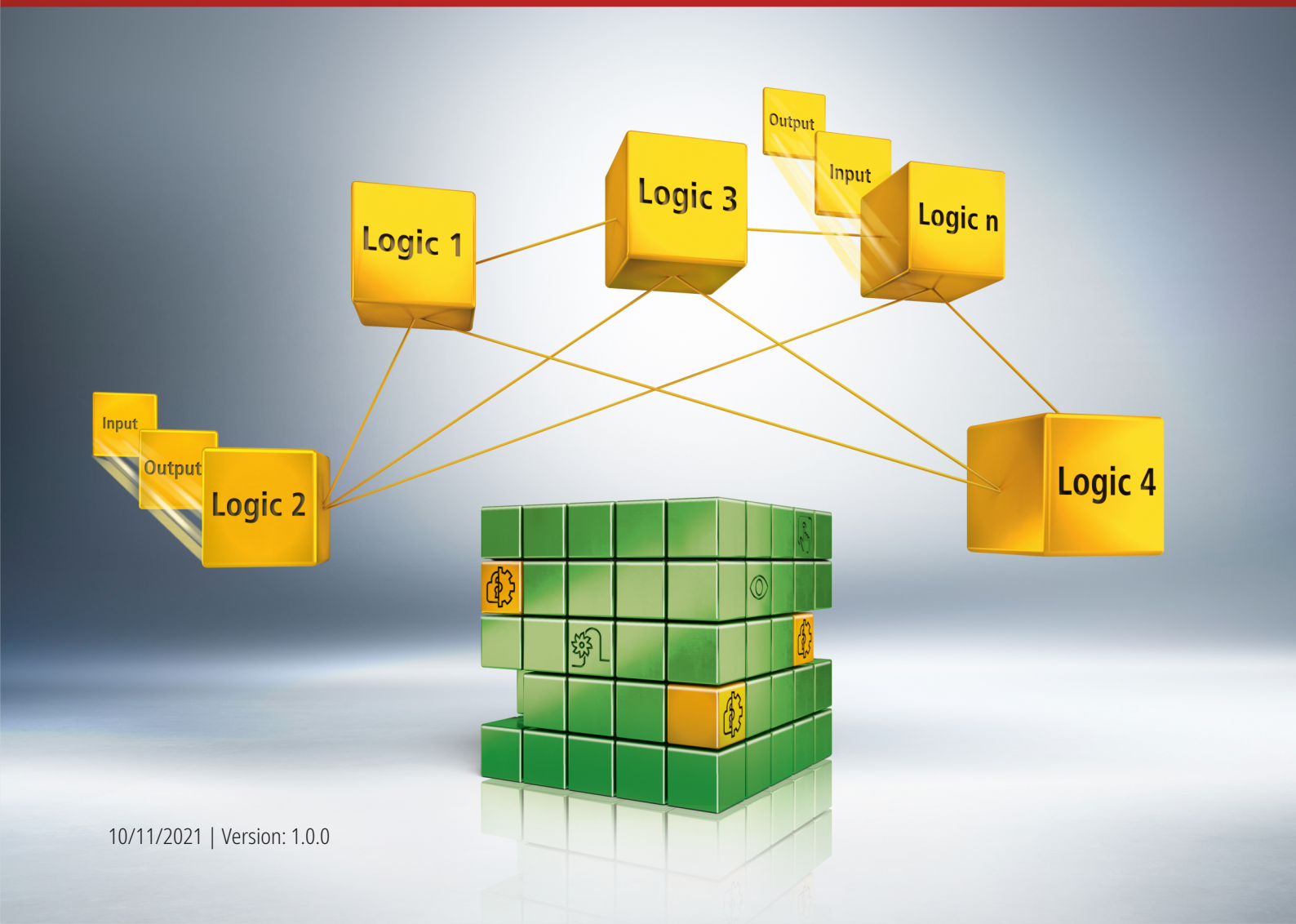
BECKHOFF New Automation Technology

TwinSAFE Tutorial 13 | EN

SafeMotion Wizard

AX8000 project with Primary and Secondary Feedback



10/11/2021 | Version: 1.0.0

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1 Introduction

TwinSAFE includes several innovations that bring more functionality and performance to your safety controller. A major innovation is that the functionality of the safety controller is integrated in each TwinSAFE component. This means that you can, for example, use a TwinSAFE input component both as an input component and the safety control integrated on it to use application-specific pre-processing.

This is tutorial 13 of a tutorial series.

The aim of this tutorial series is to familiarize you with the TwinSAFE innovations using individual examples.

This tutorial is about the realization of a Safe Motion project with the SafeMotion Wizard, which uses primary and secondary feedback at the same time.

1.1 Edition status

Edition	Comment
1.0.0	• First released edition
0.0.1	• First draft

1.2 Requirements

Meet the following requirements for this tutorial:

- TwinCAT 3 version ≥ 3.1.4024.11
- TwinCAT Safety Editor TE9000 ≥ 1.2.1.1
- TwinSAFE firmware ≥ 03
- AX8000 firmware ≥ 0104; with default module ID active

1.3 Starting point

At the starting point of the tutorial

- a TwinCAT 3 project with standard PLC exists,
- an EL6910 project exists.

1.4 Demo system

1.4.1 Hardware

The demo system of this tutorial consists of the following hardware:

- CX for EtherCAT communication and the standard PLC controller
- EL6910 as master TwinSAFE Logic
- EL1918 with safe inputs for reading light barrier signals
- Light barrier
- AX8000-x2xx
- Primary feedback via OCT Safety (AM8021)
- Secondary feedback via EnDat 2.2 Safety → mounted on linear axis

1.4.2 Desired Safety functionality

This tutorial describes the implementation of the following safety functionality using the SafeMotion Wizard:

- SLS via the Primary Feedback.
- SLP via the Secondary Feedback.

2 Demonstration

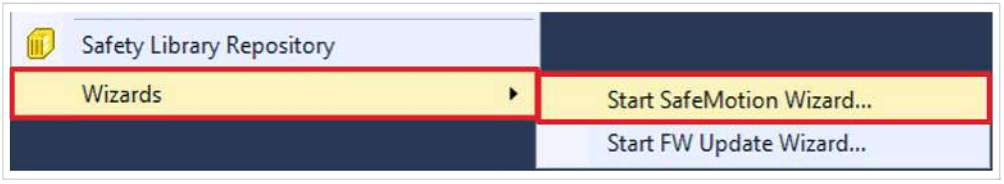
2.1 Create Safe Motion project

Starting point of the tutorial is an existing TwinCAT3 project with an existing I/O configuration and the corresponding Safe Motion entries.

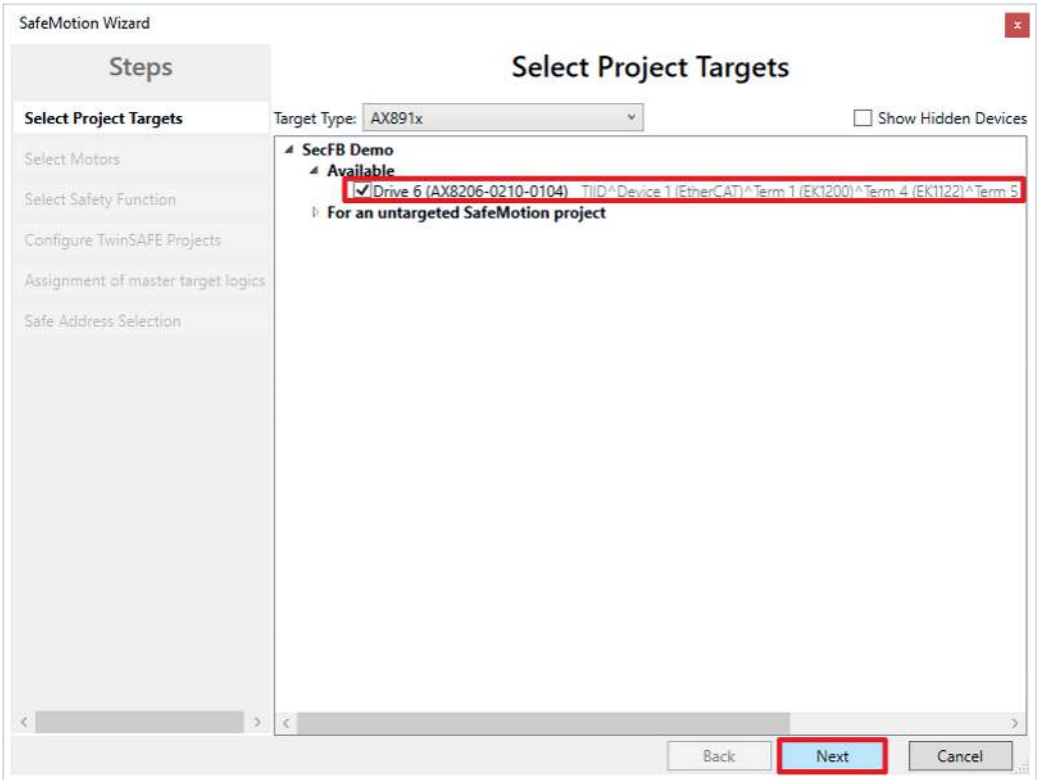
Proceed as follows to create a Safe Motion project with the SafeMotion Wizard:

1. Select project

2. Select “TwinSAFE” tab

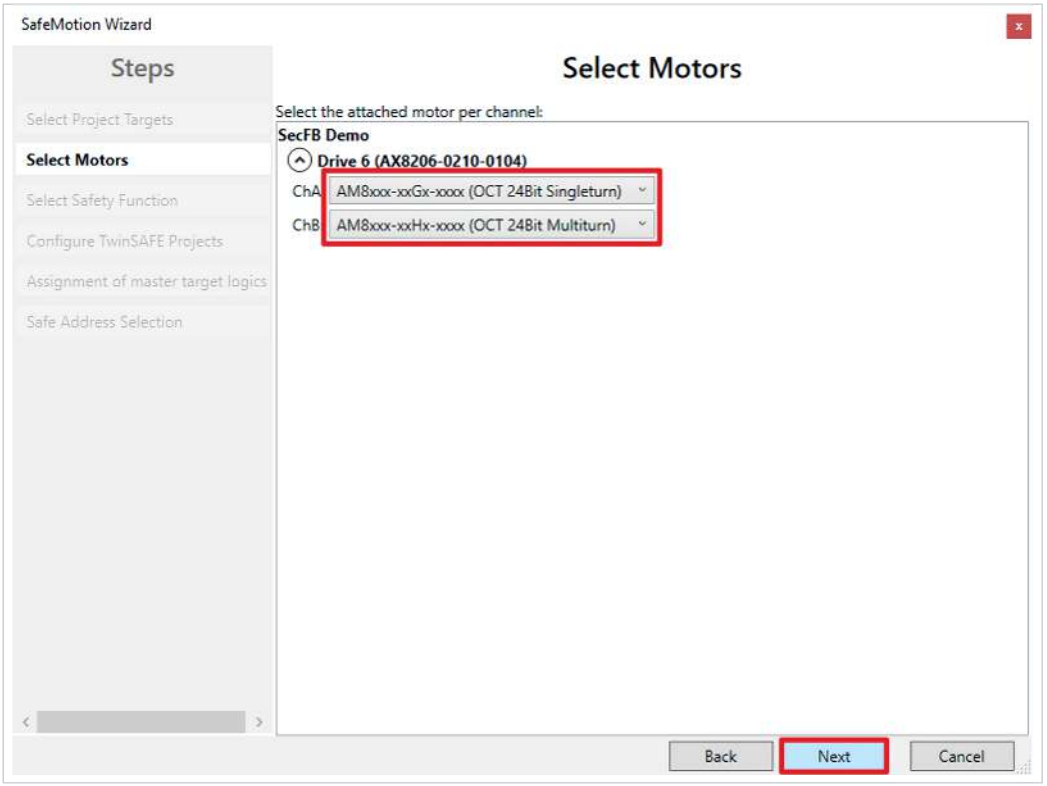


3. Select “Start SafeMotion Wizard...” via the wizard field



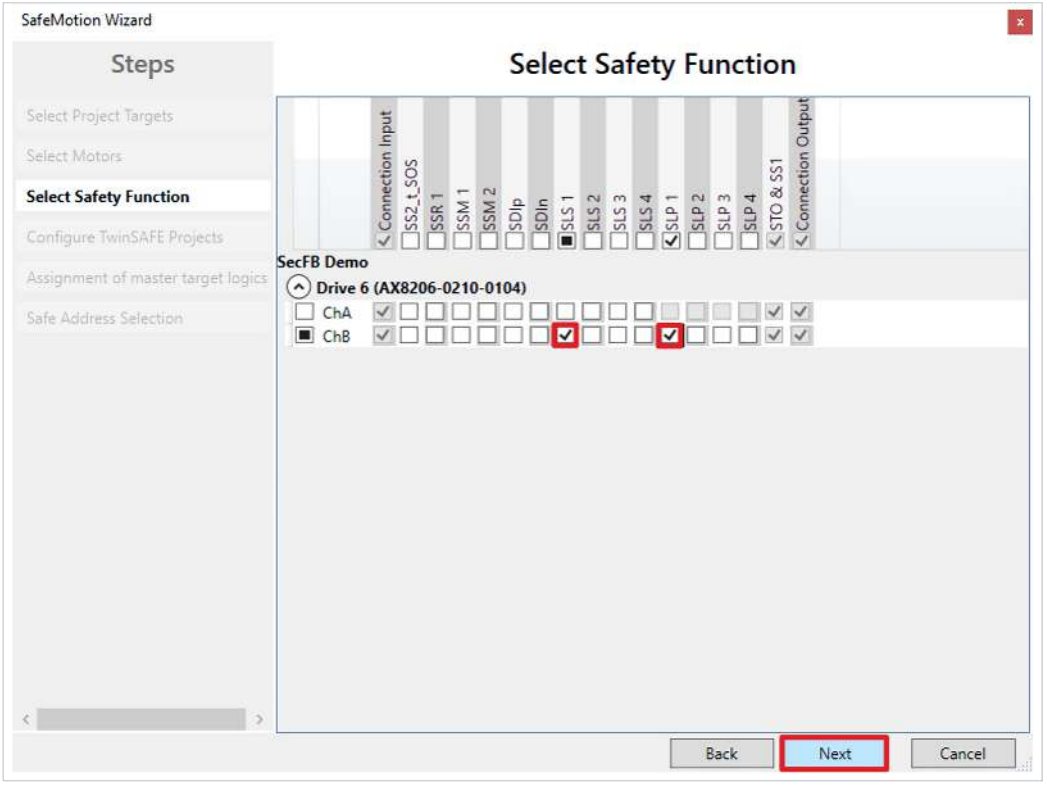
The “Select Project Targets” window opens and shows you an overview of all existing and virtual axes.

4. Select Safe-Motion component
5. Confirm selection with “Next”



In the “Select Motors” window, you configure the feedback for the individual axes.

6. Select “AM8xxx-xxGx-xxx (OCT 24Bit Singleturn)” for ChA
7. Select “AM8xxx-xxHx-xxx (OCT 24Bit Multiturn)” for ChB
8. Confirm selection with “Next”

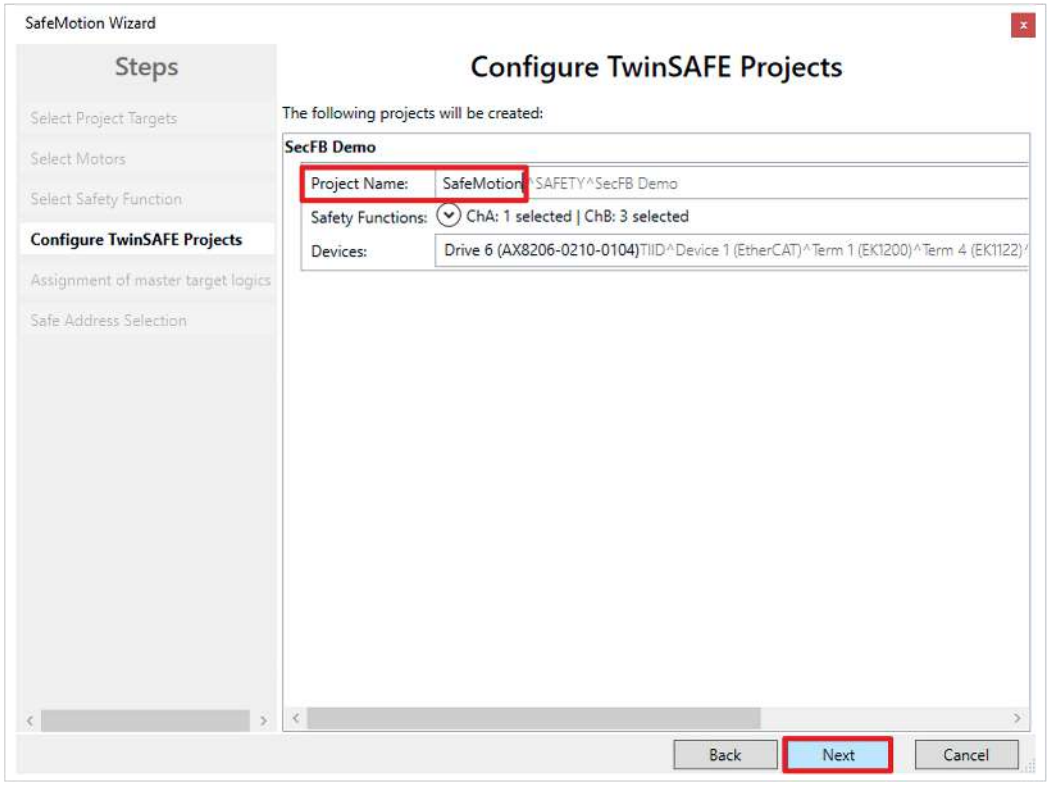


In the “Select Safety Function” window, select the desired safety functions.

9. Select the safety functions SLS1 and SLP1 for ChB

The STO safety function is active as a default setting for all channels.

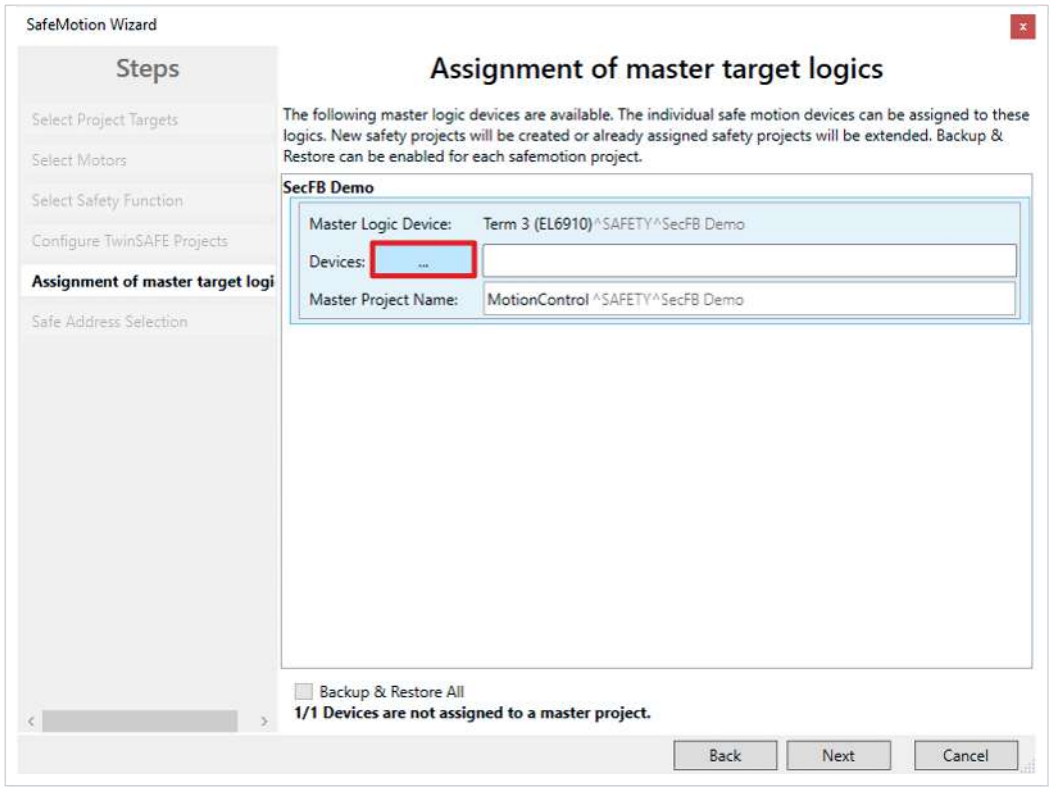
10. Confirm selection with “Next”



The “Configure TwinSAFE Projects” window opens. Here you have the option of renaming your safety project, which is generated for your safe motion component.

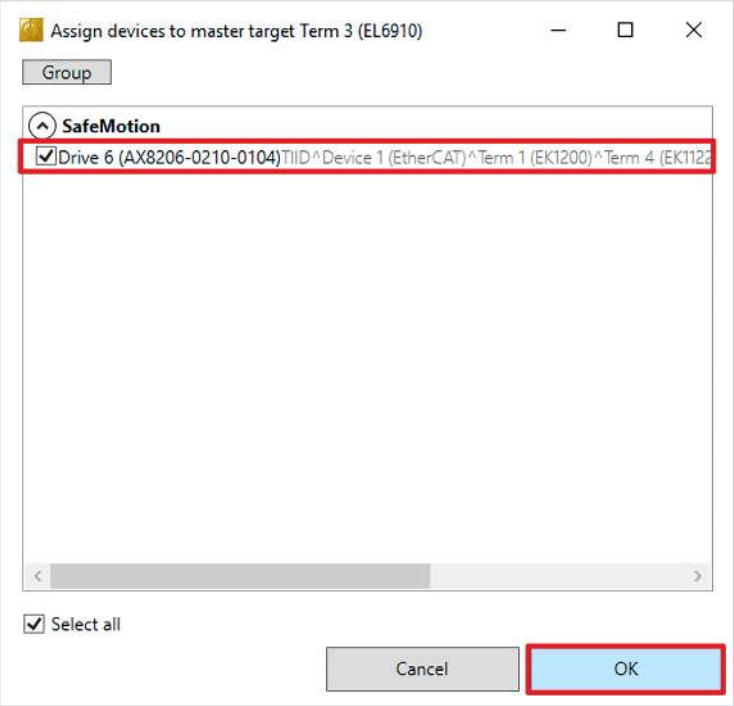
You also get an overview of the safety settings that have been made.

11. Rename project as desired
12. Check settings
13. Confirm selection with “Next”

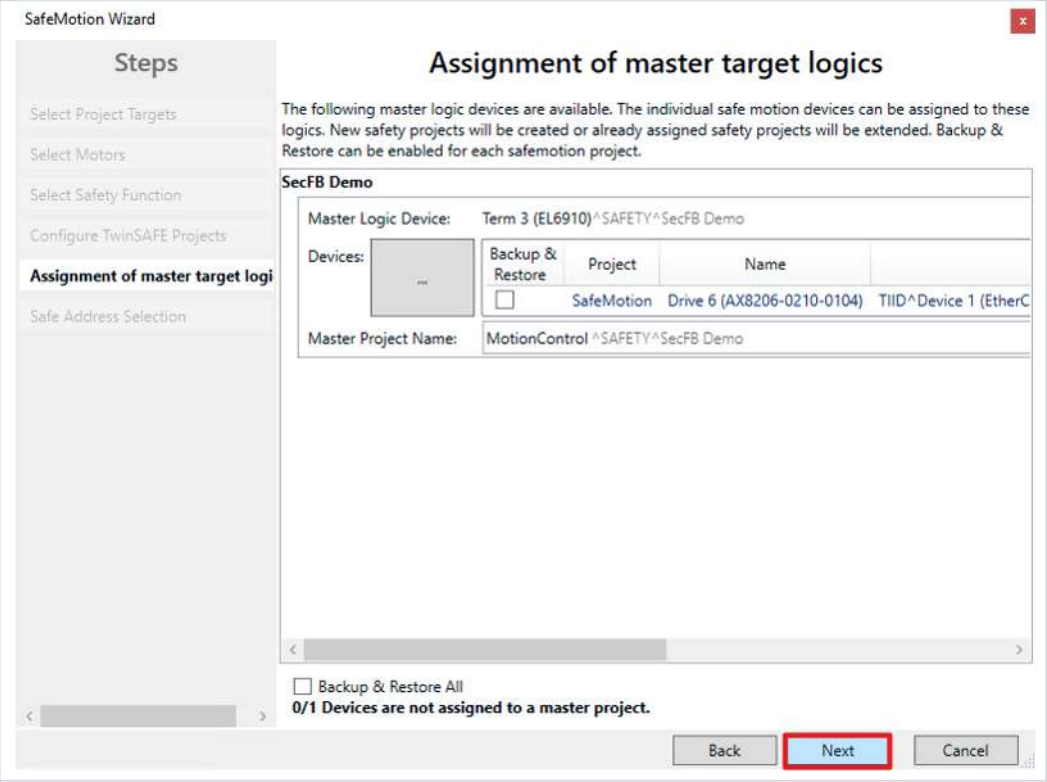


In the next window “Assignment of master target logics” the connection to the EL6910 project is closed so that your Safe Motion component can communicate with the EL6910 project. The EL6910 project is automatically found and displayed.

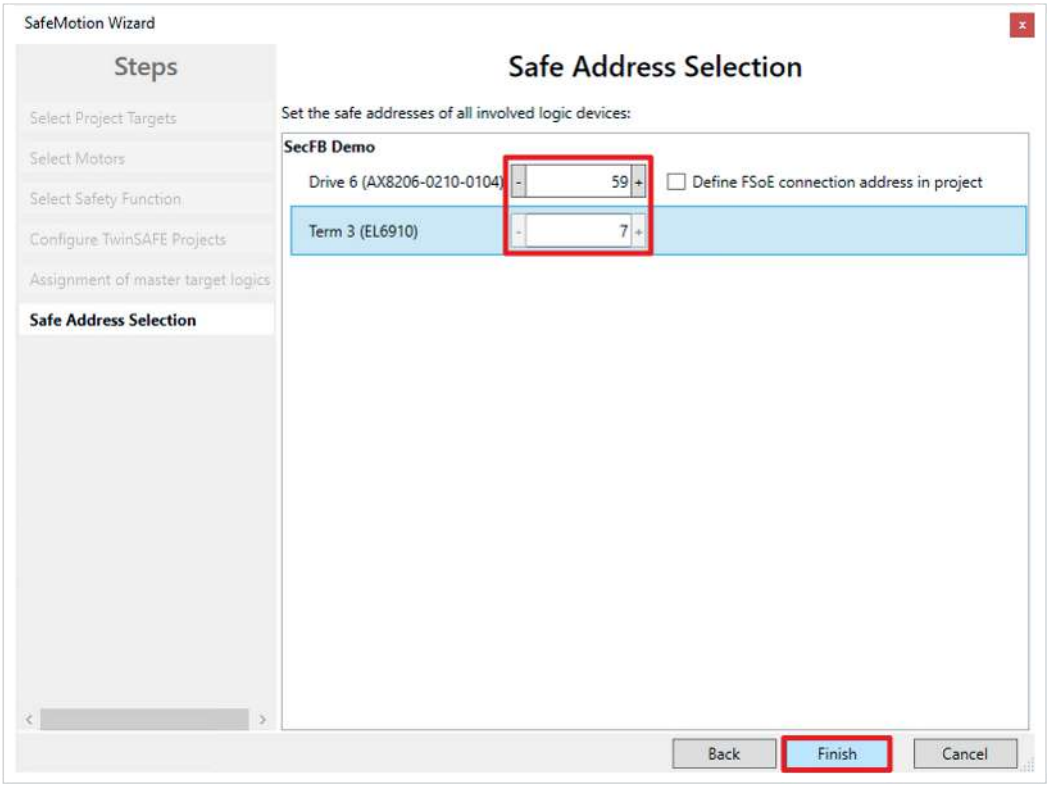
14. Click the button “ ... “



15. Select safe motion components that you want to connect to the EL6910 project
16. Confirm selection with “OK”



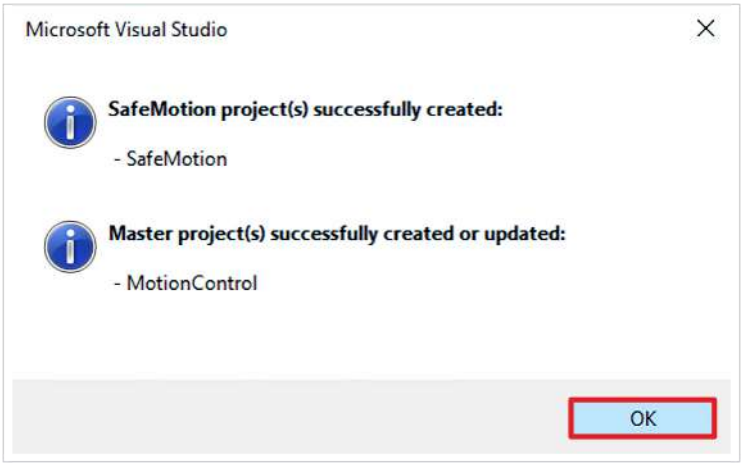
17. Confirm window with “Next”



The “Safe Address Selection” window opens. Here the safe addresses are read out automatically. For virtual axes or axes that cannot be reached, you have the option of configuring the addresses yourself.

18. Close window with “Finish”

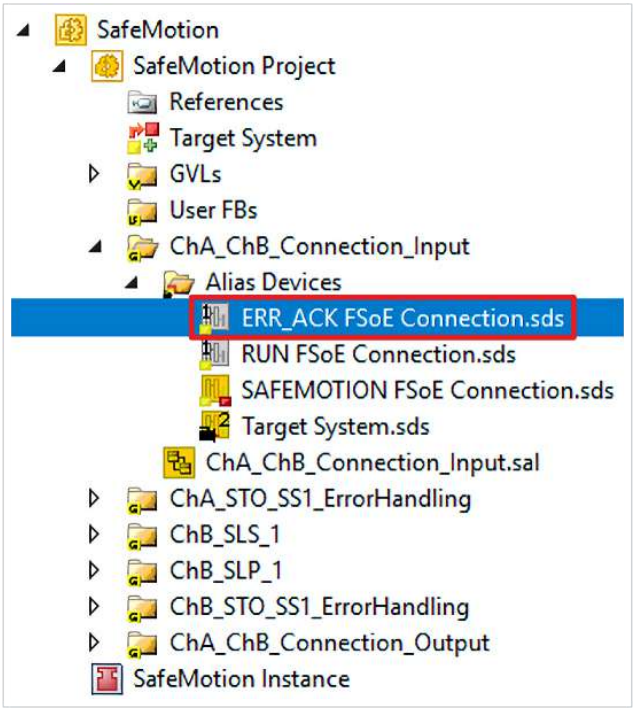
The SafeMotion Wizard configures the project.



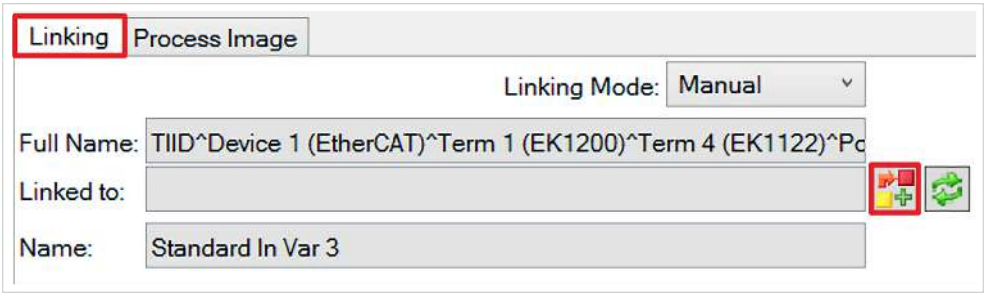
19. Close window with “OK”

2.2 Linking

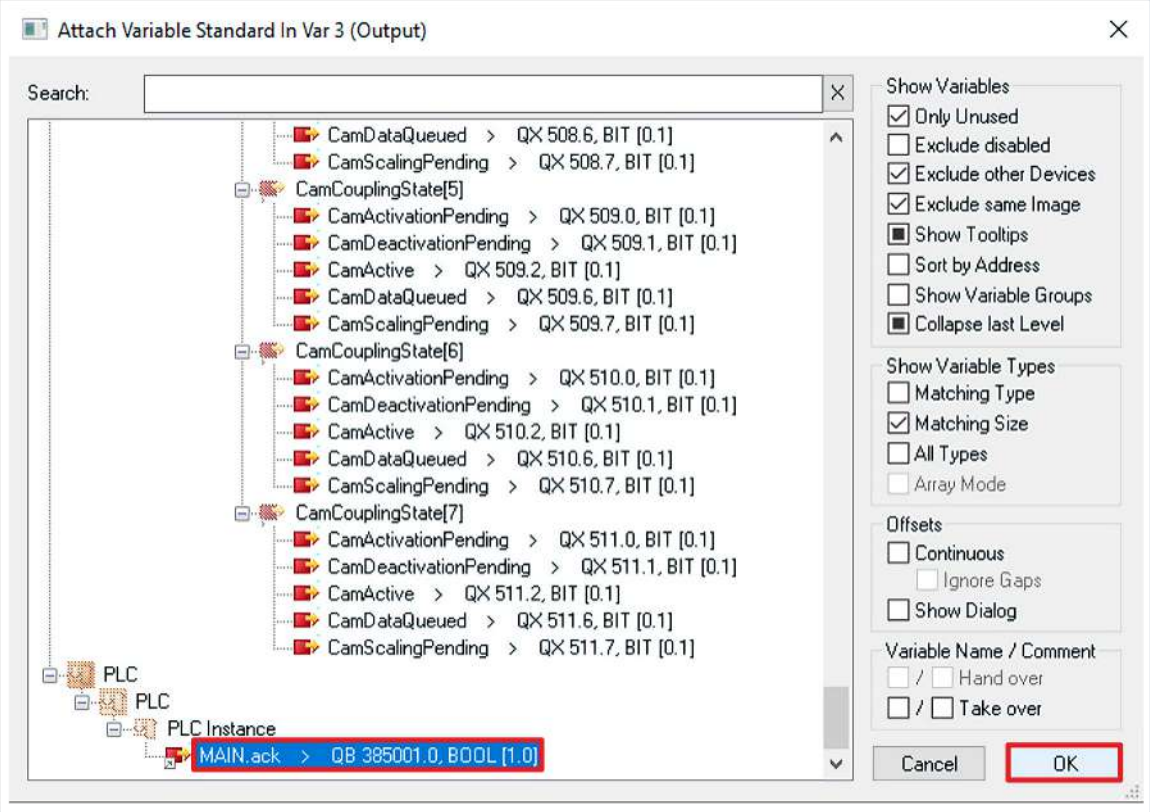
2.2.1 Link ErrAck and Run signal



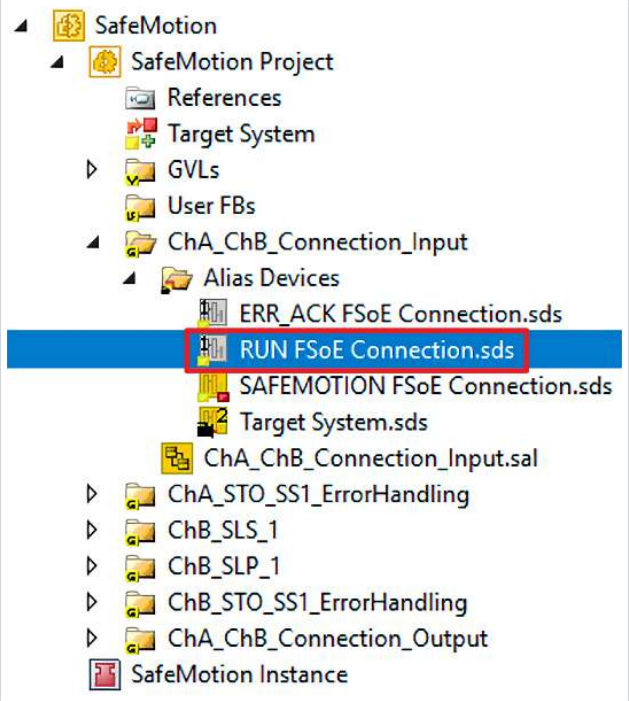
1. Open file "ERR_ACK FSoE Connection.sds



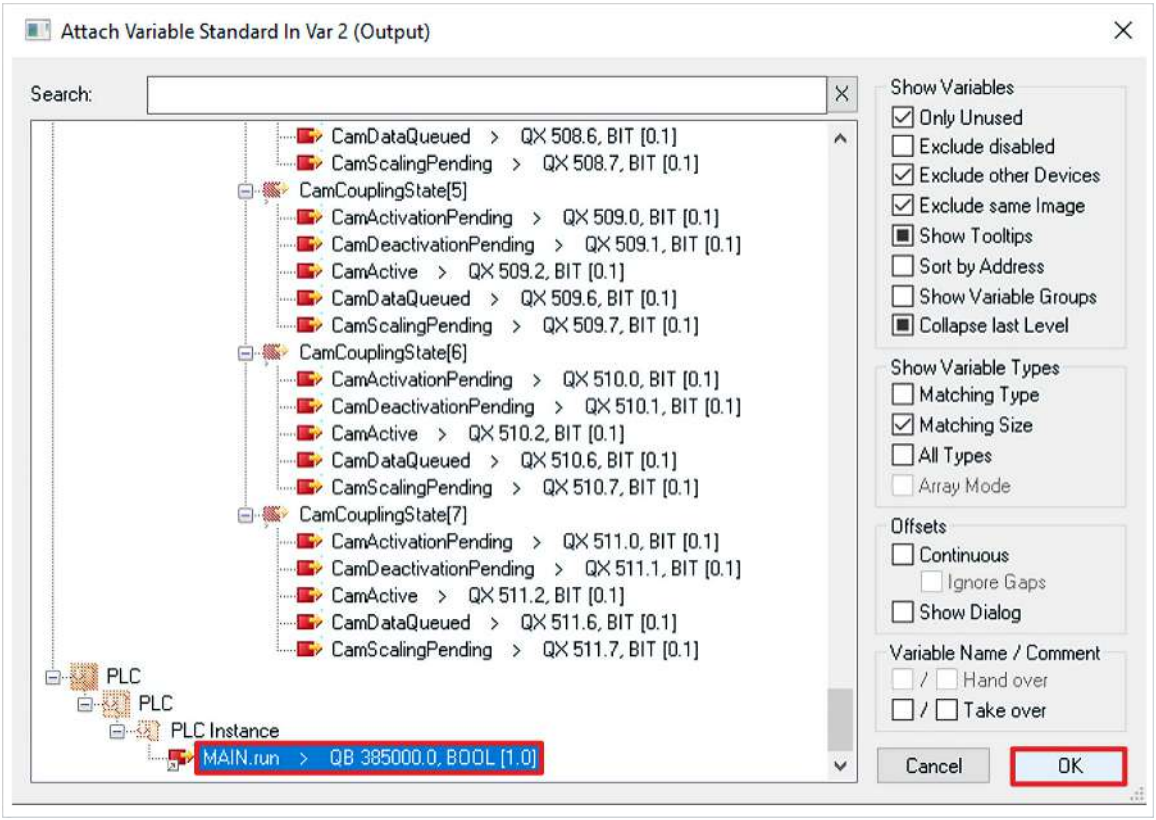
2. Click the link icon in the linking tab



3. Select "MAIN.ack”
4. Confirm selection with "OK”



5. Open file "Run FSoE Connection.sds"
6. Click the link symbol in the linking tab



7. Select "MAIN.run"
8. Confirm selection with "OK”

2.2.2 Link projects

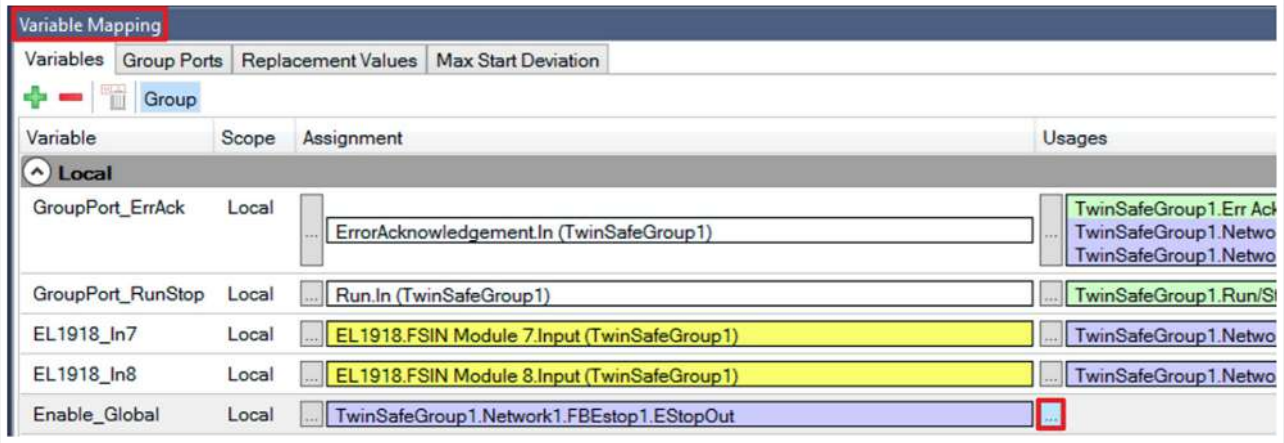
This chapter describes the linking of the SafeMotion project with the EL6910 Safety project via the EL6910 parameters.

The SafeMotion Wizard has already created the connections via the Alias Devices.

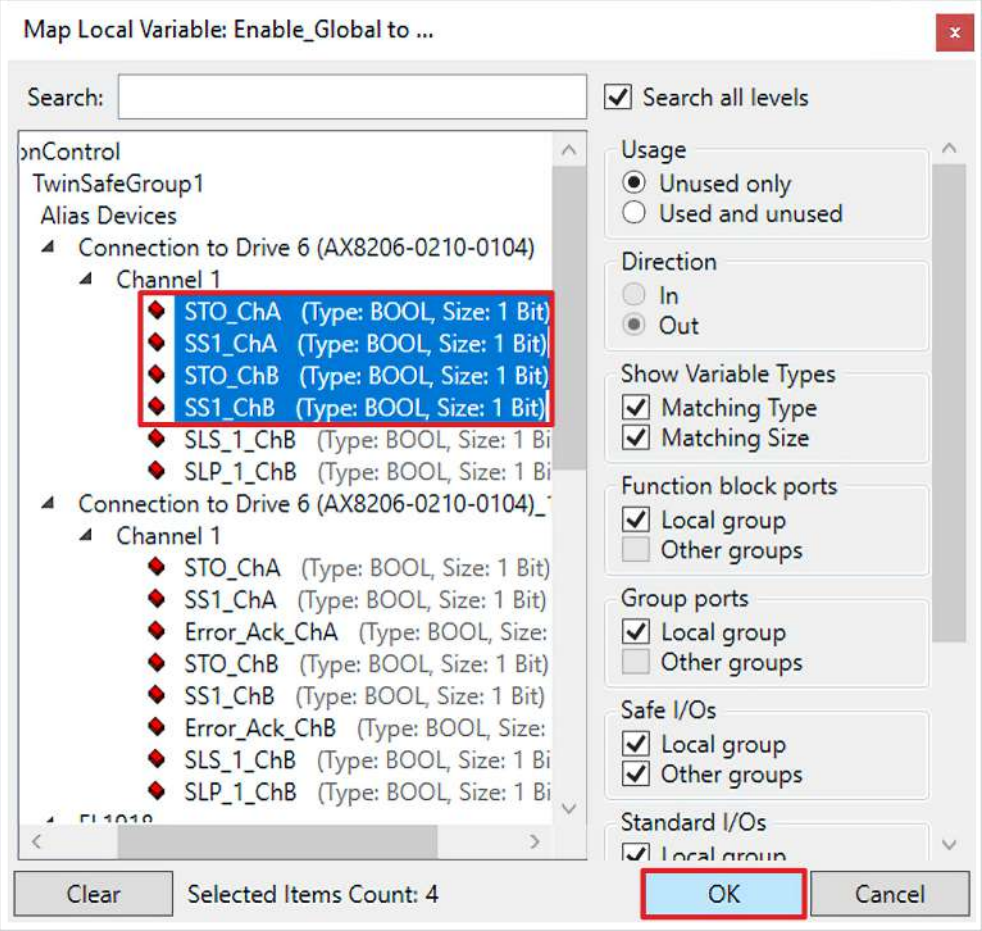
Proceed as follows:

1. Open the “TwinSafeGroup1.sal” file in your EL6910 project
2. Open the “Variable Mapping” tab

In the following you have to link the individual signals and variables in the "Variable Mapping" tab. The procedure is identical for all variables and is shown here as an example for one variable using the screenshots.



3. Click the button “ ... “ at the desired variable



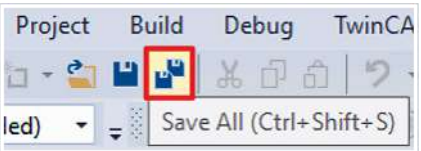
4. Select the signal for your Safe Motion component
5. Confirm selection with “OK”

The following links result for the variables:

Link

The cells with “ / “ are already filled in and do not need to be linked.

Variable	Assignment	Usages
Enable_Global	/	STO_ChA SS1_ChA STO_ChB SS1_ChB
AckReq_ChA	Error_AckReq_ChA	/
AckReq_ChB	Error_AckReq_ChB	/
AX_Ack	/	Error_Ack_ChA Error_Ack_ChB

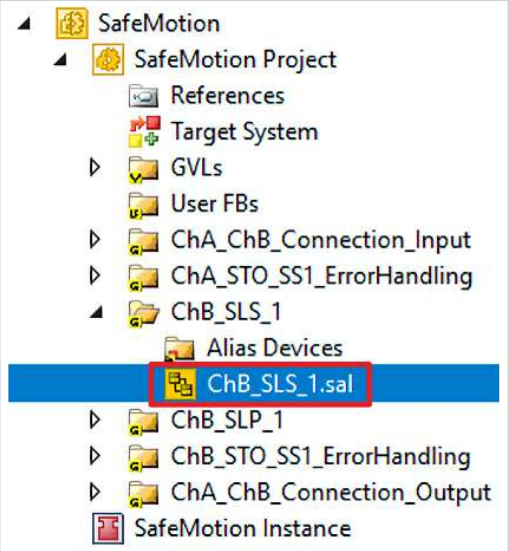


6. Click on “Save all” in the menu bar to save the settings

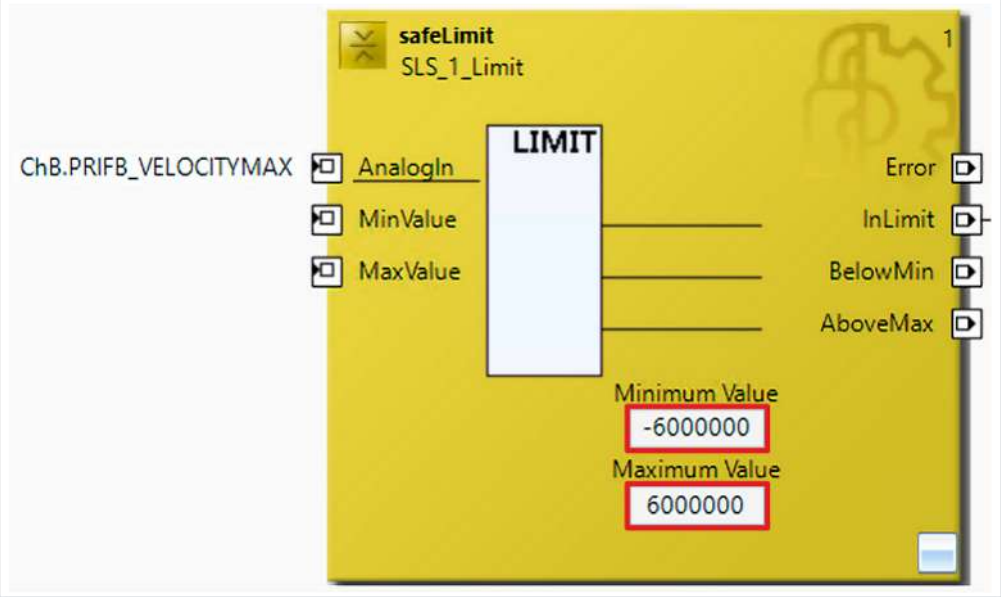
2.3 Configure primary feedback

In this application is SLS implemented on the primary feedback.

In this chapter you only enter the parameters. All other configurations are already implemented by OCT Safety.



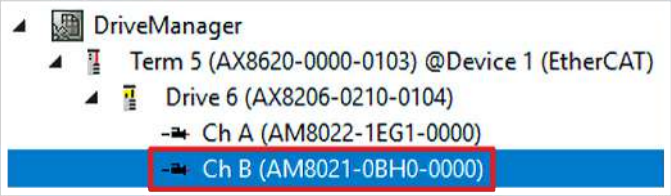
1. Open file “ChB_SLS_1.sal”



2. Enter the minimum and maximum values for FB1 as shown in the figure
3. Click on “Save all” in the menu bar to save the settings

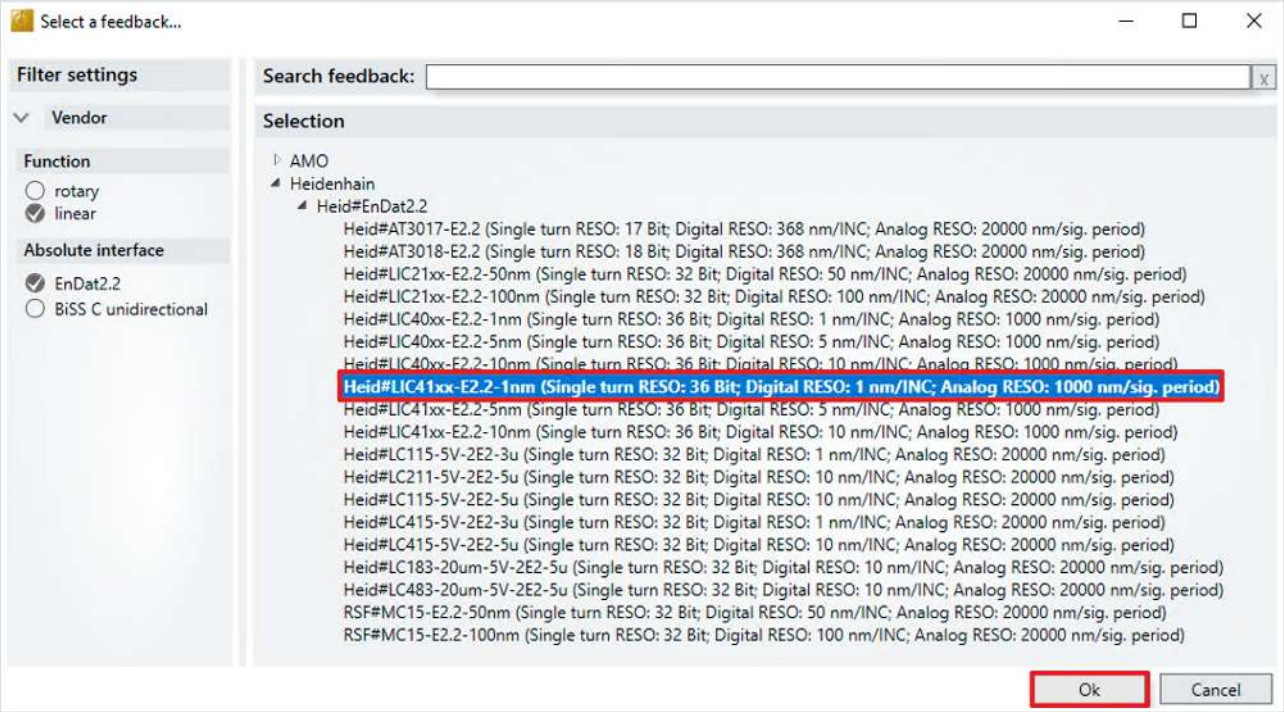
2.4 Configure secondary feedback

2.4.1 Configure encoder



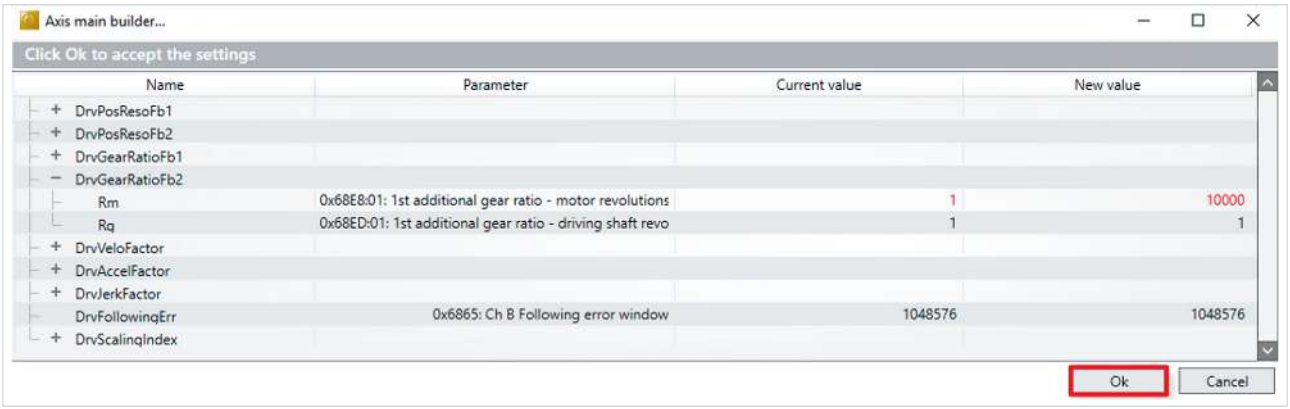
1. Open ChB in Drive Manager

2. Click on “Select” for feedback 2



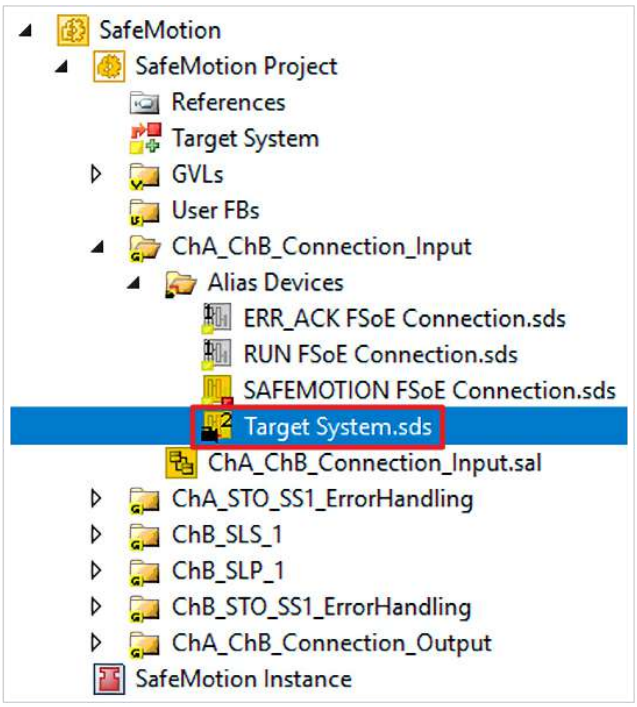
3. Select “linear” as function
4. Select “Heid#LIC41xx-E2.2-1nm (Singe turn RESO: 36 Bit; Digital RESO: 1 nm/INC; Analog RESO: 1000 nm/sig.period)” as feedback
5. Confirm selection with “Ok”

6. Confirm window “Decide the mode of the feedback 2...” with “Ok”

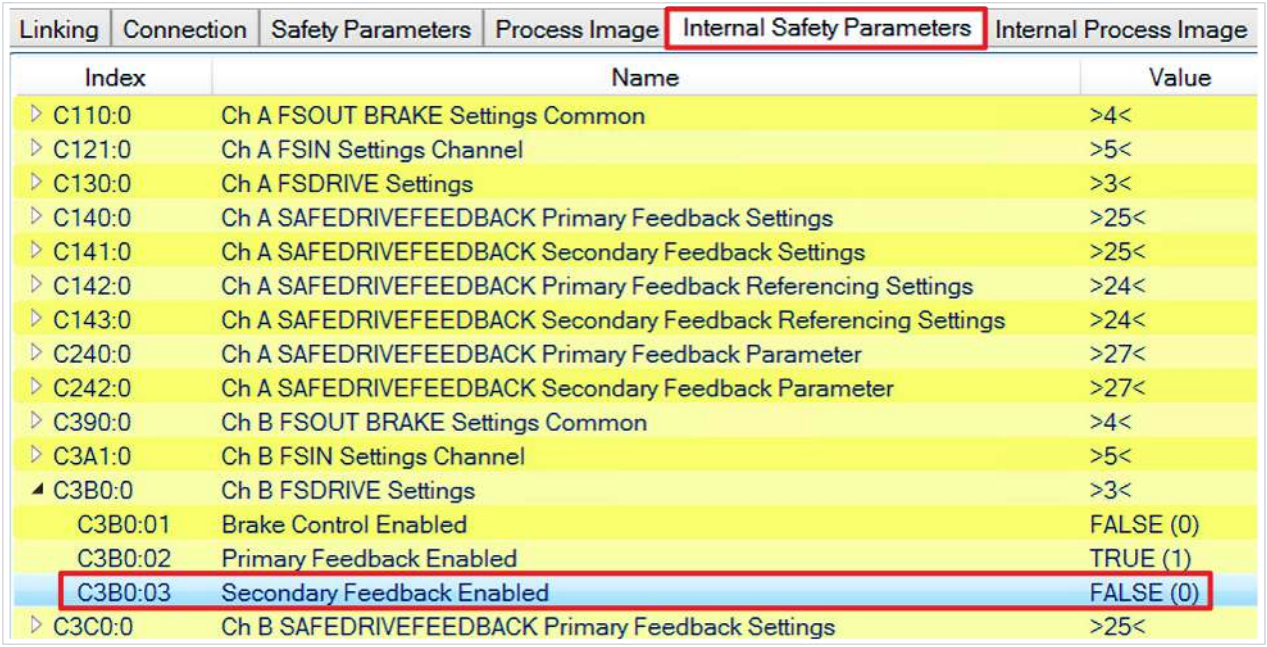


7. Confirm window “Axis main builder...” with “Ok”

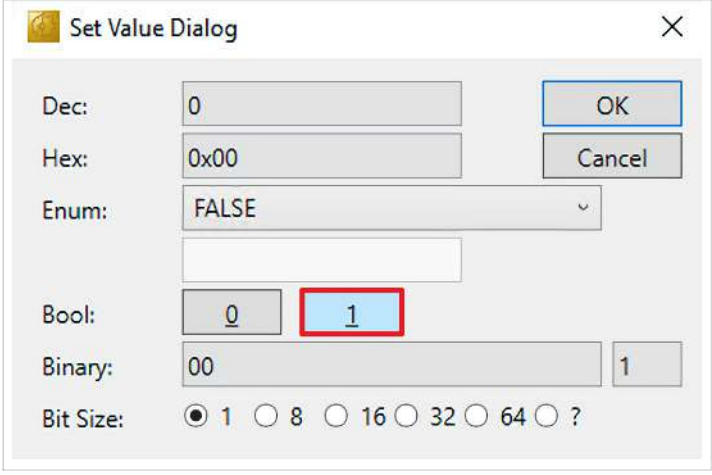
2.4.2 Configure safety parameters



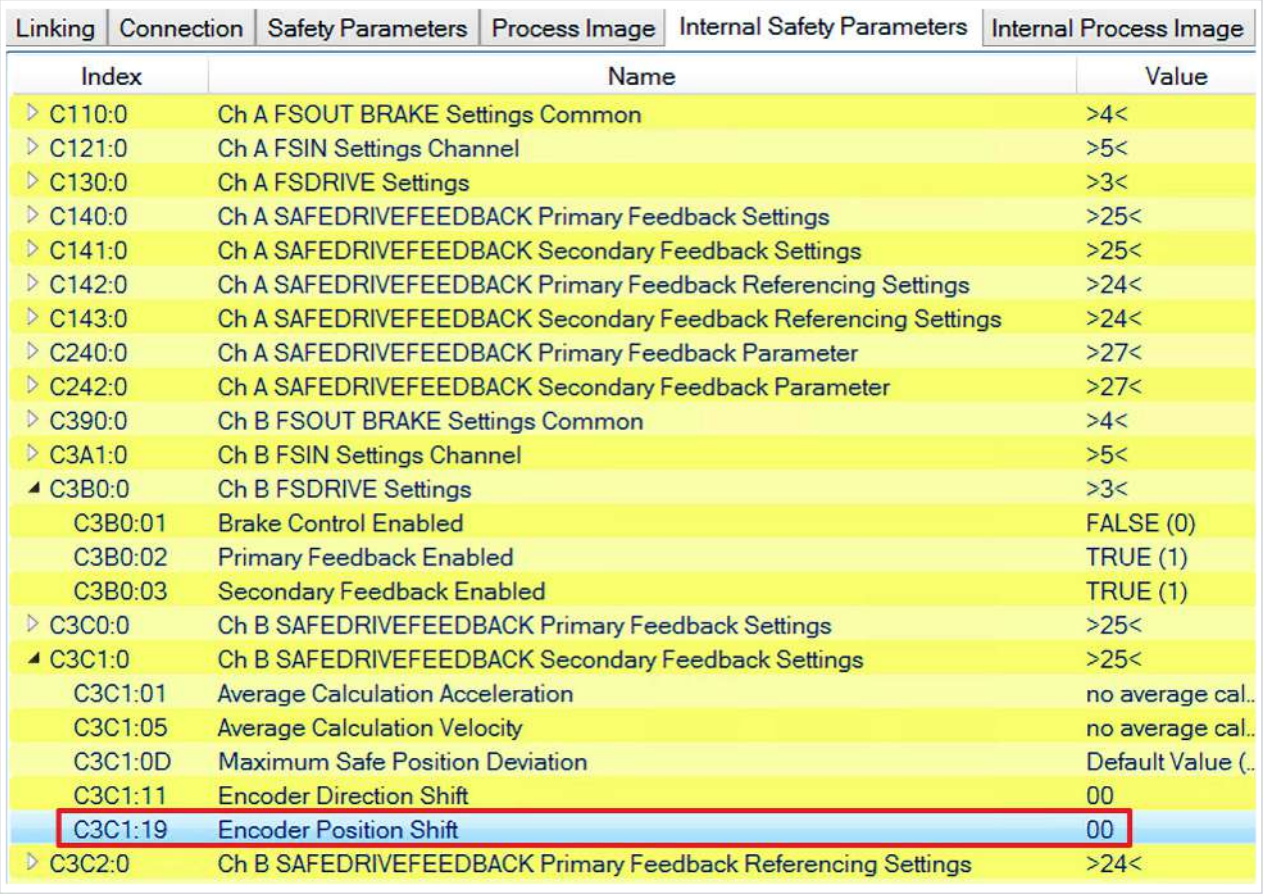
1. Open “Target Systems.sds”



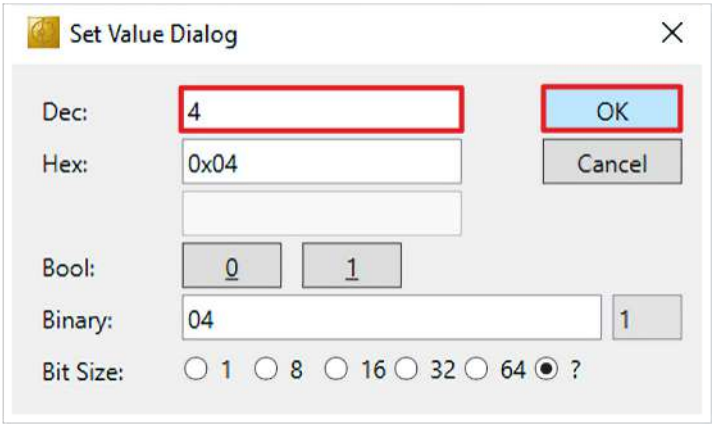
2. Open tab “Internal Safety Parameters”
3. Double click on parameter “C3B0:03 Secondary Feedback Enabled”



4. Click on “1” in the “Set Value Dialog” window to set the parameter to TRUE



5. Double click on the parameter “C3C1:19 Encoder Position Shift”

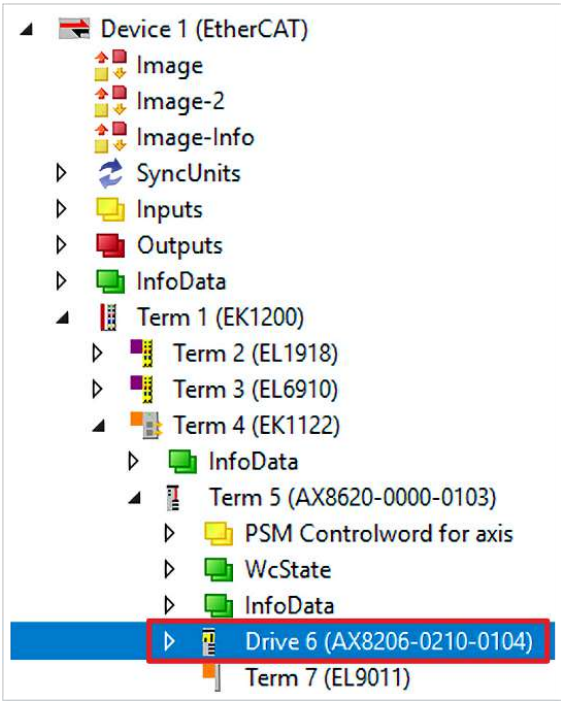


6. Enter “4” in the Dec field in the “Set Value Dialog” window

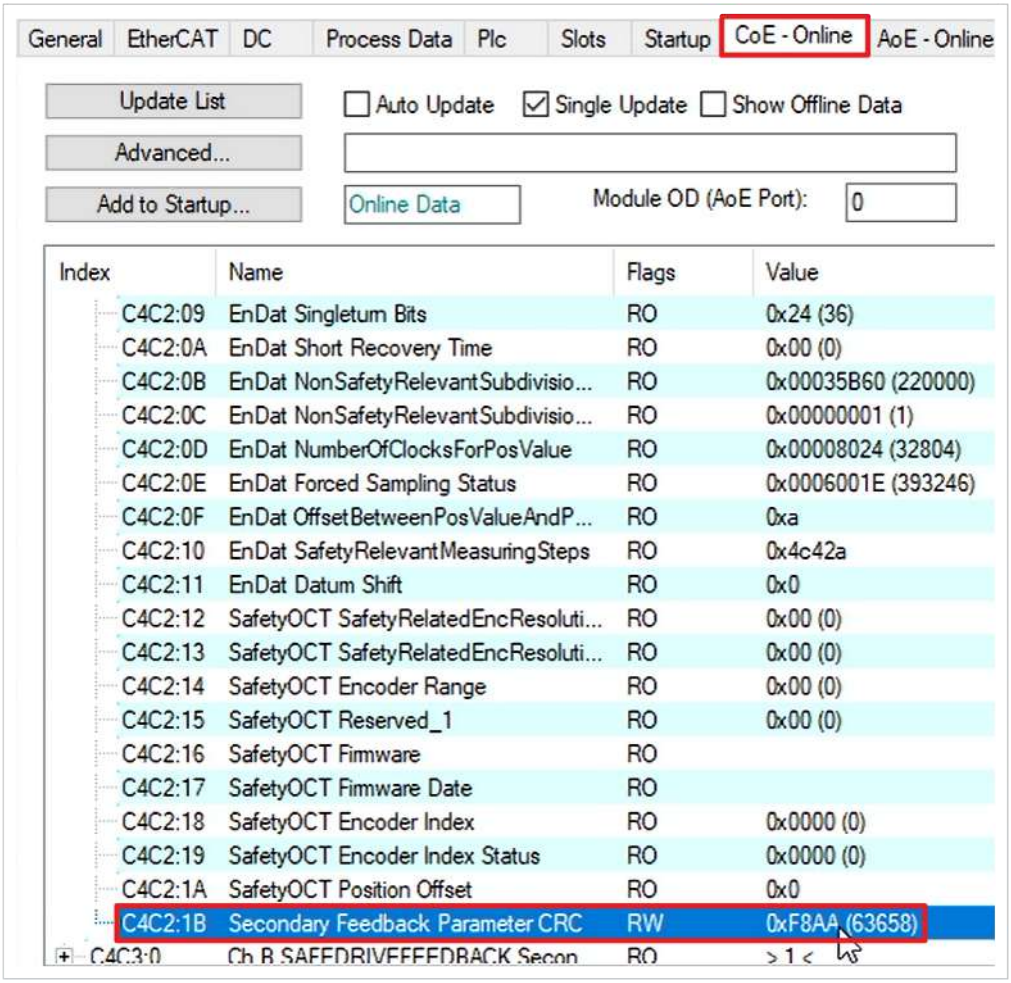
Linking | Connection | Safety Parameters | Process Image | Internal Safety Parameters | Internal Process Image

Index	Name	Value
C110:0	Ch A FSOUT BRAKE Settings Common	>4<
C121:0	Ch A FSIN Settings Channel	>5<
C130:0	Ch A FSDRIVE Settings	>3<
C140:0	Ch A SAFEDRIVEFEEDBACK Primary Feedback Settings	>25<
C141:0	Ch A SAFEDRIVEFEEDBACK Secondary Feedback Settings	>25<
C142:0	Ch A SAFEDRIVEFEEDBACK Primary Feedback Referencing Settings	>24<
C143:0	Ch A SAFEDRIVEFEEDBACK Secondary Feedback Referencing Settings	>24<
C240:0	Ch A SAFEDRIVEFEEDBACK Primary Feedback Parameter	>27<
C242:0	Ch A SAFEDRIVEFEEDBACK Secondary Feedback Parameter	>27<
C390:0	Ch B FSOUT BRAKE Settings Common	>4<
C3A1:0	Ch B FSIN Settings Channel	>5<
C3B0:0	Ch B FSDRIVE Settings	>3<
C3B0:01	Brake Control Enabled	FALSE (0)
C3B0:02	Primary Feedback Enabled	TRUE (1)
C3B0:03	Secondary Feedback Enabled	TRUE (1)
C3C0:0	Ch B SAFEDRIVEFEEDBACK Primary Feedback Settings	>25<
C3C1:0	Ch B SAFEDRIVEFEEDBACK Secondary Feedback Settings	>25<
C3C1:01	Average Calculation Acceleration	no average cal..
C3C1:05	Average Calculation Velocity	no average cal..
C3C1:0D	Maximum Safe Position Deviation	Default Value (..
C3C1:11	Encoder Direction Shift	00
C3C1:19	Encoder Position Shift	04
C3C2:0	Ch B SAFEDRIVEFEEDBACK Primary Feedback Referencing Settings	>24<
C3C3:0	Ch B SAFEDRIVEFEEDBACK Secondary Feedback Referencing Settings	>24<
C4C0:0	Ch B SAFEDRIVEFEEDBACK Primary Feedback Parameter	>27<
C4C2:0	Ch B SAFEDRIVEFEEDBACK Secondary Feedback Parameter	>27<
C4C2:1B	Secondary Feedback Parameter CRC	0x0000 (0)

Under the parameter C4C2:0 “ChB SAFEDRIVEFEEDBACK Secondary Feedback Parameter” you see the “C4C2:1B Secondary Feedback Parameter CRC”. You can take this CRC from the Safe Motion component. Proceed as follows:



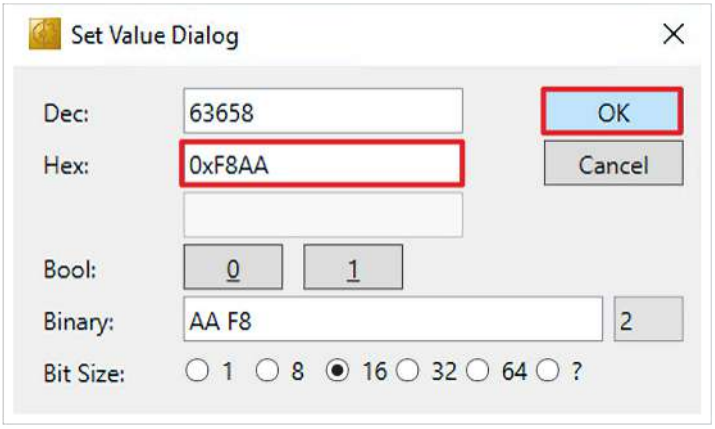
7. Open safe motion component



8. Open tab “CoE – Online”

At “C4C2:1B Secondary Feedback Parameter CRC” take the parameter CRC “0xF8AA”.

9. Open “Target Systems.sds”
10. Double click on the parameter C4C2:1B



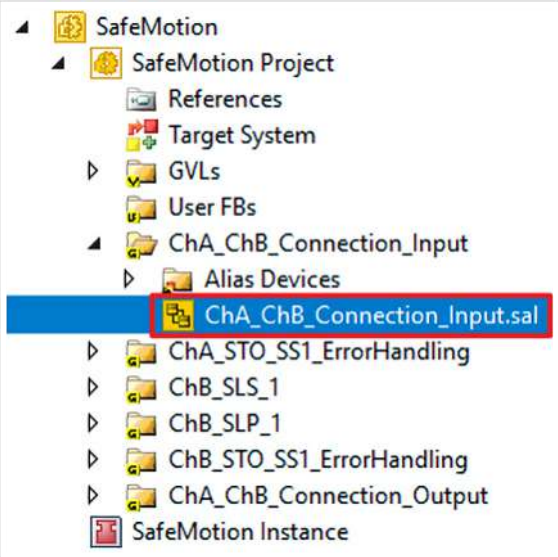
11. Enter the parameter CRC in the hex field
12. Close the window with “OK”
13. Click on “Save all” in the menu bar in order to save the settings

2.5 Integration into the Safe Motion project

2.5.1 Link inputs

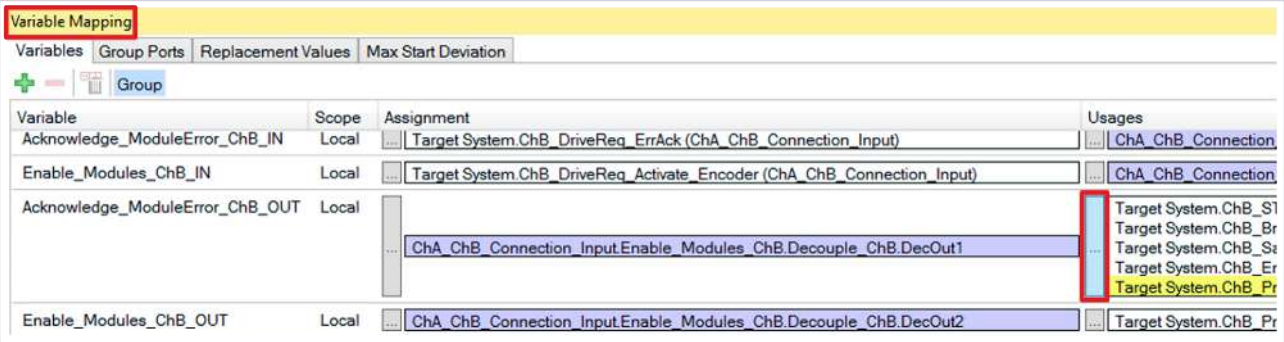
This chapter describes how to link the secondary feedback signals in the Connection_Input group.

Proceed as follows:

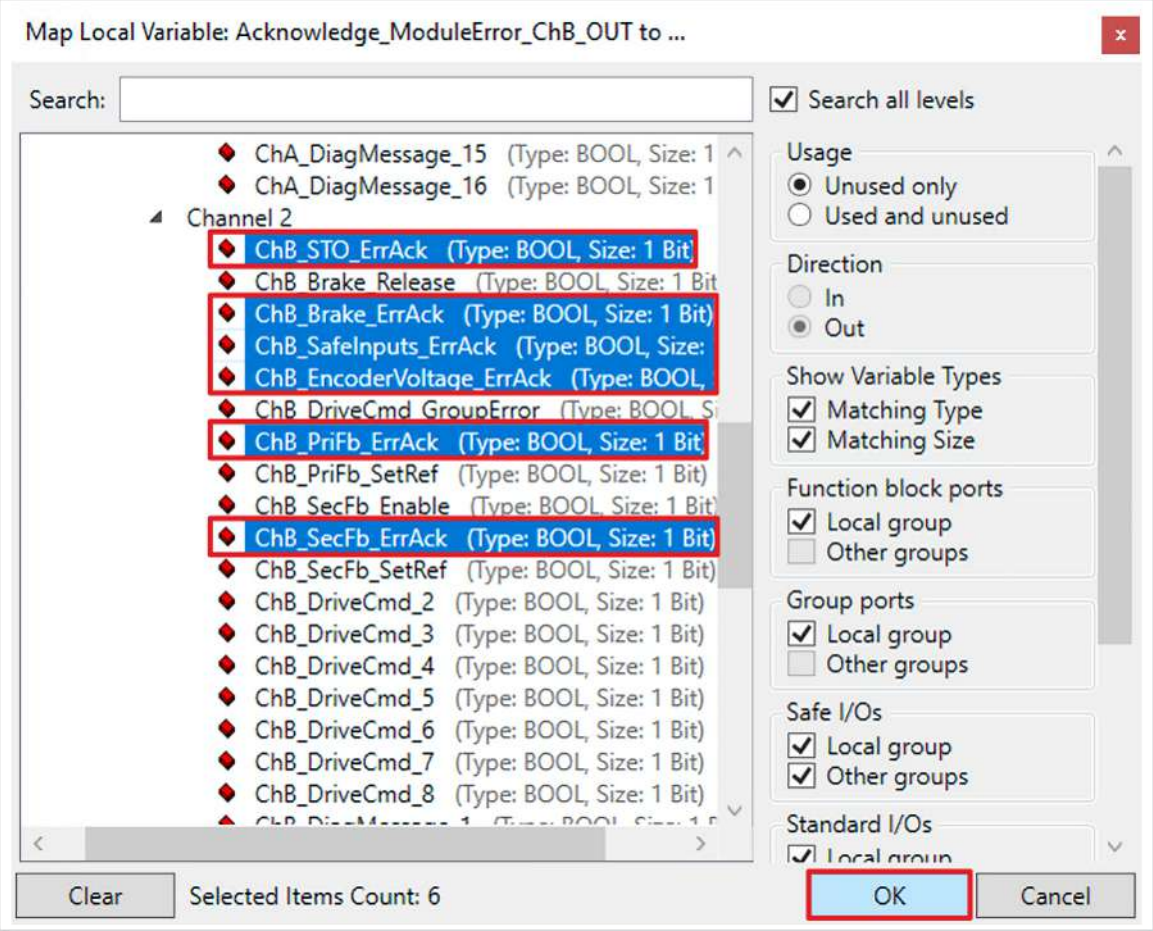


1. Open file “ChA_ChB_Connection_Input.sal”
2. Open tab “Variable Mapping”

In the following, you have to link the individual signals and variables in the "Variable Mapping" tab. The procedure is identical for all variables and is shown here as an example for one variable using the screenshots.



3. Click the button “ ... “ at the desired variable



4. Select the signal for your Safe Motion component
5. Confirm selection with “OK”

The following links are created for the variables:

Link

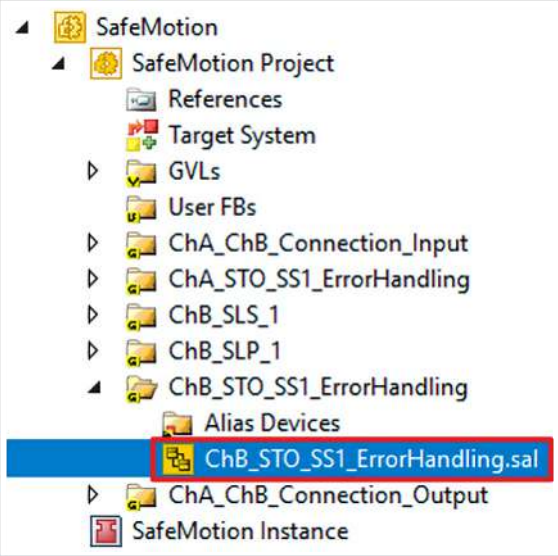
The cells with “ / “ are already filled in and do not need to be linked. Make sure that already existing links to signals are kept.

Variable	Assignment	Usages
Acknowledge_ModuleError_ChB_OUT	/	ChB_STO_ErrAck ChB_Brake_ErrAck ChB_SafeInputs_ErrAck ChB_EncoderVoltage_ErrAck ChB_PriFb_ErrAck ChB_SecFb_ErrAck
Enable_Modules_ChB_OUT	/	ChB_PriFb_Enable ChB_SecFb_Enable

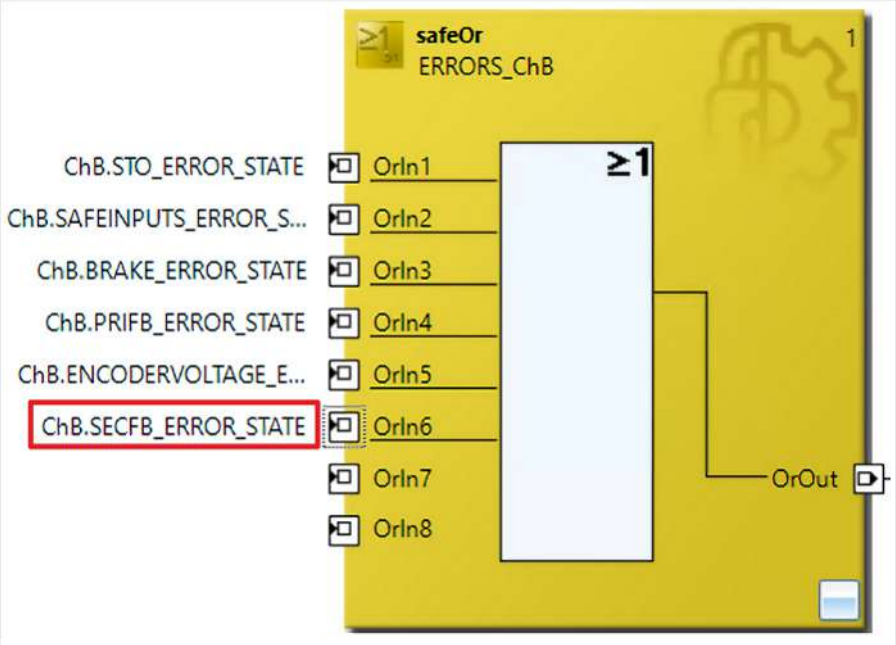
6. Click “Save all” in the menu bar to safe the settings

2.5.2 Configure ErrorHandling

This chapter describes the configuration of the secondary feedback in ErrorHandling.



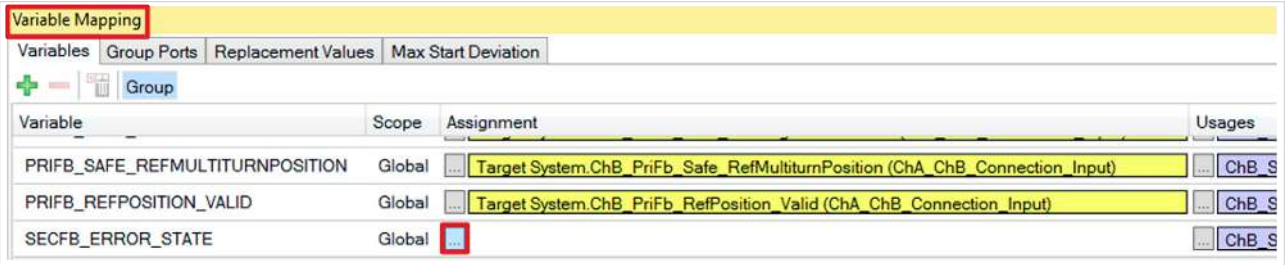
1. Open ErrorHandling



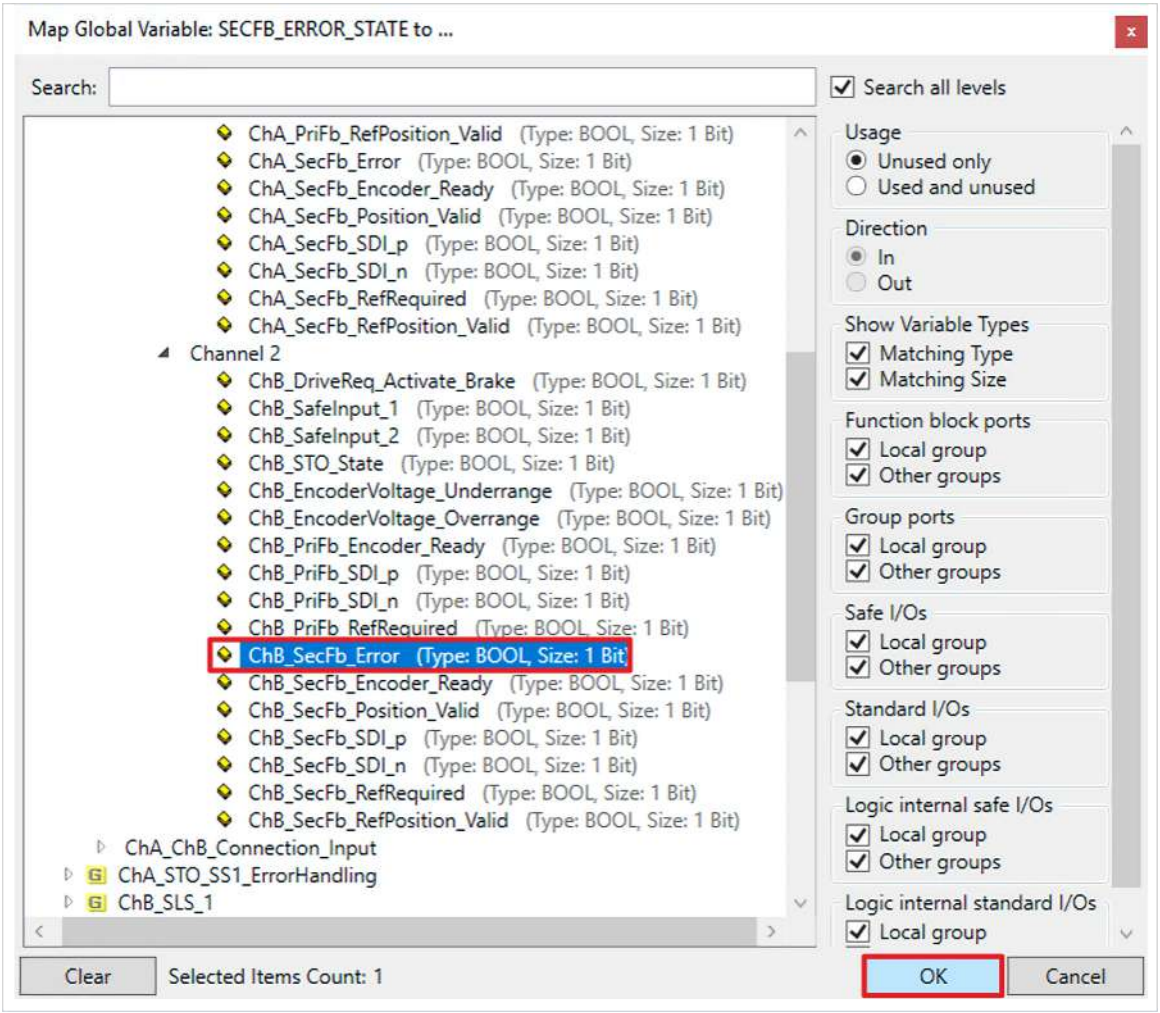
2. Add the variable “ChB.SECFB_ERROR_STATE” to the input OrIn6

With this additional input the Secondary Feedback is considered.

3. Open tab “Variable Mapping”

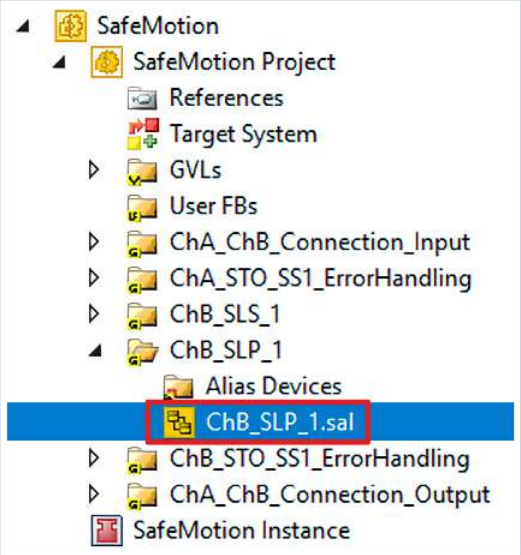


4. Click the button “ ... “ at the newly added variable

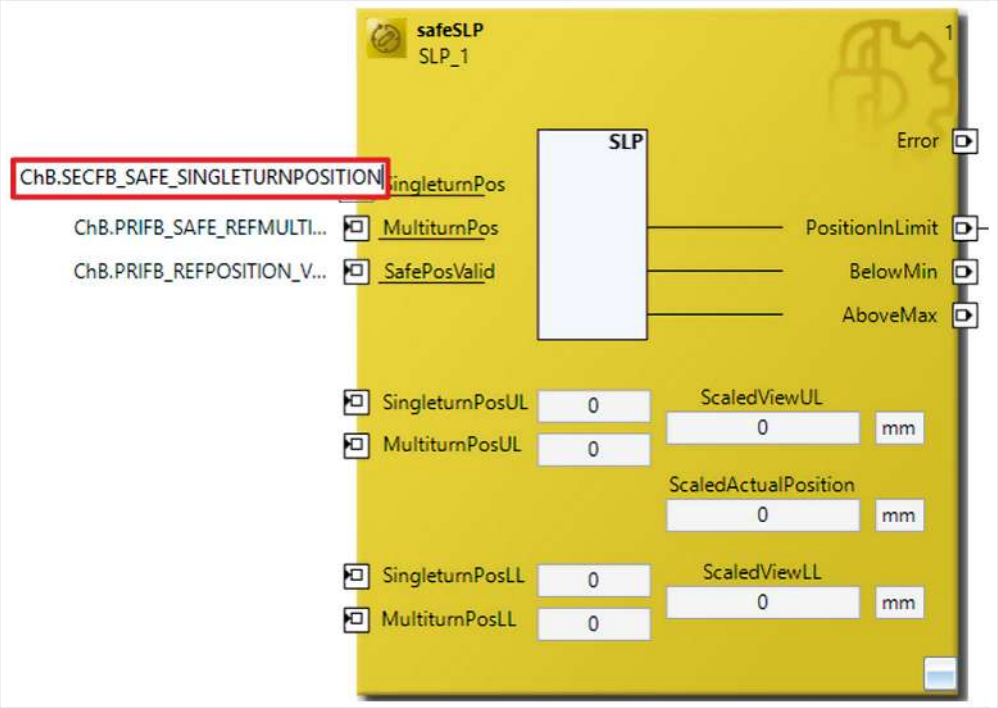


5. Select the signal “ChB_SecFb_Error”
6. Confirm selection with “OK”
7. Click on “Save all” in the menu bar to save the settings

2.6 Configure SLP



1. Open file “ChB_SLP_1.sal”

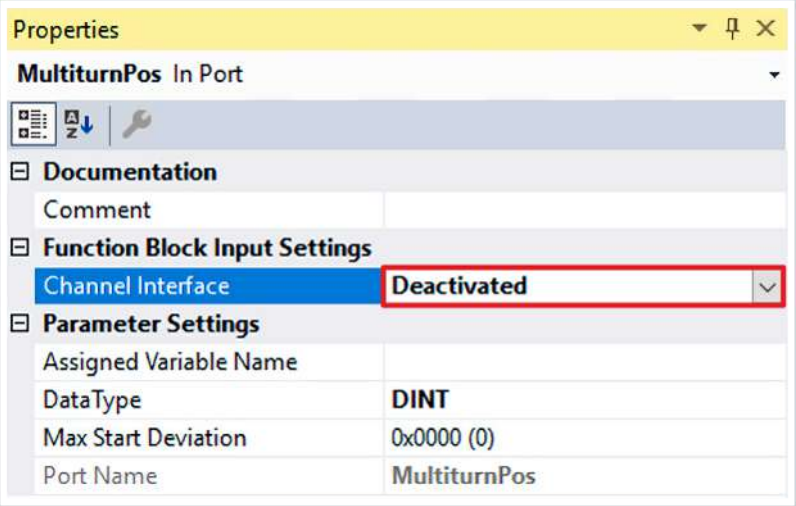


By default the first block processes the position of the Primary Feedback. Since the SLP functionality is to be implemented in the secondary feedback, adjust the function block as follows:

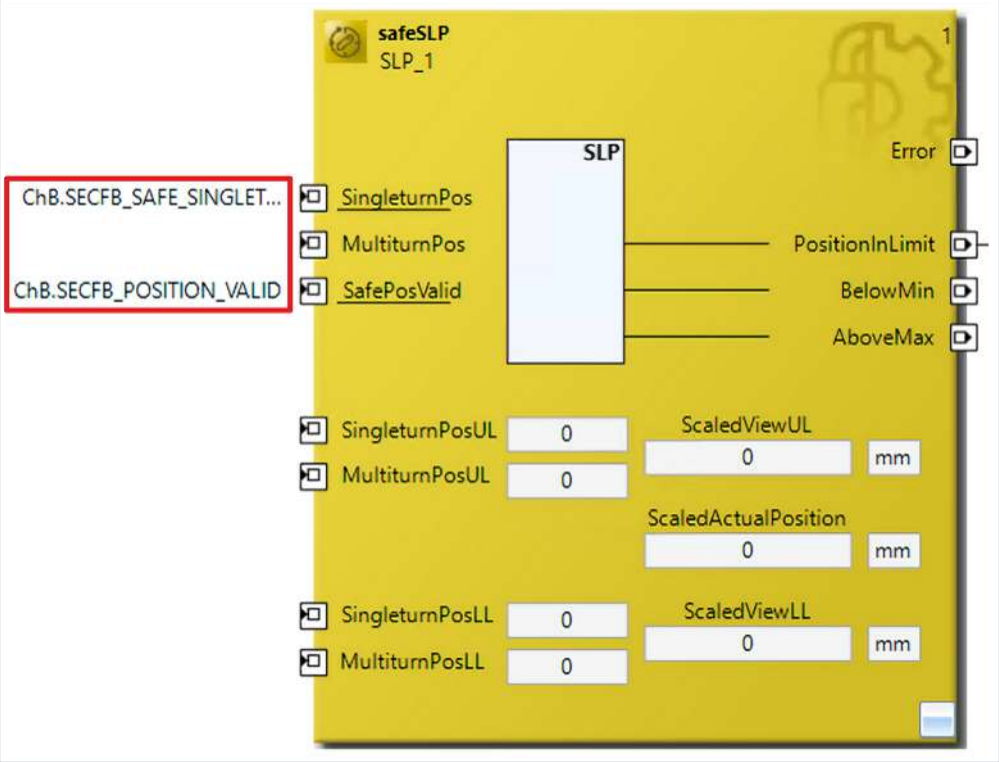
2. Rename the variable “ChB.SECFB_SAFE_SINGLETURNPOSITION” for the “SingleturnPos” input

You do not need the “MultiturnPos” input in this application because you are using a singleturn encoder. Proceed as follows:

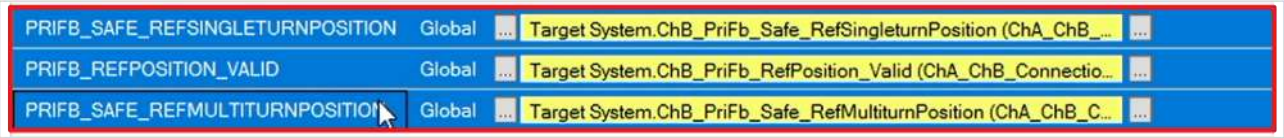
3. Delete the variable for the “MultiturnPos” input
4. Open the properties window of the “MultiturnPos” input



5. Select “Deactivated” in the drop-down menu of the channel interface to deactivate the input

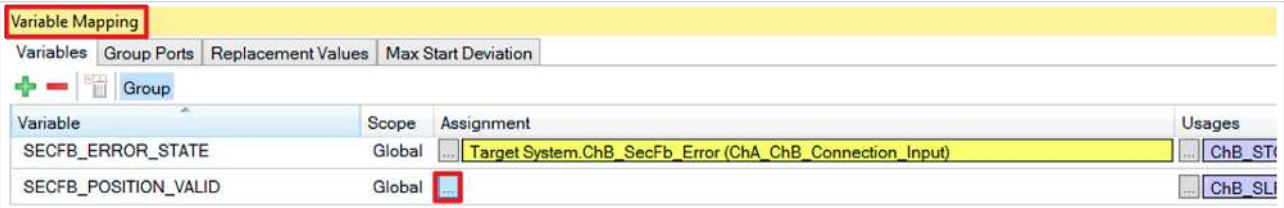


6. Rename the variable of input “SafePosValid” to “ChB.SECFB_POSITION_VALID”

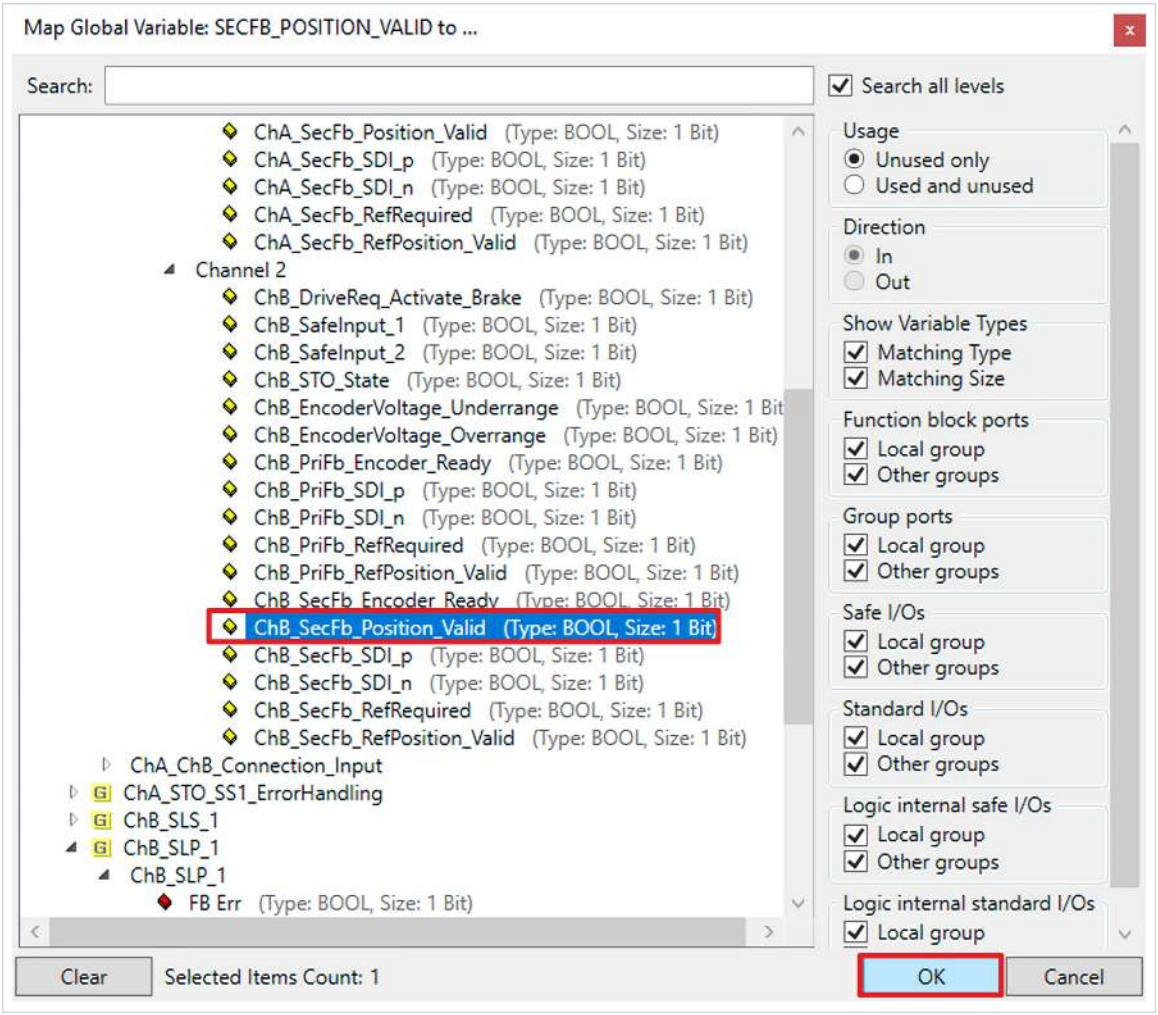


7. Delete the old SLP variables

In the following you have to link the single signals and variables in the tab "Variable Mapping". The procedure is identical for all variables and is exemplarily shown here with the help of the screenshots for one variable.



8. Click the button “ ... “ at the desired variable

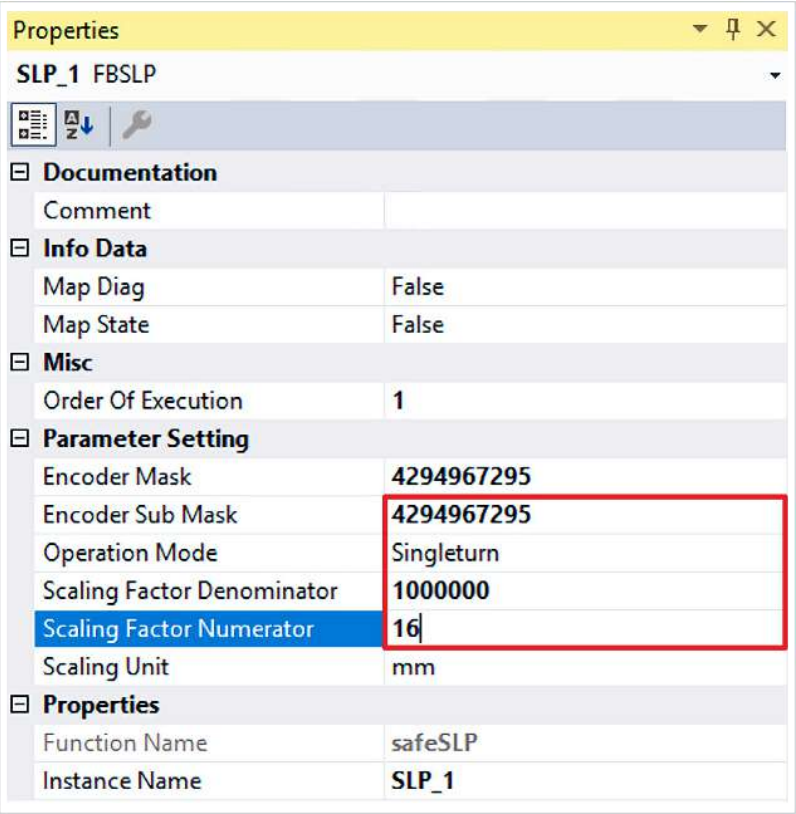


9. Select signal
10. Confirm selection with “OK”

The following links result for the variables:

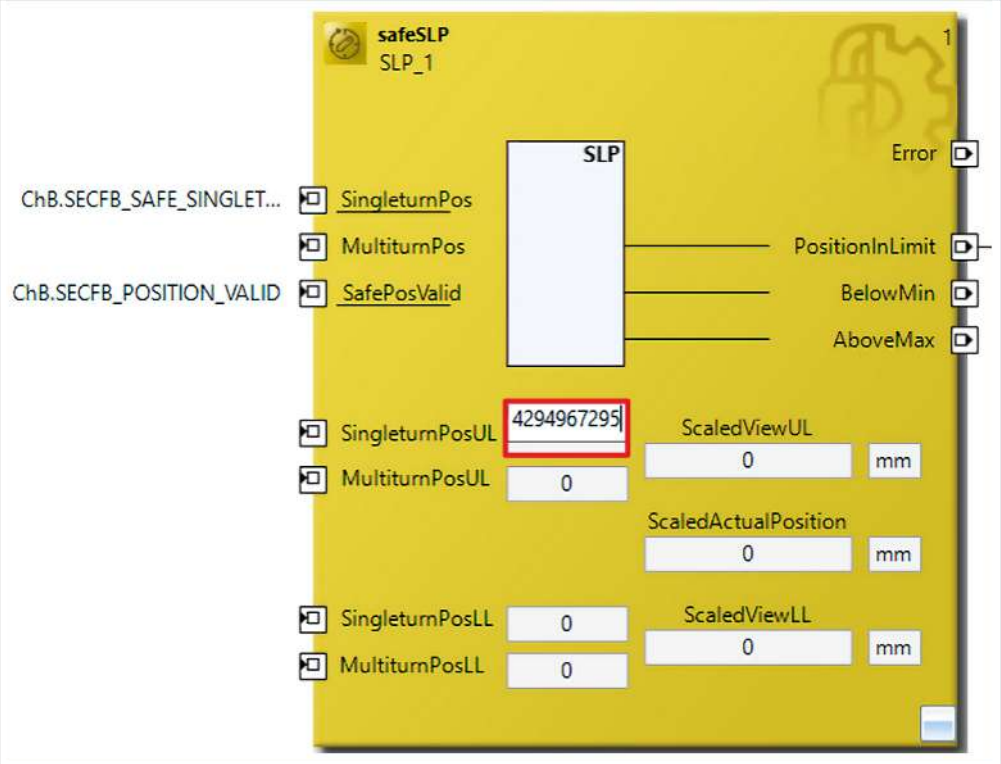
Variable	Assignment
SECFB_SAFE_SINGLETURNPOSITION	ChB_SecFb_Safe_SingleturnPosition
SECFB_POSITION_VALID	ChB_SecFb_Position_Valid

11. Select safeSLP block



12. In the properties window adjust the FB properties as follows

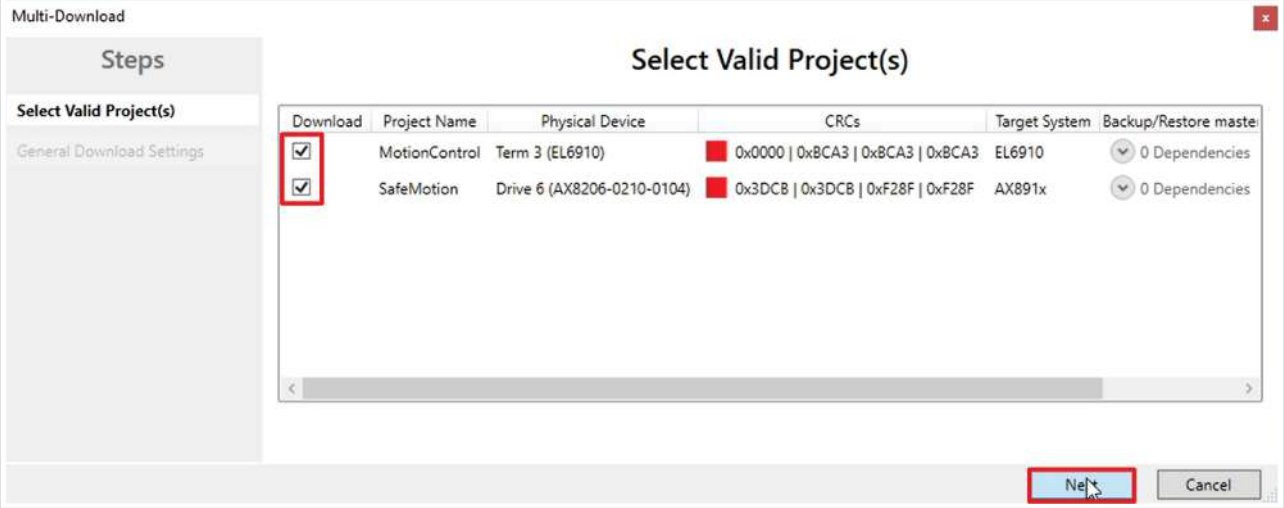
Property	Value
Encoder Sub Mask	4294967295 (taken from Encoder Mask)
Operation Mode	Singleturn
Scaling Factor Denominator	1000000
Scaling Factor Numerator	16



13. Insert the value of “Encoder Mask” and “Encoder Sub Mask” into the field “SingleturnPosUL” according to the figure
14. Click “Save all” in the menu bar to save the settings

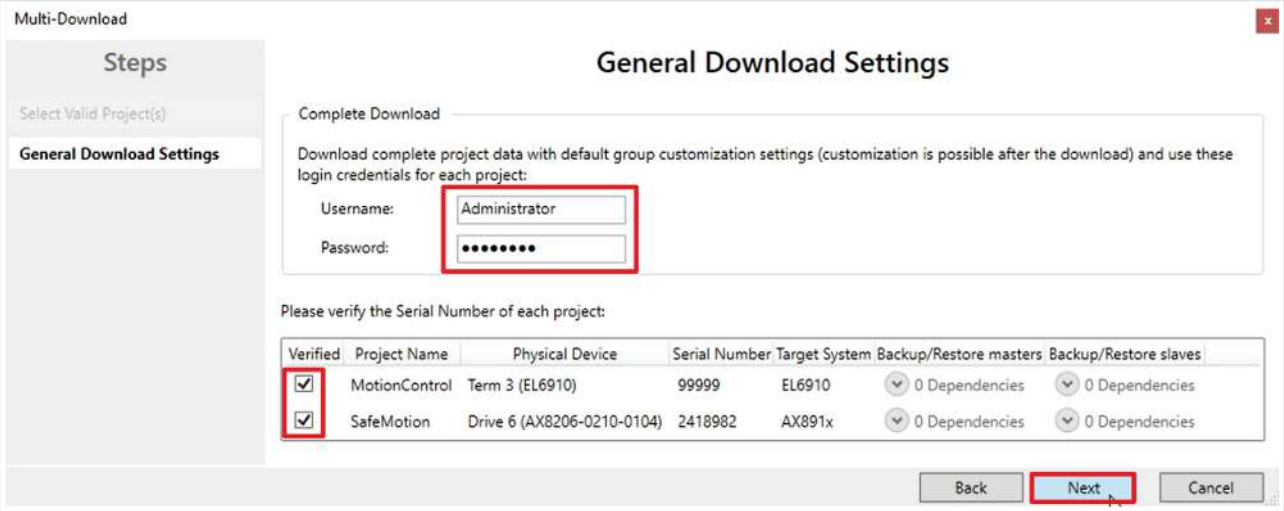
2.7 Download safety projects

1. Click on “Multi-Download Safety Project(s)”



The “Select Valid Project(s)” window opens. Here you can see which safety projects you can download.

2. Select the safety projects that you want to download
3. Confirm selection with “Next”

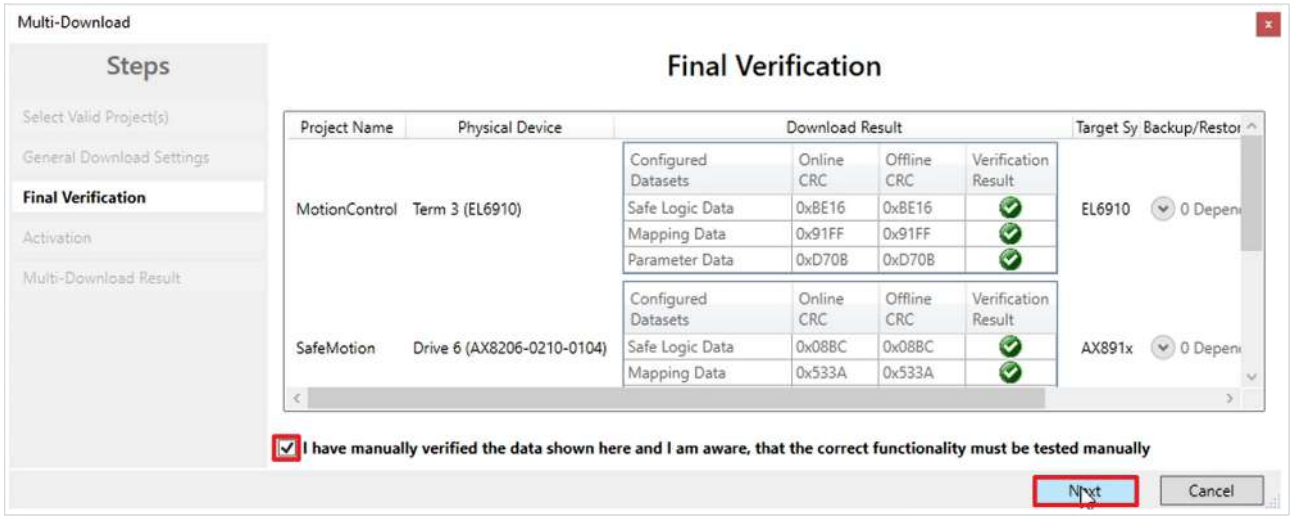


4. Enter the username and password in the “General Download Settings” window

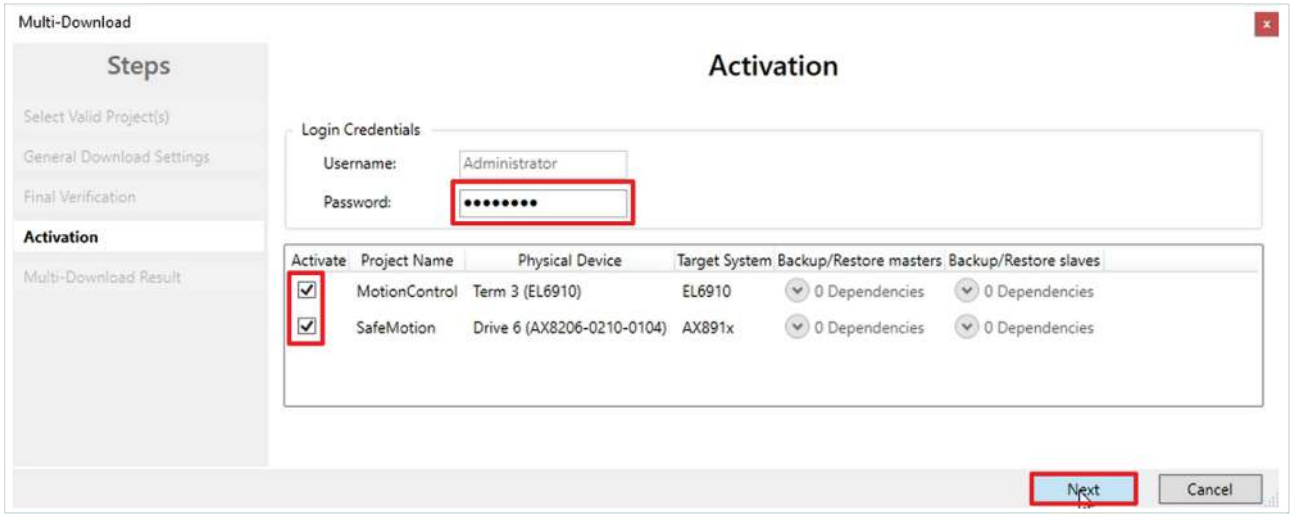
Default username: Administrator

Default password: TwinSAFE

5. Select the safety projects that you want to download
6. Confirm selection with “Next”

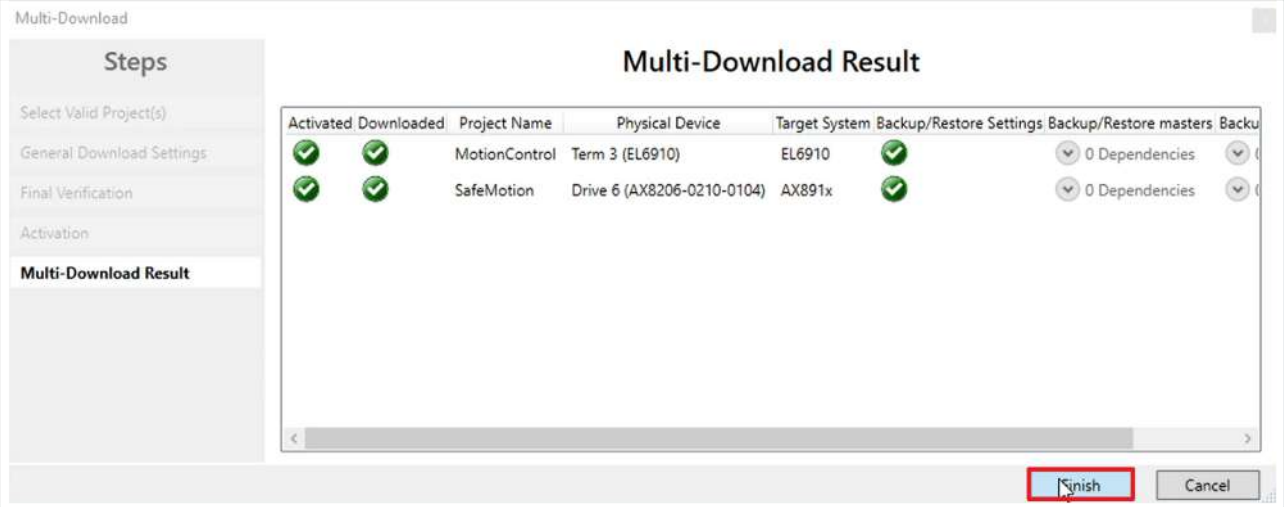


7. Check the CRCs in the “Final Verification” window
8. If the CRCs match, click on the box to confirm the verification
9. Confirm window with “Next”



The “Activation” window opens, in which you activate the safety projects.

10. Enter the default password
11. Check if the safety projects are selected
12. Confirm selection with “Next”

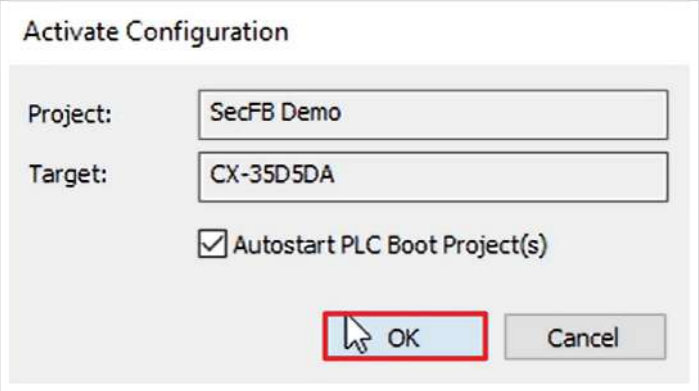


13. Close the window “Multi-Download Result” with “Finish”

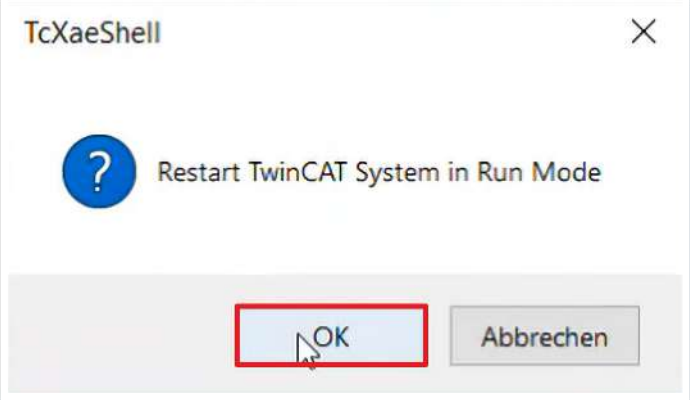
2.8 Activate configuration

Since the process images have been changed, it is necessary to reactivate the configuration. To do this, proceed as follows:

Click on “Activate Configuration” in the menu bar



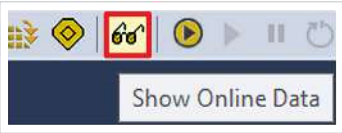
1. Confirm the “Activate Configuration” window with “OK”



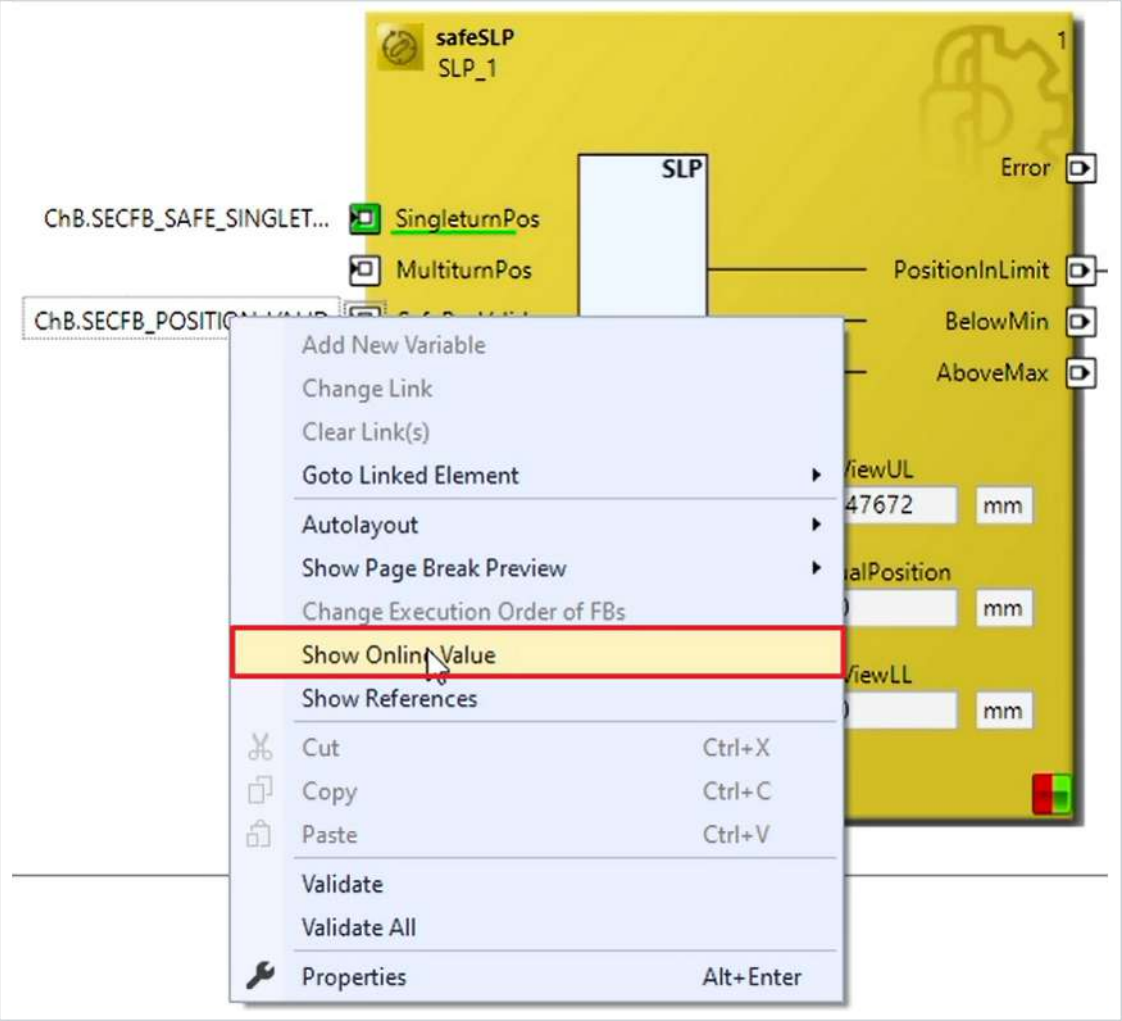
2. Confirm the “Restart TwinCAT System in Run Mode” window with “OK”

2.9 Positioning

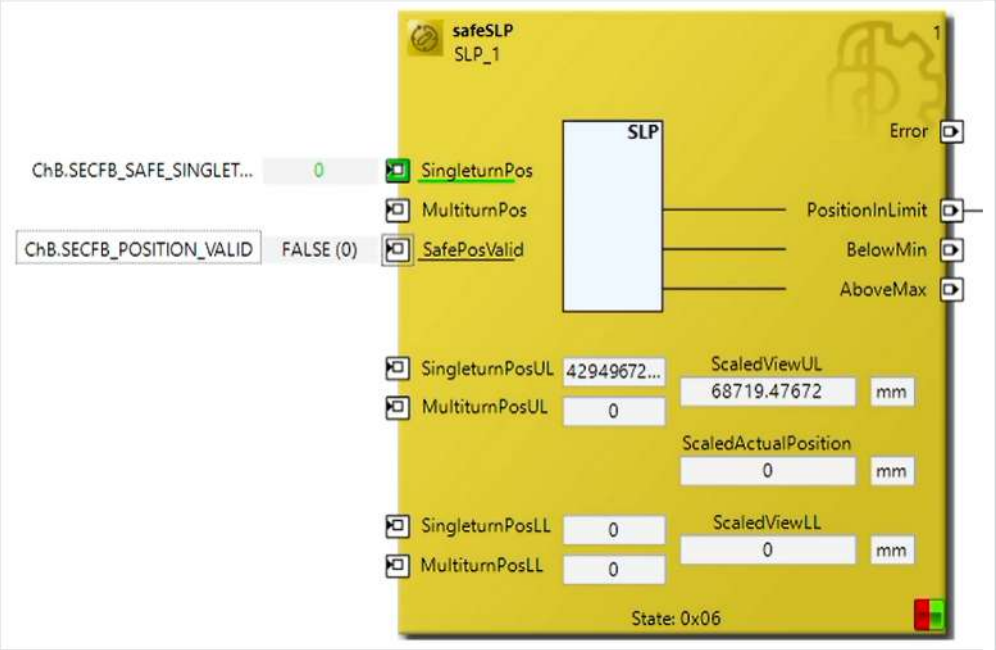
1. Open file “ChB_SLP_1.sal”



2. Click on “Show Online Data” in the menu bar to activate the online view



3. Right click in the network
4. Click “Show Online Value” to see the analog values



The signal for ChB.SECFB_POSITION_VALID is first displayed as FALSE, because more time is needed until the signal appears.

5. Open ChB in Drive Manager

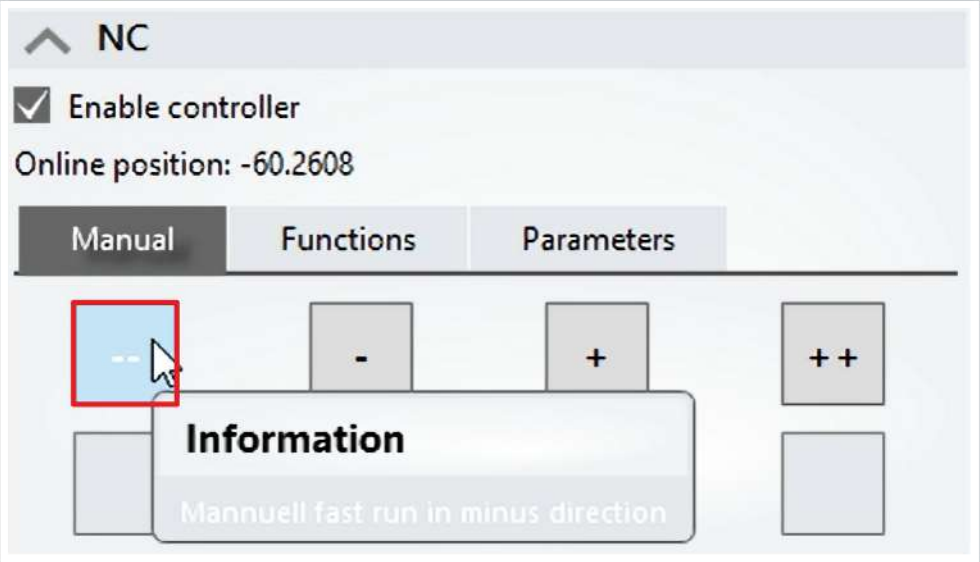
6. Arrange the Drive Manager window to the right of the SLP network
7. Open tab “Run Motor”

A warning message appears. Since this application is a demo system, there is no danger here.

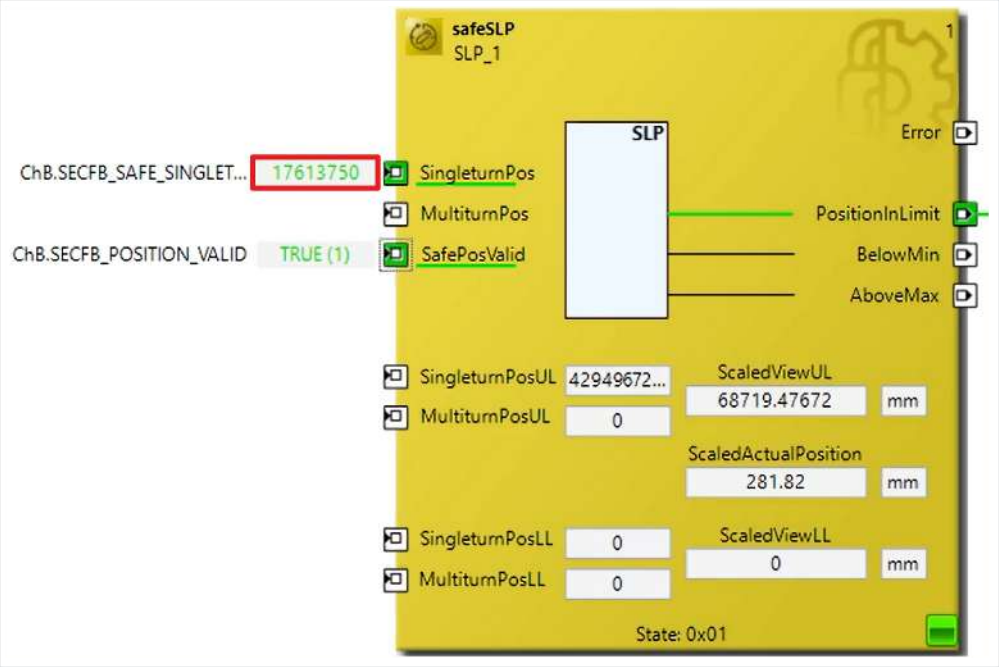
8. Close warning with “OK”

9. Click on the box “Enable controller” in the field “NC”

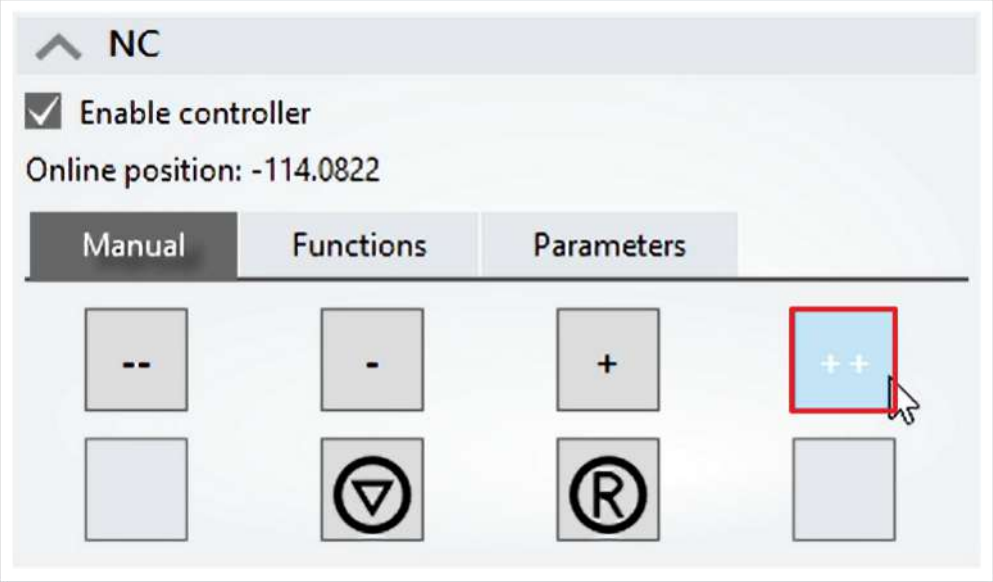
With the manual traverse function of the Drive Manager, move the linear axis in the following to determine the value range that is to be traversed later.



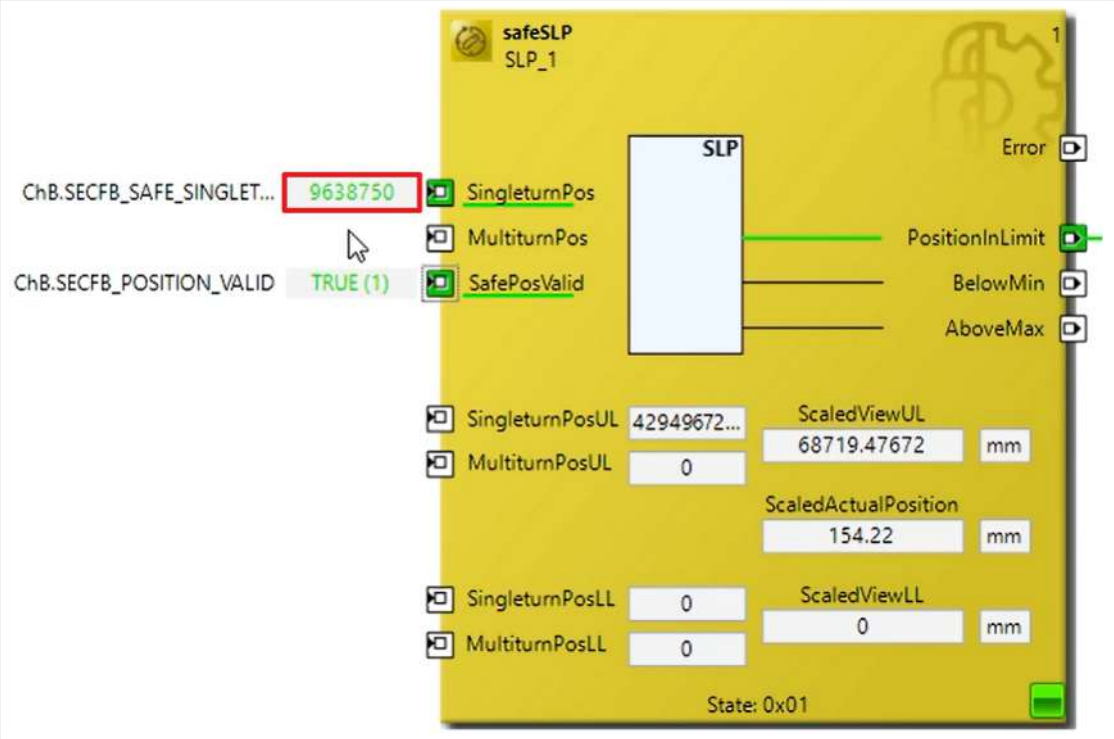
10. Click on the “—" symbol in the “Manual” tab to move the motor manually to the minus range



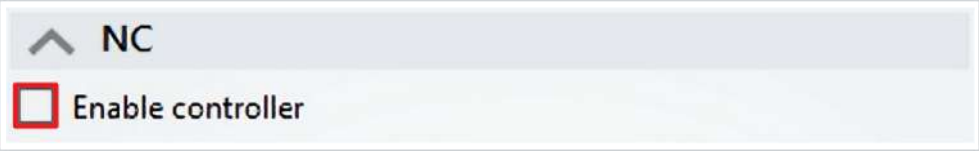
11. Remember value “17613750” of SAFE_SINGLETURN_POSITION



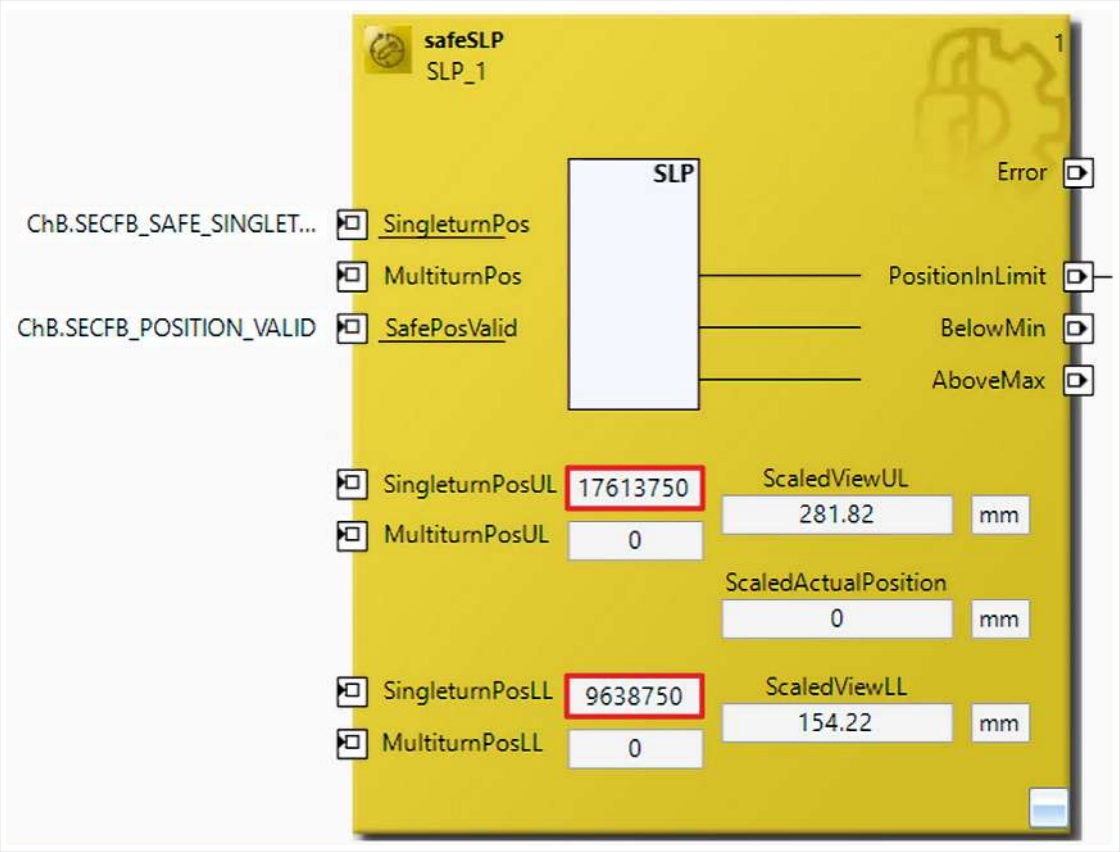
12. Click on the “++” symbol to move the motor manually into the plus range



13. Remember value “9638750” of SAFE_SINGLETURN_POSITION



14. Uncheck “Enable controller”
15. Close Drive Manager
16. Click on “Show Online Data” in the menu bar to deactivate the online view

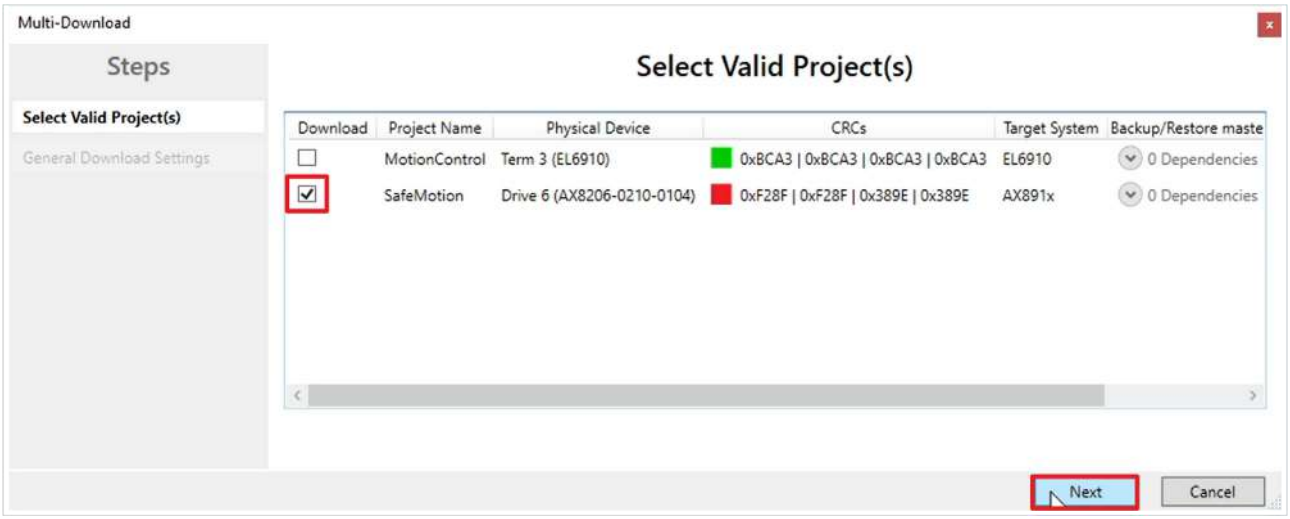


17. Enter the values of the test drive in the block as shown in the diagram
18. Click on “Save all” in the menu bar to save the settings

2.10 Download safety project

After configuration, download the safety projects. Proceed as follows:

1. Click on “Multi-Download Safety Project(s)”



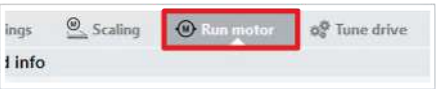
The “Select Valid Project(s)” window opens. Here you can see which safety projects you can download.

2. Select the SafeMotion Wizard project
3. Go through steps 3-13 of the chapter Download safety projects [▶ 33]

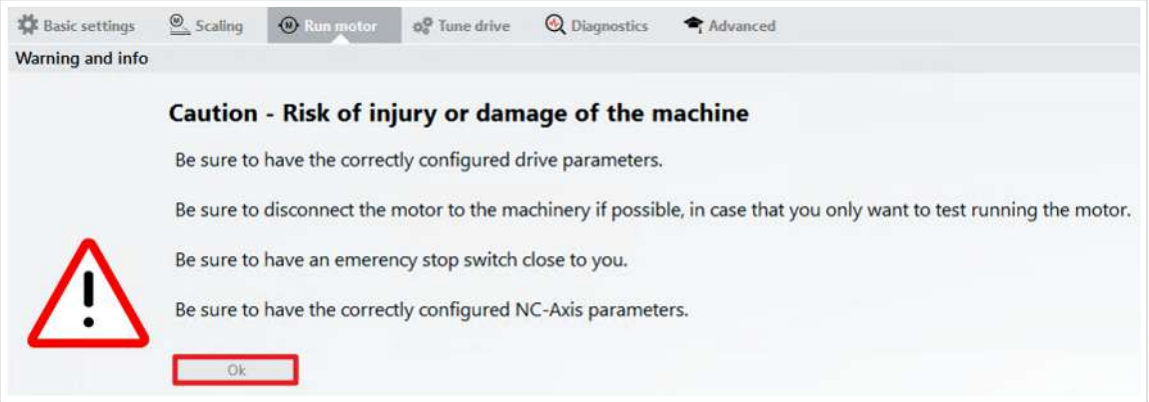
2.11 Check safety functionalities

In this chapter you will test the SLS and SLP safety functions by running the motor. Proceed as follows:

1. Open ChB in the Drive Manager



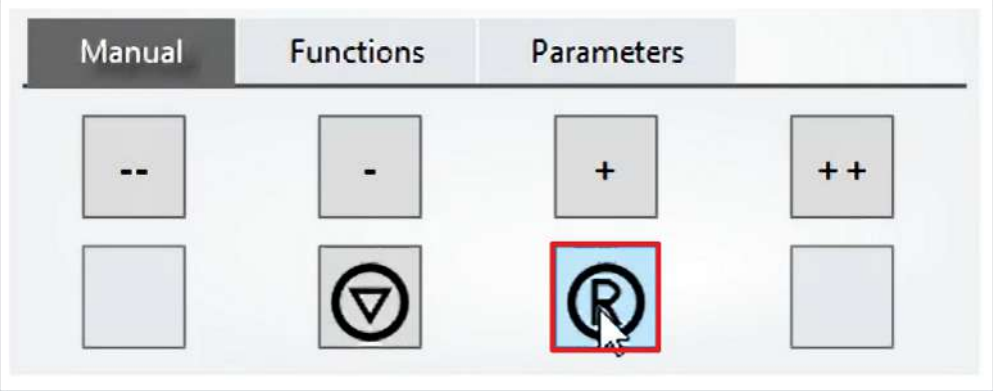
2. Open the “Run motor” tab



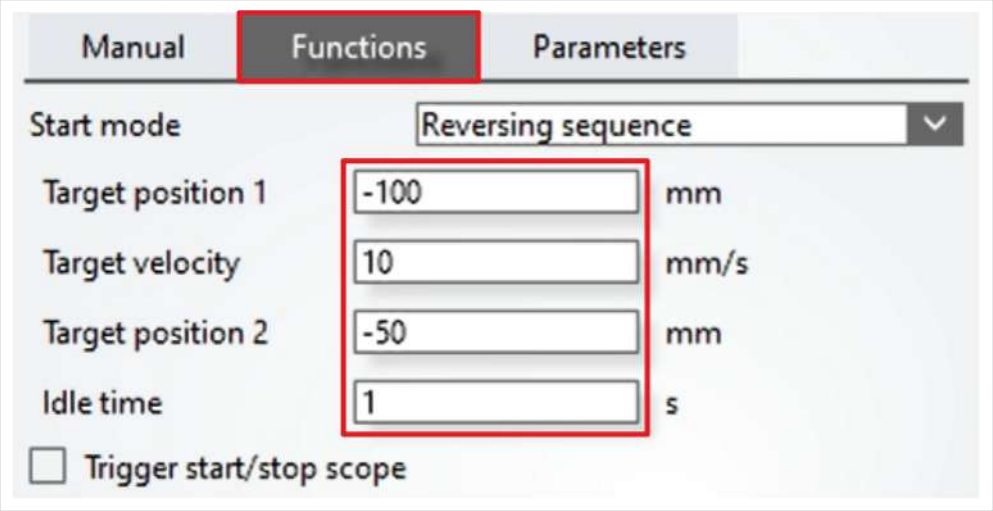
A warning message appears. Since this application is a demo system, there is no danger here.

3. Close the warning with “OK”

4. Click the box “Enable controller” in the field “NC”



5. Click on the “R” symbol in the "Manual" tab to reset the error



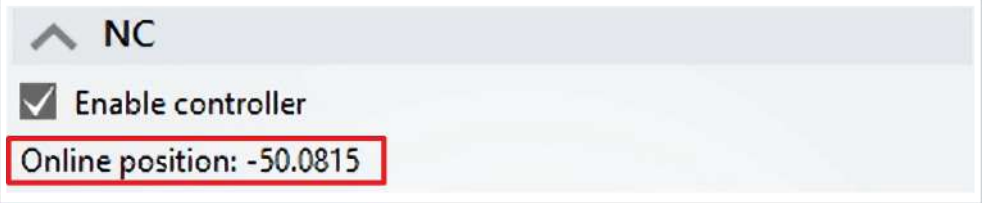
6. Open the “Functions” tab

In the "Functions" tab, configure a reverse sequence.

7. Enter the following values:

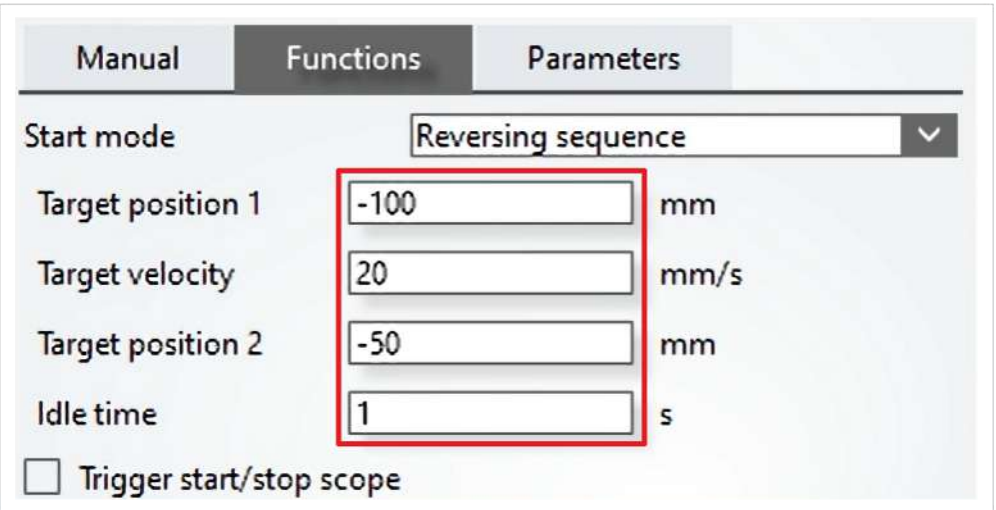
Setting	Value
Target position 1	-100 mm
Target velocity	10 mm/s
Target position 2	-50 mm
Idle time	1 s

8. Click on “Start”



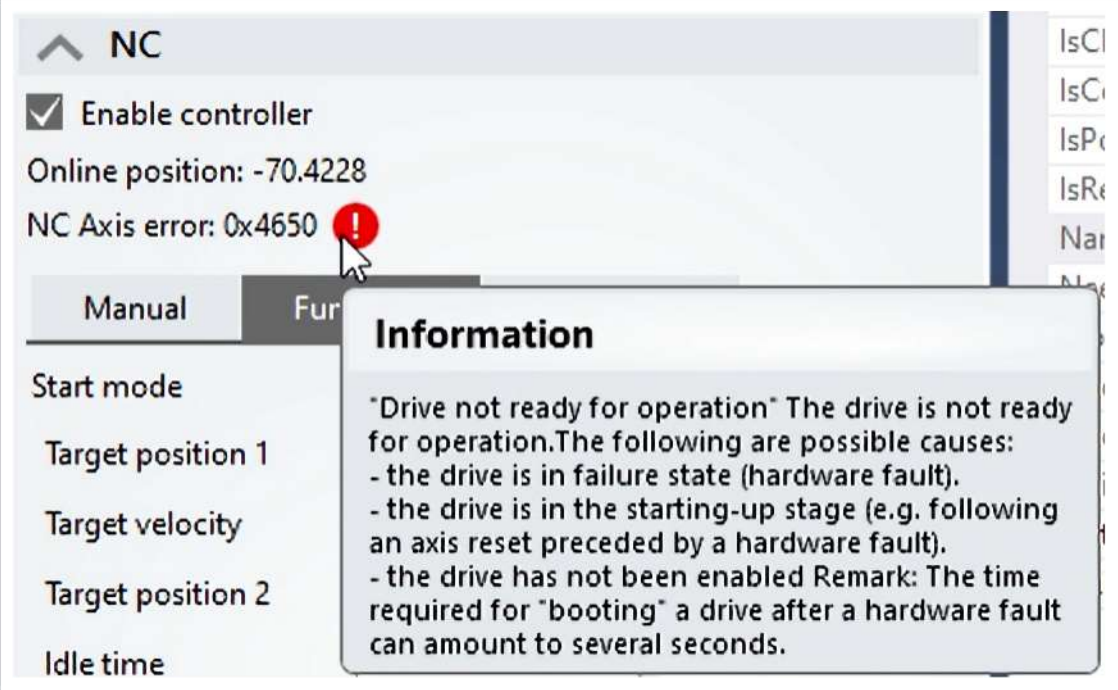
On the basis of the online position value you can see how the motor moves. The motor is within the permitted speed.

9. Click on “Stop”



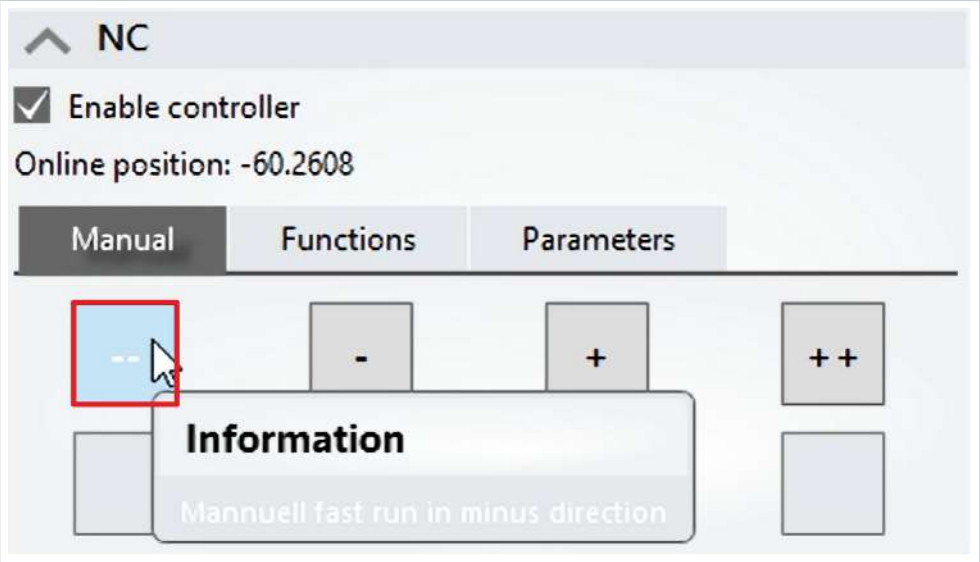
In the “Functions” tab, you can now configure an increased velocity.

10. Enter 20 mm/s in the “Target Velocity” field
11. Click on “Start”



An error message appears because the motor is too fast. The SLS functionality has been successfully implemented.

12. Reset error



13. Click on the “—" symbol in the “Manual” tab to move the motor manually out of the permitted range

An error message appears again as soon as the motor leaves the allowed range. The SLP functionality is also successfully implemented.

More Information:
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