

"Retraction" function block when using Safely Limited Position via PROFIsafe

SINAMICS • SIMATIC

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Caution

The functions and solutions described in this article are limited primarily to the implementation of the automation task. Please also note that in case of networking your plant/system area with other parts of the plant, the company network or the Internet, appropriate protective measures within the framework of industrial security must be adopted. For more information, see the entry ID 50203404.

<http://support.automation.siemens.com/WW/view/de/50203404>

Question

Contrary to using Safely Limited Position (SLP) via TM54F, for control via PROFIsafe there is no retraction routine saved in the drive. How can retraction be implemented using a fail-safe control and PROFIsafe communication?

Answer

To fully answer this question, follow the handling instructions and notes listed in this document.

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1 Introduction

1.1 Task

A traversing range in which a drive moves is to be monitored using the SLP safety function (Safety Limited Position). If the permissible traversing range is exceeded, then the configured stop response is initiated and the drive comes to a standstill. Due to the fact that the range has been violated, safety messages C01715 and C30715 with fault values 10 or 20 (limit switch pair 1 or 2) are output. SLP must be deselected in order to be able to acknowledge these messages. However, as a consequence, an unsafe state is created. This is because the operator can now continue to move into the inadmissible range. This is why a logic function should be programmed, which prevents traversing to be continued into an impermissible range, therefore guaranteeing that the safe state is maintained.

1.2 Preconditions

This block can only be used in conjunction with a SINAMICS S120 and firmware V4.5 or higher. The basic precondition is that a fail-safe control system (e.g. S7 CPU315F-2 PN/DP) is used together with PROFIsafe telegram 31, 901 or 902.

2 Description of block

2.1 Principle of operation

This block is used to retract a drive via PROFIsafe after a safe traversing range defined using the Safety Limited Position function (SLP) has been violated.

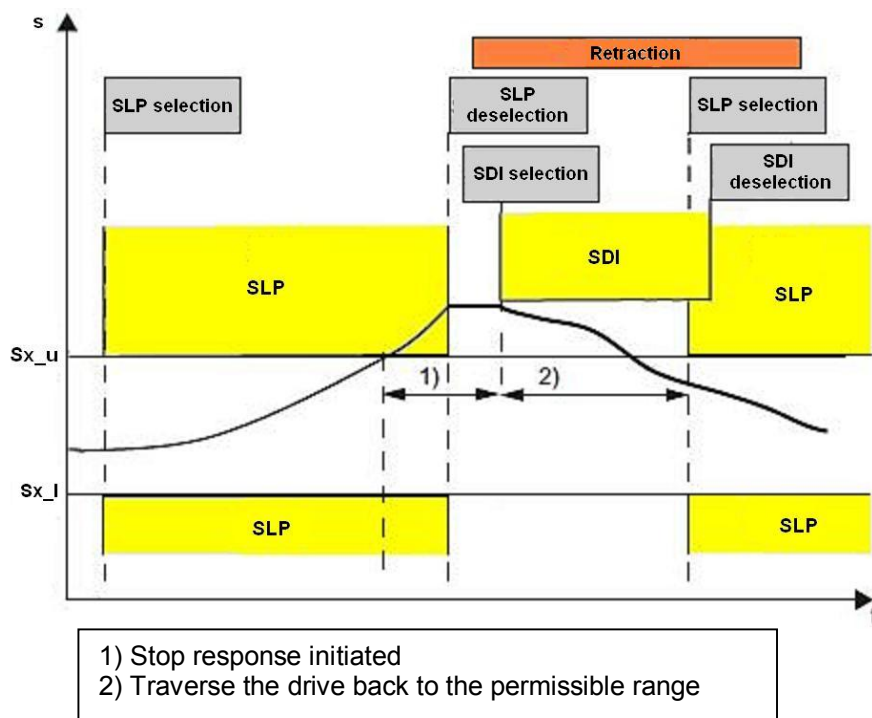
After selecting the SLP safety function, a configurable traversing range is safely monitored. If the upper or lower limit of this traversing range is violated, the parameterized stop response is initiated, and the corresponding safety messages are output. SLP must be deselected in order to acknowledge these fault messages; this means that an unsafe state would be created, as the drive can continue to traverse/move into the inadmissible range. Retraction logic is used in order to avoid this happening.

Note

As an alternative to programming retraction logic, a wider traversing range can be selected (using bit 19 in the PROFIsafe STW2). As a consequence, the safety messages can also be acknowledged and the drive can be subsequently traversed.

This FAQ concentrates on programming retraction logic; switching over the traversing range is not discussed here.

The principle of this block is shown in the following diagram:



In this case, the traversing range of SLP is considered between the software limit switches Sx_I (lower software limit switch) and Sx_u (upper software limit switch). In

this example, the upper SLP limit is exceeded, and the parameterized stop response initiated. SLP must be deselected and SDI selected to be able to retract back into the permissible traversing range. The SDI direction to be selected depends on the violated SLP limit – if the lower SLP limit is violated, then SDI+ must be selected, and when the upper SLP limit is violated, then SDI-.

Note

SLP is deselected and SDI selected in the same cycle and in the same PROFIsafe telegram. This guarantees that a safety function (SLP or SDI) is always active.

When activating the retraction logic, SLP is deselected so that the safety messages can be safely acknowledged. SDI is selected in the same cycle, in order to prevent the drive (axis) traversing beyond the limit switch. The drive can then be traversed in the permissible range.

Note

If the drive would now be further traversed into the inadmissible range, then after exceeding the SDI tolerance (p9364/p9564), the parameterized stop response of SDI would be initiated.

In order to ensure that the drive does not traverse into the permissible range for an arbitrary time, and could possibly pass (actuate) the second limit switch of the traversing range, this block has a safe timer. After selecting retraction, this timer is started – and after a retraction time, configured by the user, the timer is stopped. If the drive is still not in the permissible traversing range after this time has expired, then retraction must be reselected, the safety messages safely acknowledged and the drive traversed into the permissible traversing range.

2.2 Structure

The signals of the block and their interconnection are discussed in the following.

Fig 2-1 Block structure

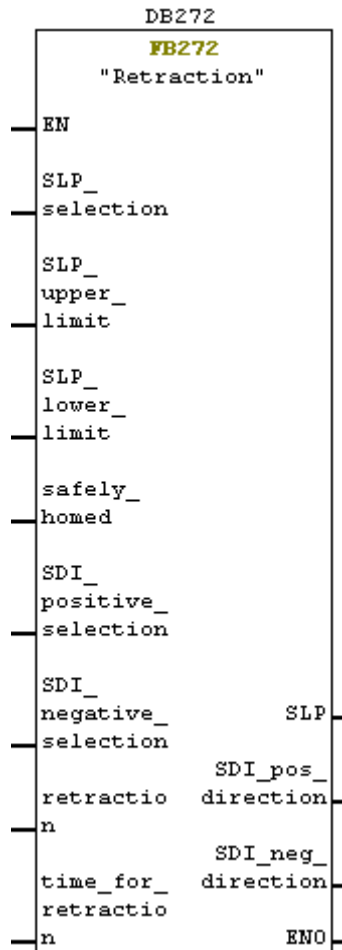


Table 2-1 Interconnecting the inputs

Inputs	Data type	Description of the interconnection
SLP_selection	BOOL	Signal used to select SLP.
SLP_upper_limit	BOOL	The user must interconnect the signal with PROFIsafe-ZSW2 bit 30 ("SLP_P_ok").
SLP_lower_limit	BOOL	The user must interconnect the signal with PROFIsafe_ZSW2 bit 31 ("SLP_N_ok").
safely_homed	BOOL	The user must interconnect the signal with PROFIsafe_ZSW2 bit 23 ("SP ref").
SDI_positive_selection	BOOL	Signal used to select SDI+.
SDI_negative_selection	BOOL	Signal used to select SDI-.
retraction	BOOL	Signal used to select retraction ("high" signal). After violation of a position range

Inputs	Data type	Description of the interconnection
		and a positive edge at "retraction", the axis can be retracted back into the permissible range.
time_for_retraction	TIME	A time is entered here, which specifies how long the retraction logic is active. After this time expires, SLP is reselected and SDI is deselected. This prevents the drive from traversing out of the permissible position range, past the second software limit switch.

Table 2-2 Interconnecting the outputs

Outputs	Data type	Description of the interconnection
SLP	BOOL	This output must be interconnected with bit 6 of PROFIsafe STW2.
SDI_pos_direction	BOOL	This output must be interconnected with bit 12 of PROFIsafe STW2.
SDI_neg_direction	BOOL	This output must be interconnected with bit 13 of PROFIsafe STW2.

Fail-safe signals are used to select SLP, SDI+, SDI- and retract (SLP_selection, SDI_positive_selection, SDI_negative_selection and retraction). If SDI is only used for retraction, then the SDI_positive_selection and SDI_negative_selection signals must be interconnected with a fail-safe "high"-signal.

The user specifies an activation time for retraction (time_for_retraction). The time depends on the particular application.

Note

The retraction time must be selected, so that when retracting with the maximum velocity, the second software limit switch cannot be passed.

The upper and lower SLP limit (SLP_upper_limit and SLP_lower_limit) is interconnected with bits 30 or 31 of PROFIsafe-ZSW2.


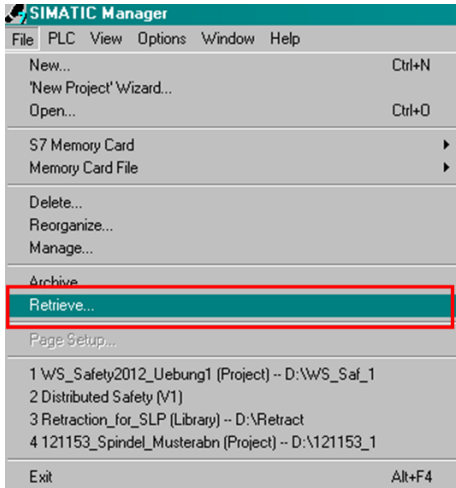
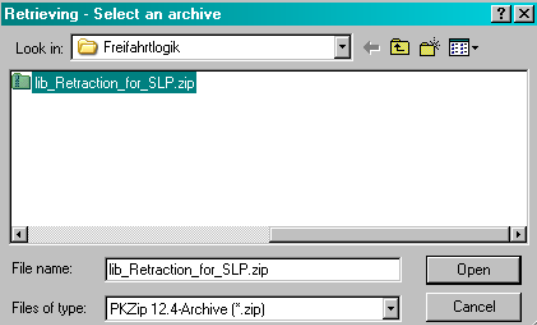
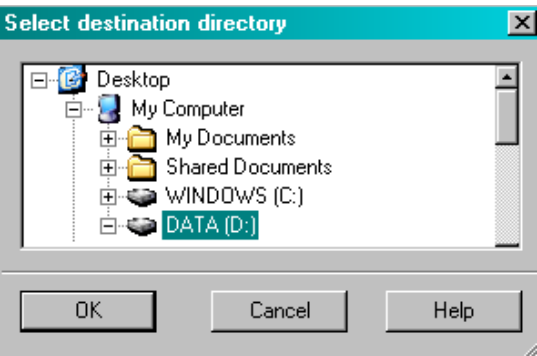
Input "safely_homed" is used to interrogate as to whether the drive has been safely homed. The user must interconnect this signal with bit 23 of PROFIsafe ZSW2.

The output signals for SLP, SDI+ and SDI- (SLP, SDI_pos_direction and SDI_neg_direction) are interconnected with PROFIsafe STW2.

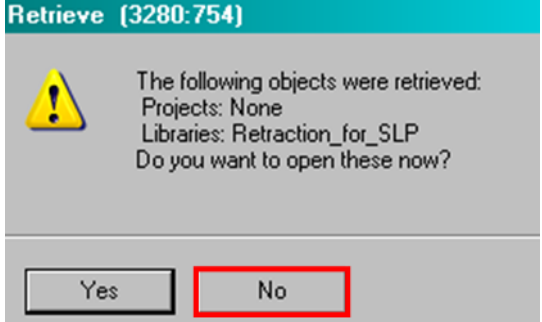
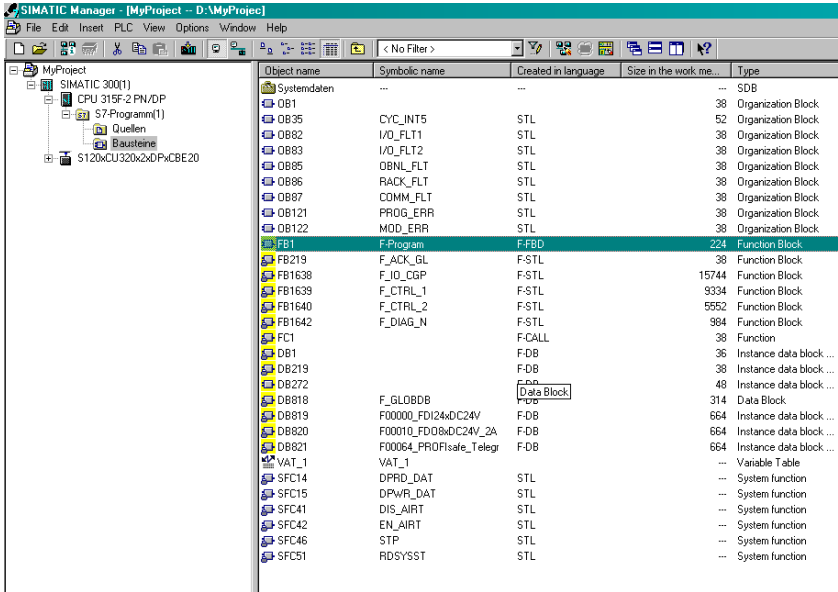
2.3 Implementation in the program

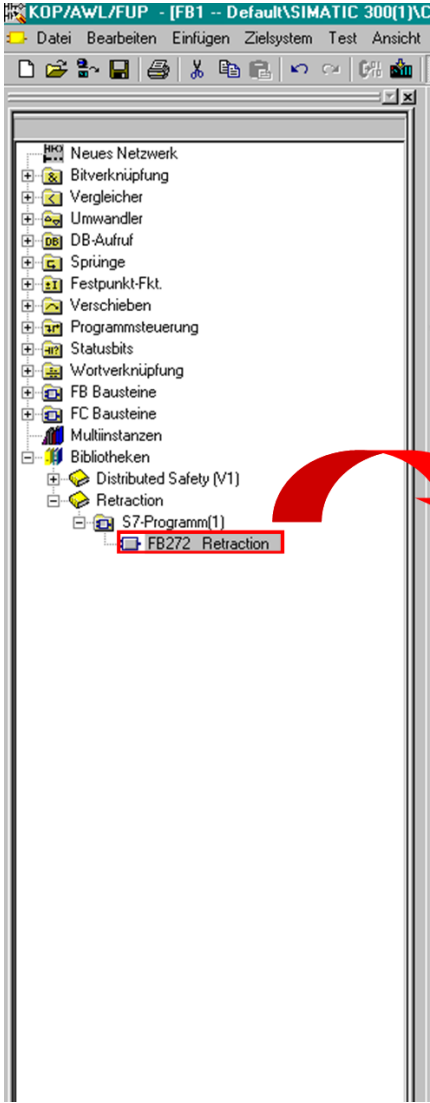
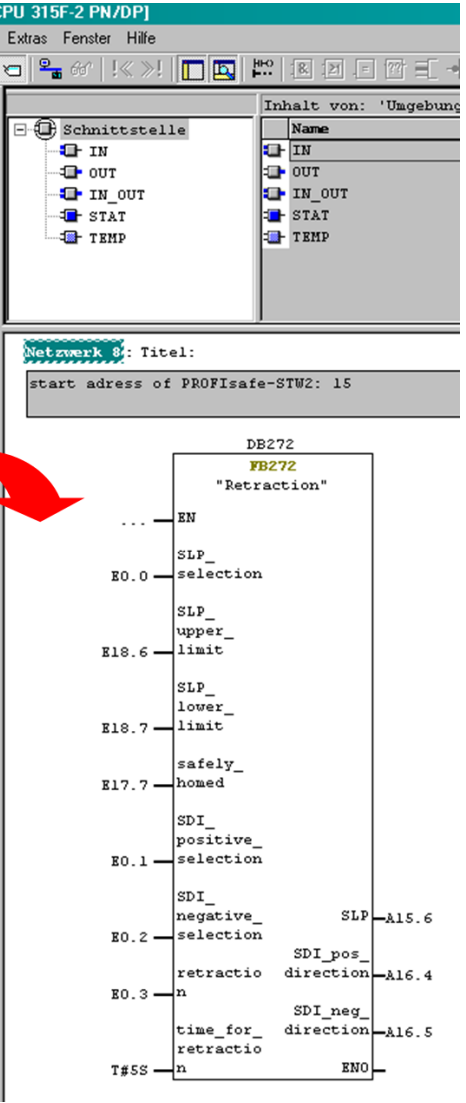
This chapter explains how to commission the block.

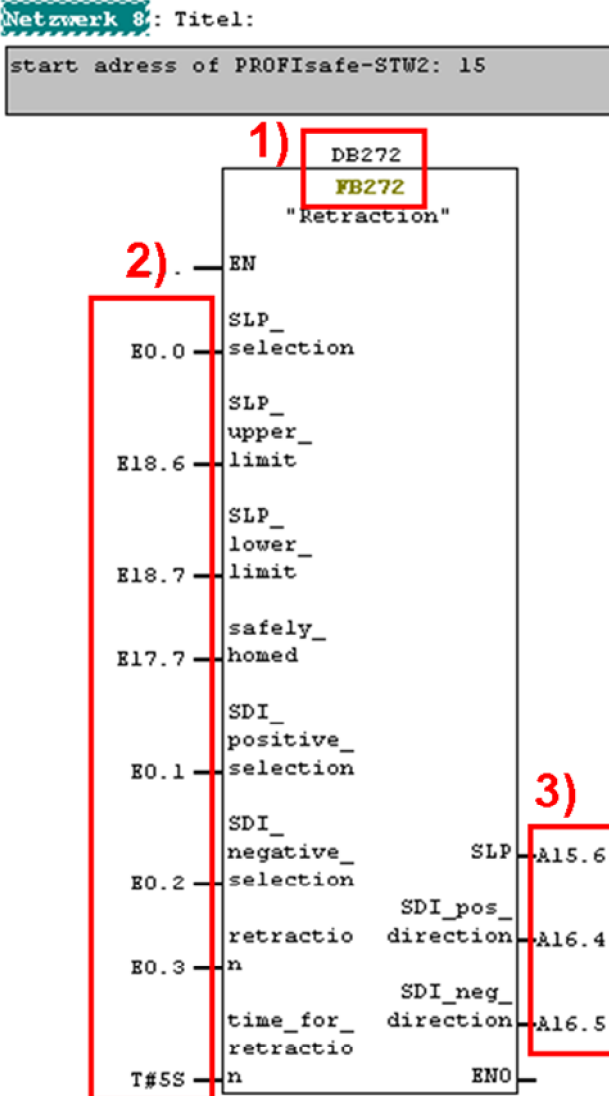
Table 2-3 Description on how to commission the block


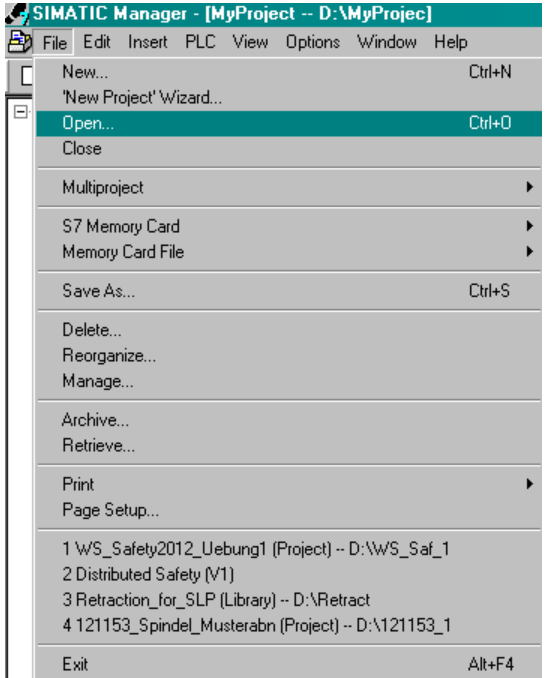
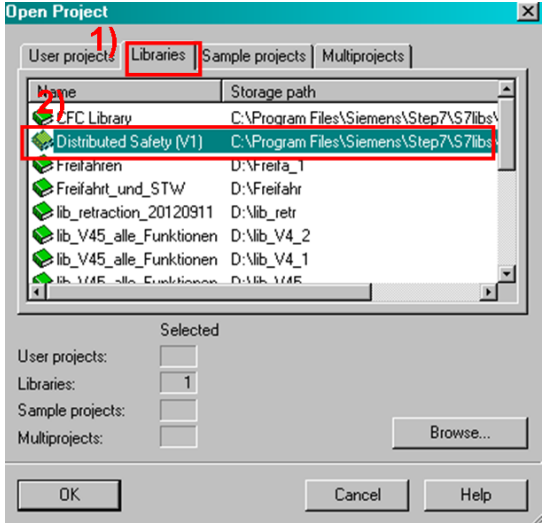
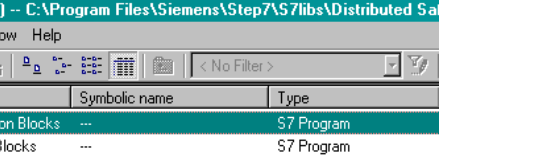
No.	Action	Remark
1.	First open the SIMATIC Manager.	
2.	Then unzip the zip file associated with this FAQ. To do this, click on "File > Retrieve...".	
3.	Now select the directory in which the zip file is saved and then open this.	
4.	Now select the target path under which the unzipped files should be saved.	

2 Description of block

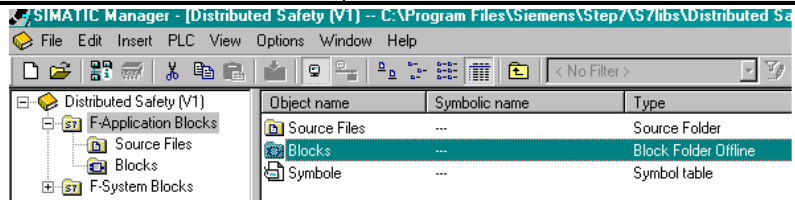
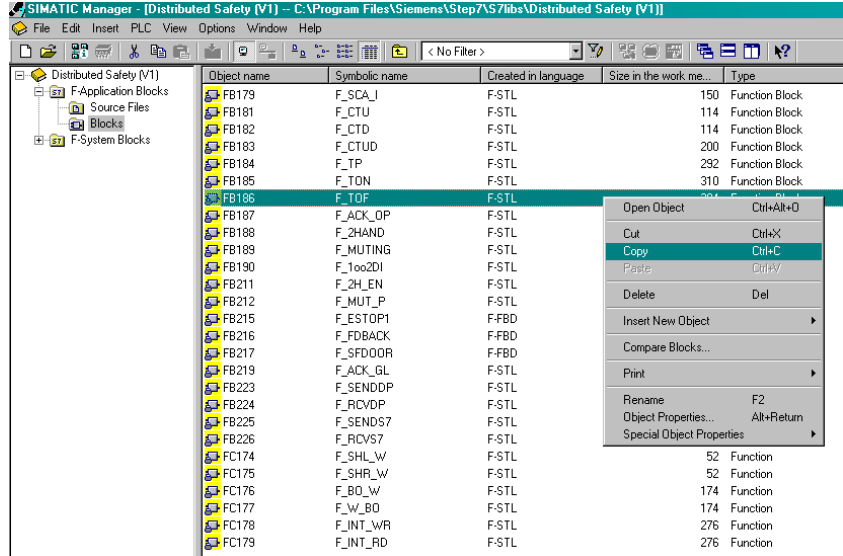
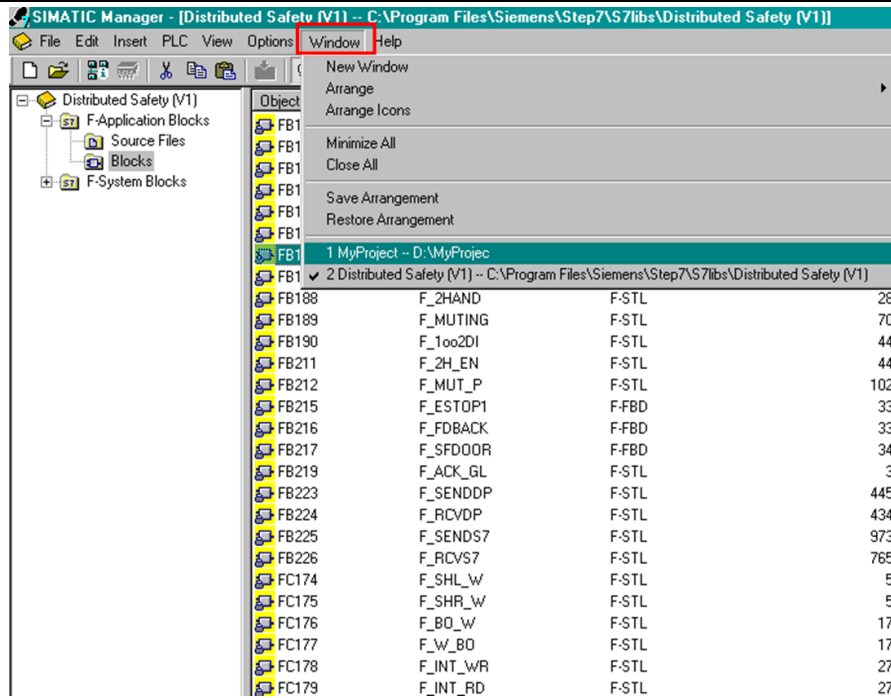
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5.	Here, you are prompted as to whether you wish to open the library. Click on "No".																																																																																																																																																																	
6.	Open your project so that you can use the library block.	 <table border="1" data-bbox="719 703 1305 1211"> <thead> <tr> <th>Object name</th> <th>Symbolic name</th> <th>Created in language</th> <th>Size in the work me...</th> <th>Type</th> </tr> </thead> <tbody> <tr><td>Systemdaten</td><td>---</td><td>---</td><td>---</td><td>SDB</td></tr> <tr><td>OB1</td><td></td><td></td><td>38</td><td>Organization Block</td></tr> <tr><td>OB35</td><td>CYC_INT5</td><td>STL</td><td>52</td><td>Organization Block</td></tr> <tr><td>OB82</td><td>I/O_FLT1</td><td>STL</td><td>38</td><td>Organization Block</td></tr> <tr><td>OB83</td><td>I/O_FLT2</td><td>STL</td><td>38</td><td>Organization Block</td></tr> <tr><td>OB85</td><td>OBNL_FLT</td><td>STL</td><td>38</td><td>Organization Block</td></tr> <tr><td>OB86</td><td>RACK_FLT</td><td>STL</td><td>38</td><td>Organization Block</td></tr> <tr><td>OB87</td><td>COMM_FLT</td><td>STL</td><td>38</td><td>Organization Block</td></tr> <tr><td>OB121</td><td>PROG_ERR</td><td>STL</td><td>38</td><td>Organization Block</td></tr> <tr><td>OB122</td><td>MOD_ERR</td><td>STL</td><td>38</td><td>Organization Block</td></tr> <tr><td>FB1</td><td>F-Program</td><td>F-FBD</td><td>224</td><td>Function Block</td></tr> <tr><td>FB219</td><td>F_ACK_GL</td><td>F-STL</td><td>38</td><td>Function Block</td></tr> <tr><td>FB1638</td><td>F_IO_CGP</td><td>F-STL</td><td>15744</td><td>Function Block</td></tr> <tr><td>FB1639</td><td>F_CTRL_1</td><td>F-STL</td><td>9334</td><td>Function Block</td></tr> <tr><td>FB1640</td><td>F_CTRL_2</td><td>F-STL</td><td>5552</td><td>Function Block</td></tr> <tr><td>FB1642</td><td>F_DIAG_N</td><td>F-STL</td><td>984</td><td>Function Block</td></tr> <tr><td>FC1</td><td>F-CALL</td><td></td><td>38</td><td>Function</td></tr> <tr><td>DB1</td><td>F-DB</td><td></td><td>36</td><td>Instance data block ...</td></tr> <tr><td>DB219</td><td>F-DB</td><td></td><td>38</td><td>Instance data block ...</td></tr> <tr><td>DB272</td><td>F-DB</td><td></td><td>48</td><td>Instance data block ...</td></tr> <tr><td>DB818</td><td>F_GLOBDB</td><td></td><td>314</td><td>Data Block</td></tr> <tr><td>DB819</td><td>F00000_FD124x0C24V</td><td>F-DB</td><td>664</td><td>Instance data block ...</td></tr> <tr><td>DB820</td><td>F00010_FD08x0C24V_2A</td><td>F-DB</td><td>664</td><td>Instance data block ...</td></tr> <tr><td>DB821</td><td>F00064_PROFIsafe_Telegr</td><td>F-DB</td><td>664</td><td>Instance data block ...</td></tr> <tr><td>VAT_1</td><td>VAT_1</td><td></td><td>---</td><td>Variable Table</td></tr> <tr><td>SFC14</td><td>OPRD_DAT</td><td>STL</td><td>---</td><td>System function</td></tr> <tr><td>SFC15</td><td>DPWR_DAT</td><td>STL</td><td>---</td><td>System function</td></tr> <tr><td>SFC41</td><td>DIS_AIRT</td><td>STL</td><td>---</td><td>System function</td></tr> <tr><td>SFC42</td><td>EN_AIRT</td><td>STL</td><td>---</td><td>System function</td></tr> <tr><td>SFC46</td><td>STP</td><td>STL</td><td>---</td><td>System function</td></tr> <tr><td>SFC51</td><td>RDSYSST</td><td>STL</td><td>---</td><td>System function</td></tr> </tbody> </table>	Object name	Symbolic name	Created in language	Size in the work me...	Type	Systemdaten	---	---	---	SDB	OB1			38	Organization Block	OB35	CYC_INT5	STL	52	Organization Block	OB82	I/O_FLT1	STL	38	Organization Block	OB83	I/O_FLT2	STL	38	Organization Block	OB85	OBNL_FLT	STL	38	Organization Block	OB86	RACK_FLT	STL	38	Organization Block	OB87	COMM_FLT	STL	38	Organization Block	OB121	PROG_ERR	STL	38	Organization Block	OB122	MOD_ERR	STL	38	Organization Block	FB1	F-Program	F-FBD	224	Function Block	FB219	F_ACK_GL	F-STL	38	Function Block	FB1638	F_IO_CGP	F-STL	15744	Function Block	FB1639	F_CTRL_1	F-STL	9334	Function Block	FB1640	F_CTRL_2	F-STL	5552	Function Block	FB1642	F_DIAG_N	F-STL	984	Function Block	FC1	F-CALL		38	Function	DB1	F-DB		36	Instance data block ...	DB219	F-DB		38	Instance data block ...	DB272	F-DB		48	Instance data block ...	DB818	F_GLOBDB		314	Data Block	DB819	F00000_FD124x0C24V	F-DB	664	Instance data block ...	DB820	F00010_FD08x0C24V_2A	F-DB	664	Instance data block ...	DB821	F00064_PROFIsafe_Telegr	F-DB	664	Instance data block ...	VAT_1	VAT_1		---	Variable Table	SFC14	OPRD_DAT	STL	---	System function	SFC15	DPWR_DAT	STL	---	System function	SFC41	DIS_AIRT	STL	---	System function	SFC42	EN_AIRT	STL	---	System function	SFC46	STP	STL	---	System function	SFC51	RDSYSST	STL	---	System function
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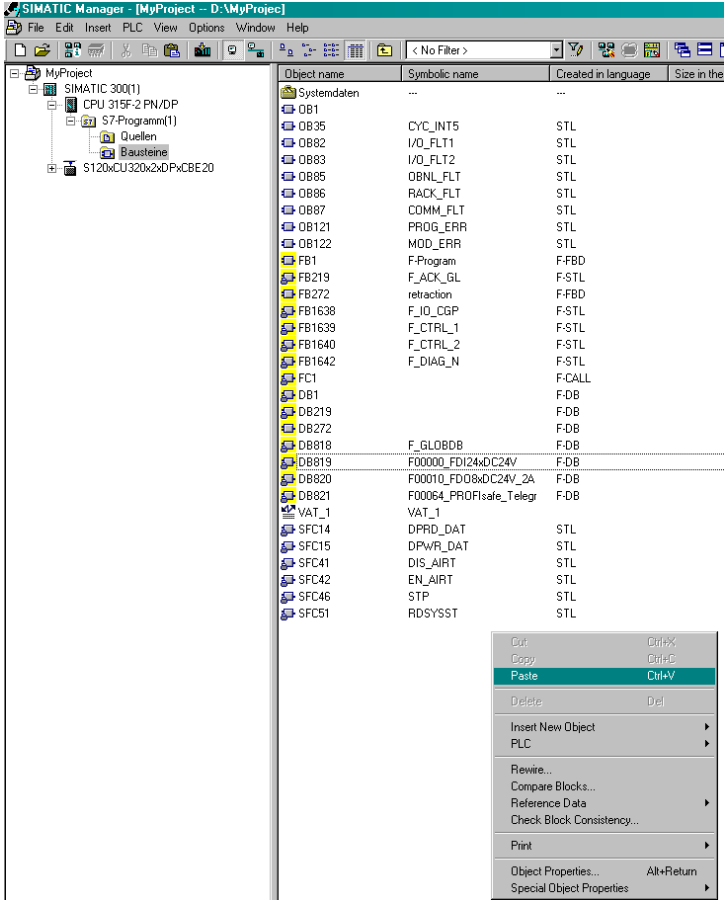
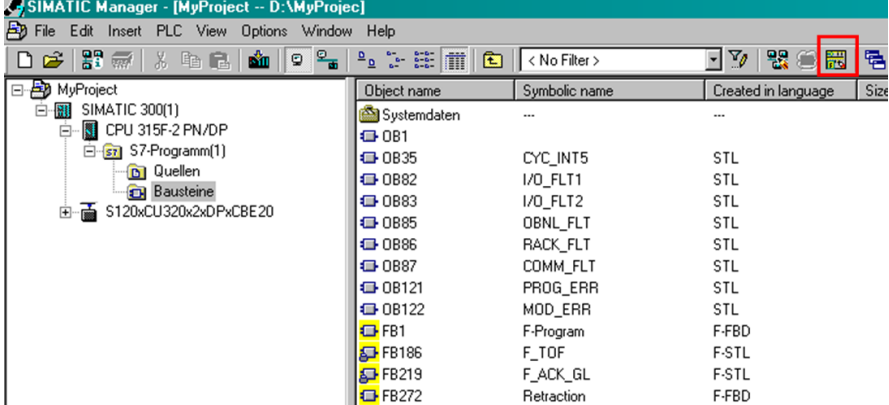
No.	Action	Remark
7.		 <p>Now open the block in which the safety program is created. In this particular example, FB1 was used.</p> <p>As can be seen in the diagram, you can find the library block under "Libraries > Retraction_for_SLP > Retraction > FB272 Retraction".</p> <p>Drag this block and drop it into your safety program.</p>

No.	Action	Remark
8.	<p>Netzwerk 8: Titel:</p> <p>start address of PROFIsafe-STW2: 15</p> 	<p>In the next step (1) the block is assigned an instance DB. DB272 was used in this example.</p> <p>In the next step (2), the input signals are interconnected. Fail-safe sensors are used to select SLP, SDI+, SDI- and retract (SLP_selection, SDI_positive_selection, SDI_negative_selection and retraction). If SDI is not separately used, then the SDI_positive_selection and SDI_negative_selection signals must be interconnected with a fail-safe "high"-signal.</p> <p>The user specifies an activation time for retraction (time_for_retraction), for example 5 seconds. The time depends on the particular application.</p> <p>The upper and lower SLP limit (SLP_upper_limit and SLP_lower_limit) is interconnected with bits 30 or 31 of PROFIsafe-ZSW2.</p> <p>Safe homing (safely_homed) is interconnected with bit 23 of PROFIsafe-ZSW2.</p> <p>In the last step (3), the output signals for SLP, SDI+ and SDI- (SLP, SDI_pos_direction and SDI_neg_direction) are interconnected with PROFIsafe STW2.</p>

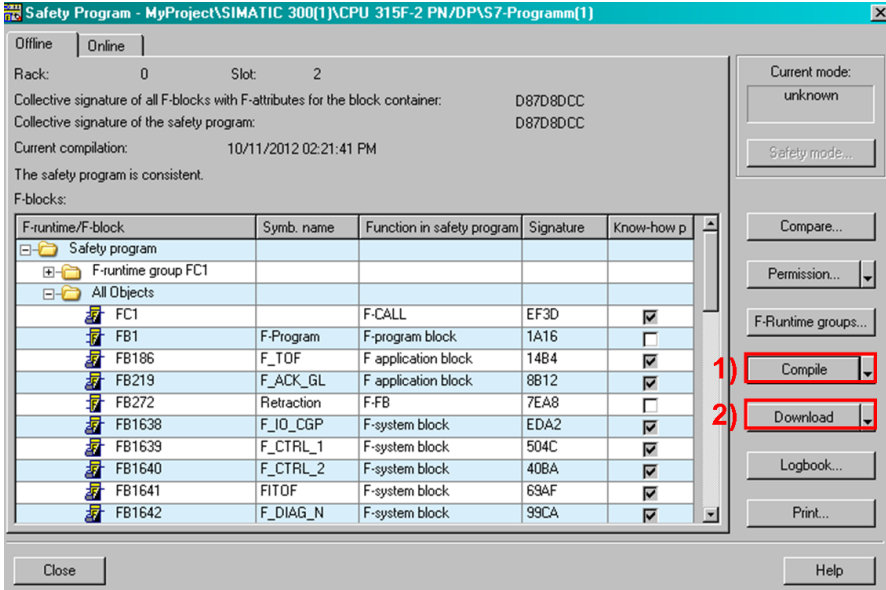
No.	Action	Remark
9.	Now save your safety program. If you have already implemented the safe timer FB186 in your block container, then you can continue with line 17 - otherwise, continue with the next line.	
10.	To insert the safe timer FB186, first click in the SIMATIC Manager on the "File > Open..." button.	 The screenshot shows the SIMATIC Manager File menu. The 'Open...' option is highlighted in blue. The menu also includes options like 'New...', 'Close', 'Save As...', and 'Exit'. The project list at the bottom shows '1 WS_Safety2012_Uebung1 (Project) -- D:\WS_Saf_1'.
11.	Then, under libraries (1) select the "Distributed Safety (V1)" library from (2).	 The screenshot shows the 'Open Project' dialog box. The 'Libraries' tab is selected, and the 'Distributed Safety (V1)' library is highlighted in red. The 'Selected' section shows 'Libraries: 1'. The 'Browse...' button is visible.
12.		 The screenshot shows the SIMATIC Manager project view for 'Distributed Safety (V1)'. The 'Object name' column lists 'F-Application Blocks' and 'F-System Blocks', both with a type of 'S7 Program'. <p data-bbox="464 1951 1050 1977">The library now opens. Click on "F-Application Blocks".</p>

2 Description of block

No.	Action	Remark												
13.	 <p>The screenshot shows the SIMATIC Manager interface with the project tree on the left. The 'Blocks' folder is selected under 'F-Application Blocks'. The main window displays a table with columns: Object name, Symbolic name, and Type. The table contains the following data:</p> <table border="1"> <thead> <tr> <th>Object name</th> <th>Symbolic name</th> <th>Type</th> </tr> </thead> <tbody> <tr> <td>Source Files</td> <td>...</td> <td>Source Folder</td> </tr> <tr> <td>Blocks</td> <td>...</td> <td>Block Folder Offline</td> </tr> <tr> <td>Symbole</td> <td>...</td> <td>Symbol table</td> </tr> </tbody> </table>	Object name	Symbolic name	Type	Source Files	...	Source Folder	Blocks	...	Block Folder Offline	Symbole	...	Symbol table	Open the "Blocks" folder.
Object name	Symbolic name	Type												
Source Files	...	Source Folder												
Blocks	...	Block Folder Offline												
Symbole	...	Symbol table												
14.	 <p>The screenshot shows the SIMATIC Manager interface with the main window displaying a list of blocks. Block FB186 (F_TOF) is selected. A context menu is open over the block, and the 'Copy' option is highlighted. The context menu options are:</p> <ul style="list-style-type: none"> Open Object (Ctrl+Alt+O) Cut (Ctrl+X) Copy (Ctrl+C) Paste (Ctrl+V) Delete (Del) Insert New Object Compare Blocks... Print Rename (F2) Object Properties... (Alt+Return) Special Object Properties 	Now copy block FB186. To do this right click in the block container and on "Copy".												
15.	 <p>The screenshot shows the SIMATIC Manager interface with the 'Window' button highlighted in the menu bar. The main window displays a list of blocks. The 'Window' button is highlighted in the menu bar.</p>	You can now change to your project using the "Window" button.												


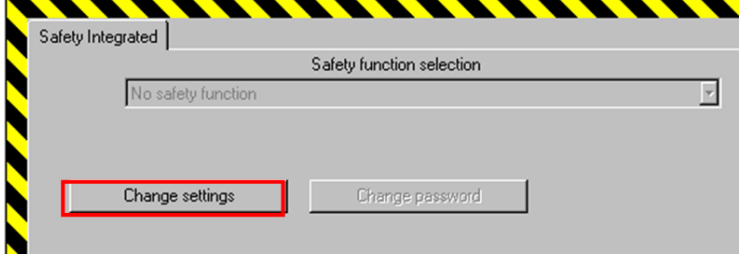
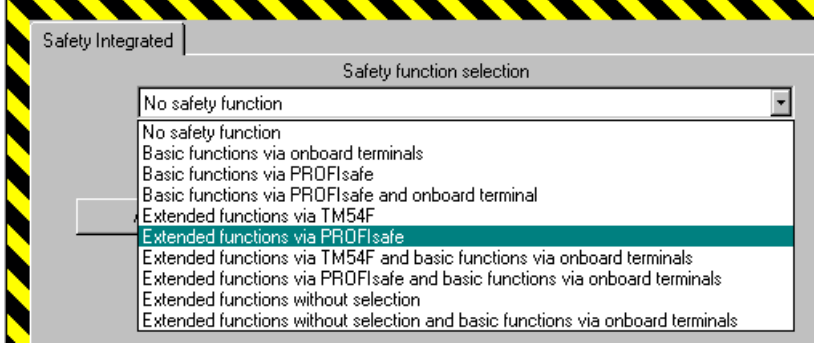
No.	Action	Remark
16.		<p>Now insert block FB186 into the block container of your project. To do this right click in the block container and on "Paste".</p>
17.		<p>To generate the safety program, click on this button marked red.</p>

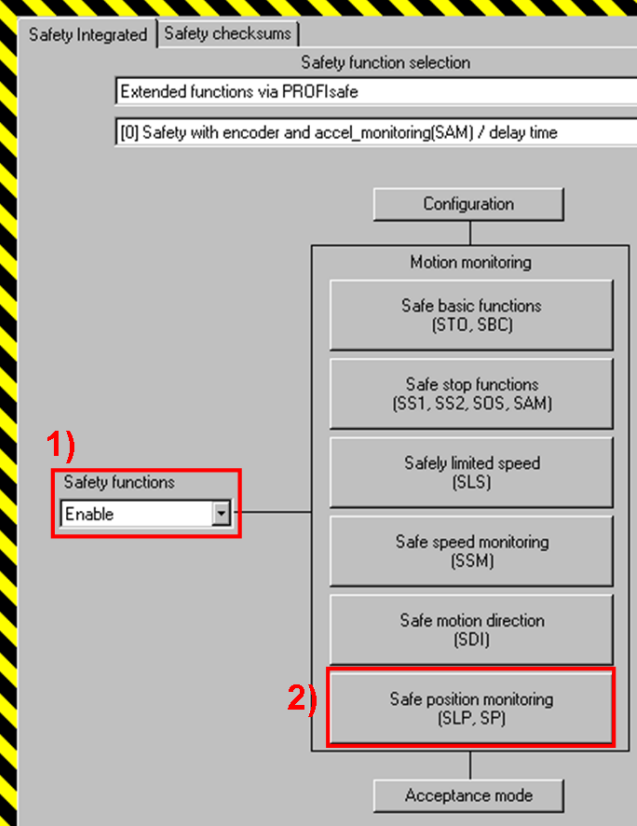
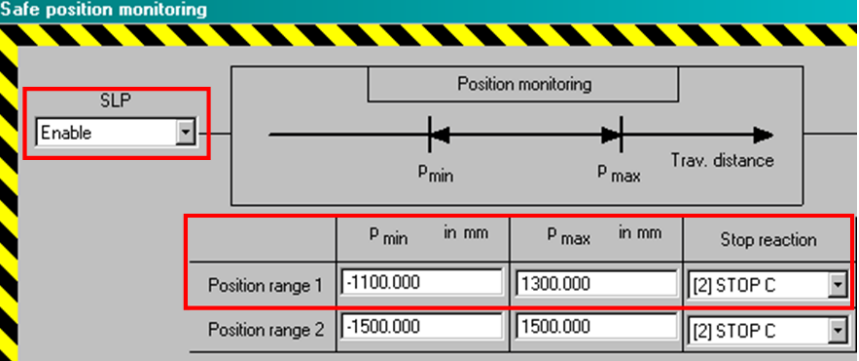
2 Description of block

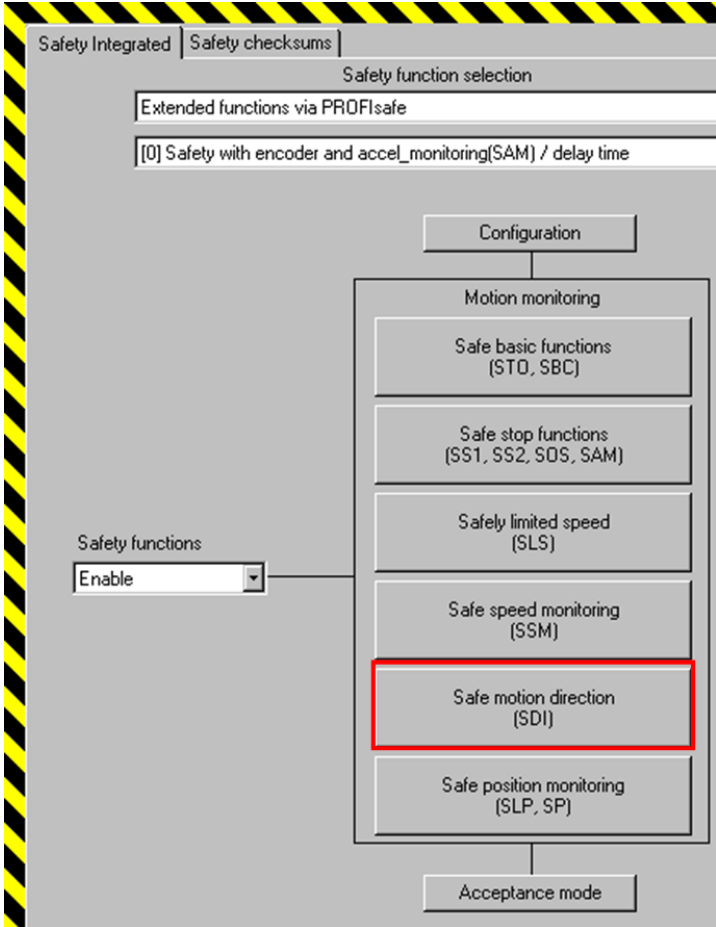
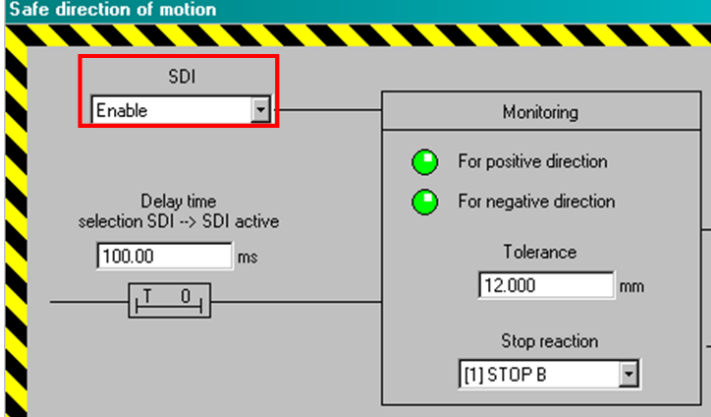
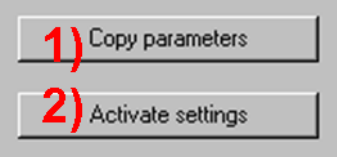

No.	Action	Remark
18.		<p>First press the "Compile" button to generate the safety program (1). The safety program is then downloaded by pressing the "Download" button in the fail-safe control (2).</p>



2.4 Parameterizing the safety functions in the drive

Table 2-4 Parameterizing the safety functions

No.	Action	Remark
1.	First open STARTER, then your project and go online.	
2.		Click in the "Safety Integrated" screen form on "Change settings".
3.		In the drop-down menu, select the control type "Extended functions via PROFIsafe".

No.	Action	Remark												
4.		<p>Then enable the safety functions (1) and select the screen form "Safe position monitoring (2)".</p>												
5.	 <table border="1" data-bbox="654 1422 1324 1556"> <thead> <tr> <th></th> <th>P min in mm</th> <th>P max in mm</th> <th>Stop reaction</th> </tr> </thead> <tbody> <tr> <td>Position range 1</td> <td>-1100.000</td> <td>1300.000</td> <td>[2] STOP C</td> </tr> <tr> <td>Position range 2</td> <td>-1500.000</td> <td>1500.000</td> <td>[2] STOP C</td> </tr> </tbody> </table>		P min in mm	P max in mm	Stop reaction	Position range 1	-1100.000	1300.000	[2] STOP C	Position range 2	-1500.000	1500.000	[2] STOP C	<p>First enable the SLP function, and then define the traversing range to be monitored (position range 1). In this example, a traversing range of between -1100mm and +1300mm should be monitored. Stop response STOP C should be initiated if this traversing range is violated.</p>
	P min in mm	P max in mm	Stop reaction											
Position range 1	-1100.000	1300.000	[2] STOP C											
Position range 2	-1500.000	1500.000	[2] STOP C											

No.	Action	Remark
6.		<p>The safety function SDI is also required for the retraction logic. Therefore, select the "Safe motion direction (SDI)".</p>
7.		<p>Safety function SDI is enabled here.</p>
8.	<p>Then click on "Copy parameters" (1) followed by "Activate settings" (2).</p>	
9.	<p>Then copy RAM to ROM and carry out a power-on reset.</p>	

No.	Action	Remark
10.	Now load your project into the PG and then save it.	 
11.	The drive must then be safely homed!	

2.5 Function test

Table 2-5 Function test of the block

Execution	Expected response	Result OK/ error
Initial status		
The safety functions SLP (Safely Limited Position) and SDI (Safe Direction) are enabled.	9501.1=1 and p9501.17=1.	
The drive is homed and safely homed.	r9723.17=1 and r9722.23=1. The "Safely_homed" bit has a value of "1".	
Test		
<u>Select SLP</u>		
Select the "SLP_selection" input.	The "SLP_selection" input and the "SLP" output assume a value of "0". SLP is selected.	
Allow the drive to rotate in the positive direction until the defined SLP end position is reached.	The drive rotates.	
After the SLP limit has been exceeded, the drive remains stationary with the configured stop response of SLP. Error messages are output.	The "SLP_upper_limit" bit assumes a value of "0". Error messages C01715(x0) and C30715(x0) are output. Additional error messages are output, depending on the stop response that has been configured. (x): Depending on the SLP traversing range x=1: Traversing range 1 x=2: Traversing range 2	
<u>Selecting retraction</u>		
Select the "retraction" input (positive edge).	SLP is deselected and SDI negative is selected. The "SLP" output assumes a value of "1" and the "SDI_neg_direction" output, a value of "0". The retraction mode is active until the "time_for_retraction" time has expired.	
<u>Note:</u> The retraction mode is active until the "time_for_retraction" time has expired.		
Fail-safe acknowledgment.	There are no longer any error messages after fail-safe acknowledgment.	
The drive is now traversed in the POSITIVE direction until the SDI	The drive rotates until the SDI tolerance (p9564) is exceeded.	

tolerance is violated.	The drive then remains stationary (zero speed). Error messages C01716 and C30716 are output. Additional error messages are output, depending on the stop response that has been configured.	
The SDI error messages must be safely acknowledged. To do this, deselect the retraction logic (negative edge at "retraction").	The "SLP" output assumes a value of "0", the "SDI_neg_direction" output, a value of "1". As a consequence, error messages for SLP are output again.	
Fail-safe acknowledgment.	The error messages for SDI disappear after fail-safe acknowledgment.	
<u>Selecting retraction</u> Select the "retraction" input (positive edge).	SLP is deselected and SDI negative is selected. The "SLP" output assumes a value of "1" and the "SDI_neg_direction" output, a value of "0".	
Fail-safe acknowledgment.	There are no longer any error messages after fail-safe acknowledgment.	
Now traverse the drive in the negative direction until the axis is again located in the valid traversing range.	The drive rotates.	
If the drive is again in the permissible traversing range after the "time_for_retraction" time has expired, then the "SLP" output goes to "0" again, and the "SDI_neg_direction" output goes to "1" again.	SLP is selected and SDI is again deselected.	
<u>Note</u> This behavior is applicable for the negative direction!		

3 History

Diagram 3-1 History

Version	Date	Change
V1.0	02/2013	First edition

4 Contact person

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