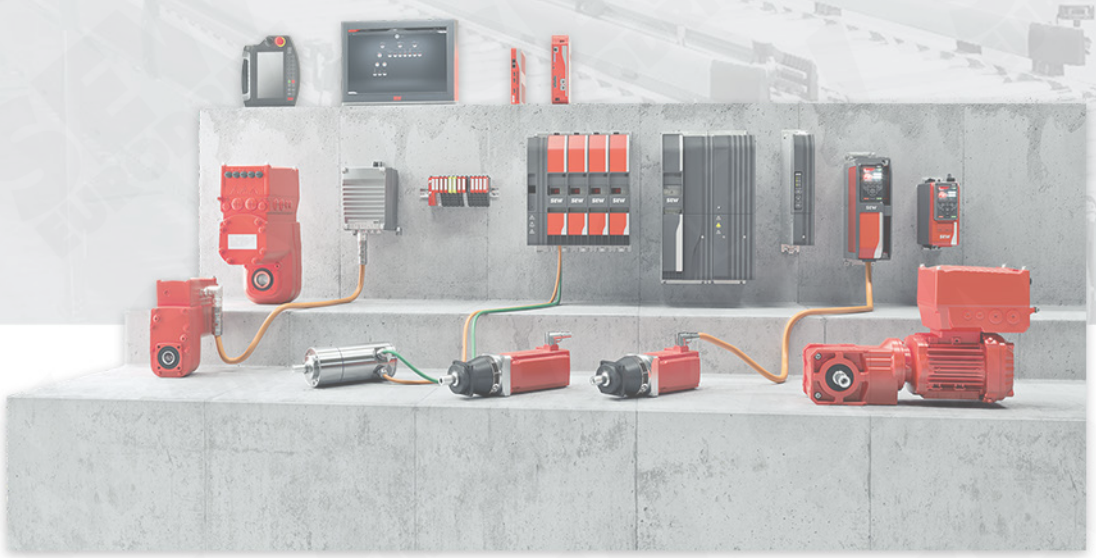
SEW EURODRIVE

Product Training Workbook



MOVI-C® modular automation system

Storage/retrieval systems with MOVIKIT® StackerCrane effiDRIVE

Parameterization, programming, startup, and diagnostics

C200

DRIVE ACADEMY®

Urheberrecht

Exclusion of liability
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Compliance with the information in the operating instructions for the devices mentioned in the training documents has priority and is a basic requirement for safe operation. The safety provisions therein apply.
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Objectives of this training document
- You will learn how to configure, program, and start up a storage/retrieval system with the MOVIKIT® StackerCrane application module.
- You will learn about the operating principle of the MOVIKIT® StackerCrane with effiDRIVE, MOVIKIT® StackerCrane MultiMotion, and MOVIKIT® StackerCrane MultiAxis Controller

Please do not hesitate to contact product training if you have any questions or suggestions.

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Meaning of the symbols:


Operating notes


Information


Safety-relevant information


Tip


Diagnostics and troubleshooting


Practical task


Additional documentation

1 Functions of an storage/retrieval system (SRS)

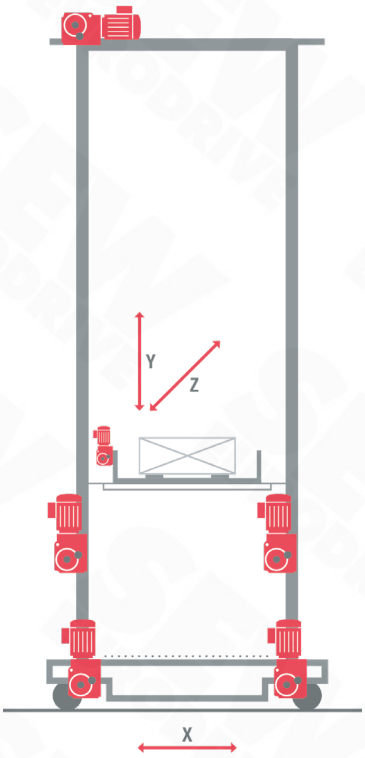
Goals

- Be acquainted with the scope of functions of the MOVIKIT® StackerCrane effiDRIVE® software module
- Be acquainted with the main startup procedure
- Be acquainted with the options for energy optimization

1.1 Scope of functions MOVIKIT® StackerCrane effiDRIVE®

The MOVIKIT® StackerCrane effiDRIVE® software module is used to operate storage/retrieval systems in an energy-efficient manner. By optimizing the travel cycles of lifting and travel drives, energy savings of up to approx. 10% are achieved compared to the connected DC link.
The software module can be used to implement storage/retrieval systems with up to 4 travel axes and up to
For 4 lifting axes. Both directions of travel require at least one external encoder each or must be connected to the environment without slippage (e.g. through a gear rack). The target positions and dynamic parameters for the travel and hoist are specified via an easy-to-use "process data interface".
The "MOVIKIT® StackerCrane MultiMotion" and "MOVIKIT® Stacker-Crane MultiAxisController" software modules are available for inserting lower-level single axes or axis groups, and the "MultiMotion add-on PositionController" and "MultiMotion add-on CombinedEncoderEvaluation" add-ons are in preparation. These software modules or Add-ons extend the range of functions by the functions shown in the following figure.

- MuMo **Energy-optimized XY operation**
- MuMo **Speed cams** for gentle travel of the buffer to make full use of the storage area
- MuMo **Brake test**
- MuMo **Combined encoder evaluation** Evaluation with increased position control loop gain
- MuMo **Electrical braking in the event of encoder fault**
- MuMo **Override** Reduction of dynamic values for energy savings at low utilization (night mode)
- MuMo **Emergency mode / Deactivation of external encoder**



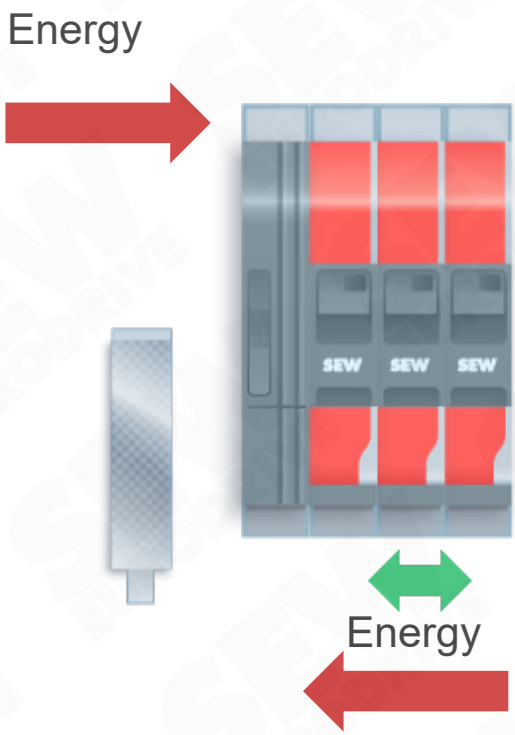
- MAC **Top drive for for vibration suppression** TopDrive
- MAC Add-on **Rope elongation compensation** even with load transfer
- MAC **Auto leveling** anti-skew even in the event of a fault
- MAC **Combined encoder evaluation** Evaluation with increased position control loop gain
- MAC **Anti-slip control** Electronic differential lock
- MAC **Combined encoder evaluation** Evaluation with increased position control loop gain
- MAC **Coupling monitoring** Slack rope monitoring
- Add-on **AntiSway control** TowerSway thanks to intelligent profiles
- Add-on **AntiSway control** BellySway for LAM thanks to intelligent profiles

Scope of functions of MOVIKIT® StackerCrane effiDRIVE® in combination with MOVIKIT®…

- MuMo MOVIKIT® MultiMotion
- MAC MOVIKIT® MultiAxisController
- Add-on Motion add-on AntiSway

1.2 Energy optimization in XY optimized mode

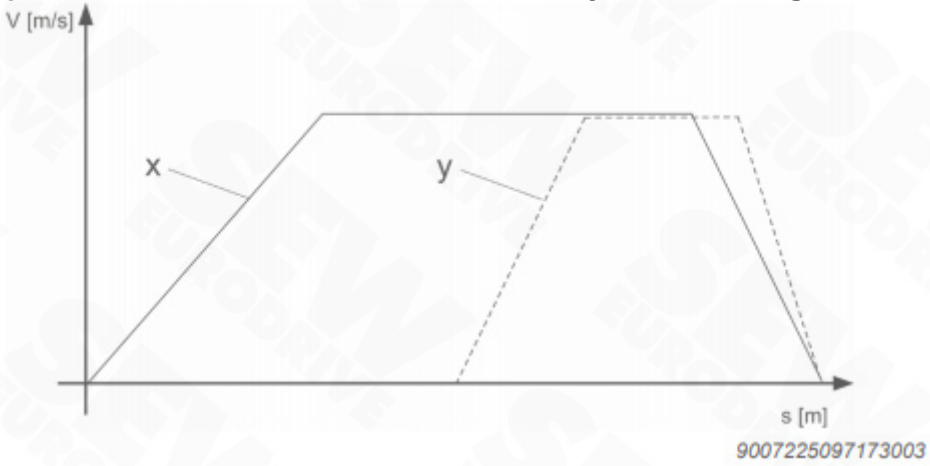
The software module offers the option of positioning the travel and lifting axes in an energy-optimized manner.
The application module coordinates the travel and lifting axes of an SRS in such a way that the energy balance is as favorable as possible. The goal is to make the energy that is generated when decelerating one axis available to the other axis that is currently accelerating. For this purpose, the speed, starting time and brake application time of the axes is adapted without extending the total time of the storage/retrieval process.
The total time of a storage/retrieval process is defined by the axis with the longest travel time (master axis). The travel time depends on the travel distance and the maximum possible acceleration, deceleration, and speed of the respective axis.
Due to a shorter distance or a higher speed, the second axis requires less time for completing the travel job.
It occurs only rarely that both axes need exactly the same time for their travel job. There is no room for optimization in this case.



- Energy is exchanged between the horizontal and vertical drive via the DC link coupling
- The axes are controlled in a manner that optimizes energy use, and as little energy as possible is lost via the braking resistance
- Detectable axis start delays are desired and monitored
- No reduction in / influence of the cycle time
- Also worthwhile when using a power feedback unit

Important: Target position and dynamics process data must not be changed during the movement!

Optimization case 1 – x-axis is the master axis, y-axis is in lifting mode

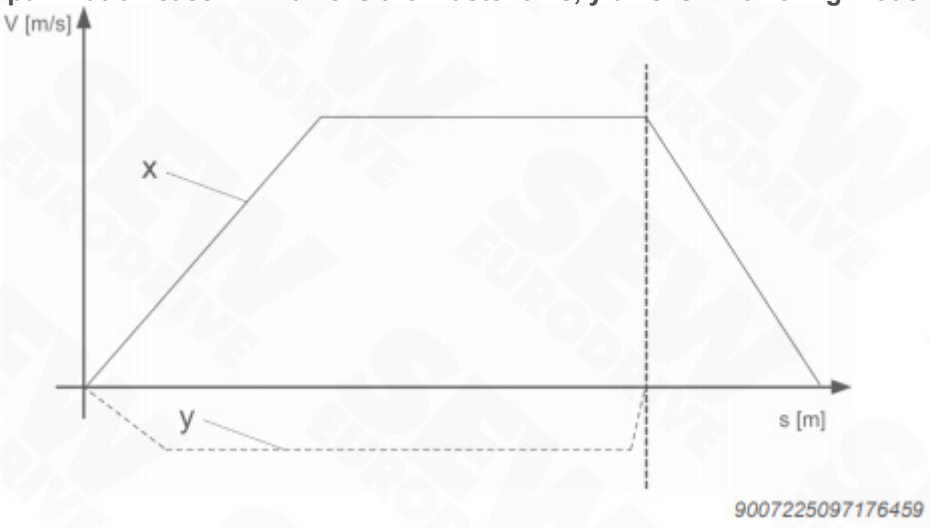


Initial situation: txVmax > tyVmax
The x-axis is the master axis because its travel time is longer than that of the y-axis due to a longer travel distance and the dynamic parameters. The y-axis is in lifting mode.

Optimization parameters:
The x-axis starts immediately and is operated with maximum dynamic parameters to achieve the required cycle time. The starting time of the y-axis is calculated so that both axes arrive at their target at the same time.

Energy saving:
The energy generated by decelerating the x-axis is used for lifting the y-axis.

Optimization case 2 – x-axis is the master axis, y-axis is in lowering mode



Initial situation: txVmax > tyVmax
The x-axis is the master axis because its travel time is longer than that of the y-axis due to a longer travel distance and the dynamic parameters. The y-axis is in lowering mode.

Optimization parameters: txVmax - txVStopRamp = tyVadjusted
The x-axis starts immediately and is operated with maximum dynamic parameters to achieve the required cycle time. The y-axis also starts immediately but travels at a reduced speed.
The speed of the y-axis is calculated so that the y-axis is in lowering mode while the x-axis is accelerating or traveling at constant speed.

Energy saving:
The energy generated by lowering the y-axis is used for accelerating the x-axis and for moving it at constant speed.

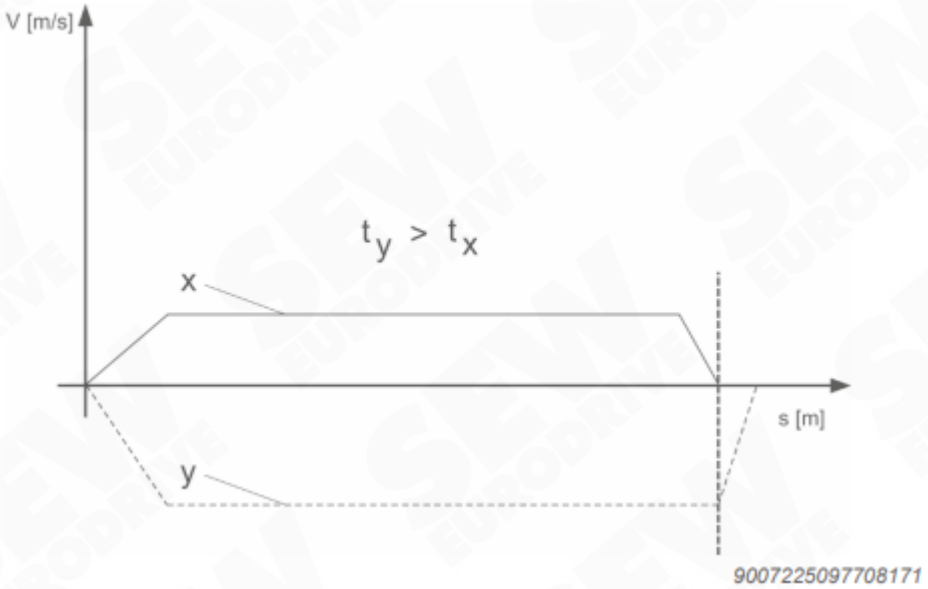
Optimization case 3 – y-axis is the master axis, y-axis is in lifting mode

Initial situation: tyVmax > txVmax
The y-axis is the master axis because its travel time is longer than that of the x-axis due to a longer travel distance and the dynamic parameters.
The y-axis is in lifting mode.

Optimization parameters: tyVmax = txVadjusted
The y-axis starts immediately and is operated with the maximum dynamic parameters to achieve the required cycle time. The x-axis also starts immediately but travels at a reduced speed.
The speed of the x-axis is calculated so that both axes arrive at their target at the same time.

Energy saving:
As the speed of the x-axis is reduced, this axis uses less energy. The energy generated by the x-axis is used for lifting the y-axis.

Optimization case 4 – y-axis is the master axis, y-axis is in lowering mode



Initial situation: tyVmax > txVmax
The y-axis is the master axis because its travel time is longer than
that of the x-axis due to a longer travel distance and the dynamic parameters. The y-axis is in lowering mode.

Optimization parameters: tyVmax = txVadjusted
The y-axis starts immediately and is operated with the maximum dynamic parameters to achieve the required cycle time. The x-axis also starts immediately but travels at a reduced speed. The speed of the x-axis is calculated so that the x-axis completes its travel motion when the y-axis begins to decelerate.

Energy saving:
As the speed of the x-axis is reduced, this axis uses less energy. The energy generated by lowering the y-axis is made available to the x-axis.

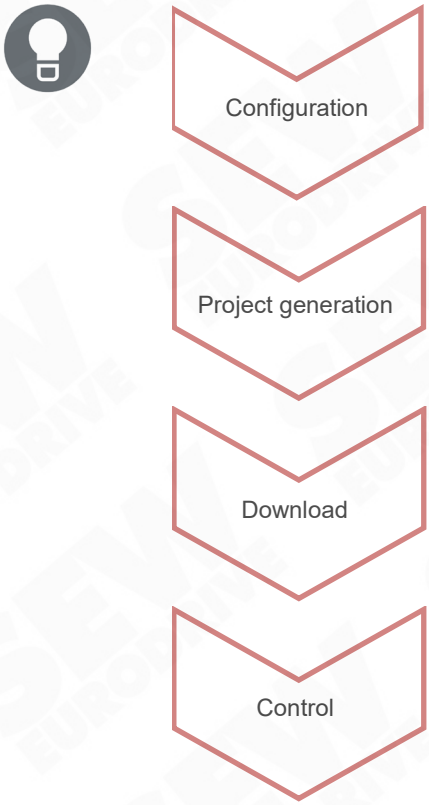
XY optimized mode: Mechanics-optimized positioning (1210)

Initial situation: tyVmax > txVmax
The y-axis is the master axis because its travel time is longer than that of the x-axis due to a longer travel distance and the dynamic parameters.

Optimization parameters: tyVmax = txVadjusted
The y-axis starts immediately and is operated with the maximum dynamic parameters to achieve the required cycle time. The x-axis also starts immediately but travels at a reduced speed. The speed of the x-axis is calculated so that both axes arrive at their target at the same time.

Energy saving:
As the speed of the x-axis is reduced, this axis uses less energy. Furthermore, the forces acting on the mechanics of the optimized axis are reduced. (Optimization: ty = tx)

1.3 Basic startup procedure



- Start up X and Y axis group members with safety
- Process data in StackerCrane: Start, length, and content
- Fieldbus in the controller

- Right-click "Update project" in MOVISUITE

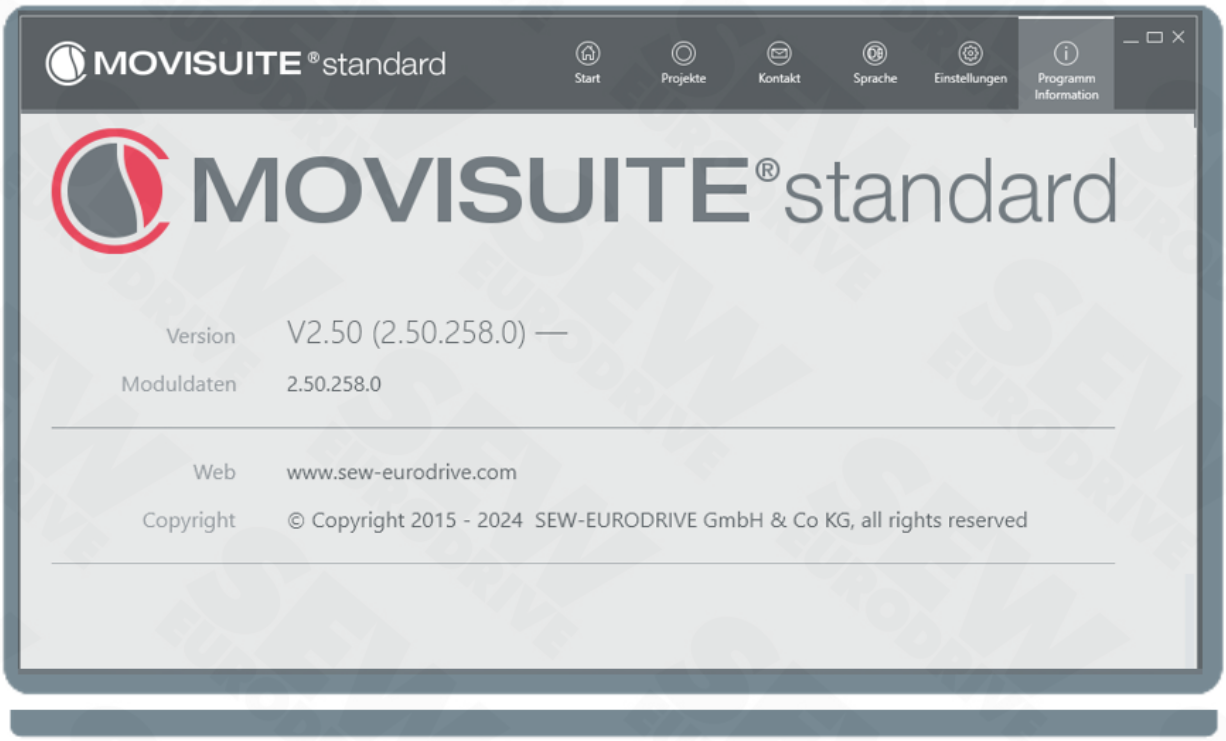
- IEC Editor → Right-click "Application" →to insert PD Monitor→ scripts
- IEC Editor → Online → Login/Create boot project

- Using the PD monitor
- Using the customer's PLC

2 System configuration

Goals

- Getting to know the versions of MOVISUITE® and MOVIKIT® StackerCrane
- Library SEW MOVIKIT® StackerCrane
- Training models Stackercrane



2.1 MOVISUITE® engineering software

2.1.1 Version and module package

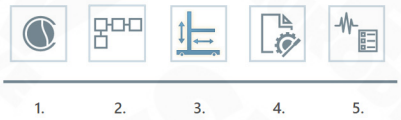
- MOVISUITE® version 2.50.258.0
- Module package 2.50.258.0
- MOVIRUN flexible version 9.0.8.200
- StackerCrane version ≥ 9.0.36.200
- StackerCrane MultiMotion ≥ 9.0.36.200
  StackerCrane MultiAxisController version ≥ 9.0.36.200

2.1.2 Firmware

- Controller firmware ≥ 9.00
- Firmware of the axis modules ≥11.00

3 Tutorial 1 – SRS with MOVIKIT® StackerCrane

Workbook steps – Tutorial 1

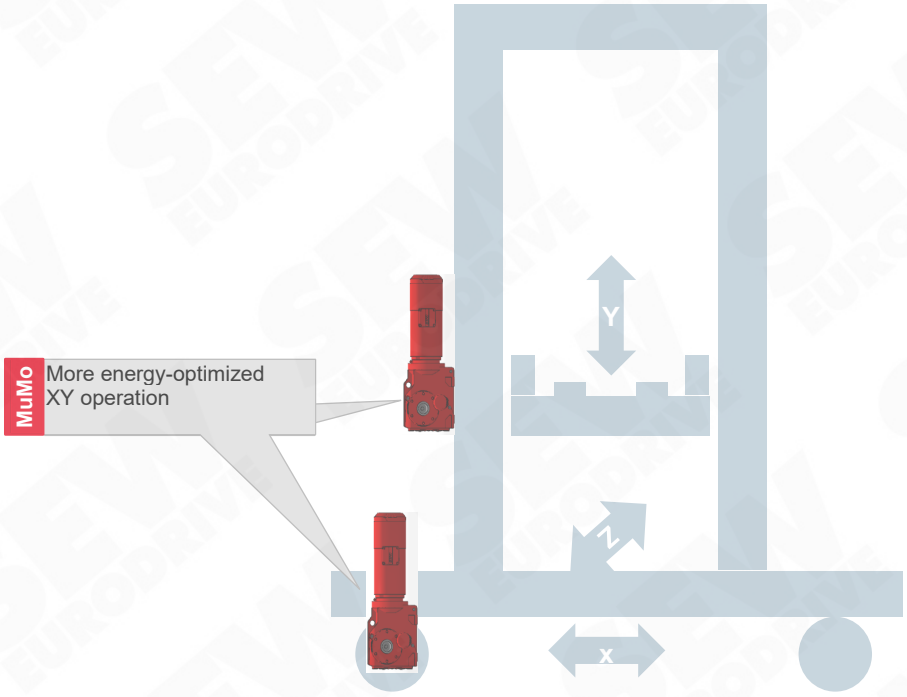


1. MOVISUITE® project structure
2. Startup of the travel and hoist axis
3. Parameterization of MOVIKIT® StackerCrane
4. Generation of the software project
5. MOVIKIT® StackerCrane effiDRIVE process data monitor

3.1 Scope of functions Tutorial 1

In this tutorial, an SRS with 2 axes is started up. The x-axis and the y-axis each have a motor encoder.

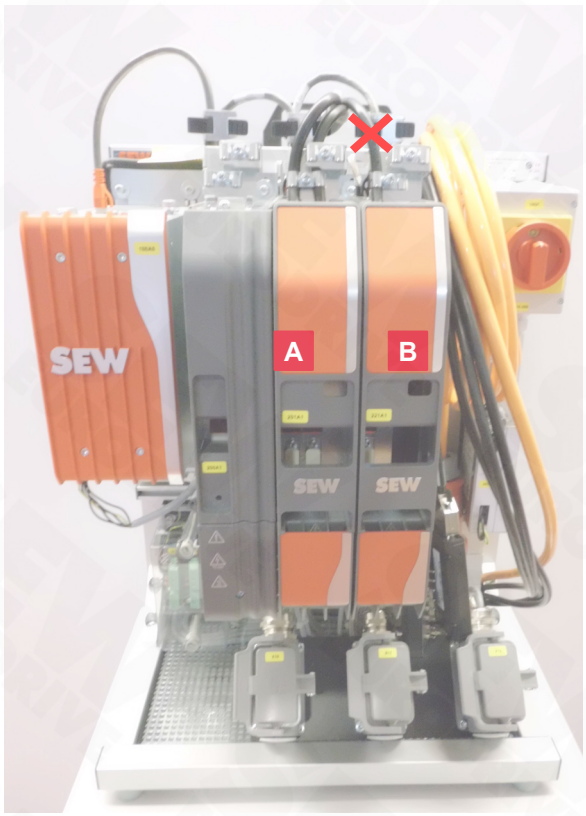
- X-axis 1 drive with motor encoder => MOVIKIT® StackerCrane MultiMotion
- Y-axis 1 drive with motor encoder => MOVIKIT® StackerCrane MultiMotion

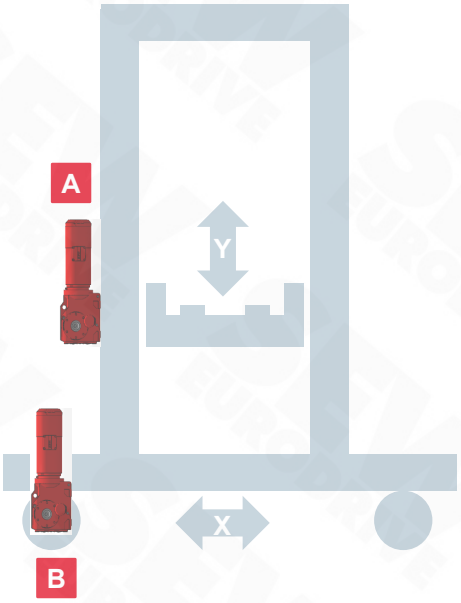


Scope of functions of MOVIKIT® StackerCrane effiDRIVE® in combination with MOVIKIT®…

MuMo MultiMotion

3.2 Training model / training system storage/retrieval system



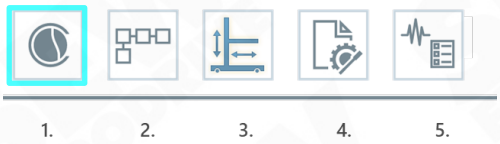


A	Hoist	CMP50S/BK/KY/AK0H/SB1
B	Running gear	CMP50S/BK/KY/RH1M/SB1

3.3 Step 1 – Project setup in MOVISUITE®

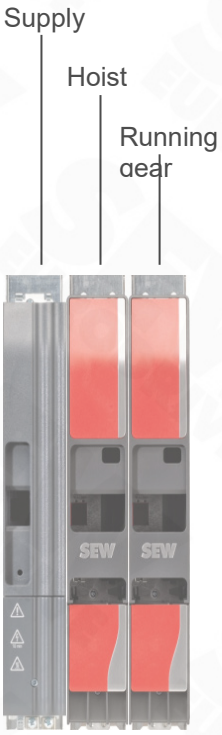
Goals

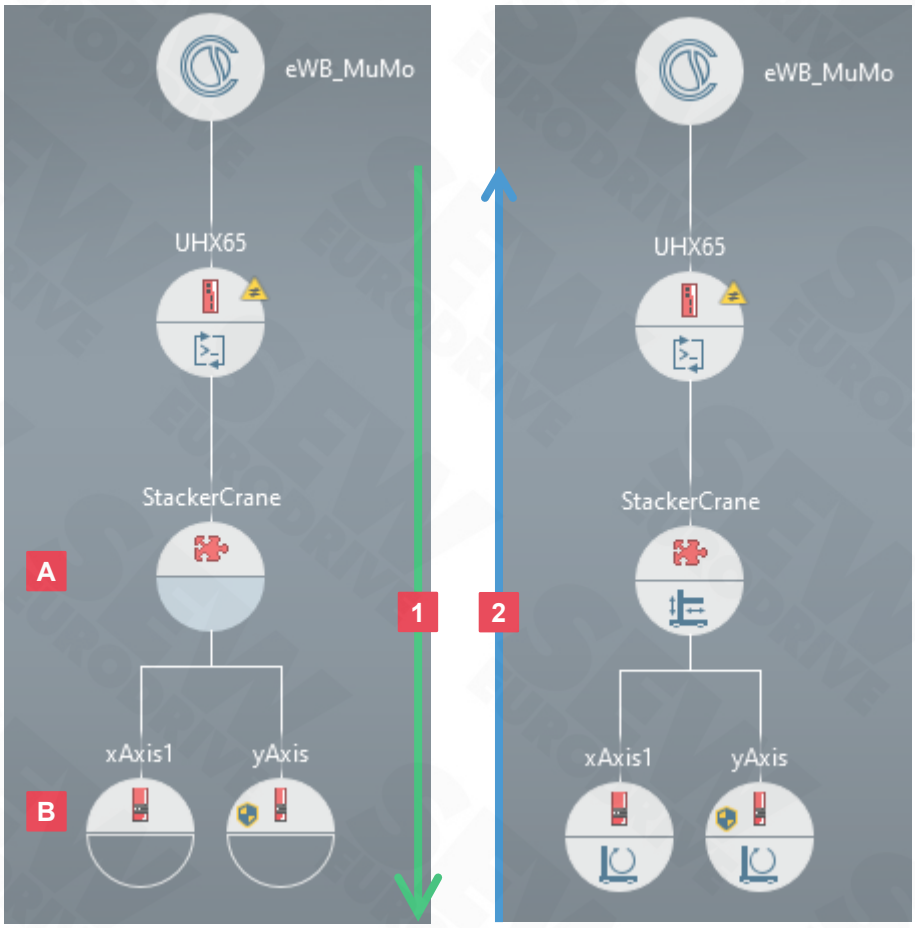
- Procedure for setting up the project offline and online
- Can set up a project



3.3.1 Useful information about the project structure

General information





1 Set up structure: **From the top to the bottom**

2 Configure and start up: **From the bottom to the top**

A Software nodes: A MOVIKIT® software module can be added to each software node for an axis group or higher-level functionality, such as:

- StackerCrane
- MultiAxisController (can also be used with only one subordinate axis)
- Robot
- …

B **Horizontal drive** must be positioned **TO THE LEFT** under the StackerCrane, regardless of the hardware structure of the axis block

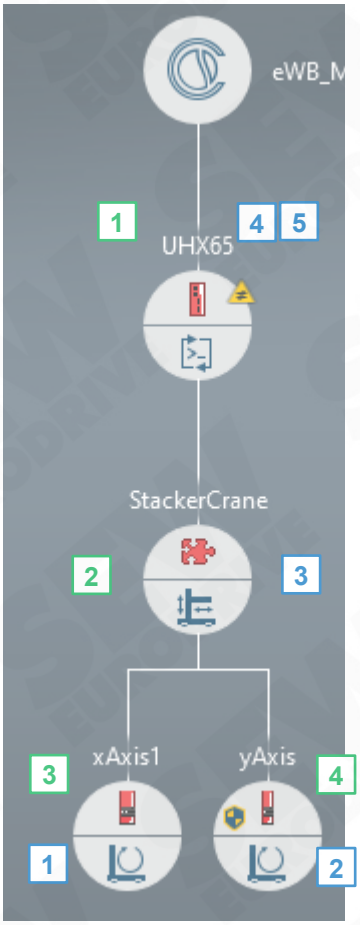
Note: The vertical drive usually needs more current than the horizontal drive. The vertical drive's axis module is therefore positioned on the left next to the horizontal drive in the hardware structure.

Observe and/or produce positioning in the MOVISUITE view during online startup

Project setup offline – MOVISUITE® planning phase

1. Build structure

1. Add MOVI-C® Controller
2. Add SoftwareNode
3. Add horizontal drive (x-axis)
4. Add lifting drive (y-axis)

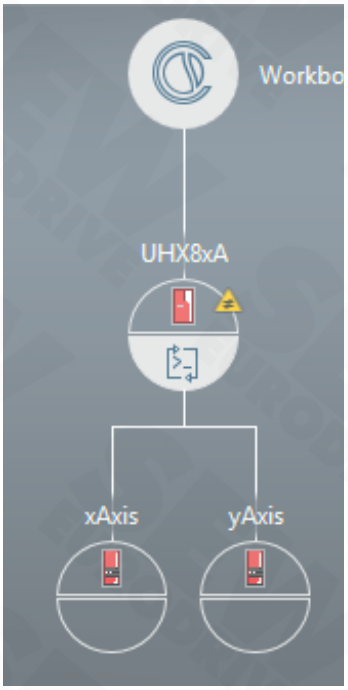


2. Configuring the modules

1. Start up & parameterize travel drive train (x-axis)
2. Start up & parameterize lifting drive train (y-axis)
3. Add & parameterize StackerCrane MultiMotion
4. Add & parameterize StackerCrane MultiMotion
5. Add StackerCrane to the SoftwareNode & parameterize
6. Configure MOVI-C® CONTROLLER
7. Create IEC project

Online project setup – MOVISUITE® startup phase

1. New project from scan

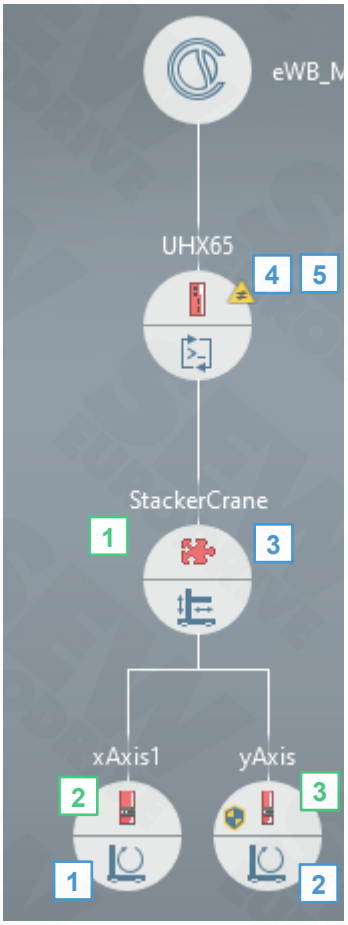


2. Configure modules

1. Insert software node
2. Inserting x-axis
3. Insert y-axis

3. Configure modules

1. Start up & parameterize the x-axis drive train with the startup wizard
2. Start up & parameterize the x-axis drive train with the startup wizard
3. Insert and parameterize StackerCrane in the software code
4. CONFIGURE MOVI-C® CONTROLLER
5. Create IEC project

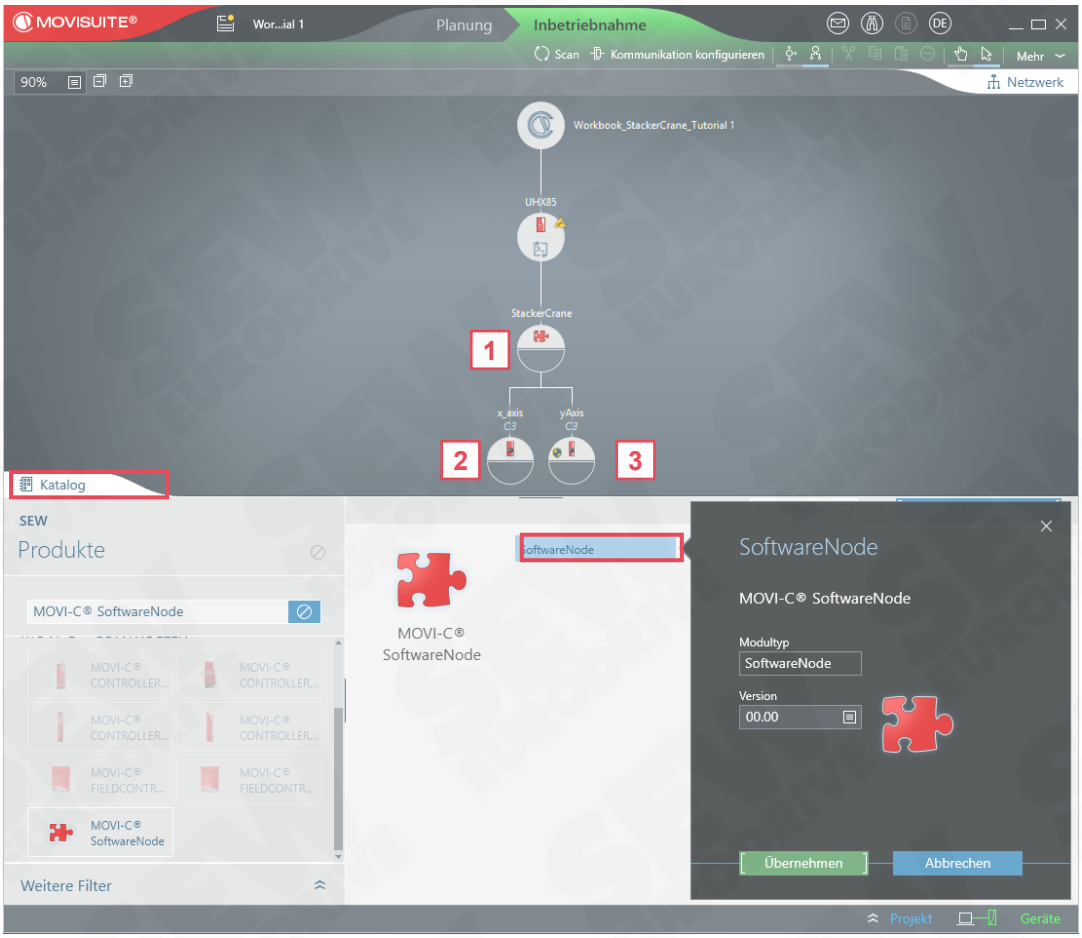


3.3.2 Create project structure

1. Scan axes

1 Click **Scan**

2. Build up the structure



1 Insert a **MOVI-C® SoftwareNode** from the **catalog**

2 Drag the horizontal drive (x-axis) TO THE LEFT under the StackerCrane SoftwareNode

3 Drag the vertical drive (y-axis) TO THE RIGHT under the StackerCrane SoftwareNode

3.4 Step 2 – Startup of the travel and hoist

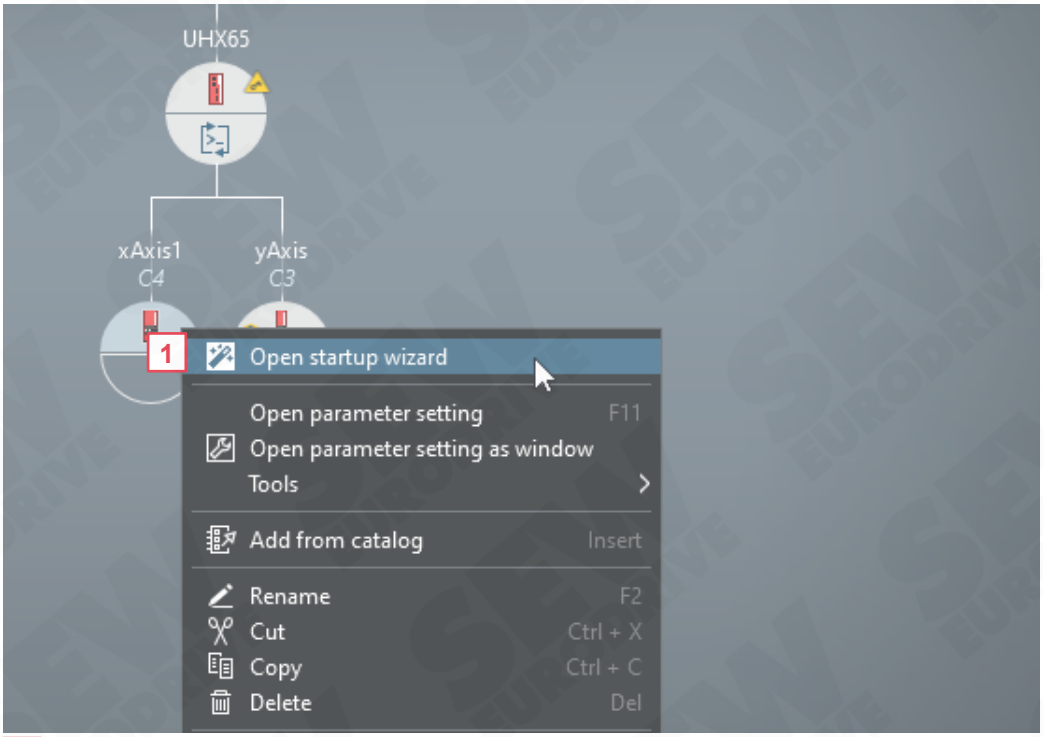
Goals

- Start up and parameterize travel axis and lifting axis drive trains.

3.4.1 Start up the drive trains

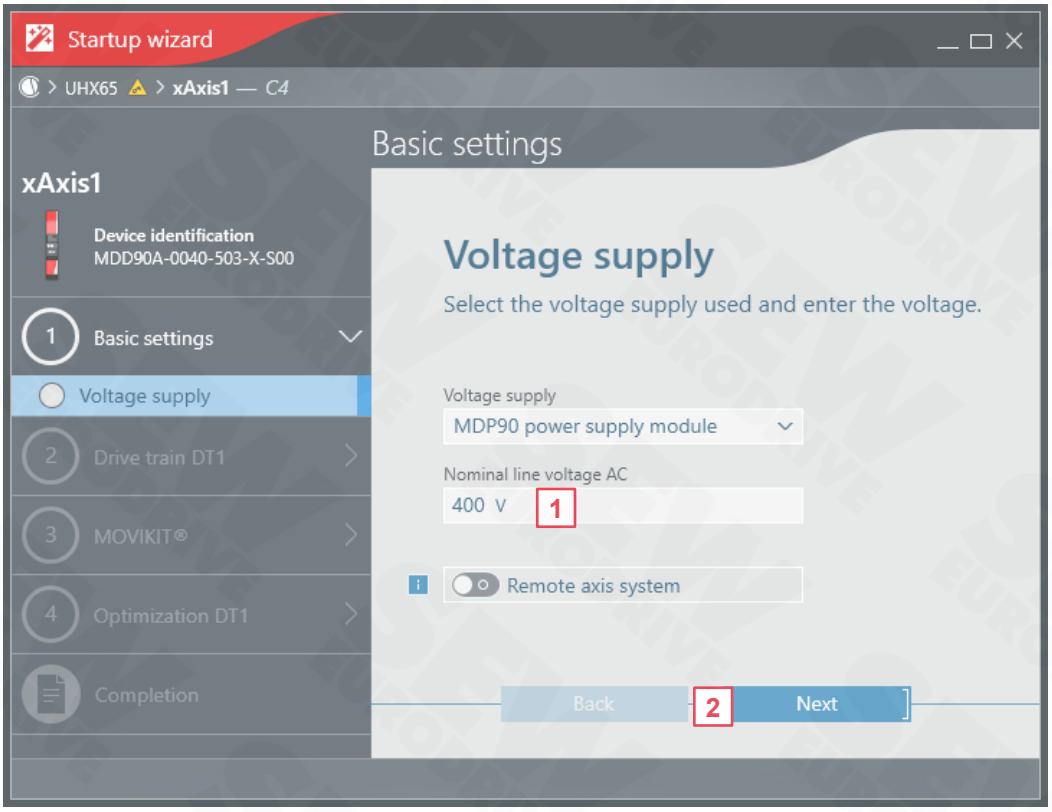
3.4.1.1 Travel unit (x-axis)

1. Open startup assistant



1 Right-click to open the **startup wizard**.

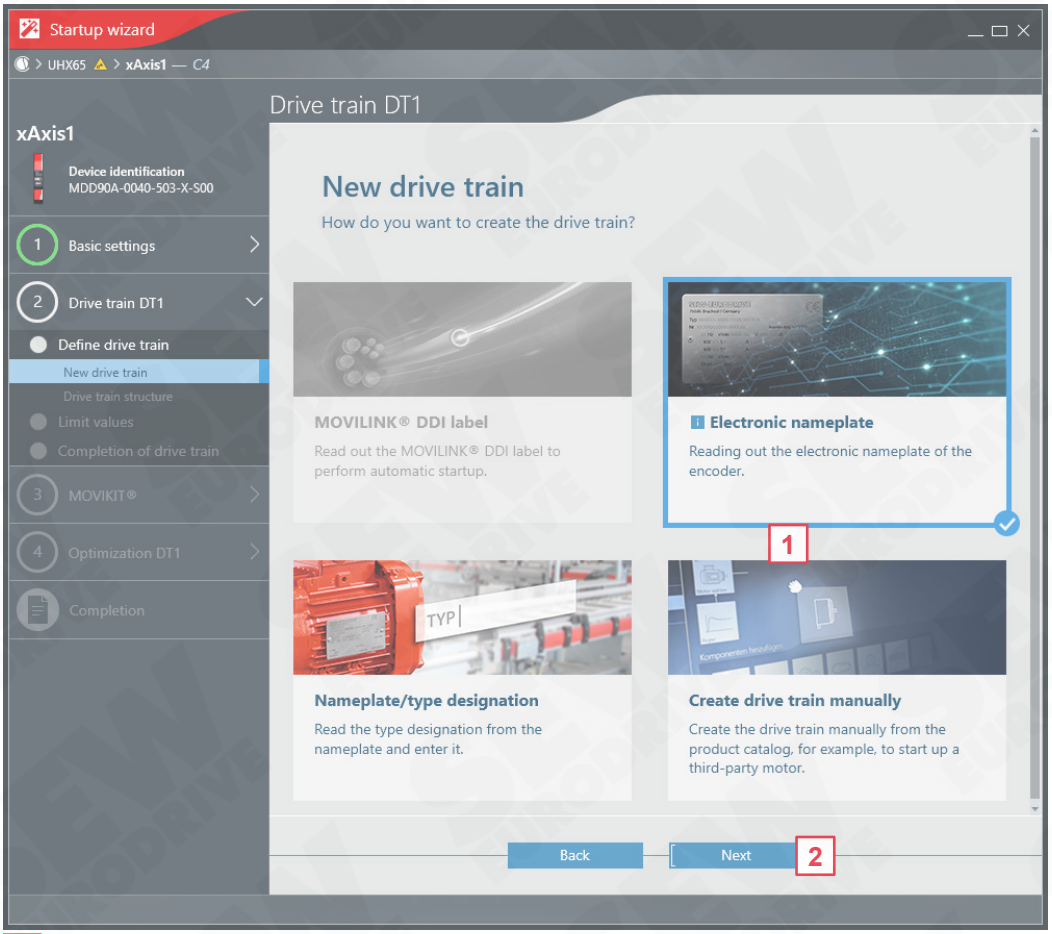
2. Voltage supply



1 Select the power supply module and the line voltage.

2 Press **Next**

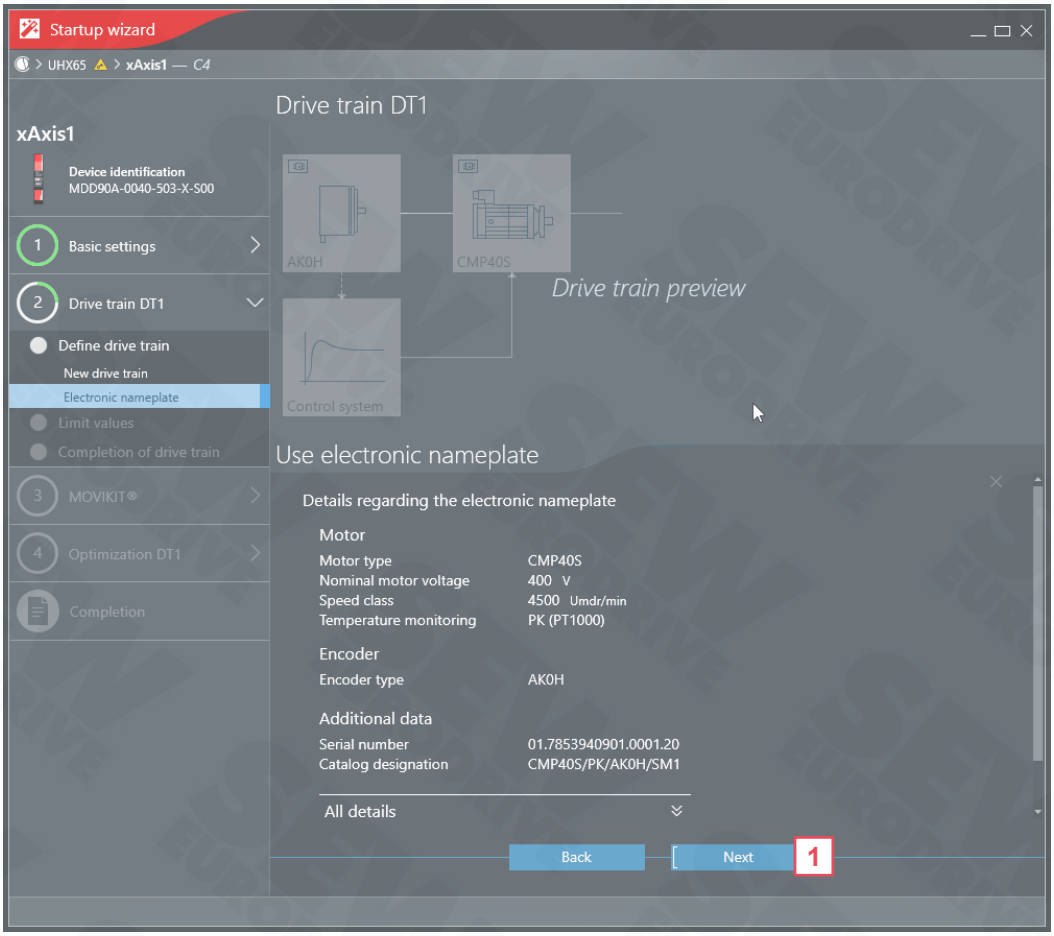
3. Edit the drive train



1 Select how you want to start up the drive train.

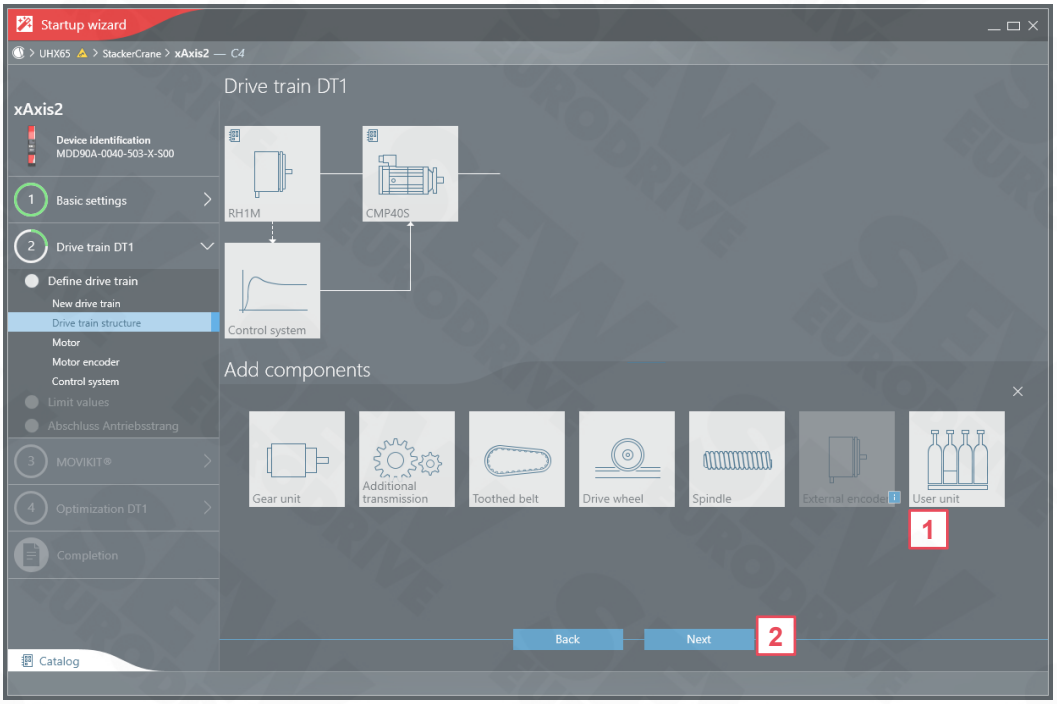
2 Press **Next**.

4. Electronic nameplate



1 Press **Next.**

5. User units



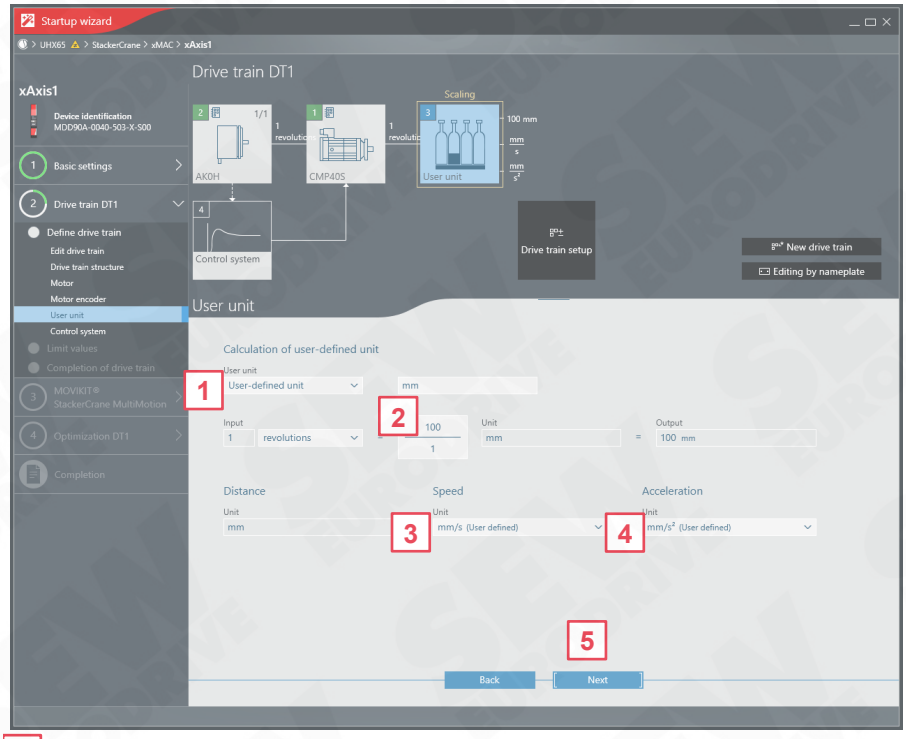
1 Add the user units.

2 Press **Next.**

6. Select position-given encoder

1 **Press Next**

7. User units



1 Define user unit. We recommend mm.

2 Set input revolutions to 100 mm.

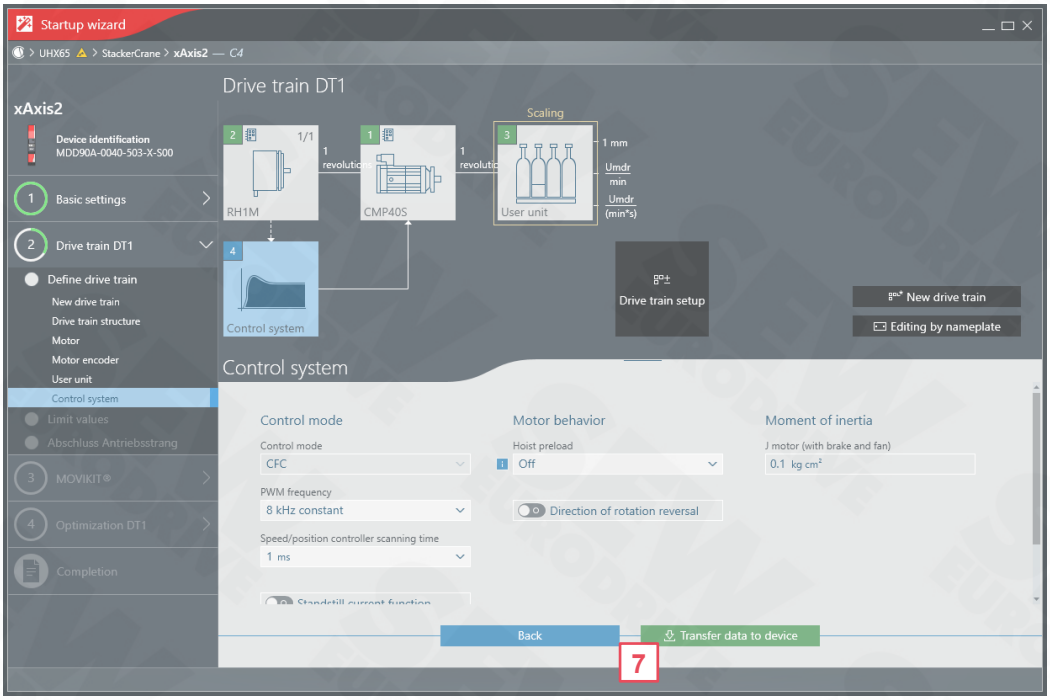
3 Select user-defined speed unit. **User unit/s** must be used.

4 Select user-defined acceleration unit. **User unit/s2** must be used.

5 Press **Next**.

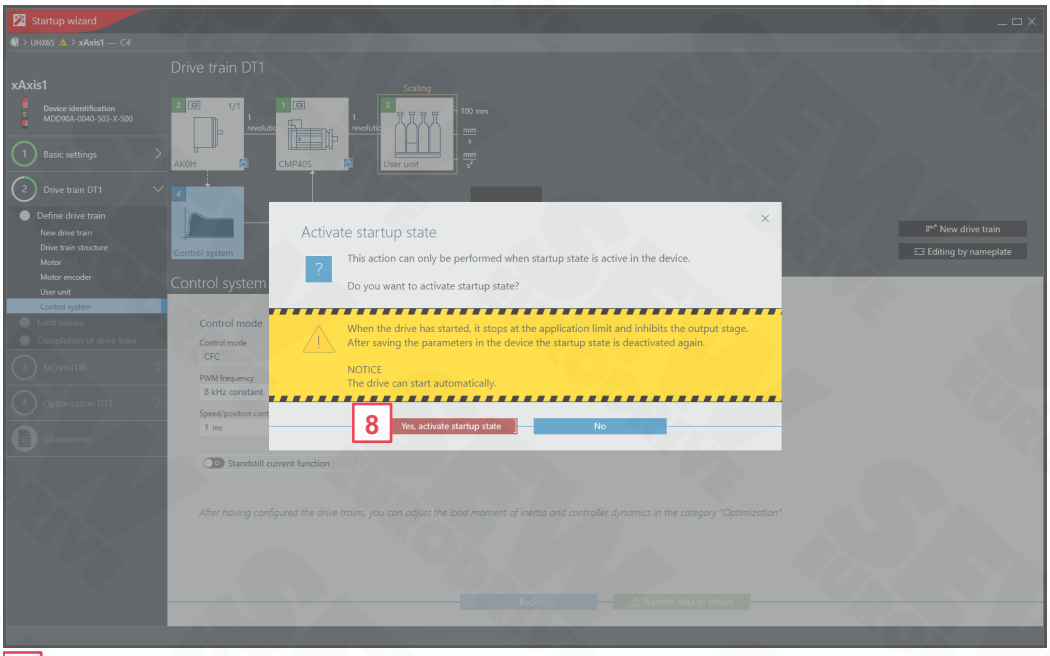
The jerk is transferred in the StackerCrane in user unit/s3.

8. Transfer data to device



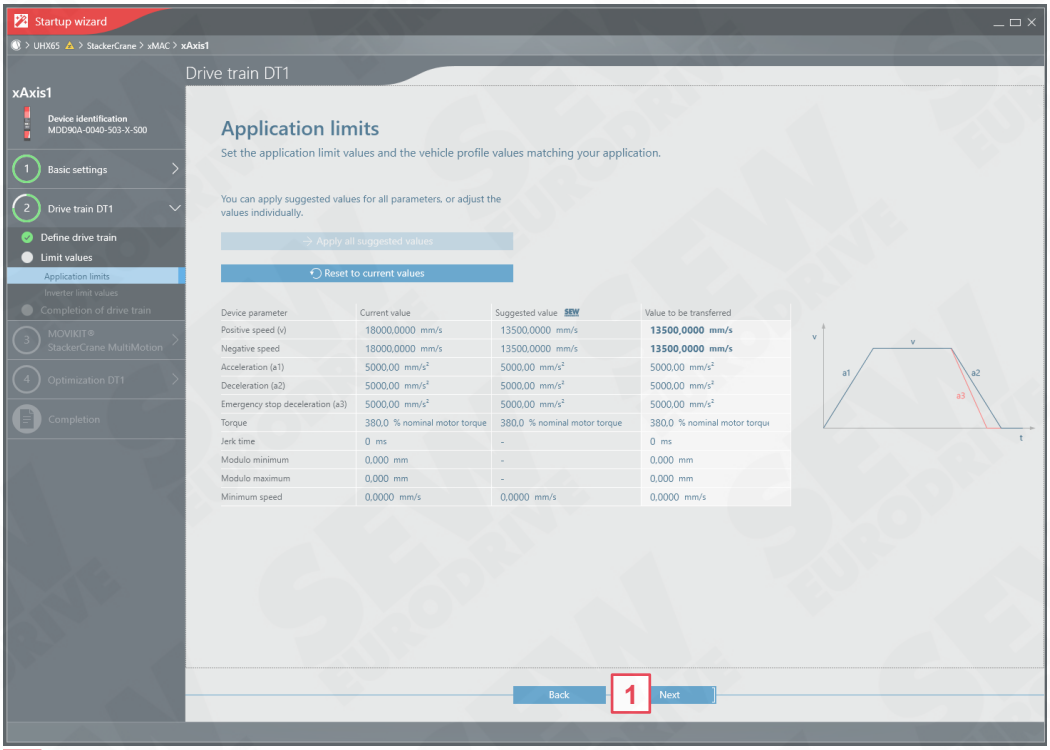
7 Press **Transfer data to device**

9. Activate startup state



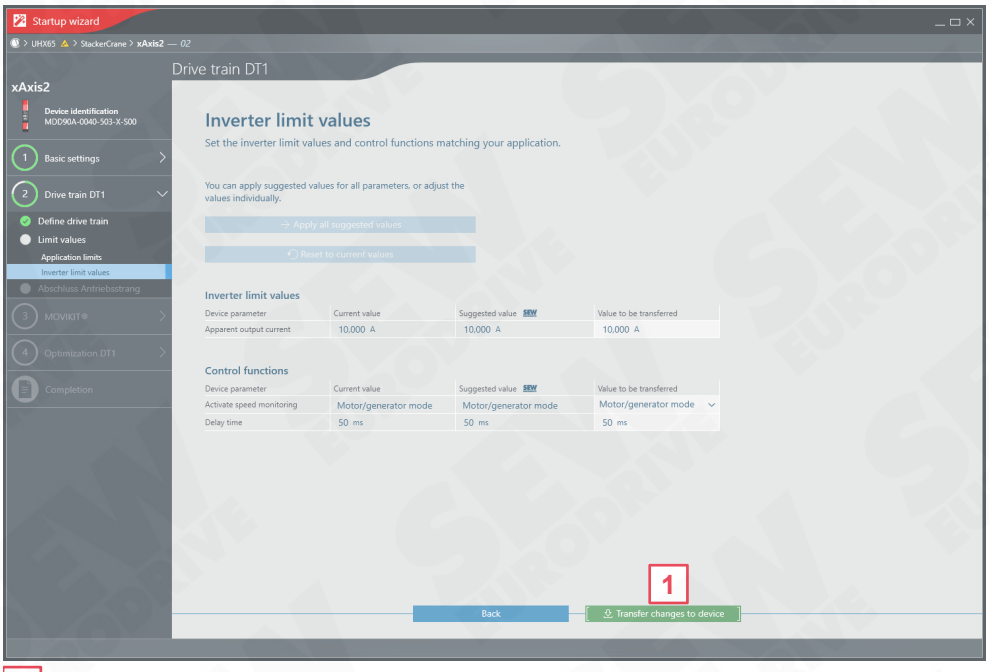
8 Press **Yes, activate startup state**

10. Application limits



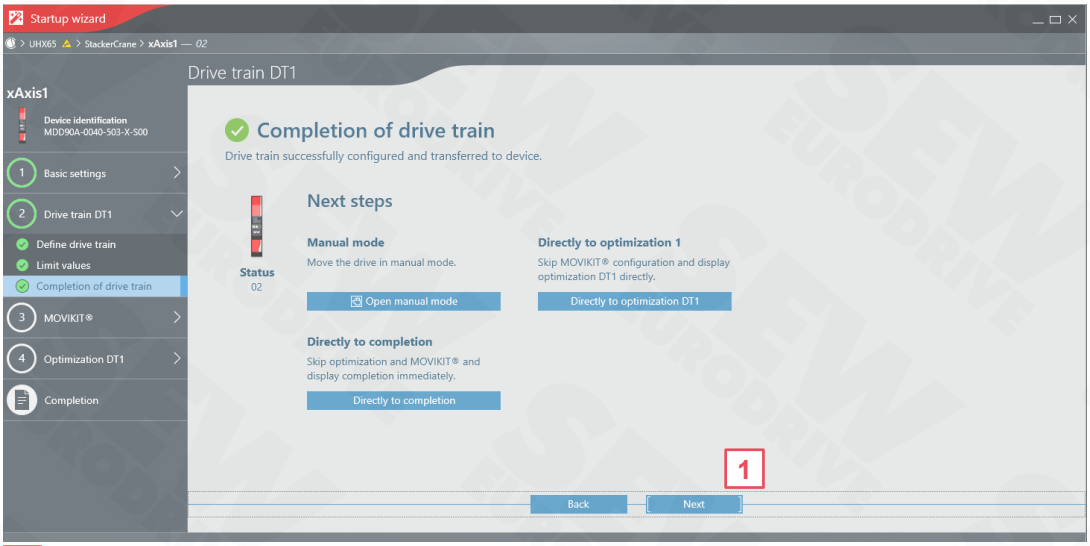
1 Press **Next.**

11. Inverter limits



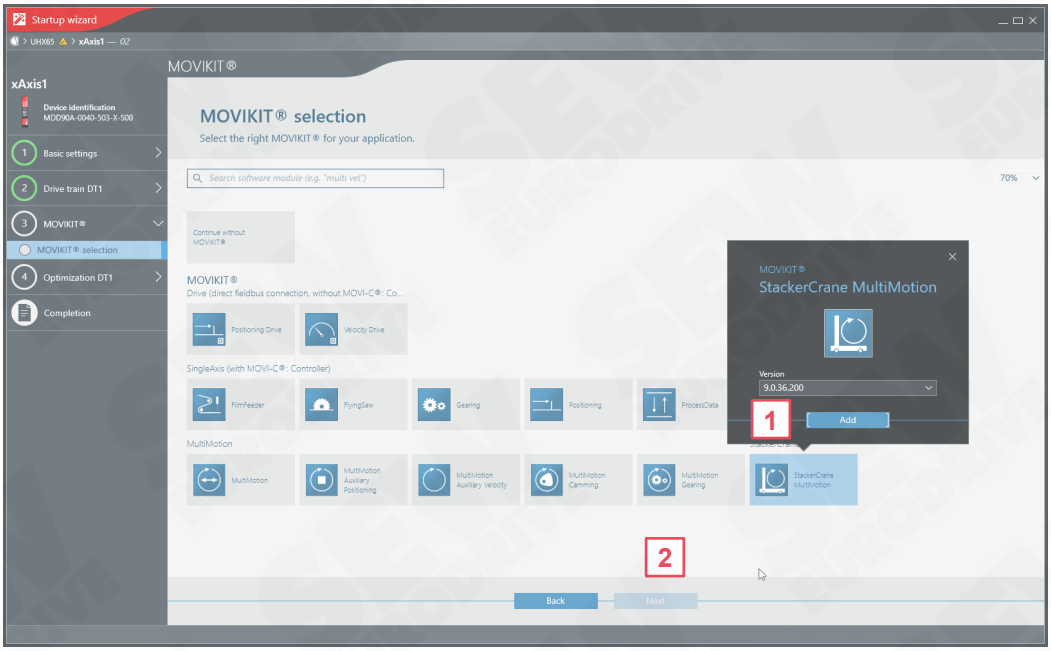
1 **Press Next**

12. Drive train fully parameterized



1 Press **Next**

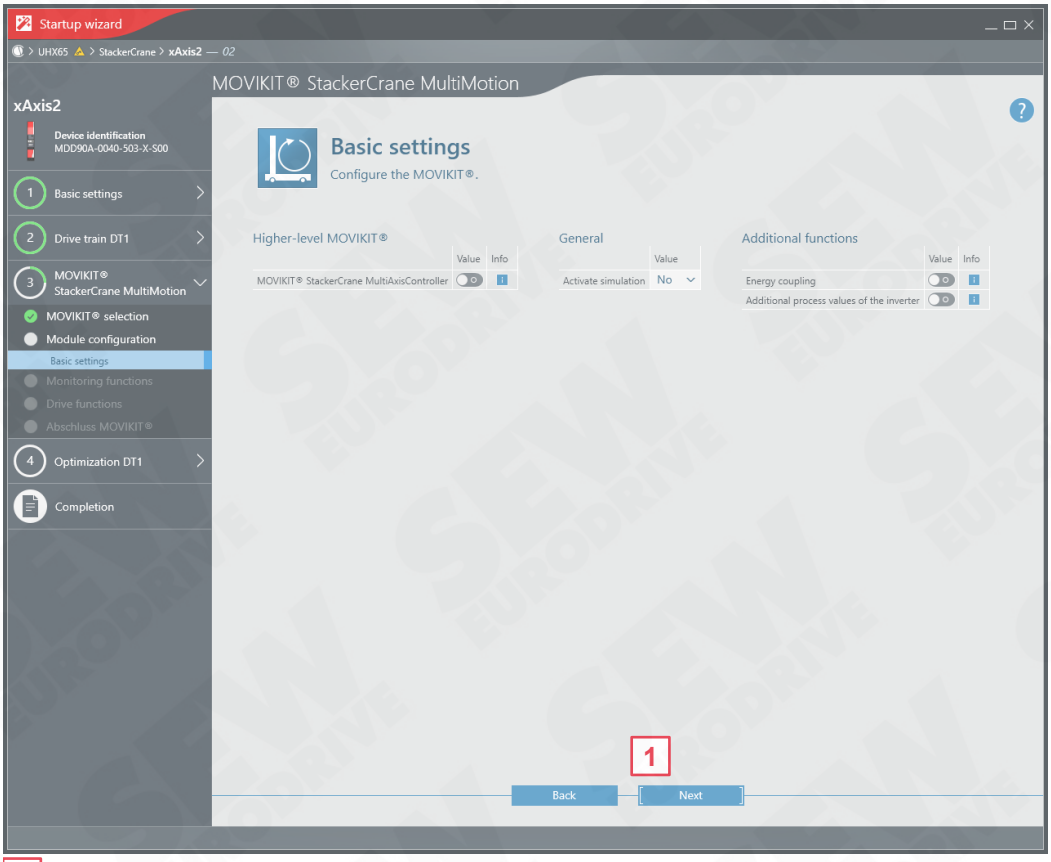
13. Add MOVIKIT®



1 Add MOVIKIT® StackerCrane MultiMotion.

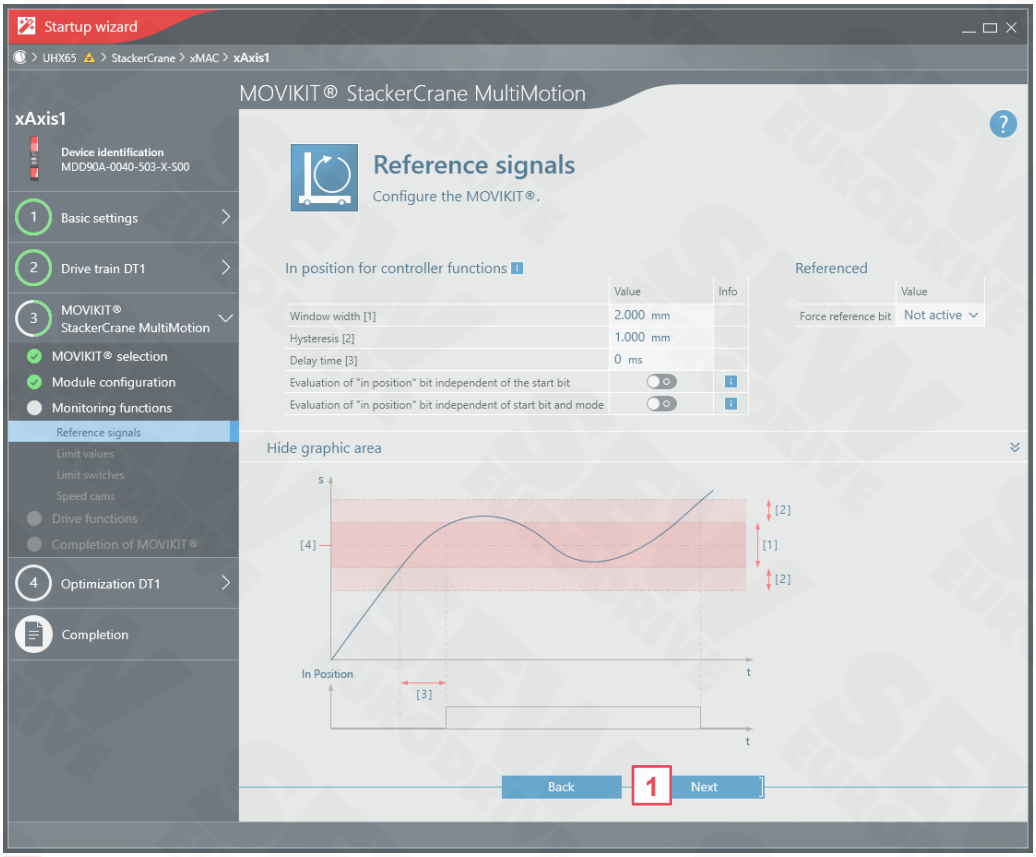
2 Press **Next.**

14. Basic settings



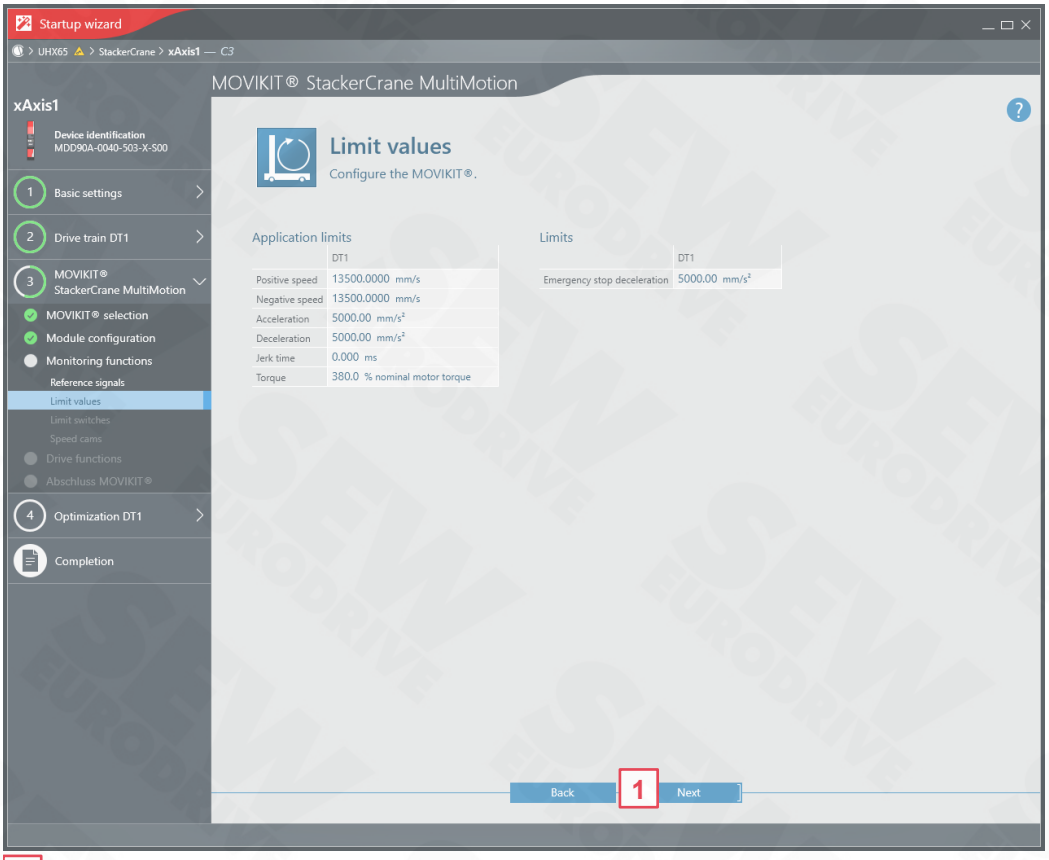
1 Press **Next.**

15. Reference signal



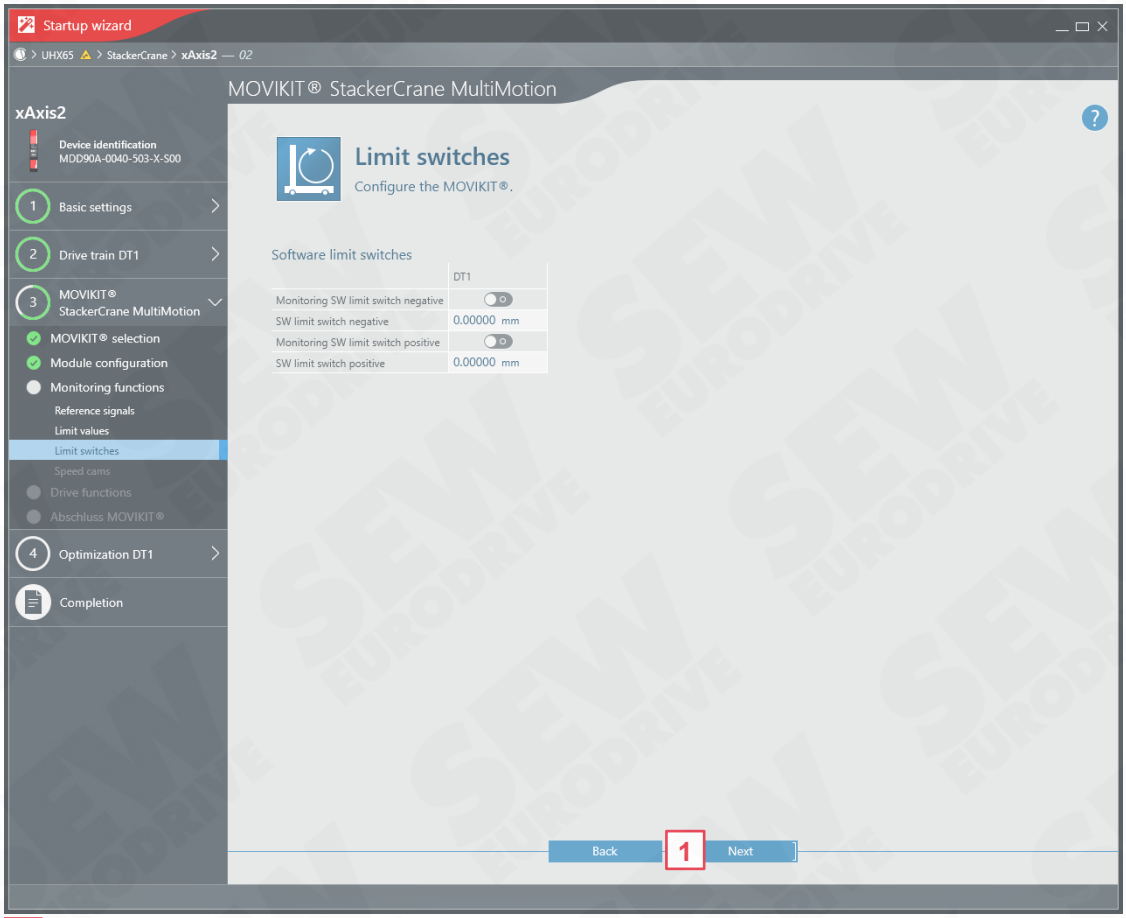
1 Press **Next.**

16. Limit values



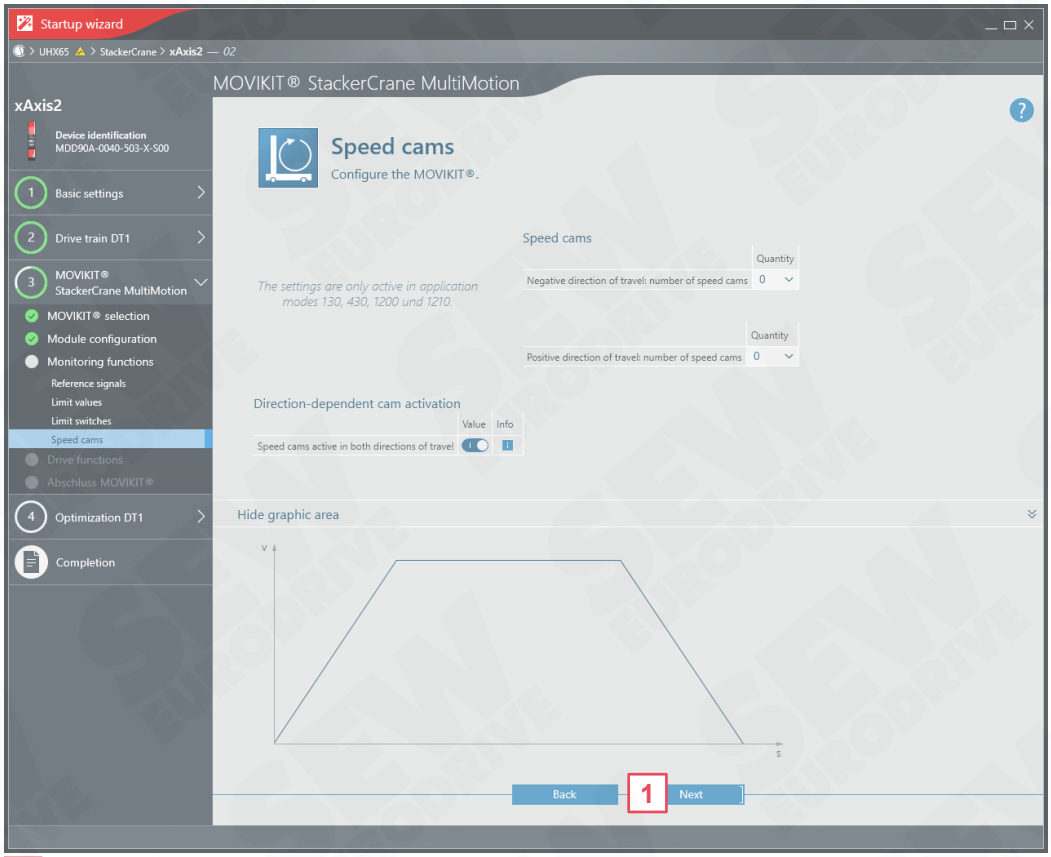
1 Press **Next.**

17. Limit switch



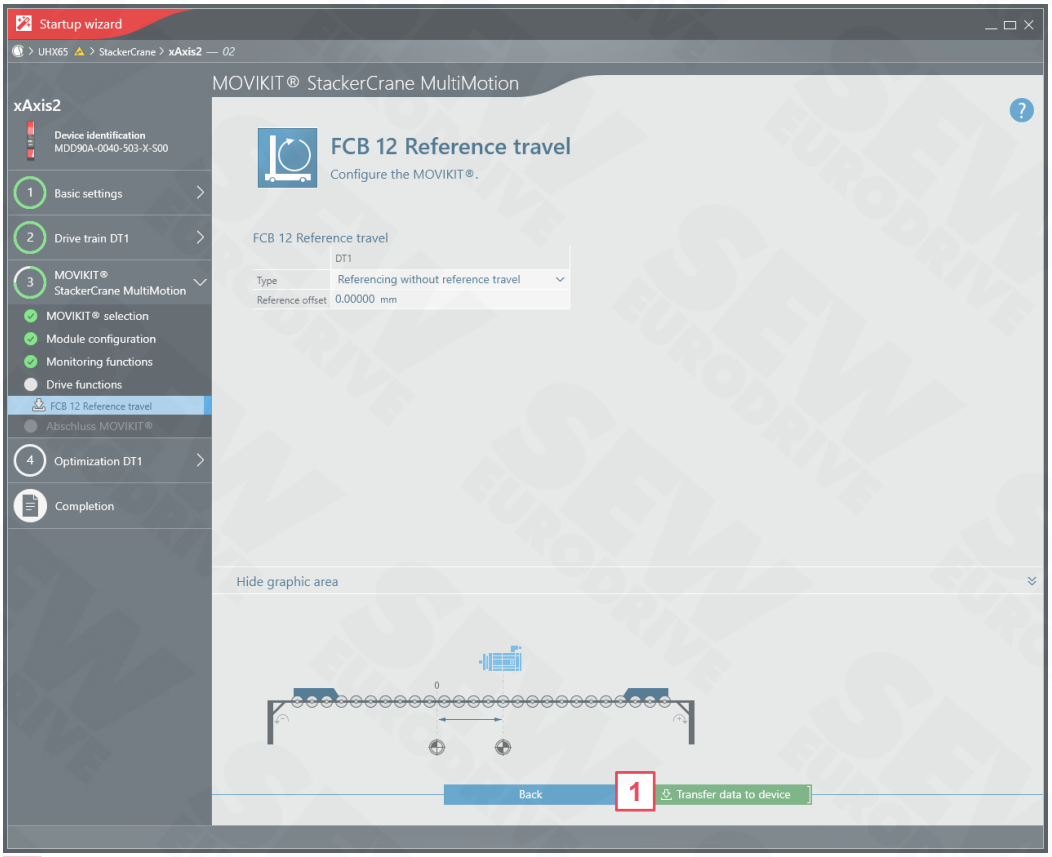
1 Press **Next.**

18. Speed cam



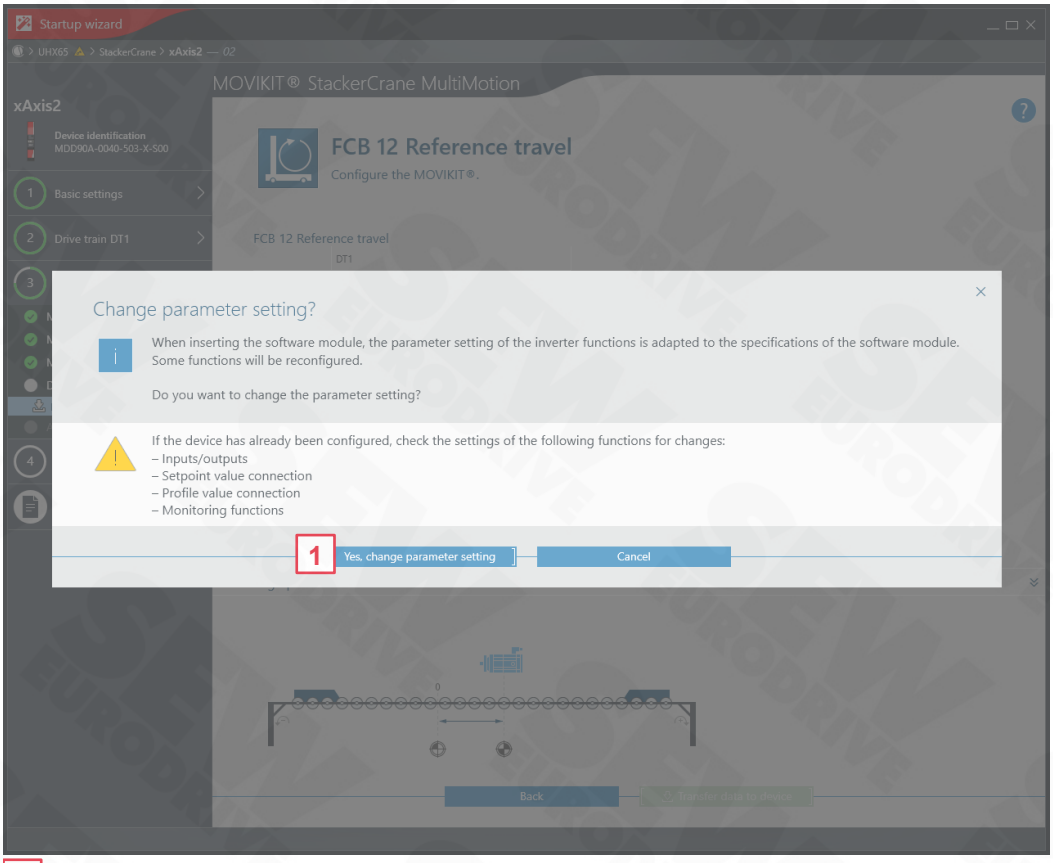
1 Press **Next.**

19. FCB 12 Reference travel



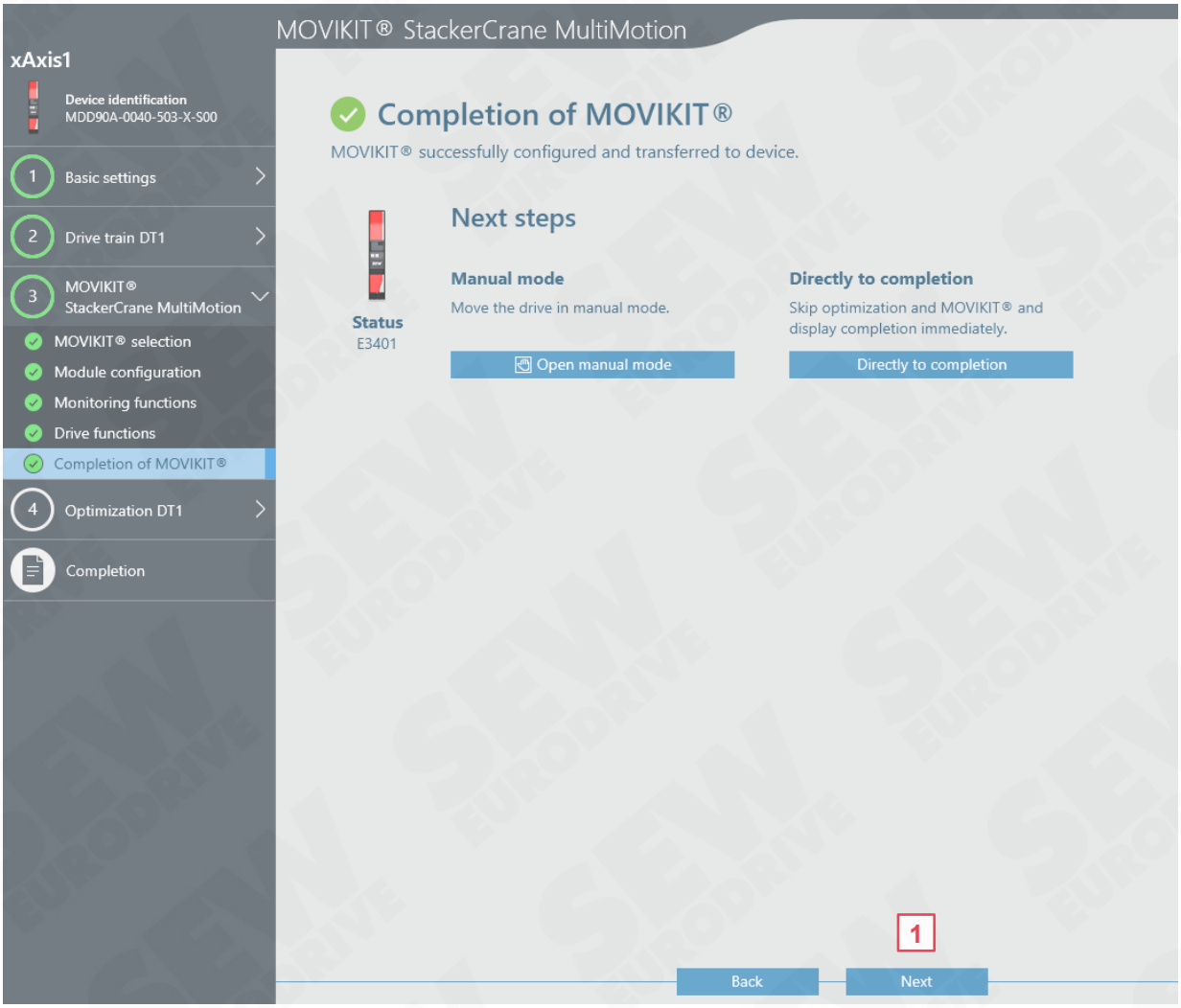
1 Press **Transfer data to device**

20. Change the parameterization



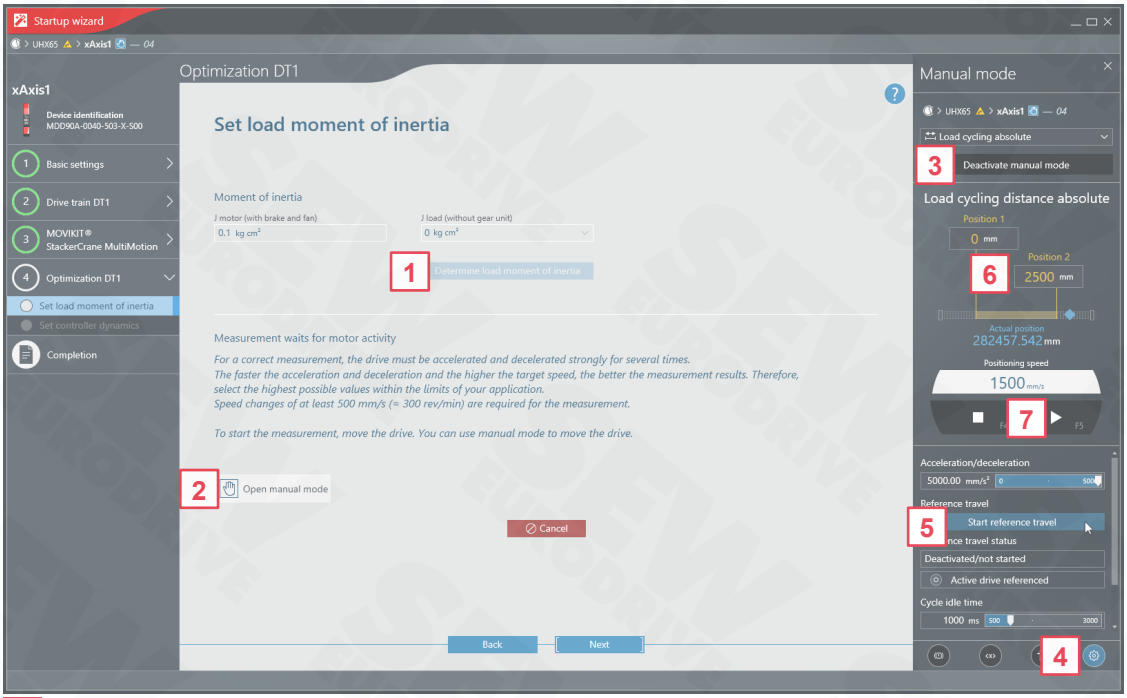
1 Press **Change parameter data.**

21. MOVIKIT® completion



1 Press **Next.**

22. Optimization – set load moment of inertia



1 Activate the load moment of inertia determination

2 Activate manual mode

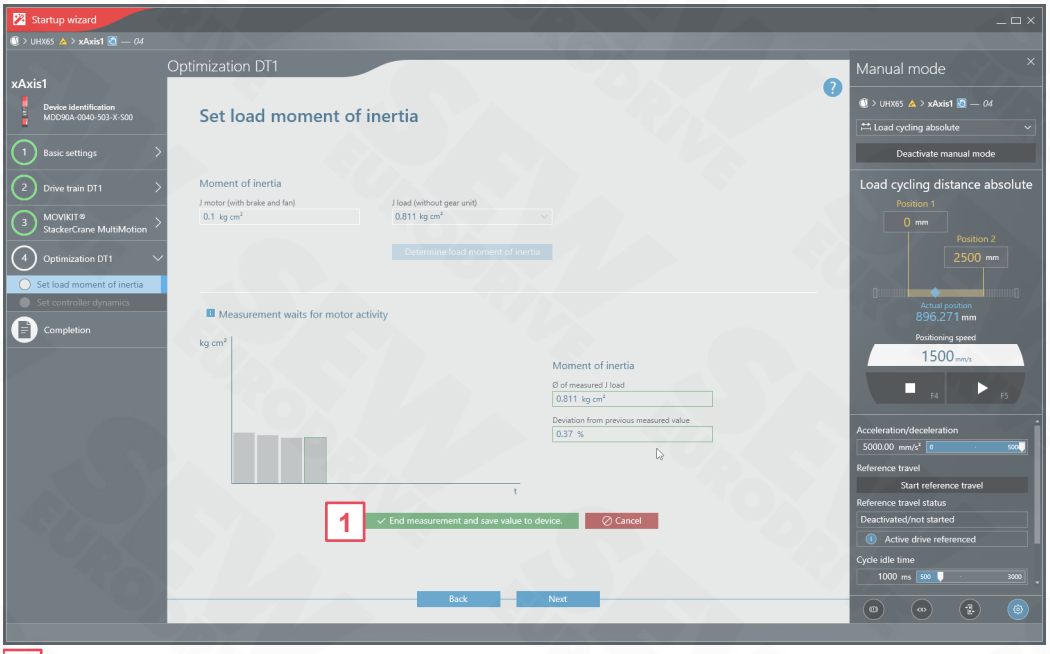
3 Switch on manual mode

4 Open the Reference travel tab using the "Gear wheel" button

5 Start reference travel

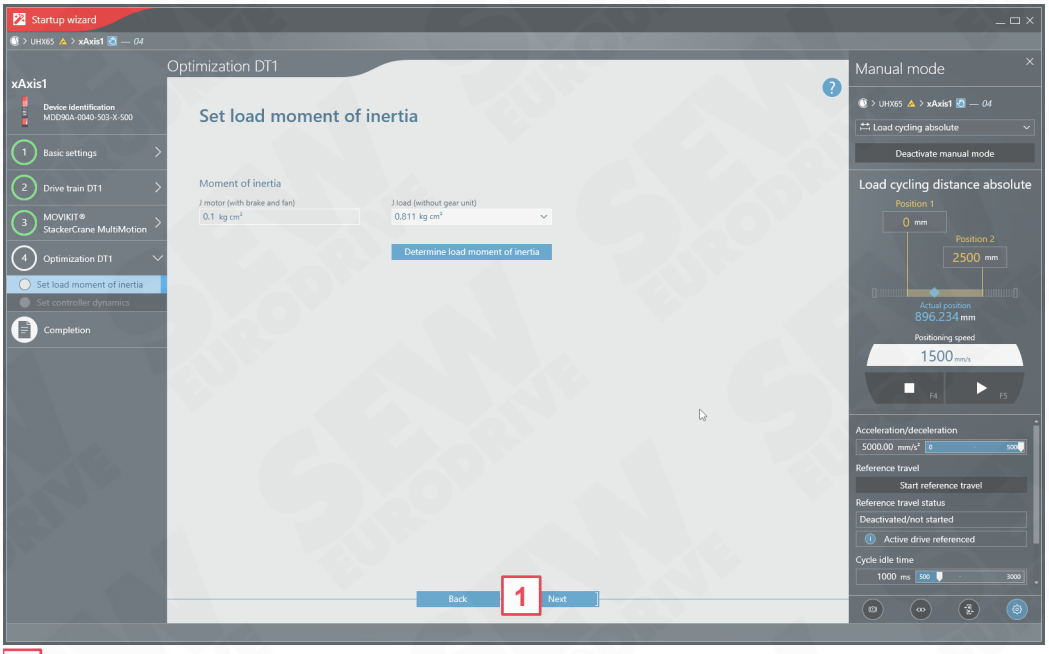
6 Defining positions 1 and 2 for the oscillation distance in absolute order

7 Start oscillation section ▶, F5

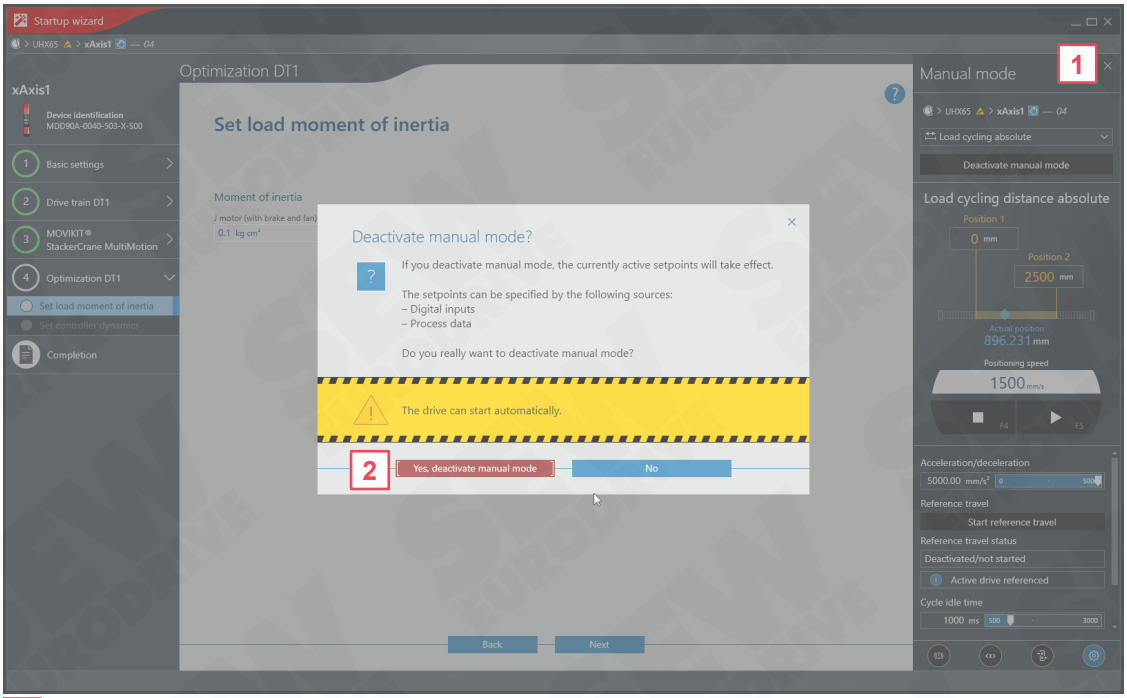


8 End measurement and save value in device

General information:
If the load moment of inertia cannot be determined, increase the acceleration and deceleration and restart the process. If the load moment of inertia still cannot be determined, also increase the positioning speed.

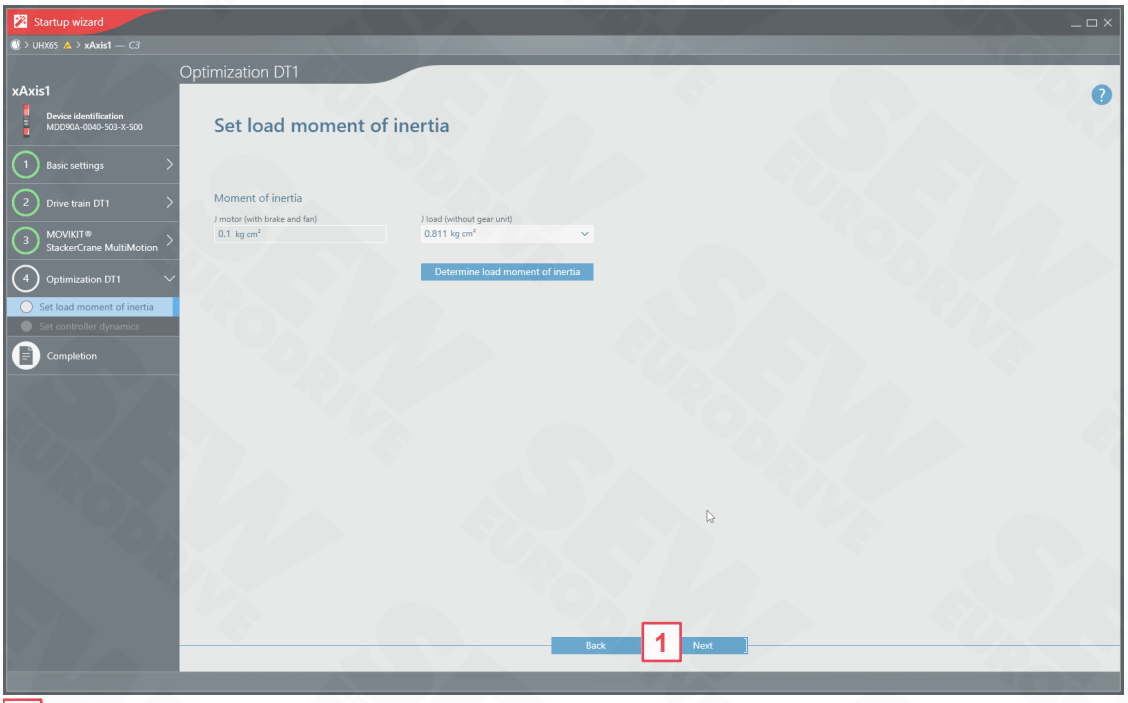


1 Press **Next.**



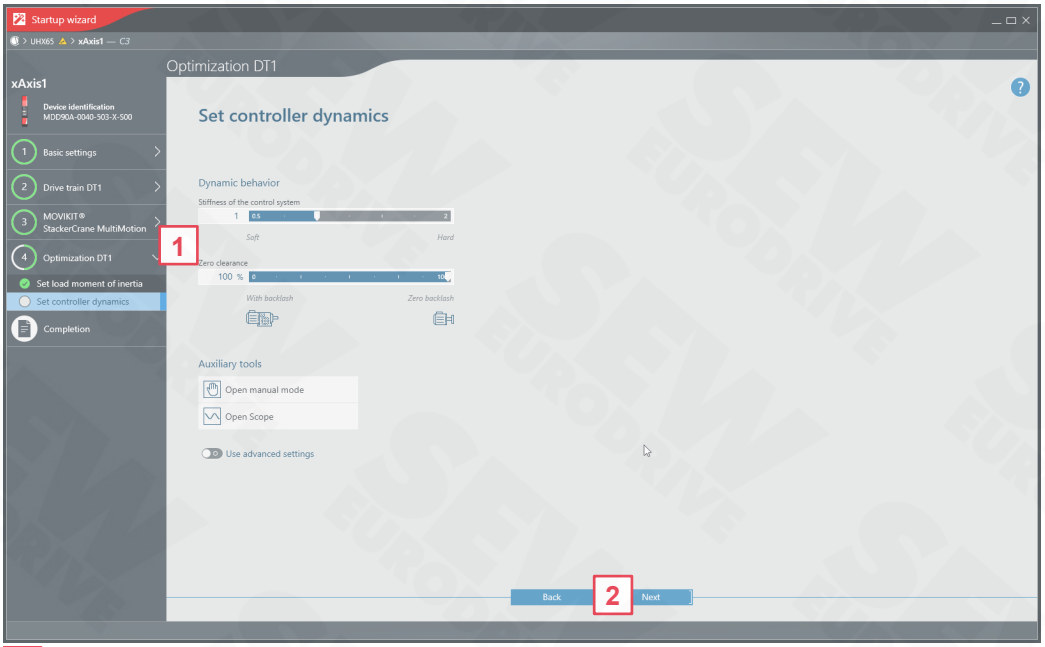
1 Close manual mode.

2 Press **Yes, activate startup state**



1 Press **Next.**

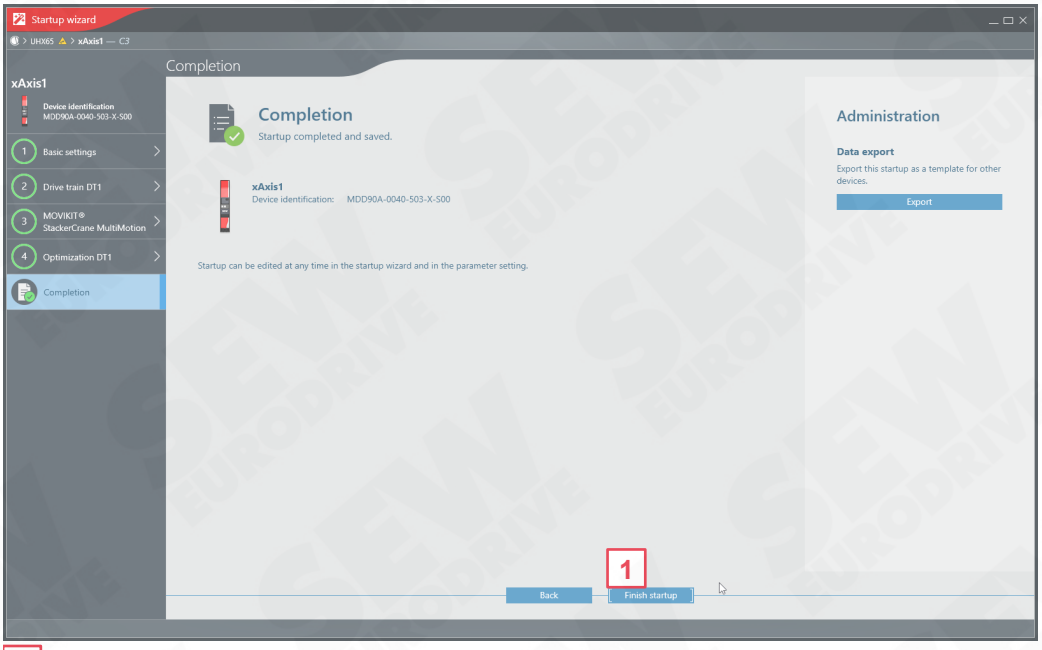
23. Set controller dynamics



1 Set stiffness and clearance. Press **Next.**

2 Press **Next.**

24. Conclusion



1 Press **Finish startup**.

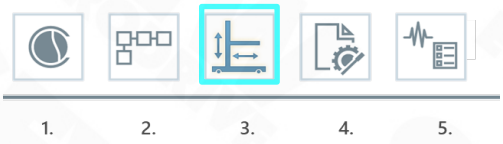
3.4.1.2 Hoist (y-axis)

1. Repeat the startup for the y-axis with the startup assistant as in the previous chapter (travel axis x-axis)

3.5 Step 3 – Parameterization of MOVIKIT® StackerCrane

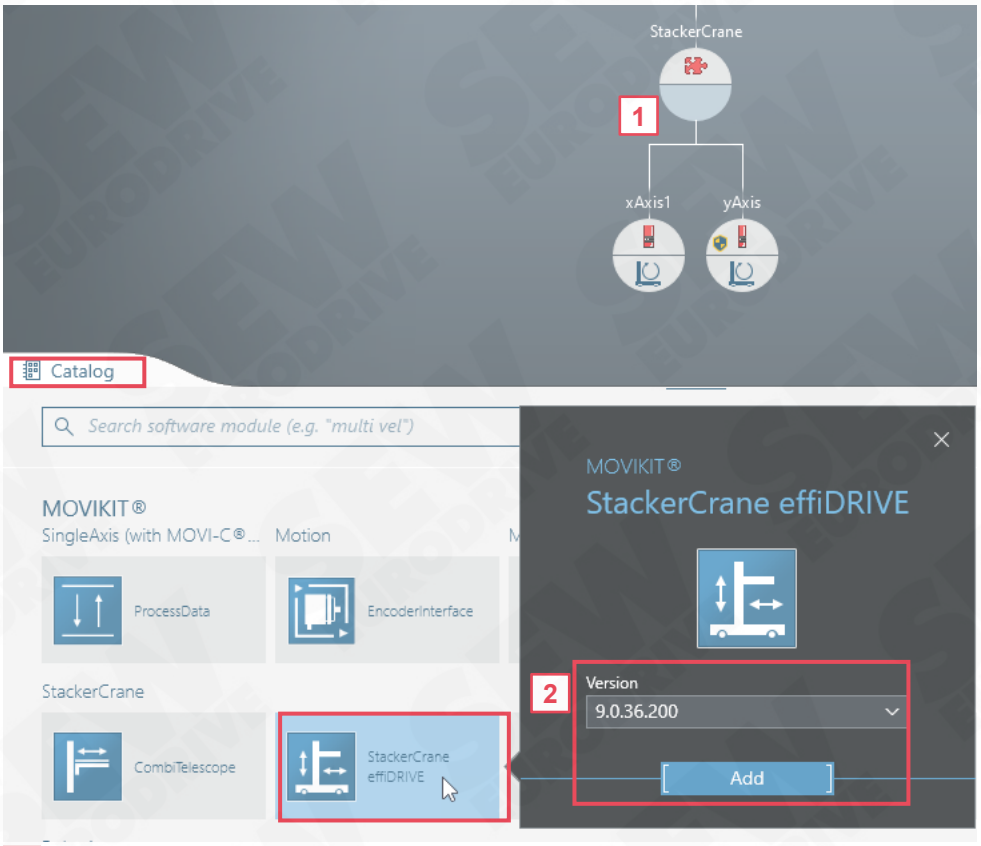
Goals

- Assigning and parameterizing MOVIKIT® StackerCrane
- Get to know the process data assignment of the fieldbus interface



3.5.1 Parameterize MOVIKIT® StackerCrane

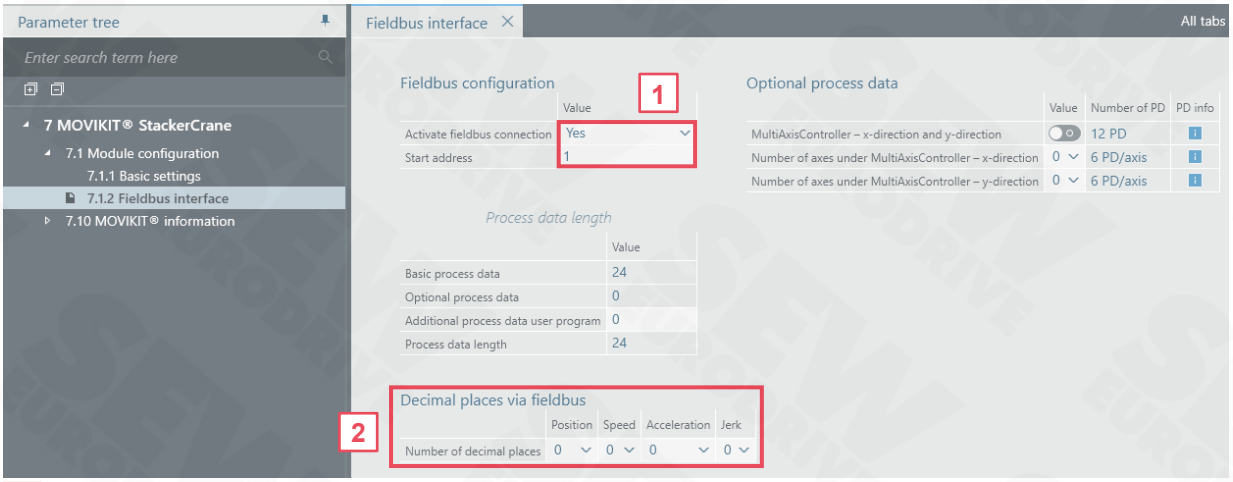
1. Assign MOVIKIT®



1 Activate the **lower semicircle of the software node**

2 Select the latest version of the **MOVIKIT® StackerCrane effiDRIVE** in the **catalog** And click **Add.**

2. Configure the fieldbus interface



1 Set **Activate fieldbus connection = Yes** and **Start address = 1**

2 Set decimal places for the fieldbus:

Number of decimal places	Value	Resolution
0	Position	1 mm = 1 mm
0	Speed	1 mm/s = 1 mm/s.
0	Acceleration	1 mm/s2 = 1 mm/s2
0	Jerk	1 mm/s3 = 1 mm/s3

3.5.2 Process data assignment of the fieldbus interface

Process data assignment in MOVISUITE®

Fieldbus interface

	PLC		PLC output data	PLC input data	MOVIKIT®
			>>>>	<<<<	
Axis group					
	Setpoint application mode	i	PO 1	PI 1	Actual application mode
	Control word	i	PO 2	PI 2	Status word
	Reserved (override)	i	PO 3	PI 3	Status or fault/subfault
	Reserved		PO 4	PI 4	Reserved
x-direction					
	Control word	i	PO 5	PI 5	Status word
	Setpoint speed		PO 6	PI 6	Actual speed
	Setpoint acceleration		PO 7	PI 7	Status or fault/subfault
	Setpoint deceleration		PO 8	PI 8	Torque
	Digital outputs	i	PO 9	PI 9	Digital inputs
	Control word MultiAxisController	i	PO 10	PI 10	Status word MultiAxisController
	Target position – high word		PO 11	PI 11	Actual position – high word
	Target position – low word		PO 12	PI 12	Actual position – low word
	Setpoint jerk		PO 13	PI 13	Actual jerk
	Reserved		PO 14	PI 14	Reserved
y-direction					
	Control word	i	PO 15	PI 15	Status word
	Setpoint speed		PO 16	PI 16	Actual speed
	Setpoint acceleration		PO 17	PI 17	Status or fault/subfault
	Setpoint deceleration		PO 18	PI 18	Torque
	Digital outputs	i	PO 19	PI 19	Digital inputs
	Control word MultiAxisController	i	PO 20	PI 20	Status word MultiAxisController
	Target position – high word		PO 21	PI 21	Actual position – high word
	Target position – low word		PO 22	PI 22	Actual position – low word
	Setpoint jerk		PO 23	PI 23	Actual jerk
	Reserved		PO 24	PI 24	Reserved

Target application mode

0 Default
100 Jog
300 Referencing configured offset
301 Referencing bus offset
400 Positioning absolute
1200 Energized-optimized XY positioning
1210 Mechanics-optimized positioning
1300 External braketest

Control word x-& y-direction

Bit 0	Enable emergency stop
Bit 1	Enable application stop
Bit 2	Reserved
Bit 3	Release brake
Bit 4	Jog positive
Bit 5	Jog negative
Bit 6	Reserved
Bit 7	Start/stop with fieldbus ramp
Bit 8	Reset fault
Bit 9	Reserved
Bit 10	Reserved
Bit 11	Deactivate external encoders
Bit 12	Deactivate SW limit switches
Bit 13	Activate output stage inhibit
Bit 14	Activate standby mode
Bit 15	MOVIKIT® Handshake In

Status word x-& y-direction

Bit 0	Ready
Bit 1	STO inactive
Bit 2	Output stage enabled
Bit 3	Brake released
Bit 4	Motor turning
Bit 5	Referenced
Bit 6	Reserved
Bit 7	In position
Bit 8	Fault
Bit 9	Reserved
Bit 10	Reserved
Bit 11	External encoder disabled
Bit 12	SW limit switch inactive
Bit 13	Reserved
Bit 14	Standby mode active
Bit 15	MOVIKIT® Handshake Out

MultiAxisController control word

Bit 0	Deactivate member 1/11
Bit 1	Deactivate member 2/21
Bit 2	Deactivate member 12
Bit 3	Deactivate member 22
Bit 4	member 1/11 Release brake with inhibited output stage
Bit 5	member 2/21 Release brake with inhibited output stage
Bit 6	member 12 Release brake with inhibited output stage
Bit 7	member 22 Release brake with inhibited output stage
Bit 8	Deactivate balance controller
Bit 9	Reserved (deactivate position controller)
Bit 10	Deactivate skewing error
Bit 11	Allow skew compensation
Bit 12	Reserved
Bit 13	Reserved
Bit 14	Reserved
Bit 15	Reserved

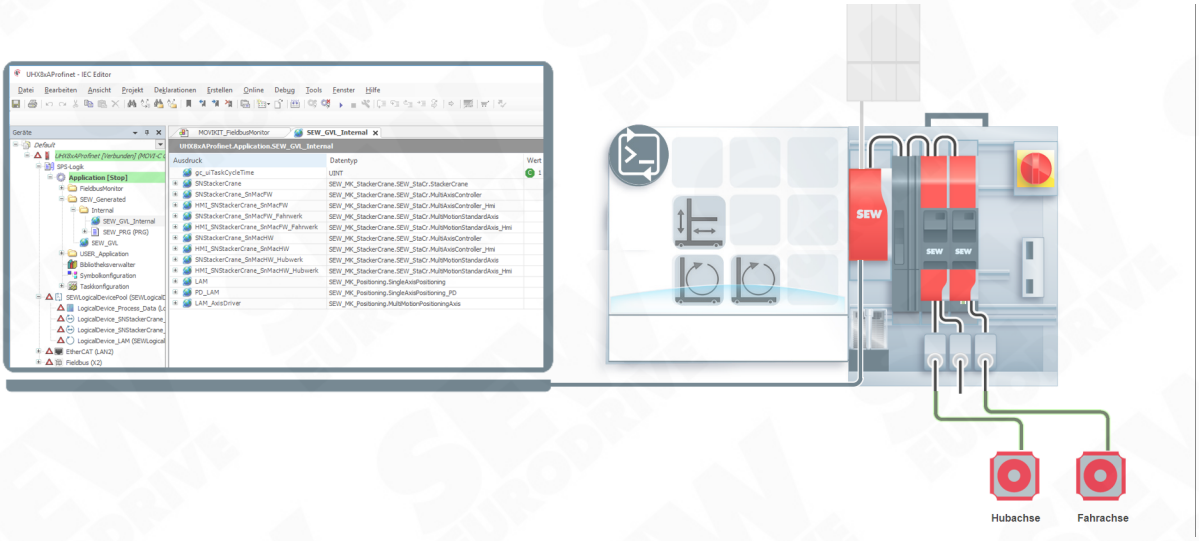
Status word x-& y-direction

Bit 0	Axis group member 1/11 deactivated
Bit 1	Axis group member 2/21 deactivated
Bit 2	Axis group member 12 deactivated
Bit 3	Axis group member 22 deactivated
Bit 4	Axis group member 1/11 brake released
Bit 5	Axis group member 2/21 brake released
Bit 6	Axis group member 12 brake released
Bit 7	Axis group member 22 brake released
Bit 8	Balance controller deactivated
Bit 9	Position controller deactivated
Bit 10	Skew in skew window
Bit 11	Overload guard active
Bit 12	Reserved
Bit 13	Reserved
Bit 14	Reserved
Bit 15	Reserved

3.6 Step 4 – Generation of the software project

Objectives

- Parameterize fieldbus
- Be able to configure cycle times
- Be acquainted with the controller stages and be able to assign licenses
- Be able to create an IEC project
- Know how to debug the IEC program



3.6.1 Fieldbus parameterization

1. Parameterize fieldbus

1 Set the fieldbus protocol to **PROFINET IO device**

2 Activate the **fieldbus connection.**

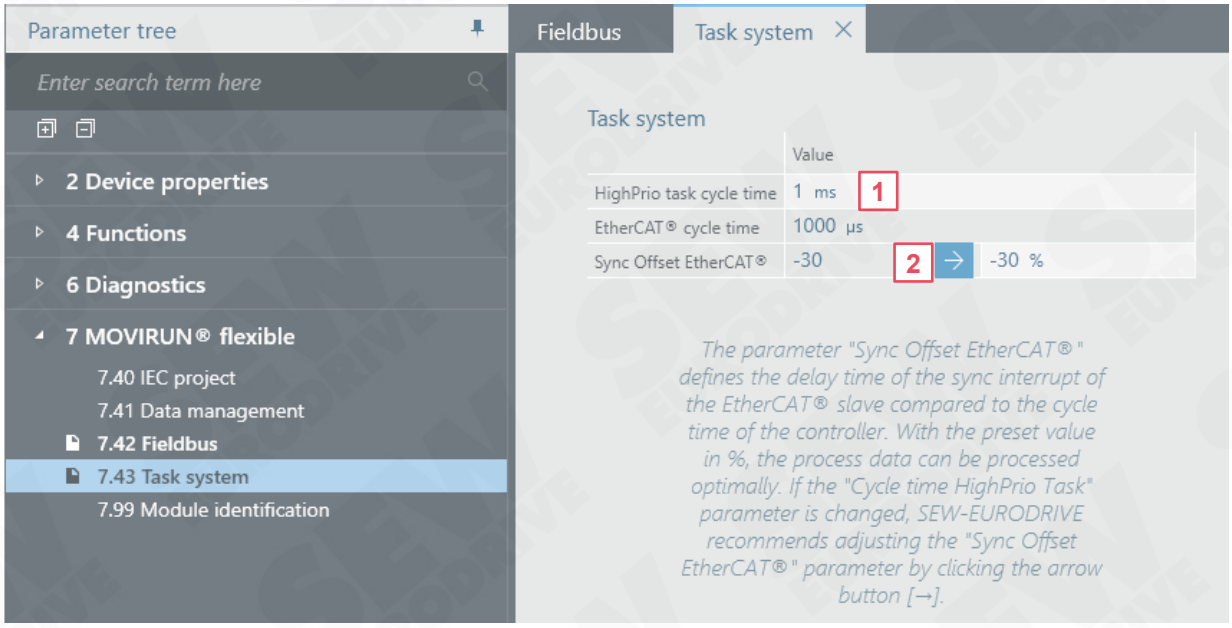
3.6.2 Cycle time on the MOVI-C® CONTROLLER

General information:
The StackerCrane applications are always operated with a cycle time of **1 ms or 4 ms** depending on the controller. Select the controller from the following table depending on the scope of application (MultiMotion / MultiAxisController / Add-on AntiSway):

Controller

MOVIKIT® StackerCrane with ...	UHX25	UHX45 UHX65A-R01	UHX65A-R02 UHX65A-R04
MOVIKIT® StackerCrane MultiMotion	1 ms	1 ms	1 ms
... With MOVIKIT® PowerMode	4 ms	1 ms	1 ms
MOVIKIT® StackerCrane MultiAxisController	-	4 ms	1 ms
… With MOVIKIT® MOTION add-on AntiSway	-	4 ms	4 ms
... With MOVIKIT® MultiAxisController add-on Cascading	-	4 ms	4 ms
... With MOVIKIT® PowerMode	-	4 ms	4 ms

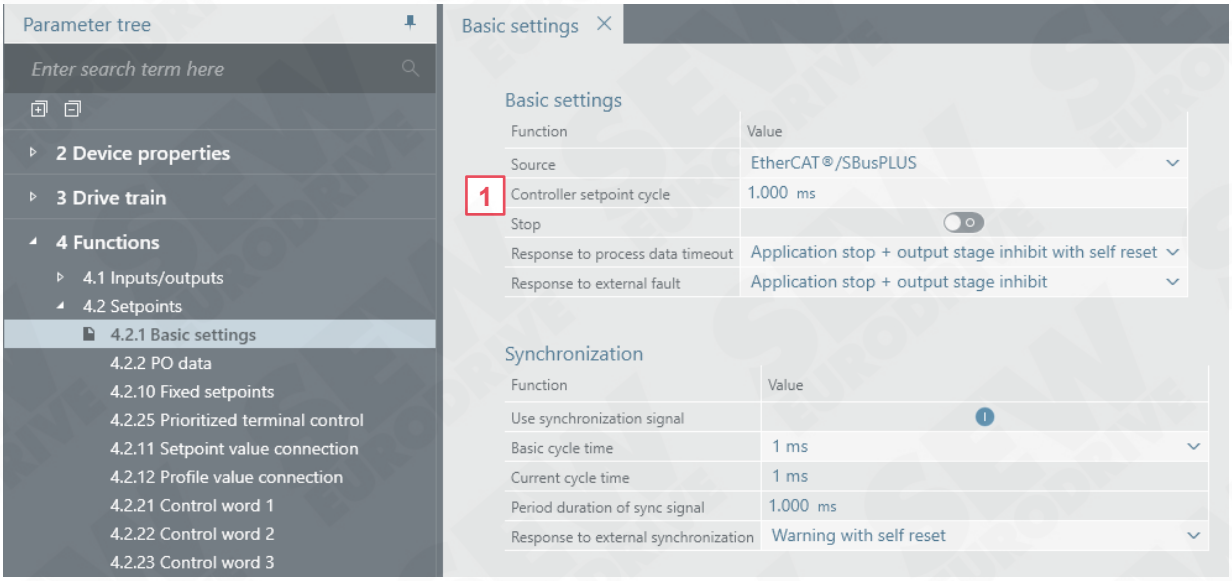
1. Parameterize the cycle time on the MOVI-C® CONTROLLER



1 Set the EtherCAT® cycle time to 1 ms (default).

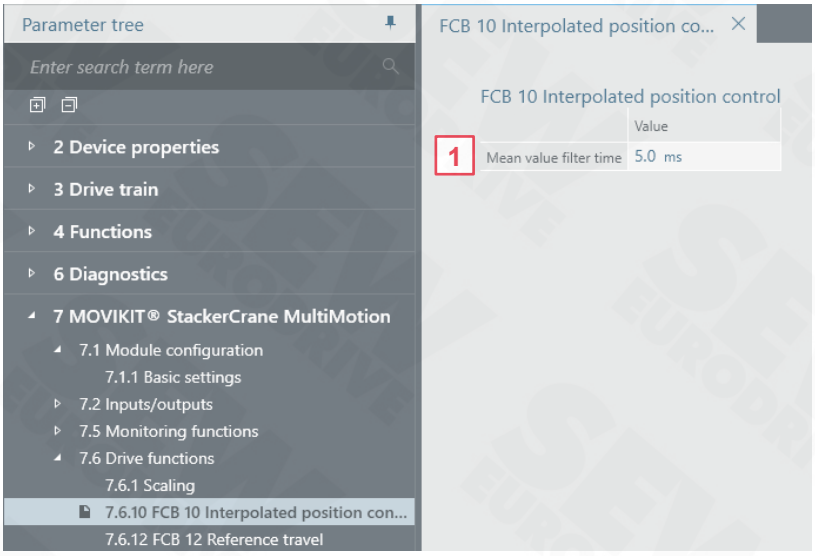
2 Apply suggested **Sync Offset EtherCAT® value**

2. Change the cycle time in the parameter tree of the axes



1 Under **Setpoints** **Basic settings**, set **Controller setpoint cycle** to 1 ms (default).

3. Parameterize the mean value filter time in the parameter tree of the axes

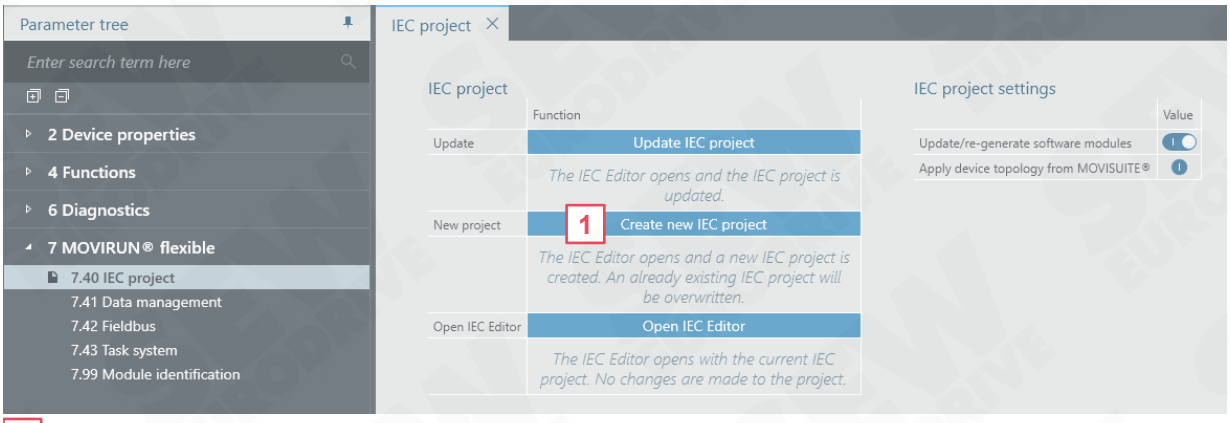


1 Under **Drive functions FCB10 Interpolated position control**, set the **Mean value filter time** to a multiple of the cycle time.

With a cycle time of 1 ms, the default value of the mean filter time (5 ms) can be used.
For a cycle time of 4 ms, we recommend a mean filter time of 8 ms.

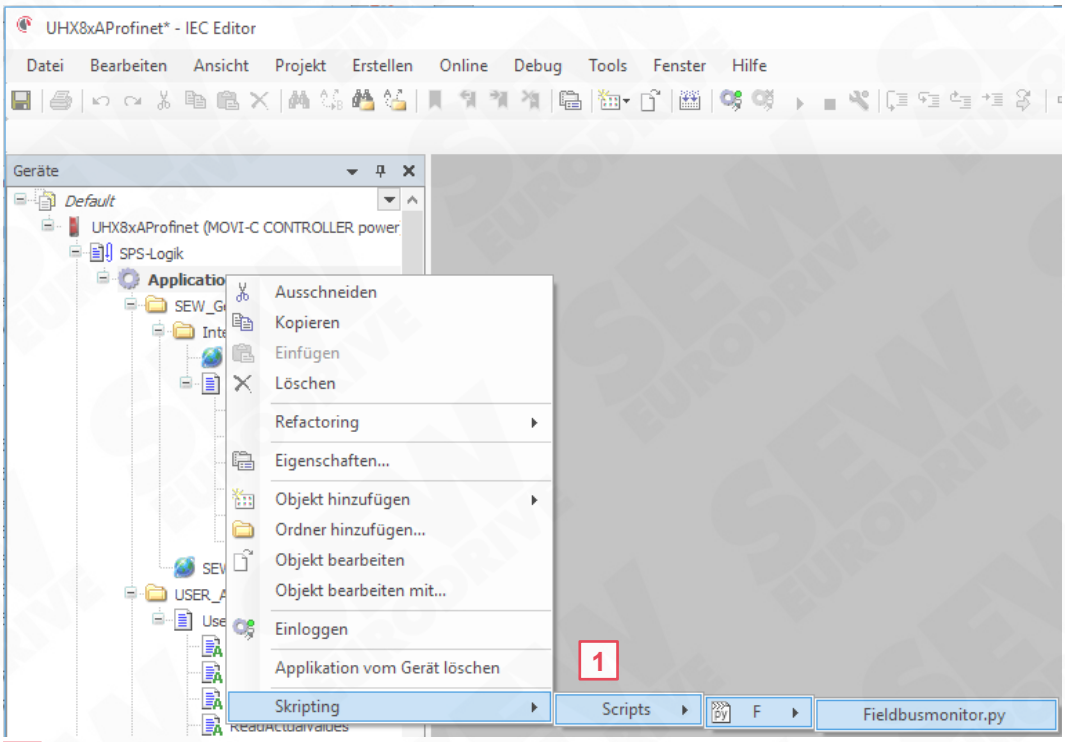
3.6.3 Create IEC project

1. Create IEC project



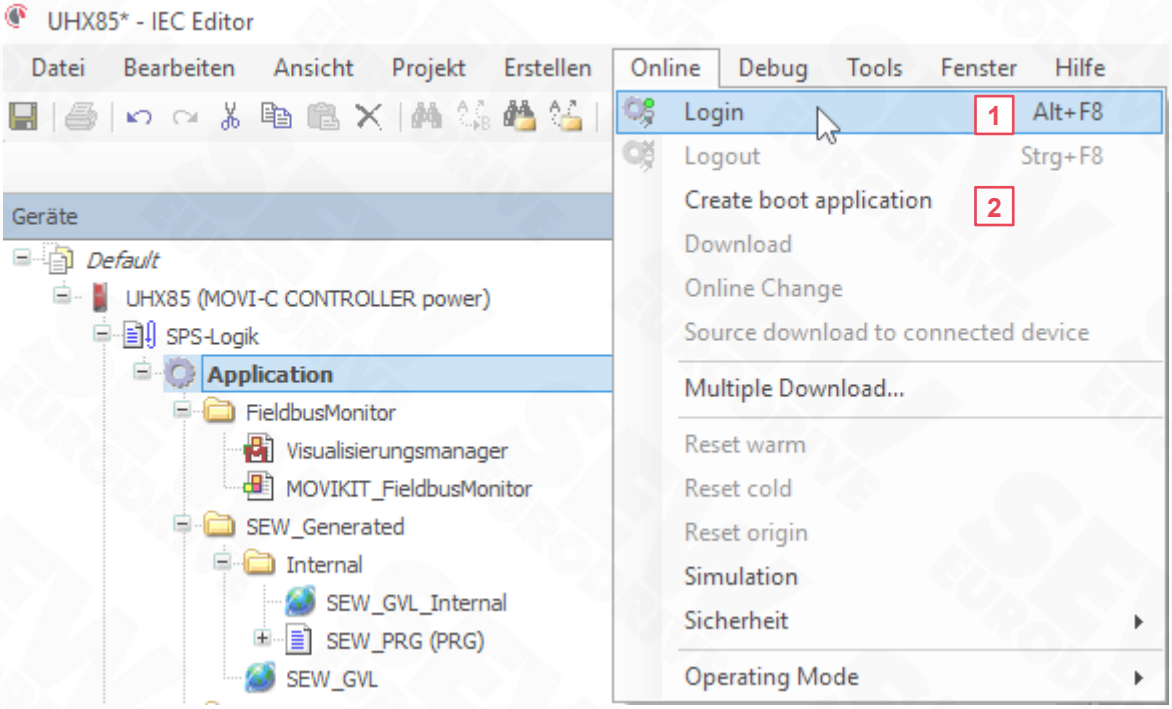
1 Click **Create new IEC project** to start the automatic code generation process

2. Import process data monitor



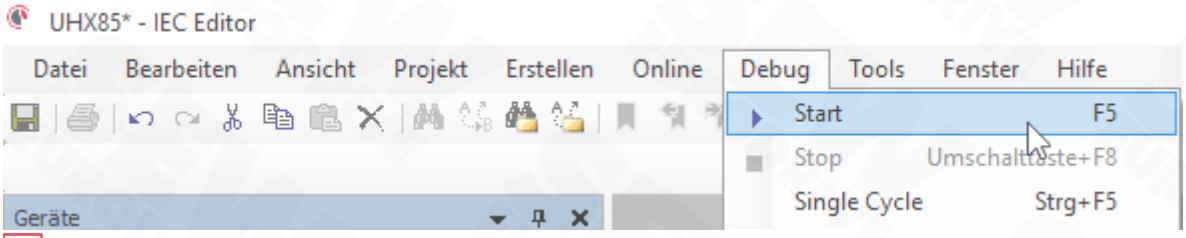
1 Activate the **fieldbus monitor.**

3. Start the project



1 Click **Login** to compile the IEC project.

2 Click Create **boot application** to start the program on the MOVI-C® CONTROLLER automatically after power off.

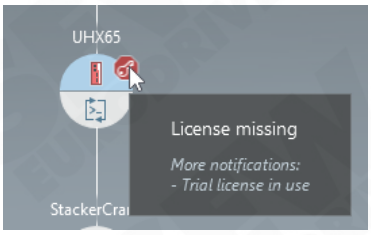


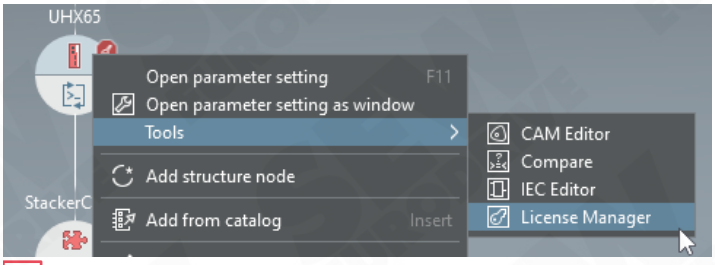
3 Start the program with **Debug Start** , ▶ Or **F5**.

3.6.4 License MOVI-C® CONTROLLER

1. Start the license manager

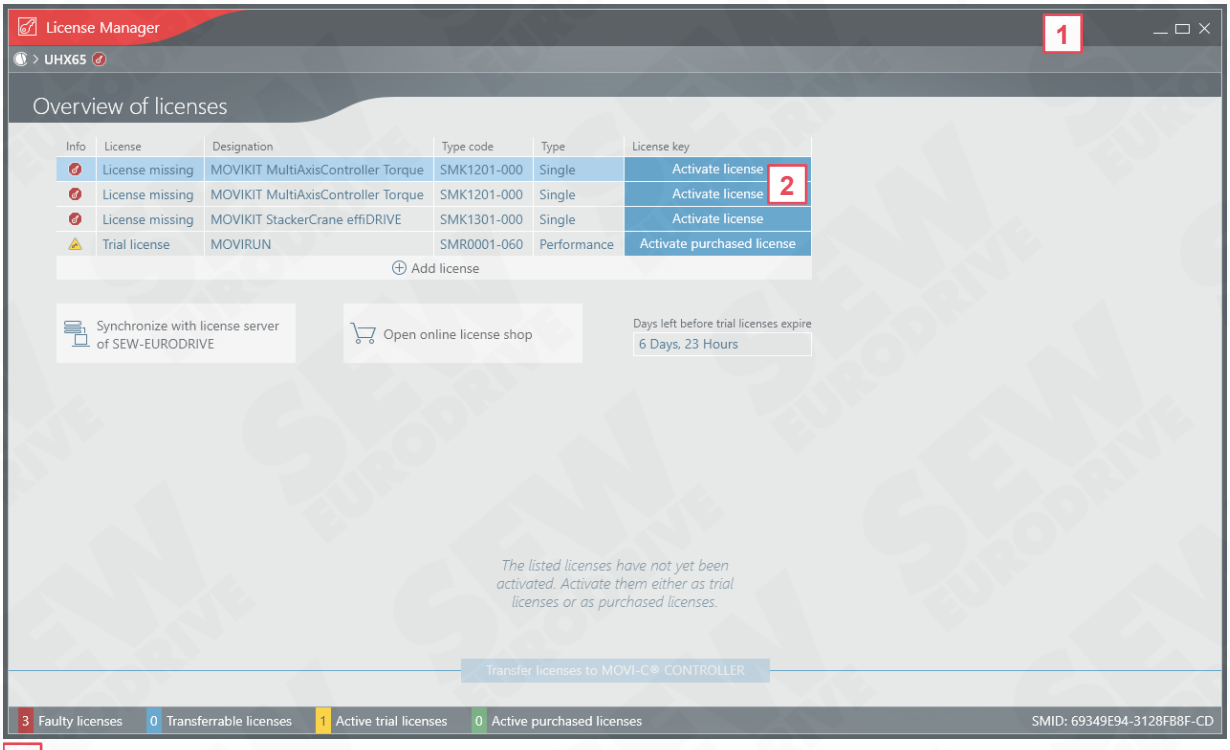
An Internet connection is required to activate the licenses. A trial license can also be generated without an Internet connection.



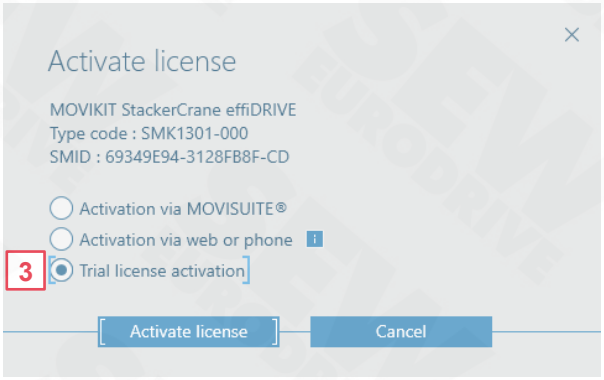


1 Start the **License Manager**

2. Activate license



2 Activate suggested licenses. Press **Activate license**

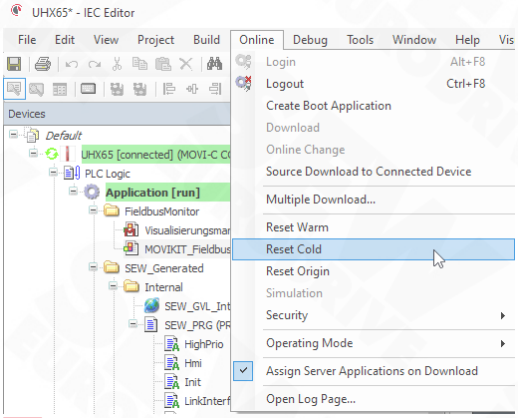


3 Activate trial license

3. Transfer licenses to MOVI-C® CONTROLLER

4 Transfer licenses to the MOVI-C® CONTROLLER

4. Cold reset



4 Perform cold reset.

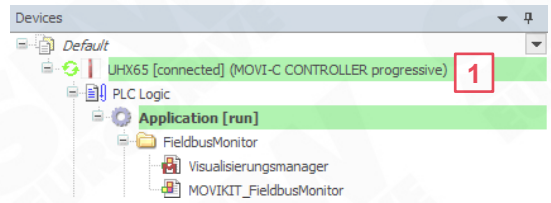
Examples of required licenses

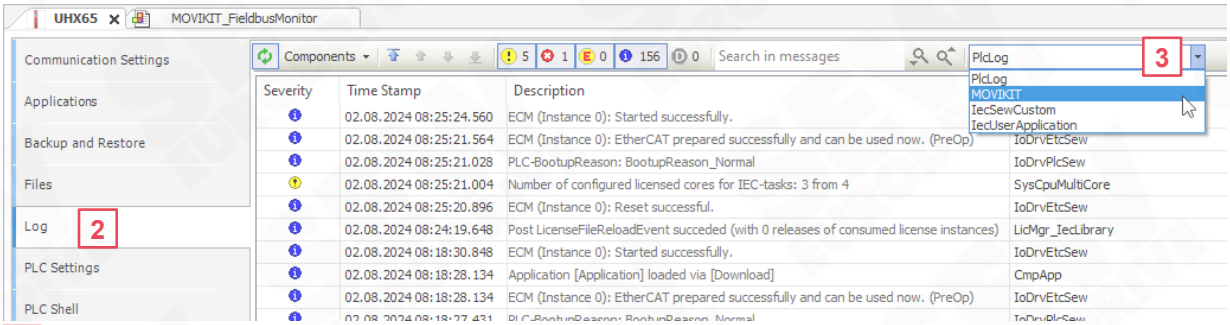
Application	Licenses
1x travel drive & 1x lifting drive	MOVIRUN® Flexible + StackerCrane
2x travel drive & 1x lifting drive	MOVIRUN® Flexible + StackerCrane + 1x MAC Torque (travel) + 1x MAC torque (lifting)
1x travel drive & 2x lifting drive	MOVIRUN® Flexible + StackerCrane + 1x MAC Torque (travel) + 1x MAC skewing (lifting)
2x travel drive & 2x lifting drive	MOVIRUN® Flexible + StackerCrane + 1x MAC Torque (travel) + 1x MAC skewing (lifting)

3.6.5 Diagnose the IEC program

1. Call up the debug log

In the event of an error, FIRST look into the log!



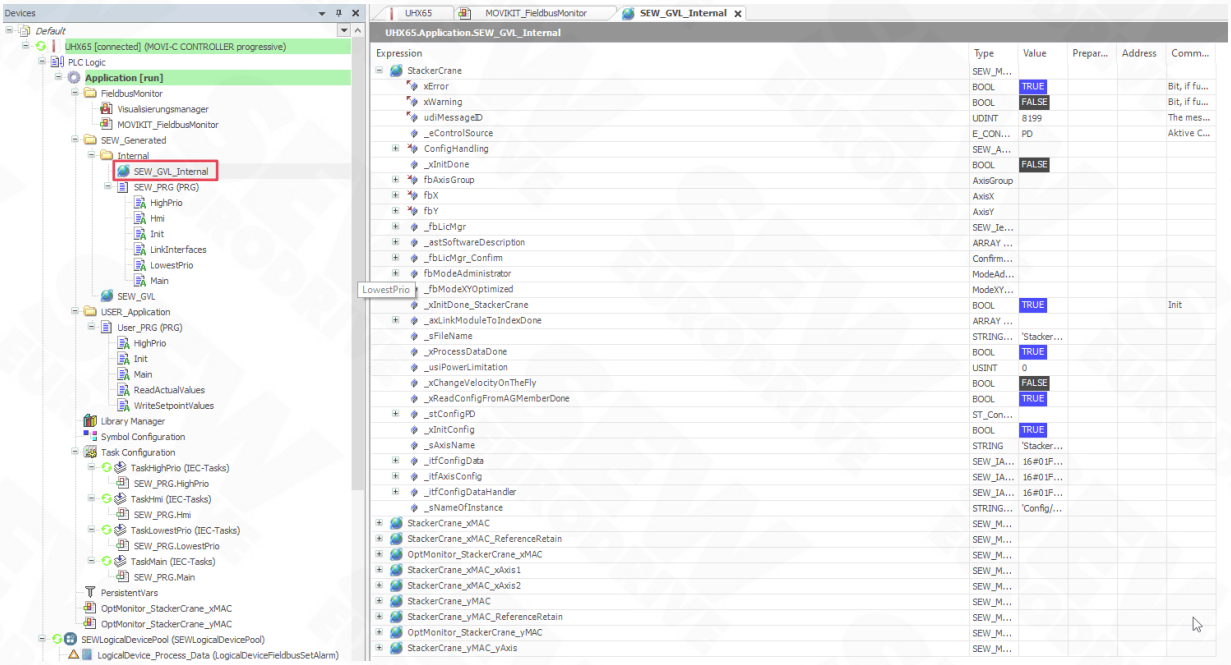


1 Click the MOVI-C® CONTROLLER

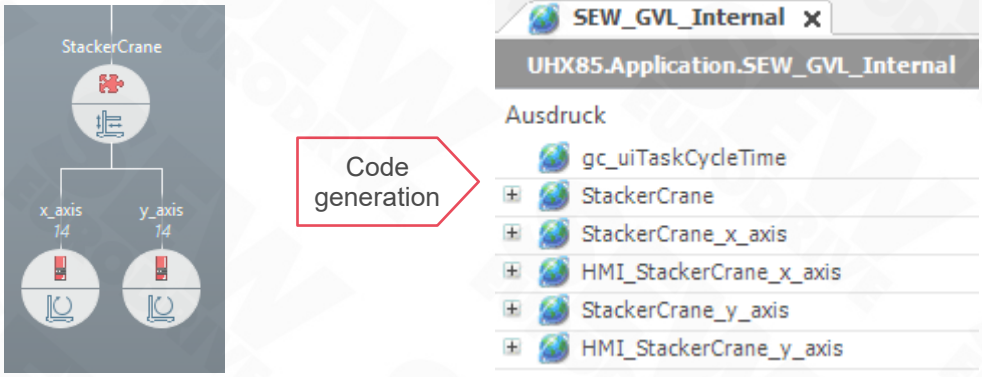
2 Click **Log**

3 Switch the logger to **MOVIKIT** in the drop-down list

2. Call up and monitor debug variables
3. Open IEC Editor →Open SEW_GVL_Internal



Global variables



Overview of debug variables

Debug variables: Fieldbus process data

SEW_GVL_Internal.StackerCrane.fbModeAdministrator._eActualMode
SEW_GVL_Internal.StackerCrane.fbModeAdministrator._eSetpointMode
SEW_GVL_Internal.StackerCrane.fbX._In
SEW_GVL_Internal.StackerCrane.fbX._Out
SEW_GVL_Internal.StackerCrane.fbX._Config
SEW_GVL_Internal.StackerCrane.fbY._In
SEW_GVL_Internal.StackerCrane.fbY._Out
SEW_GVL_Internal.StackerCrane.fbY._Config
SEW_GVL_Internal.StackerCrane.fbAxisGroup._Out

Debug variables: Error level

SEW_GVL_Internal.StackerCrane.xError
SEW_GVL_Internal. StackerCrane_x_Axis.xError
SEW_GVL_Internal. StackerCrane_y_Axis.xError

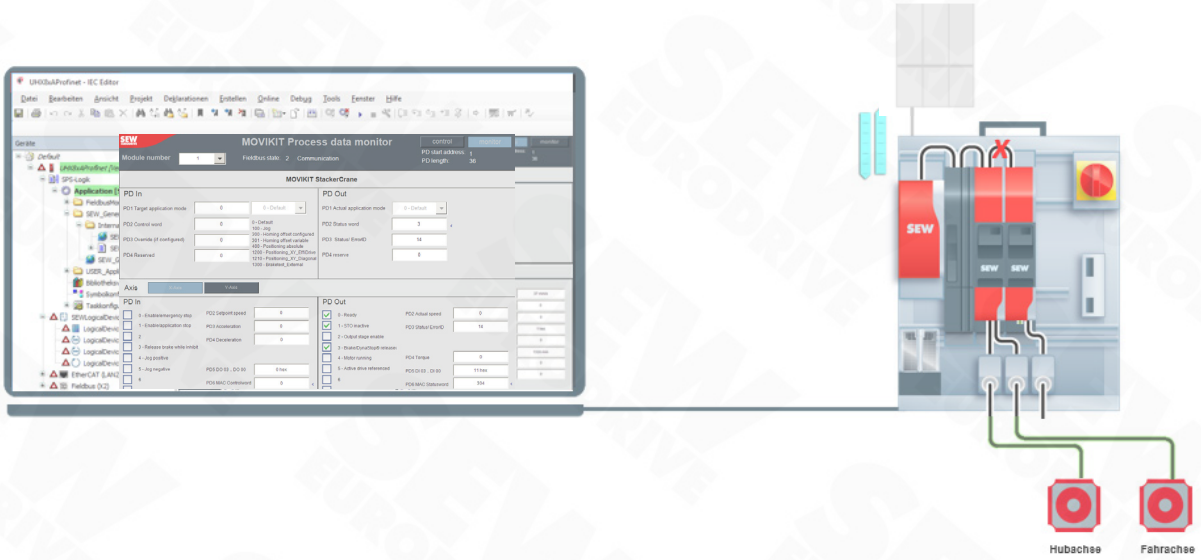
Debug variables: SC-MultiMotion

SEW_GVL_Internal.StackerCrane_x_Axis.DeviceAdapter16PD.stBasicIN
SEW_GVL_Internal.StackerCrane_x_Axis.DeviceAdapter16PD.stBasicOUT
SEW_GVL_Internal.StackerCrane_x_Axis.DeviceAdapter16PD.stInverterIN
SEW_GVL_Internal.StackerCrane_x_Axis.DeviceAdapter16PD.stInverterOUT
SEW_GVL_Internal.StackerCrane_x_Axis.DeviceAdapter16PD.stBrakeIN
SEW_GVL_Internal.StackerCrane_x_Axis.DeviceAdapter16PD.stBrakeOUT
SEW_GVL_Internal.StackerCrane_x_Axis.DeviceAdapter16PD.stActivatedDeviceModes
SEW_GVL_Internal.StackerCrane_x_Axis.DeviceAdapter16PD.stSetpointValuesVelocityInterpolated.lrVelocity
SEW_GVL_Internal.StackerCrane_x_Axis.DeviceAdapter16PD.stSetpointValuesVelocityInterpolated.lrManValPosCtrlr

3.7 Step 5 - MOVIKIT® StackerCrane process data monitor

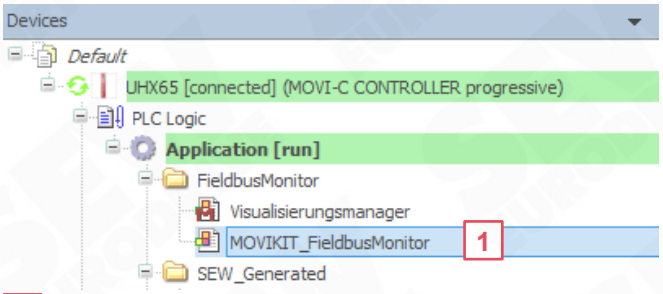
Goals

- Handling the process data monitor



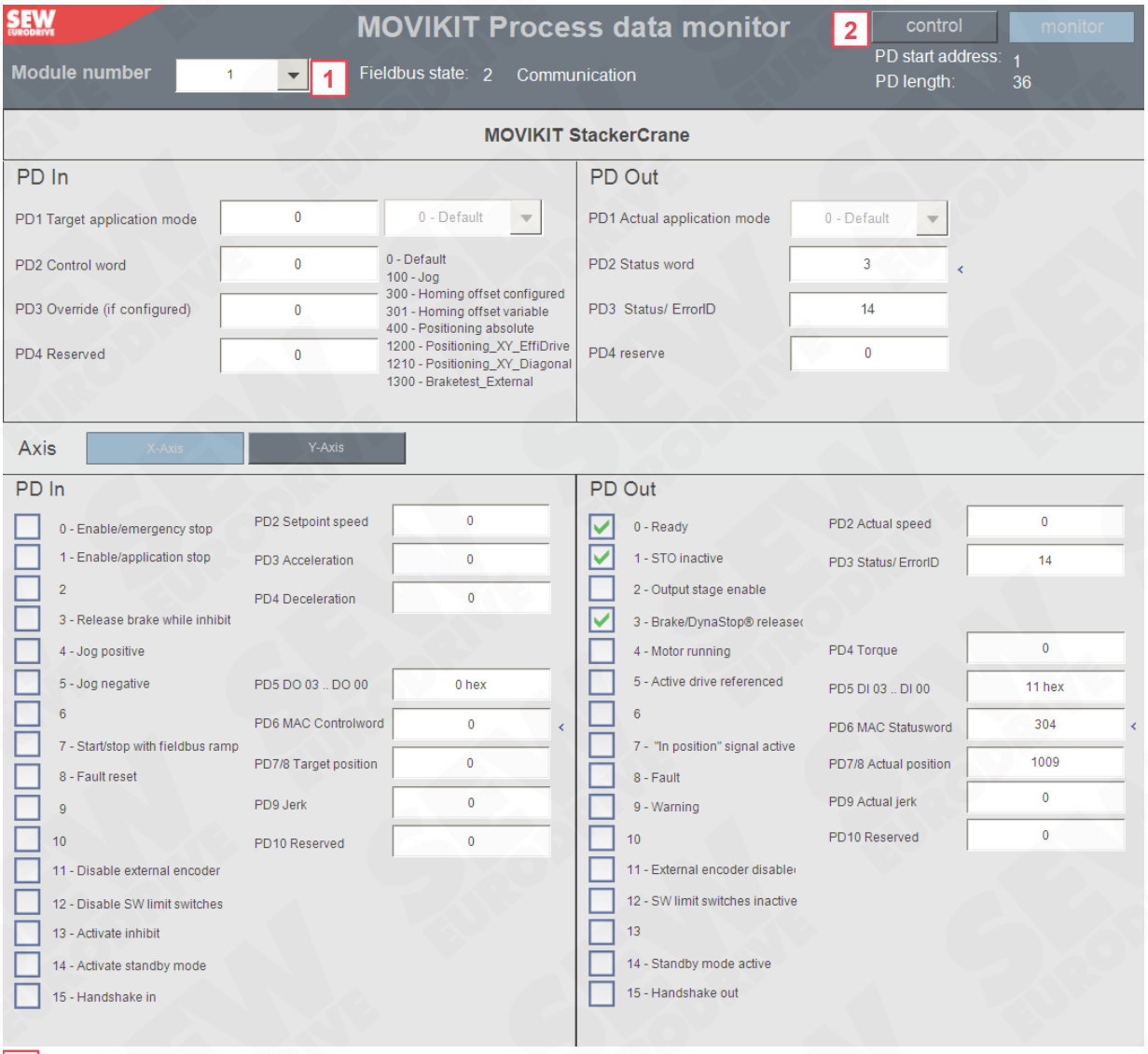
1. 2. 3. 4. 5.

1. Open the process data monitor



1 Click the **MOVIKIT_FieldbusMonitor**

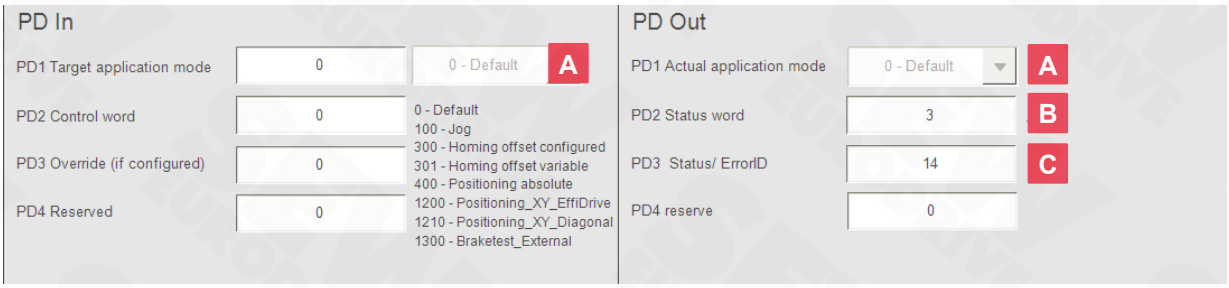
2. Switch the process data monitor mode



1 Selection of the parameterized MOVIKIT®. Select module 1 **MOVIKIT StackerCrane**

2 Switch between **control** and **monitoring**.

Groups – process data monitor



A Mode numbering

0	Default
100	Jog
300	Referencing with configured offset
301	Referencing with bus offset
400	Position
700	Test of all brakes one after the other
701	Test of the 1st axis group member of the MultiAxisController (no function without MultiAxisController)
702	Test of the 2nd axis group member of the MultiAxisController (no function without MultiAxisController)
1200	Energy-optimized X-Y positioning
1210	Mechanically optimized positioning
1300	External brake test

B Status word axis group (X and Y)

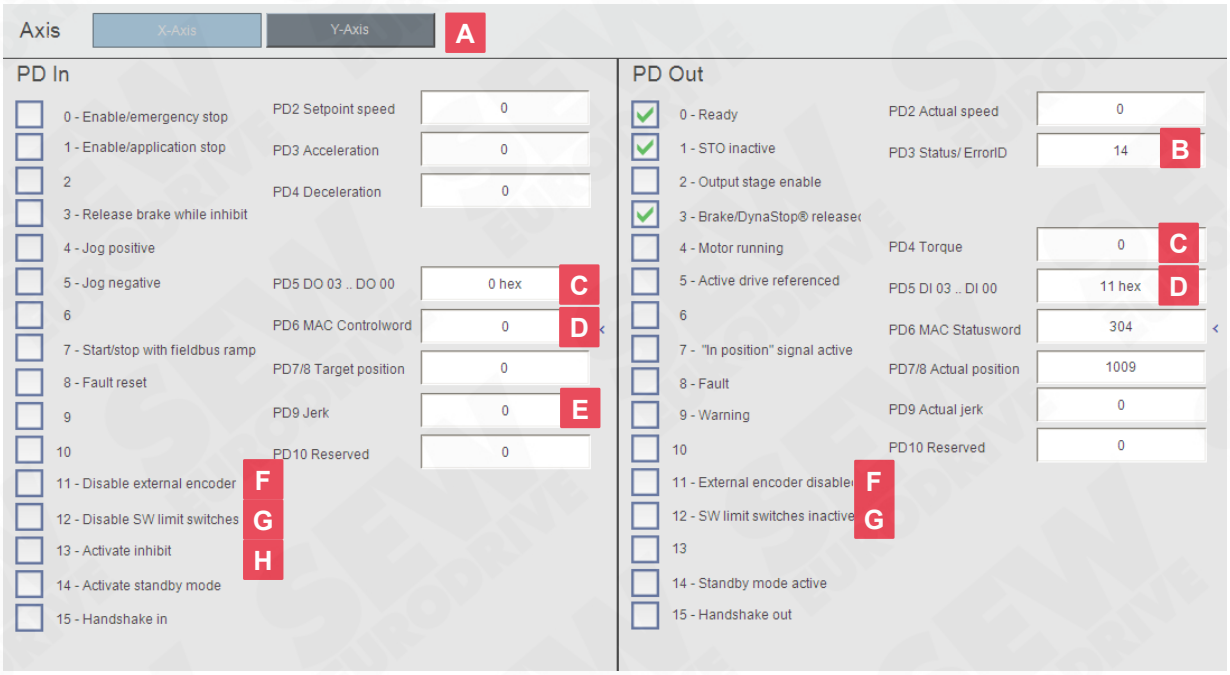
Bit 0	Ready for operation
Bit 7	In position
Bit 8	Error

C Status of the inverters,
The status of the lower-level stations is
- Equal: The status is displayed.
- Not equal: "-1" = FFFF = "undefined" is displayed.

Or in the event of an error ErrorID:

High byte	Error code
Low byte	Subfault code

Axes - Process data monitor axes



A Changeover between X and Y axes

B Status of the inverter
For MAC: The status of the lower-level stations is
- Equal: The status is displayed.
- Not equal: "-1" = FFFF = "undefined" is displayed.

Or in the event of an error ErrorID:

High byte	Error code
Low byte	Subfault code

C Digital inputs and outputs

Bits 0 – 3	Axis 1
Bits 4 – 7	Axis 2
Bits 8 – 11	Axis 3
Bits 12 – 15	Axis 4

D Control word for the MultiAxisController

Bits 0 – 3	Deactivate axis group members
Bits 5 – 7	Release brake without enable

E Jerk in user unit/s3

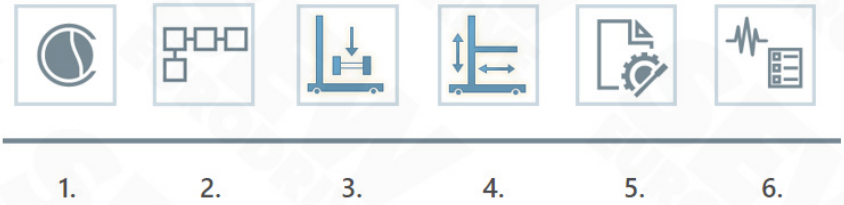
F Disable external encoder

G Disable software limit switch

H Activate controller inhibit

4 Tutorial 2 – SRS with MOVIKIT® StackerCrane MultiMotion and StackerCrane MultiAxisController

Workbook steps – Tutorial 2

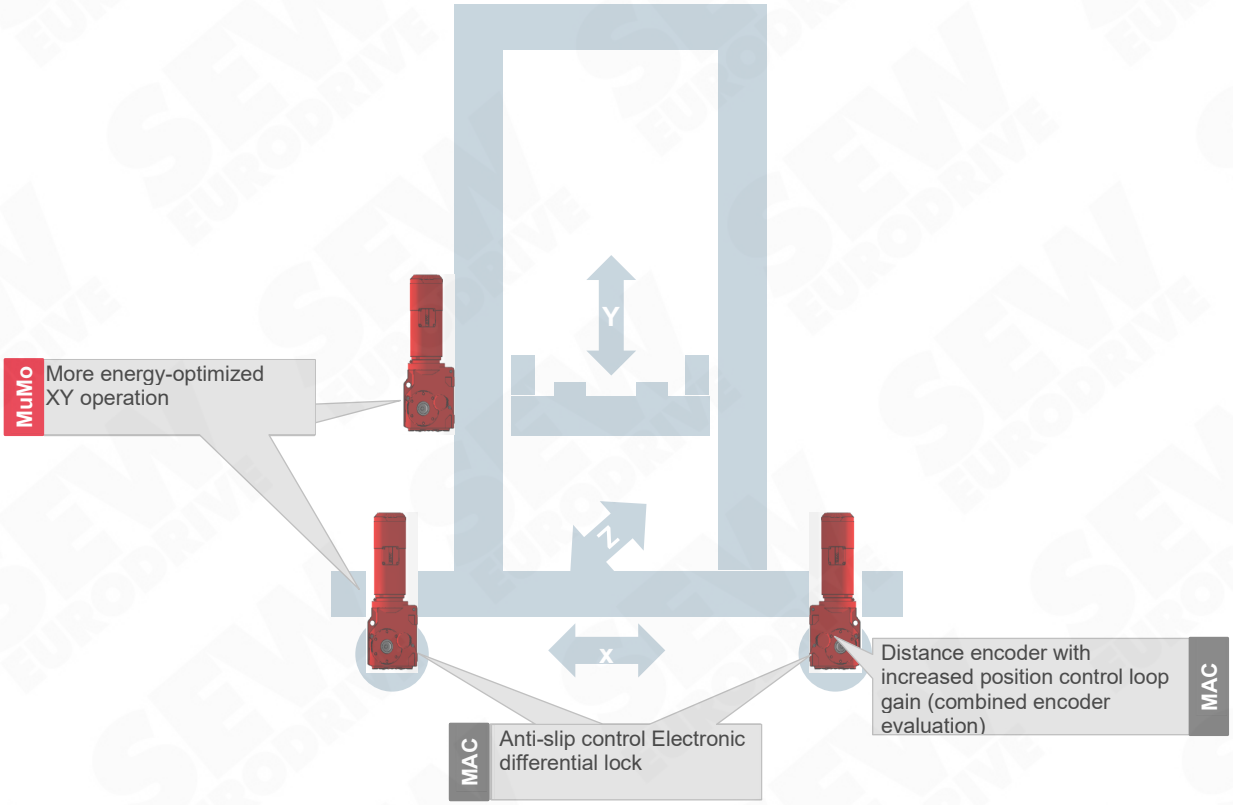


1. MOVISUITE® project structure
2. Startup of the travel and hoist
3. Parameterization of MOVIKIT® StackerCrane MultiAxisController (MAC)
4. Parameterization of MOVIKIT® StackerCrane
5. Generation of the software project
6. MOVIKIT® StackerCrane process data monitor

4.1 Scope of functions Tutorial 2

In this tutorial, an SRS with 2 axes in the chassis with motor encoder and an axis in the hoist with motor and external encoder is started up.

- X-axis 2 drives with motor encoder => MultiMotion + MAC
- Y-axis with motor encoder and external encoder => MultiMotion + MAC (combined encoder evaluation)

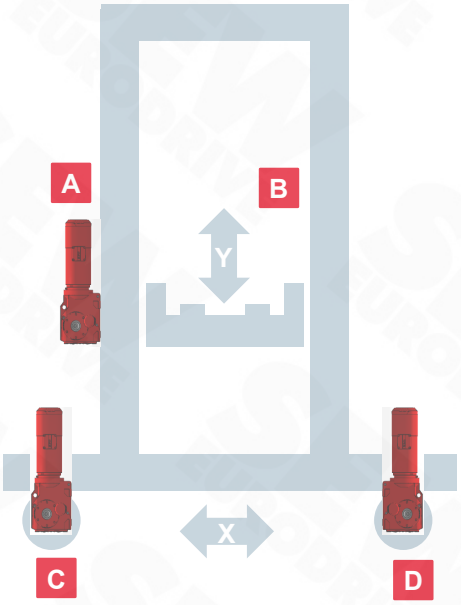


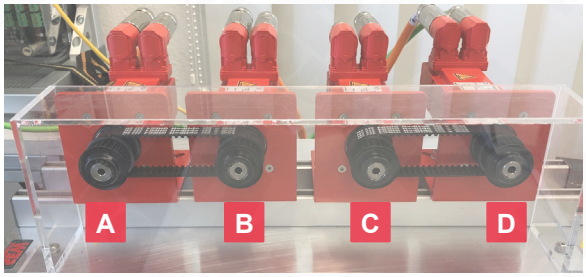
Scope of functions of MOVIKIT® StackerCrane effiDRIVE® in combination with MOVIKIT®…

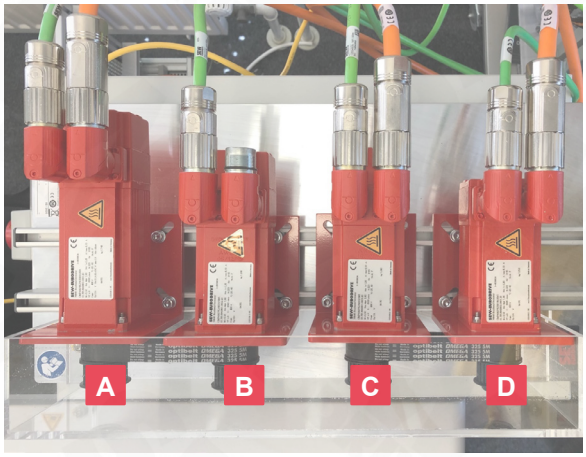
MuMo MultiMotion

MAC MultiAxisController

4.2 Training model / training system storage/retrieval system





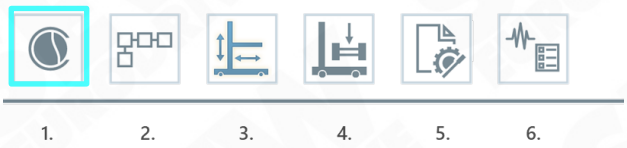


A	Vertical drive	CMP40S/BK/PK/EK0H/SB1
B	Motor B serves only as an external encoder	CMP40S/PK/AK0H/SM1
C	Horizontal drive 1	CMP40S/PK/AK0H/SM1
D	Horizontal drive 2	CMP40S/PK/RH1M/SM1

4.3 Step 1 – Project setup in MOVISUITE®

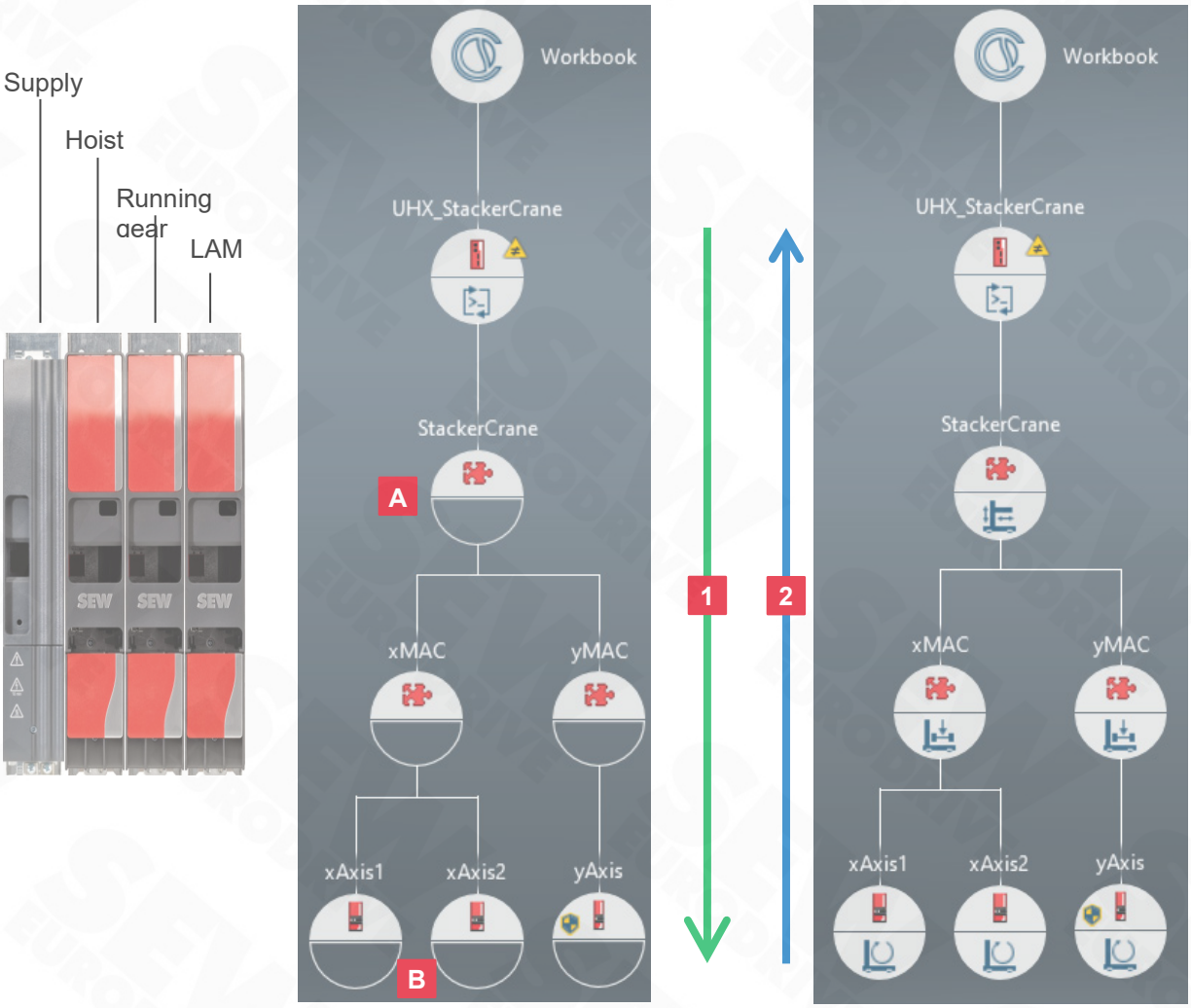
Goals

- Procedure for setting up the project offline and online
- Can set up a project



4.3.1 Useful information about the project structure

General information



1 Set up structure: **From the top to the bottom**

2 Configure and start up: **From the bottom to the top**

A Software nodes: A MOVIKIT® software module can be added to each software node for an axis group or higher-level functionality, such as:

- StackerCrane
- MultiAxisController (can also be used with only one subordinate axis)
- Robot
- …

B **Horizontal drive** must be positioned **TO THE LEFT** under the StackerCrane, regardless of the hardware structure of the axis block

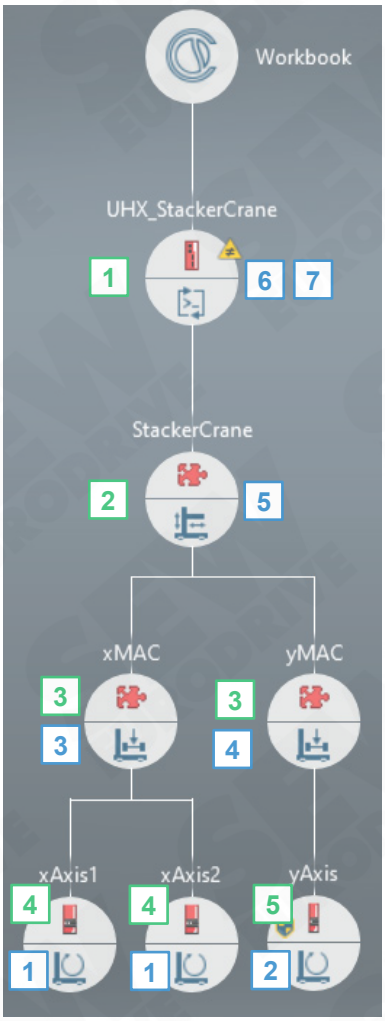
Note: The vertical drive usually needs more current than the horizontal drive. The vertical drive's axis module is therefore positioned on the left next to the horizontal drive in the hardware structure.

Observe and/or produce positioning in the MOVISUITE view during online startup

Project setup offline – MOVISUITE® planning phase

1. Build structure

1. Add MOVI-C® CONTROLLER
2. Add software node
3. Add 2 x SoftwareNode (later for MAC software module)
4. Add x-axis
5. Add y-axis

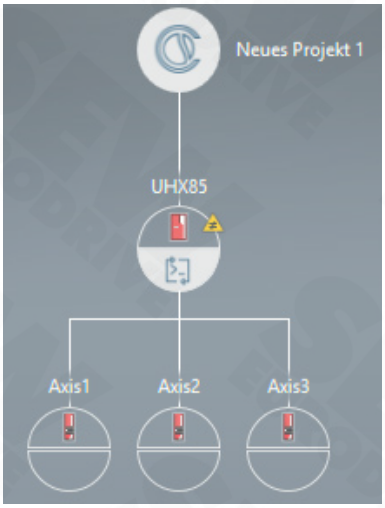


2. Configure modules

1. Parameterize the x-axes drive trains with the startup wizard
2. Parameterize the y-axis drive train with the startup wizard
3. Add and parameterize StackerCrane MultiAxisController
4. Add and parameterize StackerCrane MultiAxisController
5. Add and parameterize StackerCrane in the software code
6. Configure MOVI-C® CONTROLLER
7. Create IEC project

Online project setup – MOVISUITE® startup phase

1. New project from scan

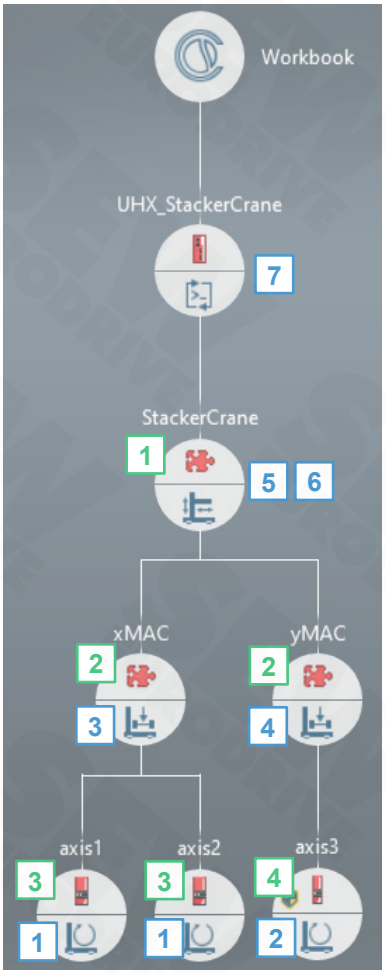


2. Build structure

1. Add SoftwareNode
2. Add 2 x SoftwareNode
3. Drag horizontal drive (x-axis 1 & x-axis 2) under SoftwareNode for horizontal drive MAC
4. Drag vertical drive (y-axis) under SoftwareNode for vertical drive MAC

3. Configure modules

1. Parameterize the x-axes drive trains with the startup wizard
2. Parameterize the y-axis drive train with the startup wizard
3. Add and parameterize StackerCrane MultiAxisController in SoftwareNode x-axis
4. Add and parameterize StackerCrane MultiAxisController into the y-axis SoftwareNode
5. Add and parameterize StackerCrane in the software code
6. Configure MOVI-C® CONTROLLER
7. Create IEC project

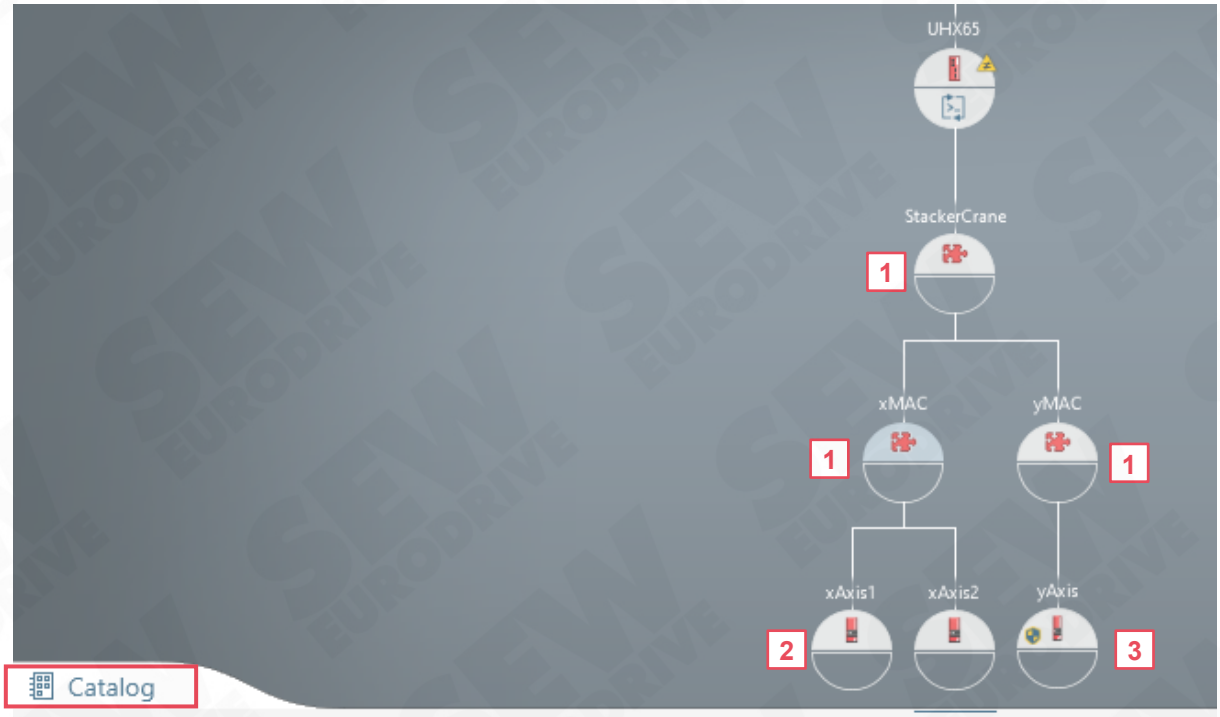


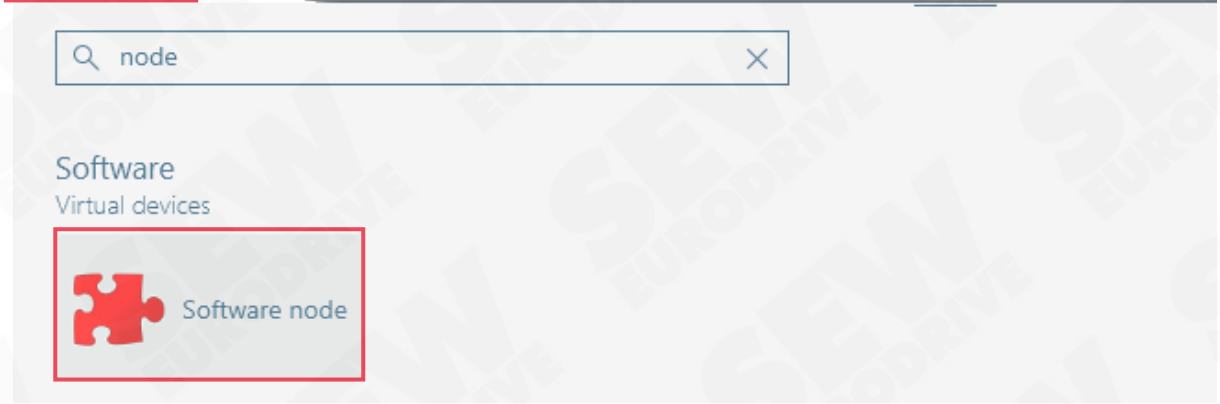
4.3.2 Create project structure

1. Scan axes

1 Click **Scan**

2. Setting up the structure





1 Insert the **MOVI-C® SoftwareNode** from the **catalog**

2 Move the x-axes below the SoftwareNode for the chassis

3 Move the y-axis below the software node for the hoist

4.4 Step 2 – Startup of the travel and hoist

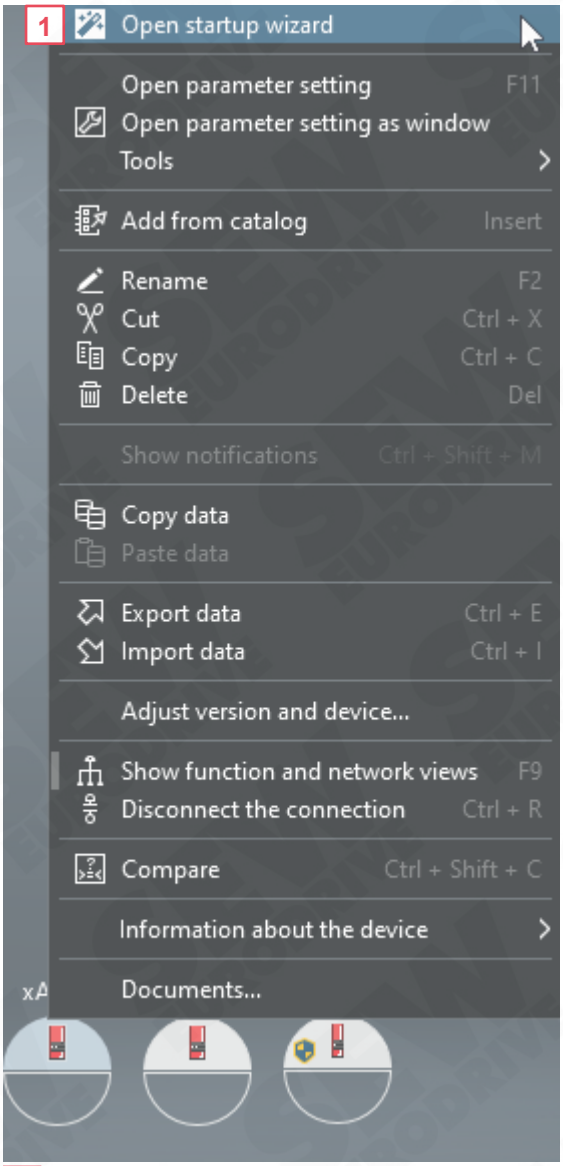
Goals

- Drive train can start up and parameterize x-axes and y-axis.
- Can assign and parameterize MOVIKIT® StackerCrane MultiMotion for the x-axes and the y-axis.

4.4.1 Start up the drive trains

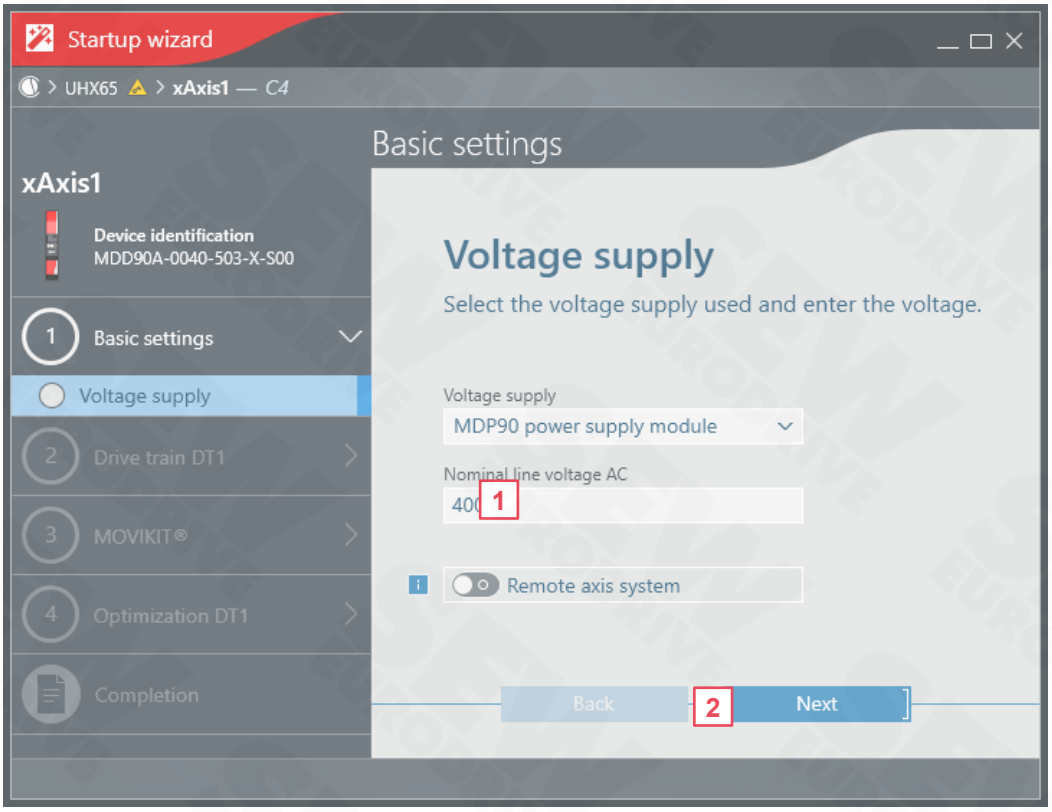
4.4.1.1 Travel unit (x-axis)

1. Open startup assistant



1 Right-click to open the startup assistant.

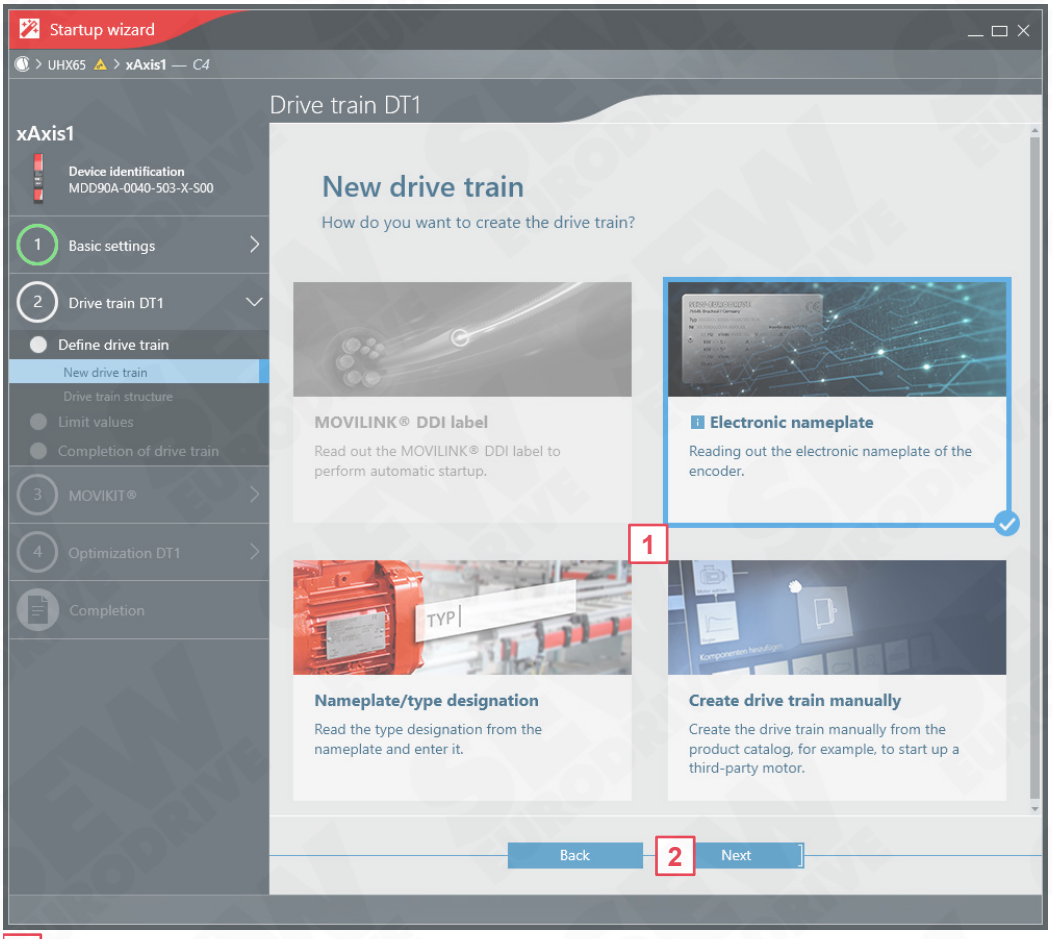
2. Voltage supply



1 Select the power supply module and the line voltage.

2 Press **Next**.

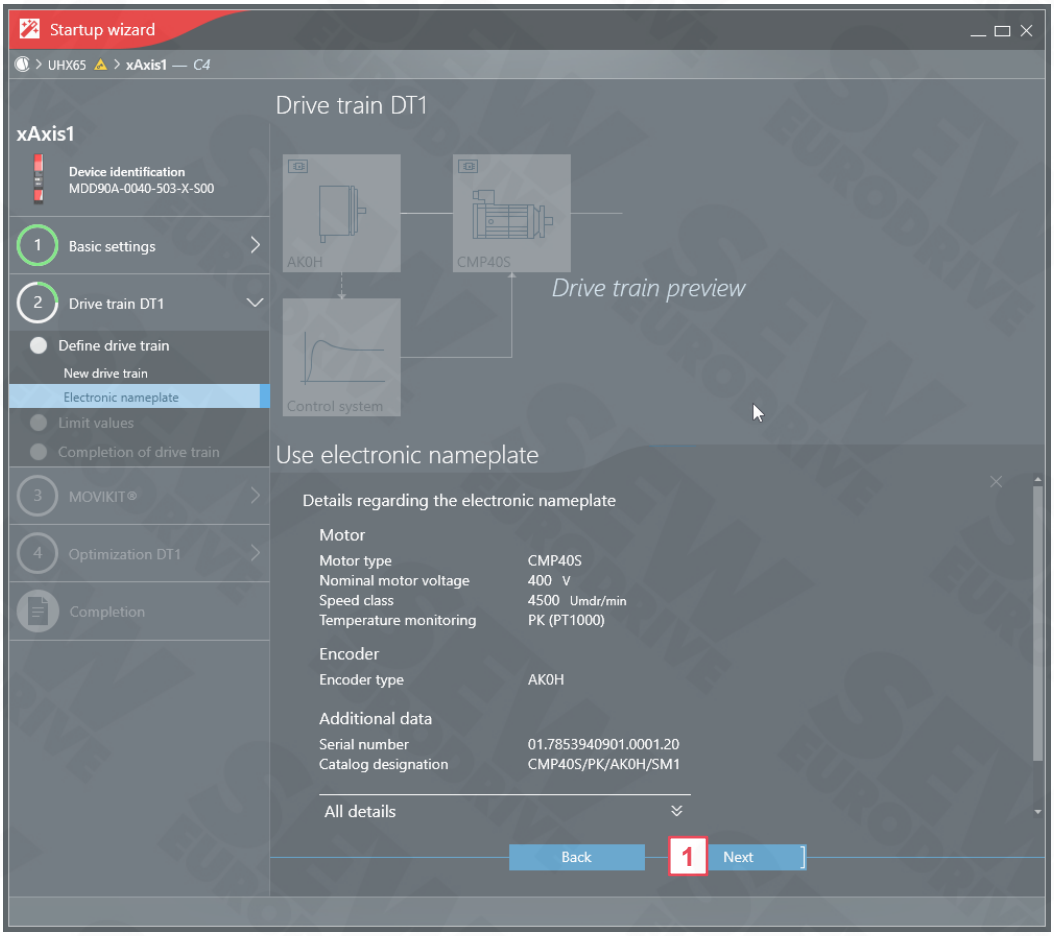
3. Edit the drive train



1 Select how you want to start up the drive train.

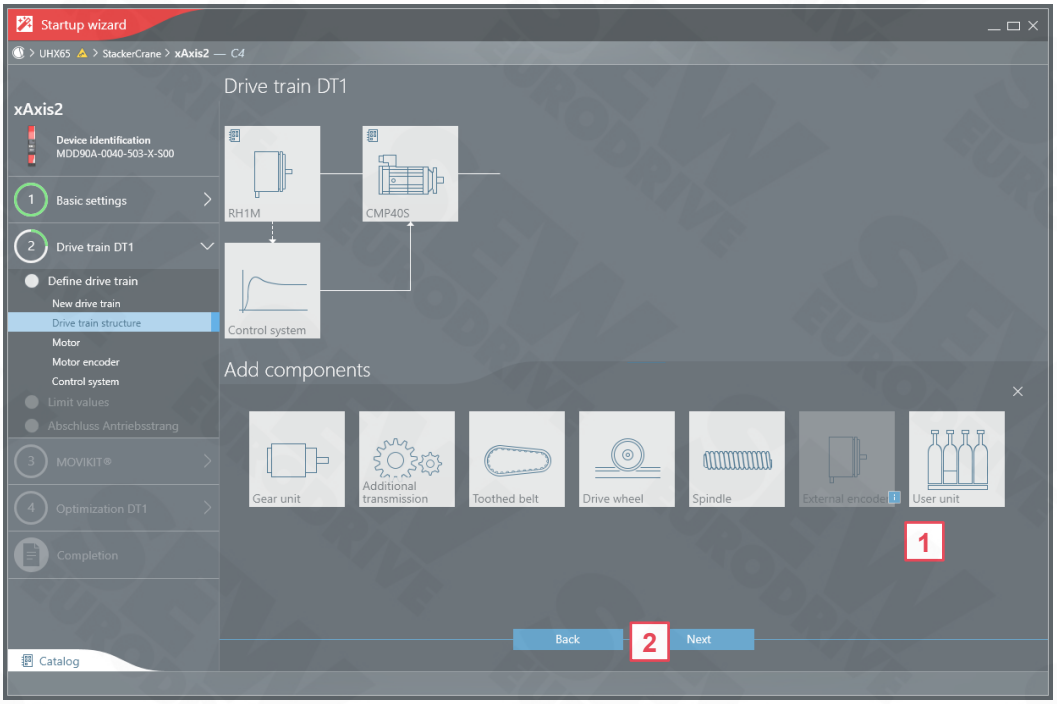
2 Press **Next.**

4. Electronic nameplate



1 Press **Next**.

5. User units



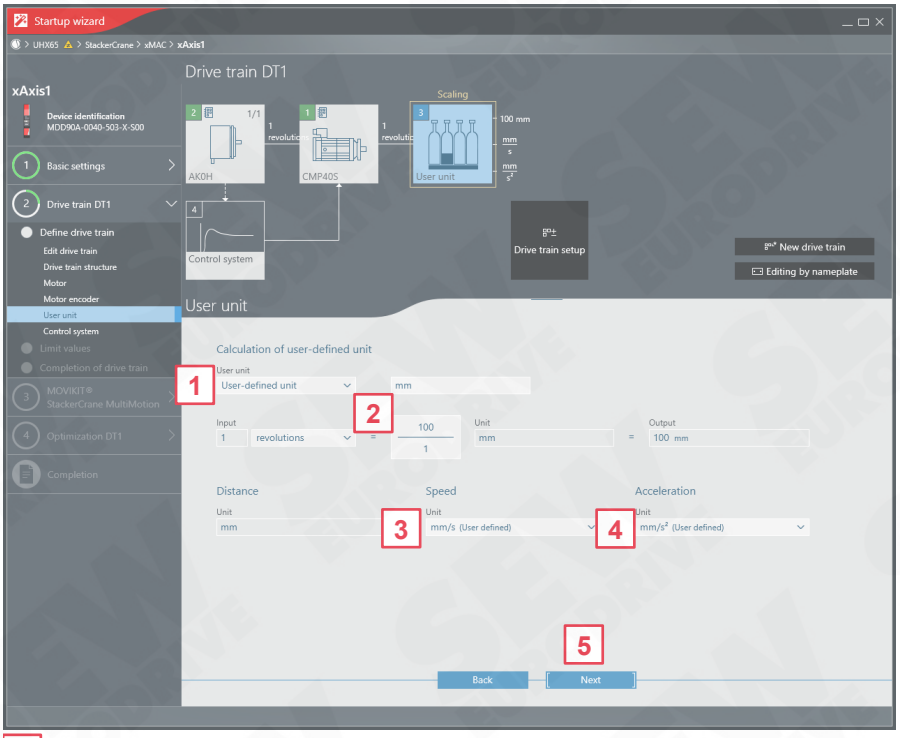
1 Add the user units.

2 Press **Next**

6. Select position-given encoder

1 **Press** Next.

7. User units



1 Define user unit. We recommend mm.

2 Set input revolutions to 100 mm.

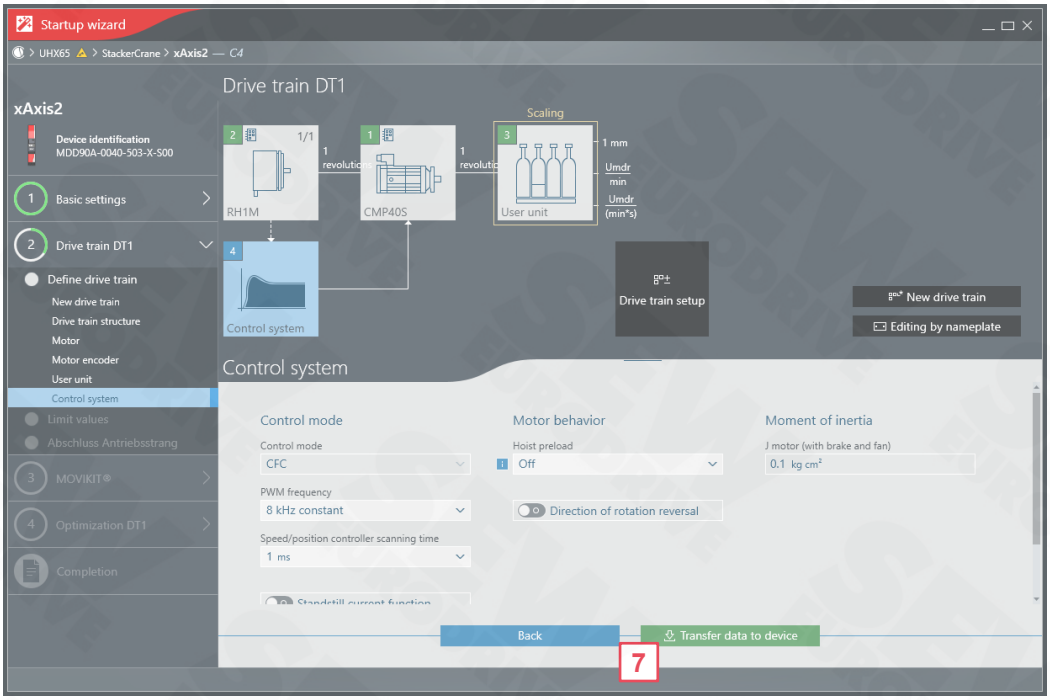
3 Select user-defined speed unit. **User unit/s** must be used.

4 Select user-defined acceleration unit. **User unit/s²** must be used.

5 Press **Next.**

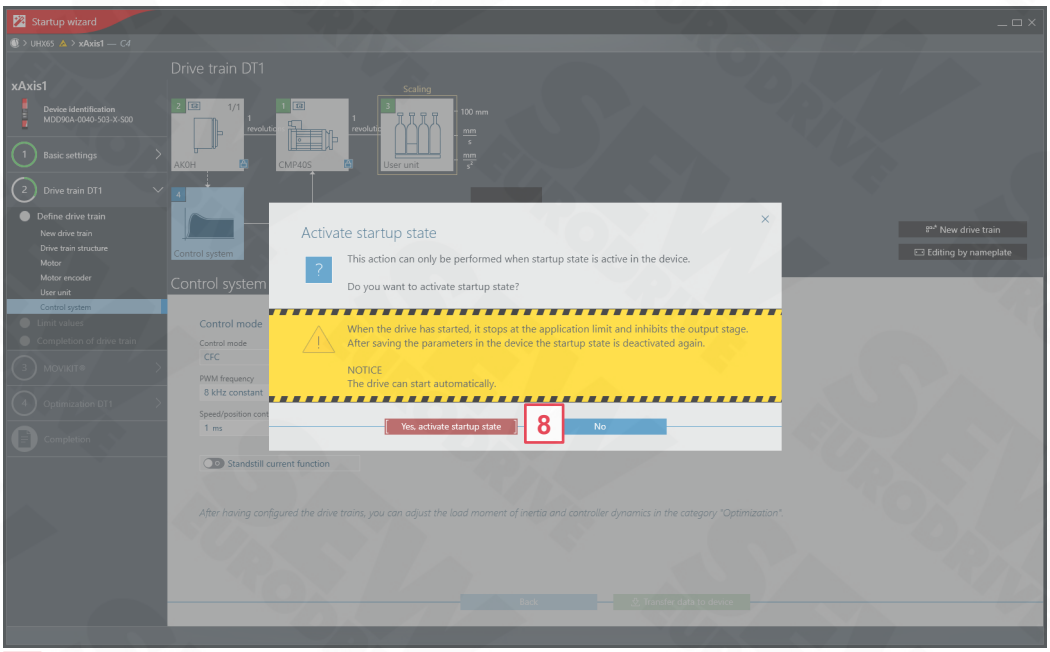
The jerk is transferred in the StackerCrane in user unit/s3.

8. Transfer data to device



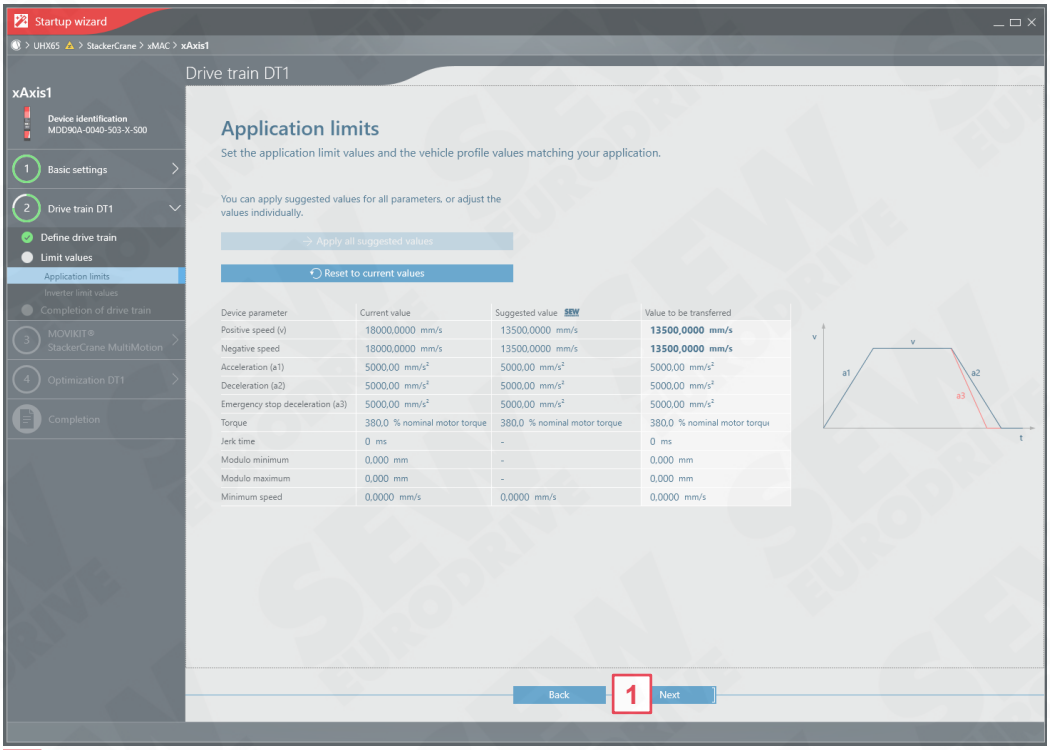
7 Press Transfer data to device.

9. Activate startup state



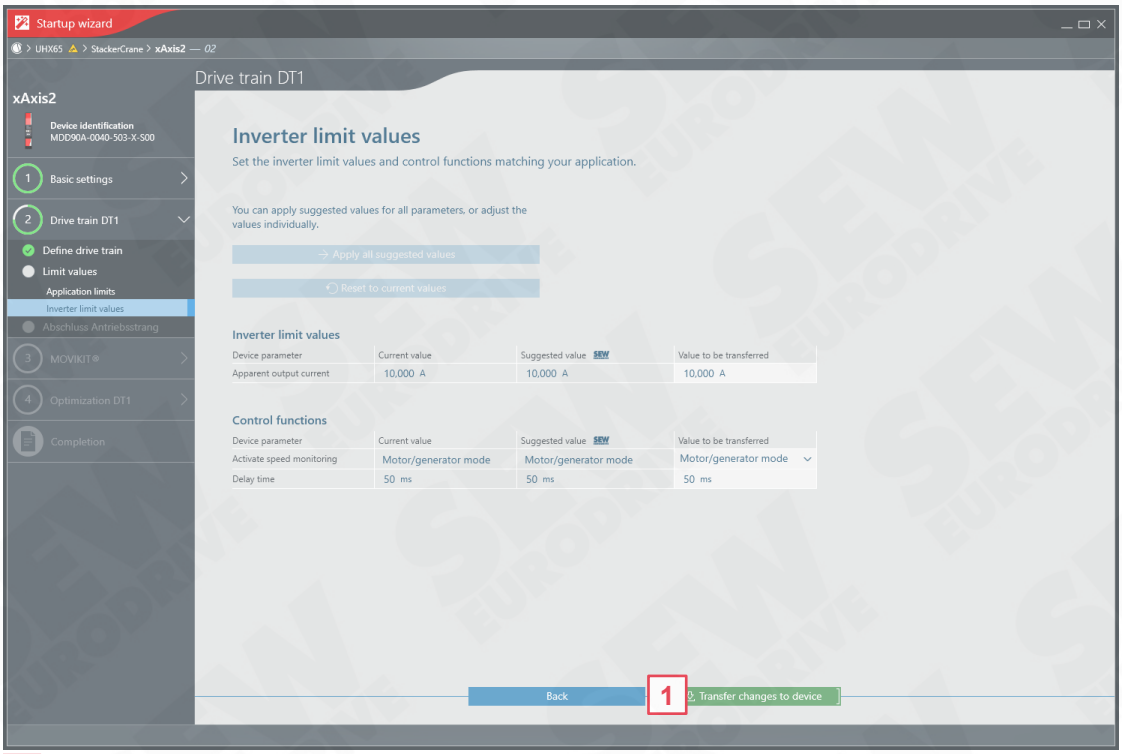
8 Press Yes, activate startup state.

10. Application limits



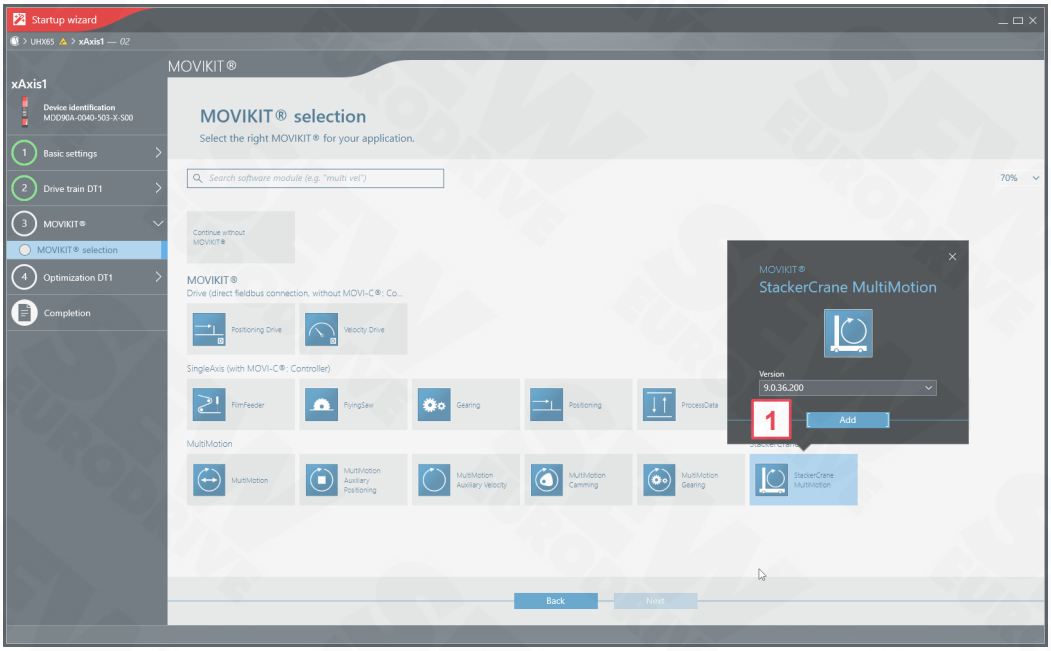
1 Press **Next.**

11. Inverter limits



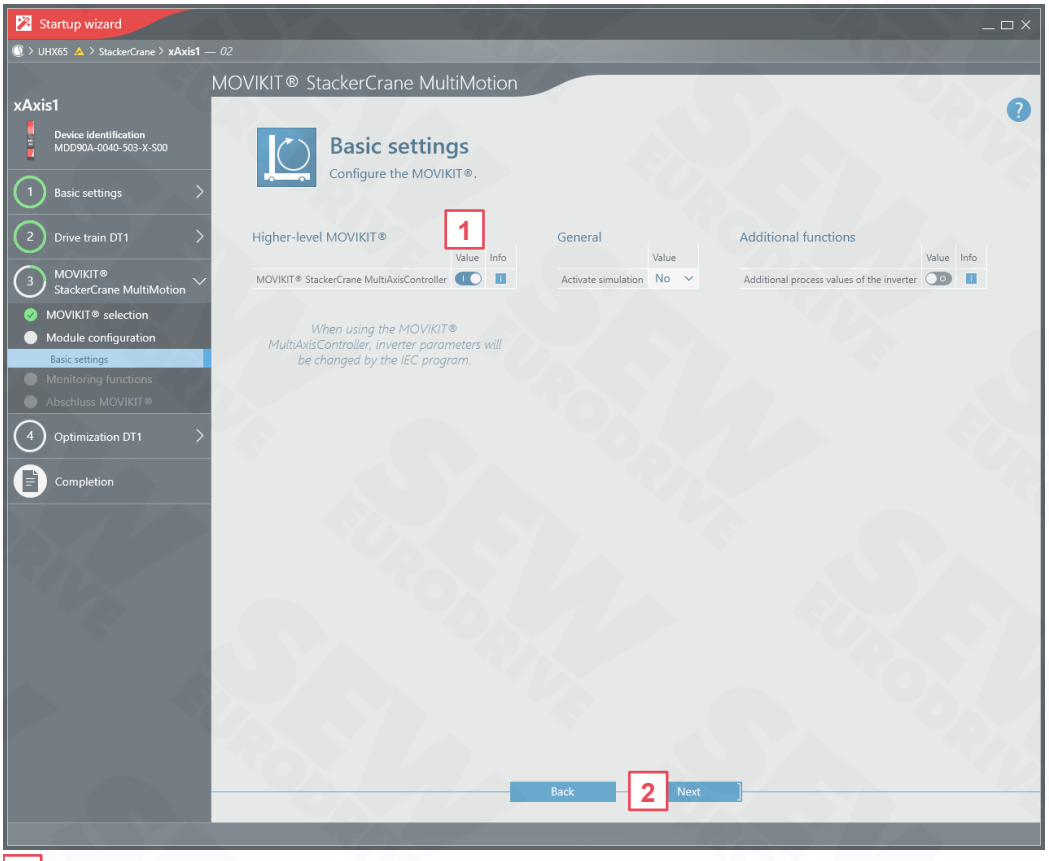
1 **Press** Next.

12. Add MOVIKIT®



1 Add MOVIKIT® StackerCrane MultiMotion.

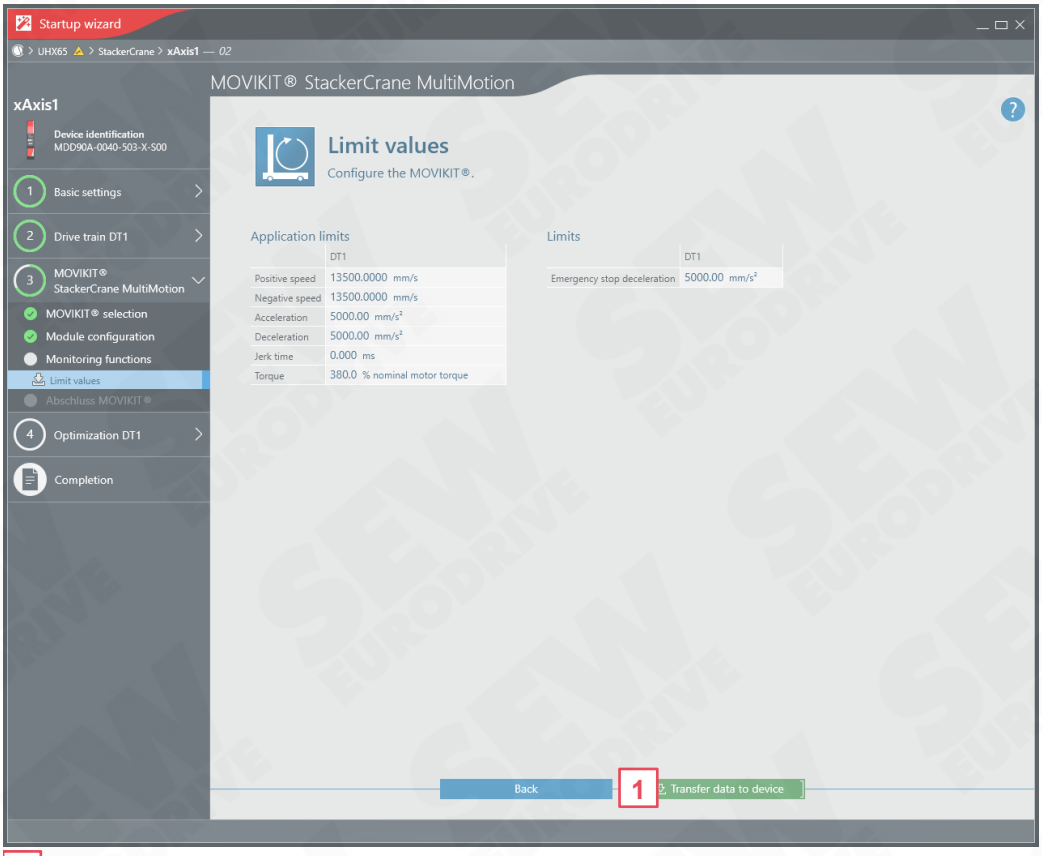
13. Basic settings



1 Activate the use of the higher-level MOVIKIT® StackerCrane MultiAxisController

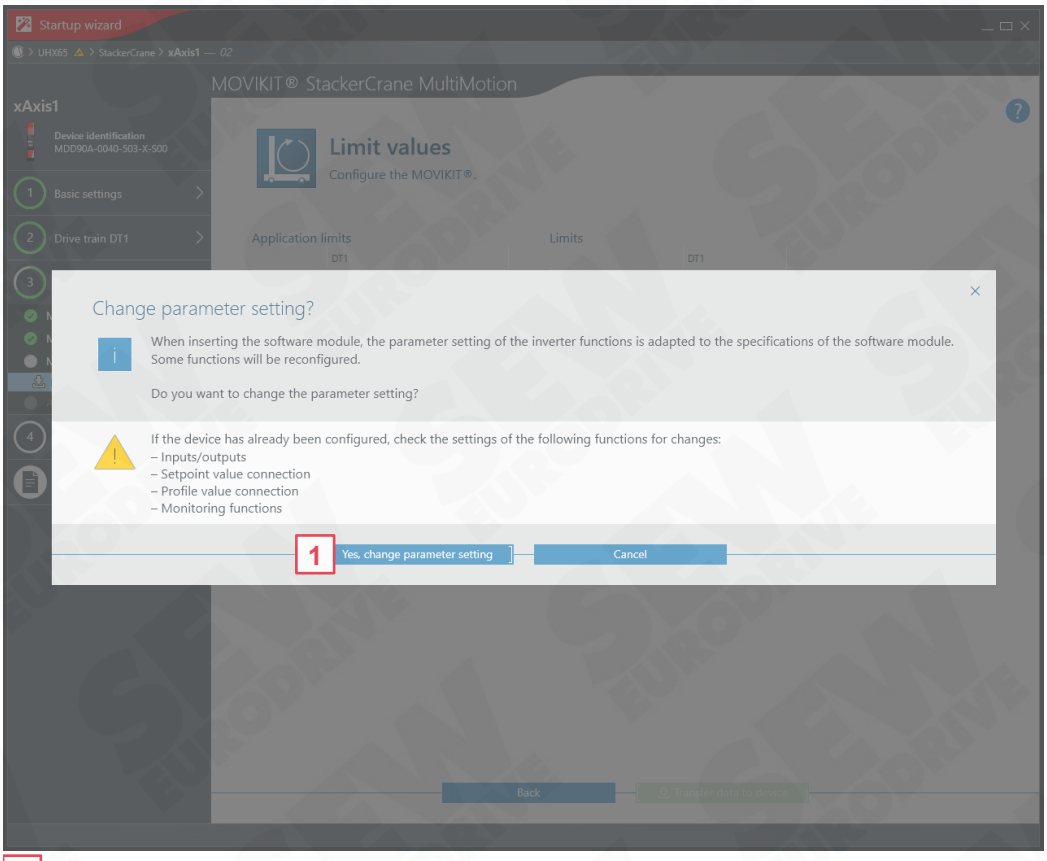
2 Press **Next**.

14. Limit values



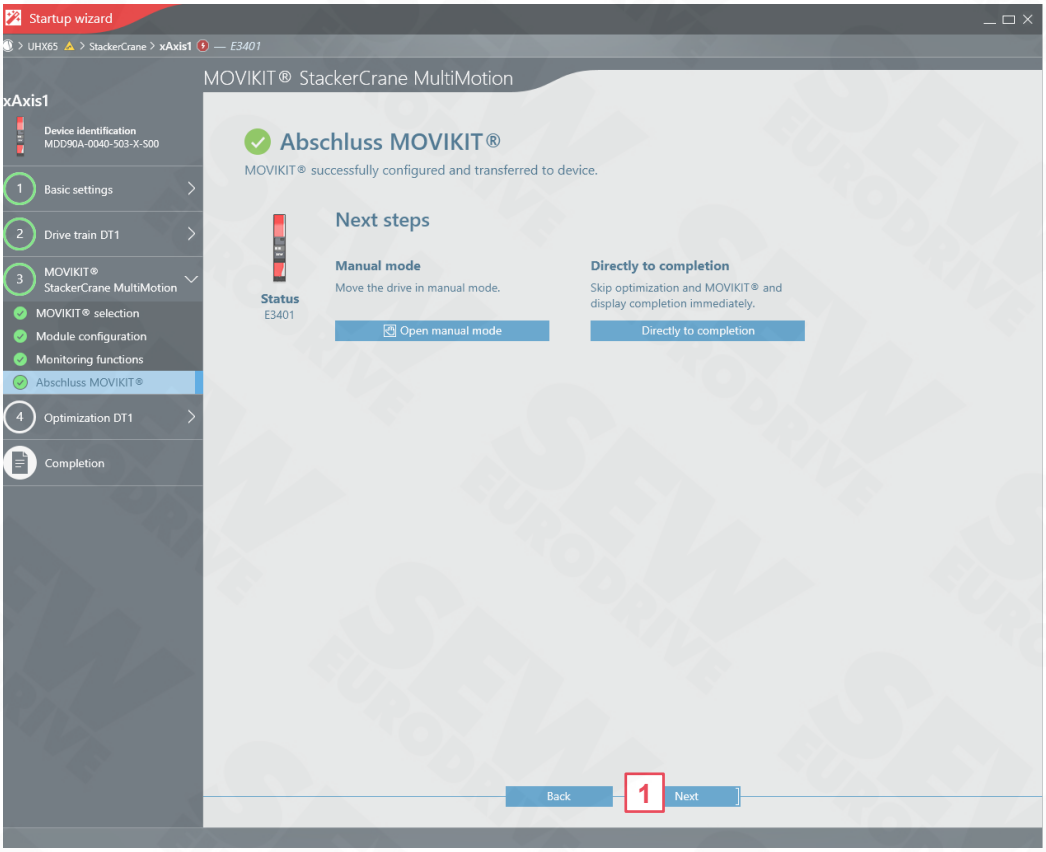
1 Press **Transfer data to device**.

15. Change the parameterization



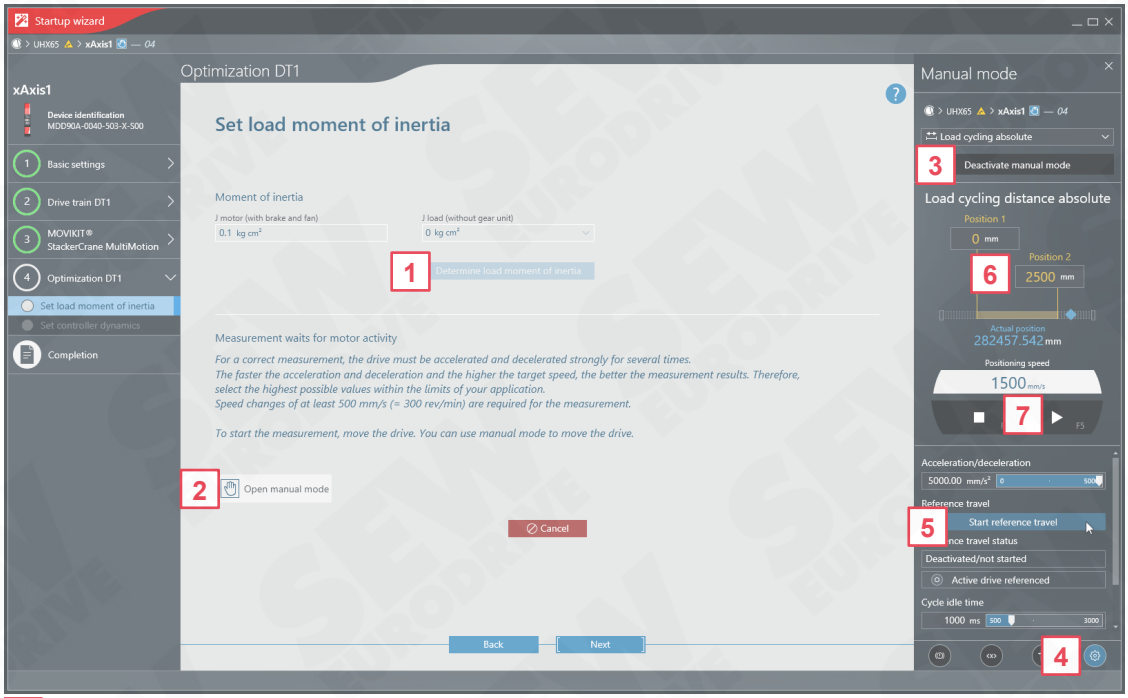
1 Press Change parameter data.

16. MOVIKIT® completion



1 Press **Next**.

17. Optimization – set load moment of inertia



1 Activate the load moment of inertia determination

2 Activate manual mode

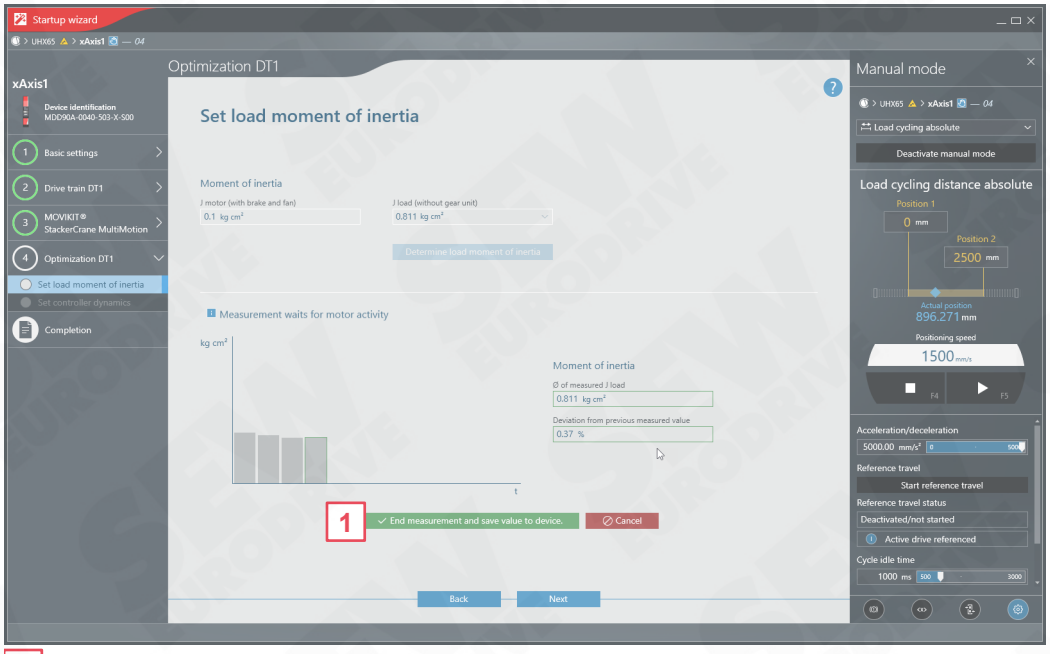
3 Switch on manual mode

4 Open the Reference travel tab using the "Gear wheel" button

5 Start reference travel

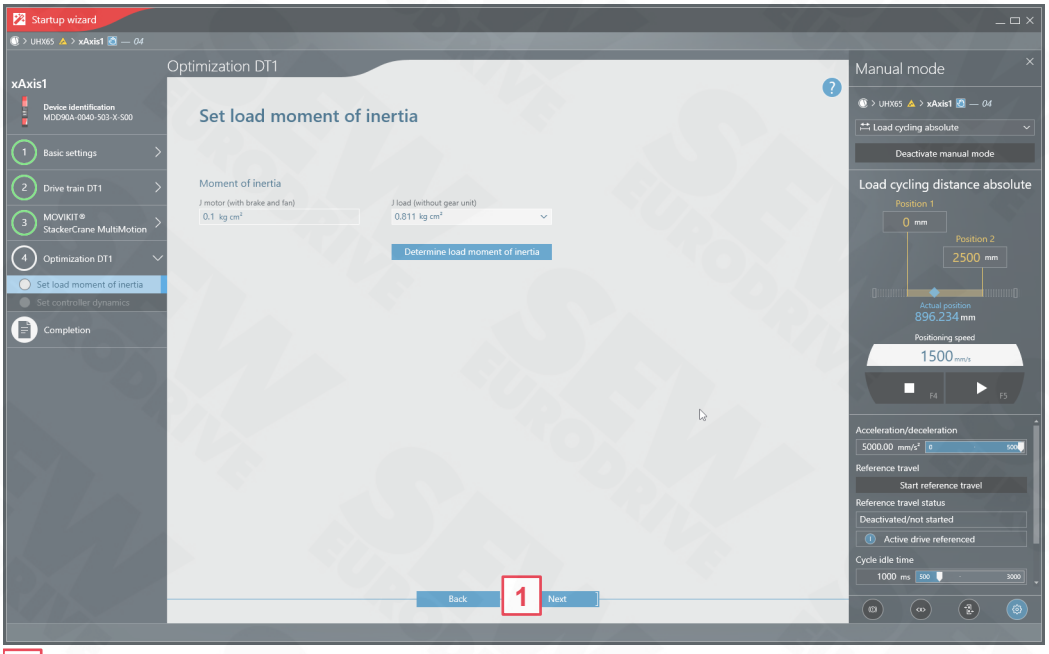
6 Defining positions 1 and 2 for the oscillation distance in absolute order

7 Start oscillation section ▶, F5

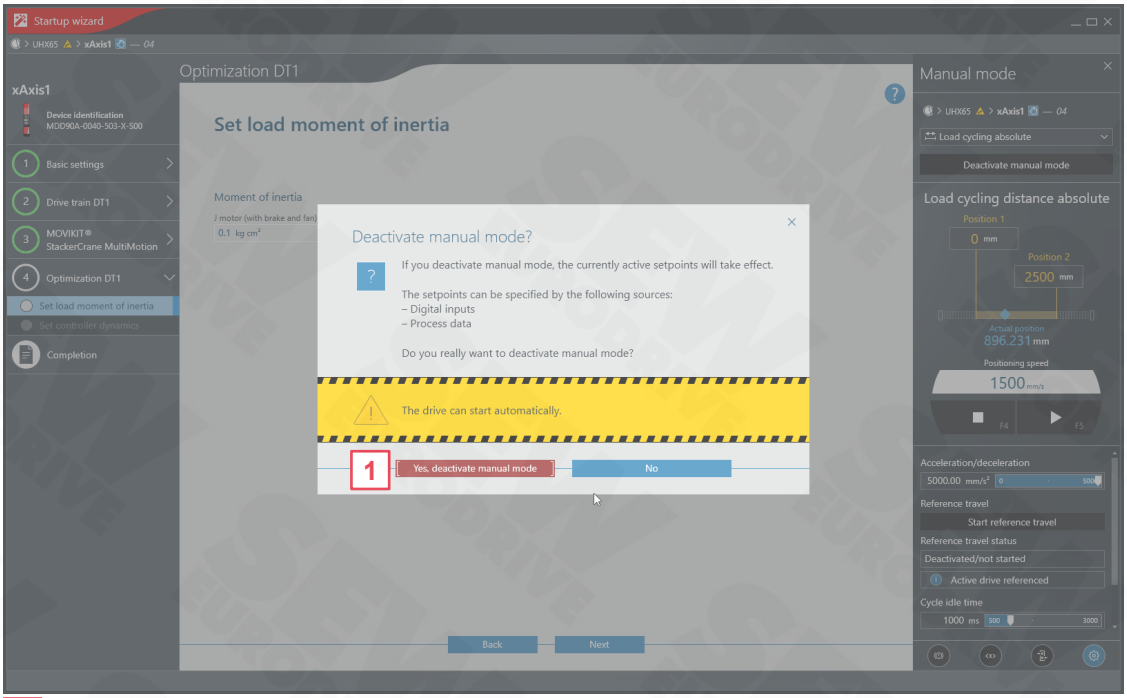


8 End measurement and save value in device

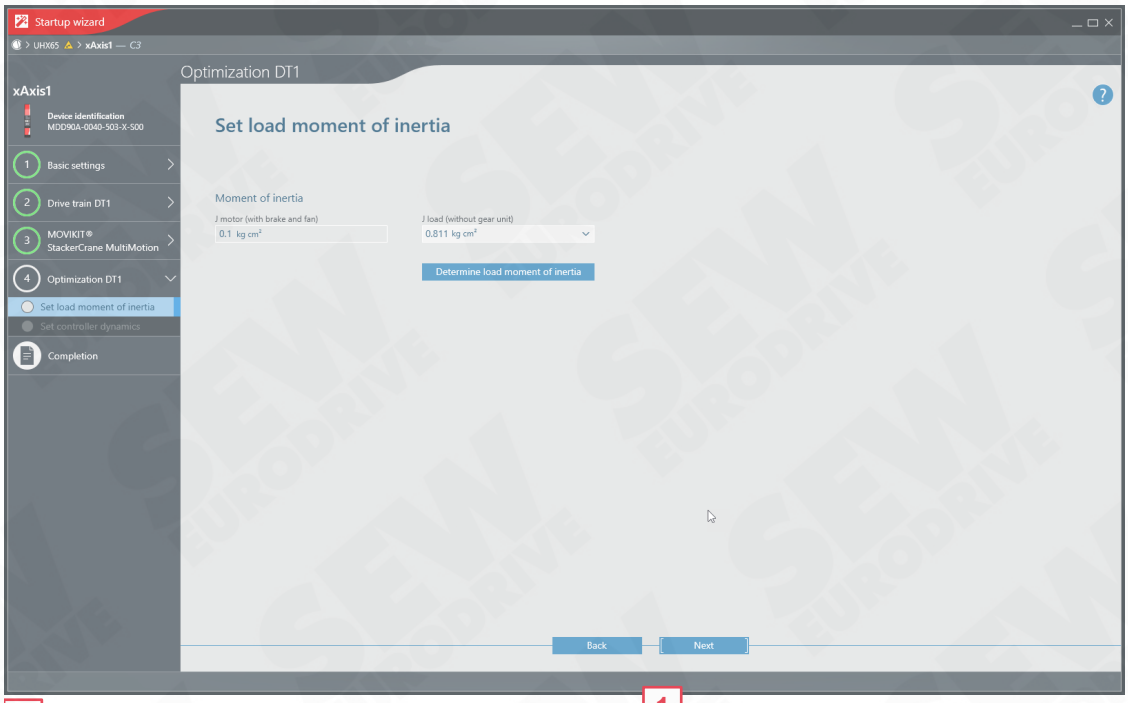
General information:
If no load moment of inertia can be determined, increase the acceleration and deceleration and start the process again. If no load moment of inertia can still be determined, increase the positioning speed additionally.



1 Press **Next**.

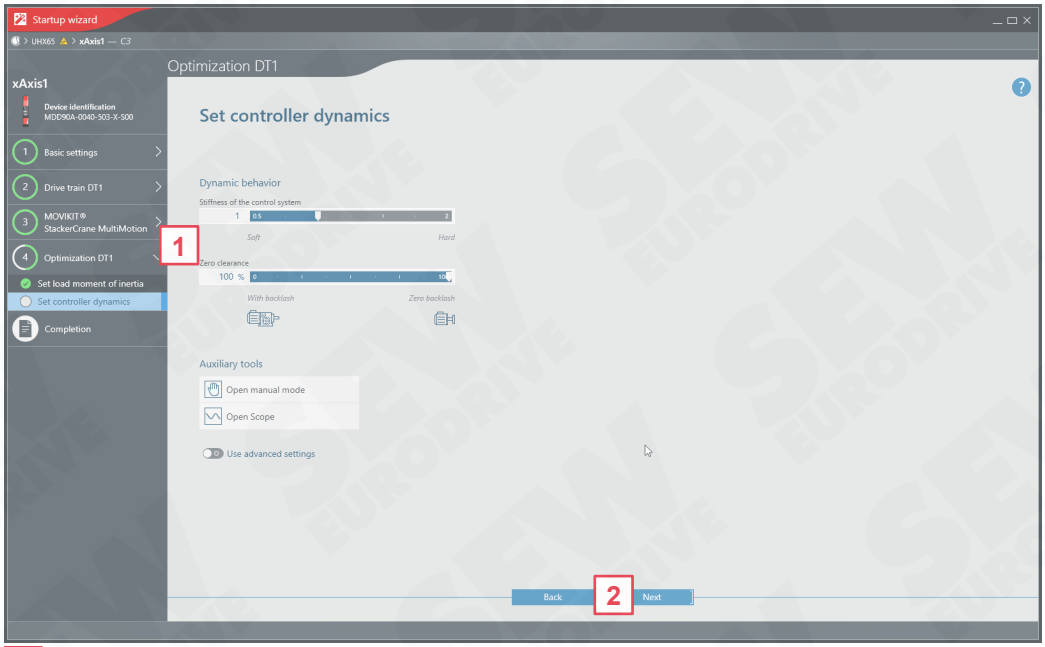


1 Press **Yes, activate startup state**



1 Press Next.

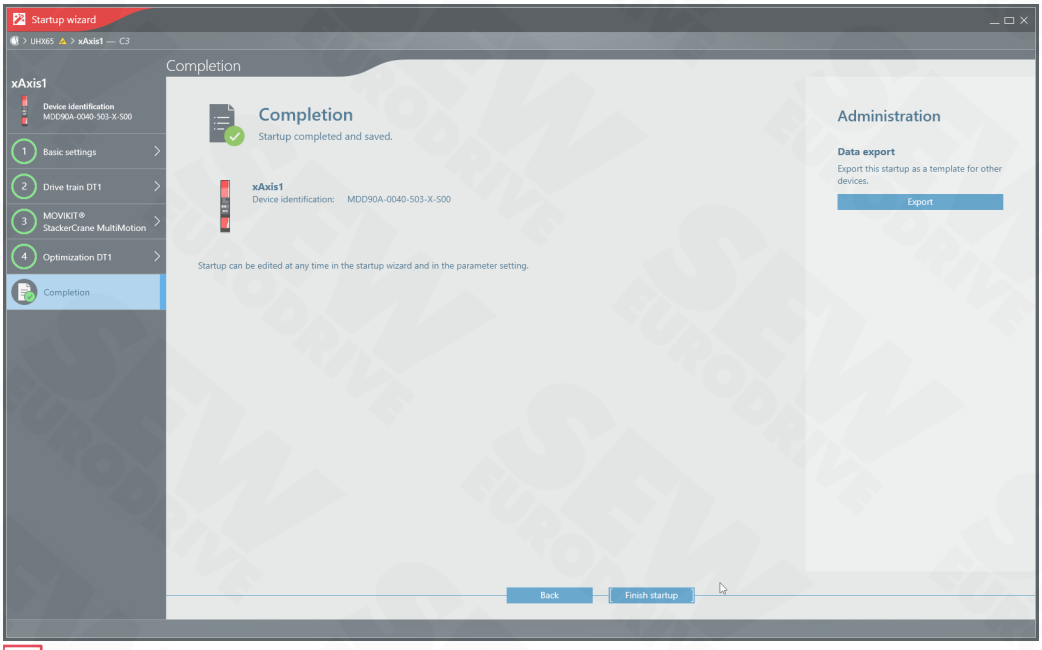
18. Set controller dynamics



1 Set stiffness and clearance. Press **Next**.

2 Press **Next**.

19. Conclusion



1 **Press** End startup.

4.4.1.2 Second axis of the landing gear (x-axis)

Repeat startup for the second x-axis with the startup wizard as in the previous chapter (travel axis x-axis)

4.4.1.3 Hoist (y-axis)

Repeat startup for the y-axis with the startup wizard as in the previous chapter (travel axis x-axis)

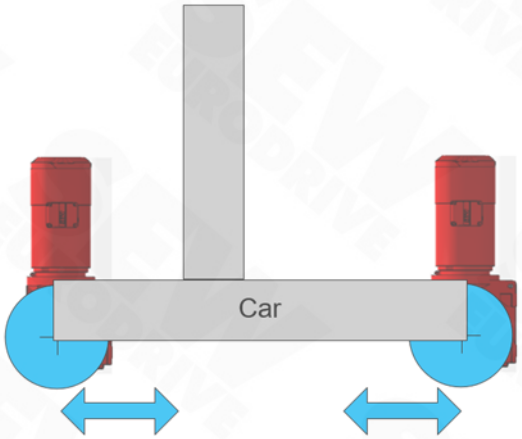
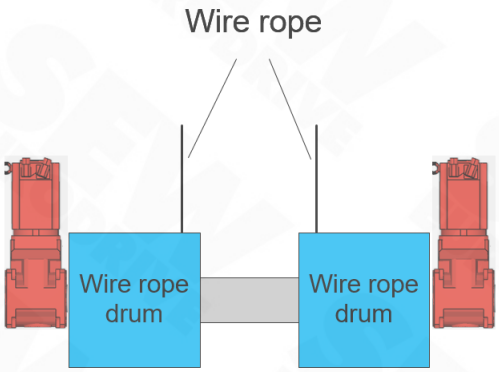
4.5 Step 3 – Startup of MOVIKIT® StackerCrane MultiAxisController MAC

Goals

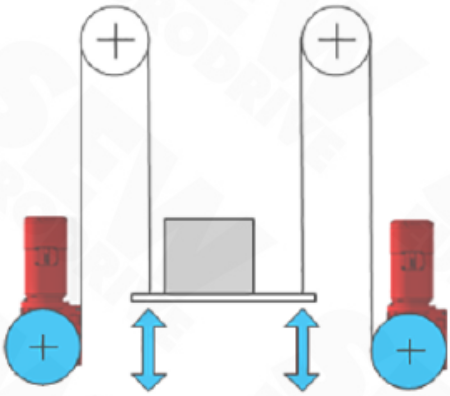
- Getting to know MOVIKIT® StackerCrane MultiAxisController Torque/Skewing
- Start up MOVIKIT® StackerCrane MultiAxisController in SoftwareNodes

4.5.1 MOVIKIT® MultiAxisController Torque/Skewing

MOVIKIT® MultiAxisController Torque balances the torque between mechanically coupled drives ("Torque priority" operating mode).

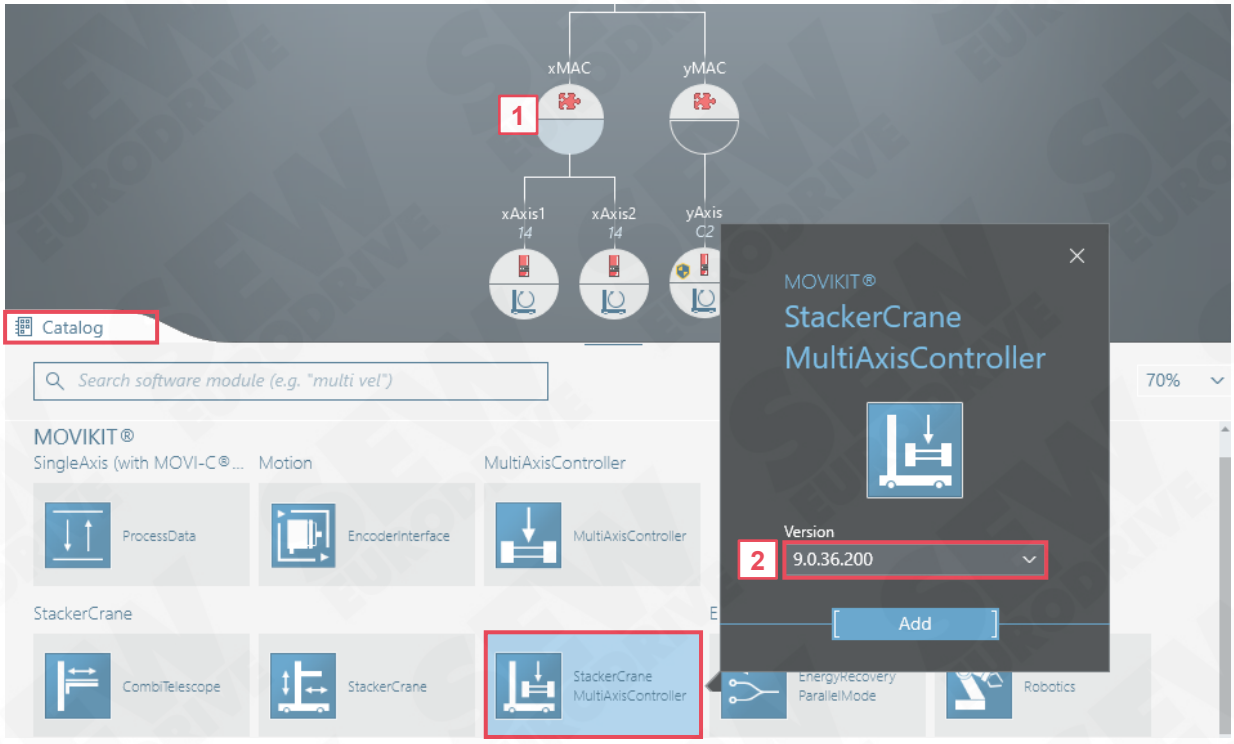
Traction-optimized carriages	Mech. Coupled rope drum
	

MOVIKIT® MultiAxisController Skewing corrects **skewing** between mechanically coupled drives ("**skewing** priority" operating mode).

Double-column hoist, SRS hoist


4.5.2 Parameterizing MOVIKIT® StackerCrane MultiAxisController (x-axis)

1. Assign MOVIKIT®

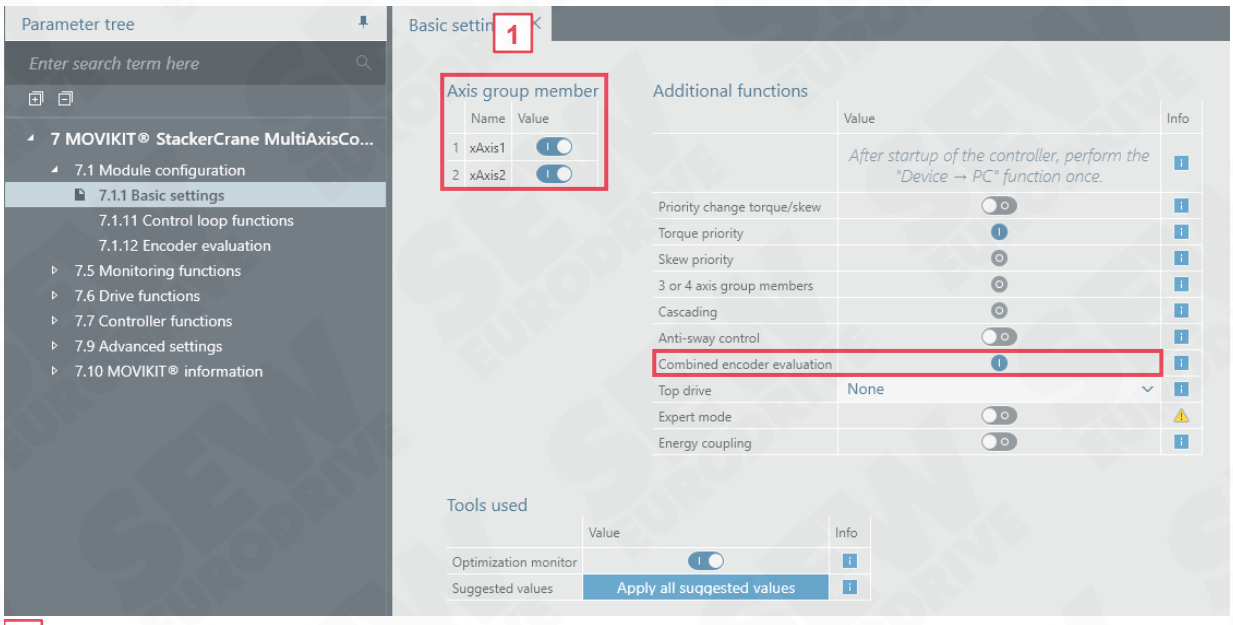


Assign the MOVIKIT® to the prepared software node for travel and hoist.

1 Activate the **lower semicircle of the chassis**

2 Select the latest version of **MOVIKIT® StackerCrane MultiAxisController** in the **catalog** and click **Add**.

2. Perform basic settings



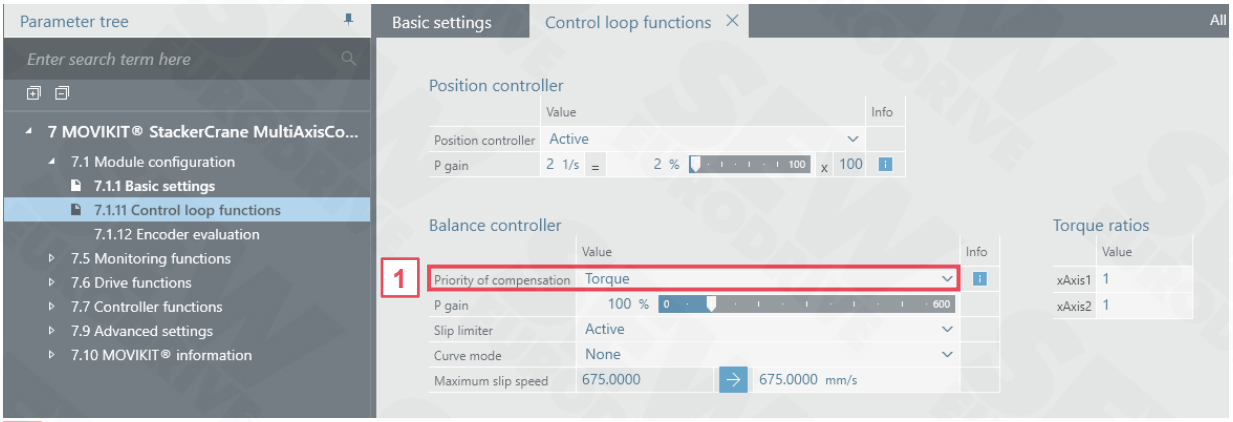
1 Perform the highlighted settings in **Basic settings**.

General information:

"Combined encoder evaluation" is always active if "Motor encoder and external encoder" is selected in the encoder source, see step 5

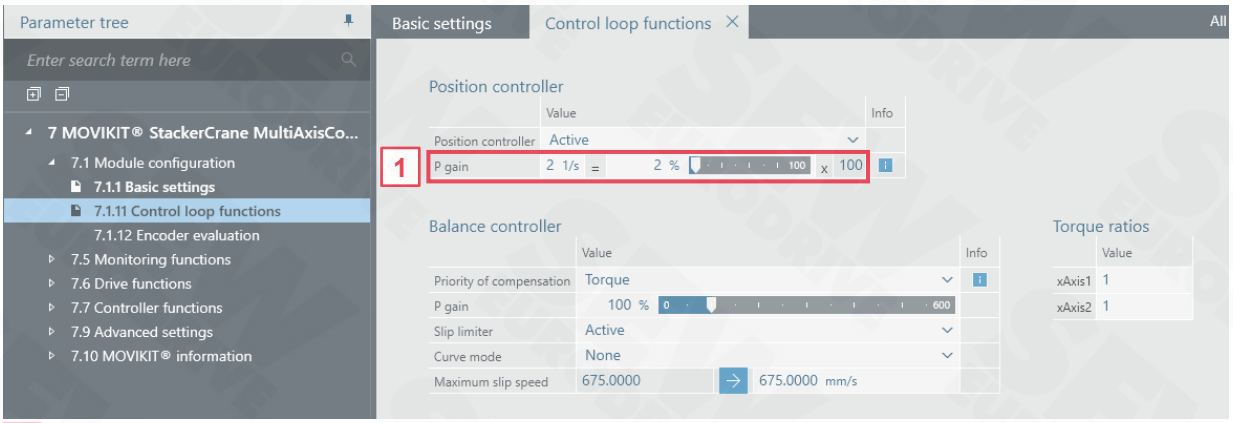
General information:
When using monitoring and/or controller functions, these must always be performed in the MultiAxisController and not in MultiMotion.

3. Configure the control function



1 Set the **priority of the compensation** as follows:
Torque: Default
Skewing: For hoists with TWO external encoders

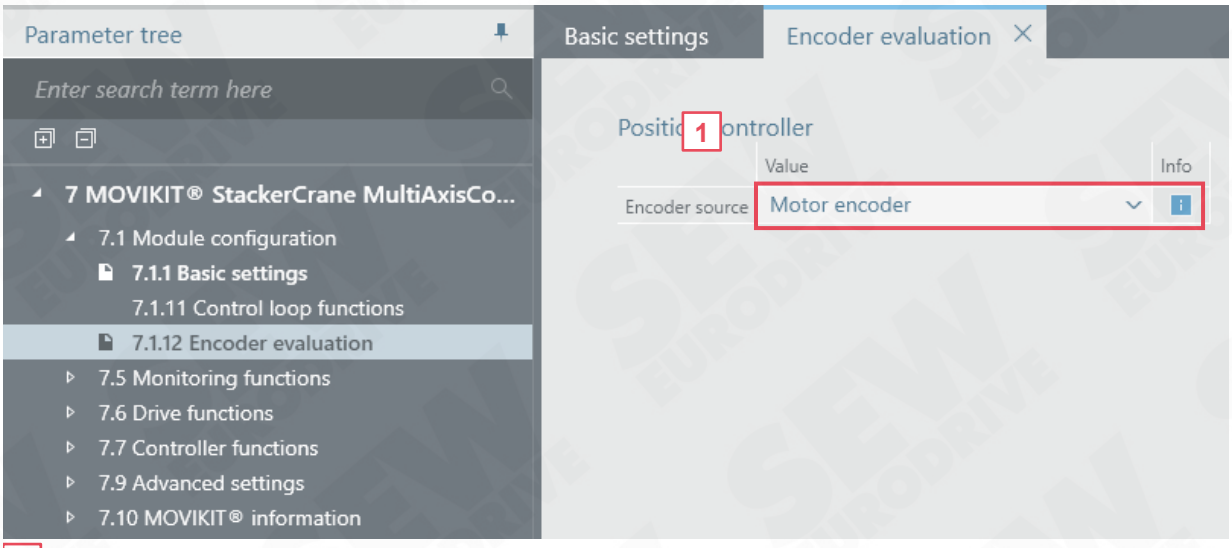
4. Configure the position controller



1 The P gain is reduced to 2%. Increase the p gain step-by-step from 2% to approx. 50%. Sometimes the position controller can be set even more strongly to up to 100%.

Note:
For **detailed information on optimizing the MultiAxisController, refer to chapter 7.8.1.2**

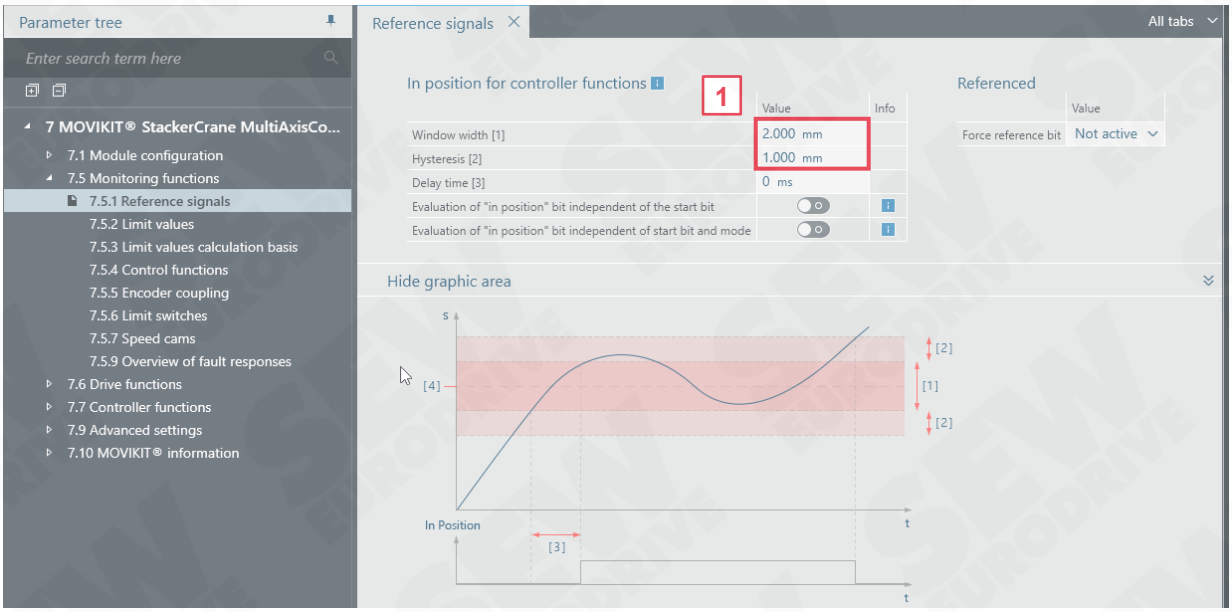
5. Configure encoder evaluation



1 Set the **encoder source** depending to your demo unit. In the shown demo unit **encoder source** is **Motor encoder.**

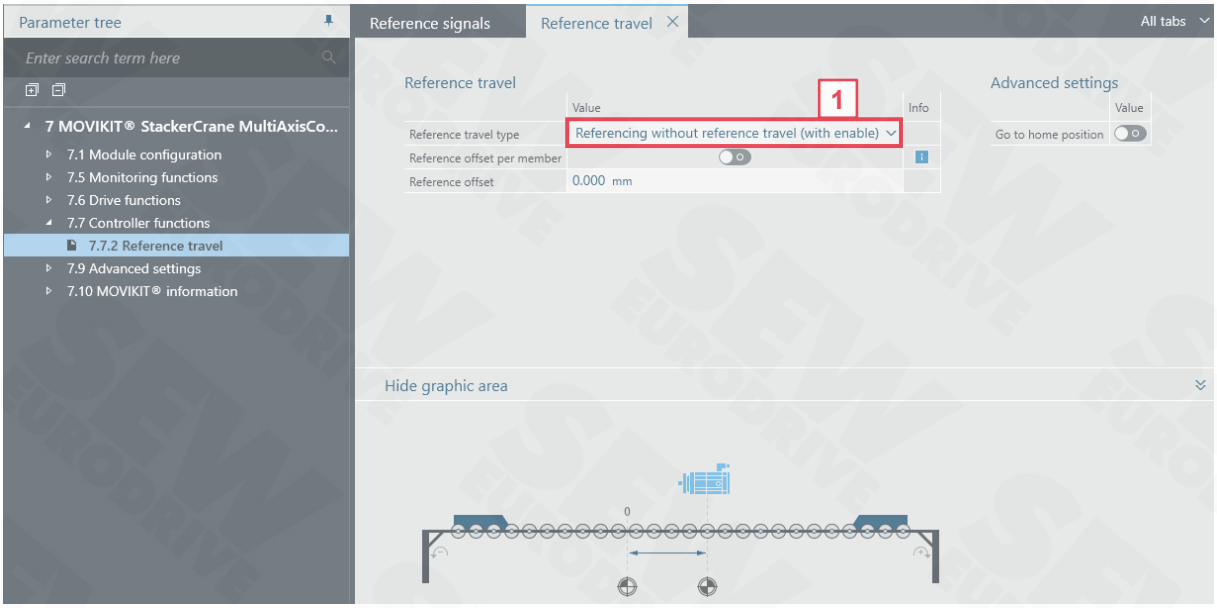
2 Set the **time constant**, if an external encoder is in use.

6. Configure reference message



1 Set the values as shown:
Recommendation: **Window width** (2 mm)
Hysteresis (1 mm)

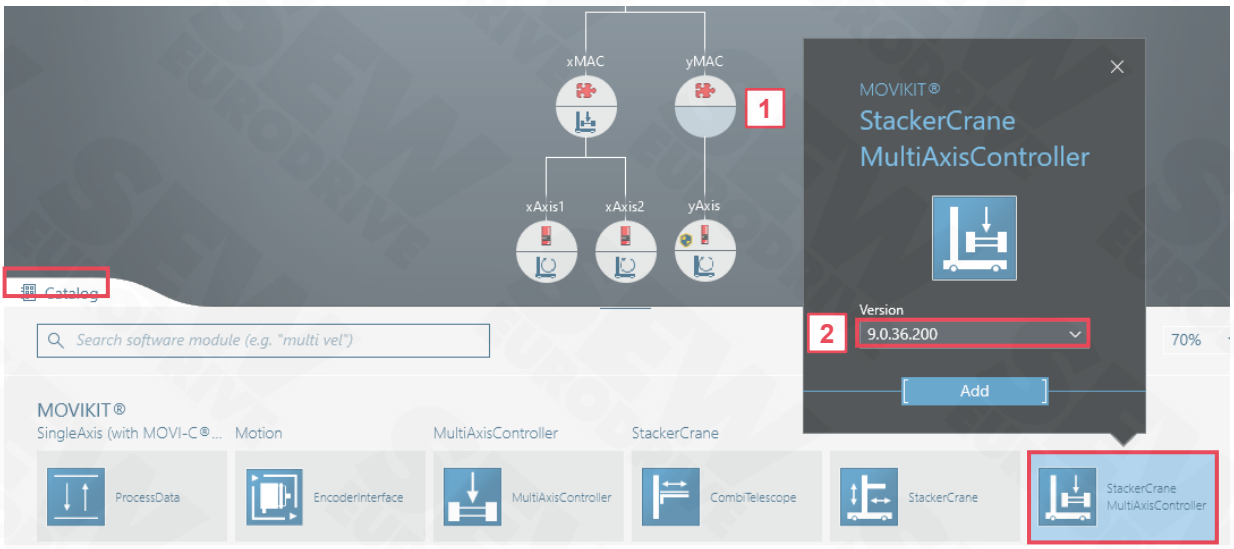
7. Configure reference travel



1 Set the **reference travel type** and the **reference offset**.

4.5.3 Parameterizing MOVIKIT® StackerCrane MultiAxisController (y-axis)

1. Assign MOVIKIT®

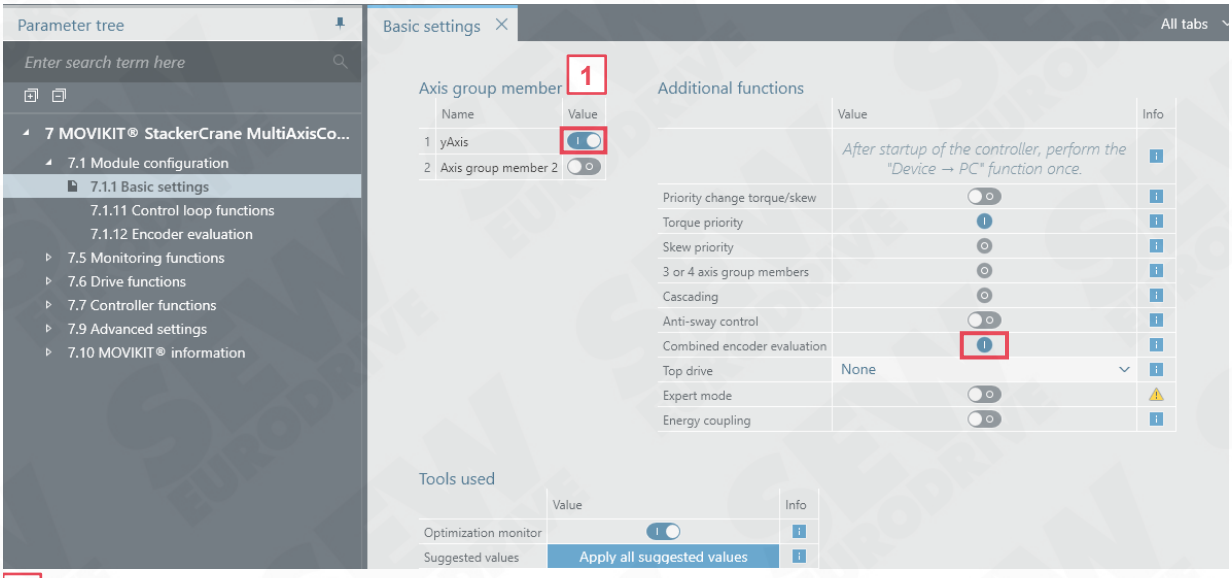


Assign the MOVIKIT® to the prepared software node for hoist.

1 Activate the **lower semicircle of the hoist**

2 In the **catalog**, select the **MOVIKIT® StackerCrane MultiAxisController** latest version
And click **Apply.**

2. Perform basic settings



1 Perform the highlighted settings in **Basic settings** according to your demi unit.

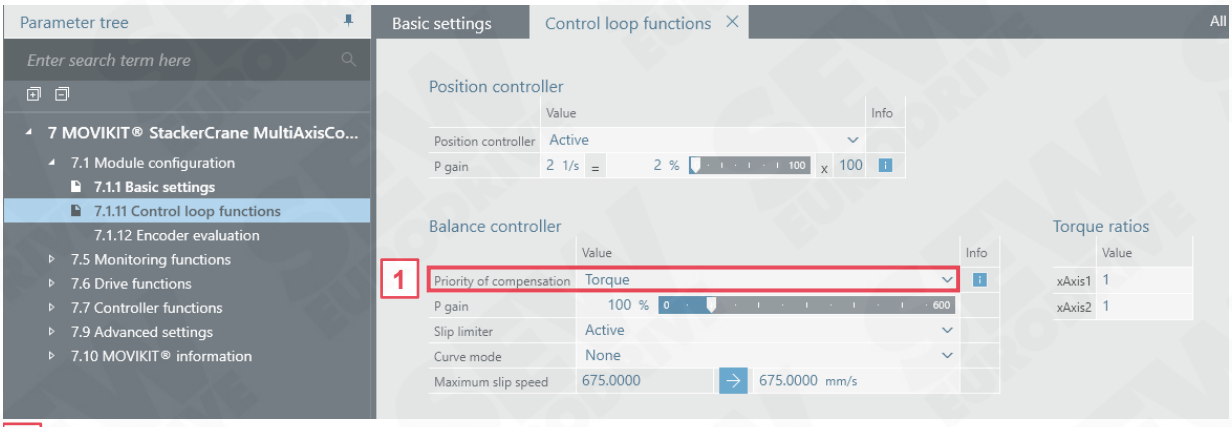
General information:

"Combined encoder evaluation" is always active if "Motor encoder and external encoder" is selected in the encoder source, see step 5.

General information:

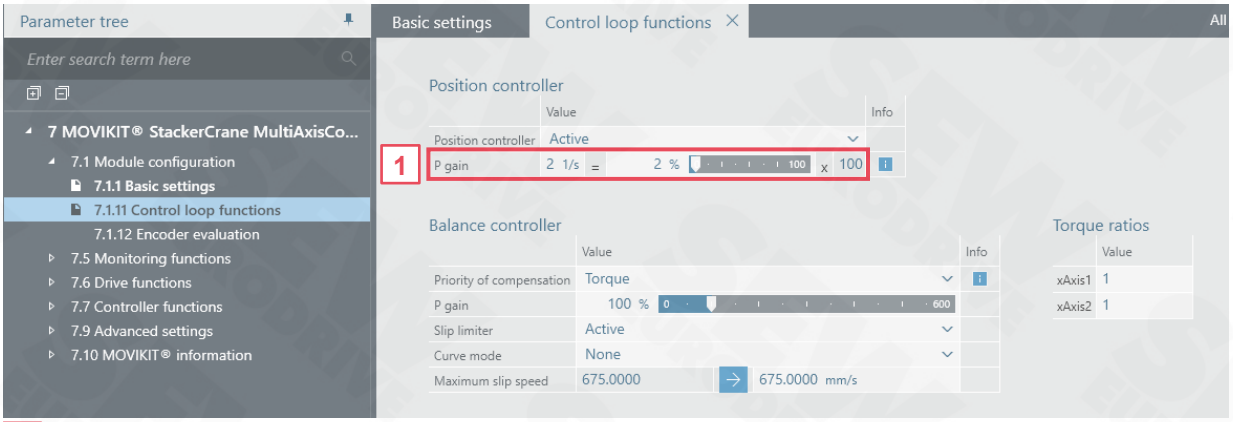
When using monitoring and/or controller functions, these must always be performed in the MultiAxisController and not in MultiMotion.

3. Configure the control function



1 Set the **priority of the compensation** as follows:
Torque: Default
Skewing: For hoists with TWO external encoders

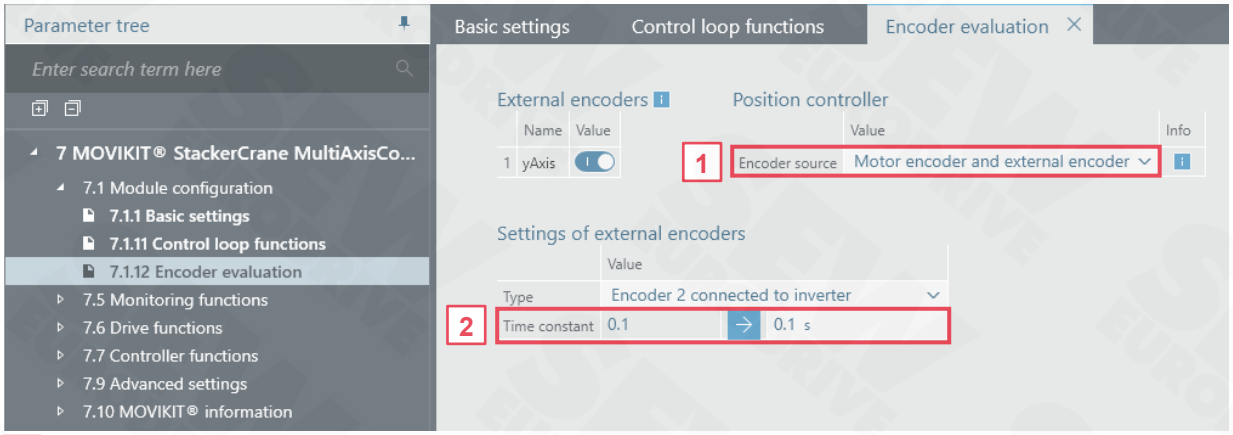
4. Configure the position controller



1 The P gain is reduced to 2%. Increase the p gain step-by-step from 2% to approx. 50%. Sometimes the position controller can be set even more strongly to up to 100%.

Note:
For det**ailed information on optimizing the MultiAxisController, refer to chapter 7.8.1.2**

5. Configure encoder evaluation



1 Set the **encoder source**.

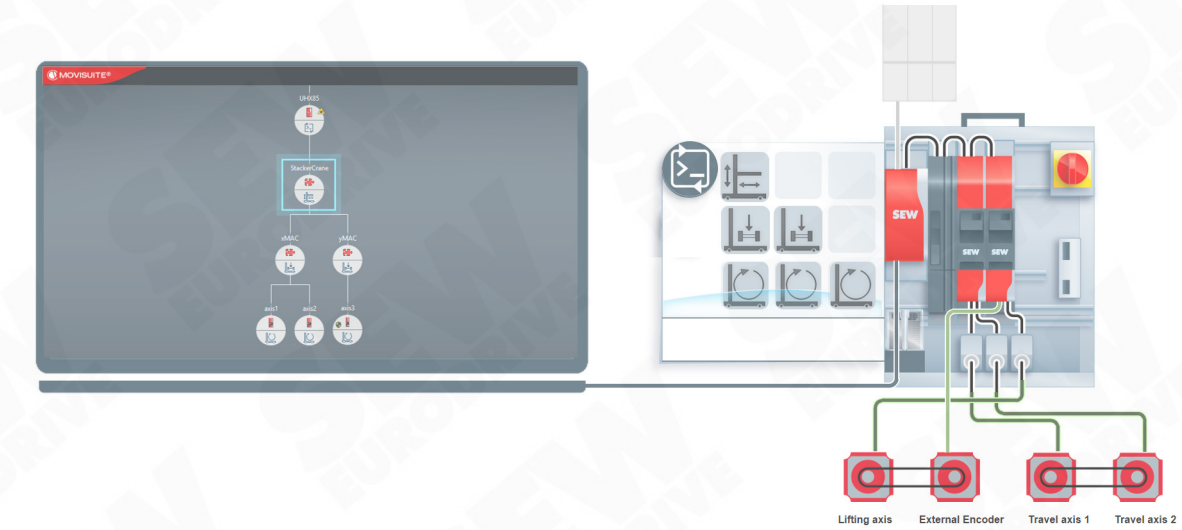
2 Set the **time constant**.

Determining the time constant
For detailed information on determining the time constant, refer to chapter 7.8.1.2

4.6 Step 4 – Startup of MOVIKIT® StackerCrane

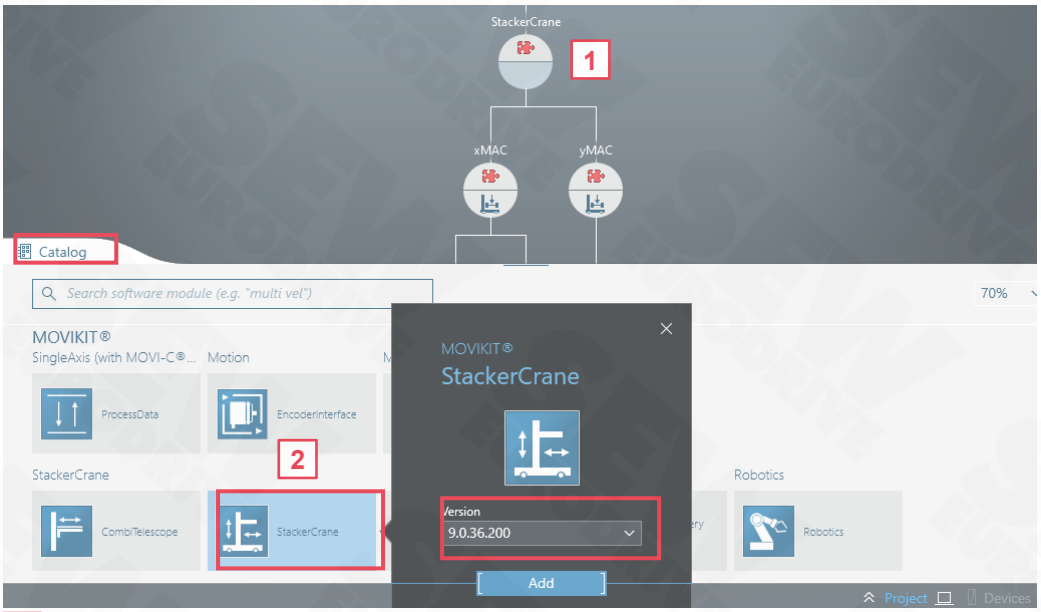
Goals

- Assigning and parameterizing MOVIKIT® StackerCrane
- Get to know the process data assignment of the fieldbus interface



4.6.1 Parameterize MOVIKIT® StackerCrane

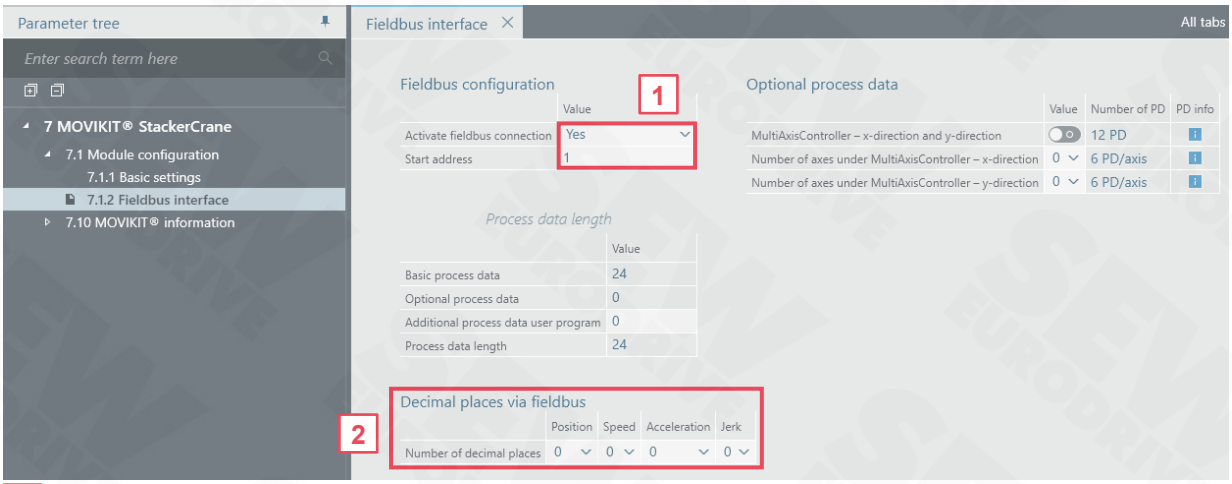
1. Assign MOVIKIT®



1 Activate the **lower semicircle of the software node**

2 Select the latest version of **MOVIKIT® StackerCrane** in the **catalog**
And click **Apply.**

2. Configure the fieldbus interface



1 Set **Activate fieldbus connection = Yes** and **start address = 1**

2 Set decimal places for the fieldbus:

Number of decimal places	Value	Resolution
0	Position	1 mm = 1 mm
0	Speed	1 mm/s = 1 mm/s
0	Acceleration	1 mm/s2 = 1 mm/s^2
0	Jerk	1 mm/s3 = 1 mm/s^3

4.6.2 Process data assignment of the fieldbus interface

Process data assignment in MOVISUITE®

Fieldbus interface

	PLC		PLC output data	PLC input data	MOVIKIT®
			>>>>	<<<<	
Axis group					
	Setpoint application mode	i	PO 1	PI 1	Actual application mode
	Control word	i	PO 2	PI 2	Status word
	Reserved (override)	i	PO 3	PI 3	Status or fault/subfault
	Reserved		PO 4	PI 4	Reserved
x-direction					
	Control word	i	PO 5	PI 5	Status word
	Setpoint speed		PO 6	PI 6	Actual speed
	Setpoint acceleration		PO 7	PI 7	Status or fault/subfault
	Setpoint deceleration		PO 8	PI 8	Torque
	Digital outputs	i	PO 9	PI 9	Digital inputs
	Control word MultiAxisController	i	PO 10	PI 10	Status word MultiAxisController
	Target position – high word		PO 11	PI 11	Actual position – high word
	Target position – low word		PO 12	PI 12	Actual position – low word
	Setpoint jerk		PO 13	PI 13	Actual jerk
	Reserved		PO 14	PI 14	Reserved
y-direction					
	Control word	i	PO 15	PI 15	Status word
	Setpoint speed		PO 16	PI 16	Actual speed
	Setpoint acceleration		PO 17	PI 17	Status or fault/subfault
	Setpoint deceleration		PO 18	PI 18	Torque
	Digital outputs	i	PO 19	PI 19	Digital inputs
	Control word MultiAxisController	i	PO 20	PI 20	Status word MultiAxisController
	Target position – high word		PO 21	PI 21	Actual position – high word
	Target position – low word		PO 22	PI 22	Actual position – low word
	Setpoint jerk		PO 23	PI 23	Actual jerk
	Reserved		PO 24	PI 24	Reserved

Target application mode

0	Default
100	Jog
300	Referencing configured offset
301	Referencing bus offset
400	Positioning absolute
1200	Energized-optimized XY positioning
1210	Mechanics-optimized positioning
1300	External braketest

Control word x-& y-direction

Bit 0	Enable emergency stop
Bit 1	Enable application stop
Bit 2	Reserved
Bit 3	Release brake
Bit 4	Jog positive
Bit 5	Jog negative
Bit 6	Reserved
Bit 7	Start/stop with fieldbus ramp
Bit 8	Reset fault
Bit 9	Reserved
Bit 10	Reserved
Bit 11	Deactivate external encoders
Bit 12	Deactivate SW limit switches
Bit 13	Activate output stage inhibit
Bit 14	Activate standby mode
Bit 15	MOVIKIT® Handshake In

Status word x-& y-direction

Bit 0	Ready
Bit 1	STO inactive
Bit 2	Output stage enabled
Bit 3	Brake released
Bit 4	Motor turning
Bit 5	Referenced
Bit 6	Reserved
Bit 7	In position
Bit 8	Fault
Bit 9	Reserved
Bit 10	Reserved
Bit 11	External encoder disabled
Bit 12	SW limit switch inactive
Bit 13	Reserved
Bit 14	Standby mode active
Bit 15	MOVIKIT® Handshake Out

MultiAxisController control word

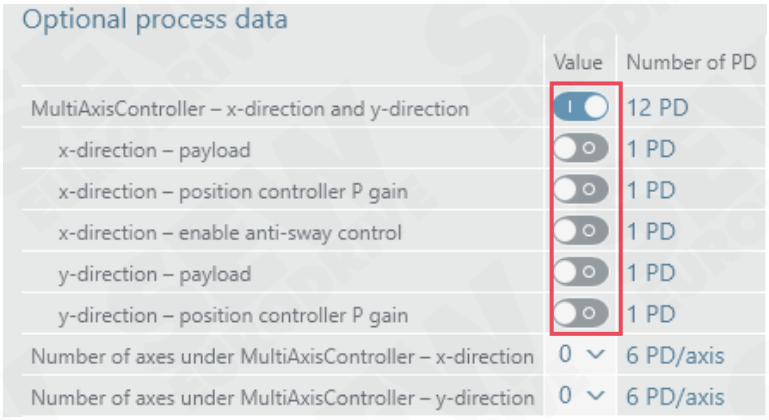
Bit 0	Deactivate member 1/11
Bit 1	Deactivate member 2/21
Bit 2	Deactivate member 12
Bit 3	Deactivate member 22
Bit 4	member 1/11 Release brake with inhibited output stage
Bit 5	member 2/21 Release brake with inhibited output stage
Bit 6	member 12 Release brake with inhibited output stage
Bit 7	member 22 Release brake with inhibited output stage
Bit 8	Deactivate balance controller
Bit 9	Reserved (deactivate position controller)
Bit 10	Deactivate skewing error
Bit 11	Allow skew compensation
Bit 12	Reserved
Bit 13	Reserved
Bit 14	Reserved
Bit 15	Reserved

Status word x-& y-direction

Bit 0	Axis group member 1/11 deactivated
Bit 1	Axis group member 2/21 deactivated
Bit 2	Axis group member 12 deactivated
Bit 3	Axis group member 22 deactivated
Bit 4	Axis group member 1/11 brake released
Bit 5	Axis group member 2/21 brake released
Bit 6	Axis group member 12 brake released
Bit 7	Axis group member 22 brake released
Bit 8	Balance controller deactivated
Bit 9	Position controller deactivated
Bit 10	Skew in skew window
Bit 11	Overload guard active
Bit 12	Reserved
Bit 13	Reserved
Bit 14	Reserved
Bit 15	Reserved

Optional process data

Optional process data can be added to use additional functions of the MAC if required (see broken down process data assignment). These can be used, for example, to specify the payload or torque distribution.



Fieldbus interface: optional process data

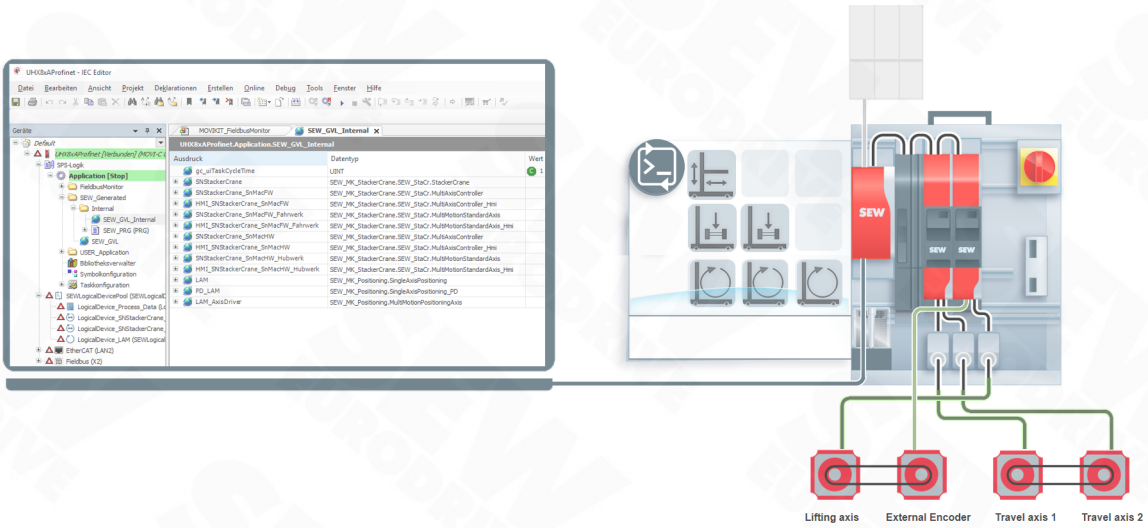
MultiAxisController – x-direction and y-direction (12 PD)

	PLC		PLC output data	PLC input data	MOVIKIT®
x-direction					
	Reserved		PO 25	PI 25	Top drive – scaled analog value
	Reserved		PO 26	PI 26	Top drive – speed correction
	Torque distribution A4 (high byte)/A3 (low byte)		PO 27	PI 27	Top drive – speed ratio
	Torque distribution A2 (high byte)/A1 (low byte)		PO 28	PI 28	Top drive – slip
	Reserved		PO 29	PI 29	Top drive – unscaled analog value
	Reserved		PO 30	PI 30	Reserved
	Reserved		PO 31	PI 31	Reserved
	Reserved		PO 32	PI 32	Reserved
y-direction					
	Reserved		PO 33	PI 33	Reserved
	Reserved		PO 34	PI 34	Reserved
	Reserved		PO 35	PI 35	Reserved
	Reserved		PO 36	PI 36	Reserved

4.7 Step 5 – Generation of the software project

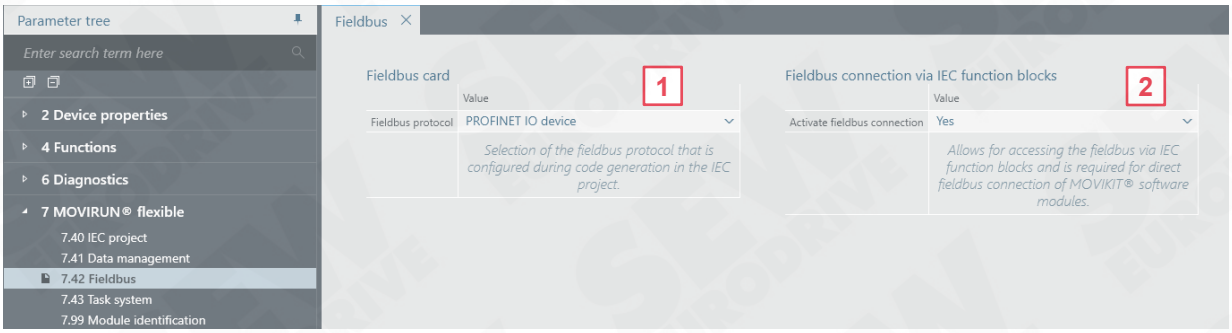
Goals

- Parameterize the fieldbus
- Can configure cycle times
- Knowing the controller level and assigning licenses
- IEC project
- Know the debug in the IEC program



4.7.1 Fieldbus parameterization

1. Parameterize fieldbus



1 Set the fieldbus protocol to **PROFINET IO device**

2 Activate the **fieldbus connection.**

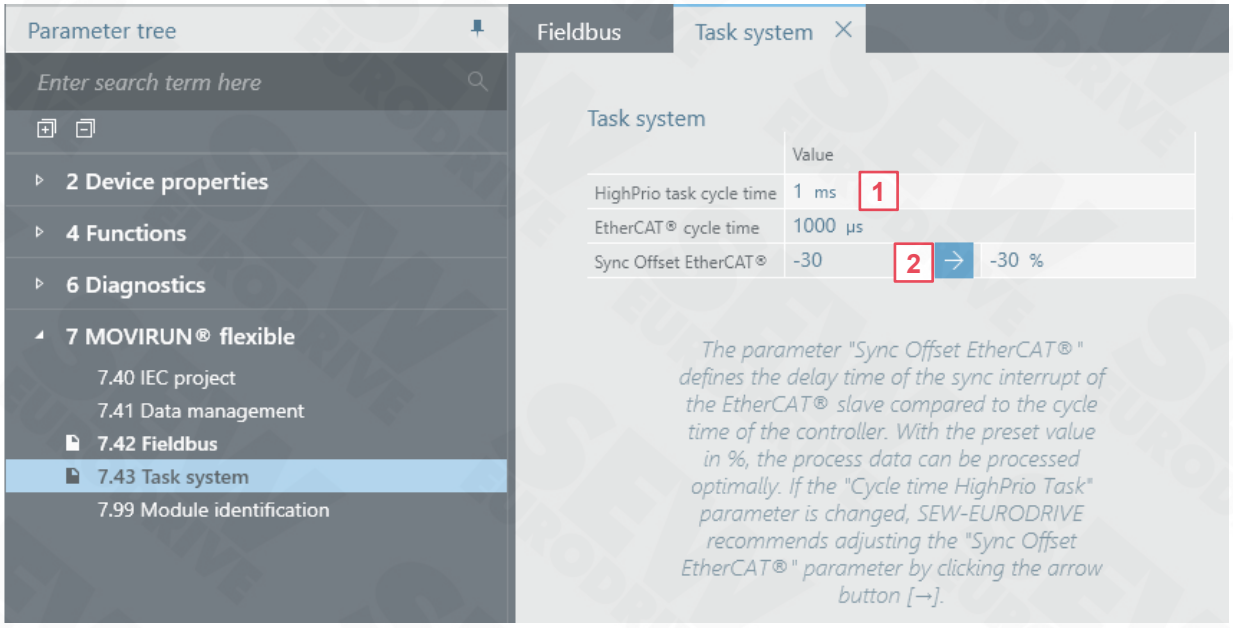
4.7.2 Cycle time on the MOVI-C® CONTROLLER

General information:
The StackerCrane applications are always operated with a cycle time of **1 ms or 4 ms** depending on the controller. Select the controller from the following table depending on the scope of application (MultiMotion / MultiAxisController / Add-on AntiSway):

Controller

MOVIKIT® StackerCrane with ...	UHX25	UHX45 UHX65A-R01	UHX65A-R02 UHX65A-R04
MOVIKIT StackerCrane MultiMotion	1 ms	1 ms	1 ms
... With MOVIKIT® PowerMode	4 ms	1 ms	1 ms
MOVIKIT StackerCrane MultiAxisController	-	4 ms	1 ms
… With MOTION add-on AntiSway	-	4 ms	4 ms
... With MOVIKIT® MultiAxisController add-on Cascading	-	4 ms	4 ms
... With MOVIKIT® PowerMode	-	4 ms	4 ms

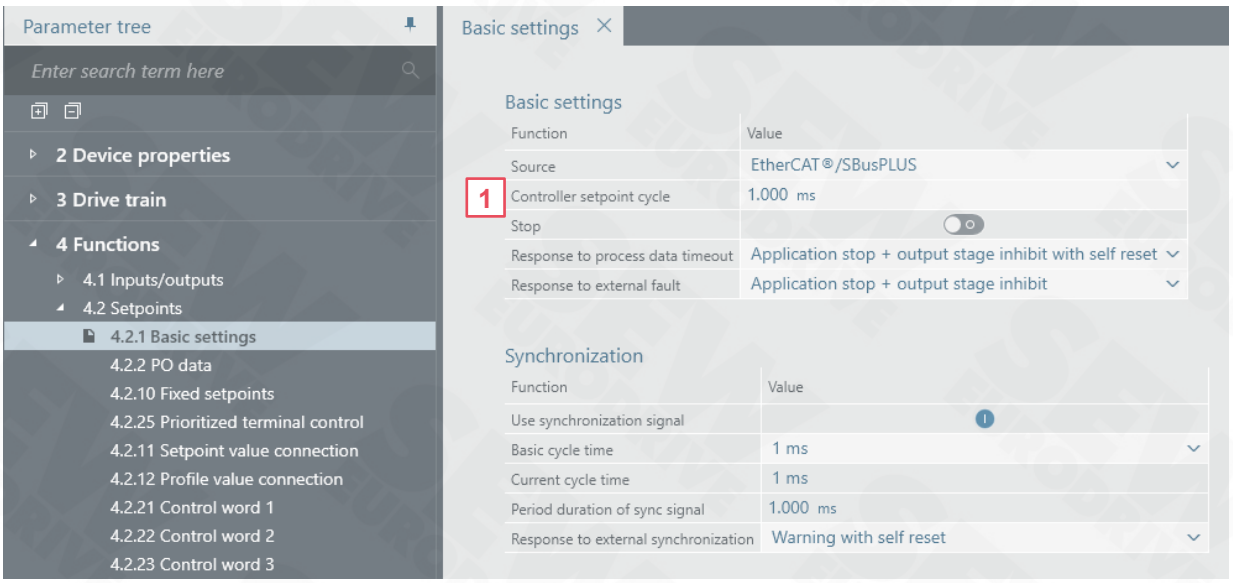
2. Parameterize the cycle time on the MOVI-C® CONTROLLER



1 Set the EtherCAT® cycle time to 1 ms (default).

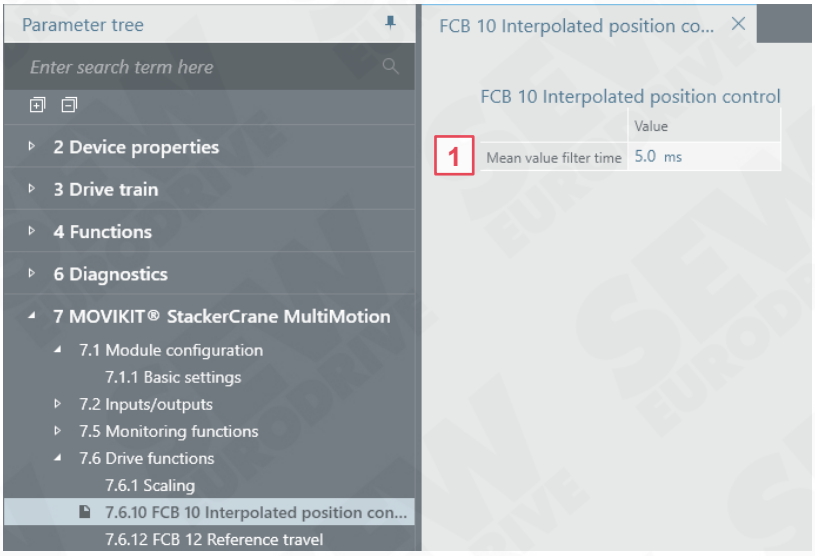
2 **Apply the** suggested value **Sync Offset EtherCAT®**

3. Change the cycle time in the parameter tree of the axes



1 Under **Setpoints** **Basic settings**, set **Controller setpoint cycle** to 1 ms (default).

4. Parameterize the mean value filter time in the parameter tree of the axes

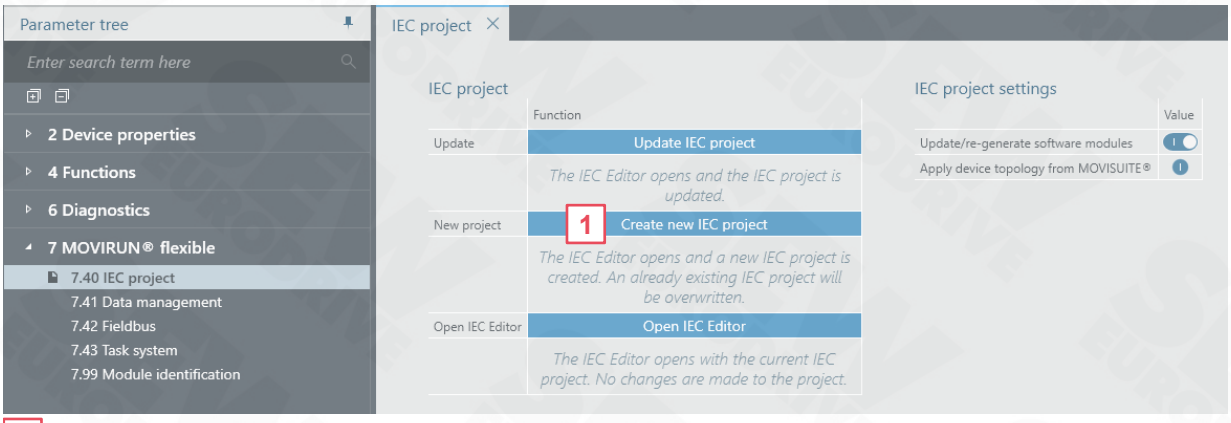


1 Under **Drive functions** **FCB10 Interpolated position control**, set the **Mean value filter time** to a multiple of the cycle time.

- With a cycle time of 1 ms, the default value of the mean filter time (5 ms) can be used.
- For a cycle time of 4 ms, we recommend a mean filter time of 8 ms.

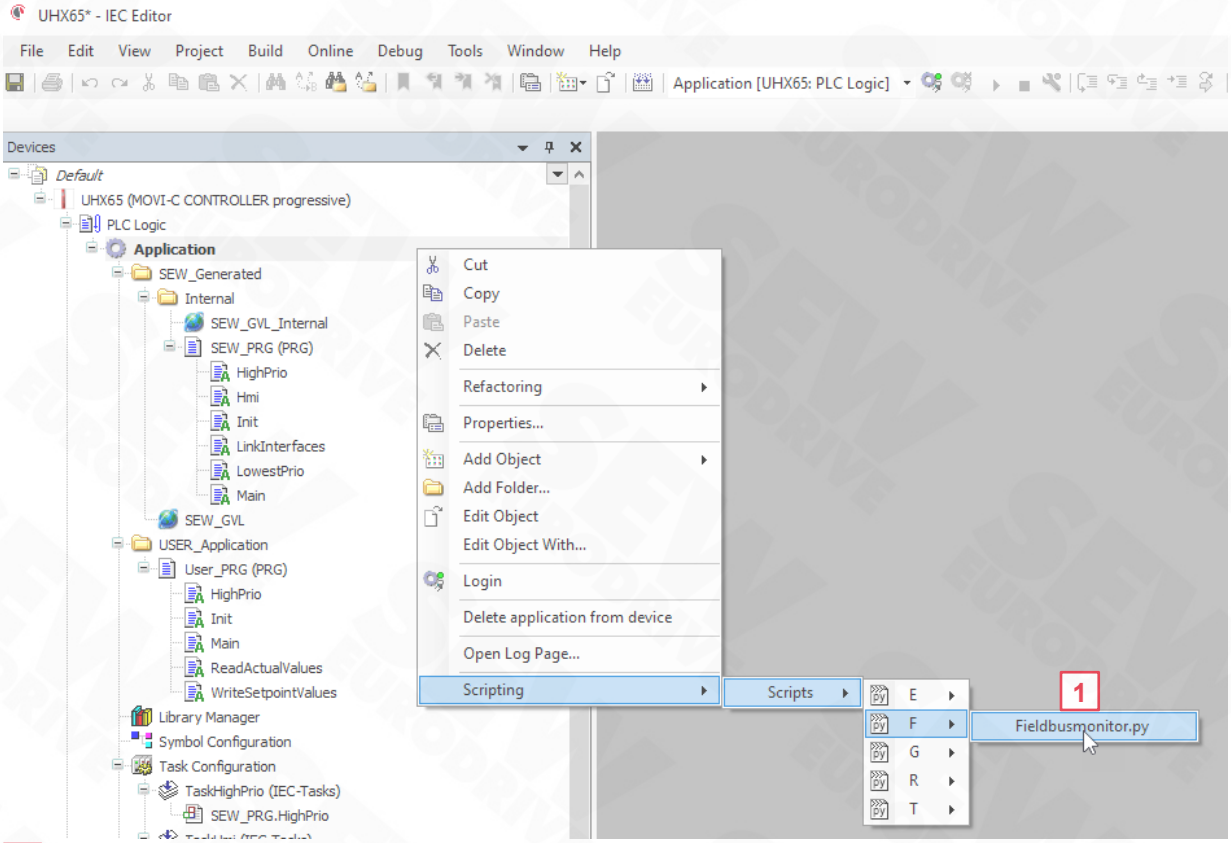
4.7.3 Create IEC project

1. Create IEC project



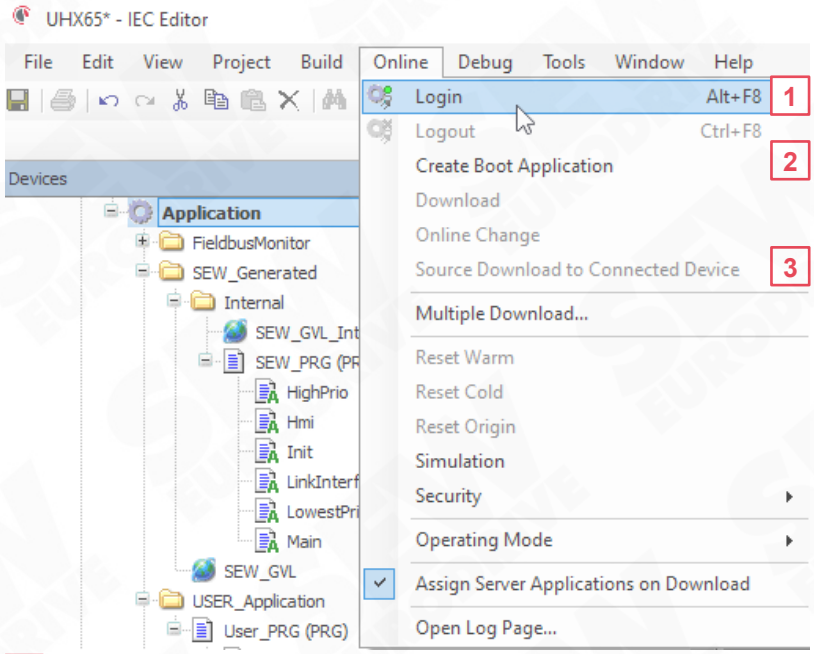
1 Click **Create new IEC project** to start the automatic code generation process

2. Import process data monitor



1 Activate the **fieldbus monitor** by pressing the right mouse button on the Application.

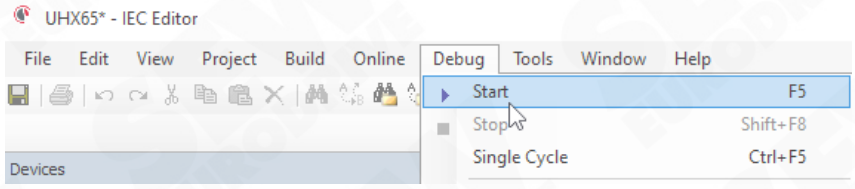
3. Start the project



1 Click **Login** to compile the IEC project.

2 Click Create **boot application** to start the program on the MOVI-C® CONTROLLER automatically after power off.

3 Click **Source download to the Connected device** to save the entire project.

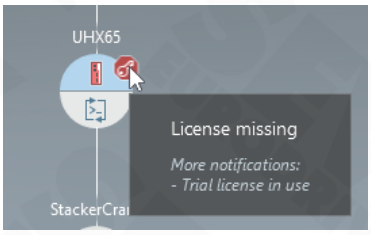


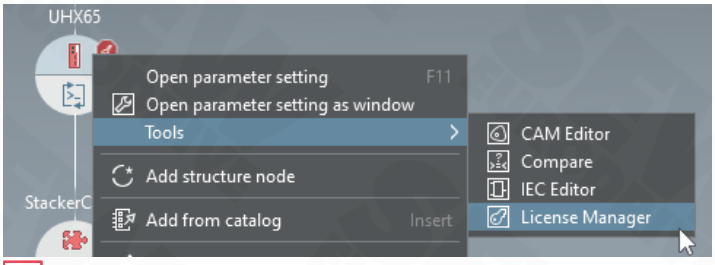
4 Start with **Debug Start** , ..▶ Or **F5**.

4.7.4 LICENSE MOVI-C® CONTROLLER

1. Start the license manager

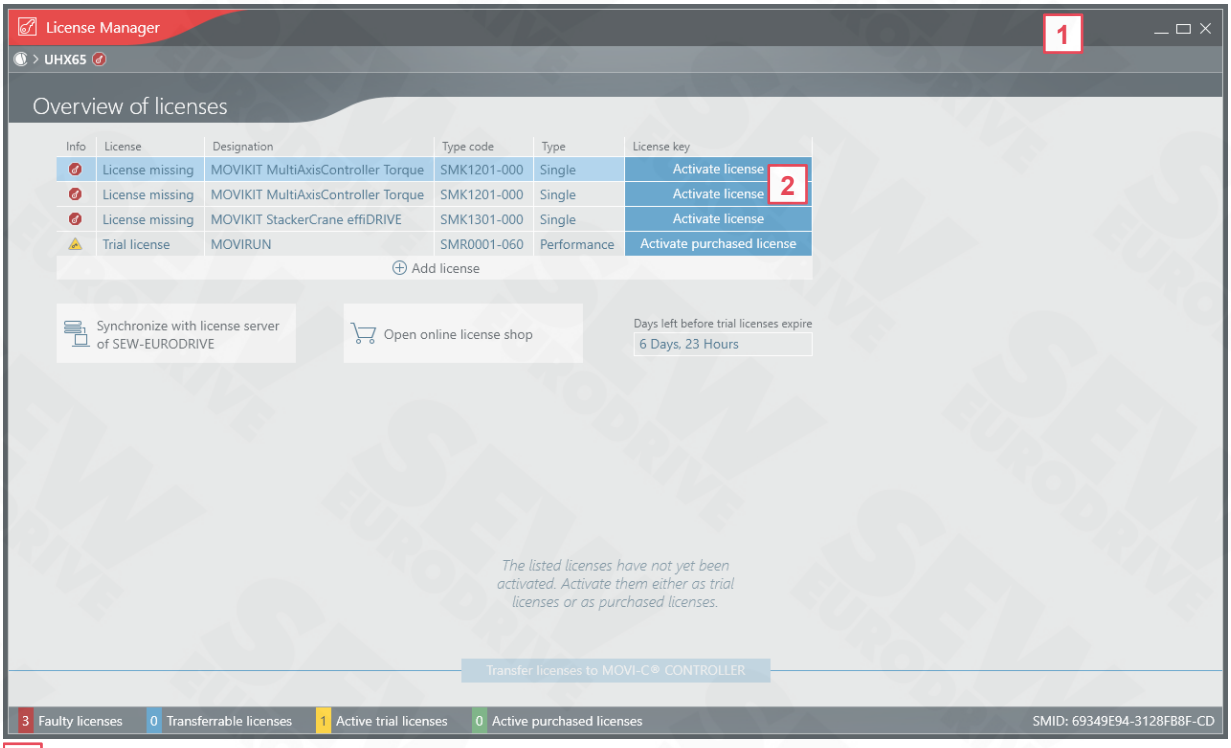
An Internet connection is required to activate the licenses. A trial license can also be generated without an Internet connection.



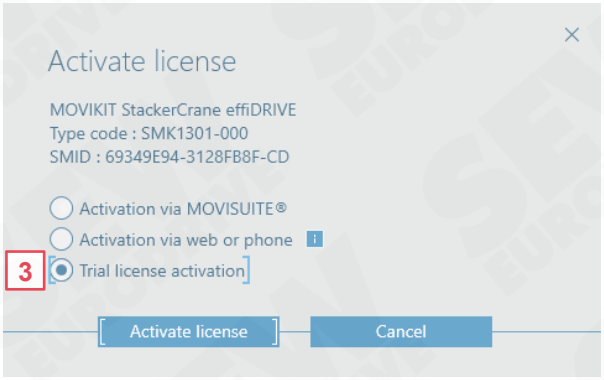


1 Start the **License Manager**

2. Activate license

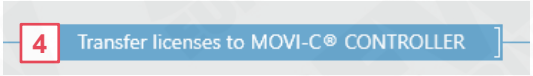


2 Activate suggested licenses. Press **Activate license**



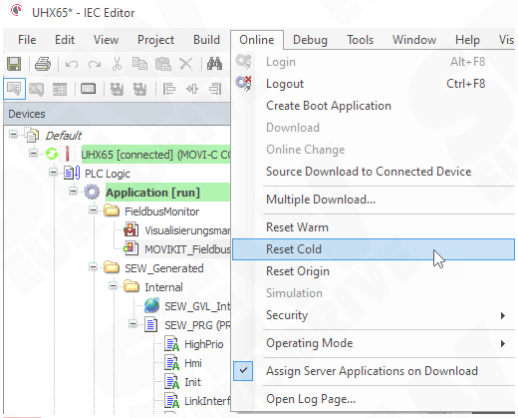
3 Activate trial license

3. Transfer licenses to MOVI-C® CONTROLLER



4 Transfer licenses to the MOVI-C® CONTROLLER

4. Cold reset



4 Perform cold reset.

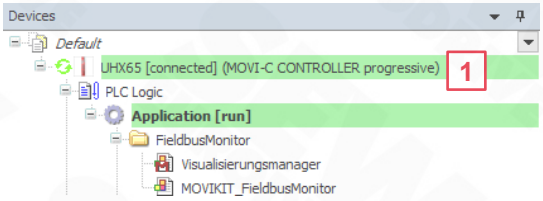
Examples of required licenses

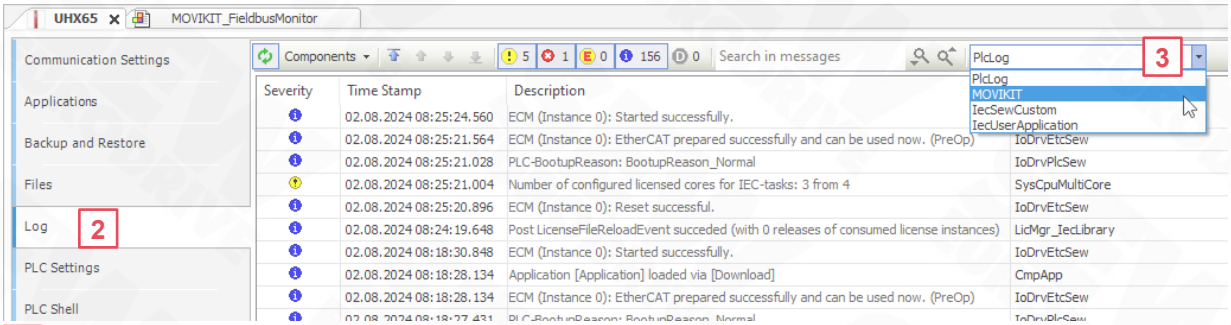
Application	Licenses
1x travel drive & 1x lifting drive	MOVIRUN Flexible + StackerCrane
2x travel drive & 1x lifting drive	MOVIRUN Flexible + StackerCrane + 1x MAC Torque (travel) + 1x MAC torque (lifting)
1x travel drive & 2x lifting drive	MOVIRUN Flexible + StackerCrane + 1x MAC Torque (travel) + 1x MAC skewing (lifting)
2x travel drive & 2x lifting drive	MOVIRUN Flexible + StackerCrane + 1x MAC Torque (travel) + 1x MAC skewing (lifting)

4.7.5 Diagnose the IEC program

1. Call up the debug log

In the event of an error, FIRST look into the log!





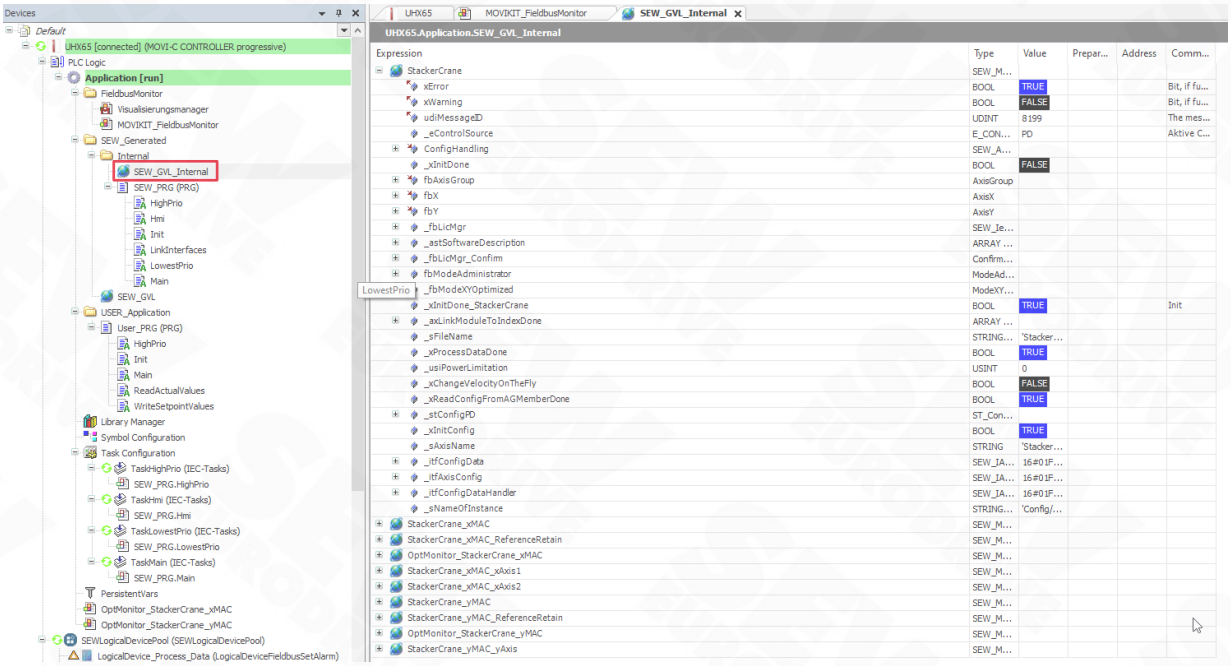
1 Click the MOVI-C® CONTROLLER

2 Click **Log**

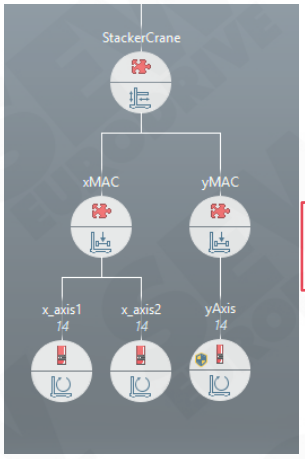
3 Switch the logger to **MOVIKIT** in the drop-down list

2. Call up and monitor debug variables

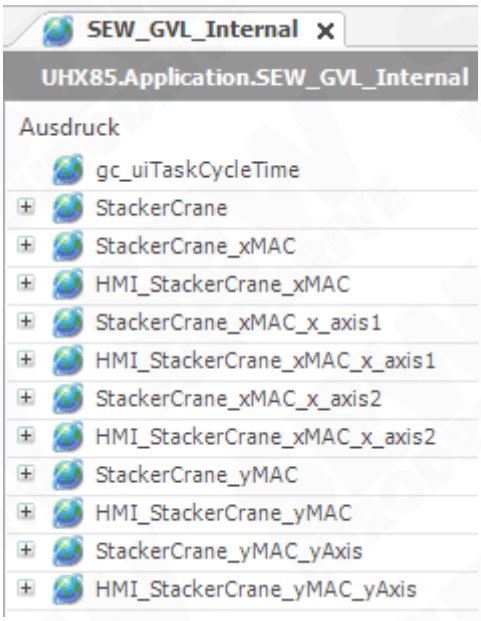
3. Open IEC Editor →Open SEW_GVL_Internal



Global variables



Code generation



Overview of debug variables

Position controller P gain
SEW_GVL_Internal.StackerCrane_xMAC._fbController._fbPositionController._stConfig.lrPGain

Encoder evaluation time constant
SEW_GVL_Internal.StackerCrane_xMac._fbController._fbEncoderEvaluation._stConfig.lrTimeConstant_MotEncTOExtEnc_Diff

Encoder evaluation dead time
SEW_GVL_Internal.StackerCrane_xMac._fbController._fbEncoderEvaluation._stConfig.lrDeadtime_ExtEnc

Trace/lag error
SEW_GVL_ Internal.StackerCrane_xMac._stBasicOut.lrActualVelocity
SEW_GVL_ Internal.StackerCrane_xMac._fbController._stSetpointValues.stFromPG.lrVelocityPrecontrol
SEW_GVL_ Internal.StackerCrane_xMac._fbController._fbPositionController._Stout.lrManVal
SEW_GVL_ Internal.StackerCrane_xMac._fbController._fbMAC._Stout.stMACManVal.stVelocityCorrection
SEW_GVL_ Internal.StackerCrane_xMac_fbController._fbPositionController._Stout.lrLagError

Debug variables: Fieldbus process data

SEW_GVL_Internal.StackerCrane.fbModeAdministrator._eActualMode
SEW_GVL_Internal.StackerCrane.fbModeAdministrator._eSetpointMode
SEW_GVL_Internal.StackerCrane.fbX._In
SEW_GVL_Internal.StackerCrane.fbX._Out
SEW_GVL_Internal.StackerCrane.fbX._Config
SEW_GVL_Internal.StackerCrane.fbY._In
SEW_GVL_Internal.StackerCrane.fbY._Out
SEW_GVL_Internal.StackerCrane.fbY._Config
SEW_GVL_Internal.StackerCrane.fbAxisGroup._Out

Debug variables: Error level

SEW_GVL_Internal.StackerCrane.xError
SEW_GVL_Internal.StackerCrane._stLocalVar_ErrorBasic.rstAdditionalText.sAdditionalText
SEW_GVL_Internal.StackerCrane_xMAC.xError
SEW_GVL_Internal.StackerCrane_xMAC._stLocalVar_ErrorBasic.rstAdditionalText.sAdditionalText
SEW_GVL_Internal.StackerCrane_xMAC_x_axis1.xError
SEW_GVL_Internal.StackerCrane_xMAC_x_axis2.xError
SEW_GVL_Internal. StackerCrane_xMAC_x_axis1._stLocalVar_ErrorBasic.rstAdditionalText.sAdditionalText
SEW_GVL_Internal. StackerCrane_xMAC_x_axis1._stLocalVar_ErrorBasic.rstAdditionalText.sAdditionalText

Debug variables: SC-MAC

STARTUP

Position controller P gain
SEW_GVL_Internal.StackerCrane_xMAC _xAxis1._fbController._fbPositionController._stConfig.lrPGain
SEW_GVL_Internal.StackerCrane_xMAC _xAxis2._fbController._fbPositionController._stConfig.lrPGain

Encoder evaluation time constant

SEW_GVL_Internal.StackerCrane_xMAC._fbController._fbEncoderEvaluation._stConfig.lrTimeConstant_MotEncToExtEnc_Diff

Encoder evaluation dead time

SEW_GVL_Internal.StackerCrane_xMAC._fbController._fbEncoderEvaluation._stConfig.lrDeadtime_ExtEnc

Trace/lag error

SEW_GVL_Internal.StackerCrane_xMAC._stBasicOut.lrActualVelocity
SEW_GVL_Internal.StackerCrane_xMAC._fbController._stSetpointValues.stFromPG.lrVelocityPrecontrol
SEW_GVL_Internal.StackerCrane_xMAC._fbController._fbPositionController._Stout.lrManVal
SEW_GVL_Internal.StackerCrane_xMAC._fbController._fbMAC._Stout.stMACManVal.stVelocityCorrection
SEW_GVL_Internal.StackerCrane_xMAC._fbController._fbPositionController._Stout.lrLagError

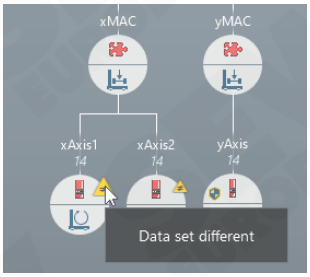
Debug variables: SC-MultiMotion

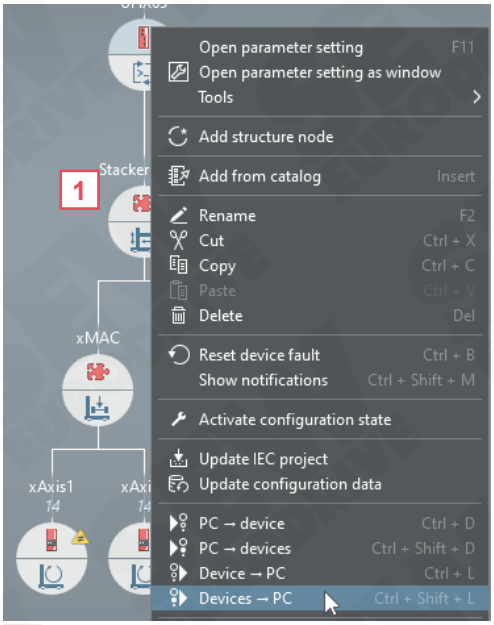
SEW_GVL_Internal.StackerCrane_xMAC _xAxis1.DeviceAdapter16PD.stBasicIN
SEW_GVL_Internal.StackerCrane_xMAC _xAxis1.DeviceAdapter16PD.stBasicOUT
SEW_GVL_Internal.StackerCrane_xMAC _xAxis1.DeviceAdapter16PD.stInverterIN
SEW_GVL_Internal.StackerCrane_xMAC _xAxis1.DeviceAdapter16PD.stInverterOUT
SEW_GVL_Internal.StackerCrane_xMAC _xAxis1.DeviceAdapter16PD.stBrakeIN
SEW_GVL_Internal.StackerCrane_xMAC _xAxis1.DeviceAdapter16PD.stBrakeOUT
SEW_GVL_Internal.StackerCrane_xMAC _xAxis1.DeviceAdapter16PD.stActivatedDeviceModes
SEW_GVL_Internal.StackerCrane_xMAC _xAxis1.DeviceAdapter16PD.stSetpointValuesVelocityInterpolated.lrVelocity
SEW_GVL_Internal.StackerCrane_xMAC _xAxis1.DeviceAdapter16PD.stSetpointValuesVelocityInterpolated.lrManValPosCtrlr

4.7.6 Update the MOVISUITE project and save

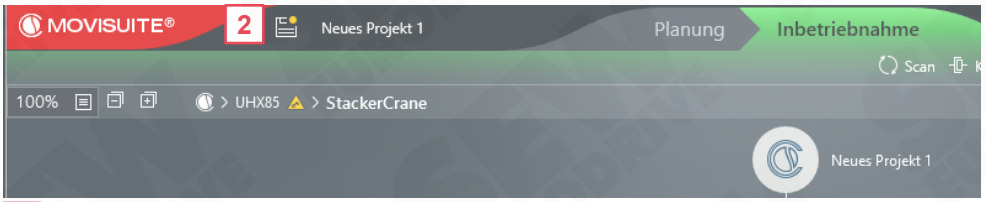
When the IEC project is created in the controller, the MOVIKIT® StackerCrane MultiAxisController automatically sets parameters in the inverters.
These are not parameterized in the MOVISUITE® project and must be transferred from the inverter to the MOVISUITE project.

1. Update the data set





1 Right-click the StackerCrane Software node **Devices -> PC**

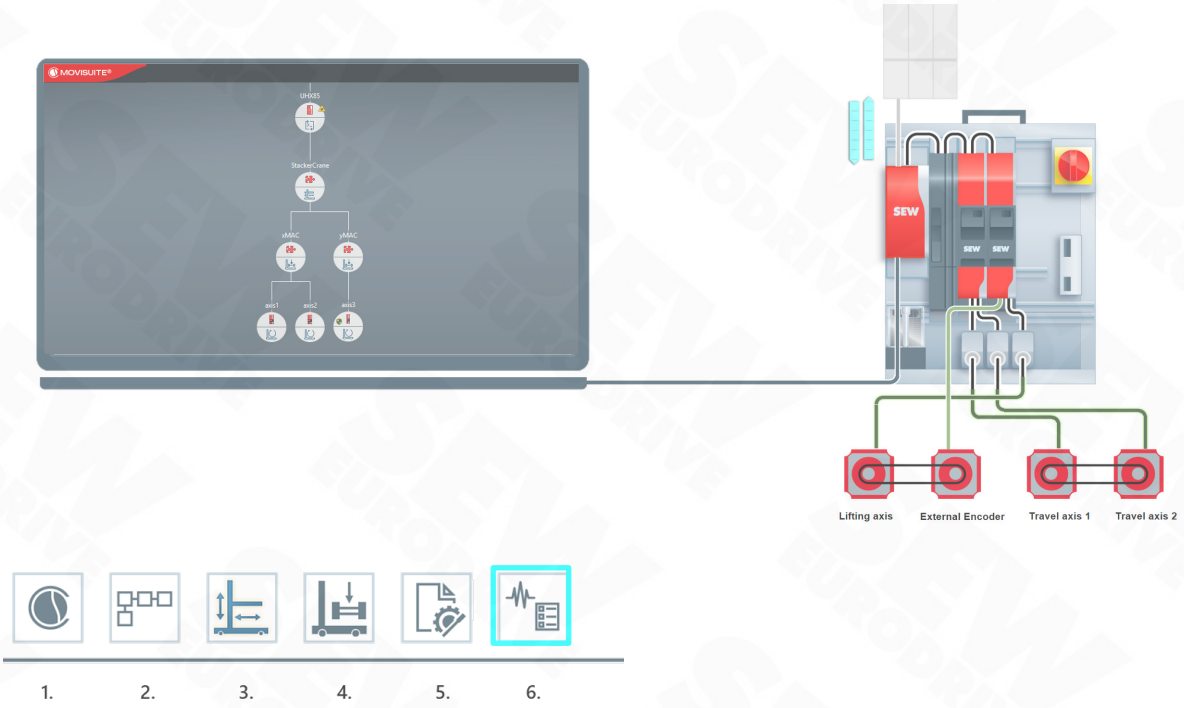


2 Save project

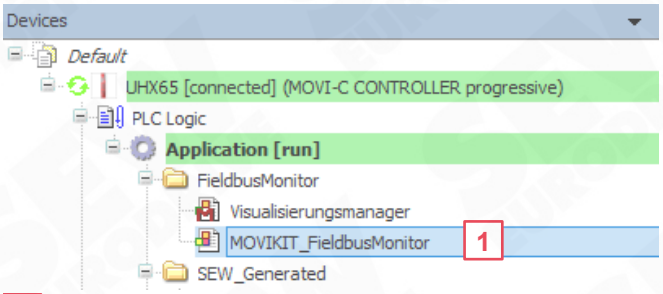
4.8 Step 6 - MOVIKIT® StackerCrane process data monitor

Goals

- Handling the process data monitor

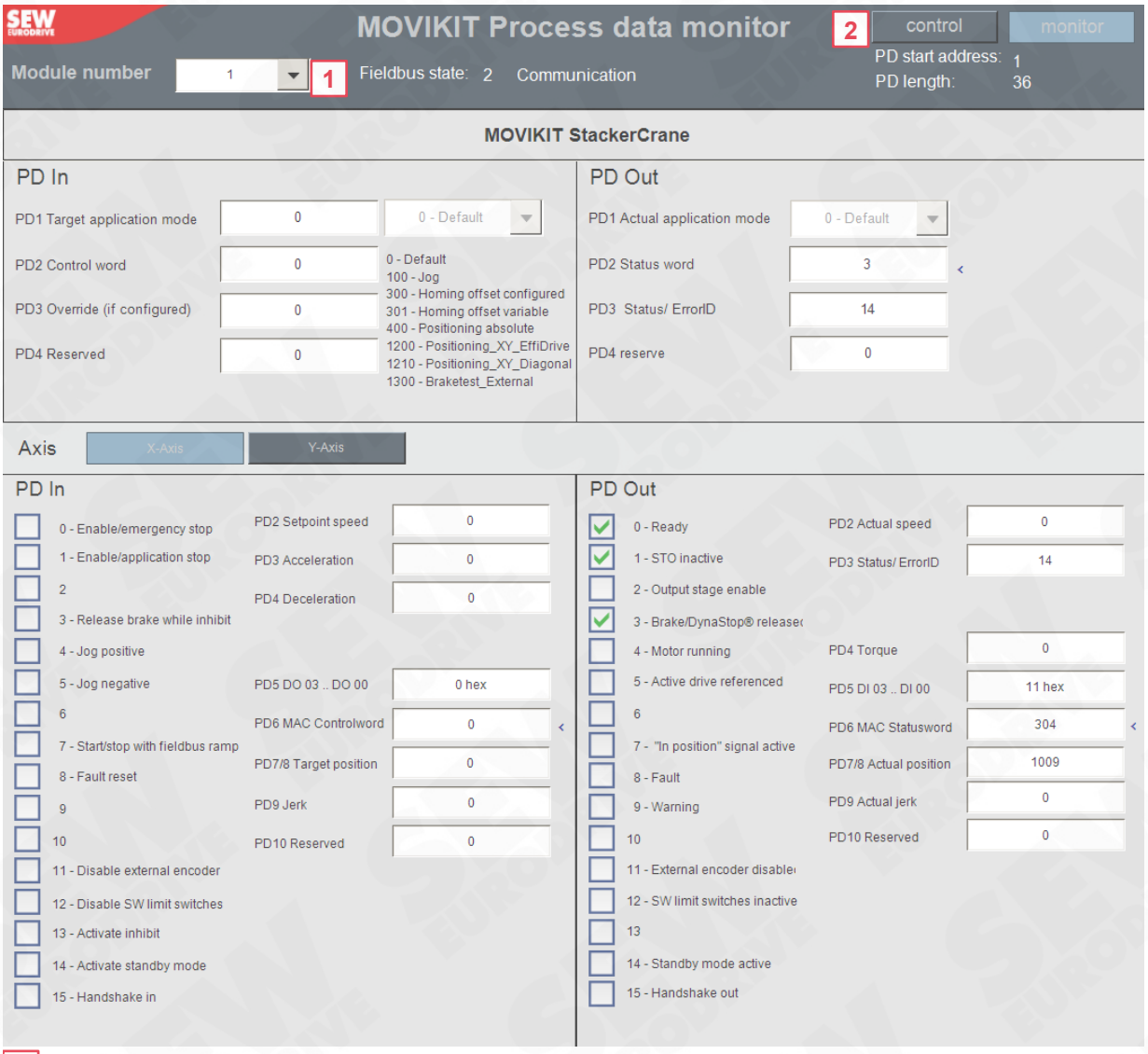


1. Open the process data monitor



1 Click the **MOVIKIT_FieldbusMonitor**

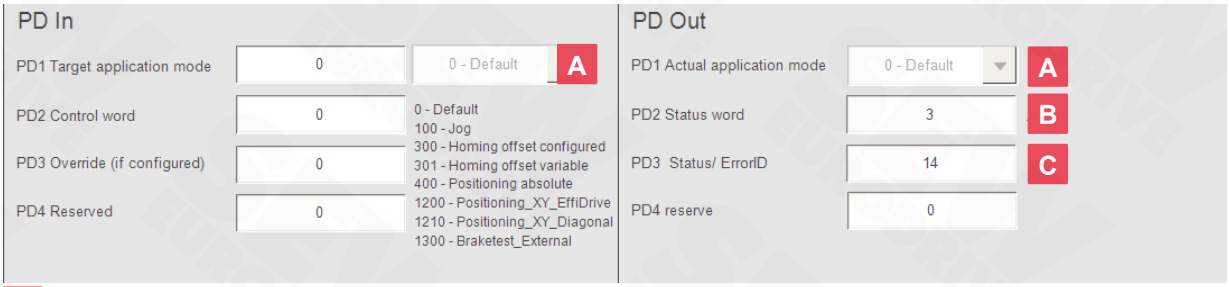
2. Switch the process data monitor mode



1 Select the module 1 **MOVIKIT® StackerCrane**

2 Switch between **control** and **monitor**.

Process data monitor group



A Mode numbering

0	Default
100	Jog
300	Referencing with configured offset
301	Referencing with bus offset
400	Position
700	Test of all brakes one after the other
701	Test of the 1st axis group member of the MultiAxisController (no function without MultiAxisController)
702	Test of the 2nd axis group member of the MultiAxisController (no function without MultiAxisController)
1200	Energy-optimized X-Y positioning
1210	Mechanically optimized positioning
1300	External brake test

B Axis group status word (X and Y rounded)

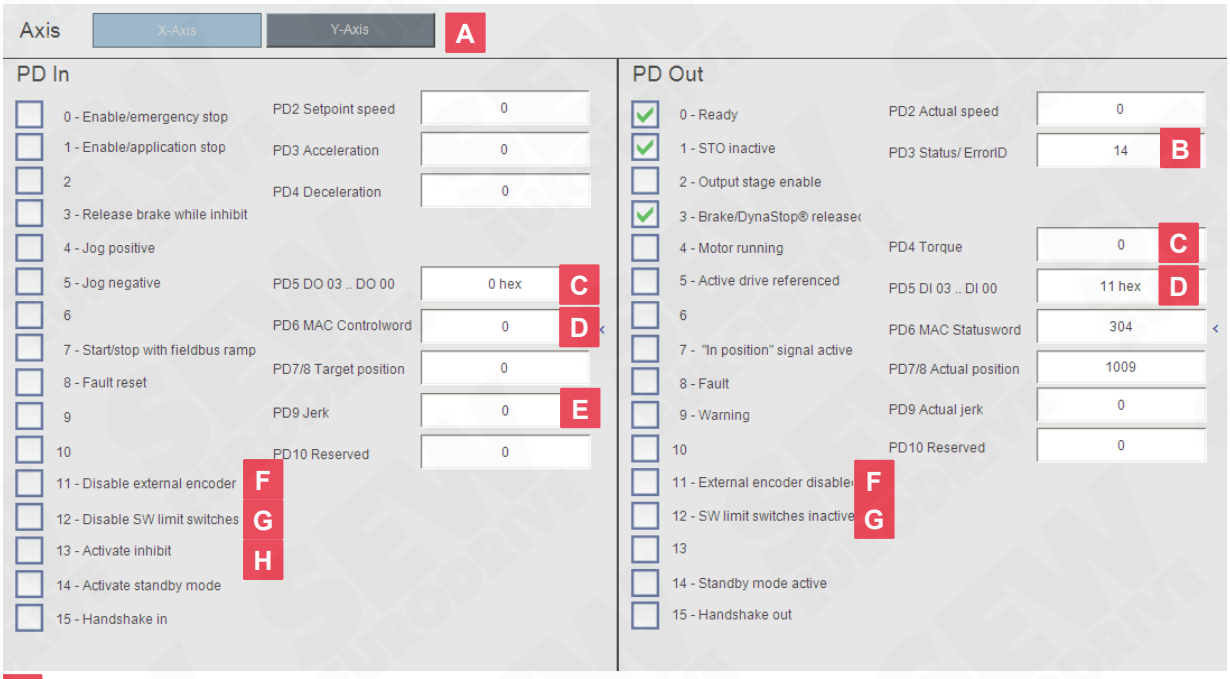
Bit 0	Ready for operation
Bit 7	In position
Bit 8	Error

C Status of the inverters,
The status of the lower-level stations is
- Equal: The status is displayed.
- Not equal: "-1" = FFFF = "undefined" is displayed.

Or in the event of an error ErrorID:

High byte	Error code
Low byte	Subfault code

Process data monitor axes



A Changeover between X and Y axes

B Status of the inverter
For MAC: The status of the lower-level stations is
- Equal: The status is displayed.
- Not equal: "-1" = FFFF = "undefined" is displayed.

Or in the event of an error ErrorID:

High byte	Error code
Low byte	Subfault code

C Digital inputs and outputs

Bits 0 – 3	Axis 1
Bits 4 – 7	Axis 2
Bits 8 – 11	Axis 3
Bits 12 – 15	Axis 4

D Control word for the MultiAxisController

Bits 0 – 3	Deactivate axis group members
Bits 5 – 7	Release brake without enable

E Jerk in user unit/s^3

F Disable external encoder

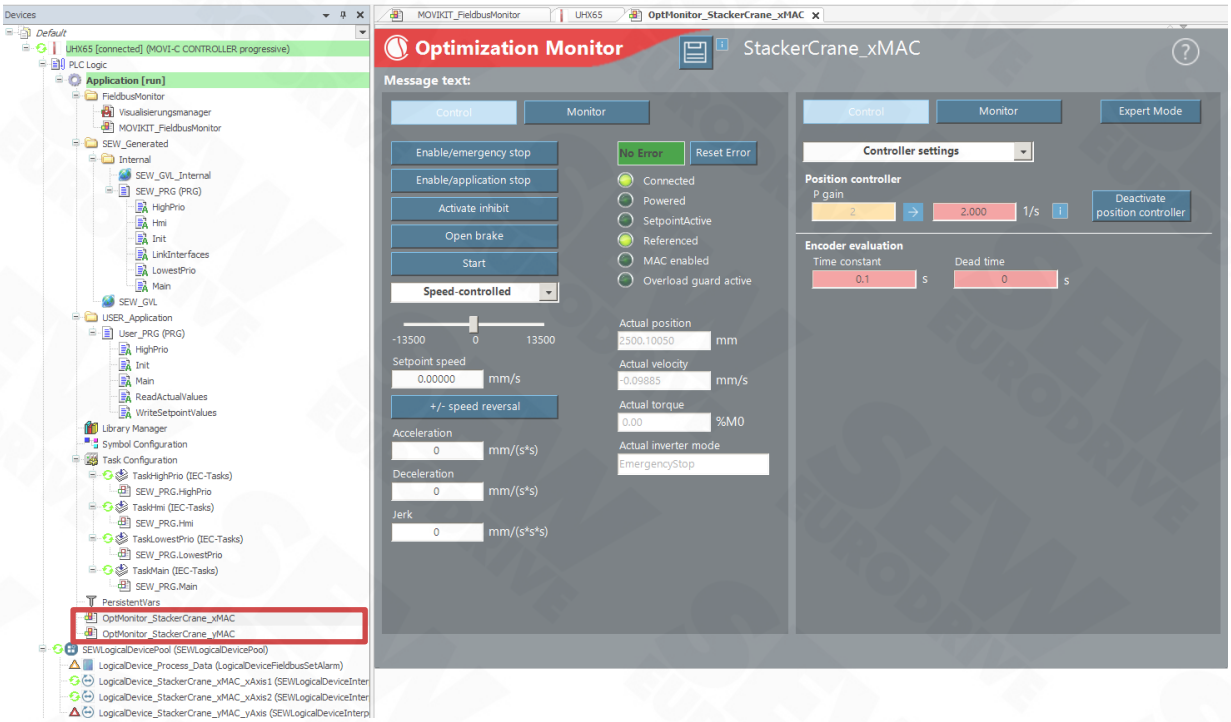
G Disable software limit switch

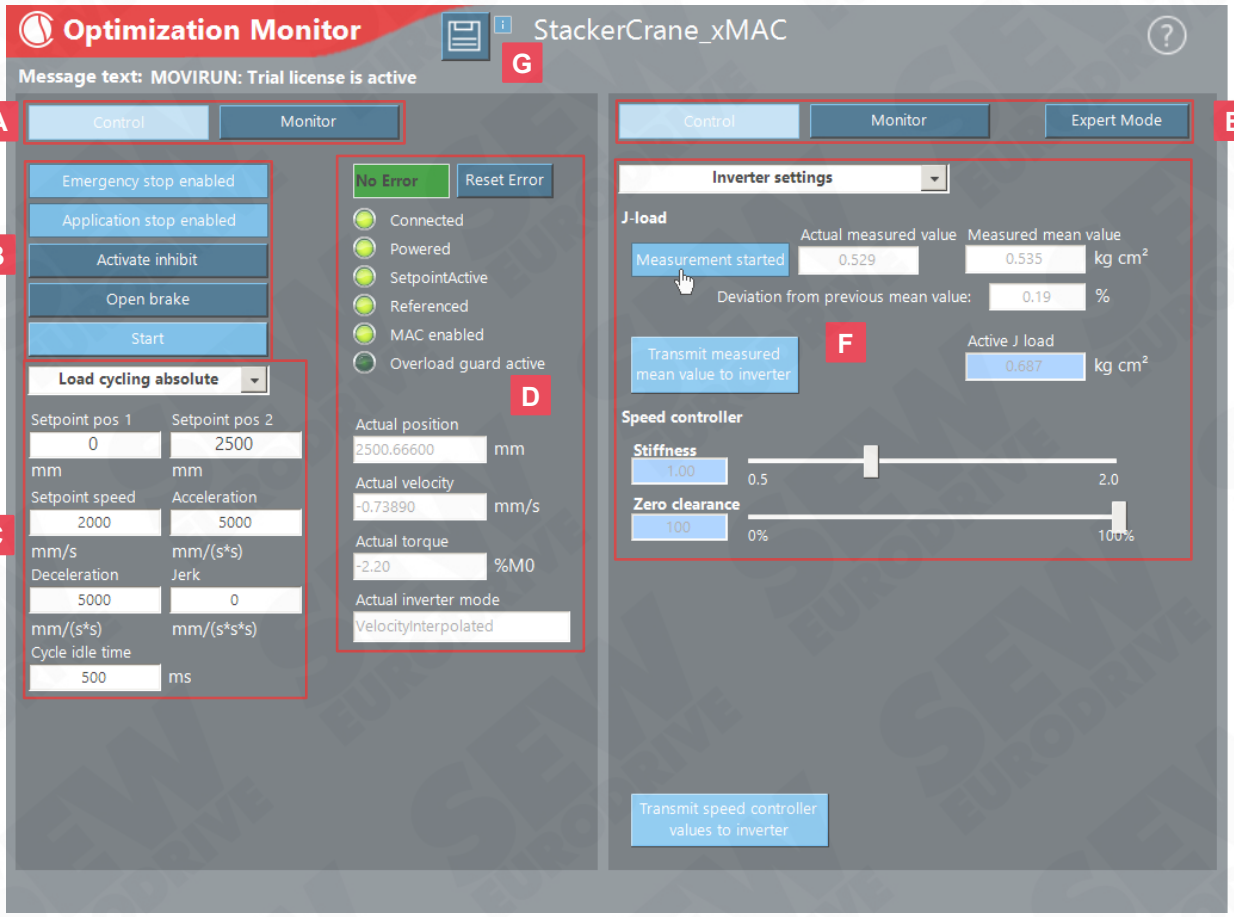
H Activate controller inhibit

4.8.1 Optimization of MultiAxisController

4.8.1.1 Optimization monitor

The optimization monitor is used to operate the MOVIKIT® MultiAxisController via manual mode and for optimizing the control function. The optimization monitor is available in MOVISUITE® in the configuration menu "Module configuration" > "Basic settings" of the MOVIKIT® MultiAxisController under "Tools used" is activated by default. The optimization monitor is added to the IEC project via code generation.





A Select the operating mode for motion control:

- Control – operate the software module independently of the application program or the control of a higher-level controller.
- Monitor (monitor mode) – View current control/status information. There is no intervention in the application program or in the control of the higher-level controller.

B **General control signals**

C **General status signals**

D **Route travel options**

- Referencing
- Speed specification
- (Absolute) positioning
- Shuttle mode

E **Operating mode and mode for the optimization functions**

- Control – Change inverter settings and settings of the MultiAxisController without preventing the control of the software module by the higher-level controller or the application program.
- Monitor (monitor mode) – Current configuration of the inverter or the MultiAxisController
- system.
- Expert mode – Show settings.

F **Optimization function**

- Inverter settings
- MultiAxisController settings
- MultiAxisController actual values
- Actual values of the axis group members of the MultiAxisController
- Advanced settings

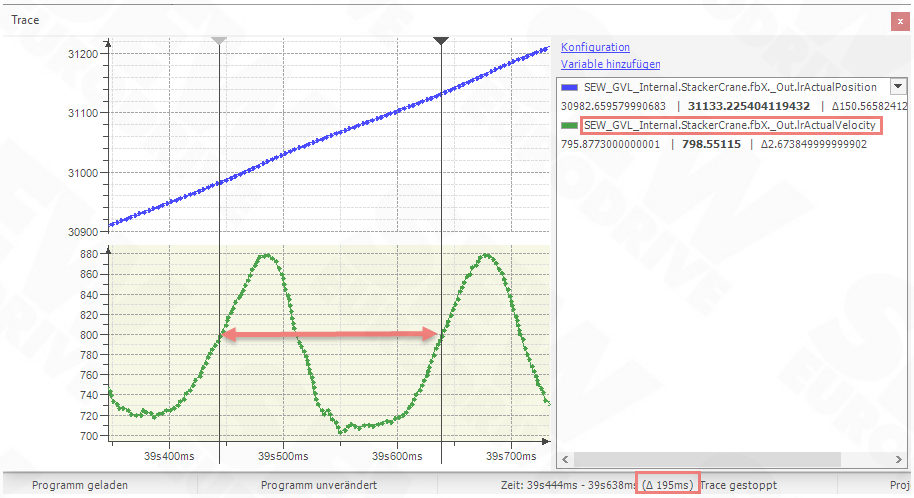
G Save settings to the memory card of the MOVI-C® CONTROLLER

NOTE: The saved values can be uploaded to MOVISUITE® via the [All devices -> PC] function.

Inverter settings, actual values, MAC deactivation, "Allow skew" and "Ignore skew error" are not saved.

4.8.1.2 Determining the time constant

- Set the jerk to "0" in the parameter tree of the axes and via the fieldbus.
- Record a travel with maximum possible ramps and speed and trace the travel.
- In the trace, the period duration corresponds to the time constant to be set.



4.8.1.3 Optimization of P gain

- Increase in P gain
  - Increase in P gain by 2-5%
- Does the controller start to vibrate?

  - No: Repeat the previous step
  - Yes: Reset the P gain to the PREVIOUSLY determined values and proceed to the next step:
- Check the following dynamic sets. If a dynamic set of this results in vibrations, go back to the step "Increase of P gain". If you can move well with all dynamics sets, you have optimized the controller of the MultiAxisController.
  - Slow acceleration and slow speed
  - Slow acceleration and fast speed
  - Fast acceleration and fast speed
  - Fast acceleration and slow speed

If the above measures are not sufficient, increase the time constant in steps of 10%.

Optimization of the MultiAxisController axis in the StackerCrane environment after completion of the initial startup

- Use of the **StackerCrane PD Editor** for controlling the X or Y axis
- **Light tuning:** See above

  Strong tuning: If the controller cannot be optimized via the slight tuning / the above process, the controller settings of the lower-level axis(s) must be checked. As soon as the controller settings of the lower-level axes are changed (e.g. doubling the speed gain), the MAC must be reinitialized.

The parameters of the parameter group [Controller functions] > [Reference travel] > [Readjustment] are overwritten. The other settings of the controller functions remain unchanged.

Then continue with the slight tuning (see above).

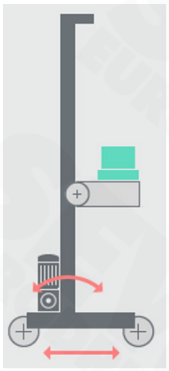
5 MOVIKIT® StackerCrane effiDRIVE add-on AntiSway

5.1 MOTION add-on AntiSway overview

The MOVIKIT® StackerCrane add-on AntiSway extends the range of functions of the MOVIKIT® StackerCrane MultiMotion and the MOVIKIT® StackerCrane MultiAxisController by a function for suppressing vibrations in the drive train.
By using the function, vibrations that have a dominant resonance frequency can be suppressed. In certain operating modes of the MOVIKIT® StackerCrane add-on AntiSway, a changing resonance frequency can also be suppressed.

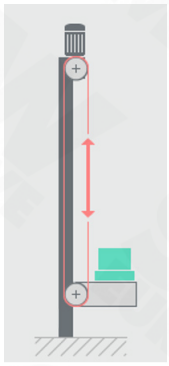
Avoidance of mast vibrations in the x direction

TowerSway - MOVIKIT® StackerCrane effiDRIVE add-on AntiSway



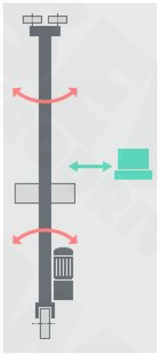
Rope length compensation in y-direction

Combined encoder evaluation - MOVIKIT® MultiMotion add-on CombinedEncoderEvaluation



Avoidance of abdominal vibrations in the z direction

BellySway - MOVIKIT® StackerCrane effiDRIVE add-on AntiSway (In preparation) - If interested, request MFA-PS-ASS.



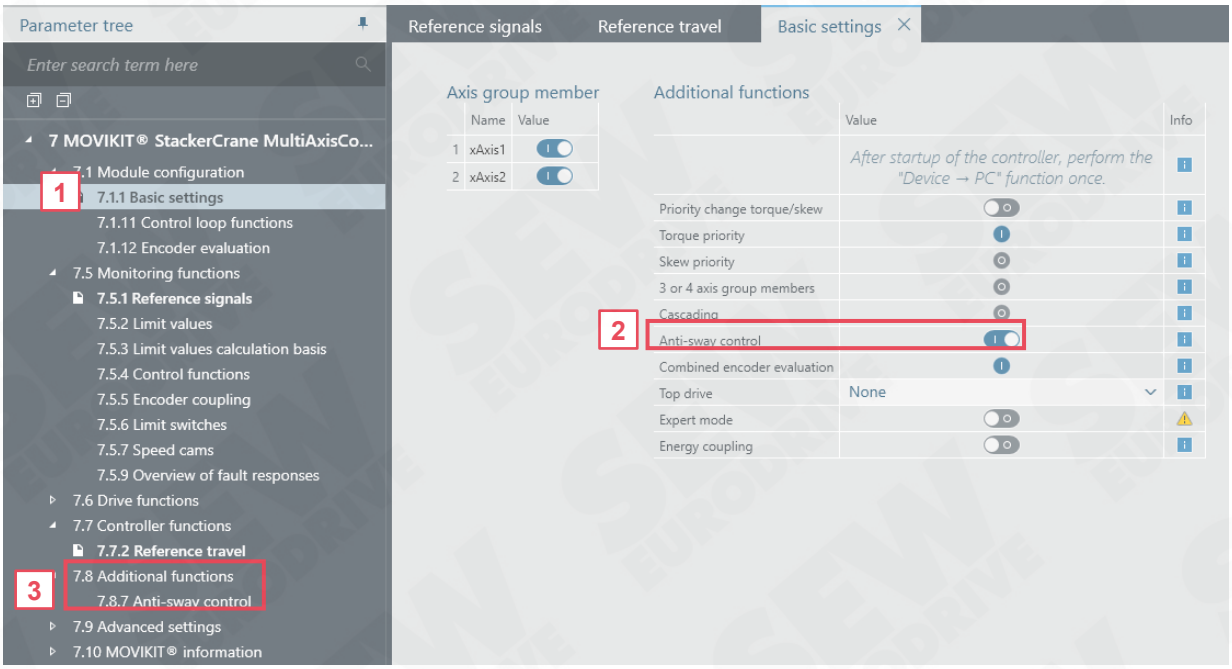
5.2 TowerSway startup

Goals Using an application example, learn how to use the AntiSway MOTION add-on "mast swinging".

5.2.1 Activation of anti-sway control in MOVIKIT® StackerCrane MultiAxisController

1. Activate anti-sway control

The add-on must be activated in the "Basic settings" configuration menu of the software module in the "Functions used" area. If the add-on is activated, the associated configuration menus are displayed in MOVISUITE® under Advanced functions and the corresponding structures are created when generating an IEC project.



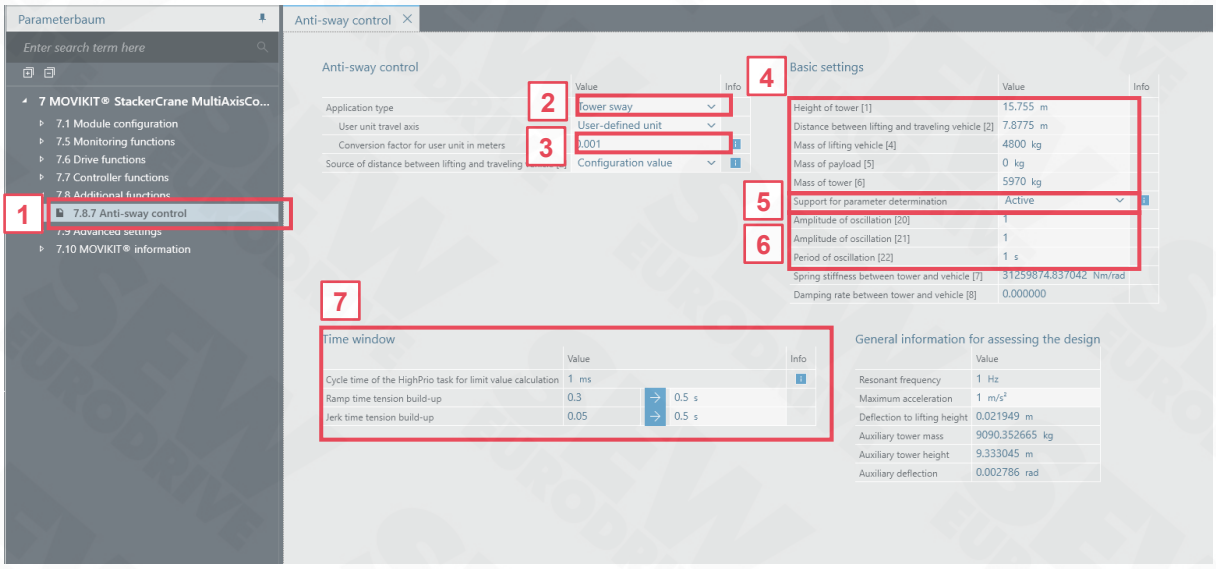
1 Click **Basic settings** in MOVIKIT ® StackerCrane MultiAxisController

2 Activate **Anti-sway control.**

3 **Anti-sway control** appears in the main menu under **Additional functions**

5.2.2 Parameterization of anti-sway control

1. Parameterize the anti-sway control



1. Click the new chapter Anti-sway control in the main menu.
2. Select the **Application type** **Tower sway**
3. Select the conversion factor for user units into m.
   This step is necessary because the function operates in physical units. System Meter is already selected as the user unit, the conversion can be set
   Of the value "0".

The conversion factor for the user unit from the drive train to the SI unit meter depends on the setting of the "User unit travel axis" parameter".

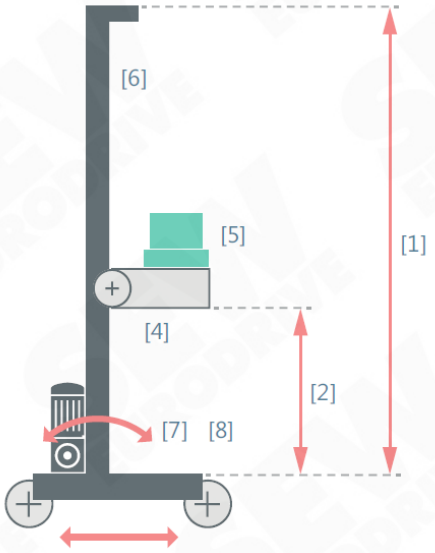
Examples:

User unit	Conversion factor	SI unit
m	* 0	≙ m
mm	* 0.001	≙ m
User-defined unit	* input value	≙ m

NOTE
For the setting "User-defined unit", both the input value 0 and 1 result in the SI unit meter. The conversion factor 0 is optimized with respect to computing time.

Example: User unit 1000 mm * 0.001 = 1 m.
Conversion factor 0.001

4 Enter the dimensions and masses of your application in the basic settings.



No.	Field in the configuration menu	IEC name
[1]	Height of the mast	RHeightTower
[2]	Distance between lifting and traveling trolley (Current position of the trolley at the time of signal recording)	RDistanceHoistToCar
[4]	Mass of the lifting trolley	LrMassHoist
[5]	Mass of the payload (Current payload on the load handling device at the time of signal acquisition)	LrMassPayload
[6]	Mass of the mast	LrMassTower
[7]	Spring stiffness between mast and trolley **Note:** To determine this parameter, see Chapter "Determining stiffness"	LrSpringTowerToCar
[8]	Degree of damping between mast and trolley	RDampTowerToCar

Configuring mast swings (TowerSway) involves defining the parameter
"Spring stiffness between mast and trolley [7] & damping degree between mast and trolley [8]".
If you do not know these values, they can be determined from the signal curve of the swinging-out
Systems by using the damping measured values in the configuration menu
Support for parameter determination.
The values "damping ratio between mast and chassis" and "spring stiffness between mast and chassis"
are calculated and applied directly for anti-sway control.

5 Activate **support for parameter determination.**

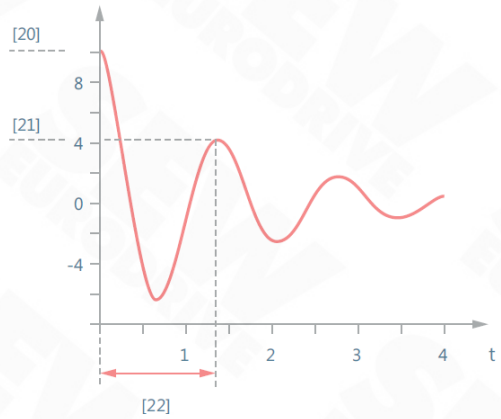
6 The **support for parameter determination** appears.

7 Recommendation: First use the default values in the time window. If the trolley
Strongly regulated (jerk) back and forth, you can set the **jerk time tension build-up** and
Increase **Ramp time tension build up**.
The original motion profile is delayed by the sum
Jerk time tension build-up (lrJerkTime) and **ramp time tension build-up** (lrRampTime).
During this time, the mechanical voltage that corresponds to the desired acceleration is built up.

5.2.3 Support for parameter determination

To determine the parameters, parameter values are also used that are specified under [Anti-sway control]
> [Basic settings]. Make sure that the values for the payload and the lifting height are entered at the time of signal recording.

Damping parameters



No.	Field in the configuration menu
[20]	Amplitude of oscillation (1st peak)
[21]	Amplitude of oscillation (2nd peak)
[22]	Period of oscillation (time between 1st and 2nd vibration amplitude)

1. Determine stiffness

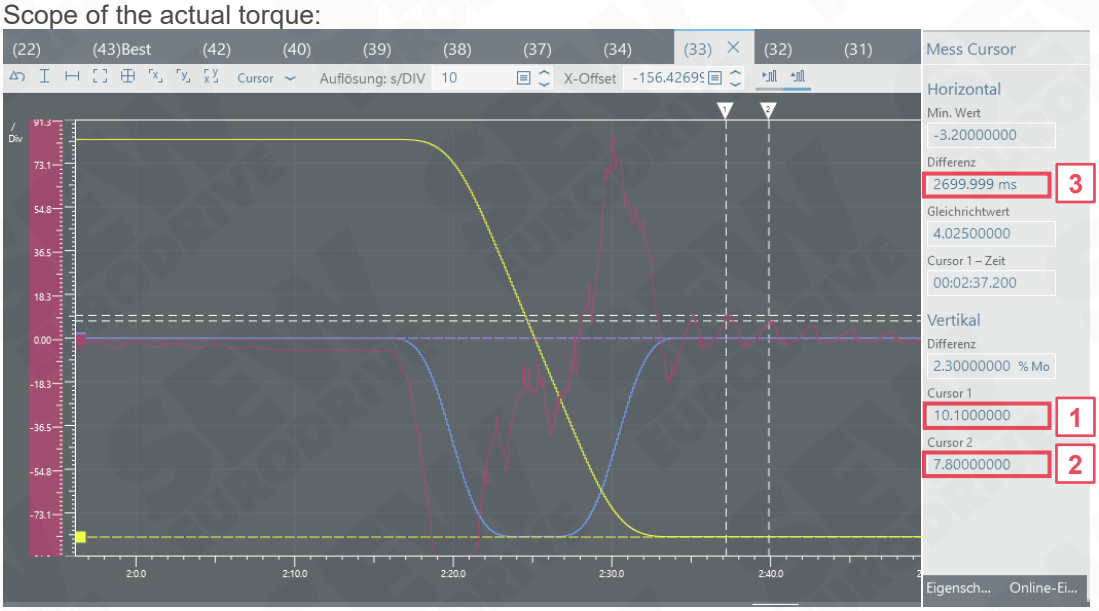
Variant 1 for determining the damping parameters using a scope of the actual torque
Load your application with the required payload and move the lifting axis to the position at which the greatest vibration of the mast occurs. At Application type "tower sway", for example, this is usually the highest point on the mast and the center of the mast for the "belly swing" application type. Update For the period during which stiffness is determined, enter the value for the "Distance" parameter between lifting and traveling trolley" to the lifting height at which the measurement is performed is carried out. If the application does not allow it without anti-sway control moving to the suggested lifting position can also cause the vibration with a lower lifting height or with a lower load. Update them accordingly the parameters.

Deactivate anti-sway control to measure the vibration in the select the setting "Anti-sway control OFF" as the "Application type" or via the fieldbus interface in the optional process data under anti-sway control switch anti-sway control off and on via the control word.

Move the application and take the amplitudes of the oscillating one systems, e.g. by means of a video recording at the point of the greatest vibration. If sufficient torque from the oscillating mass is applied to the motor, a scope recording of the torque can also be used.

Determine the 3 parameters illustrated below using the recordings. The peaks of the vibration amplitudes can also be independent of your amplitude as a ratio to each other (e.g. 1 : 0.8). The "Vibration period" can also be determined over several periods (e.g. measured time / number of oscillation periods)

Scope of the actual torque:



1 Value for **Amplitude of oscillation [20]**

2 Value for **Amplitude of oscillation [21]**

3 Value for **Period of oscillation [22]**

1. Enter damping parameters

Amplitude of oscillation [20]	1	10.1
Amplitude of oscillation [21]	2	7.8
Period of oscillation [22]	3	2.69999 s

1 Enter the **Amplitude of oscillation [20]**

2 Enter the **Amplitude of oscillation [21]**

3 Enter the **Period of oscillation [22]**

Activate anti-sway control again by selecting your application type.
Check the setting for "Name of axis for lifting position",
If you use the "mast swing" application type.

Enter the measured values determined (see figure) in the corresponding setting fields "Anti-sway control" in the configuration menu.

- The values "damping ratio between mast and chassis" and "spring stiffness between mast and chassis" are calculated and applied directly for anti-sway control.
- The natural frequency, the resonance frequency, and the "deflection at lifting height" are determined to check plausibility in relation to reality and the design calculations

General information for assessing the design

	Value
Resonant frequency	0.370058373002718 Hz
Maximum acceleration	1 m/s²
Deflection to lifting height	0.185755 m
Auxiliary tower mass	9090.352665 kg
Auxiliary tower height	9.333045 m
Auxiliary deflection	0.023583 rad

- Perform a plausibility check using the value "deflection at lifting height" in the "General information for assessing the design" area in the "Anti-sway control" configuration menu.

Perform a plausibility check using the value "deflection at lifting height" in the "General information for assessing the design" area in the "Anti-sway control" configuration menu.

2. Transfer configuration

Generate an IEC project using automatic code generation and load it and the changed configuration data onto the MOVI-C® CONTROLLER.

3. Control anti-sway control

Since the I*nPosition* bit is linked to *xBusy* (anti-sway control active) and thus the
The compensation movement of the anti-sway control is not yet complete, the *InPositions*
Bit when using anti-sway control in certain cases only with deceleration.
To control anti-sway controlthe configuration parameters of
MOVISUITE® and the following process data via the fieldbus interface can be used:

- PO 29 Enable anti-sway control: Switch the function on or off
- PO 25 X: Payload (optional)

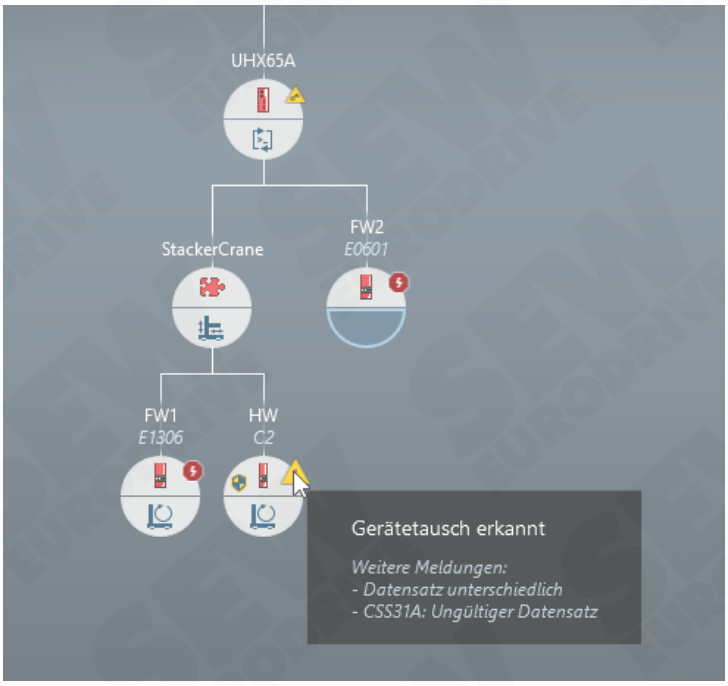
6 Copy project/aisle

Prerequisite:

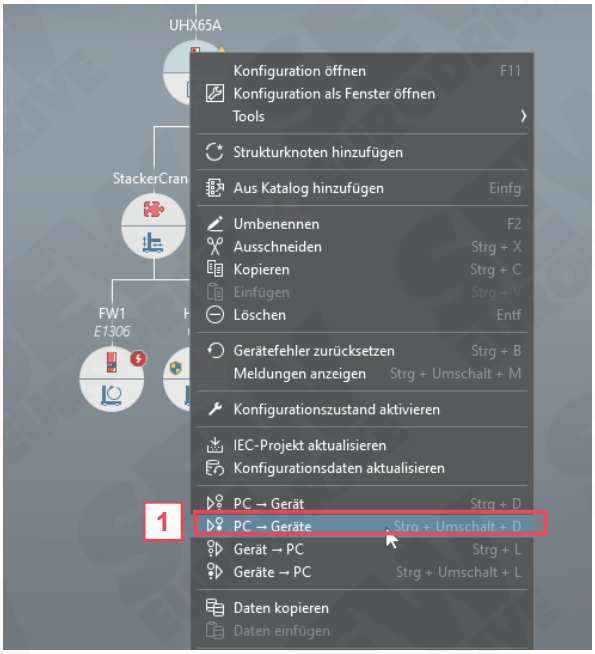
- MOVISUITE and IEC project including safety have been put into operation.
- MOVI-C CONTROLLER of the new project, e.g. aisle 2, has the same PROFINET address and firmware version.
- The same PC or laptop is used to copy the project.

6.1 Perform device replacement

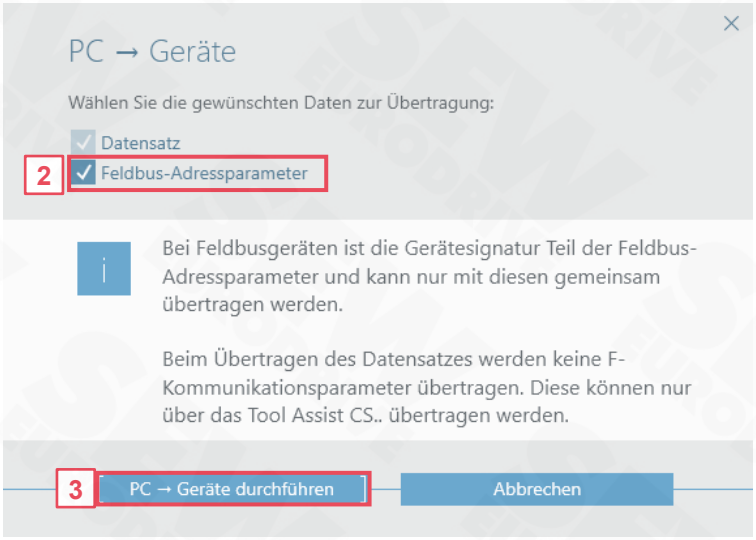
1. **Connect the project to a new aisle**
2. **Device replacement detected**



3. **Perform device replacement**

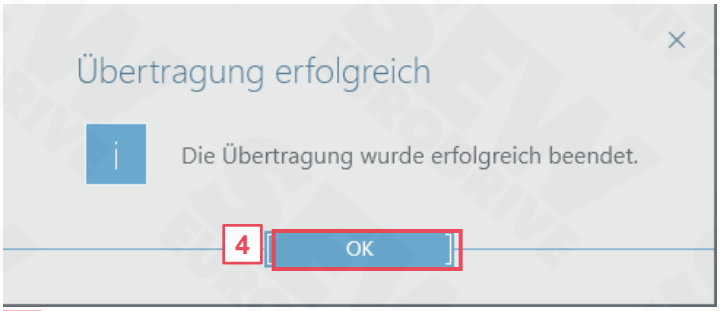


1 Select the controller and right-click and select **PC -> devices**.



2 Activate the **fieldbus address parameters for transmission.**

3 Click **PC -> Perform devices.**

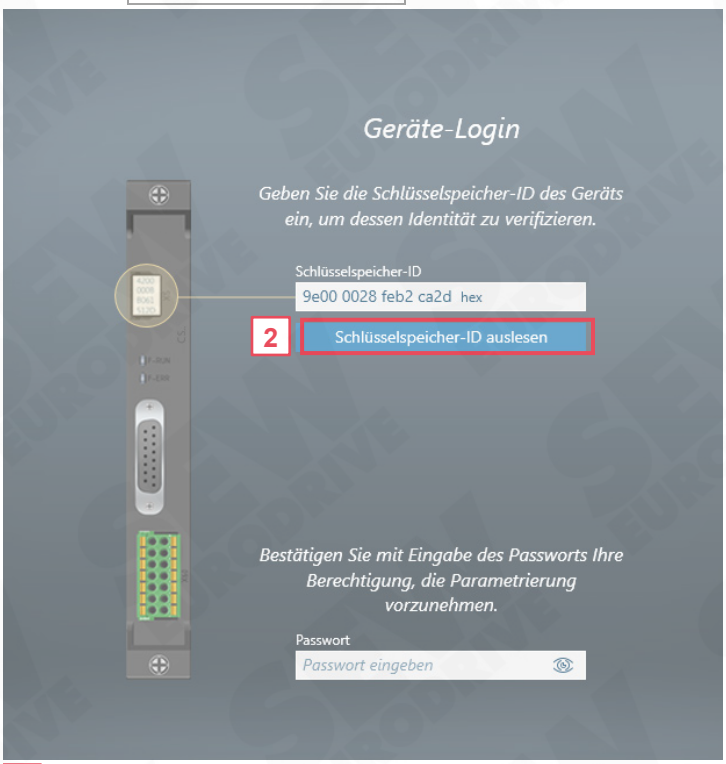


4 Click **OK.**

6.2 Safety data set in CS.. copy

1. Axes with safety cards indicate a critical error.

1 Click **Tool Assist CS.. start.**



2 Click **Read key memory ID.**

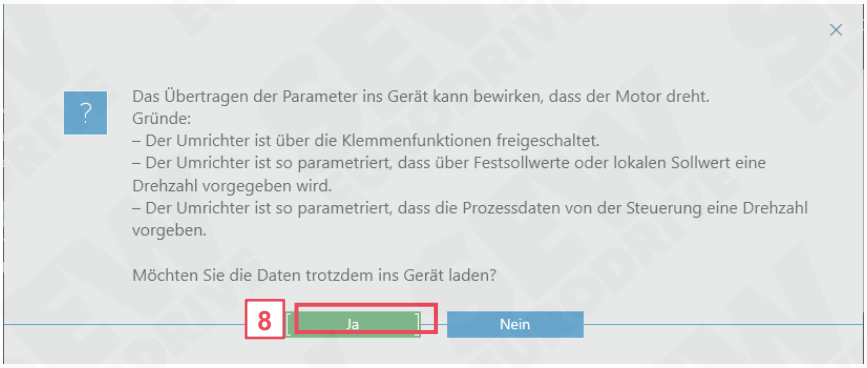
3 Check whether the selected axis flashes and click **Yes, flashing pattern identical.**

4 Enter the **password**.

5 Select **PROFIsafe** in F-communication.

6 Select the **F-address and the address type.**

7 Click **Transfer data to device** .

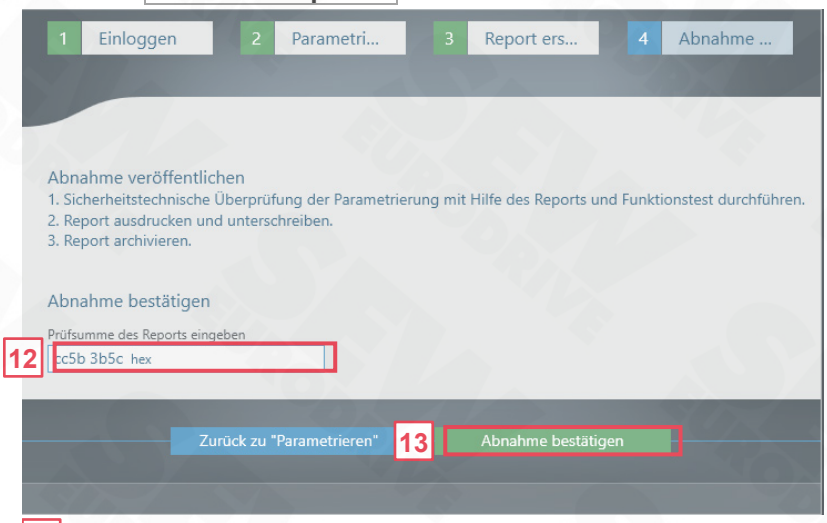


8 **Click Yes.**

9 **Click Continue to create report** .

10 Click **Continue to create report** .

11 Click **Next to acceptance**.



12 Enter the checksum of the report .

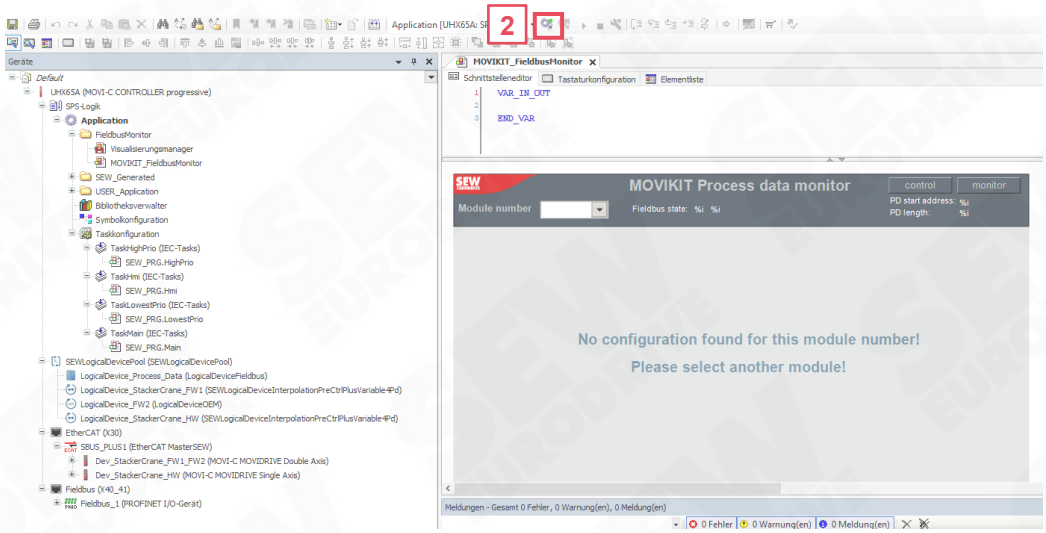
13 Click **Confirm acceptance** .

14 Click **Tool Assist CS.. exit.**

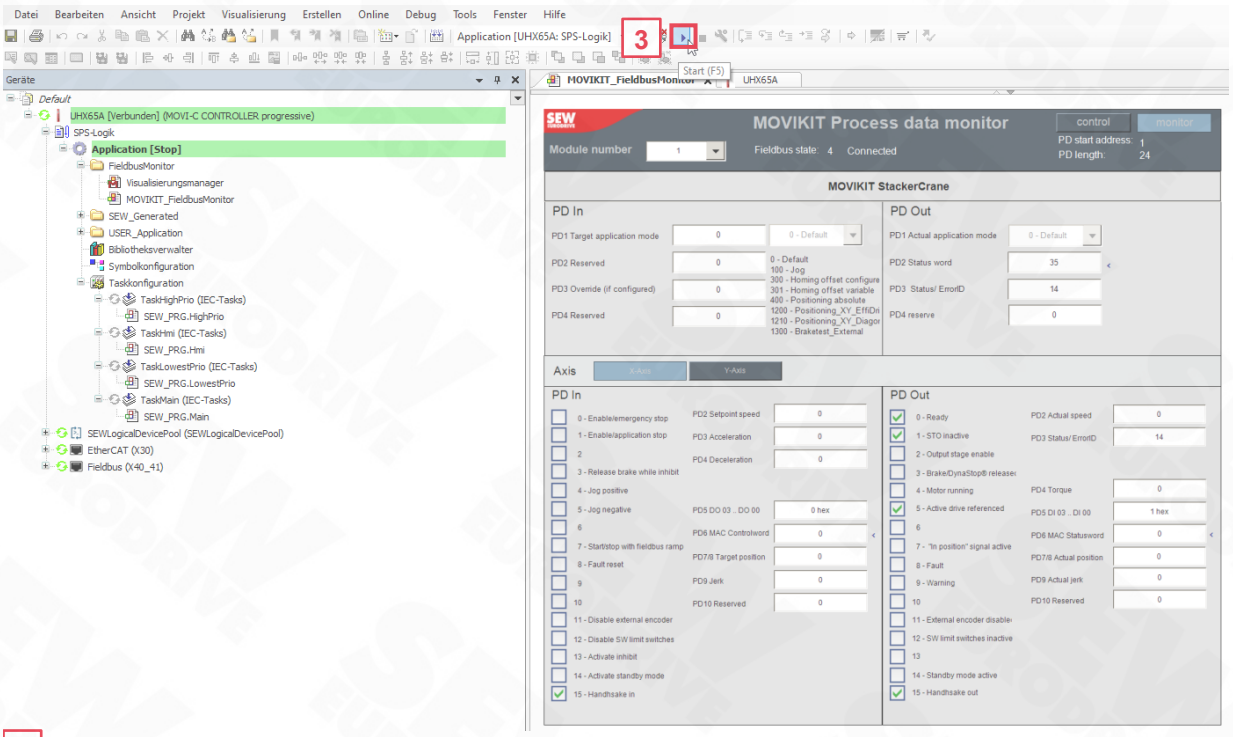
5. **Safety reset by power off/power on**

6.3 IEC project

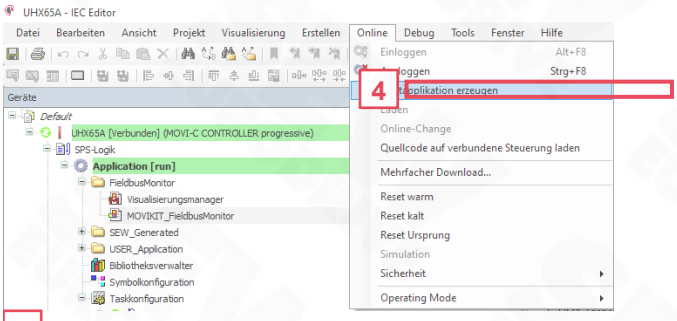
1 Click **Open IEC Editor** .



2 **Log in to the controller .**

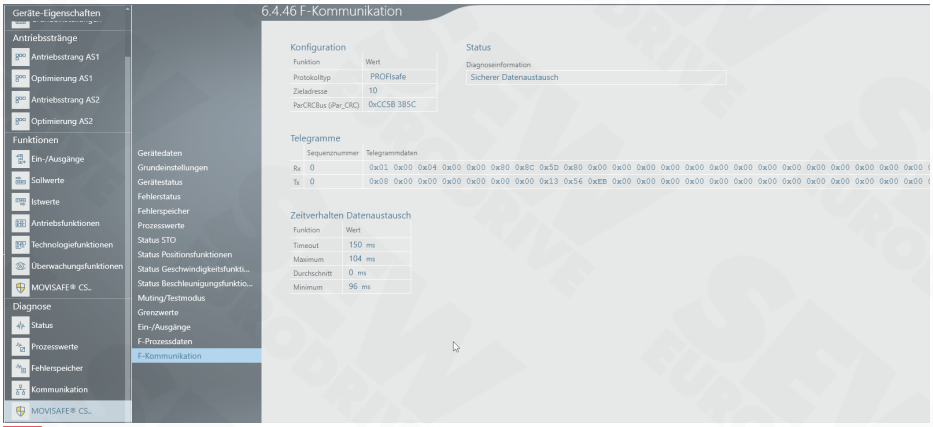


3 Click **Start** or **F5**

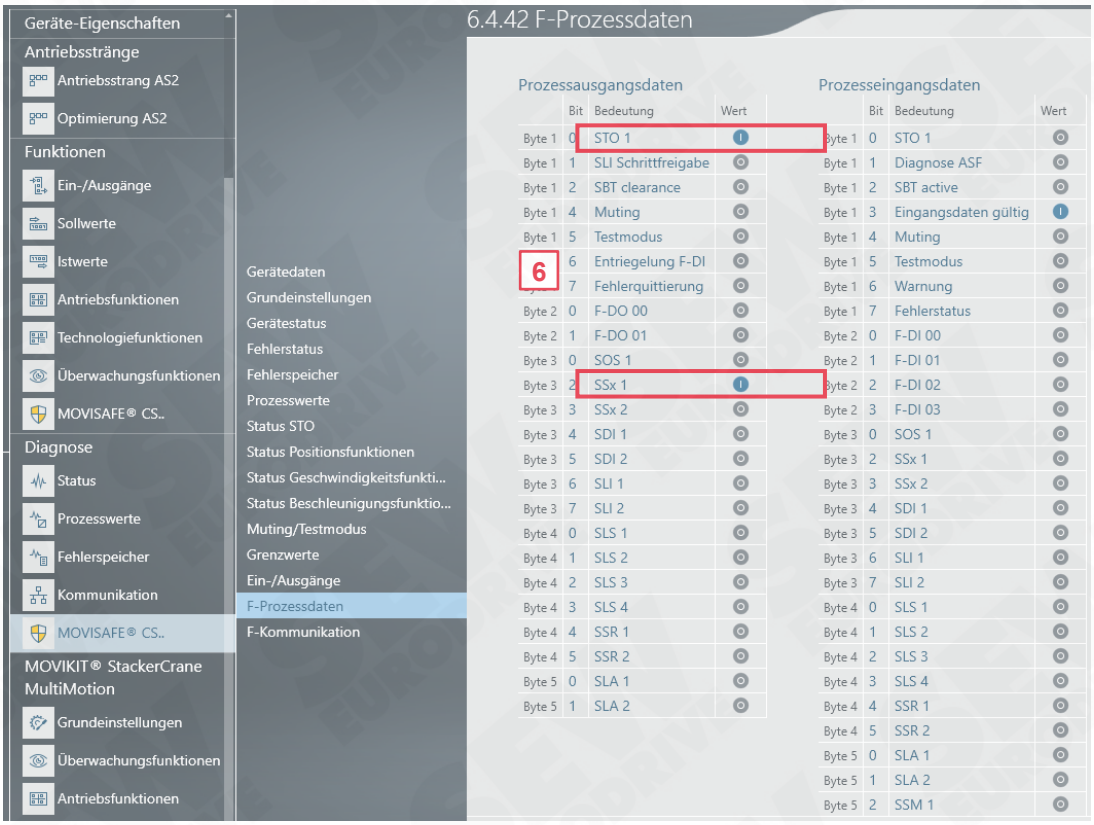


4 **Create boot application**

Check F-communication status



5 Check F-communication status **Safe data exchange**.



6 Set F-process data in S7 and check in MOVISUITE.

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