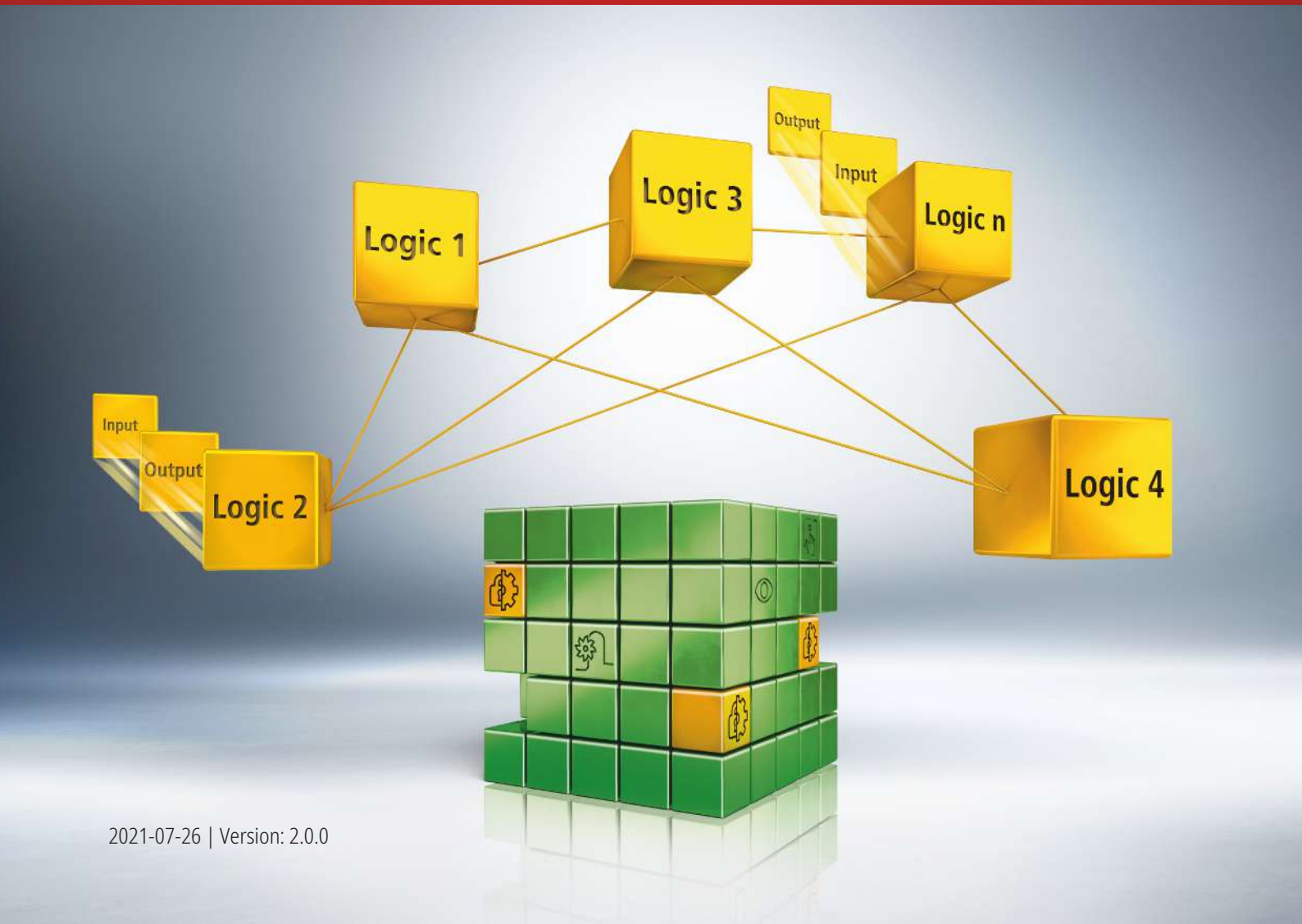
BECKHOFF New Automation Technology

TwinSAFE Tutorial 5 | EN

SafeMotion Wizard

Safe Stop 1 with envelope monitoring



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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 5 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 the Safe Stop 1 functionality with envelope monitoring.

1.1 Issue statuses

Version	Comment
2.0.0	• Table of contents added • Note added to chapter "Starting point" • Following chapter removed: ◦ "Create safe motion project" • Following chapter added: ◦ "Activate average speed calculation" ◦ "Download safety project" ◦ "Check signals" ◦ "Let motor to move" ◦ “Important tutorial aspects” • Calculation formular FB Envelope limit curve corrected • Images revised
1.0.0	• First released version
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

SLP functionality not necessary

This tutorial contains the SLP configuration of the 3rd tutorial and follows on from it. However, SLP functionality is not required.

Since STO and SS1 are active as default functions on every Safe Motion project, this tutorial is applicable for all Safe Motion projects, independent of other functionalities. Sufficient are therefore the criteria mentioned under "To the starting point of the tutorial".

At the starting point of the tutorial

- a standard PLC solution with an EL6910 project exists.
- a Safe Motion 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

1.4.2 Desired safety functionality

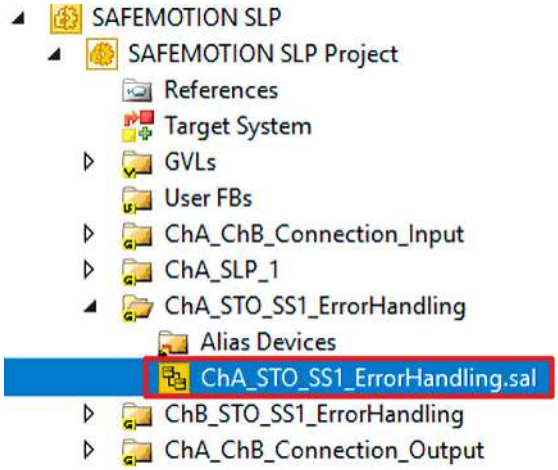
This tutorial describes the realization of the following safety functionalities:

- EL6910 triggers SS1 on the Safe Motion component.
- An envelope violation triggers STO.

2 Demonstration

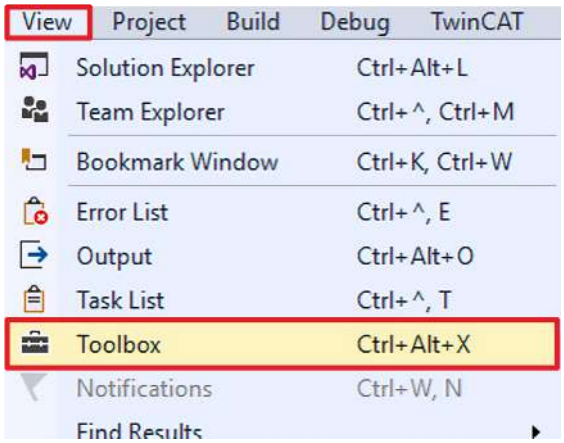
2.1 Extend ErrorHandling

For envelope monitoring, extend the ErrorHandling. Proceed as follows:

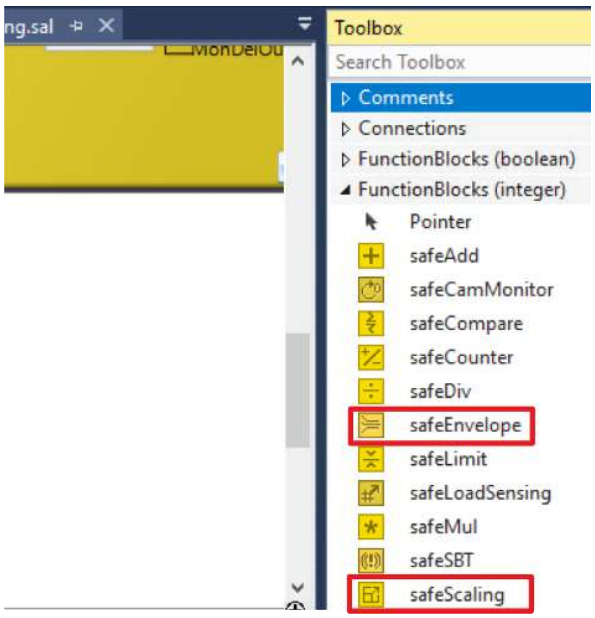


1. Open the file "ChA_STO_SS1_ErrorHandling.sal

You see the FBs generated by the SafeMotion Wizard.



2. Open the Toolbox in the tab "Views"



3. Add FB "safeScaling" to the network by drag & drop
4. Add FB "safeEnvelope" to the network by drag & drop

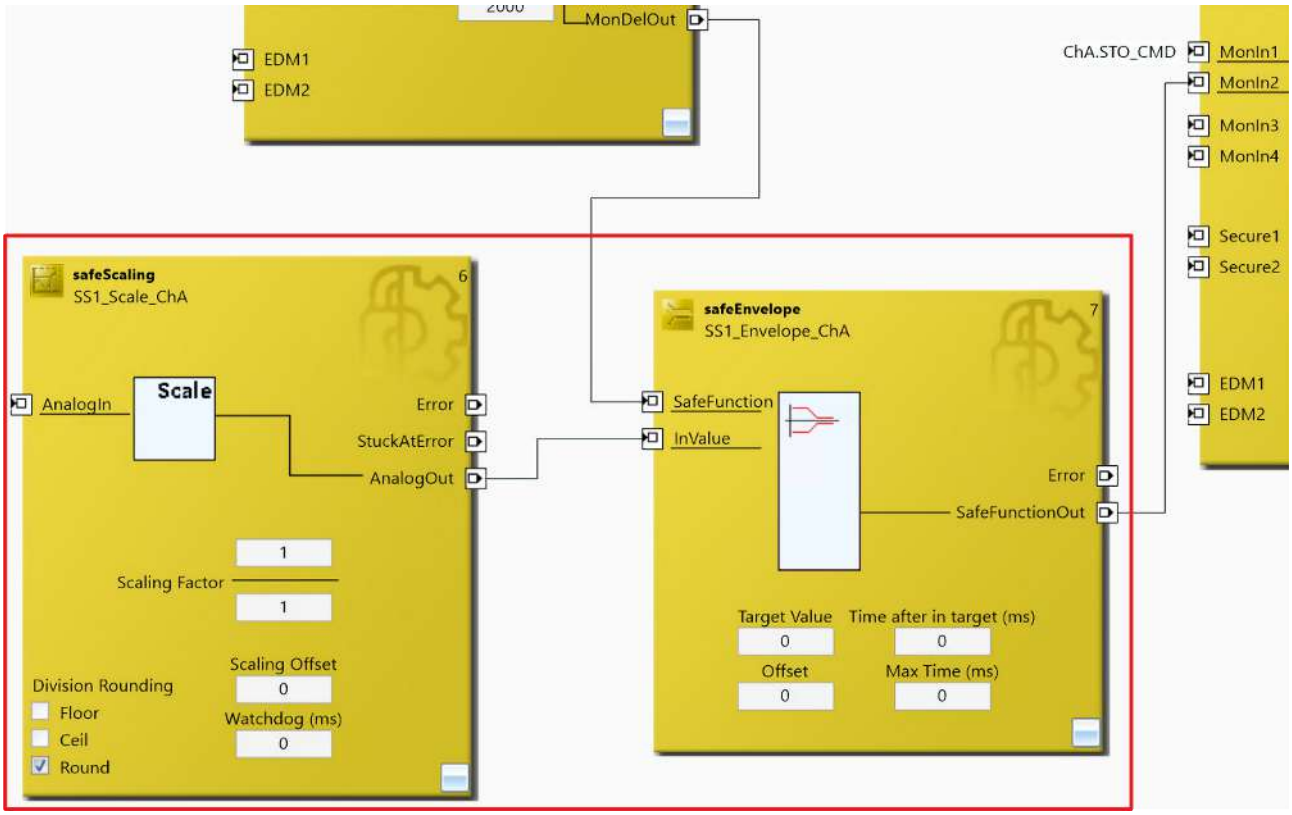
Next, change the names of the newly added FBs:

5. Rename FB safeScaling as desired

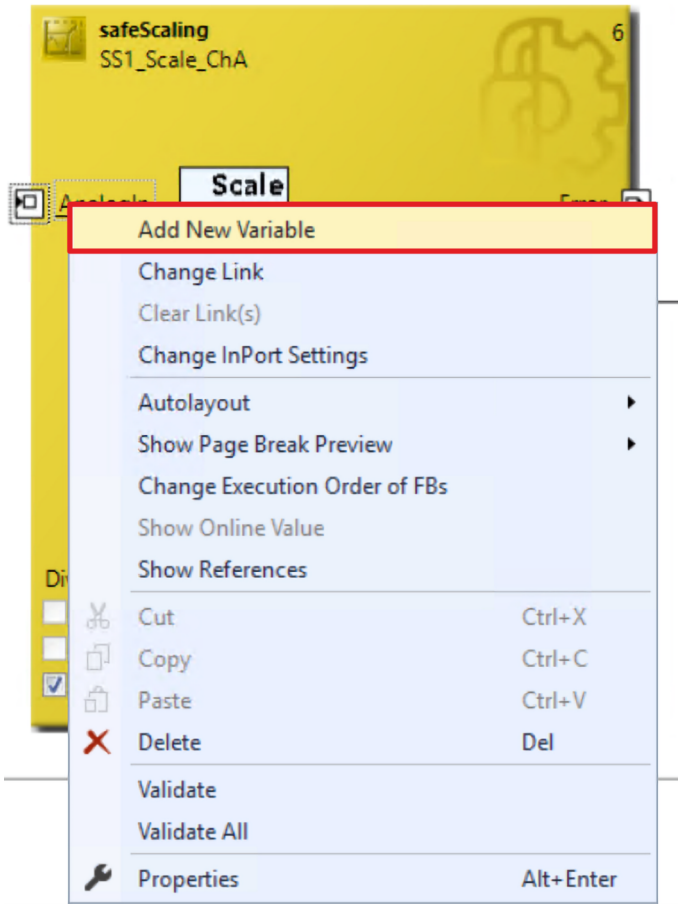
6. Rename FB safeEnvelope as desired

7. Connect the FBs as shown

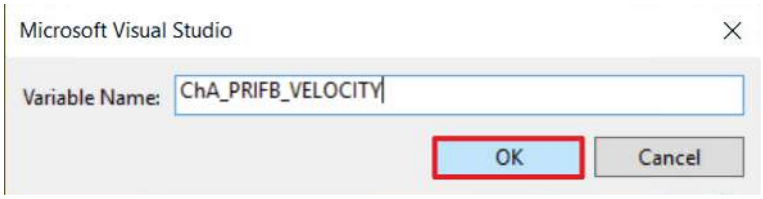
In the following figure you can see the connection in an enlarged view:



8. Right-click on the "AnalogIn" input of the safeScaling FBs



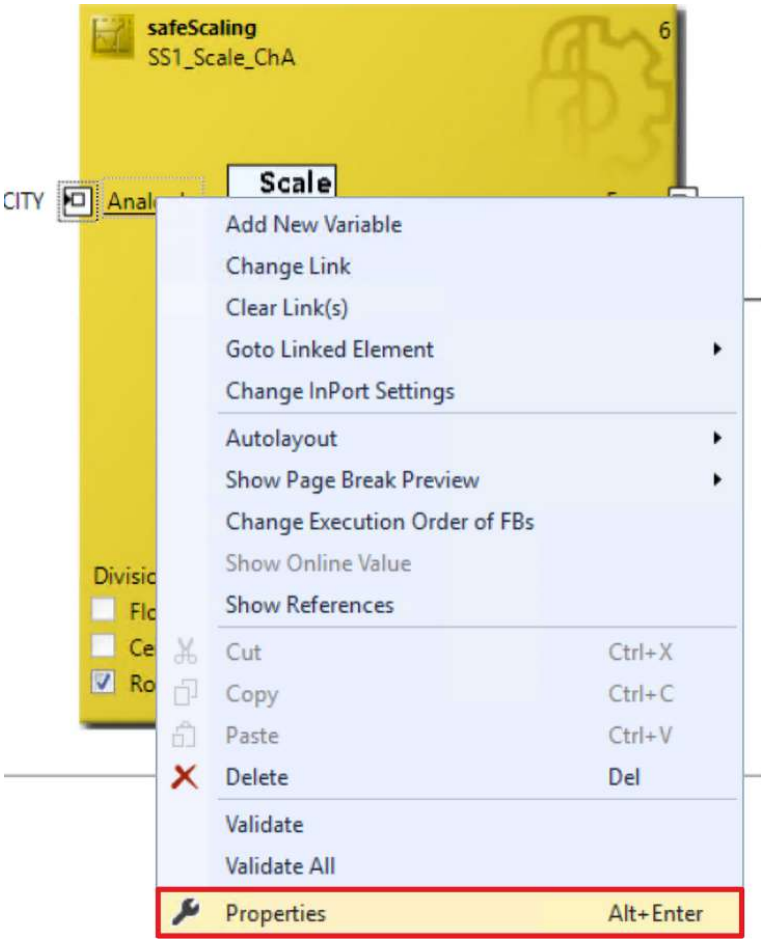
9. Click on "Add New Variable" in the context menu



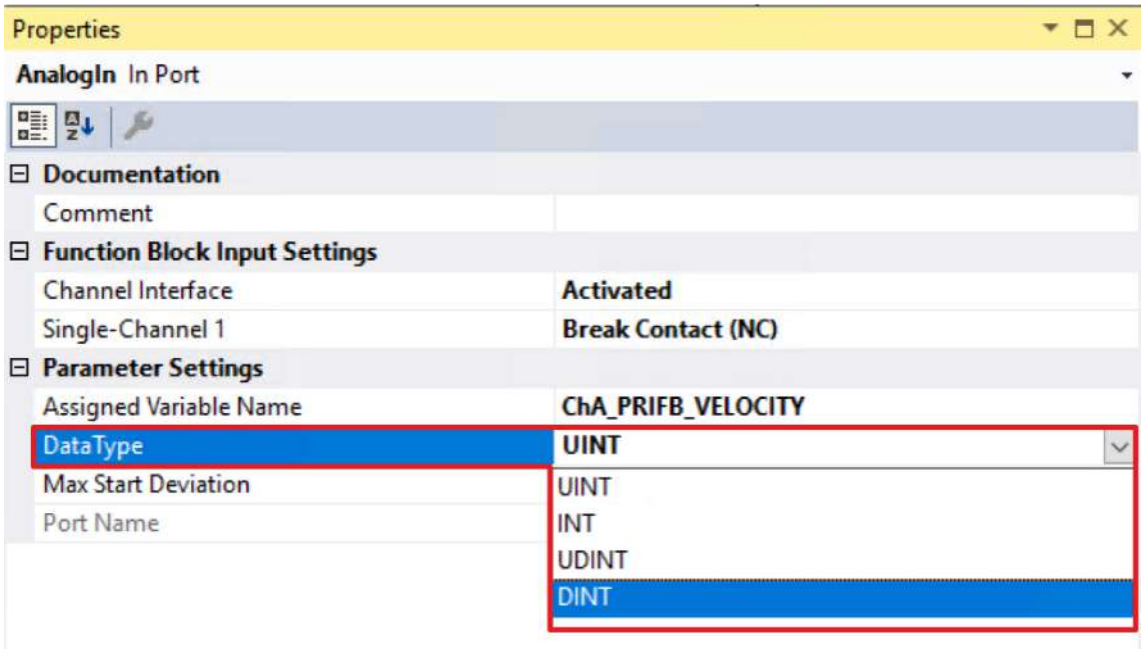
10. Enter variable name
11. Confirm input with "OK"

2.2 Set properties

In the following you must change the DataType of the inputs and outputs of the newly added FBs. The procedure is identical for all inputs and outputs and is illustrated here using the screenshots for one input as an example.

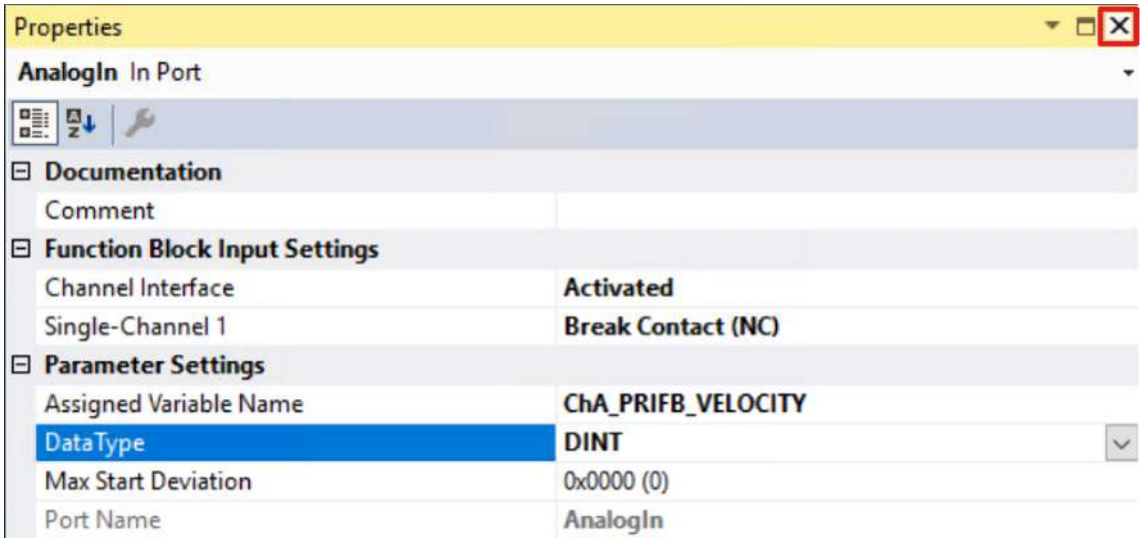


1. Right click on an input or output
2. Click on "Properties

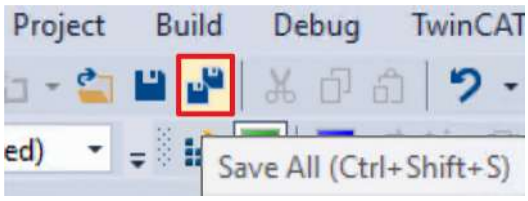


3. Change the DataType in drop-down menu according to the table

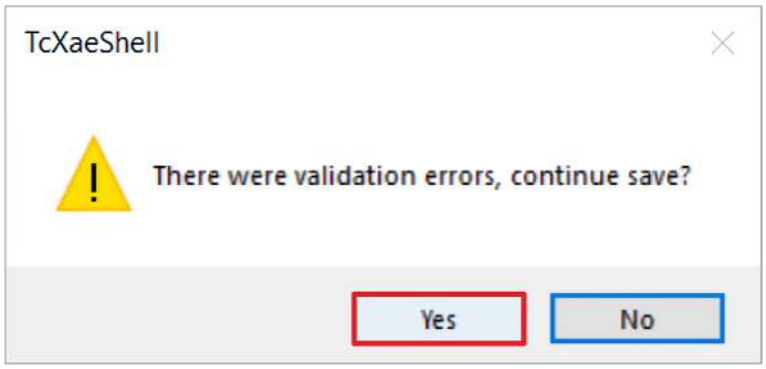
Input/Output	DataType
AnalogIn	DINT
AnalogOut	INT
InValue	INT



4. Close the properties window



5. Click on "Save all" in the menu bar to save the settings



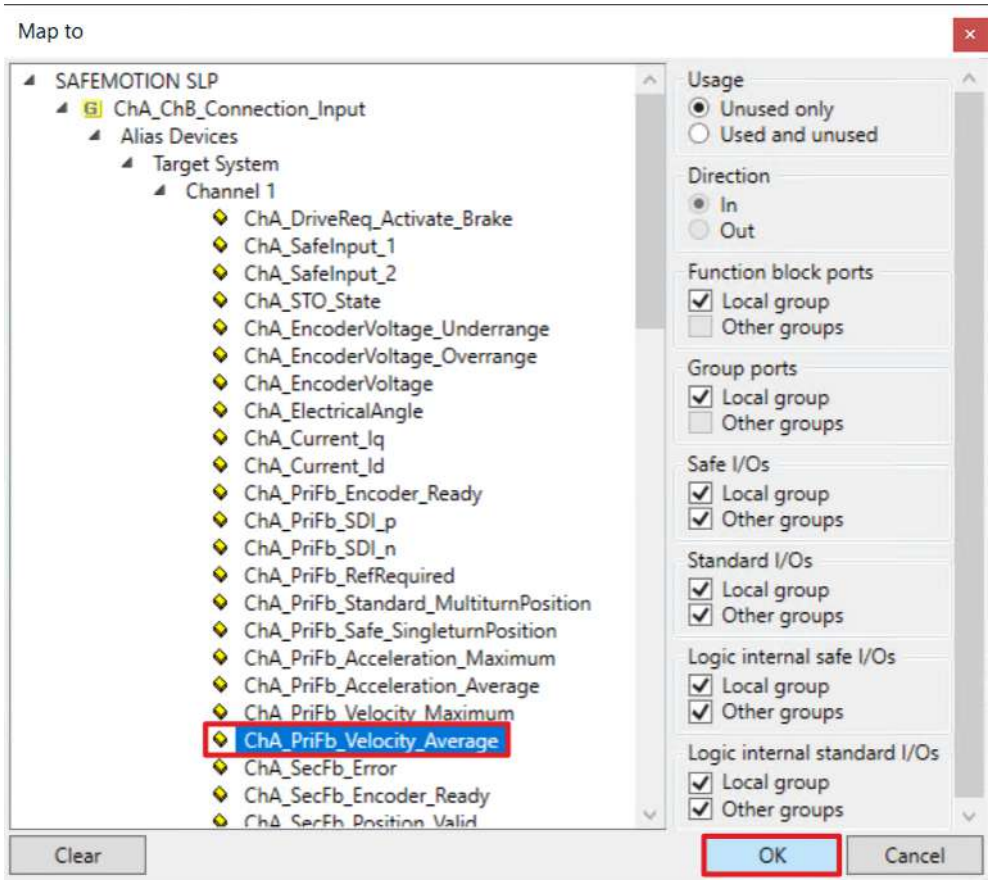
An error message appears.

6. Close the window with "Yes”

2.3 Link velocity

The next step is to link the velocity. To do this, proceed as follows:

1. Open tab "Variable Mapping"
2. Click button " ... " at variable ChA_Velocity



3. Select "ChA_PriFb_Velocity_Average" as target system
4. Confirm selection with "OK"
5. Click "Save all" in the menu bar to save the settings

2.4 Parameterize modules

Calculation formula FB Envelope limit curve:

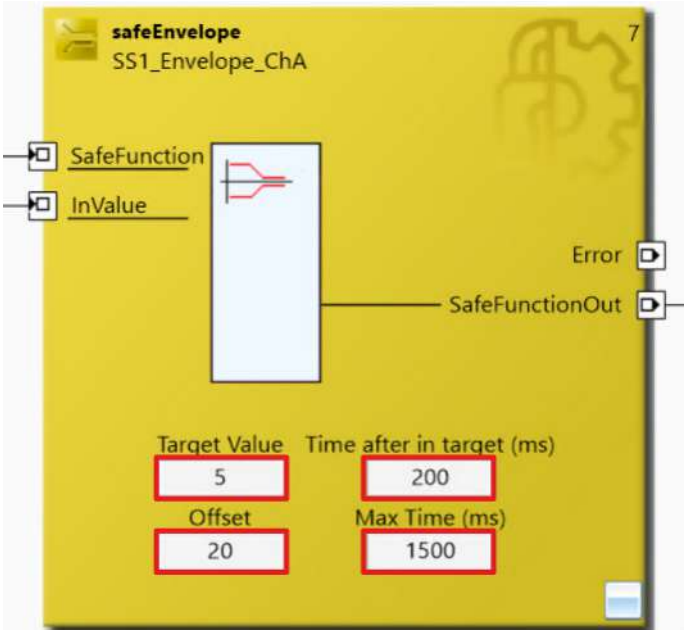
$$InValueDec = \frac{InValueLatch - TargetValue}{MaxTime}$$

The following restriction exists when parameterizing the blocks:

If InValueDec smaller 1, then InValueDec = 1.

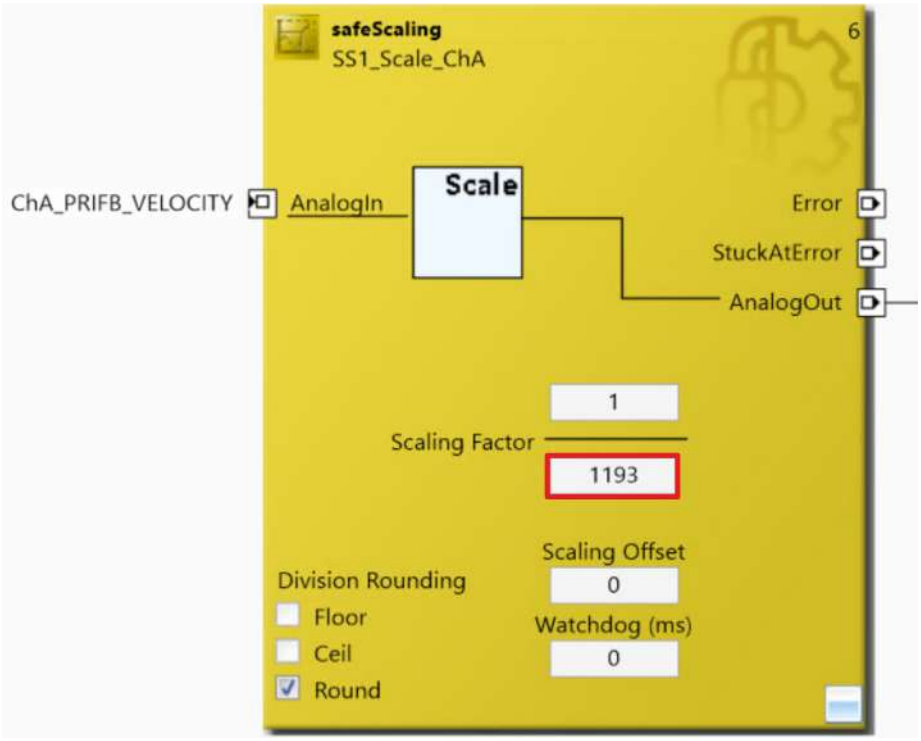
Select the input scaling so that a step size ≥ 1 is enabled. This is the only way to ensure that the ramp is not violated during monitoring.

Parameterize the FBs as follows:

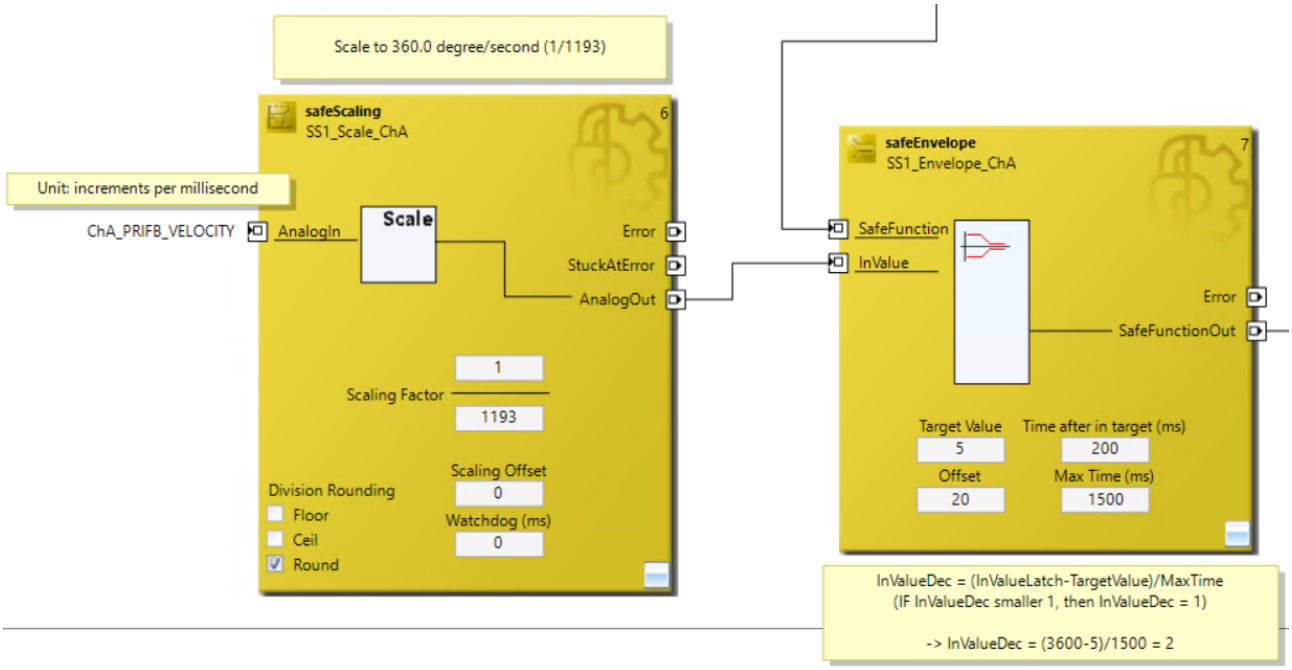


1. As shown in the figure, enter the following values in the safeEnvelope FB:
   - Target Value = 5
   - Offset = 20
   - Time after in target = 200 [ms]
   - Max Time = 1500 [ms].

Next, scale the input value for the safeEnvelope FB by adjusting the safeScaling FB as follows:



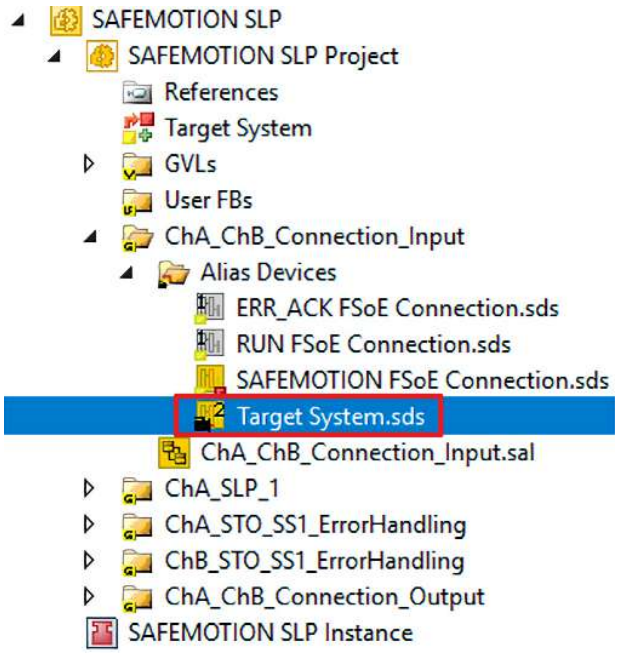
2. Consider the following aspects when scaling the safeEnvelope-FB using the scaling factor:



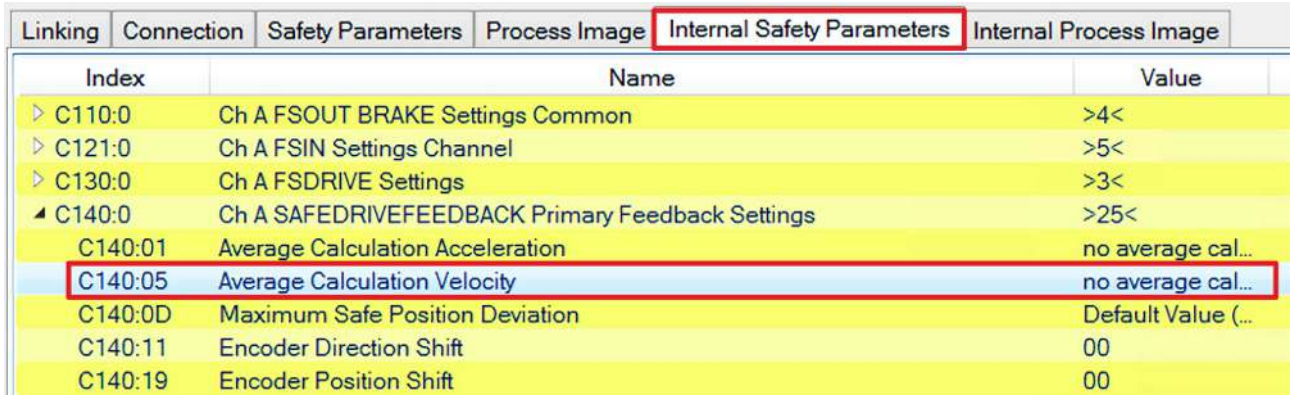
Comment	Explanation
Unit: increments per millisecond	The average speed at the safeScaling-FB input has the unit increments/millisecond.
Scale to 360.0 degree/second (1/1193)	The unit degrees/second is required at the safeScaling-FB output. Therefore, an upscaling is necessary.
InValueDec = (InValueLatch-TargetValue)/MaxTime (IF InValueDec smaller 1, then InValueDec = 1) -> InValueDec = (3600-5)/1500 = 2	Use the formula to determine whether the parameterization fits your application. Note the information block at the beginning of the chapter.

The parameterization of the function blocks is now complete.

2.5 Acitvate average velocity calculation



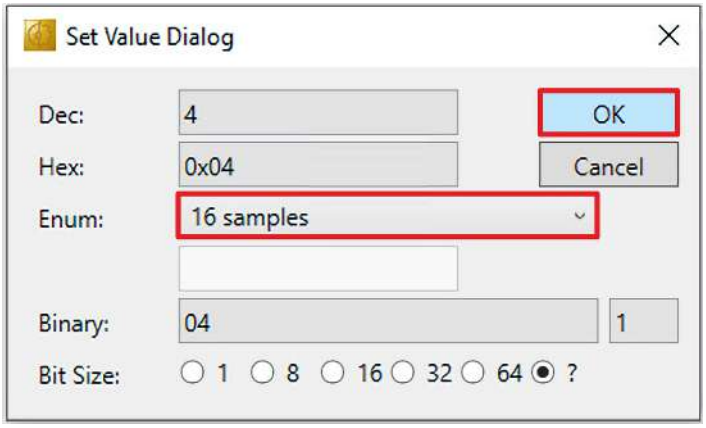
1. In the "ChA_ChB_Connection_Input" folder, open the "Target Systems.sds" file



2. Open the tab "Internal Safety Parameters"

Under the parameter C140:0 there is the parameter C140:05 "Average Calculation Velocity". Adjust this parameter as follows to activate the average velocity calculation:

3. Double click on the parameter

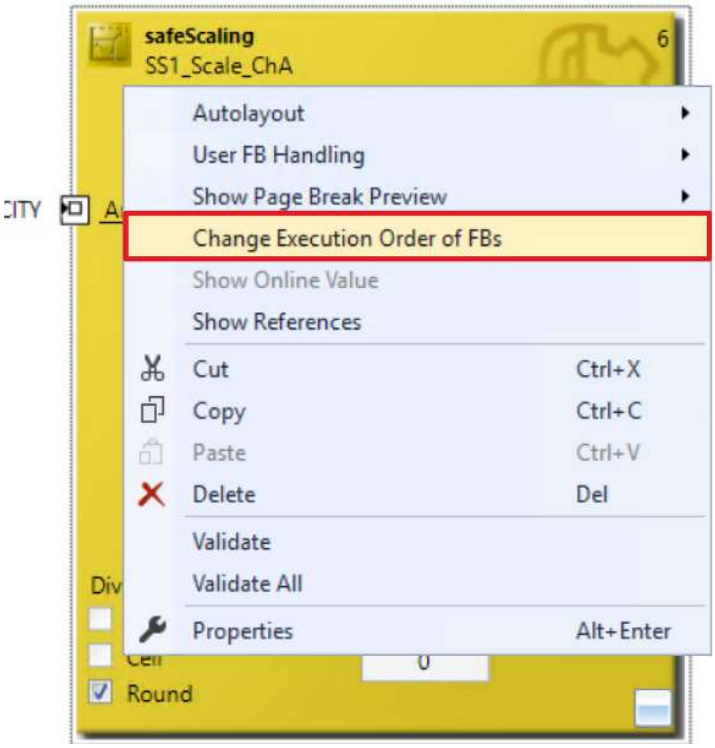


4. Select "16 samples" in the drop-down menu at "Enum"
5. Confirm the selection with "OK"

The configuration is now complete. In the next chapter you will download the safety project

2.6 Changing the order of the TwinSAFE groups

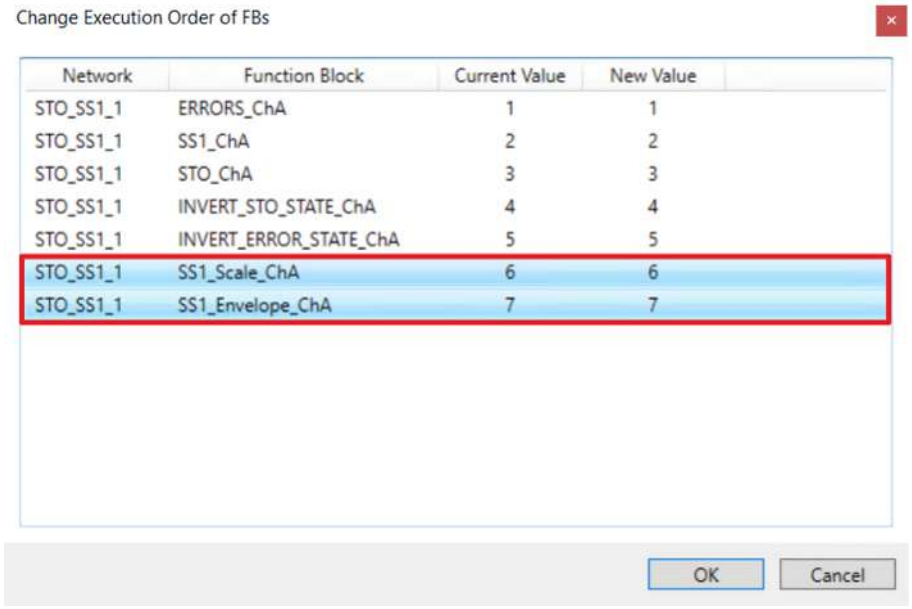
Next you change the processing order of the FBs.



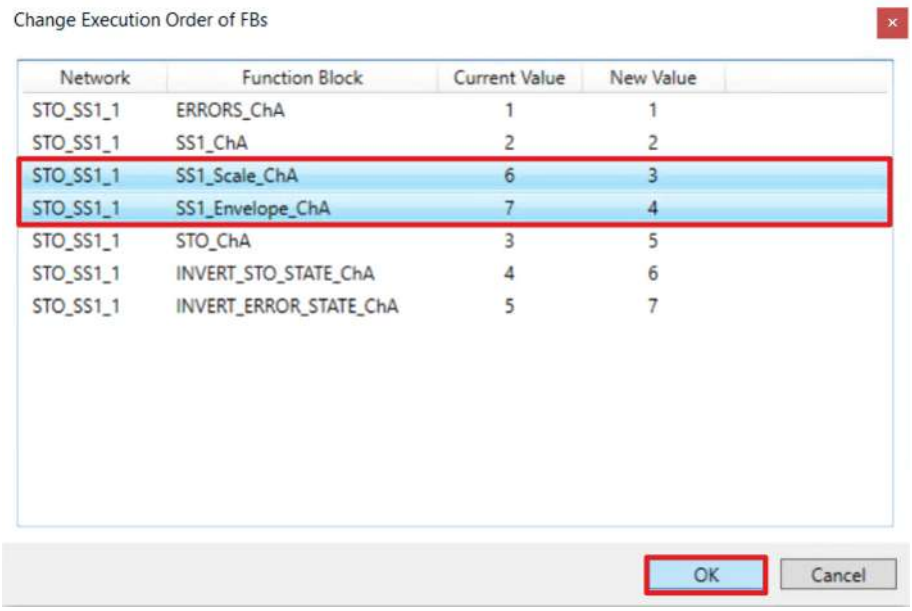
1. Right-click on an FB
2. Click on "Change Execution Order of FBs”

The FBs are displayed in the order in which they are executed.

Change the order of the FBs as follows:

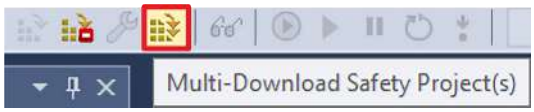


In the "Change Execution Order of FBs" window you can see a comparison of the current order values of the FBs with the new order values.

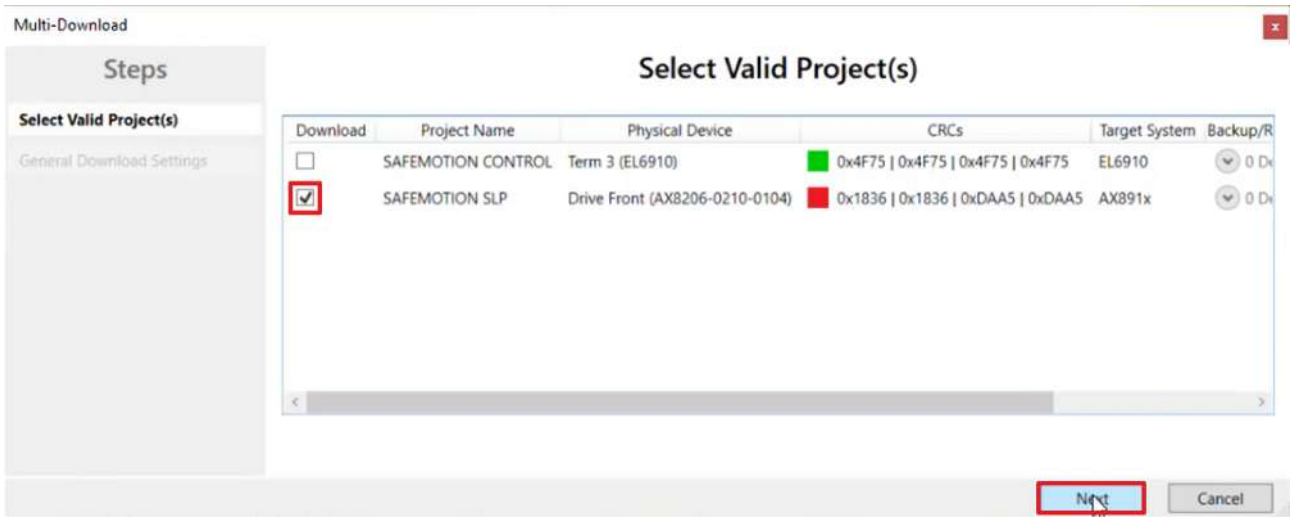


3. Click the entries SS1_Scale and SS1_Envelope and drag them with pressed mouse button to the position after SS1_ChA
4. Confirm the selection with "OK”

2.7 Download safety project

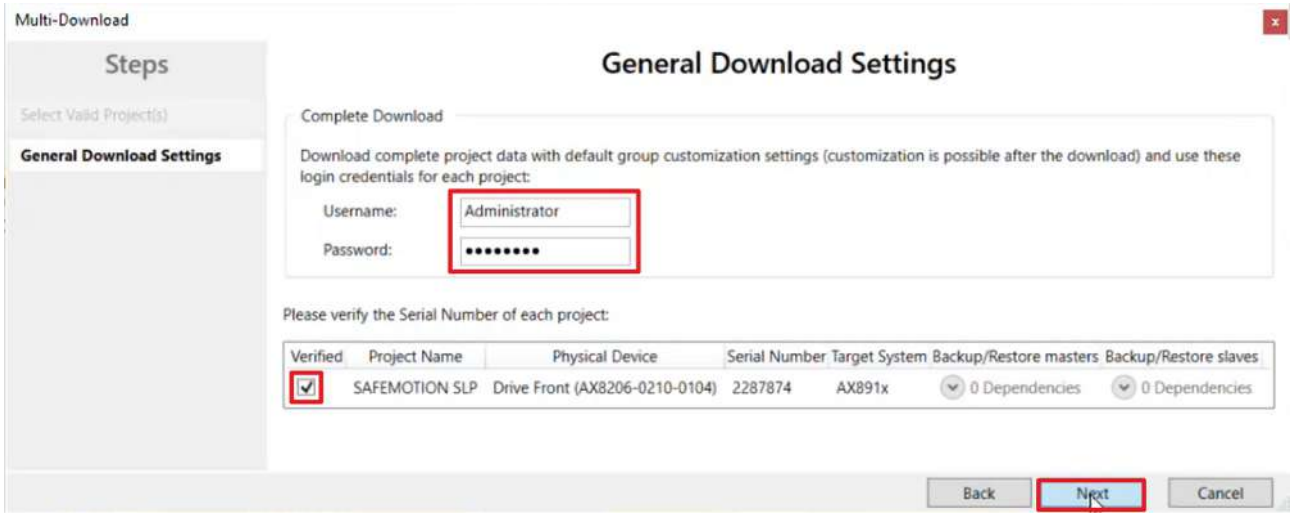


1. Click on "Multi-Download Safety Project(s)"



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

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



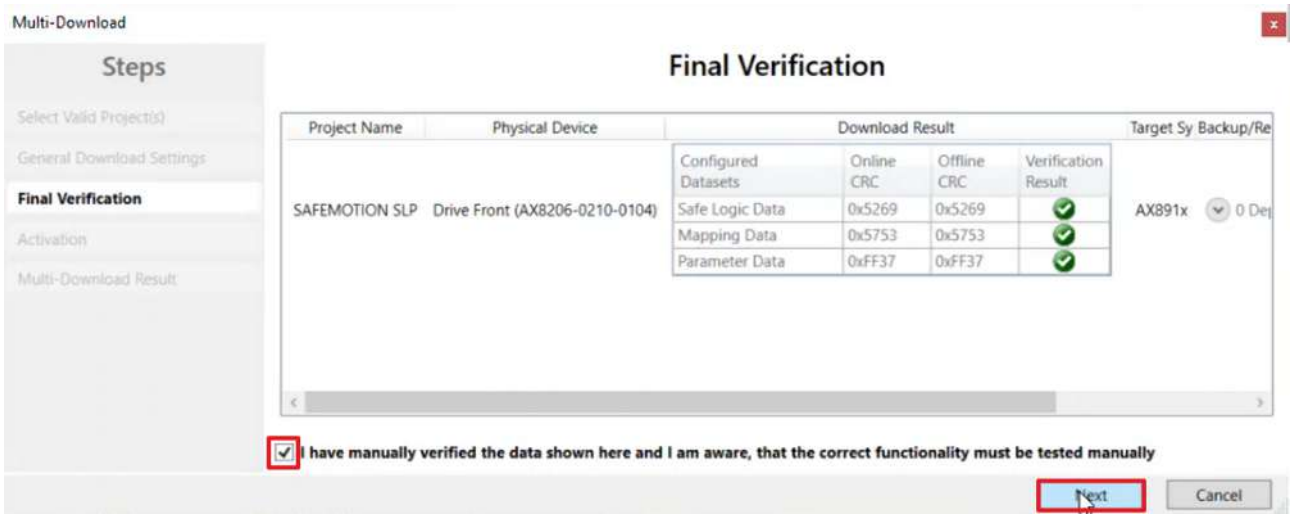
4. Enter the username and password in the "General Download Settings" window

Default username: Administrator

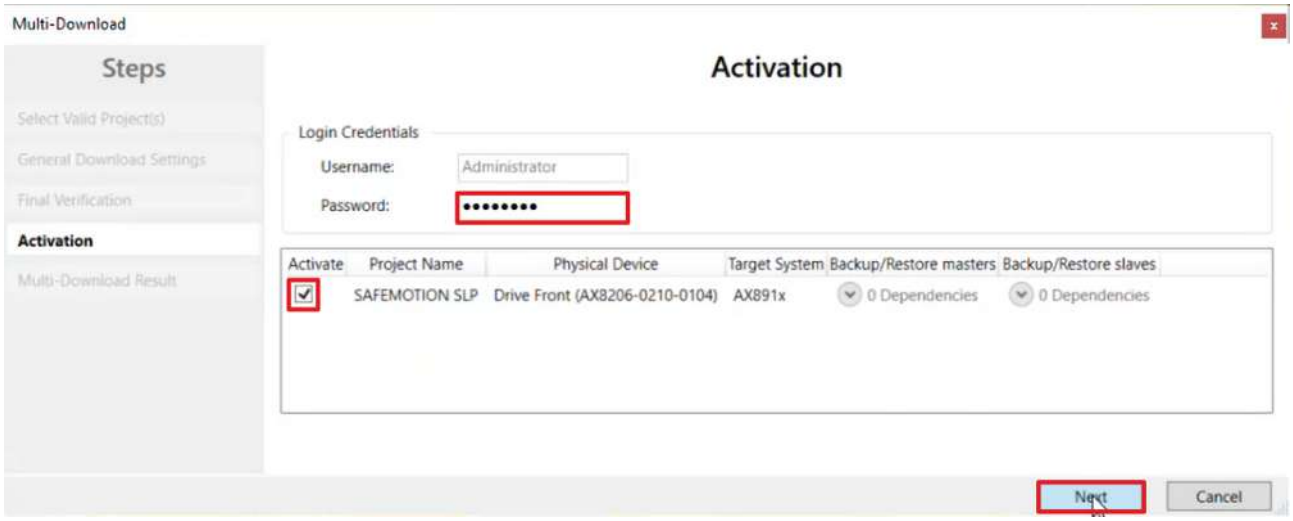
Default password: TwinSAFE

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

The safety project for your Safe Motion component is now converted into the appropriate form and transferred to your Safe Motion component.

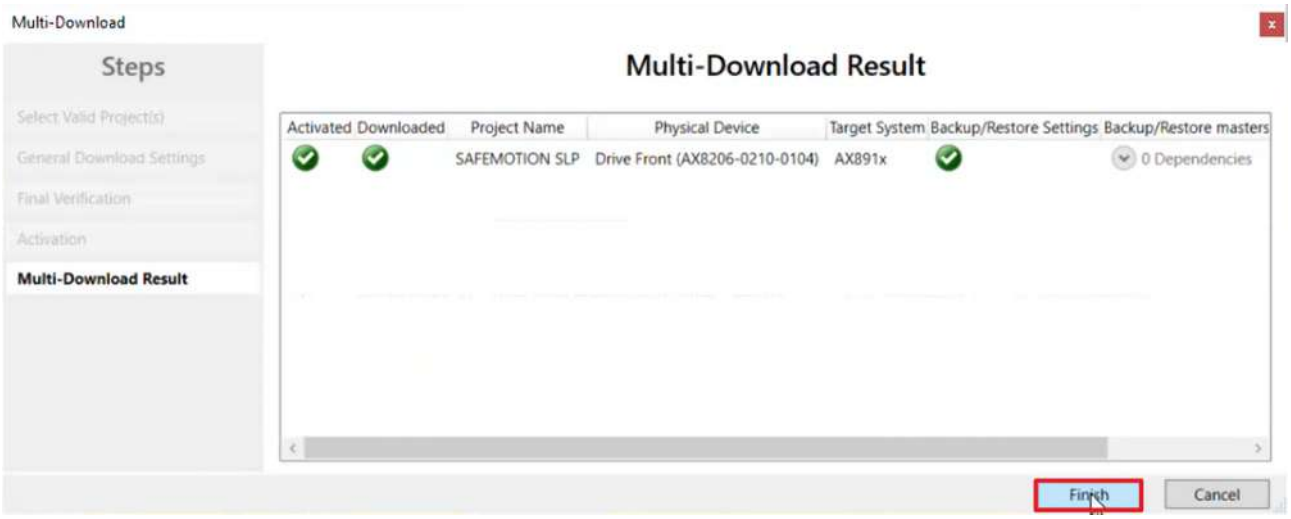


7. Check the CRCs in the "Final Verification" window
8. If the CRCs match, click on the box to confirm the verification
9. Confirm the window with “Next”



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

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

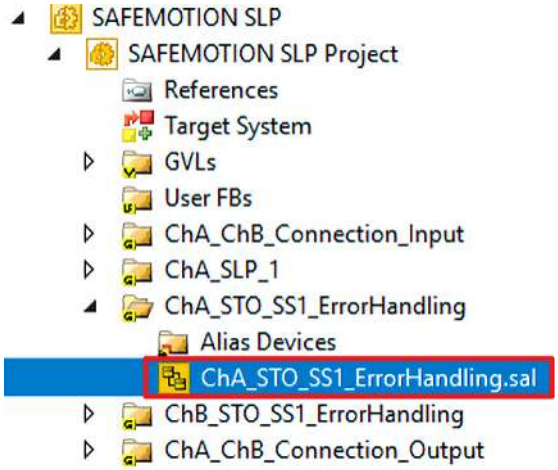


13. Close the window "Multi-Download Result" with “Finish”

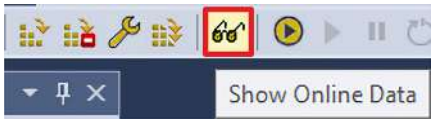
Your safety project is now downloaded and active.

The implementation of your SS1 functionality with envelope monitoring is now complete.

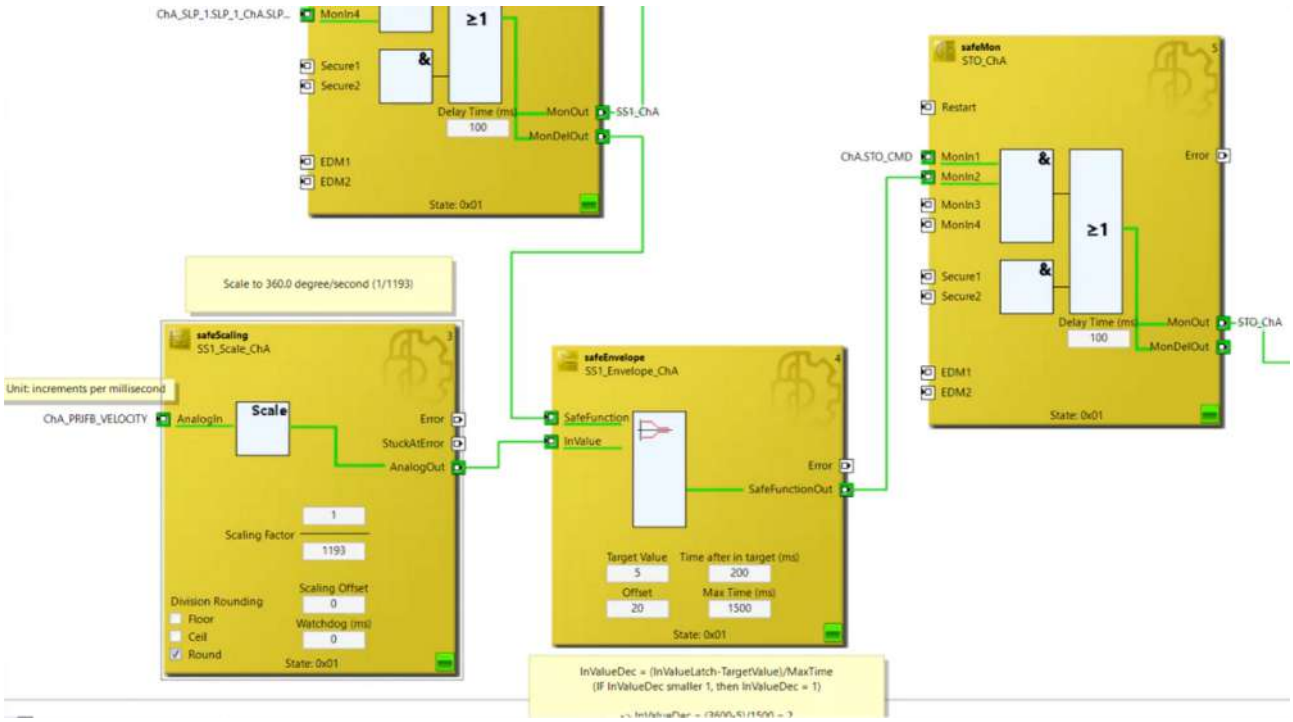
2.8 Check signals



1. Open the file "ChA_ChB_ErrorHandling.sal"

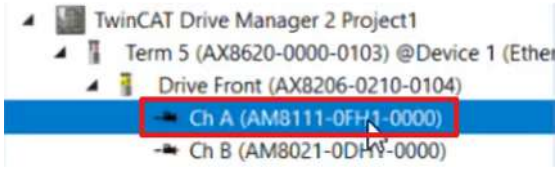


2. Click on "Show Online Data" in the menu bar to activate the online view

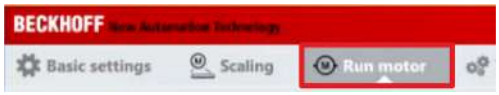


Here you can see that all signals arrive correctly.

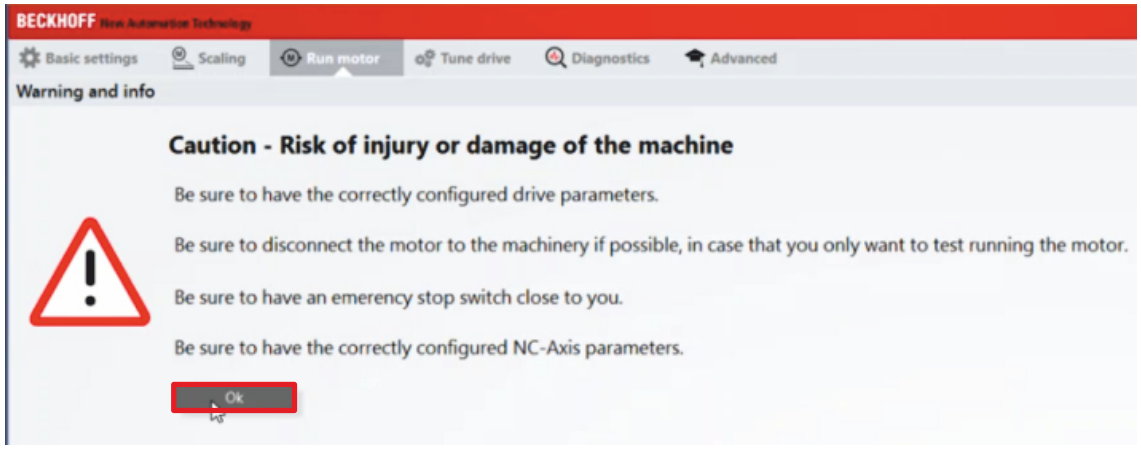
2.9 Let motor traverse



1. Open the ChA channel in the Drive Manager



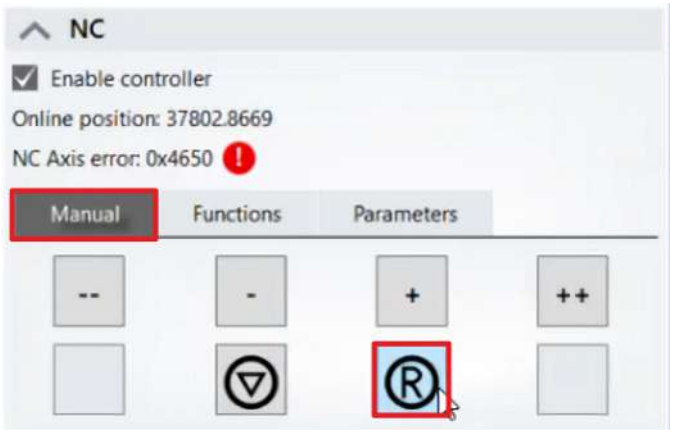
2. Open the tab "Run Motor"



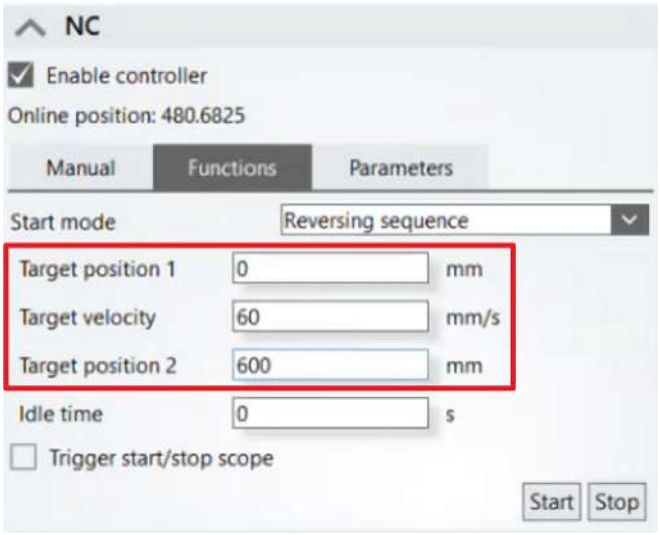
A warning message appears. Since this application is a demo system, there is no danger here.

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

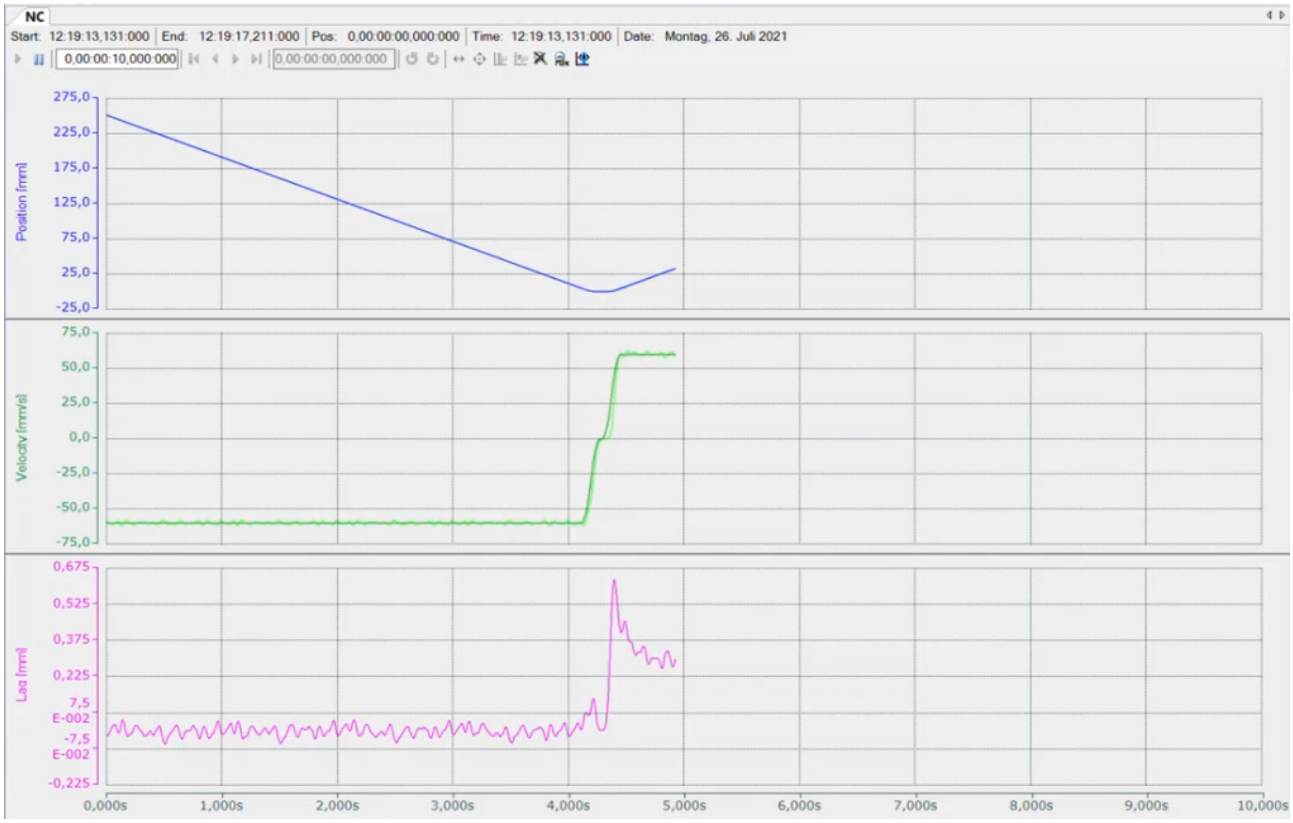
In the "Functions" tab, now configure the movement.

7. Enter the following values:

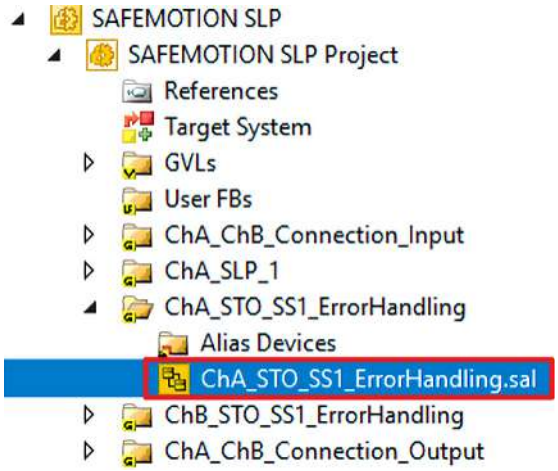
Setting	Value
Target position 1	0 mm
Target velocity	60 mm/s
Target position 2	600 mm

8. Click on "Start"

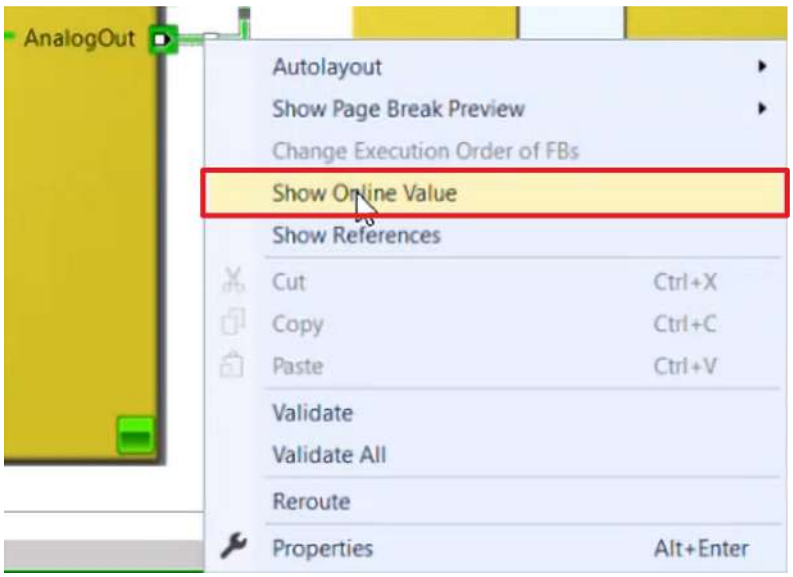
9. Click on the "Start record" field to start the Drive Manager Scope



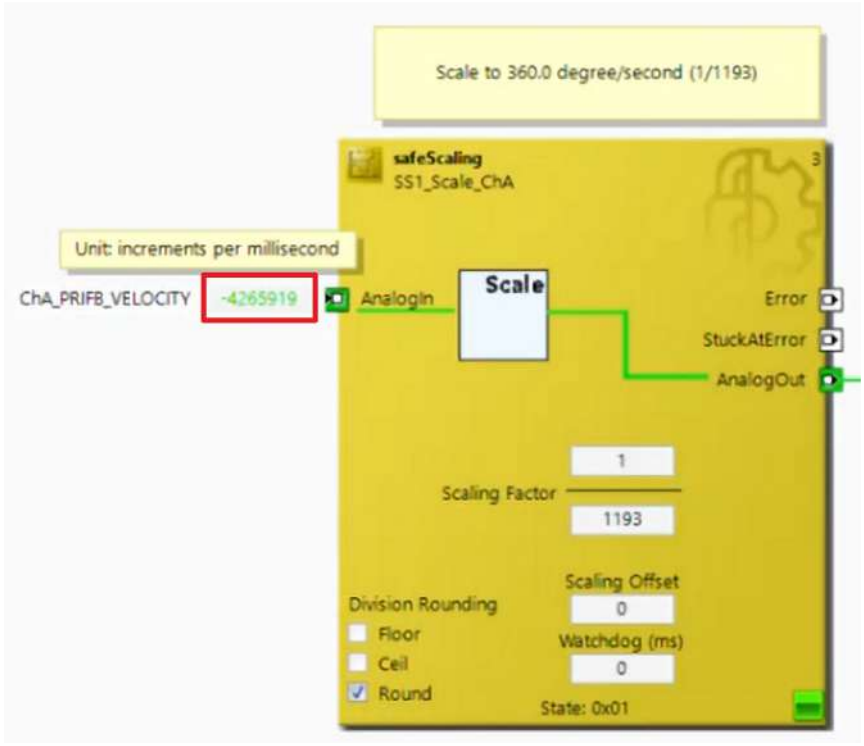
You will now see how the motor traverses.



10. Open the file "ChA_SLP_1.sal"



11. Right-click on a variable in the online view
12. Click on "Show Online Value”



You can see how the values arrive accordingly and are passed to the safeEnvelope FB.

3 Important tutorial aspects

In this chapter you will find important tutorial aspects summarized:

- Always map the velocity value to 32 bits.
- If InValueDec < 1, then the slope is too flat and thus no meaningful monitoring is possible
  - Countermeasure: Scale up value so that InValueDec ≥ 1
  - For this reason, the calculation in this tutorial also scales up to 3600 degrees/second and not to 360 degrees/second.

More Information:
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