# TwinSAFE Tutorial 1 | EN SafeMotion Wizard

Creating and configuring a Safe Motion project with SLS1



# 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 1 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 working with the SafeMotion Wizard.

#### 1.1 Issue statuses

Version	Comment
1.0.0	<ul> <li>First released version</li> </ul>
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 standard PLC project 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

#### 1.4.2 Desired Safety functionality

This tutorial describes the realization of the following safety functionalities:

- An interruption of the light barrier triggers SLS1.
- A violation of the speed limit triggers STO.

# 2 Implementation

### 2.1 Download Safe Motion project

Starting point of the tutorial is an existing TwinCAT3 project with an existing I/O configuration and the corresponding AX8000 entries.



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



1. Select the "TwinSAFE" tab.



#### 2. Select "Start SafeMotion Wizard..." via the Wizard field

SafeMotion Wizard	×
Steps	Select Project Targets
Select Project Targets	TwinCAT Demo Project
Select Motors	Crive Front (AX8206-0210-0104) TIID^Device 1 (EtherCAT)^Term 1 (EK120)^Term 4 (EK1122)^Term 5 (
Select Safety Function	Single Axis         For an untargeted SafeMotion project           Two Axes         For an untargeted SafeMotion project
Configure TwinSAFE Projects	
Assignment of master target logics	
Safe Address Selection	
< >	< >> Back Next Cancel

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

- 3. Select the AX8000 axes
- 4. Confirm with Next

SafeMotion Wizard						×
Steps		Select	M	otors		
Select Project Targets	Select t	he attached motor per channel: AT Demo Project				
Select Motors		rive Rear (AX8206-0200-0104)		1		
Select Safety Function	ChA:	AM8xxx-xxHx-xxxx (OCT 24Bit Multiturn)	v			
	ChB:	AM8xxx-xxHx-xxxx (OCT 24Bit Multiturn)	~			
Configure TwinSAFE Projects	• D	rive Front (AX8206-0210-0104)				
Assignment of master target logics	ChA:	AM8xxx-xxHx-xxxx (OCT 24Bit Multiturn)	v			
Safe Address Selection	ChB:	AM8xxx-xxHx-xxxx (OCT 24Bit Multiturn)	÷			
< >						
				Back	Next	Cancel

In the "Select Motors" window, configure the feedback for the individual axes.

- 5. Select "AM8xxx-xxHx-xxx (OCT 24Bit Multiturn)" for all axes
- 6. Confirm with Next

SafeMotion Wizard	×			
Steps	Select Safety Function			
Select Project Targets	put			
Select Motors	1 I I I I I I I I I I I I I I I I I I I			
Select Safety Function	72,2,2,5,8,8,1 M. 1 M. 1 M. 2 M. 2 M. 2 M. 2 M. 2 M. 2 M. 2 M. 2			
Configure TwinSAFE Projects				
Assignment of master target logics	TwinCAT Demo Project			
Safe Address Selection	ChA ✓			
< >				
	Back Next Cancel			

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

7. For the ChA channels of both AX8000s, select the SLS1 safety function

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

8. Confirm with Next

SafeMotion Wizard		×
Steps		Configure TwinSAFE Projects
Select Project Targets	The following project	s will be created:
Select Motors	TwinCAT Demo Proj	ect
Select Safety Function	Project Name:	SafeMotionDemo SAFETY^TwinCAT Demo Project
Configure TwinSAFE Projects	Safety Functions:	ChA: 2 selected   ChB: 1 selected ChA
Assignment of master target logics		STO_ChA SLS_1_ChA
Safe Address Selection		ChB STO_ChB
	Devices:	Drive Rear (AX8206-0200-0104) TIID^Device 1 (EtherCAT)^Term 1 (EK1200)^Term 4 Drive Front (AX8206-0210-0104)TIID^Device 1 (EtherCAT)^Term 1 (EK1200)^Term 4
< >>	<	
		Back Next Cancel

The "Configure TwinSAFE Projects" window opens. Here you have the option of renaming your Safe Motion project, which is generated for your AX8000s.

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

- 9. Rename project as desired
- 10. Check the settings
- 11. Confirm with Next

SafeMotion Wizard	×			
Steps	Assignment of master target logics			
Select Project Targets	The following master logics are available. The individual safe motion devices can be assigned to these logics. New safety projects will be created or already assigned safety projects will be extended. Backup			
Select Motors	& Restore can be enabled for each safemotion project.			
Select Safety Function	TwinCAT Demo Project			
Configure TwinSAFE Projects	Master Logic Device: Term 3 (EL6910) ^SAFETY ^TwinCAT Demo Project			
Assignment of master target logi	Devices:			
Safe Address Selection	Master Project Name: Demo Safety ^SAFETY ^TwinCAT Demo Project			
	Backup & Restore All 2/2 Devices are not assigned to a master project.			
	Back Next Cancel			

In the next window "Assignment of master target logics" the connection to the EL6910 project is closed, so that your AX8000s can communicate with the EL6910 project. The EL6910 project is automatically found and displayed.

12. Click the button " ... "

Assign devices to master target Ter	m 3 (EL6910)	_		×
Group				
SafeMotionDemo				
✓Drive Rear (AX8206-0200-0104) ⊤	ID^Device 1 (EtherCAT)^Te	rm 1 (EK	.1200) ^ Tern	n 4 (El
✓Drive Front (AX8206-0210-0104)⊺	ID^Device 1 (EtherCAT)^Te	rm 1 (EK	(1200) ^ Tern	n 4 (El
<				>
✓ Select all				
	Cancel		ОК	

- 13. Select your AX8000s that you want to connect to the EL6910 project
- 14. Confirm your selection with OK

SafeMotion Wizard					×
Steps	Assi	gnment	of master	target logics	
Select Project Targets	The following master logic logics. New safety projects	s are available will be created	The individual safe	motion devices can be assigned to d safety projects will be extended.	o these Backup
Select Motors	& Restore can be enabled	for each safem	otion project.		,
Select Safety Function	TwinCAT Demo Project				
Configure TwinSAFE Projects	Master Logic Device:	Term 3 (EL6	910)^SAFETY^TwinC	AT Demo Project	
Assignment of master target logi	Devices:	Backup & Restore	Project	Name	
			SafeMotionDemo	Drive Rear (AX8206-0200-0104)	TIID^D
			SafeMotionDemo	Drive Front (AX8206-0210-0104)	TIID^D
	Master Project Name:	Demo Safe	ty ^SAFETY^TwinCAT	Demo Project	
	<				2
< >	Backup & Restore All 0/2 Devices are not assi	gned to a ma	ster project.		
			Bac	k Next Car	icel

15. Confirm with Next

SafeMotion Wizard			×
Steps	Saf	e Address S	election
Select Project Targets	Set the safe addresses of all involved	d logic devices:	
Select Motors	TwinCAT Demo Project		
Select Safety Function	Drive Rear (AX8206-0200-0104)	- 2+	Define FSoE connection address in proje
Configure TwinSAFE Projects	Drive Front (AX8206-0210-0104)	- 3+	Define FSoE connection address in proje
Assignment of master target logics	Term 3 (EL6910)	- 1+	
Safe Address Selection			
< >	<		>
		B	ack Finish Cancel

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.

16. Close window with Finish

The SafeMotion Wizard configures the projects.

Microsoft Visual Studio	×
SafeMotion project(s) successfully created: - SafeMotionDemo	
Master project(s) successfully created or updated: - Demo Safety	
	OK

17. Close the window with OK

# 2.2 Configure SLS1 functionality

After the Safe Motion project has been created for your AX8000s, configuration takes place.

Proceed as follows for this:

SAFETY					
SafeMotionDemo					
SafeMotionDemo Project					
📊 Multi Setting.sms					
References					
🚰 Target System					
👂 🧊 GVLs					
词 User FBs					
ChA_ChB_Connection_Input					
ChA_SLS_1					
ChA_STO_SS1_ErrorHandling					
ChB_STO_SS1_ErrorHandling					
ChA_ChB_Connection_Output					
SafeMotionDemo Instance					

1. Open the Multi Settings file in the Safety project

Enter the required parameters in this file.

Multi Set	tting.sms +⊨ ×			
<b>+</b>	📲 🖛 🤹 🚔 🖶 🖬			Υ-
Filter	Filter Target System AX891x Physical Device	Filter Target System AX891x Safe Address	Elter ChA_ChB_Connection_Input SAFEMOTION FSoE Connection Alias Device	Filter * ChA_ChE SAFEMO Input - Li
MS_1		2	Demo Safety^TwinSafeGroup1^Alias Devices^Connection to Drive Rear (AX8206-0200-0104).sds	- TIID^ TIID^ TIID^
MS_2	_ Drive Front (AX8206-0210-0104)	3	- Demo Safety^TwinSafeGroup1^Alias Devices^Connection to Drive Front (AX8206-0210-0104)_1.sds	- TIID^ TIID^ TIID^
4				

2. Scroll to the right in the table

Multi Setting.sms*	-⇒ X						-
+-+-	🤹 🛖 🕁 🛈 🕎 🗳					T	•
onnection_Output .ChA	Filter ChA_ChB_Connection_Output SS1_To_NC_ChB Linked to	Filter ChA_STO_SS1_ErrorHandling SS1_ChA Delay Time (ms)	Filter ChA_SLS_1 SLS_1_Limit Minimum Value	Filter ChA_SLS_1 SLS_1_Limit Maximum Value	Filter ChB_STO_SS1_ErrorHandling SS1_ChB Delay Time (ms)	Filter Comment	4
	_	2000	0	0	2000	Base Project Configuration	
	-	2000	-3500000	3500000	2000		
4					-	Þ	

3. Enter the previously determined parameters as minimum value and maximum value for the SLS1 safety function

The SLS1 functionality for your AX8000s is now completely configured.



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

### 2.3 Download Safety projects



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

Multi-Download						×
Steps			Select Valid Proj	ect(s)		
Select Valid Project(s)	Download	Project Name	Physical Device	CRCs	Target System	Bac
General Download Settings		SAFEMOTION CONTROL	Term 3 (EL6910)	0x0000   0x2EAB   0x   0x	EL6910	~
		SafeMotionDemo	Drive Rear (AX8206-0200-0104)	0x0000   0x   0x9DD5   0x9DD5	AX891x	
		SafeMotionDemo	(MS_2) Drive Front (AX8206-0210-0104)	0x0000   0x0000   0xE66B   0xE66B	AX891x	•
1						
2i Ji						_
	C					>
				Next	Cance	

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

- 2. Select AX8000 projects
- 3. Confirm with Next

Multi-Download							
Steps	General Download Settings						
Select Valid Project(s)	Complete Download						
General Download Settings	Download complete project data with default group customization settings (customization is possible after the download) and use these login credentials for each project: Username: Password: Please verify the Serial Number of each project:						
	Verified Project Name Physical Device Serial Number Target System Backup/Restore masters Backup/Resto						
	SafeMotionDemo Drive Rear (AX8206-0200-0104) 5556661 AX891x 💿 0 Dependencies 💿 0 Dependencies						
	SafeMotionDemo (MS_2) Drive Front (AX8206-0210-0104) 2287874 AX891x 💿 0 Dependencies 💿 0 Dependencies						
	Back Next Cancel						

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

Default username: Administrator

Default password: TwinSAFE

- 5. Select the safety projects you want to download
- 6. Confirm selection with Next

The safety project for the two AX8000s is now converted into the appropriate form and transferred to your AX8000s.

Multi-Download								×
Steps		Fina	al Verificatio	on				
Select Valid Project(s)	Project Name	Physical Device		Download	Result		Target Sy	^
			Configured Datasets	Online	Offline CRC	Verification Result		
Final Verification	SafeMotionDemo	Drive Rear (AX8206-0200-0104)	Safe Logic Data	0x832D	0x832D	0	AX891x	
Activation			Mapping Data	0x1913	0x1913	0		
Multi-Download Result			Parameter Data	0xD75D	0xD75D	0		
			Configured Datasets	Online CRC	Offline CRC	Verification Result		
	SafeMotionDemo	(MS_2) Drive Front (AX8206-0210-0104)	Safe Logic Data	0x5CF1	0x5CF1	0	AX891x	
			Mapping Data	0x1913	0x1913	0		~
	<						>	
		varified the data chown here and I am a	ware that the correc	t functionality	must be to	ted manually		
		vermed the data shown here and I am a	ware, that the correc	trunctionality	must be te	sted manually		_
						Next	Cancel	

- 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

Multi-Download					
Steps		Activ	ation		
Select Valid Project(s)	Login Credentials				
eneral Download Settings	Username: Ad	ministrator			
inal Verification	Password:	•••••			
Activation	Activate Project Name	Physical Device	Target System	m Backup/Restore masters	Backup/Restore slaves
/lulti-Download Result	SafeMotionDemo       SafeMotionDemo	Drive Rear (AX8206-0200-0104) (MS_2) Drive Front (AX8206-0210-0104)	AX891x AX891x	0 Dependencies     0 Dependencies	0 Dependencies     0 Dependencies
					Next Cancel

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

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

Multi-Download						×		
Steps	Multi-Download Result							
Select Valid Project(s)	Activated Downloaded	Project Name	Physical Device	Target Syste	em Backup/Restore Se	ettings Backup/Restore r		
General Download Settings	00	SafeMotionDemo	Drive Rear (AX8206-0200-0104)	AX891x	$\bigcirc$	🕑 0 Depender		
Final Verification	00	SafeMotionDemo	(MS_2) Drive Front (AX8206-0210-0104)	AX891x	$\bigcirc$	🕑 0 Depender		
Activation								
Multi-Download Result								
	<					>		
					Finis	h Cancel		

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

The first commissioning of the SLS1 functionality on the AX8000s is now complete.

### 2.4 View SLS1 functionality in online view

To view the SLS1 functionality in the online view, proceed as follows:



1. In the folder "ChA\_SLS\_1" open the sal file to view the implementation



2. Select an AX8000 in the drop-down menu

😻 lat lat 🎤 lit 🛛	💓 💽 🕨 🔰	Ö	+	(MS_2) D
	Show Online D	ata		

3. Select the button for "Show Online Data" to activate the online view



In the online view you can see the online values as well as the set minimum value and maximum value for the selected AX8000.

		safeLimit SLS_1_Limit		r'
ChA.PRIFB_VELOCITY	MAY	Analogin Add New Variable Change Link		Error D InLimit D owMin D
		Goto Linked Element Autolayout Show Page Break Preview	> > >	veMax 🗩
		Show Online Value		
		Show References		
	ж	Cut	Ctrl+X	
		Сору	Ctrl+C	
	â	Paste	Ctrl+V	
		Validate Validate All		
ts Replacement Value	۶	Properties	Alt+Enter	

- 4. Right click on the parameter "ChA\_PRIFB\_VELOCITYMAX"
- 5. Select "Show Online Value" to display the online values

If you deactivate the online view again using the same button you used to activate it (step 3), you will see that the analog value is 0. This is because only the AX8000 project has been downloaded so far. The next chapter contains the connection to the EL6910 project.

# 2.5 Link projects

This chapter describes the step-by-step procedure for connecting the AX8000 project to the EL6910 project via the parameters.

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

Proceed as follows:



1. Open the sal file in your EL6910 project

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

ERR_ACK_AX8000_ChA	Local	Safety_Demo_Group.ERR_ACK_ChA.ERR_ACK_ChA.AndOut	
SS1_AX8000_ChA	Local	Safety_Demo_Group.STO_SS1_ChA.SS1_ChA.AndOut	
SLS_AX8000_ChA	Local	Safety_Demo_Group.SLS.SLS.MonDelOut	
SS1_Switch_ChA	Local	MAIN.AX_SS1_1_CMD_ChA.in (Safety_Demo_Group)	Safety_Der
•			
Safety Project Online View	Variable Mapp	ing Error List Output	

2. Click the " ... " button for the desired parameter



- 3. Select the signals for both AX8000s
- 4. Confirm the window with OK

The following links result for the AX8000 parameters:

Parameter	Signal
ERR_ACK_AX8000_ChA	Error_Ack_ChA
SS1_AX8000_ChA	SS1_ChA
SLS_AX8000_ChA	SLS_1_ChA
SS1_AX8000_ChB	SS1_ChB
ERR_ACK_AX8000_ChB	Error_Ack_ChB
STO_ChA	STO_ChA
STO_ChB	STO_ChB

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

The AX8000 project and the EL6910 project are now linked.

# 2.6 Download EL6910 project

The last step before commissioning is to download the EL6910 project.

To do this, proceed as follows:

1. Click on "Multi-Download Safety Project(s)" in the menu bar

Multi-Download							
Steps	Download         Project Name         Physical Device         CRCs         Target System         E						
Select Valid Project(s)							
General Download Settings	$\checkmark$	SAFEMOTION CONTROL	Term 3 (EL6910)	0x0000   0x2EAB   0x1E96   0x1E96	EL6910		
		SafeMotionDemo	Drive Rear (AX8206-0200-0104)	0x9DD5   0x9DD5   0x9DD5   0x9DD5	AX891x		
		SafeMotionDemo	(MS_2) Drive Front (AX8206-0210-0104)	0xE66B   0xE66B   0xE66B   0xE66B	AX891x		
	<				>		
				D			
				Next	Cancel		

- 2. Uncheck the boxes for the AX8000 projects so that only the EL6910 project is selected
- 3. Confirm selection with Next
- 4. Go through steps 4 13 of the chapter Download Safety Projects
- 5. Click on "Save all" in the menu bar to save the settings

After downloading the EL6910 project, it is necessary to re-enable the configuration, as the EL6910 image has been modified. Proceed as follows:



6. Click on "Activate Configuration" in the menu bar

Activate Co	onfiguration	×
Project:	TwinCAT Demo Project	
Target:		
	Autostart PLC Boot Project(s)	
	OK Cancel	

7. Confirm the "Activate Configuration" window with OK



8. Confirm the "Restart TwinCAT System in Run Mode" window with OK

Next check whether the safe connections are working.



9. To do this, open the EL6910 in I/O Configuration

Name	Online	Туре	Size	>Addre	In/Out	User ID	Linked to
🔁 Safe Logic State	1	USINT	1.0	1599.0	Input	0	
🔁 Cycle Counter	101	USINT	1.0	1600.0	Input	0	
🔁 WcState	0	BIT	0.1	3058.0	Input	0	
🔁 InputToggle	1	BIT	0.1	3060.0	Input	0	
🔁 State	8	UINT	2.0	3094.0	Input	0	
🔁 AdsAddr	5.53.213.218.2.1:1002	AMSADDR	8.0	3096.0	Input	0	
Message_4 RxPDO X	36 50 10 90 62 04 00	FSOE_7	7.0	1571.0	Output	0	FSOE . FSoE Inputs . Mod
Message_48 RxP X	36 81 00 93 BE 81 0	FSOE_11	11.0	1578.0	Output	0	Message_1 . FSoE Slave
Message_49 RxP X	36 00 00 27 85 81 0	FSOE_11	11.0	1589.0	Output	0	Message_1 . FSoE Slave
Standard In Var 1 X	1	BIT	0.1	1600.0	Output	0	MAIN.TS_Run . PIcTask O
Standard In Var 2 X	0	BIT	0.1	1600.1	Output	0	MAIN.TS FrrAck . PIcTask

In the "General" tab you can now see the 3 connections of the EL1918 and the two AX8000s running in the Data state. The connection of the two AX8000s and the EL6910 is thus successful.

The commissioning is now completed.

#### Also see about this

Download Safety projects [> 12]

#### 2.7 Check application

As a last step you have the possibility to check the wiring of your application.

#### Check light barrier

First, the connection to the light barrier is checked. Proceed as follows:

- SafeMotionDemo 4 SafeMotionDemo Project Multi Setting.sms References Target System **GVLs** Þ 📜 User FBs ChA\_ChB\_Connection\_Input Alias Devices A ChA\_ChB\_Connection\_Input.sal ChA SLS 1 Alias Devices ChA\_SLS\_1.sal ChA\_STO\_SS1\_ErrorHandling D ChB\_STO\_SS1\_ErrorHandling Þ ChA\_ChB\_Connection\_Output Þ 1. Open the file "ChA ChB Connection Input.sal" in the AX8000 project
- If the light herrier is interrupted SS1 and STO are to be triggered. You can see whether t

If the light barrier is interrupted, SS1 and STO are to be triggered. You can see whether the signals are transmitted according to your configuration in the online view.

2. Click on "Show Online Data" in the menu bar

#### Connection\_Input\_ChA



As shown in the screenshot, you can see in the online view that the signals SS1 and STO arrive successfully at channel ChA.

#### **Check Error Handling**

Next, check the error handling as follows:



- 3. Open the file "ChA\_STO\_SS1\_ErrorHandling.sal" in the AX8000 project
- 4. Click on "Show Online Data" in the menu bar





As also shown here in the screenshot, you see a successful configuration, because the axes output the corresponding signals SS1 and STO.

More Information: www.beckhoff.com/twinsafe/

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