used to decouple and stop the master axis.
- The synchronous status is "Decoupled" (IsDecoupled / synchronous status = 0).

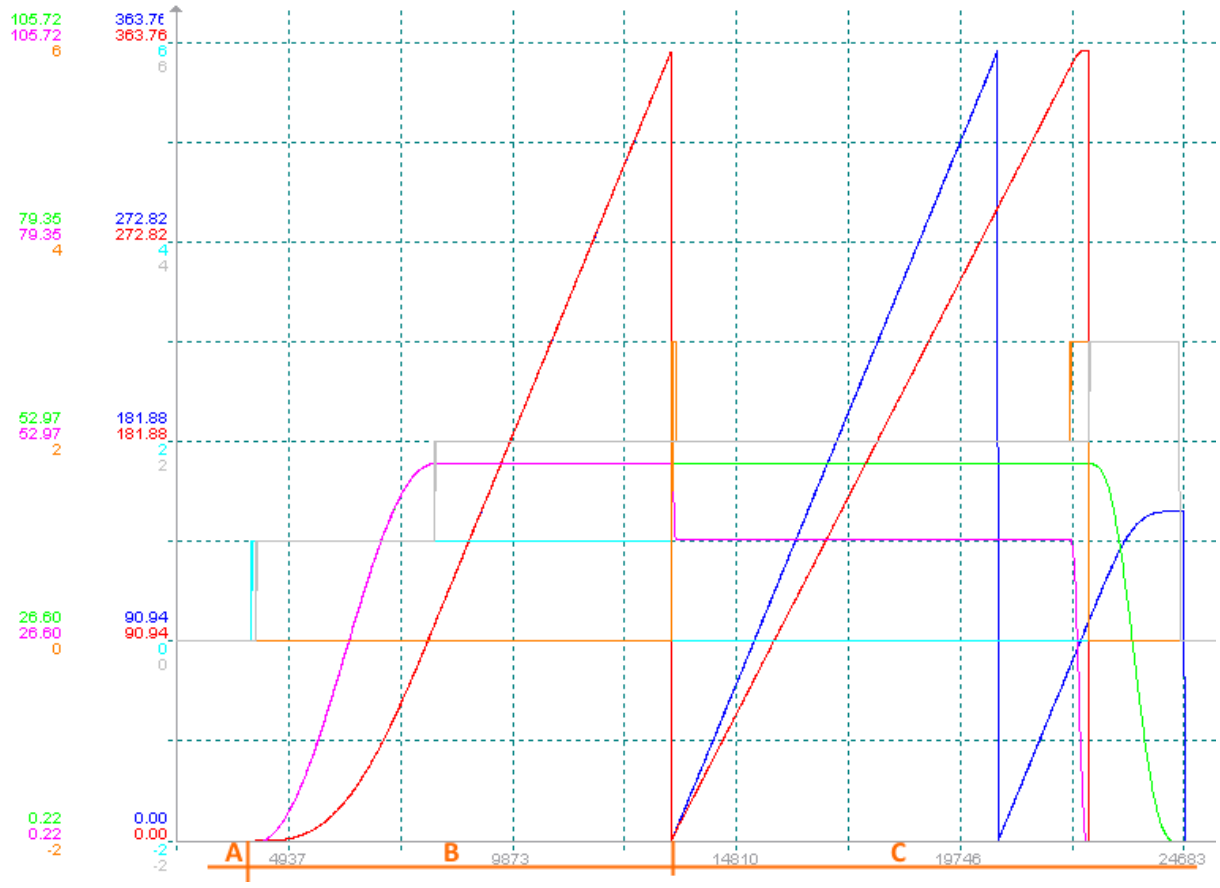
4.2.5 Immediately (Immediate)

- The follower axis moves immediately in synchronism with the master axis and follows its movements according to the gear ratio.
- If the master axis is in motion when the command is issued, the follower axis accelerates in one jump up to synchronous velocity without using an acceleration ramp.
  This coupling mode is therefore recommended for stationary master axes.
- The parameters for defining the synchronization point are not relevant here.



4.2.5.1 Use Case 09: Coupling command "Immediate" with stationary master axis

```
//-----------------------------------------------------------------
// Use case 09: Couple with mode "Immediate" and master is stopped
//-----------------------------------------------------------------
function runCoupleImmediateMasterStopped()

        tecGear.Coupling.Couple(xFollower, MCTechnoCoupleModes.Immediate);
        when xFollower.State.Techno.IsCoupled continue;
        delay(t#100ms);     // Delay acutally not necessary, only to see a short time gap in the scope

        tecGear.MoveVelocity.Start(xvMaster, Directions.Positive, 50.0, 20.0, 20.0);
        when xvMaster.Position.Setpoint > 180.0 continue;

        // Just let it run to the next modulo turn
        when xvMaster.Position.Setpoint < 100.0 continue;
        tecGear.MovePtp.Start(xFollower, MCTechnoPositioningModes.AbsModuloAuto, 0.0, 40.0, 200.0, 200.0);
        when xFollower.Mechanism.Slope.IsStopped continue;
        tecGear.MoveHalt.Start(xvMaster, MCTechnoHaltModes.Normal, 50.0);
        when tecGear.State.IsEnabled continue;

end_function;
```



Color	Description
Blue:	Target position of the master axis
Red:	Target position of the follower axis
Green	Target velocity of the master axis
Pink	Target velocity of the follower axis
Light blue	Follower axis synchronous status
Orange:	Ramp status of the follower axis
Gray	Ramp state of the technology group

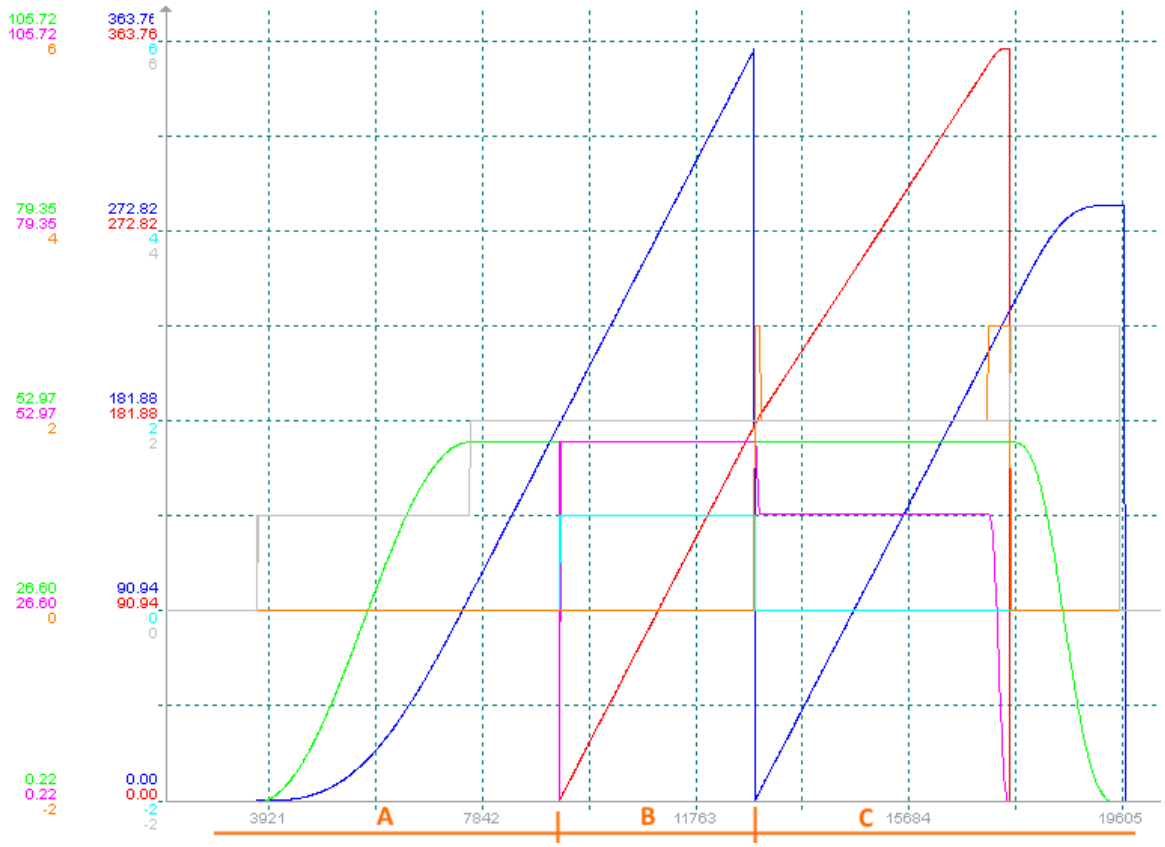
A) Preparation phase:
- Master axis and follower axis are at standstill.
- The synchronous status is "Decoupled" (IsDecoupled / synchronous status = 0).

B) Coupling:
- The coupling command is issued first. Only then does the master axis start endless positioning.
- When the coupling command is issued, the follower axis is immediately in synchronism with the master axis. Therefore, the follower axis follows the master axis at the same velocity after it is positioned in endless mode.
- From the time of the coupling command the synchronous status is set to "coupled" (IsCoupled / synchronous status = 1).

C) - According to the code example, a point-to-point positioning is used to decouple and stop the master axis.
- The synchronous status is "Decoupled" (IsDecoupled / synchronous status = 0).

4.2.5.2 Use Case 10: Coupling command "Immediate" while the master axis is moving

```
//-----------------------------------------------------------------
// Use case 10: Couple with mode "Immediate" and master is running
//-----------------------------------------------------------------
function runCoupleImmediateMasterRunning()

        tecGear.MoveVelocity.Start(xvMaster, Directions.Positive, 50.0, 20.0, 20.0);

        when xvMaster.Position.Setpoint > 180.0 continue;

        // Now you will see a speed jump
        tecGear.Coupling.Couple(xFollower, MCTechnoCoupleModes.Immediate, , Directions.Positive, );
        when xFollower.State.Techno.IsCoupled continue;

        // Just let it run to the next modulo turn
        when xvMaster.Position.Setpoint < 100.0 continue;
        tecGear.MovePtp.Start(xFollower, MCTechnoPositioningModes.AbsModuloAuto, 0.0, 40.0, 200.0, 200.0);
        when xFollower.Mechanism.Slope.IsStopped continue;
        tecGear.MoveHalt.Start(xvMaster, MCTechnoHaltModes.Normal, 50.0);
        when tecGear.State.IsEnabled continue;

end_function;
```



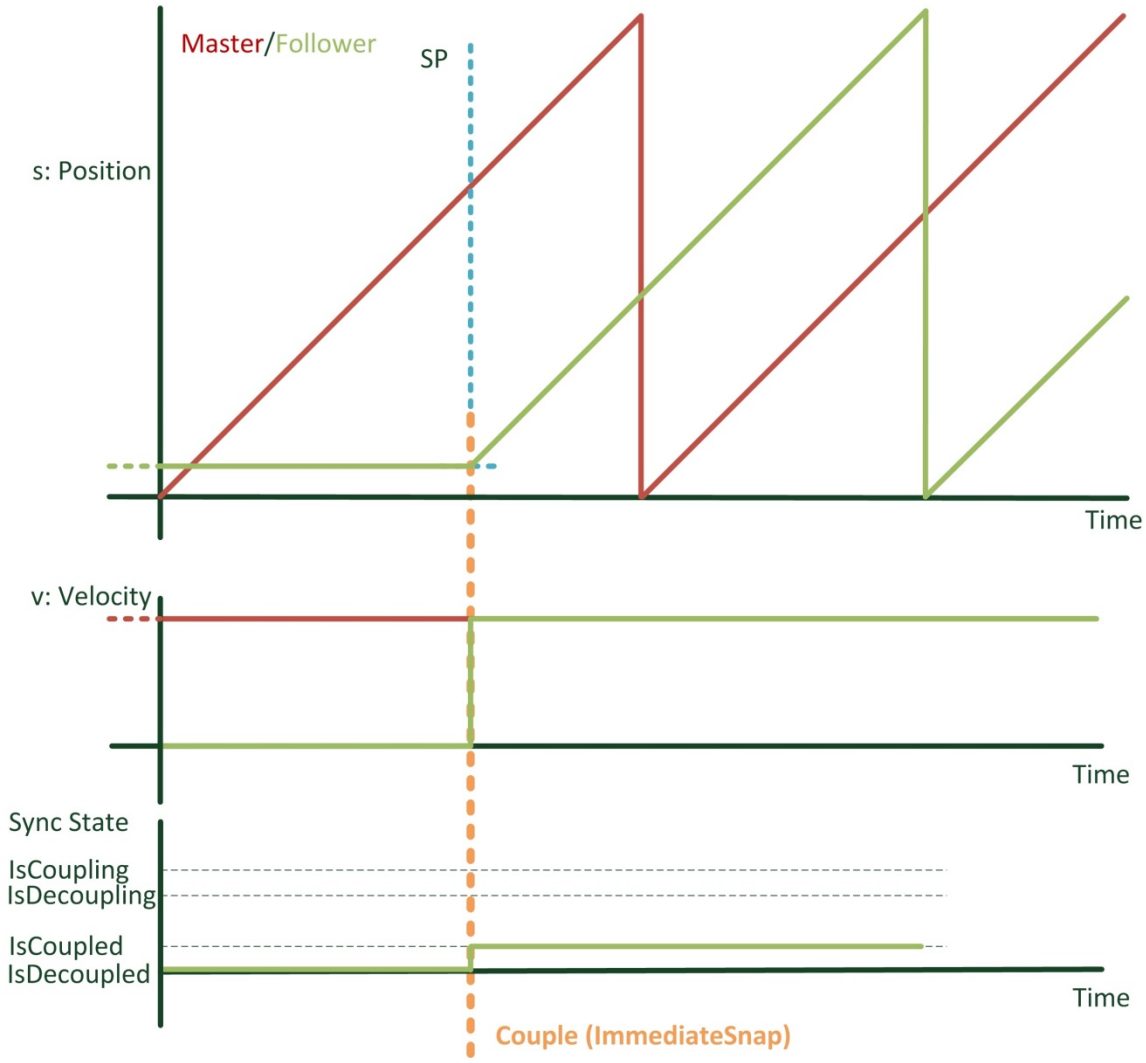
Color	Description
Blue:	Target position of the master axis
Red:	Target position of the follower axis
Green	Target velocity of the master axis
Pink	Target velocity of the follower axis
Light blue	Follower axis synchronous status
Orange:	Ramp status of the follower axis
Gray	Ramp state of the technology group

A) Preparation phase:
   - Master axis starts an endless movement.
   - The synchronous status is "Decoupled" (IsDecoupled / synchronous status = 0).
B) Coupling:
   - The coupling command is issued in accordance with the code when the master axis position of 180° is crossed.
   - When the coupling command is issued in "Immediate" mode, the follower axis follows the master axis accelerating in one jump. As can be seen in the diagram, there is no synchronizing movement, but the target speed of the follower axis jumps to the speed of the master axis.
   - From the time of the coupling command the synchronous status is set to "coupled" (IsCoupled / synchronous status = 1).
C) - According to the code example, a point-to-point positioning is used to decouple and stop the master axis.
   - The synchronous status is "Decoupled" (IsDecoupled / synchronous status = 0).

4.2.6 Immediate snap in (ImmediateSnap)

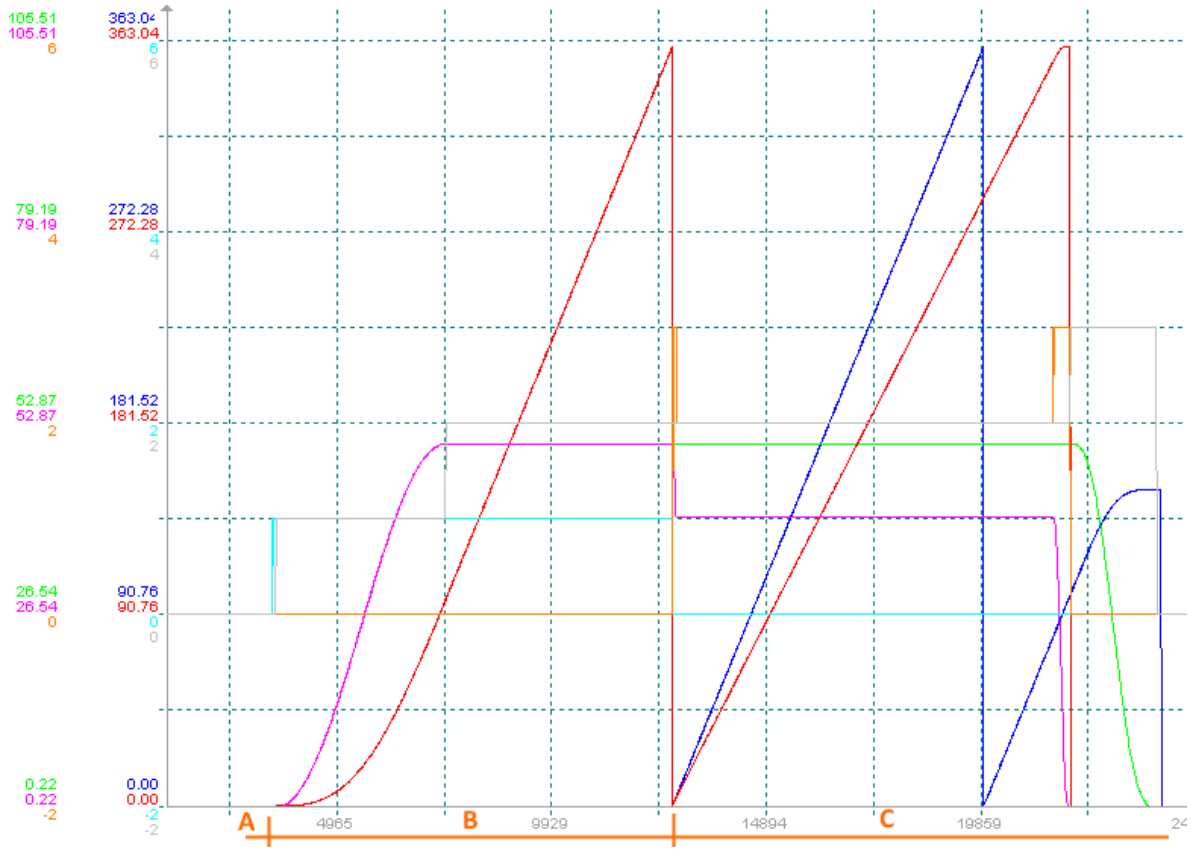
- The follower axis moves immediately in synchronism with the master axis and follows its movements according to the gear ratio.
- If the master axis is in motion when the command is issued, the follower axis accelerates in one jump up to synchronous velocity without using an acceleration ramp.
  This coupling mode is therefore recommended for stationary master axes.
- This coupling mode is mainly relevant for cams. Their definition and activation parameters give them a definite master/follower axis relationship. However, if at the time when the command is issued the follower axis is not at the synchronous point related to the cam, the cam is moved to the current setpoint position of the follower axis.
- For electrical gearboxes, the "*ImmediateSnap*" mode is identical to "*Immediate*".

The parameters for determining the synchronization point are not relevant here.



4.2.6.1 Use Case 11: Coupling command "Immediate Snap" with stationary master axis

```
//-----------------------------------------------------------------
// Use case 11: Couple with mode "ImmediateSnap" and master is stopped
//-----------------------------------------------------------------
function runCoupleImmediateSnapMasterStopped()

        tecGear.Coupling.Couple(xFollower, MCTechnoCoupleModes.ImmediateSnap);
        when xFollower.State.Techno.IsCoupled continue;
        delay(t#100ms);     // Delay acutally not necessary, only to see a short time gap in the scope

        tecGear.MoveVelocity.Start(xvMaster, Directions.Positive, 50.0, 20.0, 20.0);
        when xvMaster.Position.Setpoint > 180.0 continue;

        // Just let it run to the next modulo turn
        when xvMaster.Position.Setpoint < 100.0 continue;
        tecGear.MovePtp.Start(xFollower, MCTechnoPositioningModes.AbsModuloAuto, 0.0, 40.0, 200.0, 200.0);
        when xFollower.Mechanism.Slope.IsStopped continue;
        tecGear.MoveHalt.Start(xvMaster, MCTechnoHaltModes.Normal, 50.0);
        when tecGear.State.IsEnabled continue;

end_function;
```



Color	Description
Blue:	Target position of the master axis
Red:	Target position of the follower axis
Green	Target velocity of the master axis
Pink	Target velocity of the follower axis
Light blue	Follower axis synchronous status
Orange:	Ramp status of the follower axis
Gray	Ramp state of the technology group

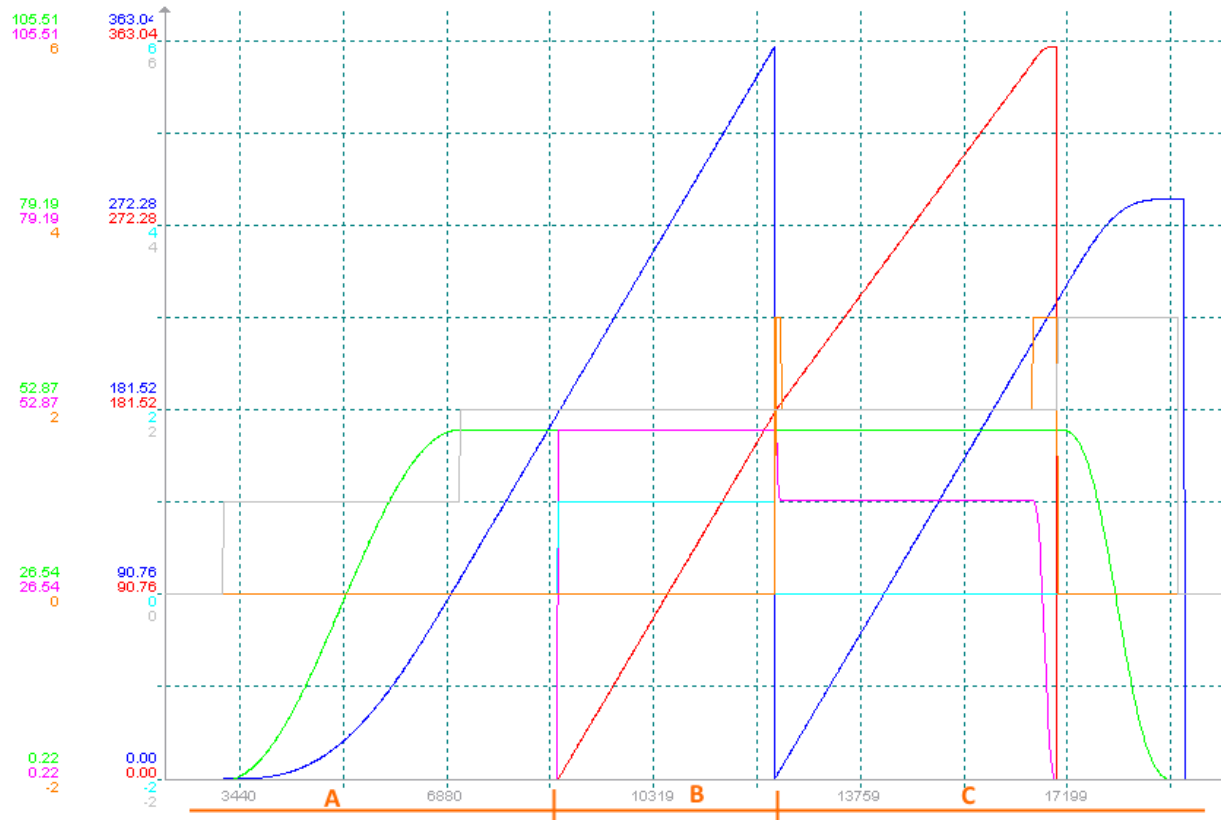
A) Preparation phase:
- Master axis and follower axis are at standstill.
- The synchronous status is "Decoupled" (IsDecoupled / synchronous status = 0).

B) Coupling:
- The coupling command is issued first. Only then does the master axis start endless positioning.
- When the coupling command is issued, the follower axis is immediately in synchronism with the master axis. Therefore, the follower axis follows the master axis at the same velocity after it is positioned in endless mode.
- From the time of the coupling command the synchronous status is set to "coupled" (IsCoupled / synchronous status = 1).

C) - According to the code example, a point-to-point positioning is used to decouple and stop the master axis.
- The synchronous status is "Decoupled" (IsDecoupled / synchronous status = 0).

4.2.6.2 Use Case 12: Coupling command "Immediate snap" while the master axis is moving

```
//-----------------------------------------------------------------
// Use case 12: Couple with mode "ImmediateSnap" and master is running
//-----------------------------------------------------------------
function runCoupleImmediateSnapMasterRunning()

        tecGear.MoveVelocity.Start(xvMaster, Directions.Positive, 50.0, 20.0, 20.0);

        when xvMaster.Position.Setpoint > 180.0 continue;

        // Now you will see a speed jump
        tecGear.Coupling.Couple(xFollower, MCTechnoCoupleModes.ImmediateSnap);
        when xFollower.State.Techno.IsCoupled continue;

        // Just let it run to the next modulo turn
        when xvMaster.Position.Setpoint < 100.0 continue;
        tecGear.MovePtp.Start(xFollower, MCTechnoPositioningModes.AbsModuloAuto, 0.0, 40.0, 200.0, 200.0);
        when xFollower.Mechanism.Slope.IsStopped continue;
        tecGear.MoveHalt.Start(xvMaster, MCTechnoHaltModes.Normal, 50.0);
        when tecGear.State.IsEnabled continue;

end_function;
```



Color	Description
Blue:	Target position of the master axis
Red:	Target position of the follower axis
Green	Target velocity of the master axis
Pink	Target velocity of the follower axis
Light blue	Follower axis synchronous status
Orange:	Ramp status of the follower axis
Gray	Ramp state of the technology group

A) Preparation phase:
- Master axis starts an endless movement.
- The synchronous status is "Decoupled" (IsDecoupled / synchronous status = 0).

B) Coupling:
- The coupling command is issued in accordance with the code when the master axis position of 180° is crossed.
- When the coupling command is issued in "ImmediateSnap" mode, the follower axis follows the master axis accelerating in one jump. As can be seen in the diagram, there is no synchronizing movement, but the target speed of the follower axis jumps to the speed of the master axis.
- From the time of the coupling command the synchronous status is set to "coupled" (IsCoupled / synchronous status = 1).

C) - According to the code example, a point-to-point positioning is used to decouple and stop the master axis.
- The synchronous status is "Decoupled" (IsDecoupled / synchronous status = 0).

INFO

If set to electrical gearbox, the behavior of the "Immediate" and "ImmediateSnap" coupling modes is identical!

4.2.7 Coupling direction (Direction)

TechnoObject.Coupling.Couple(<Follower>, Direction…)
The coupling command also provides the parameter "Direction". This parameter is relevant in the coupling modes "*Fast*" and "*Wait*".

Mode	Coupling direction
Fast	Valid
Wait	Valid
Immediate	Not used
Immediate Snap	Not used

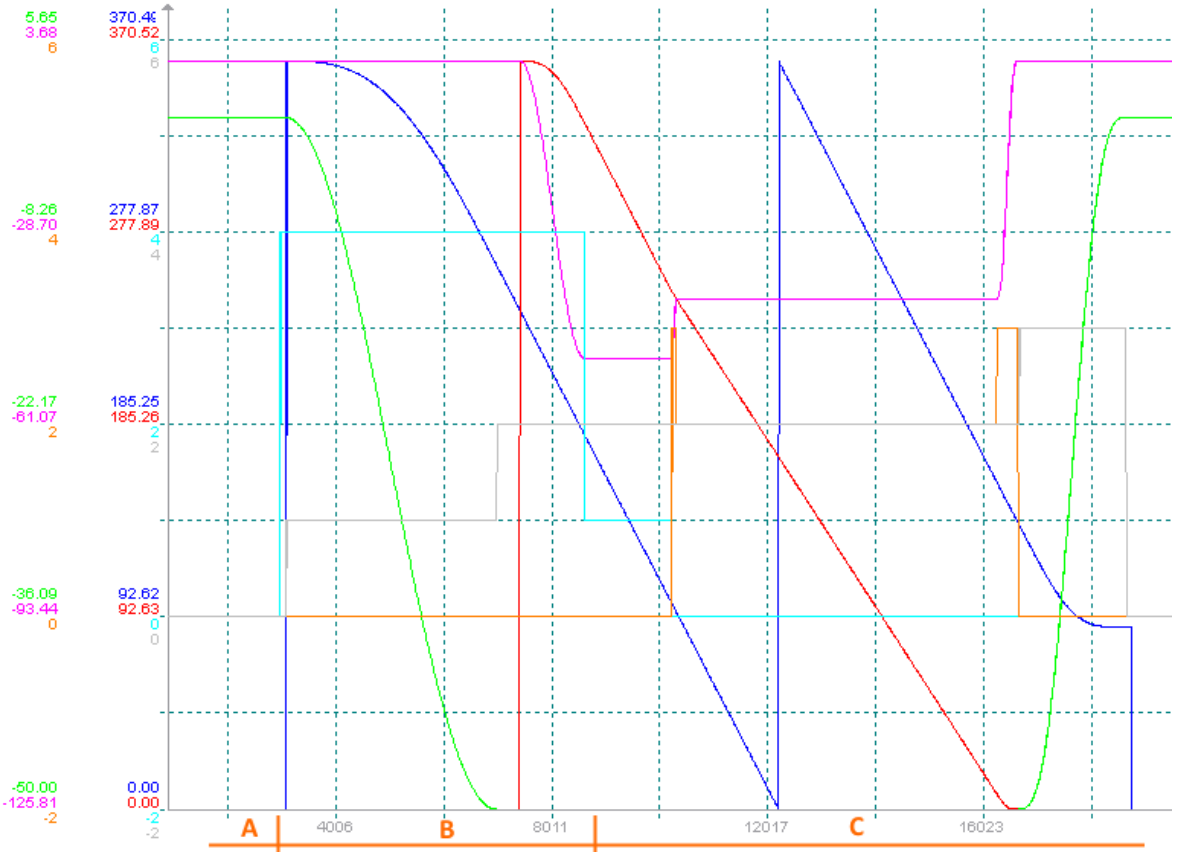
The coupling direction specifies the direction in which the master axis must move to the synchronous point in order to trigger a coupling motion of the follower axis. If, for example, the direction is positive (Directions.Positive), the follower axis does not couple in if the master axis moves in the negative direction, even if the synchronous point is passed (even several times). If the master axis reverses and now moves in positive direction, then the follower axis couples in at the synchronous point.

➢ Note: In the case of modulo master axes, coupling takes place in the modulo cycle in which the original synchronous point is located.
Example: The master axis is at 100°, synchronous point is 200°. Master axis rotates 10 revolutions in the negative direction and reverses then. Then the synchronous point is not the first 200°, but only after 10 positive revolutions.

Since in the "Immediate" and "ImmediateSnap" coupling modes the axis is directly coupled in, the direction of movement of the master axis is not relevant.

4.2.7.1 Use Case 13: Coupling command "Fast" before optimum coupling point with stationary master axis

```
//-----------------------------------------------------------------
// Use case 13: Couple with mode "Fast" before SP but master is stopped and couple diretion is negative
//-----------------------------------------------------------------
function runCoupleFastBeforeOCPStoppedMasterDirNeg()

        tecGear.Coupling.Couple(xFollower, MCTechnoCoupleModes.Fast, 180.0, Directions.Negative, 330.0);
        when xFollower.State.Techno.IsCoupling continue;
        delay(t#100ms);     // Delay acutally not necessary, only to see a short time gap in the scope

        tecGear.MoveVelocity.Start(xvMaster, Directions.Negative, 50.0, 20.0, 20.0);
        when xFollower.State.Techno.IsCoupled continue;

        // Just let it run to the next modulo turn
        when xvMaster.Position.Setpoint < 100.0 continue;
        tecGear.MovePtp.Start(xFollower, MCTechnoPositioningModes.AbsModuloAuto, 0.0, 40.0, 200.0, 200.0);
        when xFollower.Mechanism.Slope.IsStopped continue;
        tecGear.MoveHalt.Start(xvMaster, MCTechnoHaltModes.Normal, 50.0);
        when tecGear.State.IsEnabled continue;

end_function;
```



Color	Description
Blue:	Target position of the master axis
Red:	Target position of the follower axis
Green	Target velocity of the master axis
Pink	Target velocity of the follower axis
Light blue	Follower axis synchronous status
Orange:	Ramp status of the follower axis
Gray	Ramp state of the technology group

A) Preparation phase:
- Master axis and follower axis are at standstill.
- The synchronous status is "Decoupled" (IsDecoupled / synchronous status = 0).

B) Coupling:
- First, the coupling command with direction parameter set to "negative" is issued. Only then does the master axis start an endless positioning in the negative direction.
- The synchronous point should be at 180° for the master axis and 330° for the follower axis.
- The optimum coupling point thus starts at the master axis position 240°.
- Since the coupling command is issued before the optimum coupling point is reached, the follower axis waits first and starts with the synchronization motion at the optimum coupling point. A velocity increase does not take place.
- From the time when the coupling command is issued until the synchronous point is reached, the synchronous status is "Coupling" (IsCoupling / synchronous status = 4).

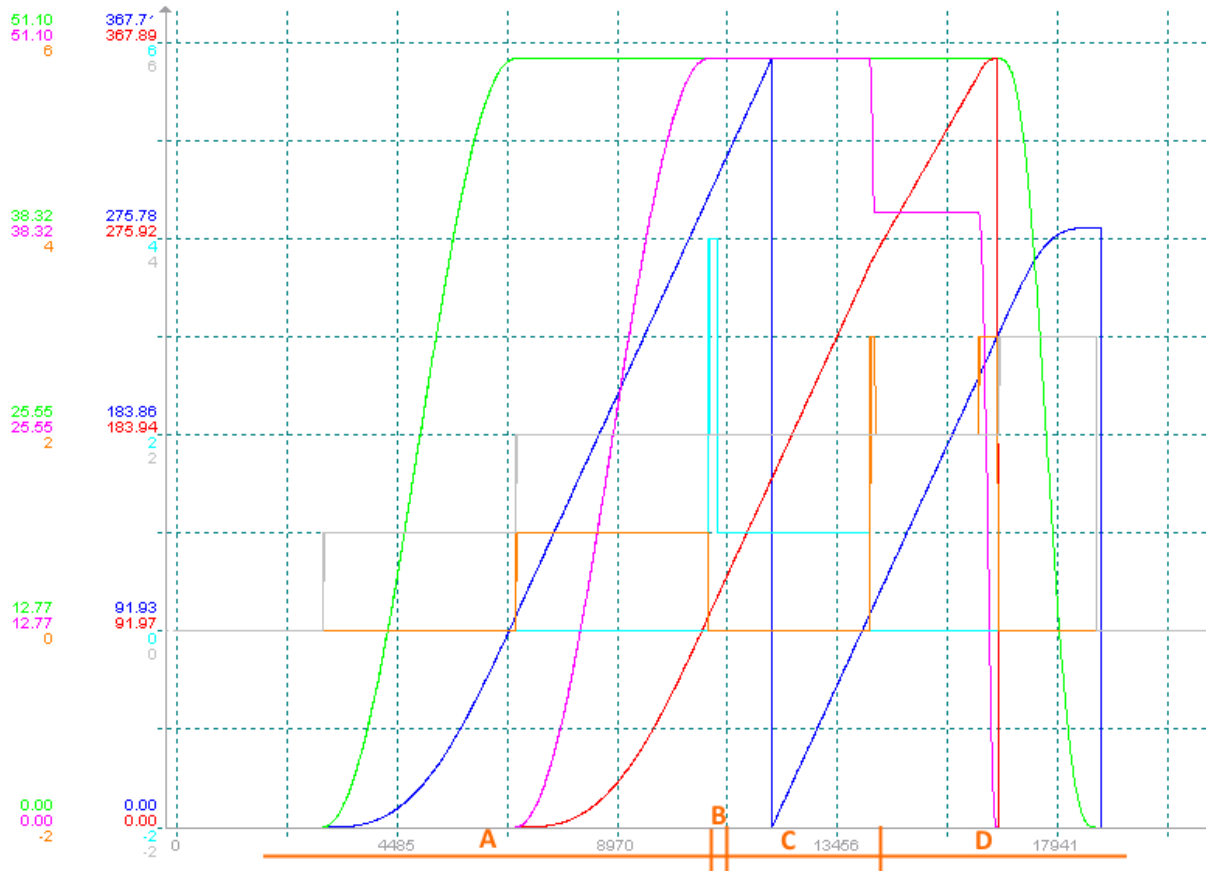
C) - When the synchronous point is reached, the follower axis is in synchronism with the master axis and follows it at the same velocity.
- Now, the synchronous status is "Coupled" (IsCoupled / synchronous status = 1).

D) - According to the code example, a point-to-point positioning is used to decouple and stop the master axis.
- The synchronous status is "Decoupled" (IsDecoupled / synchronous status = 0).

4.2.8 Coupling with master and slave axis moving

4.2.8.1 Use Case 14: Coupling "Fast" with master axis moving and follower axis moving at synchronous speed

```
//-----------------------------------------------------------------
// Use case 14: Couple with mode "Fast" with running Master and Follower
//-----------------------------------------------------------------
function runCoupleFastRunningMasterAndFollower()

        tecGear.MoveVelocity.Start(xvMaster, Directions.Positive, 50.0, 20.0, 20.0);
        when tecGear.Mechanism.Slope.IsAtConstantSpeed continue;
        tecGear.MoveVelocity.Start(xFollower, Directions.Positive, 50.0, 20.0, 20.0);
        when xFollower.Mechanism.Slope.IsAtConstantSpeed continue;

        tecGear.Coupling.Couple(xFollower, MCTechnoCoupleModes.Fast, xvMaster.Position.Setpoint + 10.0, Directions.Positive,
xFollower.Position.Setpoint + 10.0);
        when xFollower.State.Techno.IsCoupled continue;

        // Just let it run to the next modulo turn
        when xvMaster.Position.Setpoint < 100.0 continue;
        when xvMaster.Position.Setpoint > 100.0 continue;
        tecGear.MovePtp.Start(xFollower, MCTechnoPositioningModes.AbsModuloAuto, 0.0, 40.0, 200.0, 200.0);
        when xFollower.Mechanism.Slope.IsStopped continue;
        tecGear.MoveHalt.Start(xvMaster, MCTechnoHaltModes.Normal, 50.0);
        when tecGear.State.IsEnabled continue;

end_function;
```



Color	Description
Blue:	Target position of the master axis
Red:	Target position of the follower axis
Green	Target velocity of the master axis
Pink	Target velocity of the follower axis
Light blue	Follower axis synchronous status
Orange:	Ramp status of the follower axis
Gray	Ramp state of the technology group

A) Preparation phase:
- Master axis starts an endless movement.
- As soon as the target velocity of the master axis has been reached, the follower axis is also positioned in endless mode with the same target velocity as default.
- The synchronous status is "Decoupled" (IsDecoupled / synchronous status = 0).

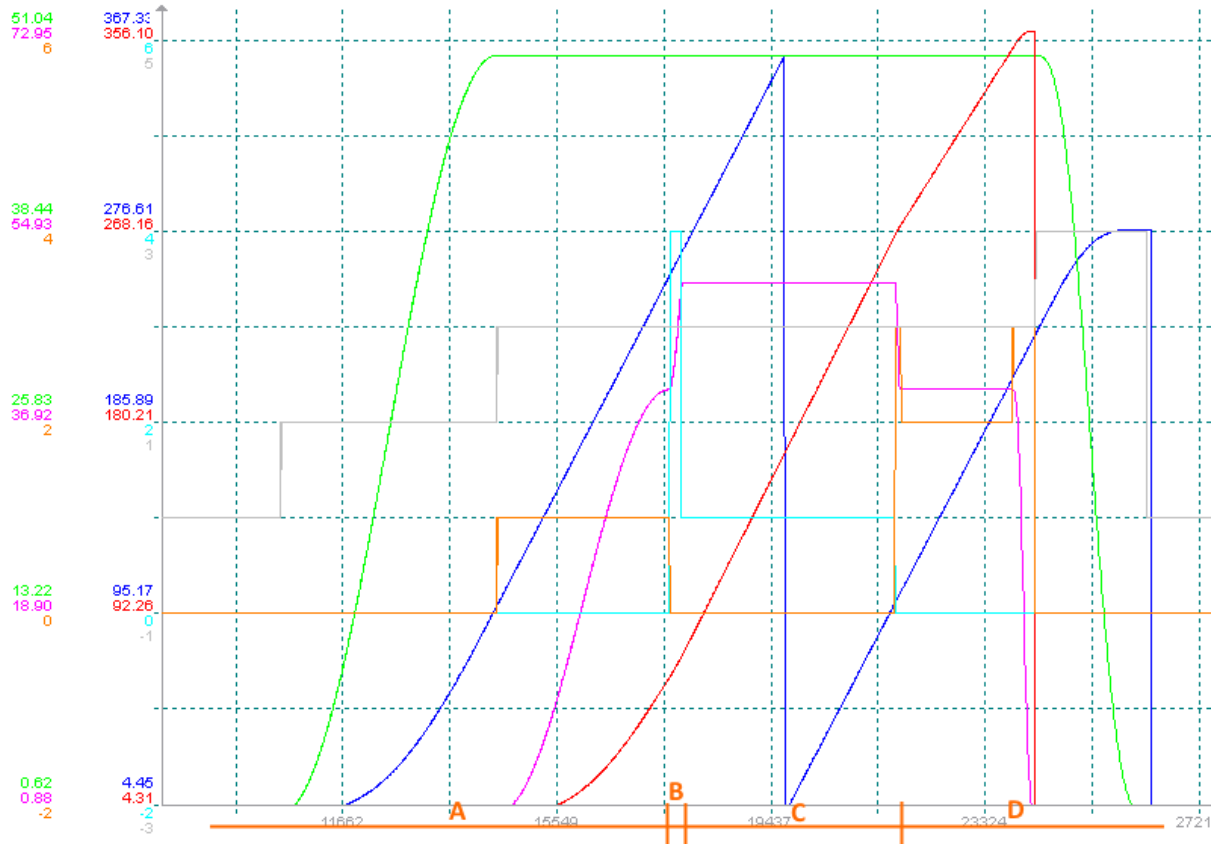
B) Coupling:
- According to the code, the coupling command will be issued when the target velocity of the follower axis is reached, whereby the synchronous point is 10° further from the current target positions of the master and follower axis.
- Due to the same velocity of both axes at a gear ratio of 1:1, the velocity of the follower axis is not changed during the coupling phase.
- From the time when the coupling command is issued until the synchronous point is reached, the synchronous status is "Coupling" (IsCoupling / synchronous status = 4).

C) - When the synchronous point is reached, the follower axis is in synchronism with the master axis and follows it at the same velocity.
- Now, the synchronous status is "Coupled" (IsCoupled / synchronous status = 1).

D) - According to the code example, a point-to-point positioning is used to decouple and stop the master axis.
- The synchronous status is "Decoupled" (IsDecoupled / synchronous status = 0).

4.2.8.2 Use Case 15: Coupling "Fast" with master axis and follower axis moving at different speeds

```
//-------------------------------------------------------------
// Use case 15: Couple with mode "Fast" with running Master and Follower, but different Speed
//-------------------------------------------------------------
function runCoupleFastRunningMasterAndFollowerDiffSpeed()

        tecGear.MoveVelocity.Start(xvMaster, Directions.Positive, 50.0, 20.0, 20.0);
        when tecGear.Mechanism.Slope.IsAtConstantSpeed continue;
        tecGear.MoveVelocity.Start(xFollower, Directions.Positive, 40.0, 20.0, 20.0);
        when xFollower.Mechanism.Slope.IsAtConstantSpeed continue;

        tecGear.Coupling.Couple(xFollower, MCTechnoCoupleModes.Fast, xvMaster.Position.Setpoint + 10.0, Directions.Positive,
xFollower.Position.Setpoint + 8.8);
        when xFollower.State.Techno.IsCoupled continue;

        // Just let it run to the next modulo turn
        when xvMaster.Position.Setpoint < 100.0 continue;
        when xvMaster.Position.Setpoint > 100.0 continue;
        tecGear.MovePtp.Start(xFollower, MCTechnoPositioningModes.AbsModuloAuto, 0.0, 40.0, 200.0, 200.0);
        when xFollower.Mechanism.Slope.IsStopped continue;
        tecGear.MoveHalt.Start(xvMaster, MCTechnoHaltModes.Normal, 50.0);
        when tecGear.State.IsEnabled continue;

end_function;
```



Color	Description
Blue:	Target position of the master axis
Red:	Target position of the follower axis
Green	Target velocity of the master axis

Color	Description
Pink	Target velocity of the follower axis
Light blue	Follower axis synchronous status
Orange:	Ramp status of the follower axis
Gray	Ramp state of the technology group

A) Preparation phase:
- Master axis starts an endless movement.
- As soon as the target velocity of the master axis has been reached, the follower axis is also positioned in endless mode with the same target velocity as default.
- The synchronous status is "Decoupled" (IsDecoupled / synchronous status = 0).

B) Coupling:
- According to the code, the coupling command is issued when the follower axis has reached the target velocity.
- The synchronous point is selected in such a way that only an increase in velocity up to synchronous velocity occurs during the synchronization motion.
- From the time when the coupling command is issued until the synchronous point is reached, the synchronous status is "Coupling" (IsCoupling / synchronous status = 4).

C) - When the synchronous point is reached, the follower axis is in synchronism with the master axis and follows it at the same velocity.
- Now, the synchronous status is "Coupled" (IsCoupled / synchronous status = 1).

D) - According to the code example, a point-to-point positioning is used to decouple and stop the master axis.
- The synchronous status is "Decoupled" (IsDecoupled / synchronous status = 0).

4.3 Decoupling

In principle, there are 2 different ways of decoupling the follower axis of an electrical gearbox:

- By starting a positioning of the follower axis:
  <Techno>.MovePtp.Start(…)
  <Techno>.MoveVelocity.Start(…)
- By using the "Decouple" command:
  <Techno>.Coupling.Decouple(…)

The axis will not decoupled in the following mode:

- Superimposed positioning:
  <Techno>. MovePtp.StartSuperPose(…)
  <Techno>.MoveVelocity.StartSuperPose(…)
- By stopping the follower axis with MoveHalt:
  <Techno>.MoveHalt.Start(..)
  If the follower axis is coupled, a superimposed positioning is stopped with MoveHalt.Start(..). Once the axis is decoupled, the current positioning is stopped.

4.3.1 Use Cases

The use cases are located in the project "*ElectricalGearDecoupling365*" and "*ElectricalGearDecoupling440*".
The following configuration is used in the use cases:

- xvMaster: Virtual axis, rotary modulo bidirectional, traversing range 0° … 360° is set in the STX project.
- xFollower: MC-JM203 as simulated axis, rotary modulo bidirectional, traversing range 0° … 360° is set in the STX project.
- tecGear: Technology group:

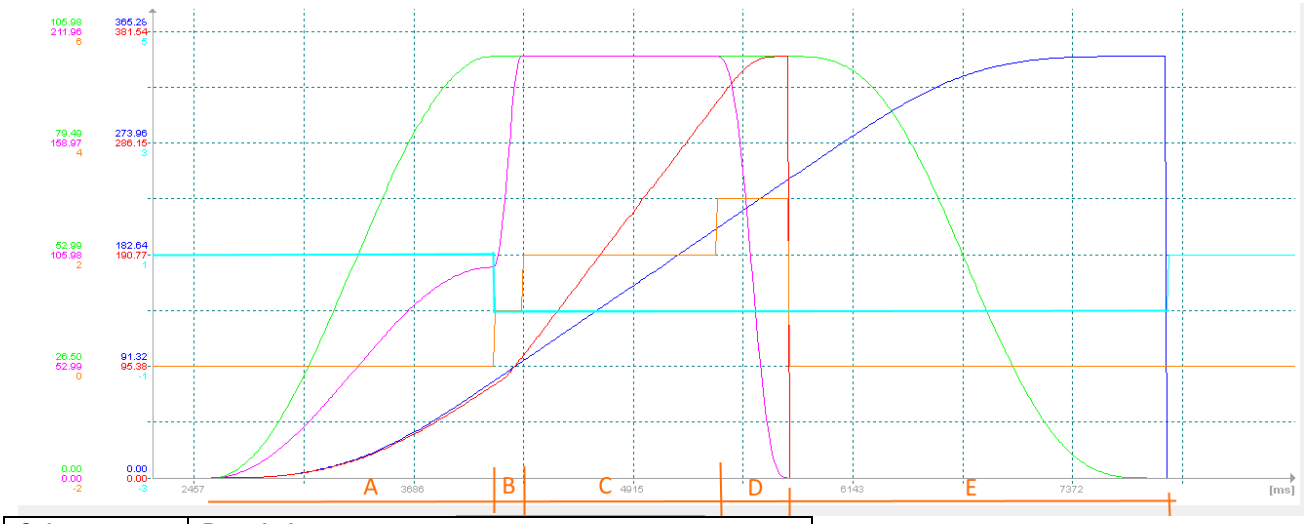
- Master axis: xvMaster,
- Follower axis: XFollower, coupling mode: Electrical gearbox, setpoint coupled

4.3.2 MovePtp

4.3.2.1 Use Case 01: Decoupling while the master axis is running

In the following example, the group is activated and the master axis is positioned in endless mode. As soon as the master axis has reached its maximum velocity, the follower axis is positioned to 0° with MovePtp.

```
// Use case 01: Decoupling of follower with MovePtp and running Master
tecGear.MoveVelocity.Start(xvMaster, Directions.Positive, 100.0, 100.0, 100.0);
when tecGear.Mechanism.Slope.IsAtConstantSpeed continue;
tecGear.MovePtp.Start(xFollower, MCTechnoPositioningModes.AbsModuloAuto, 0.0, 200.0, 1000.0, 1000.0);
when xFollower.Mechanism.Slope.IsStopped and xFollower.State.Techno.IsDecoupled continue;
tecGear.MoveHalt.Start(xvMaster, MCTechnoHaltModes.Normal, 100.0);
when tecGear.State.IsEnabled continue;
```



Color	Description
Blue:	Target position of the master axis
Red:	Target position of the follower axis
Green	Target velocity of the master axis
Pink	Target velocity of the follower axis
Light blue	Follower axis synchronous status
Orange:	Ramp status of the follower axis
Gray	Ramp state of the technology group

A) After activating the group, the master axis is positioned in endless mode. The follower axis follows according to the electrical gearbox.
The synchronous status of the follower axis is "coupled".
The ramp status is "Stopped". The ramp status refers to an active positioning and not to a synchronous motion.

B) When the maximum velocity of the master axis is reached, a positioning motion of the follower axis to 0.0° is started. Due to the positioning mode, the axis maintains the direction of rotation and positions towards the modulo limit that lies ahead.
The coupling status immediately changes to "Decoupled".
The ramp status changes to "Accelerating" because the target velocity of MovePtp is higher than the current speed.

C) The master axis continues to move independently of the follower axis.
When the target velocity is reached, the ramp status of the follower axis changes to "Maximum velocity".

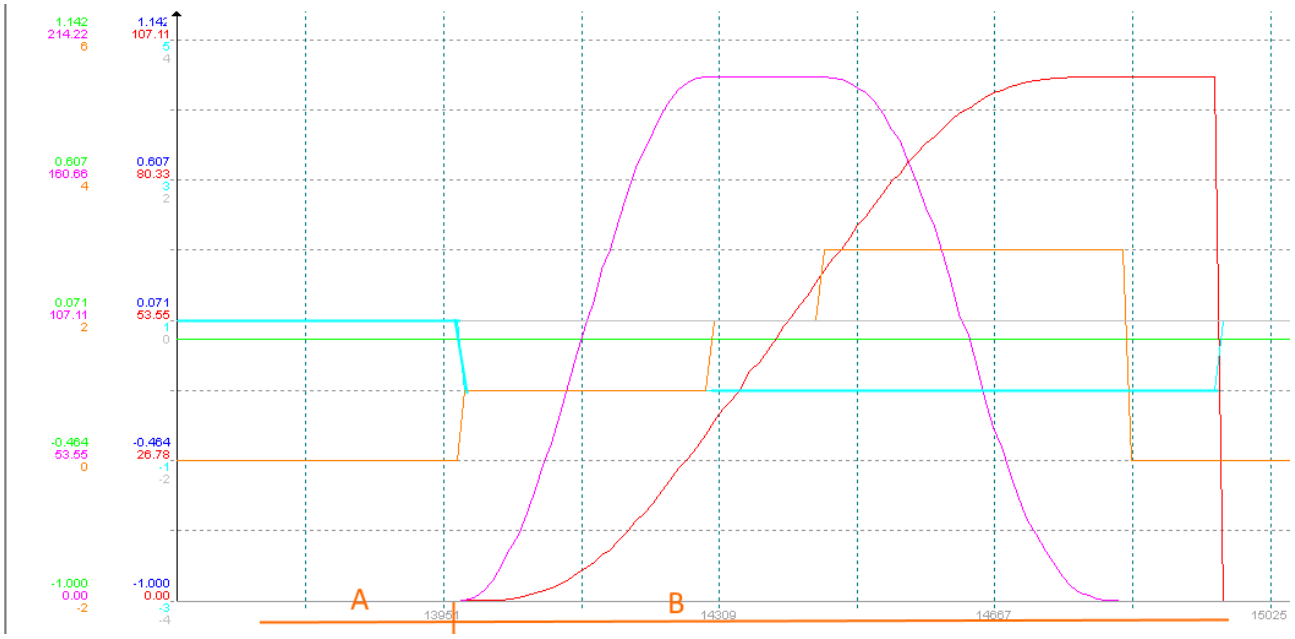
D) The master axis continues to move independently of the follower axis.
The follower axis decelerates, which is why the ramp status changes to "Decelerating".

E) According to the program, the master axis is stopped after the follower axis has reached its target position.
The ramp status of the follower axis is now "IsStopped".

4.3.2.2 Use Case 02: Decoupling with master axis stationary

Unlike Use Case 01, the master axis is stopped.

```
// Use case 02: Decoupling of follower with MovePtp and stopped Master
tecGear.MovePtp.Start(xFollower, MCTechnoPositioningModes.AbsModuloAuto, 100.0, 200.0, 1000.0, 1000.0);
when xFollower.Mechanism.Slope.IsStopped and xFollower.State.Techno.IsDecoupled continue;
```



Color	Description
Blue:	Target position of the master axis
Red:	Target position of the follower axis
Green	Target velocity of the master axis
Pink	Target velocity of the follower axis
Light blue	Follower axis synchronous status
Orange:	Ramp status of the follower axis
Gray	Ramp state of the technology group

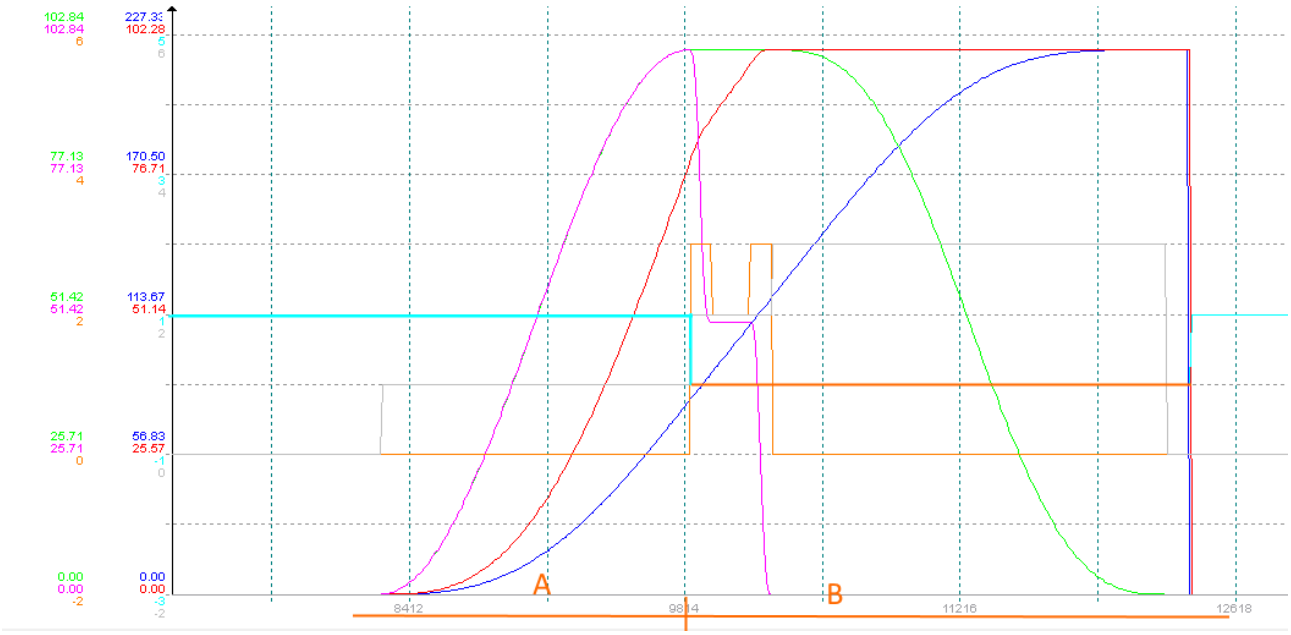
A) After activating the group, the synchronous status of the follower axis is "IsCoupled". The ramp status is "Stopped". The ramp status refers to an active positioning and not to a synchronous motion.

B) After starting a positioning motion using MovePtp.Start, the synchronous status of the follower axis changes to "IsDecoupled".
Furthermore, the follower axis carries out a normal positioning motion (see also Use Case 01.B)

4.3.3 MoveVelocity

4.3.3.1 Use Case 03: Decoupling while the master axis is running

```
// Use case 03: Decoupling of follower with MoveVelocity and running Master
tecGear.MoveVelocity.Start(xvMaster, Directions.Positive, 100.0, 100.0, 100.0);
when tecGear.Mechanism.Slope.IsAtConstantSpeed continue;
tecGear.MoveVelocity.Start(xFollower, Directions.Positive, 50.0, 1000.0, 1000.0);
when xFollower.Mechanism.Slope.IsAtConstantSpeed and xFollower.State.Techno.IsDecoupled continue;
delay(t#200ms);
tecGear.MoveHalt.Start(xFollower, MCTechnoHaltModes.Normal, 1000.0);
when xFollower.Mechanism.Slope.IsStopped continue;
tecGear.MoveHalt.Start(xvMaster, MCTechnoHaltModes.Normal, 100.0);
when tecGear.State.IsEnabled continue;
```



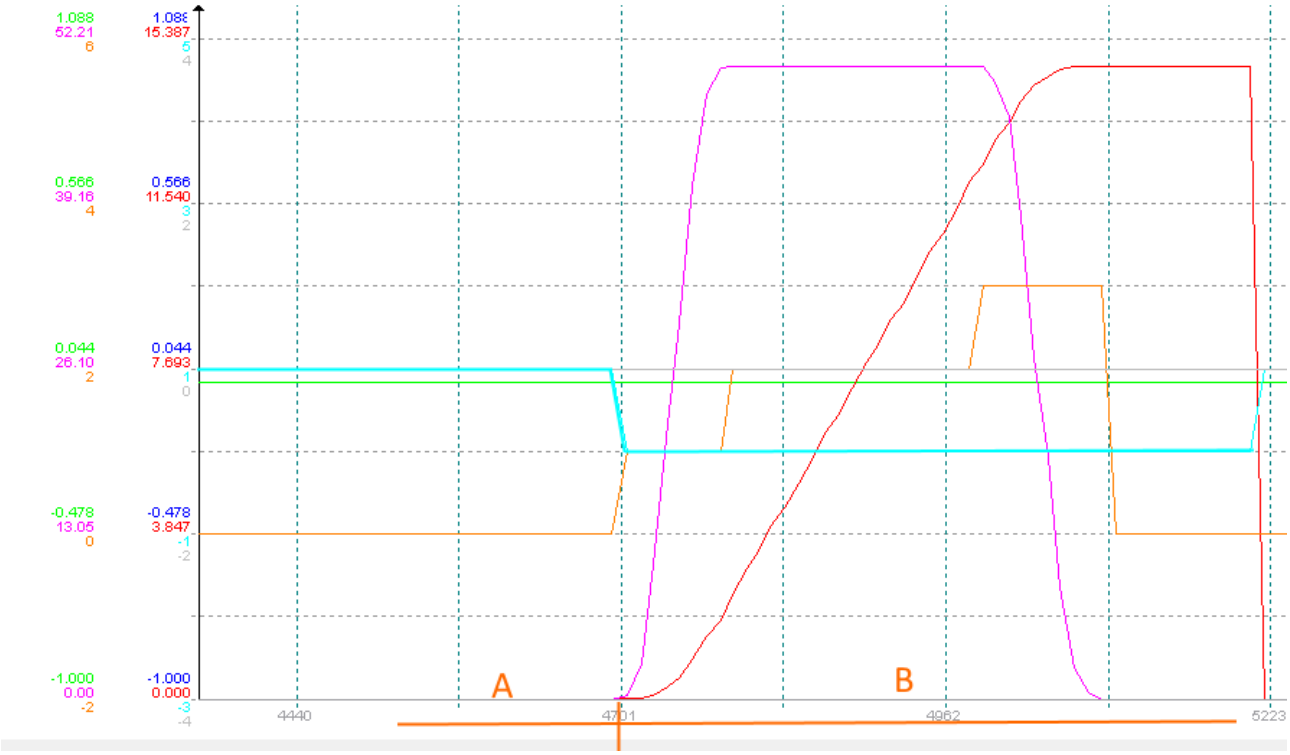
Color	Description
Blue:	Target position of the master axis
Red:	Target position of the follower axis
Green	Target velocity of the master axis
Pink	Target velocity of the follower axis
Light blue	Follower axis synchronous status
Orange:	Ramp status of the follower axis
Gray	Ramp state of the technology group

A) After activating the group, the synchronous status of the follower axis is "IsCoupled". The follower axis moves in synchronism with the master axis.
The ramp status is "Stopped". The ramp status refers to an active positioning and not to a synchronous motion.

B) After starting an endless positioning motion with MoveVelocity.Start, the synchronous status changes to "IsDecoupled".
Since a lower velocity than the current one is specified for the endless positioning, the ramp status first changes to "Decelerating" followed by "Maximum speed" and then back to "Decelerating" after the waiting time has elapsed and ends at "IsStopped" after MoveHalt.Start has been executed.

4.3.3.2 Use Case 04: Decoupling with master axis stationary

```
// Use case 04: Decoupling of follower with MoveVelocity and stopped Master
tecGear.MoveVelocity.Start(xFollower, Directions.Positive, 50.0, 1000.0, 1000.0);
when xFollower.Mechanism.Slope.IsAtConstantSpeed and xFollower.State.Techno.IsDecoupled continue;
delay(t#200ms);
tecGear.MoveHalt.Start(xFollower, MCTechnoHaltModes.Normal, 1000.0);
when xFollower.Mechanism.Slope.IsStopped continue;
```



Color	Description
Blue:	Target position of the master axis
Red:	Target position of the follower axis
Green	Target velocity of the master axis
Pink	Target velocity of the follower axis
Light blue	Follower axis synchronous status
Orange:	Ramp status of the follower axis
Gray	Ramp state of the technology group

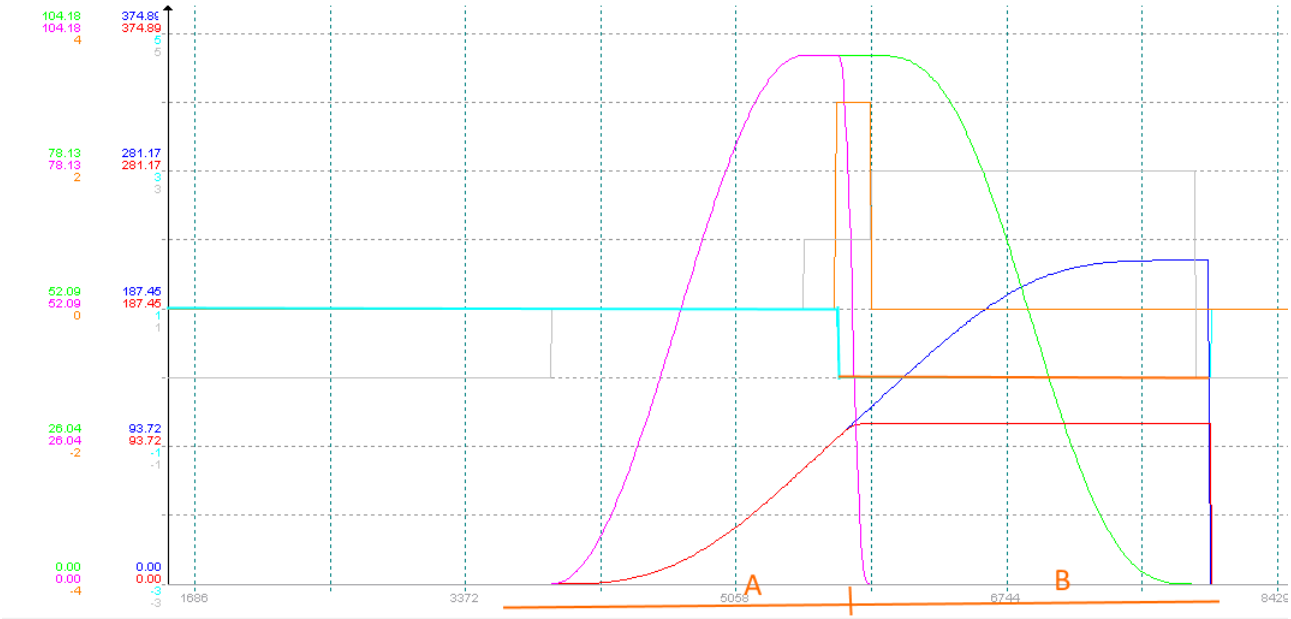
A) After activating the group, the synchronous status of the follower axis is "IsCoupled". The ramp status is "Stopped". The ramp status refers to an active positioning and not to a synchronous motion.

B) After starting an endless positioning motion with MoveVelocity.Start, the synchronous status changes to "IsDecoupled".
Since a lower velocity than the current one is specified for the endless positioning, the ramp status first changes to "Decelerating" followed by "Maximum speed" and then back to "Decelerating" after the waiting time has elapsed and ends at "IsStopped" after MoveHalt.Start has been executed.

4.3.4 Mode: Decouple with immediate stop

4.3.4.1 Use Case 05: Decoupling of follower axis with "Immediate_Stop" while the master axis is moving

```
// Use case 05: Decoupling of follower with
// Decouple(MCTechnoDecoupleModes.Immediate_Stop) and running Master
tecGear.MoveVelocity.Start(xvMaster, Directions.Positive, 100.0, 100.0, 100.0);
when tecGear.Mechanism.Slope.IsAtConstantSpeed continue;
delay(t#200ms);
tecGear.Coupling.Decouple(xFollower, MCTechnoDecoupleModes.Immediate_Stop, , 1000.0);
when xFollower.Mechanism.Slope.IsStopped and xFollower.State.Techno.IsDecoupled continue;
tecGear.MoveHalt.Start(xvMaster, MCTechnoHaltModes.Normal, 100.0);
when tecGear.State.IsEnabled continue;
```



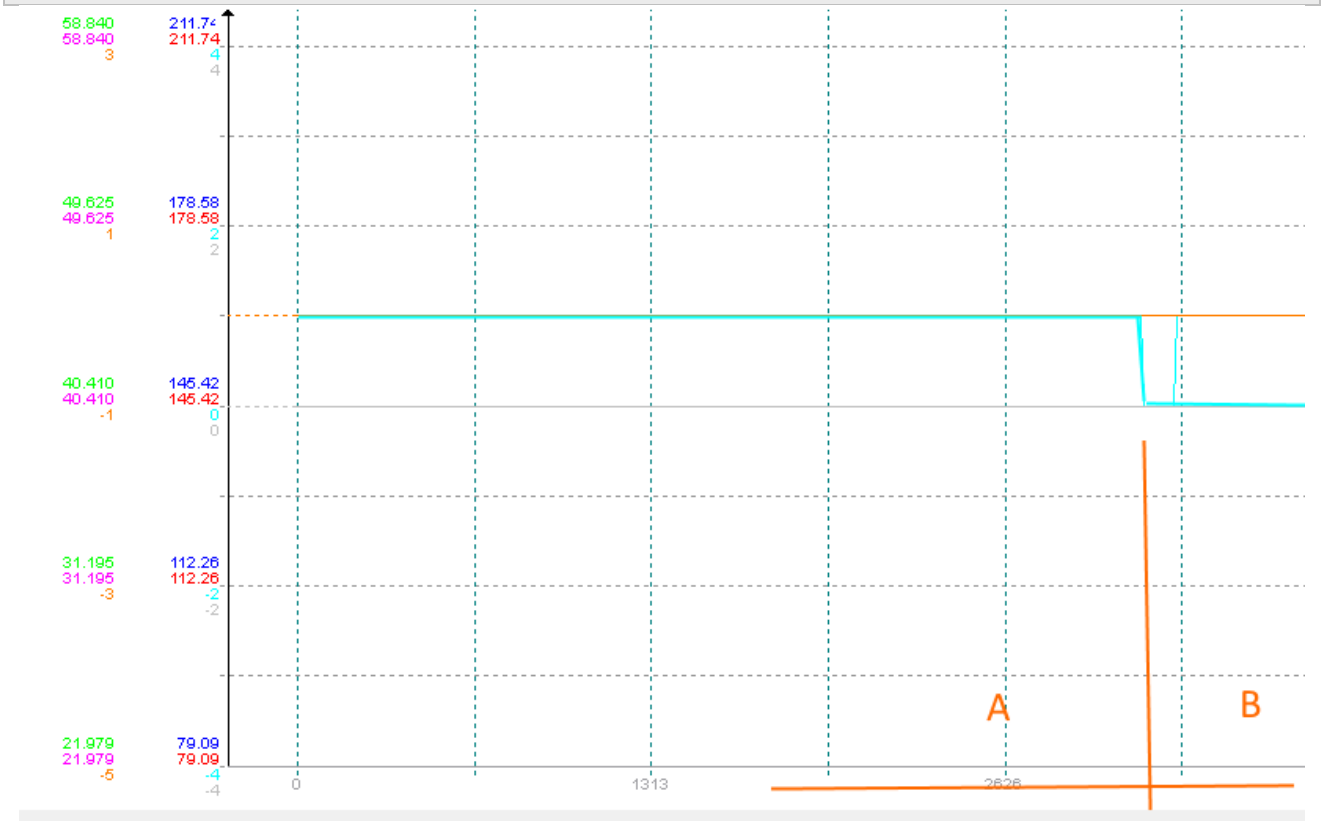
Color	Description
Blue:	Target position of the master axis
Red:	Target position of the follower axis
Green	Target velocity of the master axis
Pink	Target velocity of the follower axis
Light blue	Follower axis synchronous status
Orange:	Ramp status of the follower axis
Gray	Ramp status of the technology group

A) After activating the group, the synchronous status of the follower axis is "IsCoupled". The follower axis moves in synchronism with the master axis.
The ramp status is "Stopped". The ramp status refers to an active positioning and not to a synchronous motion.

B) Once the maximum velocity of the master axis has been reached and a waiting time has expired, the MCTechnoDecoupleModes.Immediate_Stop mode is used to decouple the follower axis.
The synchronous status immediately changes to "Decoupled".
The follower axis decelerates with the set deceleration and then remains at this position.

4.3.4.2 Use Case 06: Decoupling of the follower axis with "Immediate_Stop" mode while the master axis is stationary

```
// Use case 06: Decoupling of follower with Decouple(MCTechnoDecoupleModes.Immediate_Stop) and stopped Master
delay(t#200ms);
tecGear.Coupling.Decouple(xFollower, MCTechnoDecoupleModes.Immediate_Stop, , 1000.0);
when xFollower.Mechanism.Slope.IsStopped and xFollower.State.Techno.IsDecoupled continue;
```



Color	Description
Blue:	Target position of the master axis
Red:	Target position of the follower axis
Green	Target velocity of the master axis
Pink	Target velocity of the follower axis
Light blue	Follower axis synchronous status
Orange:	Ramp status of the follower axis
Gray	Ramp state of the technology group

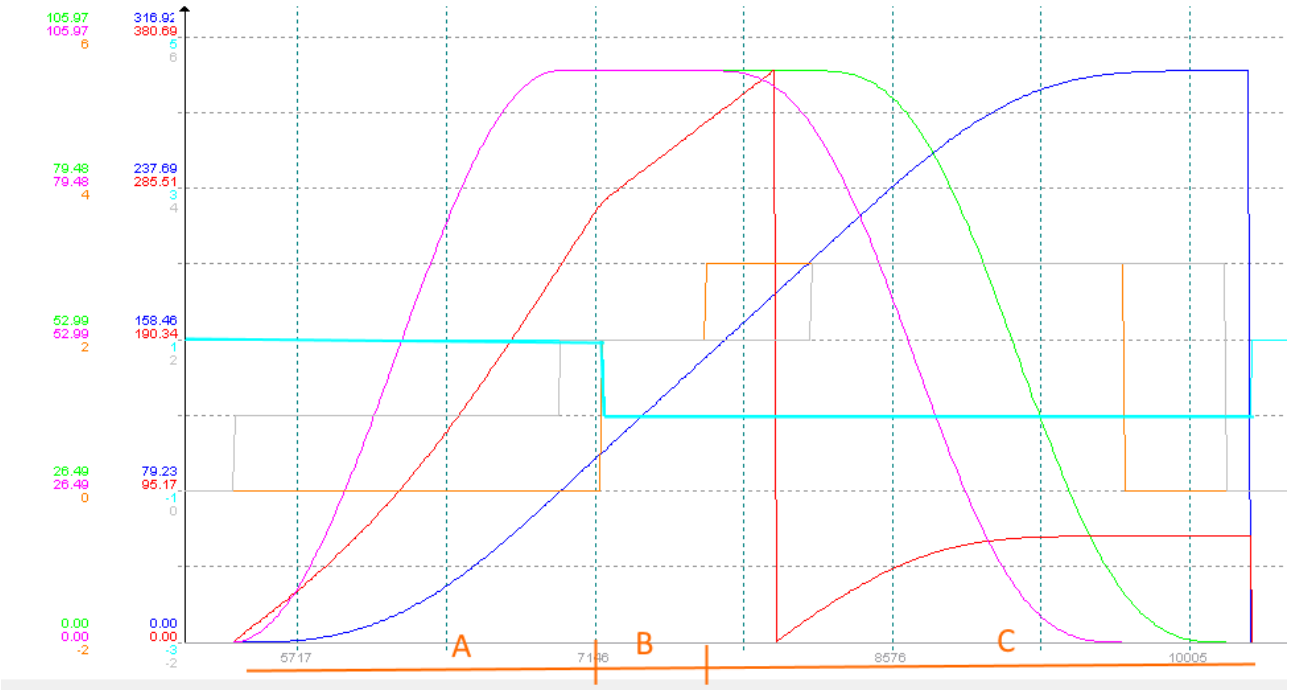
A) After activating the group, the synchronous status of the follower axis is "IsCoupled". The ramp status is "Stopped". The ramp status refers to an active positioning and not to a synchronous motion.

B) The MCTechnoDecoupleModes.Immediate_Stop mode is used to decouple the axis. The synchronous status immediately changes to "IsDecoupled". There is no movement in this constellation.

4.3.5 Mode: Immediate Keep Velocity

4.3.5.1 Use Case 07: Decoupling with "Constant speed" mode while the master axis is moving

```
// Use case 07: Decoupling of follower with Decouple(MCTechnoDecoupleModes.Immediate_KeepVelocity) and running master
tecGear.MoveVelocity.Start(xvMaster, Directions.Positive, 100.0, 100.0, 100.0);
when tecGear.Mechanism.Slope.IsAtConstantSpeed continue;
delay(t#200ms);
tecGear.Coupling.Decouple(xFollower, MCTechnoDecoupleModes.Immediate_KeepVelocity, , 1000.0);
delay(t#500ms);
tecGear.MoveHalt.Start(xFollower, MCTechnoHaltModes.Normal, 100.0);
delay(t#500ms);
tecGear.MoveHalt.Start(xvMaster, MCTechnoHaltModes.Normal, 100.0);
when tecGear.State.IsEnabled continue;
```



Color	Description
Blue:	Target position of the master axis
Red:	Target position of the follower axis
Green	Target velocity of the master axis
Pink	Target velocity of the follower axis
Light blue	Follower axis synchronous status
Orange:	Ramp status of the follower axis
Gray	Ramp state of the technology group

A) After activating the group, the synchronous status of the follower axis is "IsCoupled". The follower axis moves in synchronism with the master axis.
The ramp status is "Stopped". The ramp status refers to an active positioning and not to a synchronous motion.

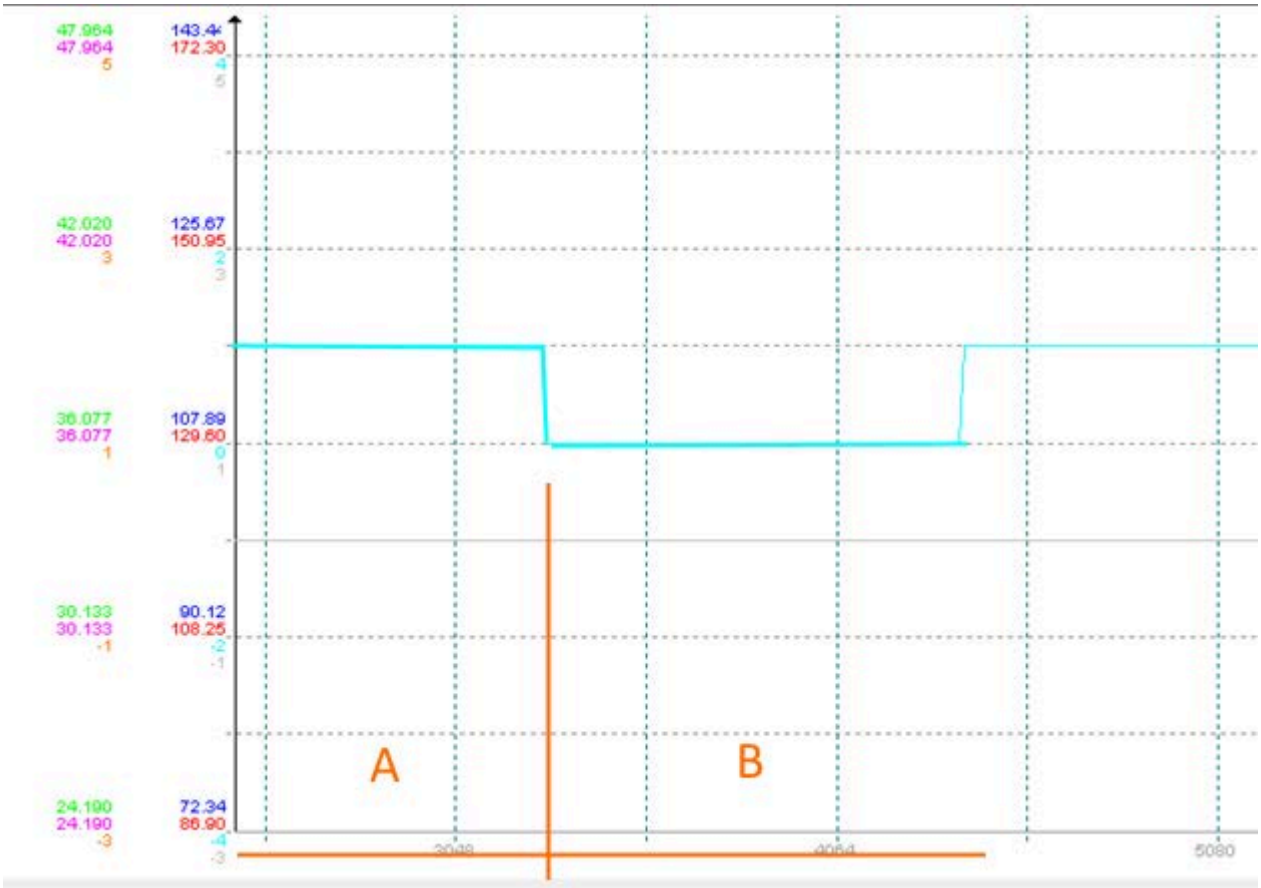
B) The "MCTechnoDecoupleModes.Immediate_KeepVelocity mode is used to "decouple the axis.
The synchronous status immediately changes to "IsDecoupled".

The ramp status immediately changes to "Maximum velocity".
The current motion is continued with the velocity at the time of decoupling.

C) MoveHalt.Start stops the current movements of the master and follower axes. Of course, other positioning motions are also possible with MovePtp or MoveVelocity.

4.3.5.2 Use Case 08: Decoupling of follower axis with "Immediate_KeepVelocity" mode while the master axis is stationary

```
// Use case 08: Decoupling of follower with Decouple(MCTechnoDecoupleModes.Immediate_KeepVelocity) and stopped master
delay(t#200ms);
tecGear.Coupling.Decouple(xFollower, MCTechnoDecoupleModes.Immediate_KeepVelocity, , 1000.0);
delay(t#500ms);
tecGear.MoveHalt.Start(xFollower, MCTechnoHaltModes.Normal, 100.0);
when tecGear.State.IsEnabled continue;
```



Color	Description
Blue:	Target position of the master axis
Red:	Target position of the follower axis
Green	Target velocity of the master axis
Pink	Target velocity of the follower axis
Light blue	Follower axis synchronous status
Orange:	Ramp status of the follower axis
Gray	Ramp state of the technology group

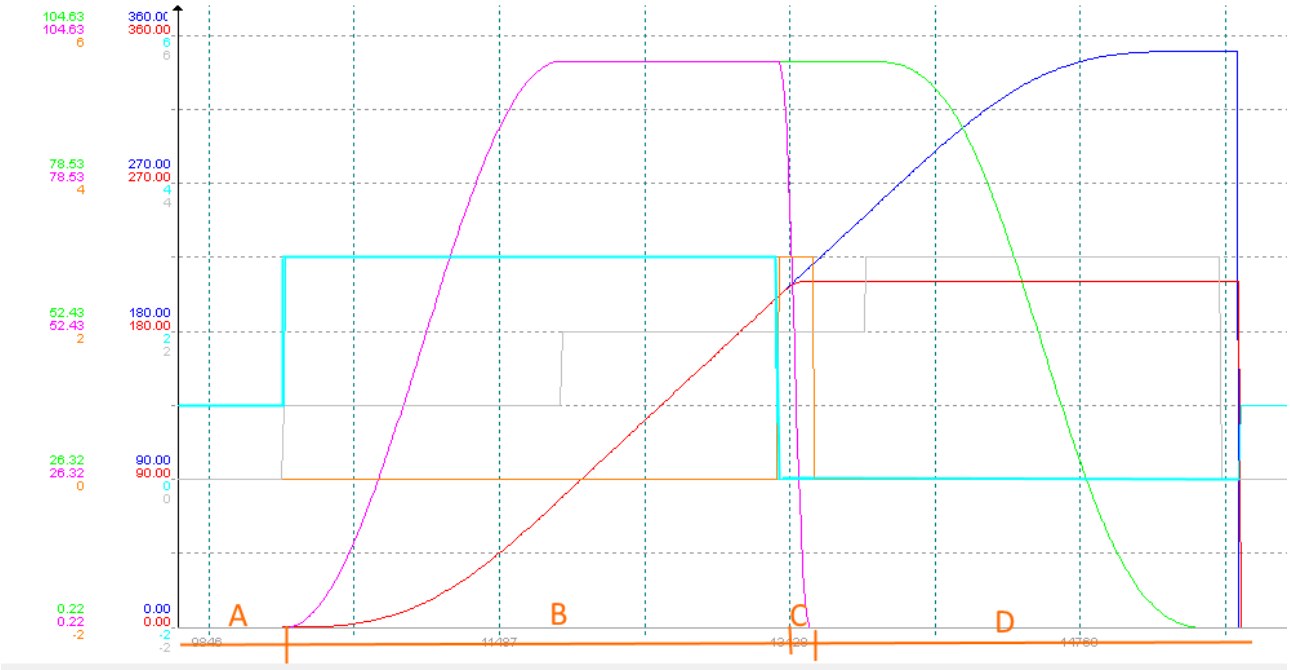
A) After activating the group, the synchronous status of the follower axis is "IsCoupled". The ramp status is "Stopped". The ramp status refers to an active positioning and not to a synchronous motion.

B) The MCTechnoDecoupleModes.Immediate_KeepVelocity mode is used to decouple the axis.
The synchronous status immediately changes to "IsDecoupled".
There is no movement in this constellation.

4.3.6 Mode: At Master Position Stop

4.3.6.1 Use Case 09: Decoupling of follower axis with "AtMasterPosition_Stop" mode while the master axis is moving

```
// Use case 09: Decoupling of follower with Decouple(MCTechnoDecoupleModes.AtMasterPosition_Stop) and running master
tecGear.MoveVelocity.Start(xvMaster, Directions.Positive, 100.0, 100.0, 100.0);
when not tecGear.Mechanism.Slope.IsStopped continue;
tecGear.Coupling.Decouple(xFollower, MCTechnoDecoupleModes.AtMasterPosition_Stop, 200.0, 1000.0);
when xFollower.Mechanism.Slope.IsStopped and xFollower.State.Techno.IsDecoupled continue;
delay(t#500ms);
tecGear.MoveHalt.Start(xvMaster, MCTechnoHaltModes.Normal, 100.0);
when tecGear.State.IsEnabled continue;
```



Color	Description
Blue:	Target position of the master axis
Red:	Target position of the follower axis
Green	Target velocity of the master axis
Pink	Target velocity of the follower axis
Light blue	Follower axis synchronous status
Orange:	Ramp status of the follower axis
Gray	Ramp state of the technology group

A) After activating the group, the synchronous status of the follower axis is "IsCoupled".
The follower axis moves in synchronism with the master axis.
The ramp status is "Stopped". The ramp status refers to an active positioning and not to a synchronous motion.

B) Immediately after starting the positioning motion of the master axis, "MCTechnoDecouple-Modes.AtMasterPosition_Stop" mode is used to decouple. Since the position has not yet

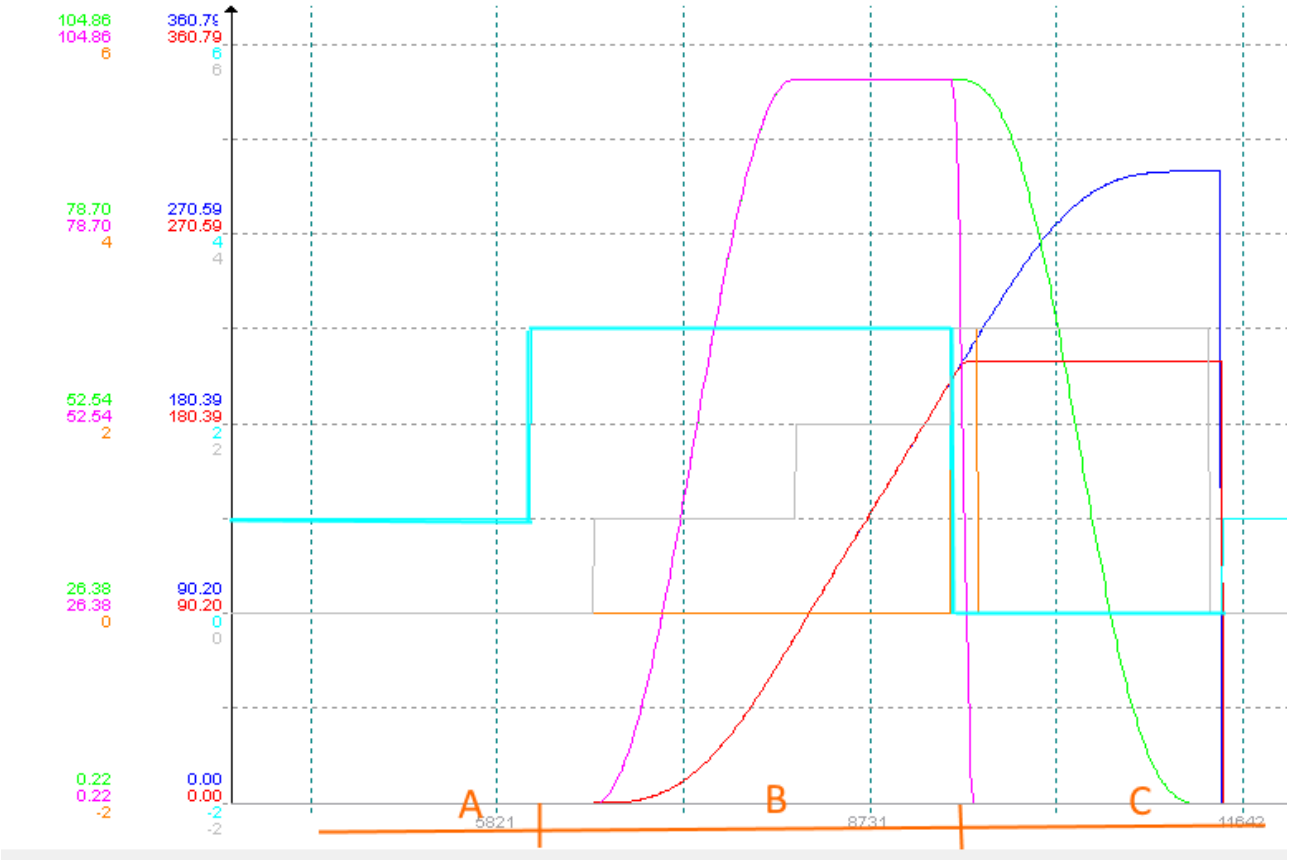
been reached, the synchronous status changes to "Decoupling active".
The ramp status remains "IsStopped".

C) When the decoupling position is reached, the synchronous status changes to "IsDecoupled".
The ramp status changes to "Decelerating" and stops at the set deceleration rate.

D) According to the program, the master axis is now also stopped after a waiting period.

4.3.6.2 Use Case 10: Decoupling with "AtMasterPosition_Stop" mode while the master axis is stationary

```
// Use case 10: Decoupling of follower with Decouple(MCTechnoDecoupleModes.AtMasterPosition_Stop) and delayed master
tecGear.Coupling.Decouple(xFollower, MCTechnoDecoupleModes.AtMasterPosition_Stop, 200.0, 1000.0);
delay(t#500ms);
tecGear.MoveVelocity.Start(xvMaster, Directions.Positive, 100.0, 100.0, 100.0);
when not tecGear.Mechanism.Slope.IsStopped continue;
when xFollower.Mechanism.Slope.IsStopped and xFollower.State.Techno.IsDecoupled continue;
tecGear.MoveHalt.Start(xvMaster, MCTechnoHaltModes.Normal, 100.0);
when tecGear.State.IsEnabled continue;
```

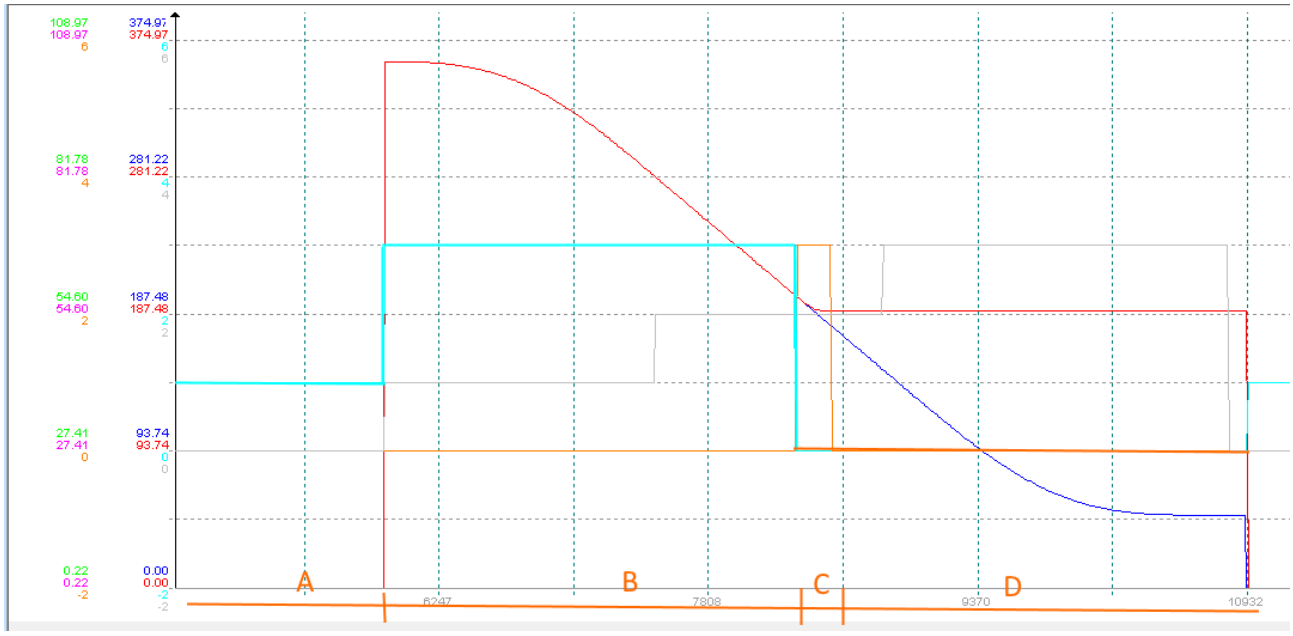


Color	Description
Blue:	Target position of the master axis
Red:	Target position of the follower axis
Green	Target velocity of the master axis
Pink	Target velocity of the follower axis
Light blue	Follower axis synchronous status
Orange:	Ramp status of the follower axis
Gray	Ramp state of the technology group

A) After activating the group, the synchronous status of the follower axis is "IsCoupled". The ramp status is "Stopped". The ramp status refers to an active positioning and not to a synchronous motion.
B) While the master axis is stopped, the follower axis is decoupled using "MCTechnoDecoupleModes.AtMasterPosition_Stop". As in Use Case 09, the synchronous status changes to "Decoupling active" and waits to decouple at the specified master axis position. The ramp status remains "IsStopped".
C) When the decoupling position is reached, the synchronous status changes to "IsDecoupled". The ramp status changes to "Decelerating" and stops at the set deceleration rate.

4.3.6.3 Use Case 11: Decoupling of follower axis with "AtMasterPosition_Stop" mode while the master axis is moving in negative direction

```
// Use case 11: Decoupling of follower with Decouple(MCTechnoDecoupleModes.AtMasterPosition_Stop) and running master
tecGear.MoveVelocity.Start(xvMaster, Directions.Negative, 100.0, 100.0, 100.0);
when not tecGear.Mechanism.Slope.IsStopped continue;
tecGear.Coupling.Decouple(xFollower, MCTechnoDecoupleModes.AtMasterPosition_Stop, 200.0, 1000.0);
when xFollower.Mechanism.Slope.IsStopped and xFollower.State.Techno.IsDecoupled continue;
delay(t#500ms);
tecGear.MoveHalt.Start(xvMaster, MCTechnoHaltModes.Normal, 100.0);
when tecGear.State.IsEnabled continue;
```



Color	Description
Blue:	Target position of the master axis
Red:	Target position of the follower axis
Green	Target velocity of the master axis
Pink	Target velocity of the follower axis
Light blue	Follower axis synchronous status
Orange:	Ramp status of the follower axis
Gray	Ramp state of the technology group

A) After activating the group, the synchronous status of the follower axis is "IsCoupled". The follower axis moves in synchronism with the master axis.

The ramp status is "Stopped". The ramp status refers to an active positioning and not to a synchronous motion.

B) Immediately after starting the positioning motion of the master axis, "MCTechnoDecoupleModes.AtMasterPosition_Stop" mode is used to decouple. Since the position has not yet been reached, the synchronous status changes to "Decoupling active".
The ramp status remains "IsStopped".

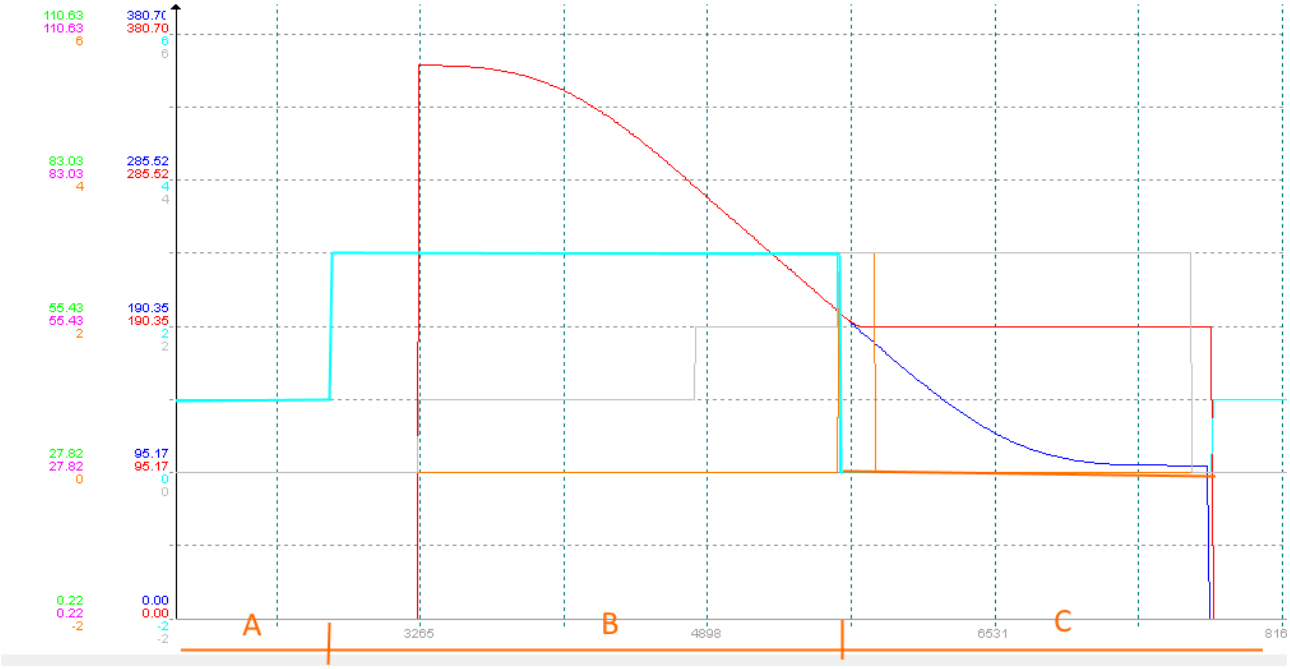
C) When the decoupling position is reached, the synchronous status changes to "IsDecoupled".
The ramp status changes to "Decelerating" and stops at the set deceleration rate.

D) According to the program, the master axis is now also stopped after a waiting period.

➔ Same behavior as in Use Case 09 only in negative direction of movement.

4.3.6.4 Use Case 12: Decoupling with "AtMasterPosition_Stop" mode while the master axis is moving in negative direction

```
// Use case 12: Decoupling of follower with Decouple(MCTechnoDecoupleModes.AtMasterPosition_Stop) and delayed Master
tecGear.Coupling.Decouple(xFollower, MCTechnoDecoupleModes.AtMasterPosition_Stop, 200.0, 1000.0);
delay(t#500ms);
tecGear.MoveVelocity.Start(xvMaster, Directions.Negative, 100.0, 100.0, 100.0);
when not tecGear.Mechanism.Slope.IsStopped continue;
when xFollower.Mechanism.Slope.IsStopped and xFollower.State.Techno.IsDecoupled continue;
tecGear.MoveHalt.Start(xvMaster, MCTechnoHaltModes.Normal, 100.0);
when tecGear.State.IsEnabled continue;
```



Color	Description
Blue:	Target position of the master axis
Red:	Target position of the follower axis
Green	Target velocity of the master axis
Pink	Target velocity of the follower axis
Light blue	Follower axis synchronous status
Orange:	Ramp status of the follower axis
Gray	Ramp state of the technology group

A) After activating the group, the synchronous status of the follower axis is "IsCoupled".
The ramp status is "Stopped". The ramp status refers to an active positioning and not to a synchronous motion.
B) While the master axis is stopped, the follower axis is decoupled using "MCTechnoDecoupleModes.AtMasterPosition_Stop". As in Use Case 09, the synchronous status changes to "Decoupling active" and waits to decouple at the specified master axis position.
The ramp status remains "IsStopped".
E) When the decoupling position is reached, the synchronous status changes to "IsDecoupled".
The ramp status changes to "Decelerating" and stops at the set deceleration rate.

→Same behavior as in Use Case 10 only in negative direction of movement.

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