SINAMICS G120

SINAMICS G120C inverter

SINAMICS G120D inverter
with Control Units   CU240D-2 and CU250D-2

SINAMICS G120 inverter
with Control Units   CU240E-2 and CU250S-2

Safety Integrated Function Manual · 01/2013

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SINAMICS G120
Safety Integrated Function Manual,
SINAMICS G120 and G120C

Function Manual

Edition 01/2013, firmware V4.6

Legal information

Warning notice system

This manual contains notices you have to observe in order to ensure your personal safety, as well as to prevent damage to property. The notices referring to your personal safety are highlighted in the manual by a safety alert symbol, notices referring only to property damage have no safety alert symbol. These notices shown below are graded according to the degree of danger.

⚠ DANGER
indicates that death or severe personal injury **will** result if proper precautions are not taken.

⚠ WARNING
indicates that death or severe personal injury **may** result if proper precautions are not taken.

⚠ CAUTION
indicates that minor personal injury can result if proper precautions are not taken.

NOTICE
indicates that property damage can result if proper precautions are not taken.

If more than one degree of danger is present, the warning notice representing the highest degree of danger will be used. A notice warning of injury to persons with a safety alert symbol may also include a warning relating to property damage.

Qualified Personnel

The product/system described in this documentation may be operated only by **personnel qualified** for the specific task in accordance with the relevant documentation, in particular its warning notices and safety instructions. Qualified personnel are those who, based on their training and experience, are capable of identifying risks and avoiding potential hazards when working with these products/systems.

Proper use of Siemens products

Note the following:

⚠ WARNING
Siemens products may only be used for the applications described in the catalog and in the relevant technical documentation. If products and components from other manufacturers are used, these must be recommended or approved by Siemens. Proper transport, storage, installation, assembly, commissioning, operation and maintenance are required to ensure that the products operate safely and without any problems. The permissible ambient conditions must be complied with. The information in the relevant documentation must be observed.

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Disclaimer of Liability

We have reviewed the contents of this publication to ensure consistency with the hardware and software described. Since variance cannot be precluded entirely, we cannot guarantee full consistency. However, the information in this publication is reviewed regularly and any necessary corrections are included in subsequent editions.

Change history

Important changes compared to the Manual, Edition 08/2012

New functions in firmware V4.6	In Chapter
New Control Unit CU250S-2 of the SINAMICS G120 inverter	Description (Page 13) Installing (Page 35)
Safe Brake Control (SBC)	Description (Page 13) Commissioning (Page 65)
Safe Stop 1 (SS1) without monitoring the speed	Description (Page 13) Commissioning (Page 65) Operation (Page 167)

An overview of all new and modified functions in Firmware V4.6 can be found in section Firmware version 4.6 (Page 257).

Corrections	In Chapter
Corrections to response times when STO is selected via the fieldbus.	System properties (Page 253)

Revised descriptions	In Chapter
Detailed description of the options available to acknowledge discrepancy messages and internal events	Response to the discrepancy of an input signal (Page 211) Response to an internal event (Page 224)
Setting and operating the SSM function without hysteresis (formerly: SSM with hysteresis)	Safe Speed Monitor (SSM) (Page 30) Setting SSM (Page 123) SSM acceptance test (Page 155) Operation (Page 167)
Measures for reduced acceptance and acceptance tests	Reduced acceptance (Page 137) Examples of acceptance tests (Page 140)

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Introduction 1

1.1 About this manual

Who requires this manual and why?

This manual is aimed primarily at machine and plant manufacturers, commissioning engineers, and service personnel. The manual describes the integrated safety functions of the SINAMICS G120 (G120, G120C and G120D) inverter family, and puts the target groups addressed in a position to correctly parameterize and commission the integrated safety functions of the inverter.

What is described in this manual?

This manual covers all the information, procedures, and operations for the following scenarios:

- Activating the safety functions via fail-safe digital inputs or PROFIsafe.
- Commissioning the safety functions.
- Performing diagnostics for the safety functions.

The appendix contains an overview of the applicable regulations and standards for using the safety functions.

What other information do you need?

This manual alone is not sufficient for installing or commissioning the standard inverter functions. An overview of the documentation available and the associated applications is provided in the section Manuals for your inverter (Page 281).

What is the meaning of the symbols in the manual?
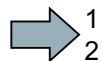
An operating instruction starts here.

This concludes the operating instruction.

1.2 Guide through this manual

Chapter	In this chapter, you will find answers to the following questions:
Description (Page 13)	• What safety functions does my inverter have? • How do the safety functions basically work? • What are typical applications for the safety functions of the inverter? • In which applications are the safety functions of my inverter not permitted?
Installing (Page 35)	• How many fail-safe inputs and outputs does my inverter have? • How do I wire up the fail-safe inputs and outputs of my inverter? • What do I have to observe if the wiring extends beyond the control cabinet? • How are the PROFIsafe control words and status words assigned?
Commissioning (Page 65)	• How do I configure the communication of my inverter via PROFIsafe? • How do I start commissioning the safety functions? • What tool do I need for commissioning? • How do I transfer the parameters of the safety functions to other inverters? • How do I reset my inverter to the factory setting? • How do I check the safety functions after commissioning? • How do I document the settings of the safety functions?
Operation (Page 167)	• How must I select and deselect the safety function? • How do the inverter and motor respond when the safety function is active? • How do the safety functions mutually influence one another? • What happens in the event of a limit violation of the safety functions? • What happens in the event of a wire break at a fail-safe input? • How do I acknowledge safety function faults?
Corrective maintenance (Page 231)	• How do I replace defective components of the inverter or the inverter itself? • How do I ensure that the safety functions are still working correctly after making a replacement? • What do I have to check after making a replacement?
Alarms and faults (Page 245)	• What do the LED signals on my inverter mean? • What is the meaning of the alarms and faults, which are assigned to the safety functions?
System properties (Page 253)	• How long does it take for my drive to respond when selecting a safety function? • How long does it take for my drive to respond when the safety function is active and the motor malfunctions? • What are the probabilities of failure of the safety functions of my inverter? • According to which standards are the safety functions of my inverter certified?
Appendix (Page 257)	• As machine manufacturer or company operating a machine, what standards and regulations must I observe? • Where can I find more information on my inverter?

Description

<div style="text-align: right; font-size: 3em;">2</div>

2.1 About this chapter

Overview

In this Chapter, users using the system for the first-time should obtain a quick overview of the principle mode of operation of the safety functions.

The table at the beginning of this chapter compares all of the devices described in this manual with other drive products with integrated safety functions.

The description of the safety functions starts with the definition according to EN 61800-5-2 and simple examples for using the function.

You can identify whether your converter supports the respective function.

The description of the functions is simplified as far as possible to clearly show the essential properties and setting options.

2.2 Drive products with integrated safety functions

	Applications with fixed speed		Applications with variable speed				High-performance and motion control applications				
	SIMATIC ET 200S Motor starters	SIMATIC ET 200pro Motor starters	SIMATIC ET 200pro FC	SINAMICS G120C	SINAMICS G120	SINAMICS G120D	SINAMICS G130	SINAMICS G150	SINAMICS S110	SINAMICS S120	SINAMICS S150
Integrated safety functions according to IEC 61800-5-2											
STO Safe Torque Off	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
SS1 Safe Stop 1	-	-	Yes	-	Yes	Yes	Yes	Yes	Yes	Yes	Yes
SBC Safe Brake Control	-	-	-	-	Ja [2]	-	Yes [3]	Yes [3]	Yes [4]	Yes [3]	Yes [3]
SBT Safe Brake Test	-	-	-	-	-	-	Yes	Yes	-	Yes	Yes
SLS Safely-Limited Speed	-	-	Yes	-	Yes	Yes	Yes	Yes	Yes	Yes	Yes
SSM Safe Speed Monitor	-	-	-	-	Yes	Yes	Yes	Yes	Yes	Yes	Yes
SDI Safe Direction	-	-	-	-	Yes	Yes	Yes	Yes	Yes	Yes	Yes
SOS Safe Operating Stop	-	-	-	-	-	-	-	-	Yes	Yes	Yes
SS2 Safe Stop 2	-	-	-	-	-	-	-	-	Yes	Yes	Yes
SLP Safely-Limited Position	-	-	-	-	-	-	-	-	-	Yes	Yes
Fail-safe interfaces											
PROFIBUS with PROFIsafe profile	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
PROFINET with PROFIsafe profile	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fail-safe inputs	Yes, with external components			Yes	Yes	Yes	Yes	Yes	Yes, external components required in certain cases		
Fail-safe outputs	-	-	-	-	Yes	Yes	-	-	Yes	Yes, when using the TM54F	Yes, when using the TM54F
Certifications											
EN ISO 13849-1	Cat. 4/PL e	Cat. 3/PLd	Cat. 3/PLd	Cat. 3/PLd	Cat. 3/PLd	Cat. 3/PLd	Cat. 3/PLd	Cat. 3/PLd	Cat. 3/PL d	Cat. 3/PL d	Cat. 3/PL d
EN 61508	SIL 3	SIL 2	SIL 2	SIL 2	SIL 2	SIL 2	SIL 2	SIL 2	SIL 2	SIL 2	SIL 2
NFPA 79	Yes	-	-	-	-	-	-	-	Yes	Yes	-
NRTL listed	Yes	-	-	-	-	-	-	-	-	Yes [1]	-

Content of this manual

[1] only for SINAMICS S120 Booksize

[2] only for CU250S-2 with Safe Brake Relay

[3] for Chassis and Cabinet Modules with Safe Brake Adapter

[4] with Safe Brake Relay

Figure 2-1   Overview of products for drive technology with integrated safety functions

2.3 Safe Torque Off (STO)

Definition according to EN 61800-5-2:

"[…] [The inverter] does not supply any energy to the motor, which can generate a torque (or for a linear motor, a force)."
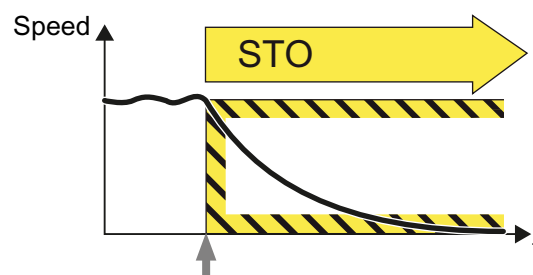
Application examples

Example	Possible solution
When the Emergency Stop button is pressed, it is not permissible that a stationary motor undesirably starts.	• Wire the Emergency Stop button with a fail-safe input. • Select STO via the fail-safe input.
A central Emergency Stop button ensures that several drives cannot unintentionally start.	• Evaluate the Emergency Stop button in a central control. • Select STO via PROFIsafe.

How does STO function in detail?

The inverter recognizes the selection ofSTO via a fail-safe input or via the safe communicationPROFIsafe.

The inverter then safely switches off the torque of the connected motor.
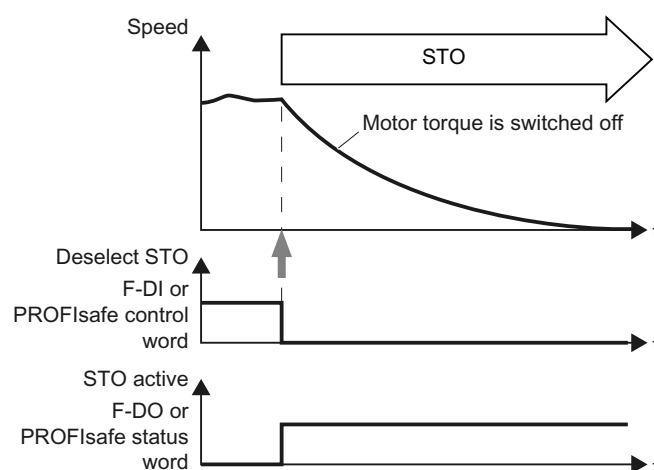
If no motor holding brake is present, the motor coasts to a standstill.

If you use a motor holding brake, the inverter closes the brake immediately after selecting STO.

Which converters support this function?

SINAMICS G120	SINAMICS G120D	SINAMICS G120C
with all CU240E-2 and CU250S-2 Control Units:	with all CU240D-2 and CU250D-2 Control Units:	in all versions:
CU240E-2 CU240E-2 DP CU240E-2 F CU240E-2 DP-F CU240E-2 PN CU240E-2 PN-F CU250S-2 CU250S-2 DP CU250S-2 PN CU250S-2 CAN	CU240D-2 DP CU240D-2 DP-F CU240D-2 PN CU240D-2 PN-F CU240D-2 PN-F PP CU250D-2 DP-F CU250D-2 PN-F CU250D-2 PN-F PP	G120C G120C DP G120C PN G120C CAN

2.4 Safe Brake Control (SBC)

Definition according to EN 61800-5-2:

"The SBC function supplies a safe output signal to control an external brake."
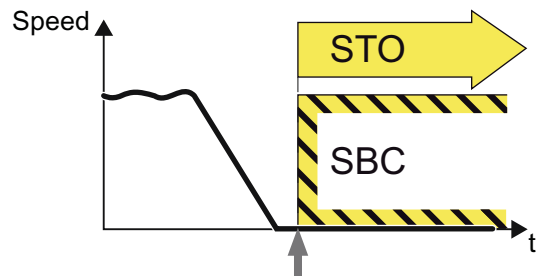
Application example

Example	Possible solution
Once a hoisting gear has stopped, it is not permissible that the suspended load sags/drops.	• Connect the motor holding brake to the converter via the Safe Brake Module. • Select STO when the drive stops.

How does SBC function in detail?

For the SBC function, you must equip the inverter with a Safe Brake Relay.

SINAMICS G120
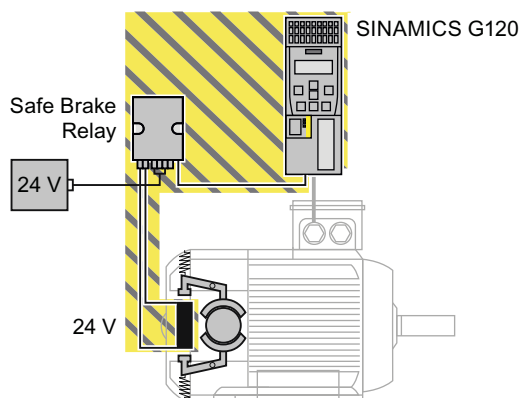
The Safe Brake Relay controls a 24 V brake.

When the STO function is active, the Safe Brake Relay safely closes the connected brake. The SBC function monitors the control of the brake, however, not its mechanical functioning.

The inverter controls the connected brake using the "motor holding brake" function. The "motor holding brake" function is described in the operating instructions of your inverter.

Which converters support this function?

SINAMICS G120	SINAMICS G120D	SINAMICS G120C
with the CU250S-2 Control Units: CU250S-2 CU250S-2 DP CU250S-2 PN CU250S-2 CAN	These converters do not support the SBC function.	

2.5 Safe Stop 1 (SS1)

The converter brakes the motor using the SS1 function, and after defined conditions, initiates the STO function.

Definition according to EN 61800-5-2:

"[…] Initiate and monitor the magnitude of the motor deceleration within defined limits and initiate the STO function if the motor speed falls below a defined limit value.
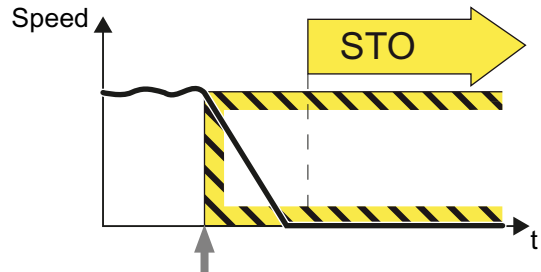
or

Initiate motor deceleration, and after an application-specific time delay, initiate the STO function."
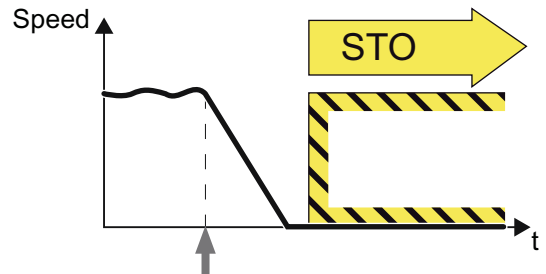
Application example

Example	Possible solution
The drive must brake as quickly as possible after the Emergency Stop button has been pressed. It is not permissible that the stationary motor undesirably accelerates.	• Select SS1 in the converter using a fail-safe input or via PROFIsafe .

How does SS1 function in detail?

SS1 with monitoring

SS1 brakes the motor and monitors the absolute speed.

If the motor speed is low enough, the converter safely switches off the motor torque using STO .
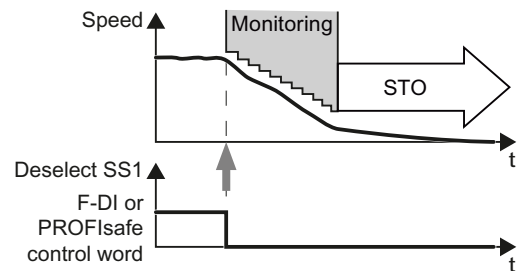
SS1 without monitoring

The converter brakes the motor, without monitoring the actual braking.

After a defined time, the converter safely switches off the motor torque with STO.
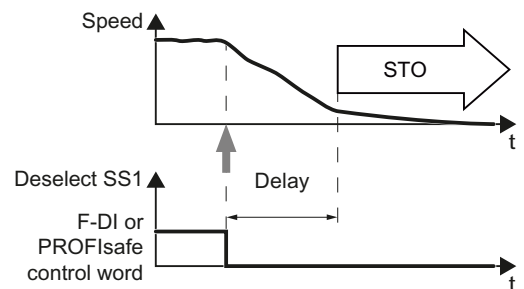
Select SS1

As soon as the converter identifies that SS1 has been selected via a fail-safe input or via safe communication PROFIsafe , the following happens:

● If the motor has already been switched off when selecting SS1 , then the converter safely switches off the motor torque (STO).

● If the motor is switched on when SS1 is selected, the converter brakes the motor with the OFF3 ramp-down time.

Monitoring modes

You can select between two different monitoring modes of the SS1function.

Braking ramp monitoring	Acceleration monitoring

• Using the SBR (Safe Brake Ramp) function, the converter monitors whether the motor speed decreases.
 	
• The gradient of the SBR function can be adjusted. The SBR function only starts after the "Delay time for braking ramp". The SBR function starts with the speed setpoint, which was present at the instant in time that SS1 was selected.
 	
• When the standstill monitoring threshold is fallen below, the converter safely switches off the motor torque (STO) .
	• The converter monitors the motor speed using the function SAM (Safe Acceleration Monitor).
	
	• The converter prevents the motor from re-accelerating by continuously adjusting the monitoring threshold to the decreasing speed.
	
	• The converter reduces the monitoring threshold until the "Shutdown speed" has been reached.
	
	• The converter safely switches off the motor torque (STO), if one of the following conditions is fulfilled:
	  – The converter detects that the motor is stationary.
	  – The maximum time until the torque is switched off has expired.

Which converters support this function?

SINAMICS G120	SINAMICS G120D	SINAMICS G120C
SS1 with monitoring		
with Control Unit:	with Control Unit:	---
CU240E-2 F CU240E-2 DP-F CU240E-2 PN-F CU250S-2 [1] CU250S-2 DP [1] CU250S-2 PN [1] CU250S-2 CAN [1]	CU240D-2 DP-F CU240D-2 PN-F CU240D-2 PN-F PP CU250D-2 DP-F CU250D-2 PN-F CU250D-2 PN-F PP	
[1] requires a license for the safety functions		
SS1 without monitoring		
with Control Unit:	with Control Unit:	---
CU250S-2 CU250S-2 DP CU250S-2 PN CU250S-2 CAN		

For these converters, an encoder to sense the motor speed is not required for the SS1 function.

2.6 Safely Limited Speed (SLS)

Definition according to EN 61800-5-2:

"The SLS function prevents the motor from exceeding the defined speed limit."
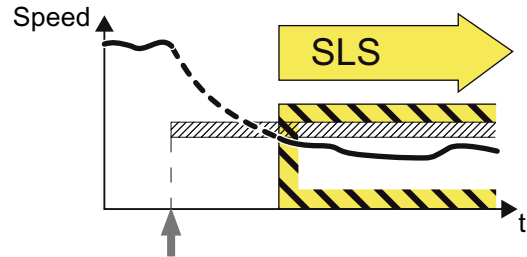
Application examples

Example	Possible solution
Setup mode: The machine operator must enter the danger area of a machine and manually introduce material into a machine part.	• Select SLS in the inverter using a fail-safe input or PROFIsafe . • The inverter limits and monitors the speed of the machine part.
A turning machine must not exceed a specific maximum torque in order to protect the drill chuck from damage.	
Depending on the diameter of the saw blade, a circular saw must not exceed a specific maximum speed.	• Select SLS and the corresponding SLS level in the inverter via PROFIsafe.

How does SLSfunction in detail?

Overview
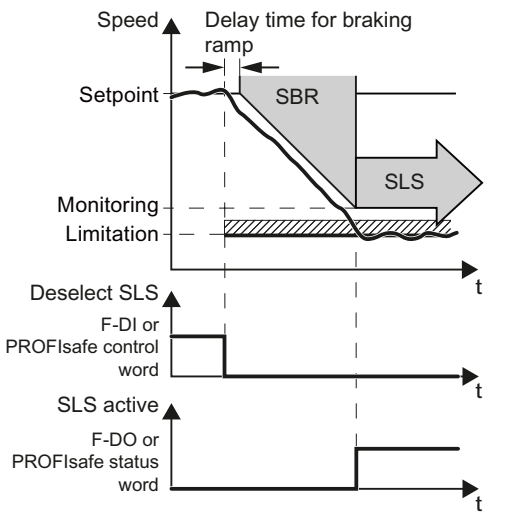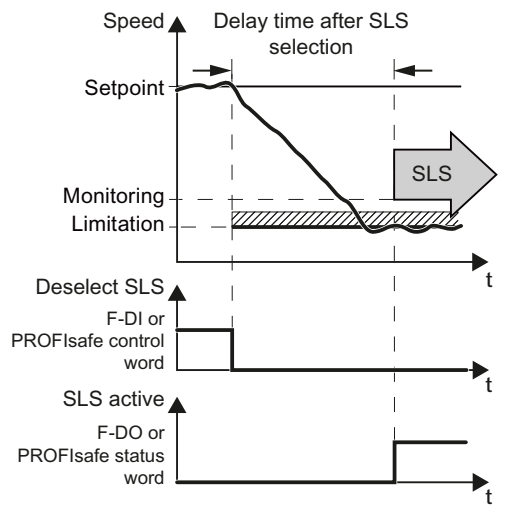
SLS monitors the absolute value of the actual speed.

In addition, SLS limits the speed to values below the monitoring threshold.
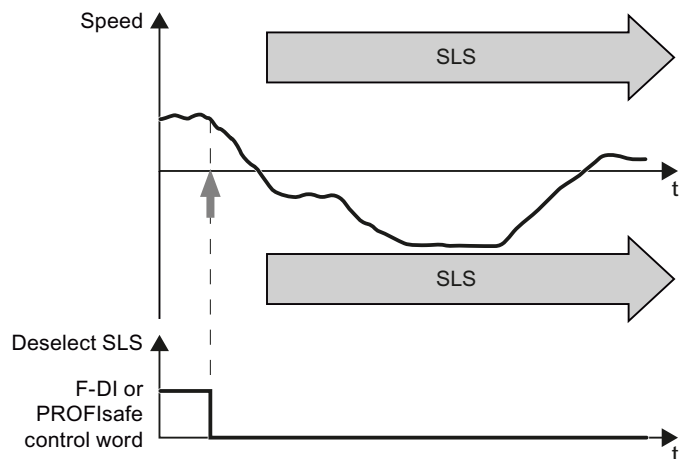
Selecting SLS when the motor is switched on

As soon as the converter identifies that SLS has been selected via a fail-safe input or via safe communication PROFIsafe , the following happens:

- The converter limits the speed to a value below the SLS monitoring and brakes the motor with the OFF3 ramp-down time.

- You can select whether the converter monitors motor braking using the SBR (Safe Brake Ramp) function or not.

With braking ramp monitoring	Without braking ramp monitoring
After the adjustable "delay time for the braking ramp", using the SBR (Safe Brake Ramp) function, the converter monitors whether the speed decreases. The converter switches from SBR to SLS as soon as one of the following two conditions are fulfilled: • The SBR monitoring ramp has reached the value of the speed monitoring. This case is shown in the diagram above. • The actual load speed reaches the value of the speed monitoring and the "delay time for braking ramp" has expired.	The converter monitors the load speed after an adjustable delay time has expired.
Benefits: • Already during braking, the converter detects as to whether the load speed decreases too slowly. • The feedback signal "SLS active" generally comes earlier than for the alternative acceleration monitoring.	Advantage: • Commissioning is simplified, because instead of the subfunction SBR of the alternative brake ramp monitoring, you only have to set the delay time.

Selecting SLS at low motor speeds

If the motor speed when selecting SLS is less than the SLSlimit, then the drive responses follows:

With braking ramp monitoring	Without braking ramp monitoring
The converter monitors the speed after the "delay time for the braking ramp".	The converter monitors the load speed after an adjustable delay time has expired.
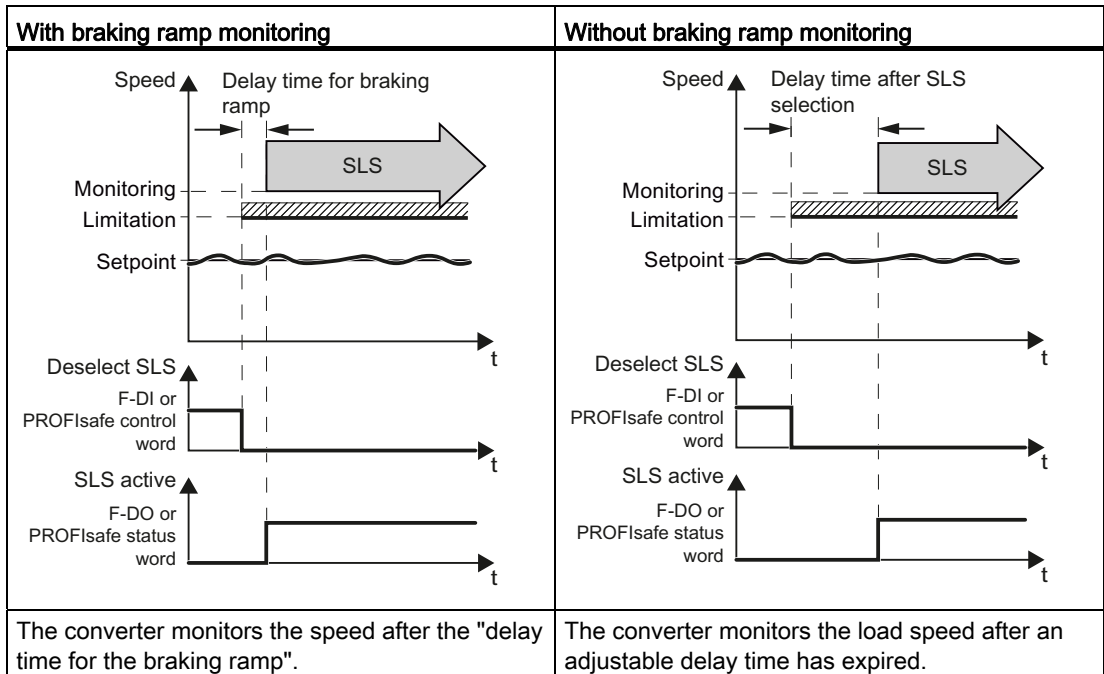
Deselecting SLS

If the higher-level control deselects SLS , then the converter deactivates limiting and monitoring.
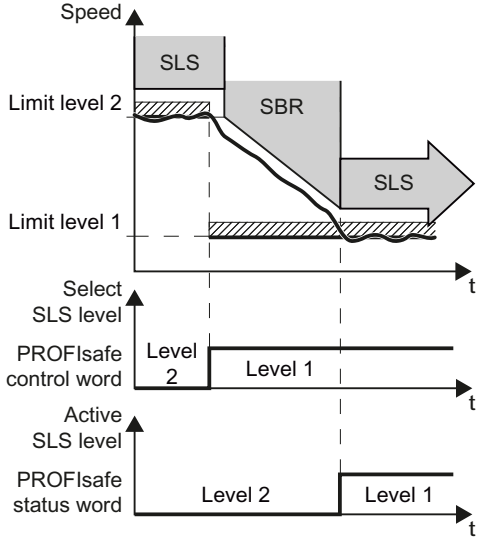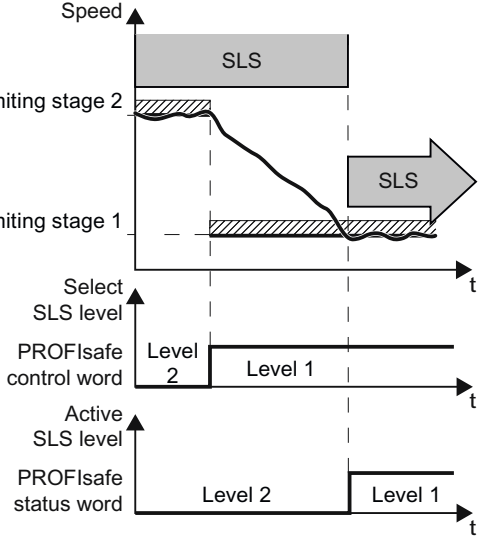
Changing over the monitoring thresholds

When SLS is active, you can switch between four different speed levels.

Note

Switching over the speed levels is only possible via PROFIsafe .

Switching to a lower speed level

With braking ramp monitoring	Without braking ramp monitoring

• Once the "delay time for braking ramp" has elapsed, the converter monitors the motor speed using the function SBR (Safe Brake Ramp).
 	
• The converter switches from SBR monitoring to SLS monitoring as soon as one of the two following conditions is fulfilled:
  – The SBRmonitoring ramp has reached the value of the SLSmonitoring.
    This case is shown in the diagram above.
  – The load speed has decreased down to the value SLSmonitoring and the "delay time for braking ramp" has expired.
	• The converter monitors the speed with the lower SLS level after the "delay time for SLS switchover" has expired.

Switching to a higher speed level

If you switch over from a lower to a higher speed level, the converter immediately monitors the actual speed against the higher speed.

Which converters support this function?

SINAMICS G120	SINAMICS G120D	SINAMICS G120C
with Control Unit:	with Control Unit:	---
CU240E-2 F CU240E-2 DP-F CU240E-2 PN-F CU250S-2 [1] CU250S-2 DP [1] CU250S-2 PN [1] CU250S-2 CAN [1]	CU240D-2 DP-F CU240D-2 PN-F CU240D-2 PN-F PP CU250D-2 DP-F CU250D-2 PN-F CU250D-2 PN-F PP	
[1] requires a license for the safety functions		

For these converters, an encoder to sense the motor speed is not required for the SLS function.

2.7 Safe Direction (SDI)

Definition according to EN 61800-5-2:

"The SDI function prevents the motor shaft moving in the wrong direction."
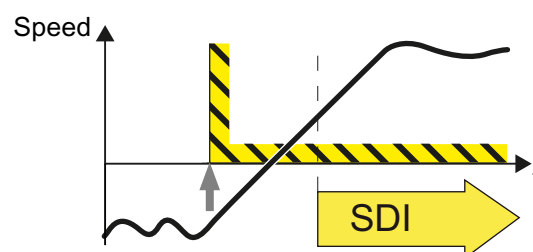
Application examples

Example	Possible solution
When replacing the pressure cylinders of the plates, the drive must only move in the safe direction of rotation.	• Select SDI in the inverter using a fail-safe input or PROFIsafe . • In the inverter, inhibit the direction of rotation that is not permitted.
After a protective device to detect a jammed door responds, a rolling shutter gate may only start to move in one direction.	
When a crane trolley is at the operating limit switch then it may only start in the opposite direction.	
To manually clean the roller in a printing machine, the roller must only turn in a specific direction.	

How does SDIfunction in detail?

Overview

SDI monitors the actual direction of rotation.

In addition, SDI limits the speed to values in the permissible direction.
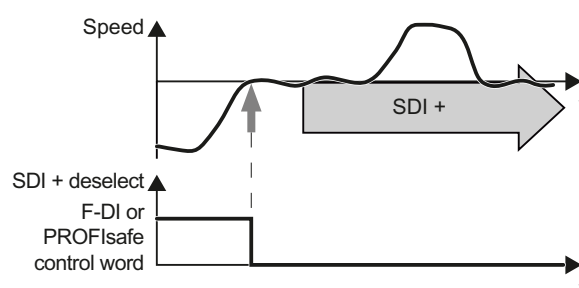
Selecting and deselecting SDI

As soon as the converter has detected the selection of SDI+ or SDI- via a fail-safe input or via the safe communication PROFIsafe , the following happens:

● The converter is set in the factory, so that after selecting SDI, it limits the speed in the permitted direction of rotation.

● After the delay time has expired, the converter monitors the direction of rotation of the motor.

● If the higher-level control deselects SDI , then the converter deactivates limiting and monitoring.
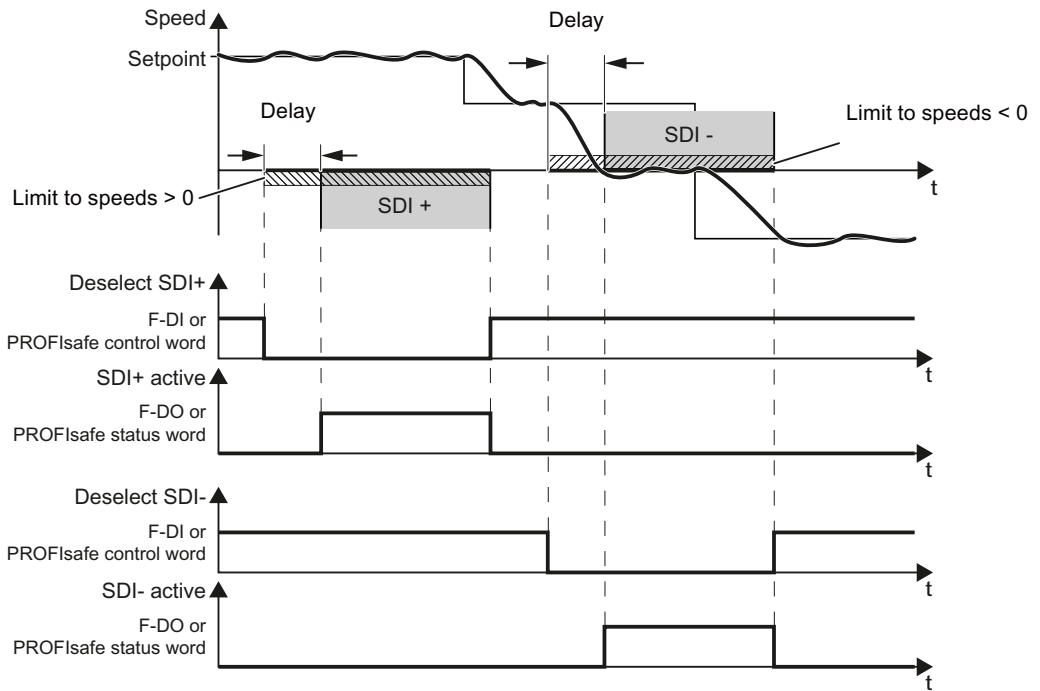
Figure 2-2   Time response of the safety function SDI (Safe Direction)

The converter allows load movements in the monitored direction of rotation within an adjustable tolerance.

Which converters support this function?

SINAMICS G120	SINAMICS G120D	SINAMICS G120C
with Control Unit:	with Control Unit:	---
CU240E-2 F CU240E-2 DP-F CU240E-2 PN-F CU250S-2 [1] CU250S-2 DP [1] CU250S-2 PN [1] CU250S-2 CAN [1]	CU240D-2 DP-F CU240D-2 PN-F CU240D-2 PN-F PP CU250D-2 DP-F CU250D-2 PN-F CU250D-2 PN-F PP	
[1] requires a license for the safety functions		

For these converters, an encoder to sense the motor speed is not required for the SDI function.

2.8 Safe Speed Monitor (SSM)

Definition according to EN 61800-5-2:

"The SSM function supplies a safe output signal, to indicate whether the motor speed lies below a defined limit."
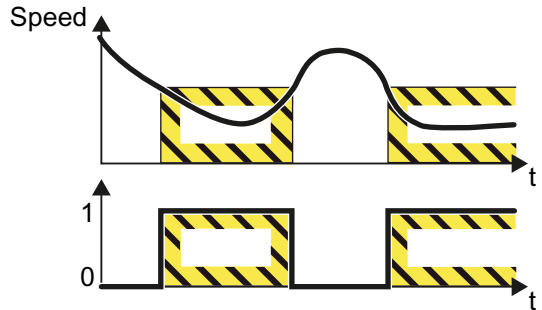
Application example

Example	Possible solution
A centrifuge may only filled below a certain minimum velocity.	• The converter safety monitors the centrifuge speed and enables the process to advance to the next step using the PROFIsafe status bit "Status SSM ".

How does SSMfunction in detail?

Preconditions

The safety function SSM cannot be selected or deselected using external control signals. SSM is active when you have set a monitoring velocity > 0 for SSM .

Evaluating the speed

The converter compares the load speed with the speed limit and signals if the limit value is fallen below to the high-level control.
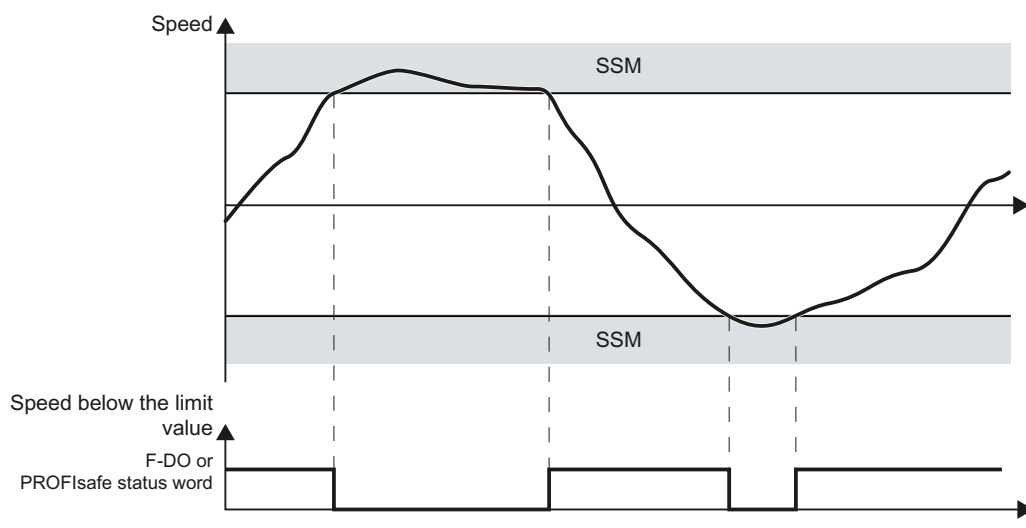
Figure 2-3   Time response of the safety function SSM (Safe Speed Monitor)

Which converters support this function?

SINAMICS G120	SINAMICS G120D	SINAMICS G120C
with Control Unit:	with Control Unit:	---
CU240E-2 DP-F CU240E-2 PN-F CU250S-2 [1] CU250S-2 DP [1] CU250S-2 PN [1] CU250S-2 CAN [1]	CU240D-2 DP-F CU240D-2 PN-F CU240D-2 PN-F PP CU250D-2 DP-F CU250D-2 PN-F CU250D-2 PN-F PP	
[1] requires a license for the safety functions		

For these converters, an encoder to sense the motor speed is not required for the SSM function.

2.9 Preconditions and restrictions when used in an application

2.9.1 General conditions

Prerequisites for using fail-safe functions

1. The machine risk assessment, e.g. in compliance with DIN EN ISO 12100, "Safety of machinery - general design principles – Risk assessment and risk minimization", allows converter safety functions to be used in accordance with SIL 2 or PL d.

2. The closed-loop speed control of the converter must function properly. Each fail-safe drive train must be set up in such a way that all the operating procedures performed by the driven machine can be properly monitored and that the converter operates below its limit values (for current, temperature, voltage, etc.). The drive train comprises a converter, motor, brake and driven machine. The performance and parameters of the converter must be compatible with both the connected motor and the application in question.

3. Once the machine has been successfully commissioned, you must review the typical operating conditions and operate the machine close to the permissible limit values. The converter must not malfunction during this test.

Permissible control modes for using fail-safe functions

When the above-mentioned conditions are fulfilled, all of the fail-safe functions can be used for both V/f control and vector control.

Permissible motors for using fail-safe functions

When the above-mentioned conditions are fulfilled, all of the fail-safe functions can be used for induction motors from SIEMENS and other manufacturers.

Synchronous motors are not permitted.

2.9.2 Prohibited applications

Prohibited applications

The safety function STO may be used without any restrictions in all applications.

> ⚠️ **WARNING**
>
> **Death or serious physical injury due to suspended loads falling**
>
> In some cases, the speed control of the induction motor may start to behave incorrectly and this may not be reliably detected by the encoderless safety functions in the inverter. This can lead to a suspended load accelerating unintentionally.
>
> - If the machine can accelerate the motor after it has been switched off, it is not permissible to use safety functions SS1, SLS, SSM or SDI.
> - You can implement speed monitoring in the relevant machines in one the following ways:
>   - Select a drive with safety functions that use an encoder, for example SINAMICS S120.
>   - Implement the speed monitoring functions in the higher-level control system.

1. Example: Use of the safety functions without encoder which is absolutely prohibited

For the hoisting gear of a crane, the suspended load can accelerate the motor as soon as the motor is switched off. In this case, encoderless safety functions SS1, SLS, SSM and SDI are not permissible.
Even if the higher-level control system closes the mechanical brake of the hoisting gear after the motor has been switched off, this is irrelevant regarding the fact that safety functions SS1, SLS, SSM and SDI are absolutely prohibited in this application.

2. Example: Permissible use of encoderless safety functions

A horizontal conveyor is always braked to a standstill due to friction as soon as the motor is switched off. In this case, encoderless safety functions SS1, SLS, SSM and SDI can be used without any restrictions.

Prohibited Power Modules

PM230 Power Module: Safety functions cannot be used

A modular SINAMICS G120 inverter with the PM230 Power Module has no safety functions.

You must use one of the following Power Modules in order to utilize the safety functions of the inverter.

- PM240
- PM240-2
- PM250
- PM260

PM240 FSGX Power Module: Extended safety functions cannot be used

With the PM240 Power Module frame size GX, only the STO safety function of the basic functions is permitted. It is not permissible that you use the following safety functions in an inverter equipped with the PM240 FSGX Power Module:

- STO of the extended functions
- SS1
- SLS
- SDI
- SSM

2.9.3 Impermissible functions

Malfunction of the safety function and drive stop

With some inverter functions the motor speed fluctuates significantly. If a safety function is simultaneously active, then this can result in a malfunction of the safety function and the inverter initiates a STOP F.

When one or several of the safety functions SS1, SLS, SSM or SDI are active or enabled, then you must not use the following inverter functions:

- Motor identification
- Flying restart
- DC braking
- Compound braking

Further, if SS1, SLS, SSM or SDI is active, it is not permissible to switch over the control mode of the motor, e.g. from closed-loop speed control to closed-loop torque control.

Installing

<div style="text-align: right; font-size: 3em;">3</div>

3.1 Installing the inverter

Procedure

1
2

The overview below shows the procedure for installing an inverter with integrated safety functions. The step selected in gray is described in this manual. For information on the steps that are not selected, you will need to consult descriptions in other manuals.

Proceed as follows:

1. If you are using a higher-level control system (PLC), then create the control program first.

   Information on the PROFIsafe interface of the inverter → in this manual: The PROFIsafe profile (Page 37).

2. Install the inverter.

   → operating instructions of your inverter.

3. Connect the inverter to the line supply, and wire the standard inputs and outputs of the inverter.

   → operating instructions of your inverter.

4. Wire the fail-safe inputs and outputs

   → in this manual: Activation via F-DI (Page 44).

   → in this manual: Evaluating via F-DO (Page 58).
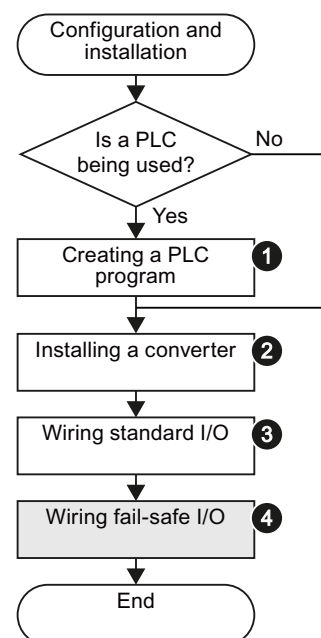
You have installed the inverter and prepared it for commissioning.

3.2 Overview of the interfaces

Depending on the converter version, fail-safe digital inputs and outputs (F-DI, F-DO) or safe bus communication PROFIsafe are available as interface for the safety functions.

Converter		Interfaces			
		F-DI	F-DO	PROFIsafe	Safe brake
	SINAMICS G120C USS SINAMICS G120C CAN	1	0	No	No
	SINAMICS G120C DP SINAMICS G120C PN	1	0	Yes	No
	SINAMICS G120 with Control Unit …				
	CU240E-2	1	0	No	No
	CU240E-2 DP CU240E-2 PN	1	0	Yes	No
	CU240E-2 F	3	0	No	No
	CU240E-2 DP-F CU240E-2 PN-F	3	0	Yes	No
	CU250S-2 CU250S-2 CAN	3	1	No	Yes, with Safe Brake Relay
	CU250S-2 DP CU250S-2 PN	3	1	Yes	Yes, with Safe Brake Relay
	SINAMICS G120D with Control Unit …				
	CU240D-2 DP CU240D-2 PN	1	0	Yes	No
	CU240D-2 DP-F CU240D-2 PN-F CU240D-2 PN-F PP CU250D-2 DP-F CU250D-2 PN-F CU250D-2 PN-F PP	3	1	Yes	No

3.3 The PROFIsafe profile

3.3.1 Converter with PROFIsafe

The PROFIsafe profile is implemented in all converters with PROFIBUS or PROFINET interface.

Converters with the PROFIsafe profile	
	SINAMICS G120C DP SINAMICS G120C PN
	SINAMICS G120 with Control Unit … CU240E-2 DP CU240E-2 PN CU240E-2 DP-F CU240E-2 PN-F CU250S-2 DP CU250S-2 PN
	SINAMICS G120D with Control Unit … CU240D-2 DP CU240D-2 PN CU240D-2 DP-F CU240D-2 PN-F CU240D-2 PN-F PP CU250D-2 DP-F CU250D-2 PN-F CU240D-2 PN-F PP

3.3.2 Communication via PROFIsafe

Communication via PROFIsafe

You must connect the inverter to a central fail-safe control (F-CPU) via either PROFIBUS or PROFINET.
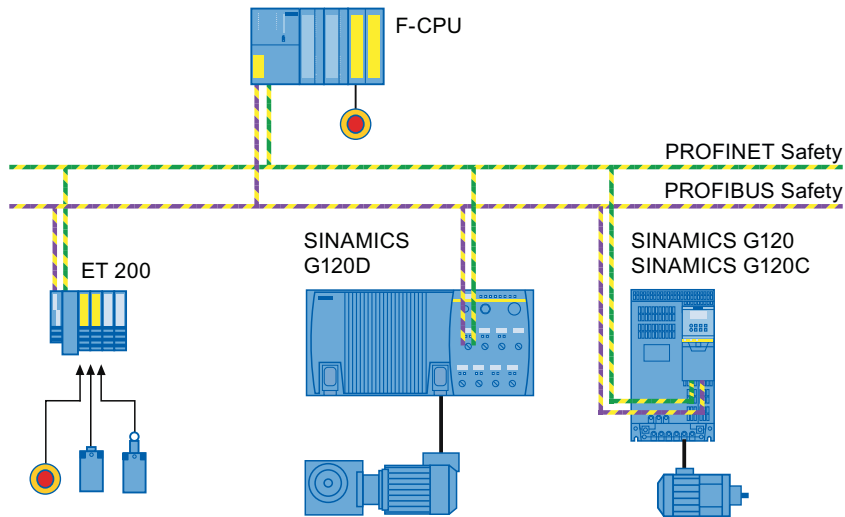
Figure 3-1   PROFIsafe communication between F-CPU and inverter

Shared Device

The PROFINET "Shared Device" function allows two controls to just access one inverter:

- A fail-safe control system (F-CPU) controls the safety functions in the inverter.

- A standard control transfers the commands and setpoints required for operation.
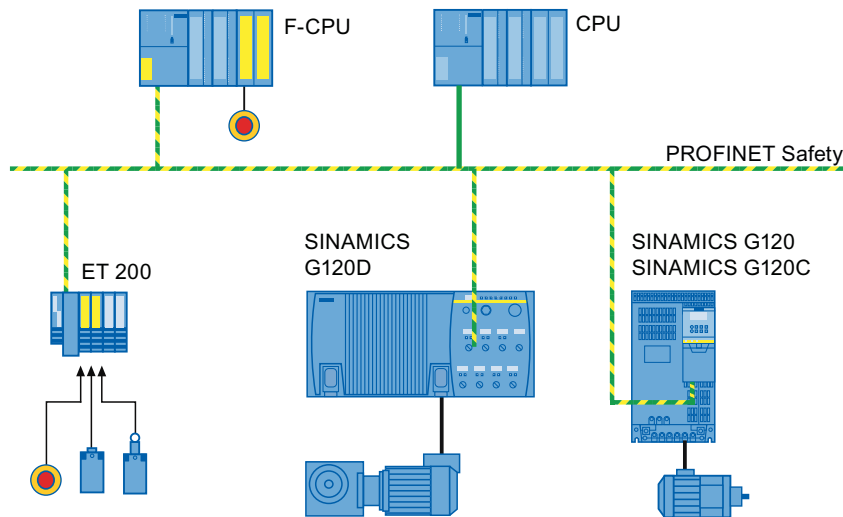
Figure 3-2   Bus configuration, shared device

Not possible: Communication I-slave ↔ slave

PROFIsafe communication between the inverter and a F-CPU as slave (I-slave) is not possible.
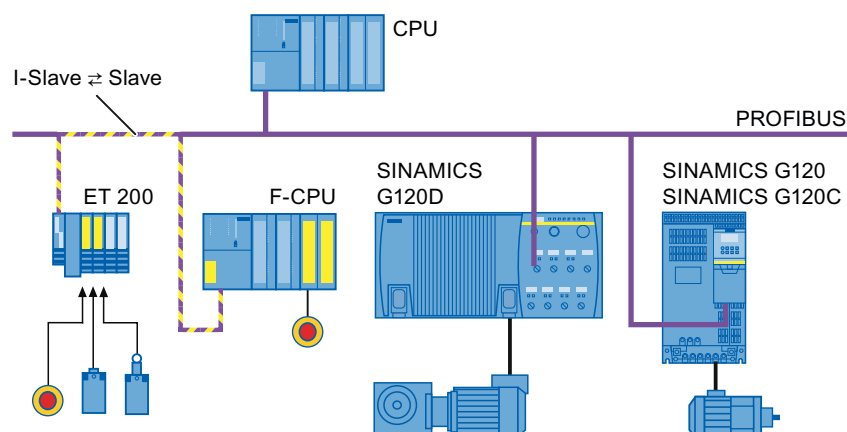
Figure 3-3   No PROFIsafe communication between F-CPU as I-slave and inverter

3.3.3   Telegram types

Two telegrams are available for the data exchange via PROFIsafe between the converter and the higher-level controller:

Table 3- 1   Telegram types

Telegram type	Process data (PZD) - control and status words	
	PZD1	PZD2
Telegram 30 PZD 1/1	STW1	---
	ZSW1	---
Telegram 900 PZD 2/2	STW1	STW5
	ZSW1	ZSW5

STW: Control word; ZSW: Status word

The higher-level controller triggers the safety functions in the converter via the control word. The converter uses the status word to report the status of the safety functions to the controller.

Which converters have which telegram type?

SINAMICS G120	SINAMICS G120D	SINAMICS G120C
Telegram 30		
with Control Unit:	with Control Unit:	G120C DP
CU240E-2 DP CU240E-2 DP-F CU240E-2 PN CU240E-2 PN-F CU250S-2 DP CU250S-2 PN	CU240D-2 DP CU240D-2 DP-F CU240D-2 PN CU240D-2 PN-F CU240D-2 PN-F PP CU250D-2 DP-F CU250D-2 PN-F CU250D-2 PN-F PP	G120C PN
Telegram 900		
with Control Unit:	with Control Unit:	---
CU240E-2 DP-F CU240E-2 PN-F CU250S-2 DP CU250S -2 PN	CU240D-2 DP-F CU240D-2 PN-F CU240D-2 PN-F PP CU250D-2 DP-F CU250D-2 PN-F CU250D-2 PN-F PP	

3.3.4 Control word 1 and status word 1 (basic functions)

Table 3- 2   Control word 1 (bit 0 ... 15)

Bit	Function	Comment	
0	STO	1	Select STO
		0	Deselect STO
1 … 6	*Reserved*		
7	Internal event ack	1	Acknowledge serious safety function faults with a signal change 1 → 0
		0	Do not acknowledge faults
8 … 15	*Reserved*		

Table 3- 3   Status word 1 (bit 0 ... 15)

Bit	Function	Comment	
0	Power removed	1	STO is active
		0	STO is not active
1 … 6	*Reserved*		
7	Internal Event	1	The inverter has detected a severe fault in the safety functions.
		0	Fault-free operation
8 … 15	*Reserved*		

3.3.5   Control word 1 and status word 1 (extended functions)

Table 3- 4   Control word 1 (bit 0 ... 15)

Bit	Function	Comment			
0	STO	1	Deselect STO		
		0	Select STO		
1	SS1	1	Deselect SS1		
		0	Select SS1		
2, 3	*Reserved*				
4	SLS	1	Deselect SLS		
		0	Select SLS		
5, 6	*Reserved*				
7	Internal event ack	1	Acknowledge serious safety function faults with a signal change 1 → 0		
		0	Do not acknowledge faults		
8	*Reserved*				
9	SLS-level, bit 0	Select SLS level		Bit 10	Bit 9
10	SLSlevel, bit 1		Level 1	0	0
			Level 2	0	1
			Level 3	1	0
			Level 4	1	1
11	*Reserved*				
12	SDI Positive	1	Deselect SDI with positive direction of rotation		
		0	Select SDI with positive direction of rotation		
13	SDI Negative	1	Deselect SDI with negative direction of rotation		
		0	Select SDI with negative direction of rotation		
14, 15	*Reserved*				

Table 3- 5   Status word 1 (bit 0 ... 15)

Bit	Function	Comment			
0	Power removed	1	STO is active		
		0	STO is not active		
1	SS1 active	1	SS1 is active		
		0	SS1 is not active		
2, 3	*Reserved*				
4	SLS active	1	SLS is active		
		0	SLS is not active		
5, 6	*Reserved*				
7	Internal Event	1	The inverter has detected a severe fault in the safety functions.		
		0	Fault-free operation		
8	*Reserved*				
9	SLSlevel, bit 0	Active SLS level		Bit 10	Bit 9
			Level 1	0	0
10	SLSlevel, bit 1		Level 2	0	1
			Level 3	1	0
			Level 4	1	1
11	*Reserved*				
12	SDI positive active	1	SDI positive direction of rotation is active		
		0	SDI positive direction of rotation is not active		
13	SDI negative active	1	SDI negative direction of rotation is active		
		0	SDI negative direction of rotation is not active		
14	*Reserved*				
15	Status SSM	1	Speed is within the SSM limit value		
		0	Speed is outside the SSM limit value		

3.3.6 Control word 5 and status word 5

Telegram 900 of the PROFIsafe profile also contains control and status word 5. The inverter uses status word 5 to transfer the status of the fail-safe digital inputs to the controller.

Table 3- 6   Control word 5 (bit 0 ... 15)

Bit	Function	Comment
0 … 15	*Reserved*	Assign the value 0 to the reserved bits.

Table 3- 7   Status word 5 (bit 0 ... 15)

Bit	Function	Comment		SINAMICS G120	SINAMICS G120D
0 … 7	*Reserved*	-			
8	**Status of fail-safe inputs**	0	LOW signal (0 V)	At terminals 5 and 6	At pins X7.2 and X7.4
		1	HIGH signal (24 V)		
9		0	LOW signal (0 V)	At terminals 7 and 8	At pins X8.2 and X8.4
		1	HIGH signal (24 V)		
10		0	LOW signal (0 V)	At terminals 16 and 17	At pins X9.2 and X9.4
		1	HIGH signal (24 V)		
11 … 15	*Reserved*	-			

An overview of the fail-safe inputs can be found in the section Fail-safe inputs (Page 44).

The status bit of a fail-safe input in status word 5 is always 0 if one of the following two conditions is fulfilled:

● The relevant fail-safe input is not used.

● The inverter has deactivated the relevant fail-safe input due to a discrepancy.

3.4 Activation via F-DI

3.4.1 Fail-safe inputs

In the factory setting of the converter, the fail-safe inputs are not assigned to the integrated safety functions. Only when commissioning do you define whether you use, for example, the digital inputs DI 4 and DI 5 for standard functions, or by combining, you create a fail-safe two-channel input.

Assignment of the fail-safe inputs

Table 3- 8   Converter (chassis units IP20) with only one fail-safe input

SINAMICS G120C	SINAMICS G120 with Control Unit CU240E-2 CU240E-2 DP CU240E-2 PN	Terminal strip	Digital input	Fail-safe input
		16	DI 4	F-DI 0
		17	DI 5	

Table 3- 9   Converter (chassis units IP20) with several fail-safe inputs

SINAMICS G120 with Control Unit CU240E-2 F CU240E-2 DP-F CU240E-2 PN-F CU250S-2 CU250S-2 CAN CU250S-2 DP CU250S-2 PN	Terminal strip	Digital input	Fail-safe inputs	
			Basic functions	Extended functions
	5	DI 0	-	F-DI 0
	6	DI 1		
	7	DI 2		F-DI 1
	8	DI 3		
	16	DI 4	F-DI 0	F-DI 2
	17	DI 5		

Table 3- 10   Converter for cabinet-free installation (IP65) with only one fail-safe input

SINAMICS G120D with Control Unit CU240D-2 DP CU240D-2 PN	Connector.pin	Digital input	Fail-safe input
	X9.4	DI 4	F-DI 0
	X9.2	DI 5	

Table 3- 11   Converter for cabinet-free installation (IP65) with several fail-safe inputs

SINAMICS G120D with Control Unit CU240D-2 DP-F CU240D-2 PN-F CU240D-2 PN-F PP CU250D-2 DP-F CU250D-2 PN-F CU250D-2 PN-F PP	Connector.pin	Digital input	Fail-safe inputs	
			Basic functions	Extended functions
	X7.4	DI 0	-	F-DI 0
	X7.2	DI 1		
	X8.4	DI 2		F-DI 1
	X8.2	DI 3		
	X9.4	DI 4	F-DI 0	F-DI 2
	X9.2	DI 5		

Safety-related signals, e.g. the switching state of a sensor, must be wired using two channels with a fail-safe input. The converter evaluates the signal on two separate signal paths.

What devices can be connected?

The fail-safe input is designed for the following devices:

- Connection of safety sensors, e.g. emergency stop command devices or light curtains.
- Connection of pre-processing safety relays, e.g. fail-safe controllers.

Signal states at the fail-safe input

The inverter expects signals with the same state at its fail-safe input:

- High signal: The safety function is deselected.
- Low signal: The safety function is selected.

Special measures for wiring of a fail-safe input

The inverter evaluates deviations in the two signals of the fail-safe input. The inverter thus detects, for example the following faults:

- Cable break

- Defective sensor

The inverter cannot detect the following faults:

- Cross-circuit of the two cables

- Short-circuit between signal cable and 24 V power supply

You have the following options to reduce the risk of damaged cables during operation of your machine or plant:

- Use shielded cables with grounded shield.

- Lay signal cables in steel pipes.

These special types of cable routing are normally required only if the cables are laid over larger distances, e.g. between remote control cabinets.

3.4.2 Wiring examples

On the following pages, you will find examples of interconnecting the fail-safe digital inputs in accordance with PL d to EN 13849-1 and SIL 2 to IEC 61508.

3.4.2.1 Connecting sensors

Electromechanical sensor

If there is a risk of cross-circuits or short-circuits, the cables between the sensor and the converter must be protected, for example, by routing them in a steel tube.

The converter provides the supply voltage
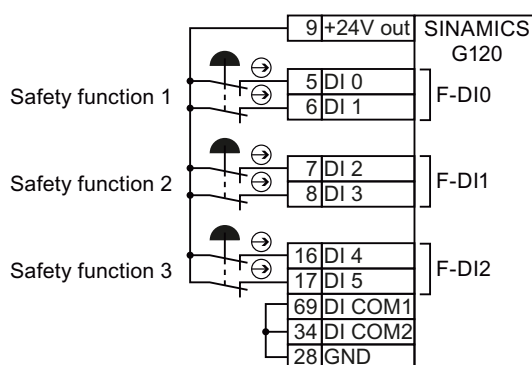
Figure 3-4   Connecting an electromechanical sensor to the converter power supply

External power supply
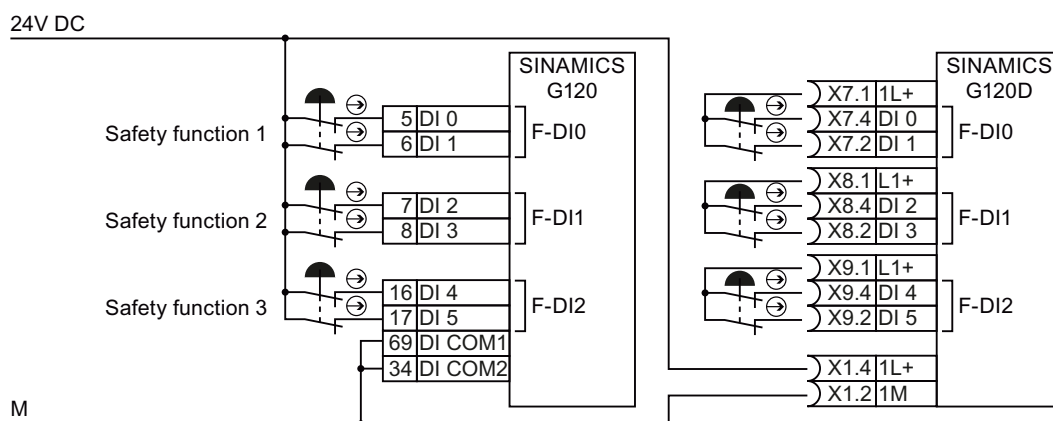
Figure 3-5   Connecting an electromechanical sensor to an external power supply

Series-connected electromechanical sensors

You may connect Emergency Stop control devices in series if it can be ruled out that the Emergency Stop command devices are simultaneously actuated. The simultaneous failure of Emergency Stop control devices connected in series can generally be ruled out.

According to IEC 62061 (SIL) and ISO 13849-1 (PL), position switches of protective doors may also connected in series.
Exception: If several protective doors are regularly opened at the same time, it is not possible for faults to be detected, which means that the position switches must not be connected in series.

If there is a risk of cross-circuits or short-circuits, the cables between the sensor and the converter must be protected, for example, by routing them in a steel tube.

The converter provides the supply voltage

Connect the 24 V supply of the converter to the sensors and connect the reference potentials of the inputs used to GND.
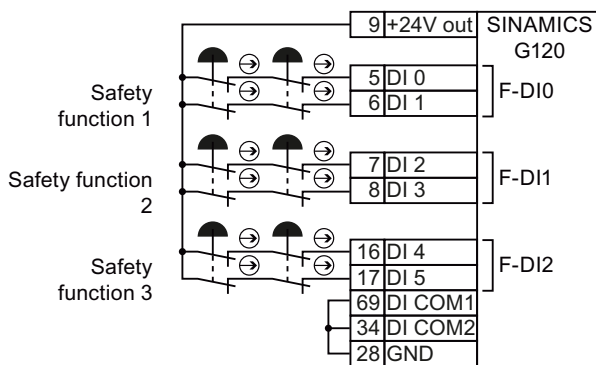
Figure 3-6   Connecting electromechanical sensors to the converter power supply in series

External power supply

Connect the external power supply to the sensors and connect the reference potentials of the inputs used to the reference potential of the external power supply.
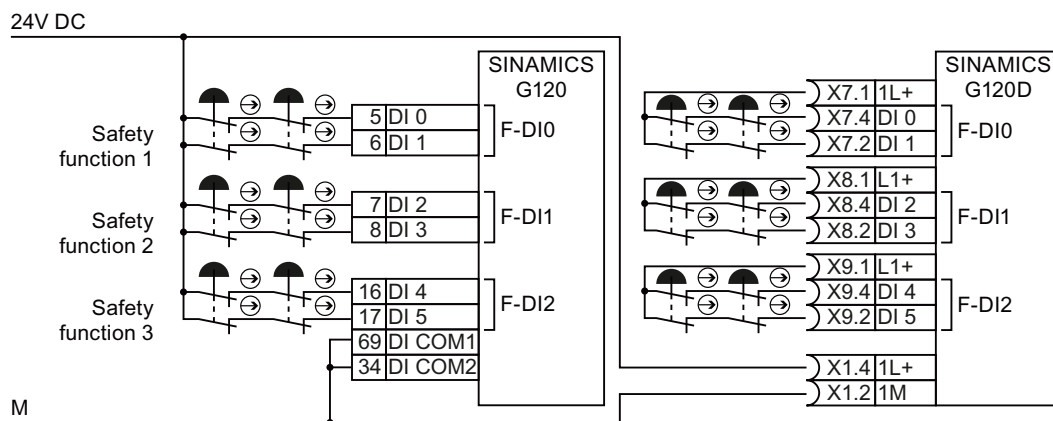
Figure 3-7   Connecting electromechanical sensors to an external power supply in series

Activating several inverters simultaneously

You may activate the safety functions of several converters simultaneously with one or several series-connected safety sensors.

If there is a risk of cross-circuits or short-circuits, the cables between the sensor and the converter must be protected, for example, by routing them in a steel tube.

The converter provides the supply voltage

Connect the 24 V supply of the converter to the sensors and connect the reference potentials of the inputs used to GND.
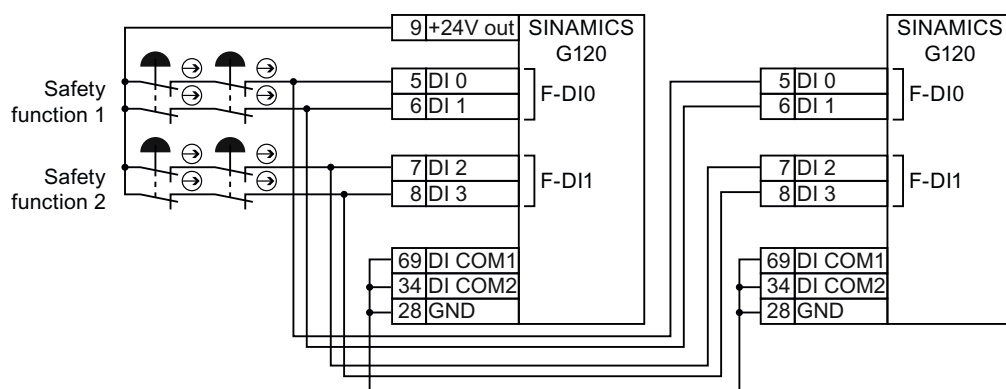
Figure 3-8   Simultaneous activation of several converters with converter power supply

External power supply

Connect the external power supply to the sensors and connect the reference potentials of the inputs used to the reference potential of the external power supply.
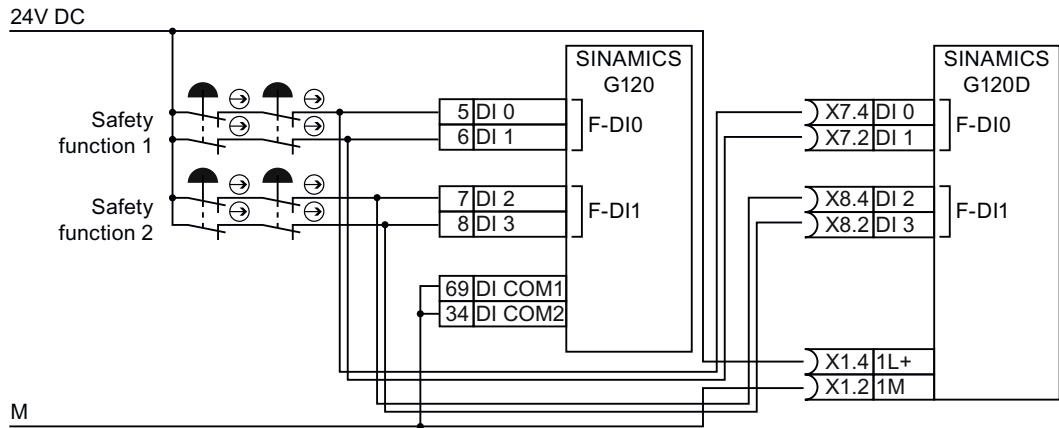
Figure 3-9   Simultaneous activation of several converters with external power supply

3.4.2.2   Connecting pre-processing devices

If you use safety relays with electronic enabling circuits, the relays must feature outputs that switch to P potential. The safety relay switches the 24 V supply line to the converter but not the ground return line.

Safety relays with relay enabling circuits are only permitted if, as a minimum, they have an internal two-channel configuration.

The following pages describe a number of typical circuits for various types of safety relay. Exactly how these are interconnected depends on whether the safety relay and the converter are housed in the same or separate control cabinets.

3TK28 safety relay

The typical circuits described on the following pages are based on safety relays with relay enabling circuits. Safety relays with semiconductor enabling circuits can also be used.

The diagrams only show how the safety relay and converter are interconnected. Information providing full details of how the safety relay is wired can be found in the product-specific documentation: SIRIUS 3TK28 safety relays (http://support.automation.siemens.com/WW/view/en/26414637/133300).

Components in the same control cabinet

A control cabinet that has been set up and wired correctly does not contain any damaged wiring or cross circuits.

For this reason, you may interconnect a safety relay and converter in the same control cabinet by means of a single-channel wiring arrangement. The two terminals of the fail-safe input must be connected to each other on the converter.

Figure 3-10   Interconnecting the converter and safety relay within the same control cabinet

Components in separate control cabinets

If the components are located in separate control cabinets, the wiring between the safety relay and fail-safe inputs on the converter must be installed such that it is protected against cross and short-circuits.

Transfer the two signals for activating a safety function via wires in separate lines. In the example, the signals for terminal 5 and 7 are transferred via the first wire. The signals for terminal 6 and 8 are then transferred via the second wire.

Figure 3-11   Interconnecting the converter and safety relay in separate control cabinets

3RK3 Modular Safety System

You can use both the fail-safe outputs in the MSS Basic central unit of the 3RK3 Modular Safety System as well as the outputs in the EM 2/4F-DI 2F-DO expansion module to activate the F-DIs of the converter.

The fail-safe relay outputs of the EM 2/4F-DI 1/2F-RO expansion module must not be used because these only have a single-channel configuration.

The diagrams only show how the 3RK3 Modular Safety System and converter are interconnected. Information providing full details of how the 3RK3 Modular Safety System are wired can be found in the product-specific documentation: SIRIUS 3RK3 Modular Safety System (http://support.automation.siemens.com/WW/view/en/26412499/133300).

Components in the same control cabinet

A control cabinet that has been set up and wired correctly does not contain any damaged wiring or cross circuits.

You may interconnect the Modular Safety System and converter within the same control cabinet by means of a single-channel wiring arrangement. The two terminals of the fail-safe input must be connected to each other on the converter.
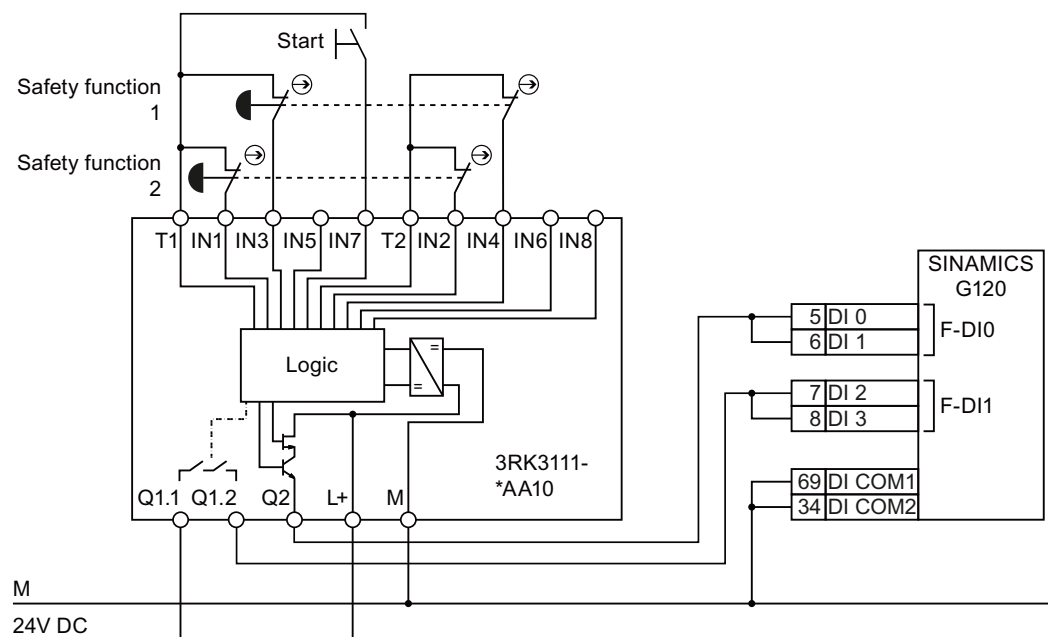
Figure 3-12   Interconnecting the converter and Modular Safety System within the same control cabinet

Components in separate control cabinets

If the components are located in separate control cabinets, the wiring between the Modular Safety System and the F-DIs on the converter must be installed such that it is protected against cross and short-circuits.

Transfer the two signals for activating a safety function via wires in separate lines. In the example, the signals for terminal 5 and 7 are transferred via the first wire. The signals for terminal 6 and 8 are then transferred via the second wire.

If you want to use the fail-safe outputs of the 3RK3 central unit for transferring signals via two channels, converter discrepancy monitoring must be adapted to the different switching times of the electronic output and relay contact.
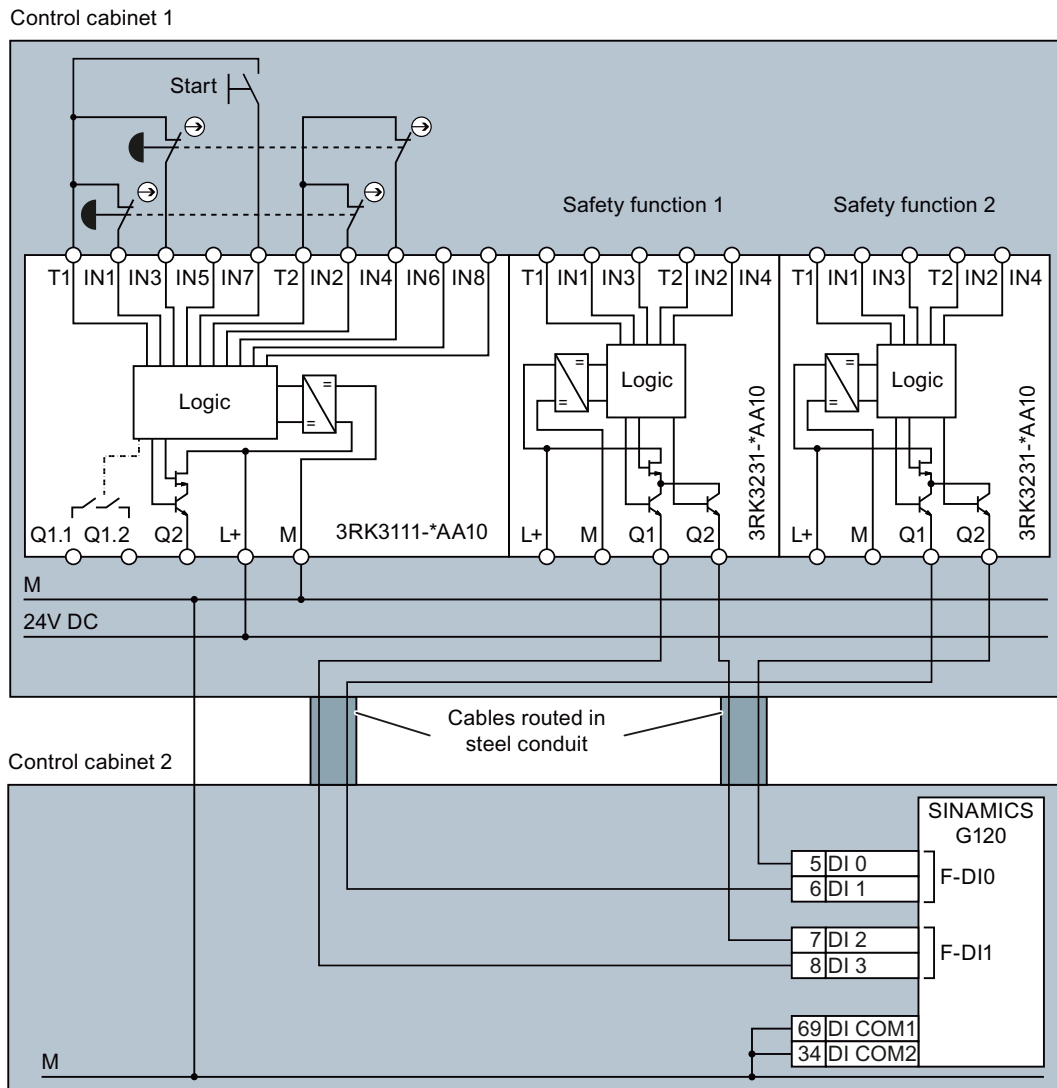
Figure 3-13   Interconnecting the converter and Modular Safety System in separate control cabinets

S7-300 I/O modules

Fail-safe outputs that switch to P potential are required for activating the fail-safe digital inputs of the SINAMICS G120. From the S7-300 range, the SM326 DO 10 x 24 V / 2 A PP I/O module fulfills this requirement.

The diagrams only show how the I/O module and converter are interconnected. Information providing full details of how the I/O module is wired can be found in the product-specific documentation: S7-300 (http://support.automation.siemens.com/WW/view/en/10805159/133300).

Components in the same control cabinet

A control cabinet that has been set up and wired correctly does not contain any damaged wiring or cross circuits.

You may interconnect the SM326 I/O module and converter within the same control cabinet by means of a single-channel wiring arrangement. The two terminals of the fail-safe input must be connected to each other on the converter.
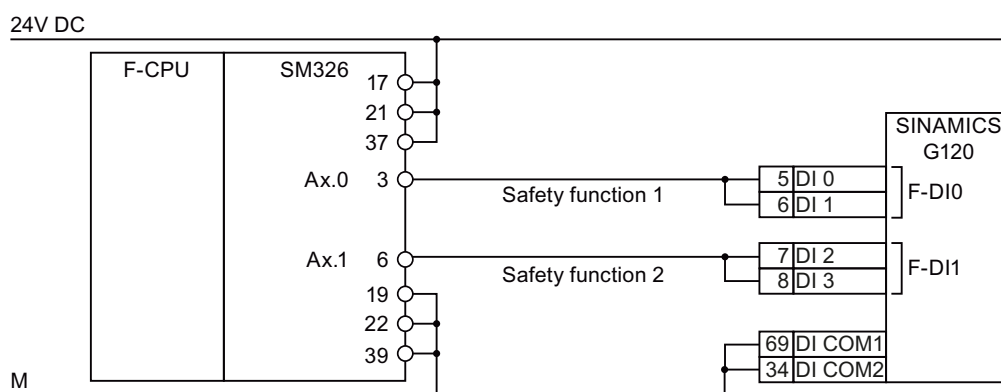
Figure 3-14   Interconnecting the converter and SM326 I/O module within the same control cabinet

Components in separate control cabinets

If the components are located in separate control cabinets, the wiring between the SM326 I/O module and the F-DIs on the converter must be installed such that it is protected against cross and short-circuits.

Transfer the two signals for activating a safety function via wires in separate lines. In the example, the signals for terminal 5 and 7 are transferred via the first wire. The signals for terminal 6 and 8 are then transferred via the second wire.
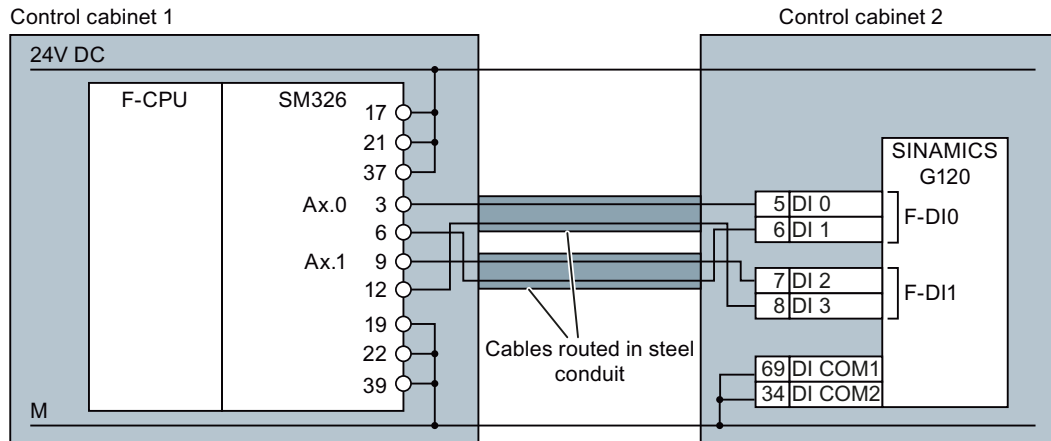
Figure 3-15   Interconnecting the converter and SM326 I/O module in separate control cabinets

ET 200 I/O modules

Fail-safe outputs that switch to P potential are required for activating the fail-safe digital inputs of the SINAMICS G120. From the ET 200 system range, only the fail-safe relay module EM 1 F-RO DC 24 V / AC 24…230 V / 5 A of the ET 200S system fulfills this requirement.

The fail-safe relay module is activated via a fail-safe ET 200S output module.

The diagrams only show how the I/O modules and converter are interconnected. Information providing full details of how the I/O modules is wired can be found in the product-specific documentation: ET 200S (http://support.automation.siemens.com/WW/view/en/10805258/133300).

Components in the same control cabinet

A control cabinet that has been set up and wired correctly does not contain any damaged wiring or cross circuits.

For this reason, you may interconnect the I/O modules and converter in a control cabinet by means of a single-channel wiring arrangement. The two terminals of the fail-safe input must be connected to each other on the converter.
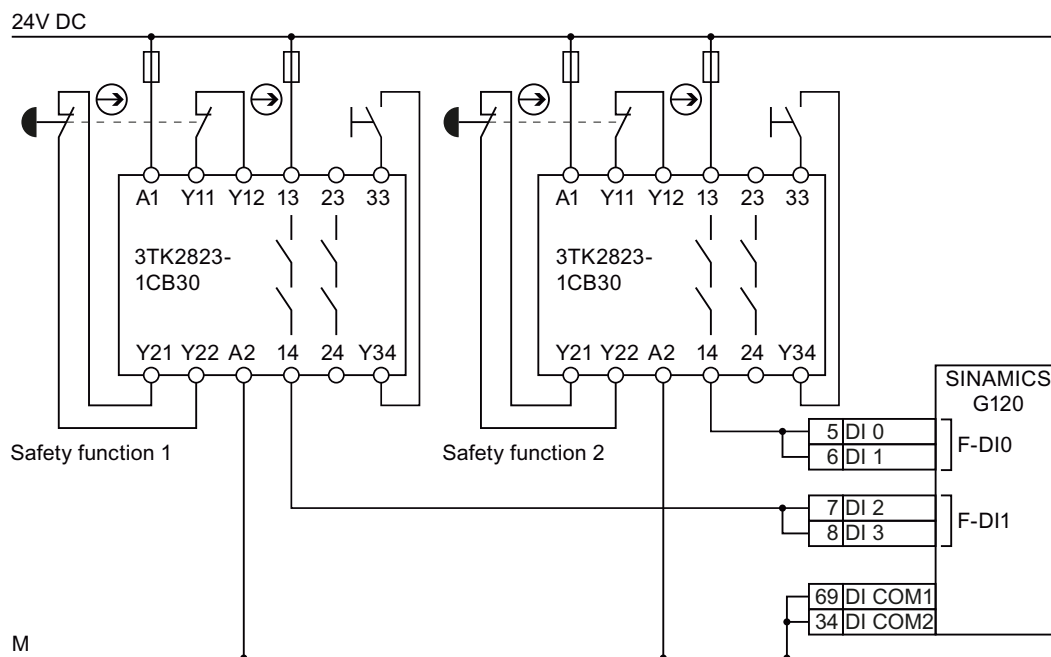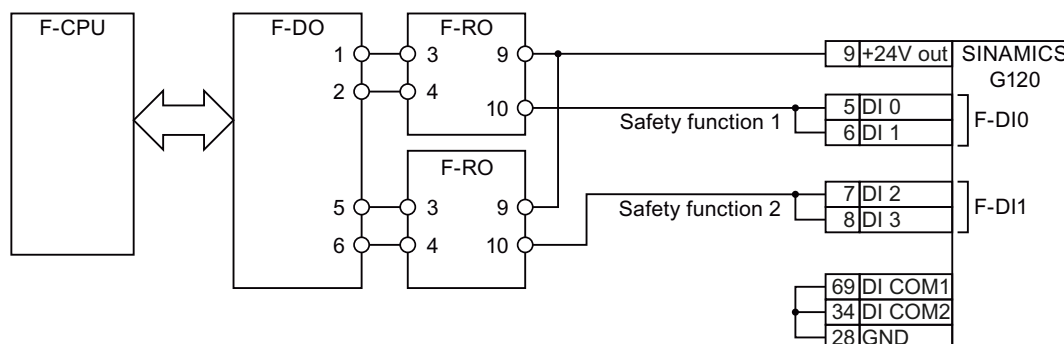

Figure 3-16   Interconnecting the converter and I/O modules within the same control cabinet

Components in separate control cabinets

If the components are located in separate control cabinets, the wiring between the I/O modules and the F-DIs on the converter must be installed such that it is protected against cross and short-circuits.

Transfer the two signals for activating a safety function via wires in separate lines. In the example, the signals for terminal 5 and 7 are transferred via the first wire. The signals for terminal 6 and 8 are then transferred via the second wire.
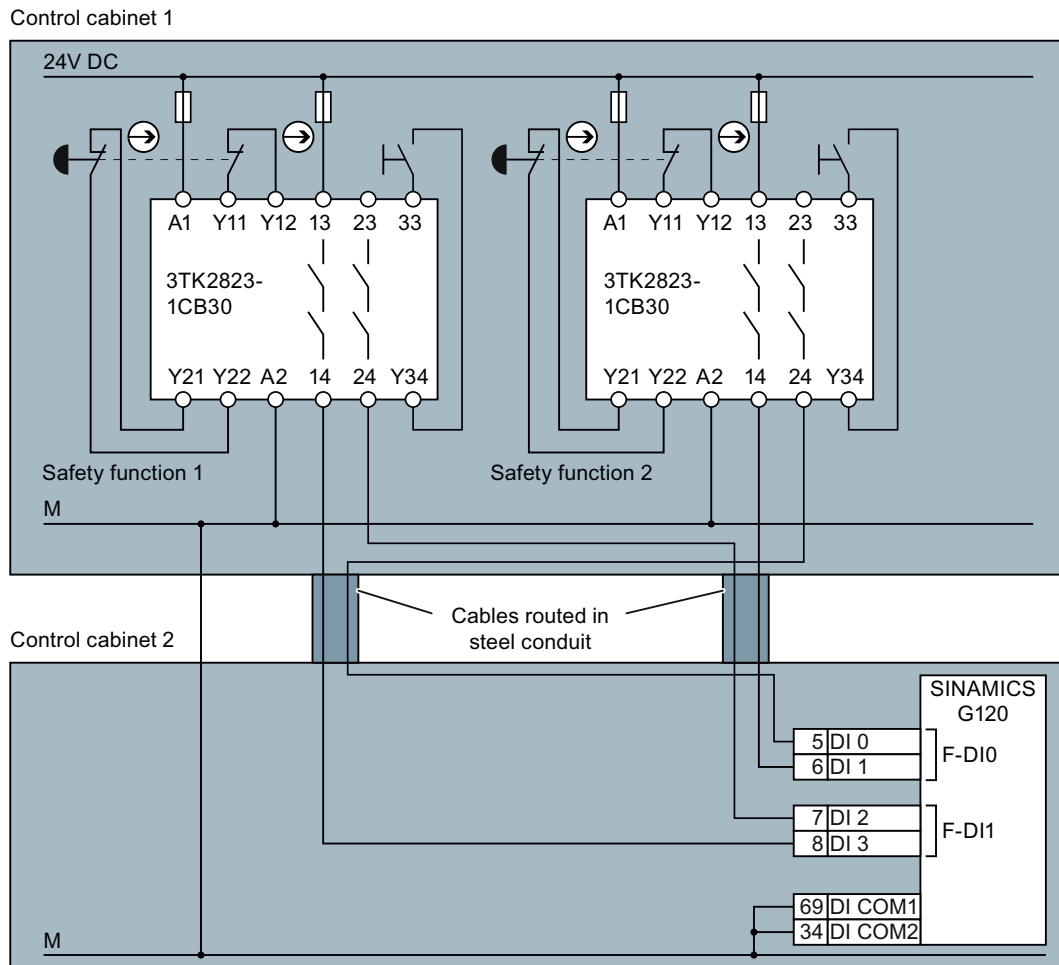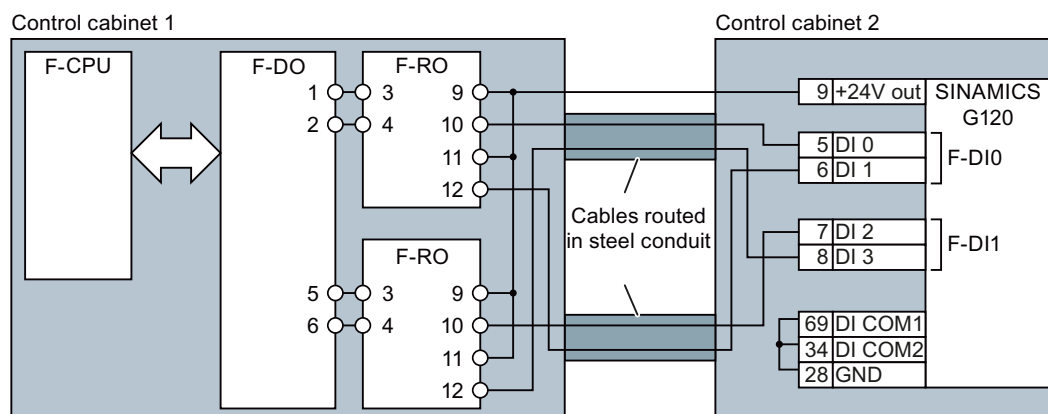

Figure 3-17   Interconnecting the converter and I/O modules in separate control cabinets

3.5 Evaluating via F-DO

3.5.1 Fail-safe output

In the factory setting of the inverter, the fail-safe output is assigned to none of the integrated safety functions. Only when commissioning do you define whether you use, for example, the two digital outputs for standard functions, or you combine them to create a fail-safe, two-channel output.

Table 3- 12   inverters for cabinet-free installation (IP65)

SINAMICS G120D with Control Unit CU240D-2 DP-F CU240D-2 PN-F CU240D-2 PN-F PP CU250D-2 DP-F CU250D-2 PN-F CU250D-2 PN-F PP	Connector.pin	Digital output	Fail-safe output
	X5.4	DO 0	F-DO 0
	X5.2	DO 1	

Table 3- 13   Inverter for installation in a control cabinet (IP20)

SINAMICS G120 with Control Unit CU250S-2 CU250S-2 DP CU250S-2 PN CU250S-2 CAN	Relay contacts on the terminal strip	Digital output	Fail-safe output
	18, 19, 20	DO 0	F-DO 0
	23, 24, 25	DO 2	

The inverter monitors the two signals of the fail-safe output for inconsistency.

What devices can be connected?

The fail-safe output is designed for the following devices:

- Direct connection of a fail-safe input.
- Connection of two relays.

The two signals of the fail-safe output each have the same state:

- High signal: Fail-safe output is active.
- Low signal: Fail-safe output is not active.

3.5.2   Connecting the fail-safe output for SINAMICS G120D

Testing a fail-safe output

You must interconnect the fail-safe output corresponding to your application in order that the converter can test its fail-safe output at regular intervals.

During the self-test the converter temporarily switches off the connected actuator. With the self test, the converter checks whether the output transistors and the connected components can be switched off.

Information on how you can set the particular test mode is provided in Section: Setting a fail-safe output (Page 105).
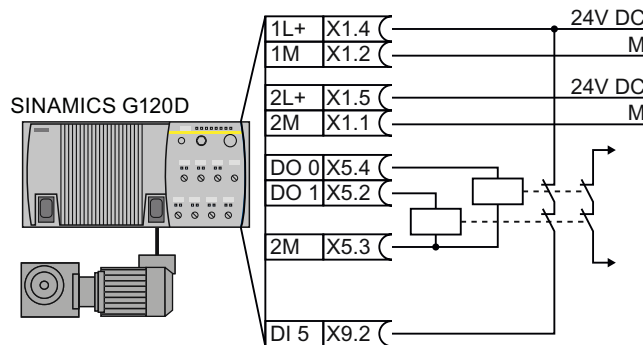
Connecting a relay

Figure 3-18   Connecting a relay at the F-DO

When testing the fail-safe output, the converter switches off the two outputs one after the other and evaluates the feedback signal via digital input DI 5.

Connecting an actuator with feedback signal
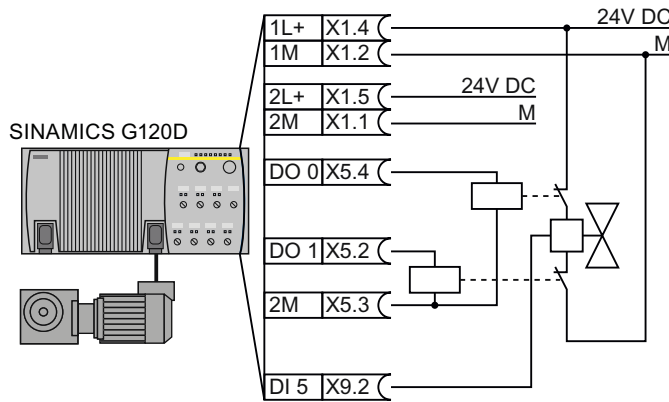
Figure 3-19   Connecting an F-DO to an actuator, mode 3

When testing the fail-safe output, the converter switches off the two outputs one after the other and evaluates the feedback signal via digital input DI 5.

Connecting a fail-safe digital input
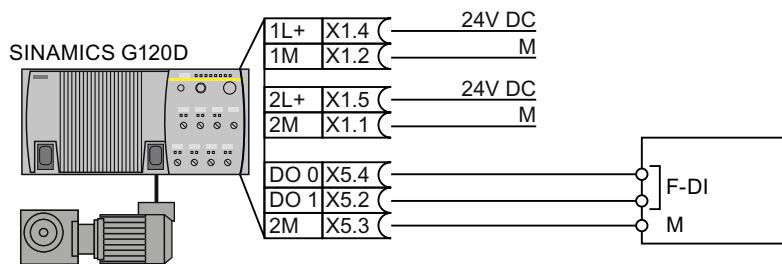
Figure 3-20   Connecting an F-DO with an F-DI, mode 4

When testing the fail-safe output, the converter evaluates internal feedback signals.

3.5.3   Connecting a fail-safe output for SINAMICS G120

Testing a fail-safe output

You must interconnect the fail-safe output corresponding to your application in order that the converter can test its fail-safe output at regular intervals.

During the self-test the converter temporarily switches off the connected actuator. With the self test, the converter checks whether the output transistors and the connected components can be switched off.

Information on how you can set the particular test mode is provided in Section: Setting a fail-safe output (Page 105).
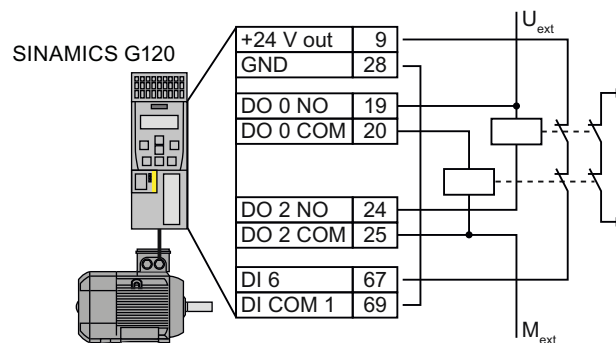
Connecting a relay

Figure 3-21   Connecting a relay at the F-DO

When testing the fail-safe output, the converter switches off the two outputs one after the other and evaluates the feedback via digital input DI 6.

Connecting an actuator with feedback signal
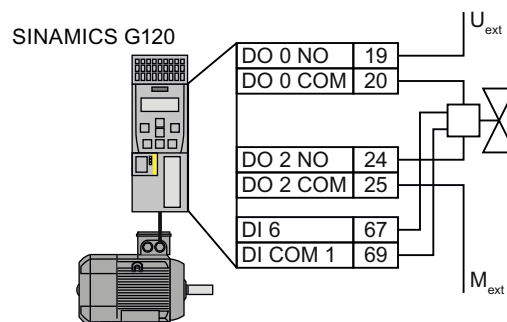
Figure 3-22   Connecting an F-DO to an actuator, mode 3

When testing the fail-safe output, the converter switches off the two outputs one after the other and evaluates the feedback via digital input DI 6.

Connecting an actuator without feedback signal
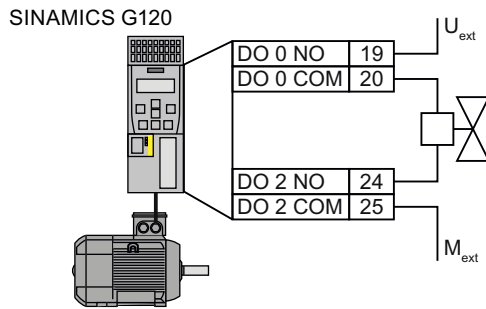
Figure 3-23   Connecting an F-DO to an actuator, mode 4

When testing the fail-safe output, the converter evaluates internal feedback signals.

Connecting a fail-safe digital input
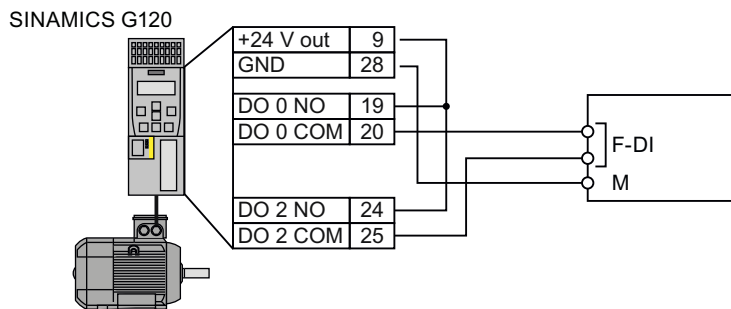
Figure 3-24   Connecting an F-DO with an F-DI, mode 4

When testing the fail-safe output, the converter evaluates internal feedback signals.

3.6 Connecting a motor holding brake to a Safe Brake Relay

Connecting a Safe Brake Relay and a motor holding brake

The Safe Brake Relay serves as an interface between the Power Module and the motor's brake coil.

The following options are available for installing the Safe Brake Relay:

- On a mounting plate
- On the control cabinet wall
- On the inverter's shield connection kit

For additional information, please refer to the associated installation instructions: Installation instructions for the Brake Relay (http://support.automation.siemens.com/WW/view/en/23623179).

Cable to the Power Module
External 24 V supply
Motor holding brake

Safe Brake Relay connections

Procedure

1
2

To interconnect the inverter with the motor holding brake via the Safe Brake Relay, proceed as follows:

1. Connect the Safe Brake Relay to the Power Module using the cable harness provided.

Power Modules FSA … FSC: Power Modules FSD … FSF
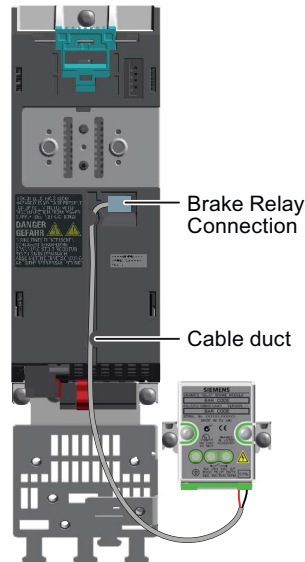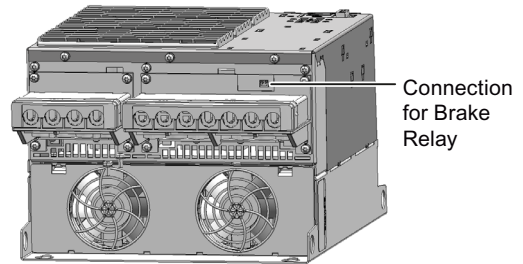
- Connect the Safe Brake Relay at the connector on the front of the Power Module.
- Route the control cable in the guide on the Power Module.

- Connect the Safe Brake Relay at the connector on the lower side of the Power Module.

2. Connect the motor holding brake to the terminals of the Safe Brake Relay:
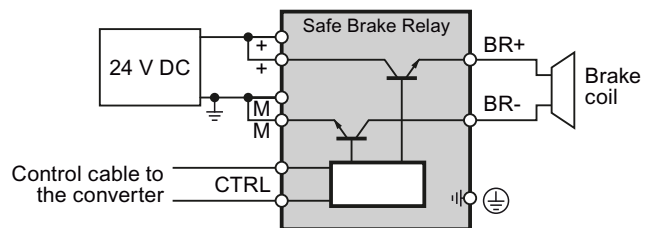
You have connected the motor holding brake to the inverter via the Safe Brake Relay.

Commissioning

4

4.1 Commissioning guidelines

The overview below shows the procedure for commissioning an inverter with integrated safety functions.

The steps for commissioning the safety functions form part of the activities for commissioning the entire drive.

- The commissioning steps marked in gray are described → in this manual.
- For the other steps, you are supported by → additional manuals.

Procedure

To commission an inverter with integrated safety functions, proceed as follows:

1. Connect the fieldbus to the inverter, and configure the communication in the higher-level control.

    → manual of your control system

    → operating instructions of your inverter

2. Configure the PROFIsafe communication in the higher-level control system.

    → in this manual: Configure PROFIsafe in the higher-level control system (Page 66).

3. Carry out the basic commissioning of the drive.

    → operating instructions of your inverter

4. Set the inverter safety functions.

    → subsequent pages in this manual

5. Commission all of the other inverter functions required, e.g. motor control or the protective functions.

    → operating instructions of your inverter

6. Perform an acceptance test for the safety functions.

    → in this manual: Acceptance tests for the safety functions (Page 136)
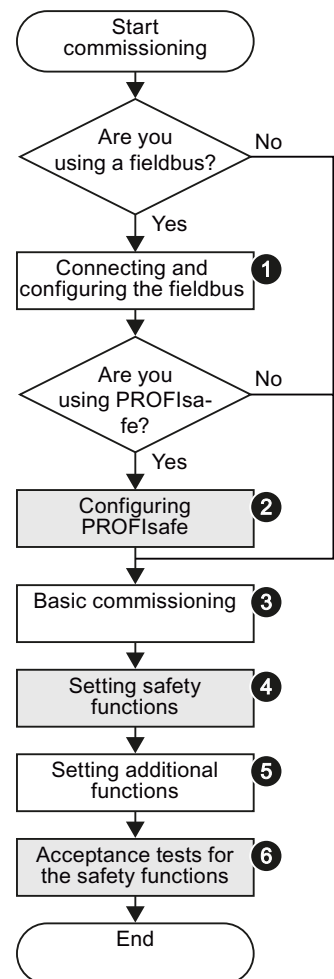
You have commissioned the inverter with integrated safety functions.

4.2 Configure PROFIsafe in the higher-level control system

4.2.1 STEP 7 example: Configuring PROFIsafe communication (telegram 30) via PROFIBUS

Procedure

1
2

To configure PROFIsafe communication via PROFIBUS in the higher-level control, proceed as follows:

1. Configure your SIMATIC CPU (for example, a CPU315F-2 PN/DP) with a PROFIBUS network.

2. Integrate the inverter via its GSD into the PROFIBUS network.

3. Assign the first inverter slot to the PROFIsafe telegram.

4. Assign standard telegram 1, for example, to the other slots of the inverter.
   The operating instructions contain further information on the telegrams and slot sequence.
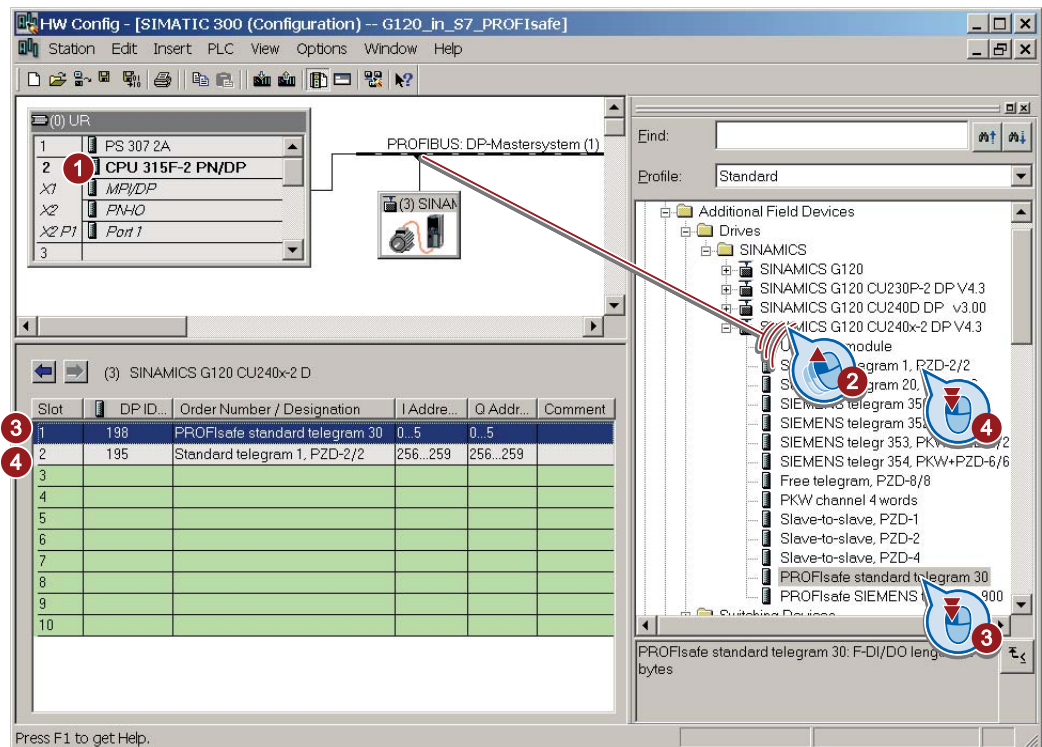
5. Open the properties dialog by double-clicking on the PROFIsafe telegram.

6. Set the input and output range, e.g. to address 14:
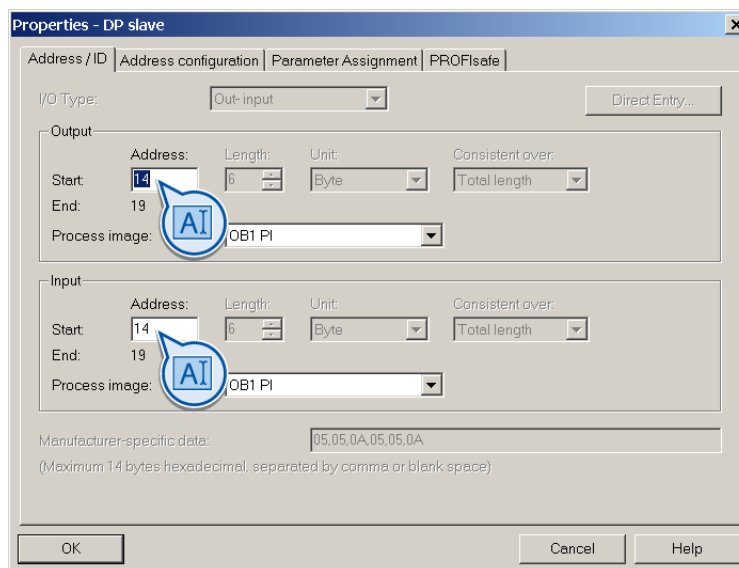
7. In this dialog, select the "PROFIsafe" tab.

   – ① F_Dest_Add

   Note the value of this address. You require this value when commissioning the safety functions.

   – ② F_WD_Time

   Set a value which is greater than the cycle time of your safety program.

   If your safety program is called every 150 ms, for example, in OB35, set the value of F_WD_Time to 200.
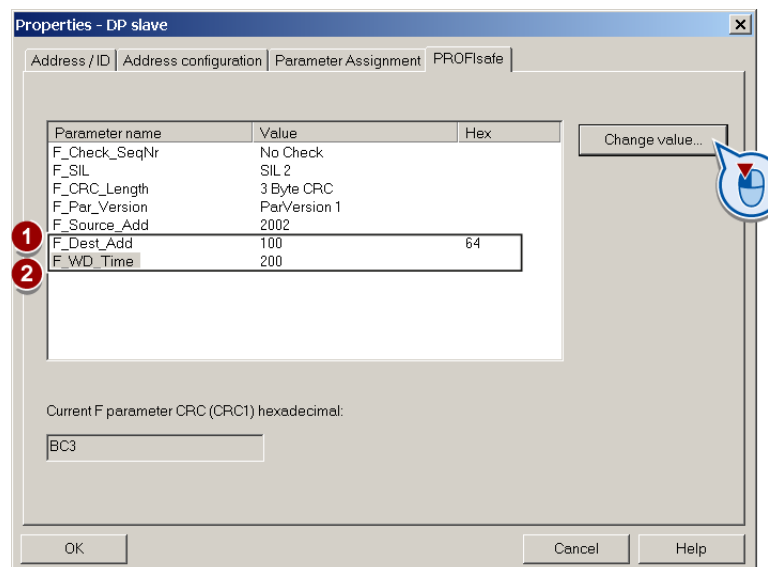
8. Save and compile your project and download the data to your SIMATIC CPU.

9. Close HW Config.

You have configured the PROFIsafe communication in the higher-level control system.

4.2.2 Example: Interface to the S7 safety program

When you configure the hardware in STEP 7, you assign the control word and status word in the PROFIsafe profile of the converter to specific output and input addresses of the SIMATIC controller. In the section STEP 7 example: Configuring PROFIsafe communication (telegram 30) via PROFIBUS (Page 66), start address 14, for example, was assigned. This results in the following assignments between the I/O addresses and converter signals for this example:

Table 4- 1   Control word 1

I/O address	Meaning	Comment	
A14.0	Select STO	1	Deselect STO
		0	Select STO
A14.1	Select SS1	0	Select SS1
A14.4	Select SLS	0	Select SLS
A14.7	Internal event ACK	-	Acknowledge with signal change 1 → 0
A15.1	Select SLS level bit 0	-	Selection of the SLS level
A15.2	Select SLS level, bit 1	-	
A15.4	Select SDI positive	0	Select SDI positive
A15.5	Select SDI negative	0	Select SDI negative

Table 4- 2   Status word 1

I/O address	Meaning	Comment	
E14.0	Power removed	1	The motor torque has been switched off safely.
		0	The motor torque has not yet been switched off safely.
E14.1	SS1 active	1	SS1 is active
E14.4	SLS active	1	SLS is active
E14.7	Internal event	1	The converter has detected an internal fault and responded accordingly, e.g. with a STOP A.
E15.1	Active SLS level, bit 0	-	Active SLS level
E15.2	Active SLS level, bit 1	-	
E15.4	SDI positive active	1	SDI positive direction of rotation is active
E15.5	SDI negative active	1	SDI negative direction of rotation is active
E15.7	Status SSM	1	Speed is within the SSM limit value

A detailed description of the PROFIsafe interface can be found in the section Control word 1 and status word 1 (extended functions) (Page 41).

4.2.3 STEP 7 example: Configuring PROFIsafe communication (telegram 900) via PROFIBUS

If you want to evaluate the status of the fail-safe inputs in the higher-level controller directly, select PROFIsafe telegram 900. The inverter writes the signals of its fail-safe inputs to status word 5.

Hardware configuration

The basic procedure is described in the section STEP 7 example: Configuring PROFIsafe communication (telegram 30) via PROFIBUS (Page 66). Instead of telegram 30, select telegram 900:

4.2.4 STEP 7 example: Configuring Shared Device communication via PROFINET

In the following example, the standard CPU and the F-CPU are combined in a single project. The communication via the Shared Device is also possible, even if both controls are configured in different projects.

Firmware required: see also Support of the IO controller (http://support.automation.siemens.com/WW/view/en/44383955).

Procedure

To configure communication via "Shared Device" in the higher-level control, proceed as follows:

1. Configuring your system with the standard control.

2. In HW Config, in addition to the protocol for the standard functions (for example: telegram 1), insert your communications protocol for the fail-safe functions (e.g. PROFIsafe telegram 30).

3. Deactivate the access to the PROFIsafe telegram via the context menu of the right mouse button:
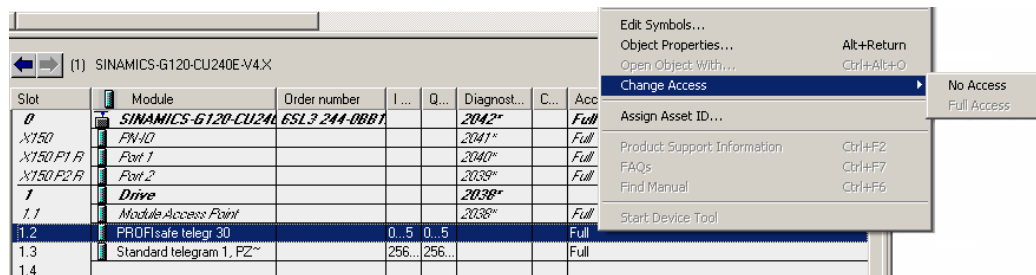
4. You can configure your F-CPU in HW Config, without inserting an inverter.

5. Copy the inverter into the standard control

6. Insert the inverter as "Shared" in the F-CPU.
   This results in the access rights being "reversed".
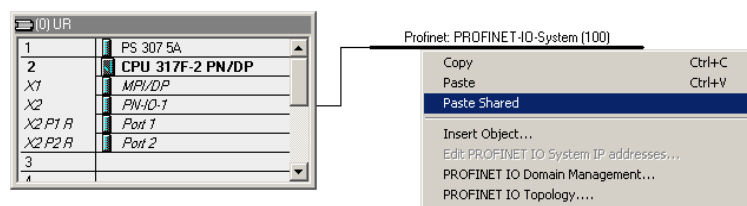
7. Select the F-CPU in HW Config

8. Open the "Object Properties" dialog window.

9. In this window, select the "Protection" tab.

10. Activate the access protection for F-CPU and assign a password.

11. Check the box for "CPU contains safety program" and exit the screen with OK.

12. Save and compile your 🖳 project.

13. Load your project via 🖳 into the fail-safe control.

☑   You have configured the communication via "Shared Device" in the higher-level control system.

4.3   Commissioning tool

We strongly recommend that you commission the safety functions using the STARTER PC tool.

If you use STARTER for commissioning, then you set the functions using the graphic screen forms and you do not have to work with parameters. In this case, you can ignore the parameter tables in the following sections.

Table 4- 3   STARTER commissioning tool (PC software)

Download	Order number
STARTER (http://support.automation.siemens.com/WW/view/en/10804985/130000)	6SL3255-0AA00-2CA0 PC Connection Kit, includes STARTER DVD and USB cable

Commissioning: Online or offline

With STARTER, you can work offline (without a connection to the converter) as well as online. We recommend that you commission the safety functions online.

This manual provides a detailed description of the online commissioning procedure. The section Offline commissioning (Page 133) describes the important points to remember when commissioning the safety functions offline.

Additional information about STARTER is provided in the operating instructions of your converter.

4.4 Resetting the safety function parameters to the factory setting

Procedure

1
2
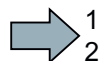
To reset the safety function settings to the factory setting without changing the standard settings, proceed as follows:

1. Go online with STARTER

2. Open the screen form for the safety functions ①.
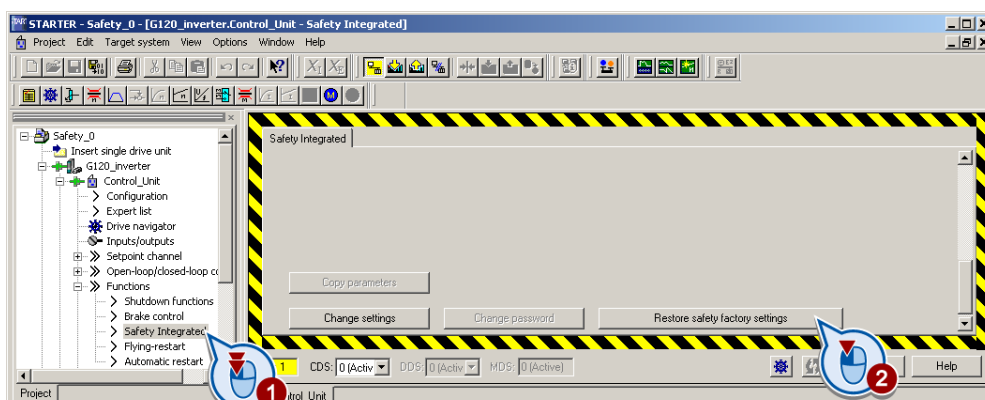
3. Press the button to restore the factory settings ②.

4. Enter the password,for the safety functions.

5. Confirm saving parameters (RAM to ROM).

6. Go offline with STARTER .

7. Switch off the inverter supply voltage.

8. Wait until all of the LED on the inverter go dark. Now switch on the inverter power supply again (power on reset).

You have restored the safety functions in the inverter to the factory settings.

Parameters	Description	
p0010	**Drive, commissioning parameter filter**	
	0	Ready
	95	Safety Integrated commissioning
p0970	**Reset drive parameters**	
	0	Inactive
	5	Starts a safety parameter reset. After the reset, the inverter sets p0970 = 0.
p9761	**Enter a password** (factory setting 0000 hex) Permissible passwords lie in the range 1 … FFFF FFFF.	
p9762	**New password**	
p9763	**Confirm password**	

4.5 Changing settings

Procedure

To start commissioning the safety functions, proceed as follows:

1. Go online with STARTER.

2. In STARTER, select the fail-safe functions.

3. Select "Change settings".

Parameter	Description
p0010 = 95	**Drive commissioning parameter filter** Safety Integrated commissioning
p9761	**Enter a password** (factory setting 0000 hex) Permissible passwords lie in the range 1 … FFFF FFFF.
p9762	**New password**
p9763	**Confirm password**

4. Define what the results of your commissioning should look like:

- If you are only using STO as safety function of the converter, select the basis functions ① with the interface that matches your particular application.
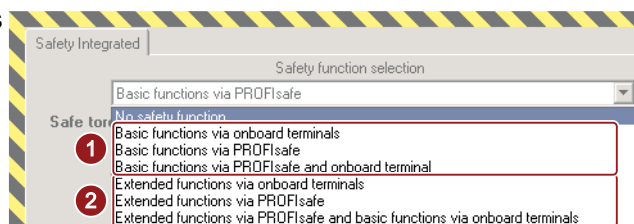
- If, in addition to STO you use other safety functions, then select the extended functions ② with the interface that matches your particular application.

  Additional information on the basic and extended functions are provided on the following pages of this section.

You have completed the following commissioning steps:

- You have started to commission the safety functions.

- You have decided to use either the basic functions or the extended functions.

Parameter	Description	
p9601	**Enable functions integrated in the drive** (factory setting: 0000 bin)	
	0	Safety functions integrated in the drive inhibited
	1	Basic function STO via on-board terminals is enabled
	4	Extended Functions via onboard terminals are enabled
	8	Basic function STO via PROFIsafe is enabled
	9	Basic function STO via PROFIsafe and onboard terminal is enabled
	C hex	Extended functions via PROFIsafe are enabled
	D hex	Extended functions via PROFIsafe and basic function STO via onboard terminal are enabled

Overview of the safety functions

The overview below shows the options that the inverter offers and the result of the commissioning depending on your particular choice.
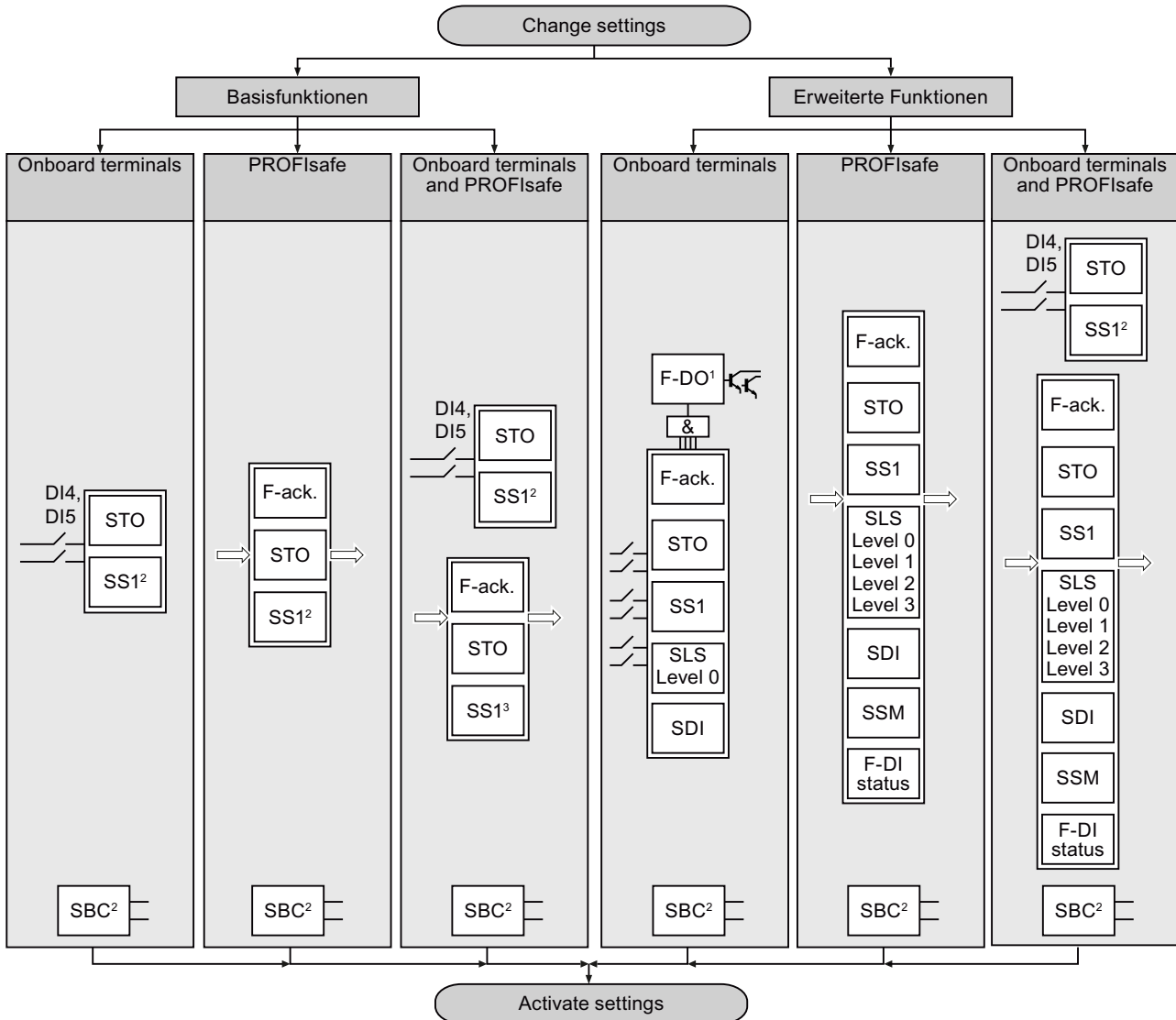
[1] Not all of the Control Units have a fail-safe output, also refer to Section: Overview of the interfaces (Page 36).

[2] The SS1 basic functions and the SBC function are only available with the CU250S-2 Control Unit, see also sections:

* Safe Stop 1 (SS1) (Page 18)
* Safe Brake Control (SBC) (Page 16)

Your selection	Outcome of commissioning	See section ...
Basic functions via onboard terminals	• Select STO via F-DI . • Acknowledge safety function faults after selecting and deselecting STO. Only with CU250S-2: • Select SS1 using F-DI. • Control the motor holding brake using SBC.	Setting basic functions (Page 79).
Basic functions via PROFIsafe	• Select STO via PROFIsafe . • Evaluate the state of STO via PROFIsafe . • Acknowledge safety function faults via PROFIsafe . Only with CU250S-2: • Select SS1 using F-DI. • Control the motor holding brake using SBC.	

Basic functions via PROFIsafe and onboard terminals	• Select STO via F-DI as well as also via PROFIsafe .
	• Evaluate the state of STO via PROFIsafe.
	• Acknowledge safety function faults:
	  – via PROFIsafe
	  – after selecting and deselecting STO
	Only with CU250S-2:
	• Select SS1 using F-DI.
	• Control the motor holding brake using SBC.	

Extended functions via onboard terminals	• Select safety functions via F-DI .
	• Only one monitoring limit of SLS can be used (SLS level 0).
	• Acknowledge safety function faults:
	  – via F-DI
	  – after selecting and deselecting STO
		Setting extended functions (Page 91).

Extended functions via PROFIsafe	• Select safety functions via PROFIsafe . • Evaluate the state of the safety functions via PROFIsafe . • All four monitoring limits of SLS can be used (SLS levels 0 … 3) • Acknowledge safety function faults via PROFIsafe . • Evaluate the state of the fail-safe inputs via PROFIsafe.	

Extended functions via PROFIsafe and basic functions via onboard terminals	• Select safety functions via PROFIsafe .
	• Select STO additionally via F-DI .
	• Evaluate the state of the safety functions via PROFIsafe .
	• All four monitoring limits of SLS can be used (SLS levels 0 … 3)
	• Acknowledge safety function faults:
	  – via F-DI
	  – after selecting and deselecting STO
	• Evaluate the state of the fail-safe inputs via PROFIsafe.	

Converter with basic functions and extended functions

The basic functions and extended functions are not available in all converters.

Converter		Fail-safe inputs (onboard terminals)	PROFIsafe
	SINAMICS G120C USS SINAMICS G120C CAN	Basic functions	No
	SINAMICS G120C DP SINAMICS G120C PN	Basic functions	
	SINAMICS G120 with Control Unit …		
	CU240E-2	Basic functions	No
	CU240E-2 DP CU240E-2 PN	Basic functions	
	CU240E-2 F CU250S-2 CU250S-2 CAN	Basic functions and extended functions	No
	CU240E-2 DP-F CU240E-2 PN-F CU250S-2 DP CU250S-2 PN	Basic functions and extended functions	
	SINAMICS G120D with Control Unit …		
	CU240D-2 DP CU240D-2 PN	Basic functions	
	CU240D-2 DP-F CU240D-2 PN-F CU240D-2 PN-F PP CU250D-2 DP-F CU250D-2 PN-F CU240D-2 PN-F PP	Basic functions and extended functions	

4.6   Setting basic functions

STARTER screen form for the basic functions

Depending on the interface that has been selected, one of the following versions is displayed on the STARTER screen form of the basic functions:

- ① the onboard terminals

- ② the PROFIsafe interface

- ① + ② both onboard terminals as well as PROFIsafe interface

- ③ + ④ if you have a converter equipped with the CU250S-2 Control Unit, the delay time for SS1 and the enable for SBC are visible.
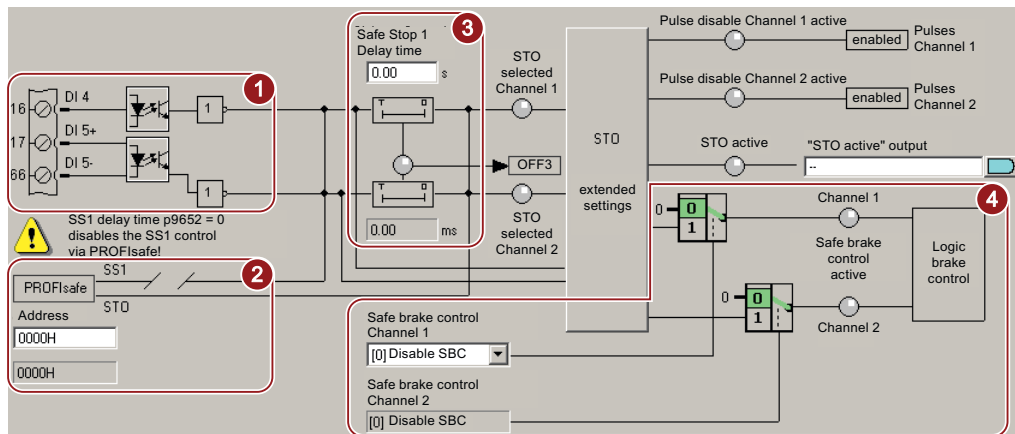
4.6.1   Interconnecting the "STO active" signal

If you require the feedback signal "STO active" of the inverter in your higher-level control system, then you must appropriately interconnect the signal.

Procedure

To interconnect the "STO active" checkback signal, proceed as follows:

1. Select the button for the feedback signal.
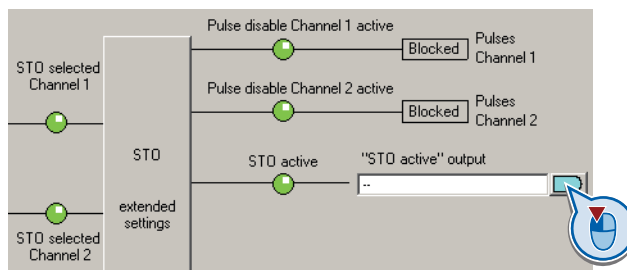
2. In the following selection menu, select the appropriate setting for your particular application.

☐ You have interconnected the "STO active" checkback signal. The inverter signals "STO active" to the higher-level control after STO has been selected.

Parameter	Description
r9773.01	**1 signal**: STO is active in the drive

4.6.2 Configuring PROFIsafe

Setting the address

Procedure

To set the PROFIsafe address, proceed as follows:

1. In STARTER, select the input field for the PROFIsafe address
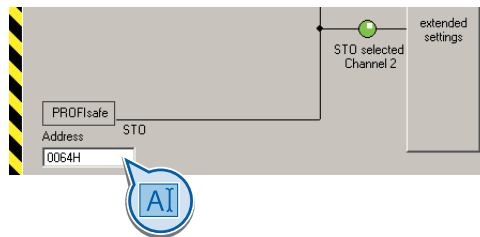
2. Enter the same address as hexadecimal value, which you defined in the hardware configuration (F_Dest_Add).

See also Section: STEP 7 example: Configuring PROFIsafe communication (telegram 30) via PROFIBUS (Page 66).

☐ You have configured the communication between the inverter and the higher-level control (F-CPU) via PROFIsafe telegram 30.

Parameter	Description
p9610	**PROFIsafe address** (factory setting: 0000 hex)

Enabling Shared Device

If you control the inverter safety functions via PROFINET and "Shared Device", you must enable this function in the inverter.

See also Section: STEP 7 example: Configuring Shared Device communication via PROFINET (Page 70).

Procedure

To configure communication via "Shared Device" in the inverter, proceed as follows:

1. In STARTER change to the expert list.

2. In STARTER, set p8929 = 2.

You have configured the communication via "Shared Device" in the inverter.

Starting communication via PROFIsafe

When you connect the converter to the higher-level control system (F-CPU) via the fieldbus for the first time, the central control system sends the PROFIsafe configuration to the converter. After the configuration data have been received in the converter, PROFIsafecommunication starts.

The converter only monitors the communication to the F-CPU after the configuration data have been received from the central control system.

4.6.3   Setting the filter for fail-safe inputs

Procedure

To set the input filter and monitoring for simultaneous operation for a fail-safe input, proceed as follows:

1. Select the advanced settings for STO.
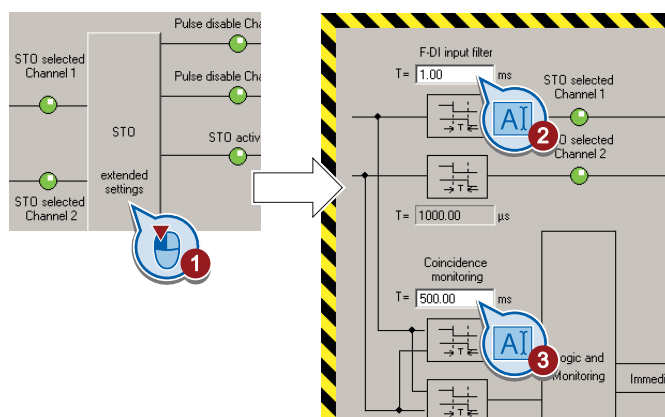
2. Set the debounce time for the F-DI input filter.

3. Set the discrepancy for the simultaneity monitoring.

4. Close the screen form.

You have set the input filter and the simultaneity monitoring of the fail-safe input.

Description of the signal filter

The following are available for the signal processing of the fail-safe inputs:

- A tolerance for the simultaneous monitoring.
- A filter to suppress short signals, e.g. test pulses.

A tolerance for the simultaneous monitoring

The inverter checks whether the signals at both inputs always have the same signal status (high or low).

With electromechanical sensors (e.g. emergency stop buttons or door switches), the two sensor contacts never switch at exactly the same time and are therefore temporarily inconsistent (discrepancy). A long-term discrepancy indicates a fault in the wiring of a fail-safe input, e.g. a wire break.

When appropriately set, the inverter tolerates brief discrepancies.

The tolerance time does not extend the inverter response time. The inverter selects its safety function as soon as one of the two F-DI signals changes its state from high to low.

Figure 4-1   Tolerance regarding discrepancy

Filter to suppress short signals

The inverter normally responds immediately to signal changes at its fail-safe inputs. This is not required in the following cases:

1. When you interconnect a fail-safe input of the inverter with an electromechanical sensor, contact bounce may result in signal changes occurring, to which the inverter responds.

2. Several control modules test their fail-safe outputs using bit pattern tests (on/off tests), in order to identify faults due to either short-circuit or cross-circuit faults. When you interconnect a fail-safe input of the inverter with a fail-safe output of a control module, the inverter responds to these test signals.
   A signal change during a bit pattern test usually lasts:

   – On test: 1 ms

   – Off test: 4 ms

If the fail-safe input signals too many signal changes within a certain time, then the inverter responds with a fault.

Figure 4-2   inverter response to a bit pattern test

An adjustable signal filter in the inverter suppresses temporary signal changes using bit pattern test or contact bounce.

The filter increases the inverter response time. The inverter only selects its safety function after the debounce time has elapsed.
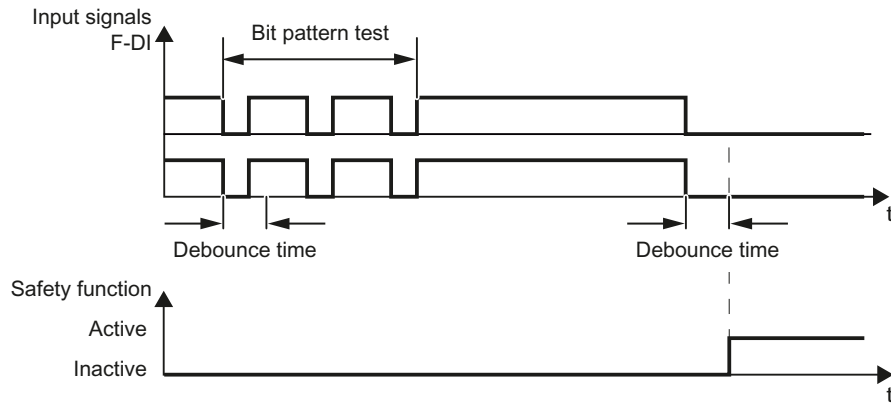
Figure 4-3   Filter for suppressing temporary signal changes

Parameter	Description
p9650	**F-DI changeover tolerance time** (factory setting: 500 ms) Tolerance time to change over the fail-safe digital input for the basic functions.
p9651	**STO debounce time** (factory setting: 1 ms) Debounce time of the fail-safe digital input for the basic functions.

Debounce times for standard and safety functions

The debounce time p0724 for "standard" digital inputs has no influence on the fail-safe input signals. Conversely, the same applies: The F-DI debounce time does not affect the signals of the "standard" inputs.

If you use an input as a standard input, set the debounce time using parameter p0724 .

If you use an input as a fail-safe input, set the debounce time as described above.

4.6.4 Setting forced dormant error detection

Procedure

To set forced dormant error detection of the basic functions, proceed as follows:

1. Select the advanced settings for STO.
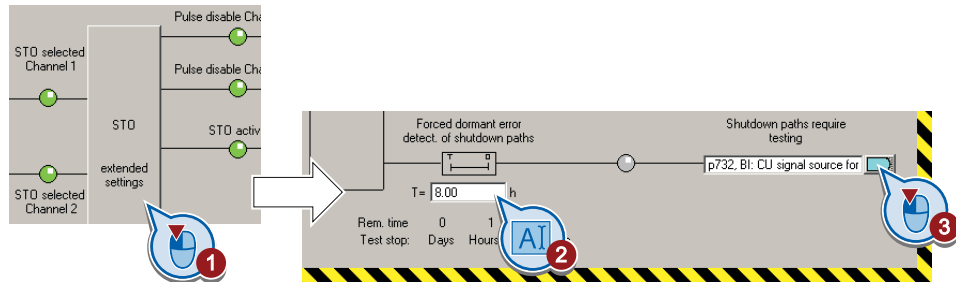
2. Set the monitoring time to a value to match your application.

3. Using this signal, the inverter signals that a forced dormant error detection is required.

   Interconnect this signal - for example - with a digital output of your choice.

You have set the forced dormant error detection for the basic functions.

Description of the forced dormant error detection

To meet the requirements of the standards ISO 13849-1 and IEC 61508 in terms of timely fault detection, the inverter must test its safety-related circuits regularly - at least once a year - to ensure that they are functioning correctly.

Forced dormant error detection of the basic functions

The forced dormant error detection of the basic functions is the regular self-test of the inverter that causes the inverter to check its circuits to switch-off the torque. If you use the Safe Brake Relay, for a forced dormant error detection, the inverter also checks the circuits of this option module.

The inverter executes a forced dormant error detection under the following circumstances:

- every time the supply voltage is connected.

- every time after the STOfunction has been selected.

The inverter monitors the regular forced dormant error detection.
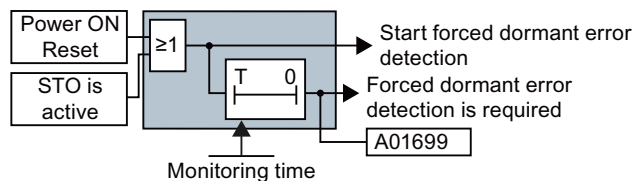
Figure 4-4   Triggering and monitoring the forced dormant error detection

Parameter	Description
p9659	**Forced dormant error detection timer** (Factory setting: 8 h) Monitoring time for the forced dormant error detection
r9660	**Forced dormant error detection remaining time** Displays the remaining time until the forced dormant error detection and testing the safety switch-off signal paths.
r9773.31	**1 signal: Forced dormant error detection is required** Signals for the higher-level control system.

Time of the forced dormant error detection

In the case of warning A01699 , you must initiate a forced dormant error detection at the next opportunity. These alarms do not affect the operation of your machine.

● Switch off the motor.

● Select function STO or switch off the inverter supply voltage temporarily and on again.

Examples for the times when forced dormant error detection is performed:

● When the drives are at a standstill after the system has been switched on.

● When the protective door is opened.

● At defined intervals (e.g. every 8 hours).

● In automatic mode (time and event dependent).

4.6.5   Setting the delay time for SS1

Procedure

1
2

Set the delay time for SS1. The delay time must be longer than the OFF3 ramp-down time.
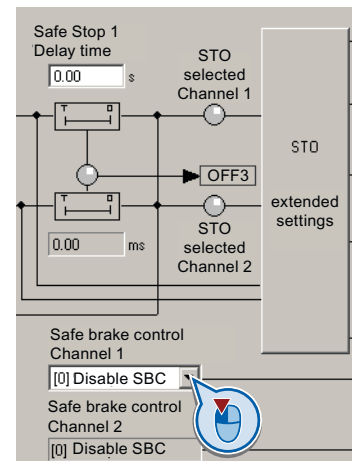
You have set the SS1 function.

Parameter	Description
p9652	**Safe Stop 1 delay time** Sets the delay time of the pulse suppression for the "Safe Stop 1" (SS1) function to brake with the OFF3 ramp-down time.
p1135	OFF3 ramp-down time

Description: the SS1 function without monitoring the speed
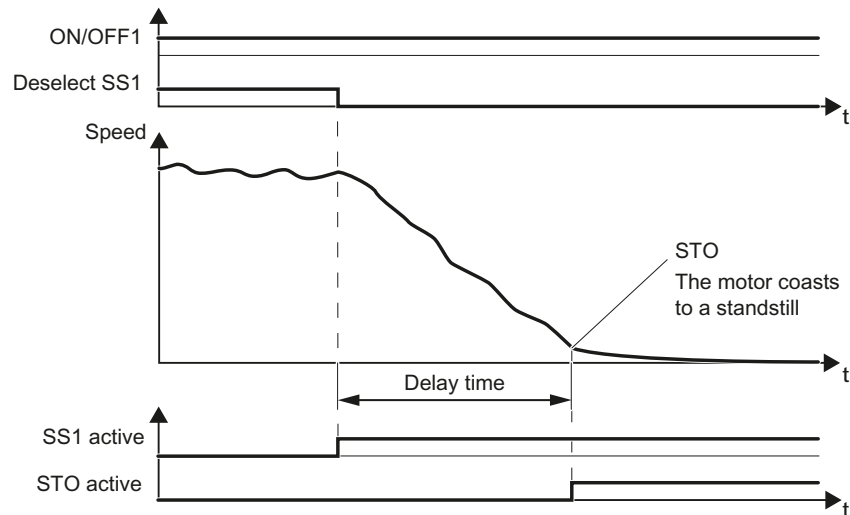
Figure 4-5   SS1 without monitoring the speed

When SS1 is selected, the inverter brakes the motor with the OFF3 ramp-down time.

After the delay time, independent of the actual speed, the inverter switches off the motor torque using the STO function.

4.6.6   Enabling SBC

Procedure

1
2

Enable the SBC function.
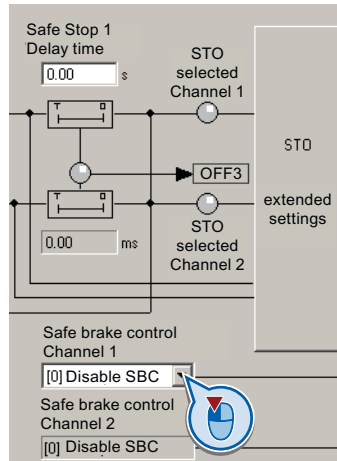
You have enabled the SBC function.

Parameter	Description
p9602	**Enable safe brake control** 0: SBC is locked 1: SBC is enabled

4.6.7   Final steps

Activate settings

Procedure

1
2

To activate the settings for the safety functions, proceed as follows:

1. Press the "Copy parameters" button, to create a redundant image of your inverter settings.

2. Press the "Activate settings" button.

3. If the password is the factory default, you are prompted to change the password.
   If you try to set a password that is not permissible, the old password will not be changed.

4. Confirm the prompt for saving your settings (copy RAM to ROM).

5. Switch off the inverter supply voltage.

6. Wait until all LEDs on the inverter go dark (no voltage condition).

7. Switch on the inverter supply voltage again.

Your settings are now active.

Parameter	Description
p9700 = 57 hex	**SI copy function** (factory setting: 0) Start copy function SI parameter.
p9701 = AC hex	**Confirm data change** (factory setting: 0)Confirm data change overall.
p0010 = 0	**Drive commissioning parameter filter** 0: Ready
p9761	**Enter a password** (factory setting 0000 hex) Permissible passwords lie in the range 1 … FFFF FFFF.
p9762	**New password**
p9763	**Confirm password**

Checking the assignment of the digital inputs

If you control the safety functions in the inverter using digital inputs, then you must check as to whether these digital inputs have been assigned other functions.

Figure 4-6   Example: Assignment of digital inputs DI 4 and DI 5 with STO

Both, the assignment of digital inputs with the selection of a safety function or with a "standard" function can lead to an unexpected behavior of the drive.

Procedure

1
2

To check the assignment of the digital inputs, proceed as follows:

1. In STARTER, select the screen form for the terminals of the digital inputs.

2. Remove all signal interconnections of the digital inputs that you wish to use as fail-safe input F-DI:
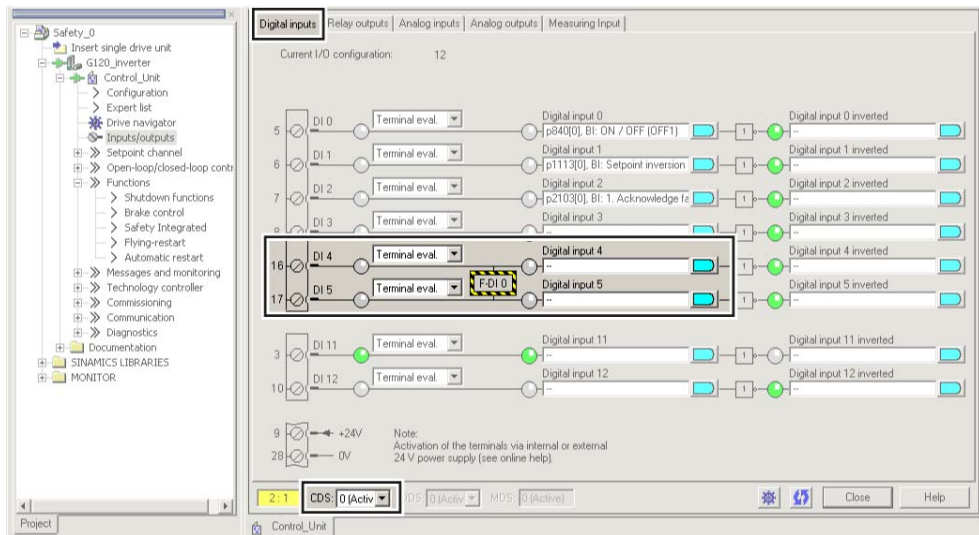
Figure 4-7   Remove pre-assignment of digital inputs DI 4 and DI 5

3. When you use the data set changeover CDS, you must delete the multiple assignment of the digital inputs for all CDS.

You have ensured that the fail-safe inputs of the safety functions do not control other functions in the inverter.

4.7 Setting extended functions

Screen form for setting the extended functions

The following STARTER screen form is the starting point for all subsequent settings:

Overview of the procedure

To set all extended functions, proceed as follows:

1. Define the basic settings for all of the safety functions. See Section: Basic settings (Page 92).

2. If necessary, interconnect the fail-safe inputs and outputs. See sections:

   – Setting fail-safe inputs (Page 98)

   – Setting a fail-safe output (Page 105).

3. If necessary, configure the communication via PROFIsafe. See section: Configuring PROFIsafe in the converter (Page 110).

4. Adapt the safety functions that you are using to suit your application. See Sections:

   – Setting SS1 (Page 113)

   – Setting SLS (Page 119)

   – Setting SSM (Page 123)

   – Setting SDI (Page 127)

5. Complete commissioning. See also Section: Final steps (Page 131).

You have set the extended functions.

4.7.1 Basic settings

4.7.1.1 Enabling safety functions

Enabling safety functions

Procedure

To enable the safety functions, proceed as follows:

7. Select the STARTER screen form for the extended functions.
8. Enable the safety functions.
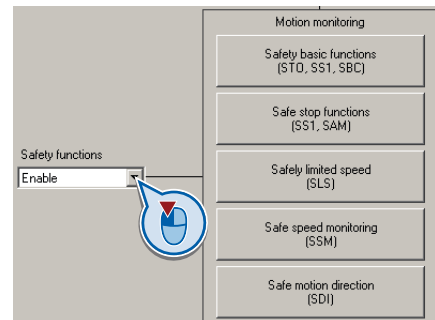
You have enabled the safety functions in the inverter.

4.7.1.2 Setting forced dormant error detection

Procedure

To set the forced dormant error detection of the extended functions, proceed as follows:

1. Press the "Configuration" button.
2. Set the following:
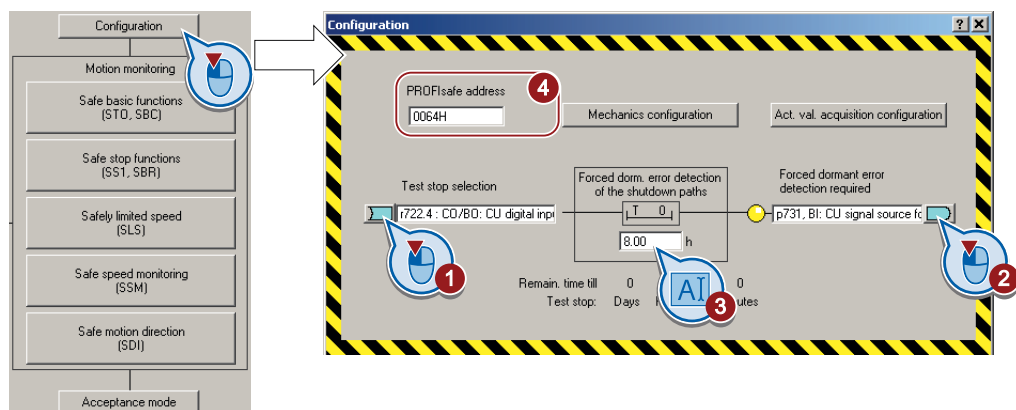
– ① This signal starts the forced dormant error detection and sets the remaining monitoring time to the value ③. Interconnect this signal, for example, with a digital input or a bit in the fieldbus control word.

– ② You must conduct a forced dormant error detection for this signal. Interconnect this signal, for example with a digital output of your choice or a status bit in the fieldbus.

– ③ Monitoring time for forced dormant error detection.

3. Close the screen form.

4. Press the button for the "STO" function:
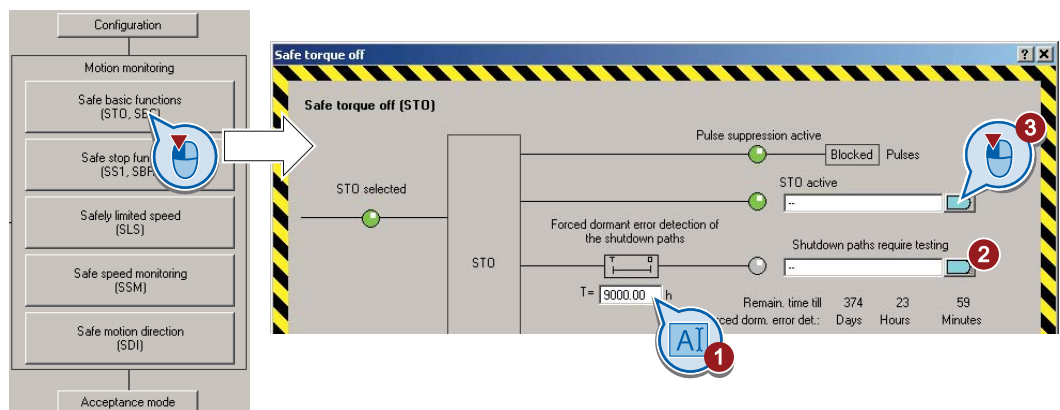
5. Set the following:

– ① monitoring time = maximum value (9000 hours). This means that you deactivate the forced dormant error detection monitoring for the basic functions.

This monitoring is not required when using the extended functions, as the test of the extended functions also includes the test of the basic functions.

– ② No setting is required.

– ③ If necessary, interconnect the status of the function STO with a digital output of your choice, for example.

6. Close the screen form.

You have set the forced dormant error detection of the extended functions.

Description of the forced dormant error detection

To meet the requirements of the standards ISO 13849-1 and IEC 61508 in terms of timely fault detection, the inverter must test its safety-related circuits regularly - at least once a year - to ensure that they are functioning correctly.

Forced dormant error detection of the extended functions

The forced dormant error detection of the extended functions involves the regular self-test of the inverter. Here, the inverter checks its circuits to monitor the speed and to shut down the torque.

The inverter monitors the regular forced dormant error detection using a time block.

You must start the forced dormant error detection with a signal of your choice.
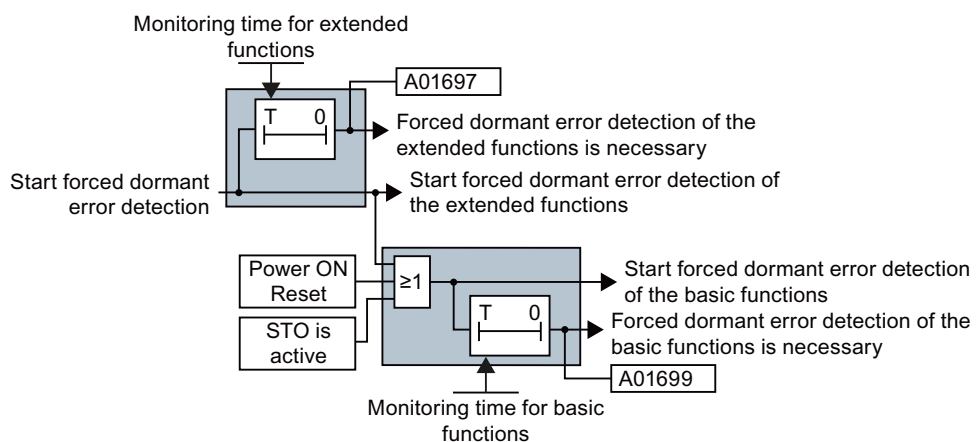
Figure 4-8   Triggering and monitoring the forced dormant error detection

For the forced dormant error detection of the extended functions, the inverter switches the motor into a no-torque condition.

Parameter	Description
p9559	**Forced dormant error detection timer** (Factory setting: 8 h) Monitoring time for the forced dormant error detection of the extended functions.
p9659	**Forced dormant error detection timer** (Factory setting: 8 h) Monitoring time for the forced dormant error detection of the basic functions.
r9660	**Forced dormant error detection remaining time** Displays the remaining time up to performing the forced dormant error detection of the basic functions.
p9705	**Forced dormant error detection signal source** (Factory setting: 0) Signal source for the forced dormant error detection of the basic functions and the extended functions.
p9723.0	**1 signal: Forced dormant error detection of the extended functions is necessary** Signal for the higher-level control.
p9765	**Forced dormant error detection remaining time** Displays the remaining time up to performing the forced dormant error detection of the extended functions.
r9773.31	**1 signal: Forced dormant error detection of the basic functions is required**

Time of the forced dormant error detection

If the inverter outputs alarm A01699 or A01697 , you must initiate forced dormant error detection at the next opportunity. These alarms do not influence the operation of your machine.

● Switch on the motor. If you wish to carry out the forced dormant error detection at standstill, the speed setpoint must be = 0

● Start the forced dormant error detection using a signal of your choice, for example a digital input.

● If you start the forced dormant error detection with STO active, then the inverter responds with a fault.

Examples for the times when forced dormant error detection is performed

● When the system is switched on.

● At defined intervals (e.g. every 8 hours).

● In automatic mode (time and event dependent).

4.7.1.3 Setting the gear ratio and actual value tolerance

Procedure

To set the gear ratio and the actual value tolerance, proceed as follows:

1. Press the "Configuration" button.

2. Press the "Mechanical configuration" button.

3. Set the following:

   – ① **Actual value tolerance**:
   In most cases, you do not have to change this value. If, in operation, the inverter issues message C01711 or C30711, increase this value step-by-step until the message to longer occurs.
   Note: If you increase this value, the speed monitoring of the inverter becomes less sensitive to limit violations.

   – ②, ③ **Gear ratio**:
   Read off the pole pair number ④ of the motor, and set the data of your motor according to the following table.

	Number of load revolutions	Number of motor revolutions
Without gear	Value ② = 1	Value ③ = pole pair number ④
Gearbox with speed ratio Load/motor = L/M	Value ② = L	Value ③ = M × pole pair number ④

Example: The drive has a gearbox with a load/motor speed ratio = 1/3 ⇒

⇒ value ② = 1, value ③ = 3 × pole pair number ④
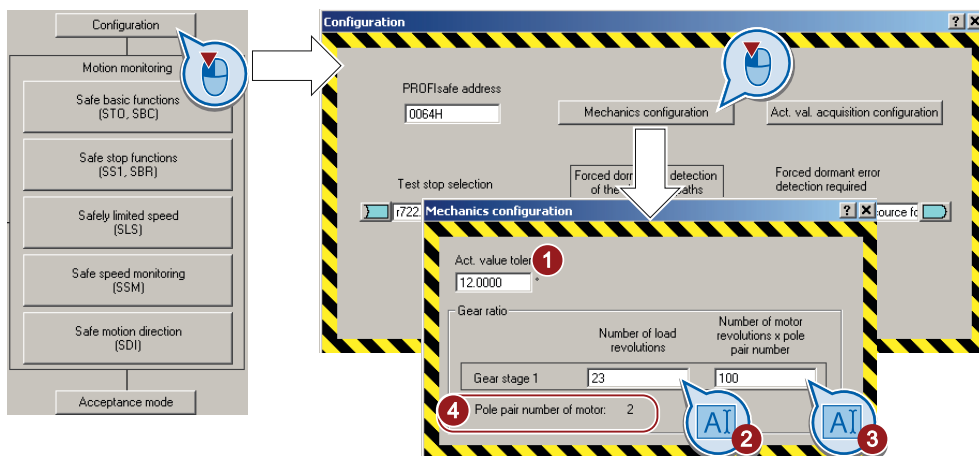
4. Close the screen forms.

You have set the gearbox ratio and actual value tolerance.

4.7.1.4 Setting encoderless actual value sensing

Procedure
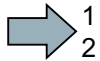
To set the encoderless actual value tolerance, proceed as follows:

1. Press the "Configuration" button.

2. Press the "Configuration actual value sensing" button.

3. Set the following:

   – ① **Delay time actual value sensing**:
   In most cases, you do not have to change this value. If you switch on the motor with the safety functions active (SLS, SDI or SSM) and the inverter responds when switching on with a safety fault, increase this value in the range 50 % … 100 % of the motor excitation build-up time (p0346).

   – ② **Minimum current actual value sensing**:
   In most cases, you do not have to change this setting. When the motor draws a low current, and the inverter responds with a fault, then reduce this value in steps of 1 % until the fault no longer occurs.

   – ③ **Voltage tolerance acceleration:**
   In most cases, you do not have to change this parameter. During acceleration with very short ramp-up and ramp-down times, if the inverter responds with a safety function fault, increase this value step-by-step by approx. 10%.

   – ④ **Fault tolerance**:
   In most cases, you do not have to change this parameter. This parameter can suppress sporadic faults of the safety functions. The parameter defines how often the inverter tolerates its internal plausibility monitoring per second.
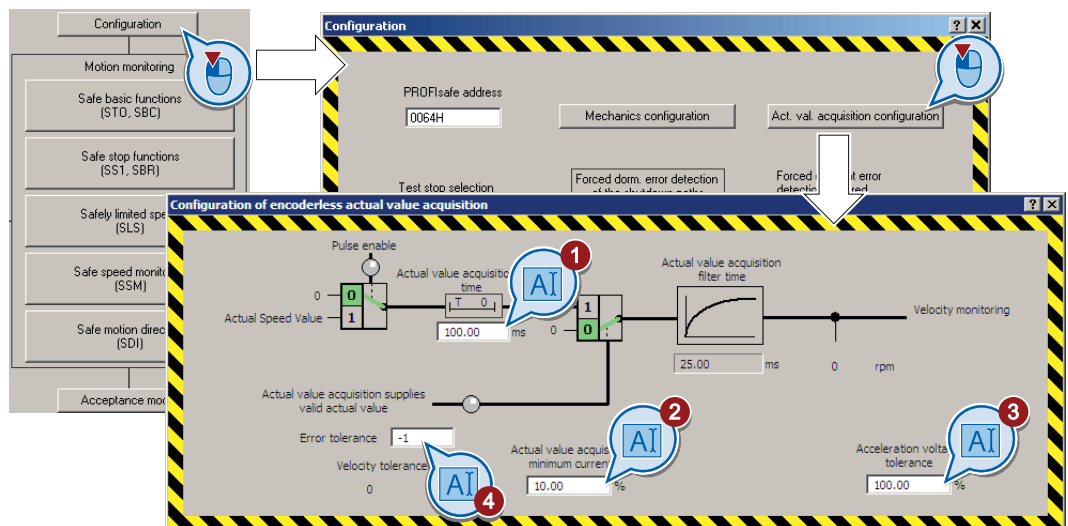
4. Close the screen forms.

You have set the encoderless actual value sensing.

4.7.2 Setting fail-safe inputs

Precondition

You have selected the extended functions via onboard terminals.

Procedure

To interconnect the fail-safe inputs with safety functions, proceed as follows:

1. Press the "Safety inputs/outputs" button.

2. Click the "Drive" button.

3. Interconnect the fail-safe inputs with the safety functions:

    – ③ If you are not using a safety function, set the associated "Select F-DI" = "[255] Statically inactive".

    – ④ interconnect the fail-safe inputs with the corresponding safety functions.

    – ⑤ if a safety function should always be active, set the associated "Select F-DI" = "[0] Statically active".
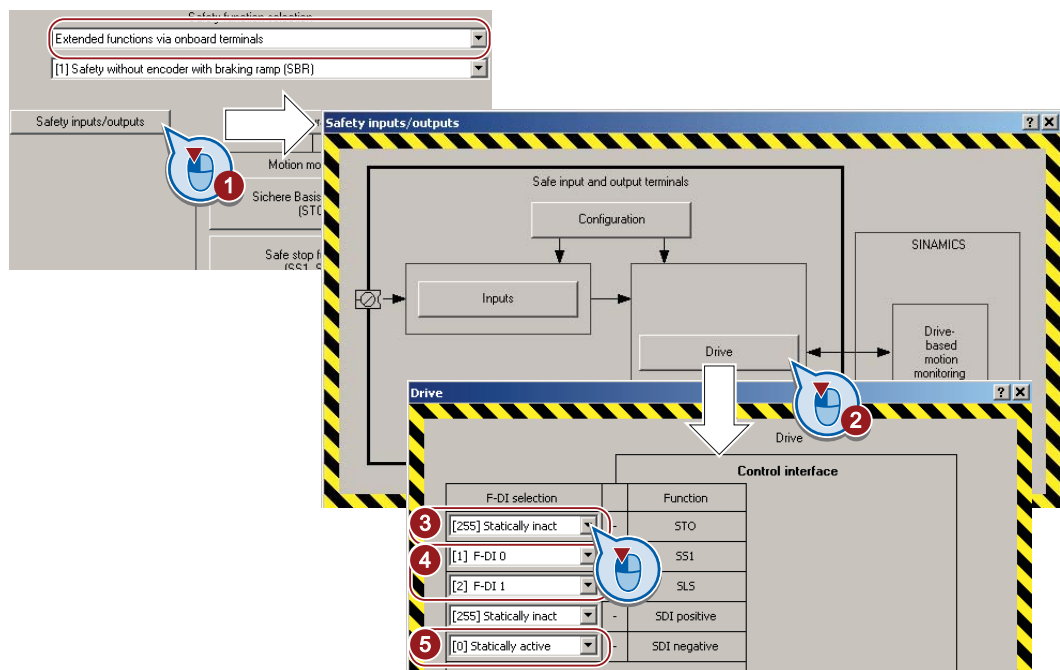
4. Close the screen forms.

You have assigned specific safety functions to the fail-safe inputs.

4.7.2.1   Setting the filter for fail-safe inputs

Control via onboard terminals

Precondition

You have selected the extended functions via onboard terminals.

Procedure

To set the filters for the fail-safe inputs, proceed as follows:
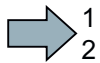
1. Press the "Safety inputs/outputs" button.

2. Press the "Configuration" button.

3. Set the following:

   – ③ Discrepancy time of the fail-safe digital inputs.

   – ④ Input filter of the fail-safe digital inputs.

4. Close the screen forms.

You have set the filter for the fail-safe inputs.

Control via PROFIsafe and onboard terminals

Precondition

You have selected the extended functions via PROFIsafe and onboard terminals.

Procedure

1
2
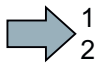
To set the filters for the fail-safe inputs, proceed as follows:

1. Press the "Safety basic functions" button.

2. In the following two screen forms, press the "STO" button.

3. Set the following:

   – ③ Discrepancy time (simultaneity monitoring) of the fail-safe input.

   – ④ Input filter of the fail-safe input.
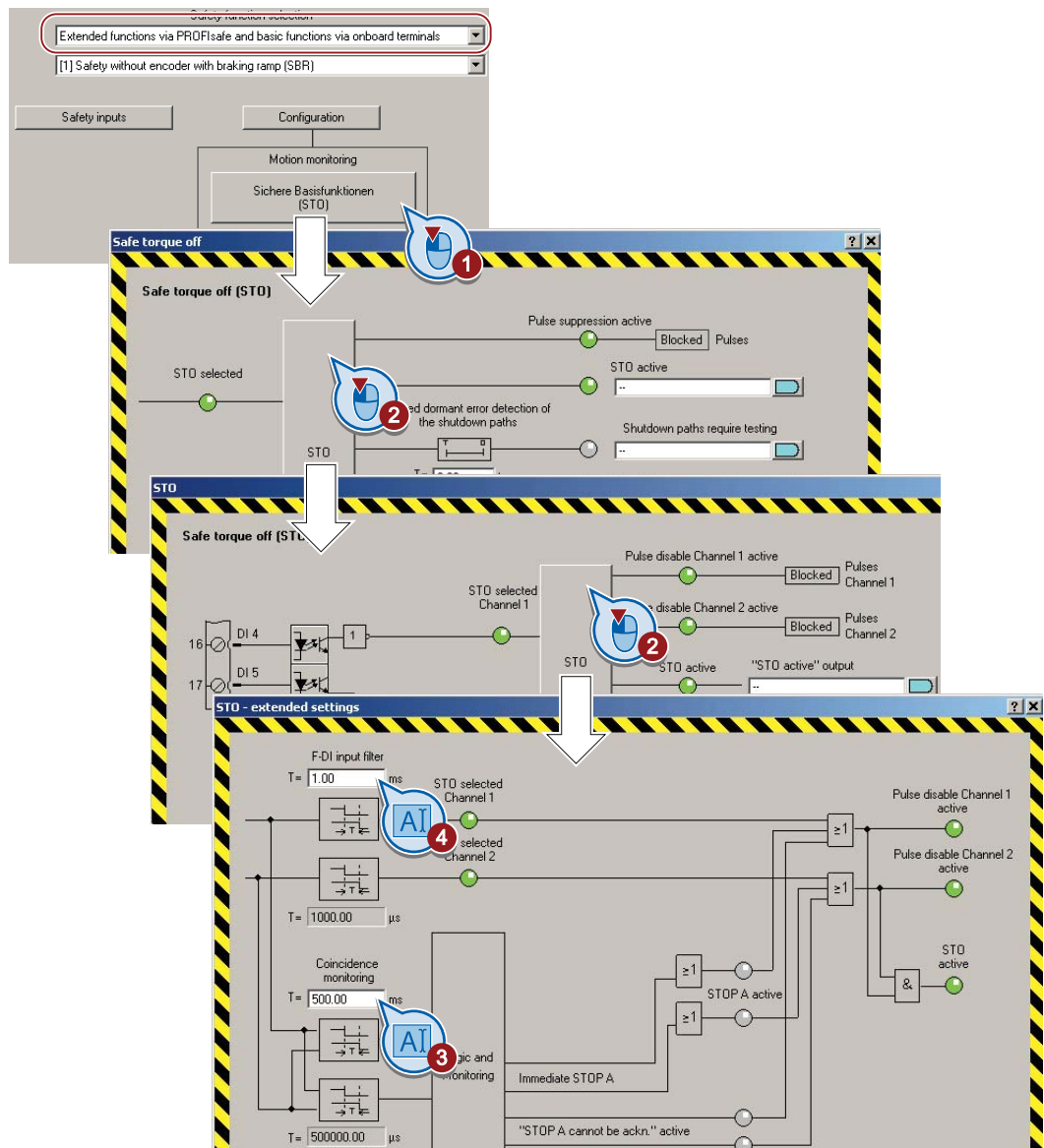
4. Close the screen forms.

You have set the filter for the fail-safe inputs.

Description of the signal filter

The following are available for the signal processing of the fail-safe inputs:

● A tolerance for the simultaneous monitoring.

● A filter to suppress short signals, e.g. test pulses.

A tolerance for the simultaneous monitoring

The inverter checks whether the signals at both inputs always have the same signal status (high or low).

With electromechanical sensors (e.g. emergency stop buttons or door switches), the two sensor contacts never switch at exactly the same time and are therefore temporarily inconsistent (discrepancy). A long-term discrepancy indicates a fault in the wiring of a fail-safe input, e.g. a wire break.

When appropriately set, the inverter tolerates brief discrepancies.

The tolerance time does not extend the inverter response time. The inverter selects its safety function as soon as one of the two F-DI signals changes its state from high to low.

Figure 4-9   Tolerance regarding discrepancy

Filter to suppress short signals

The inverter normally responds immediately to signal changes at its fail-safe inputs. This is not required in the following cases:

1. When you interconnect a fail-safe input of the inverter with an electromechanical sensor, contact bounce may result in signal changes occurring, to which the inverter responds.

2. Several control modules test their fail-safe outputs using bit pattern tests (on/off tests), in order to identify faults due to either short-circuit or cross-circuit faults. When you interconnect a fail-safe input of the inverter with a fail-safe output of a control module, the inverter responds to these test signals.
   A signal change during a bit pattern test usually lasts:

   – On test: 1 ms

   – Off test: 4 ms

If the fail-safe input signals too many signal changes within a certain time, then the inverter responds with a fault.

Figure 4-10   inverter response to a bit pattern test

An adjustable signal filter in the inverter suppresses temporary signal changes using bit pattern test or contact bounce.

The filter increases the inverter response time. The inverter only selects its safety function after the debounce time has elapsed.
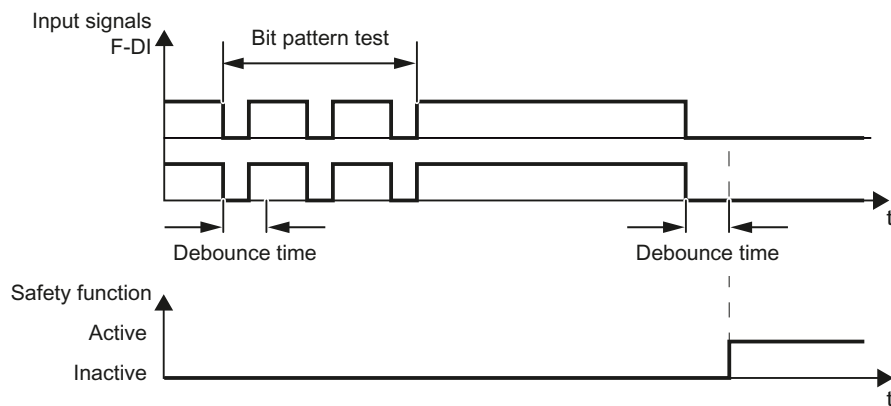
Figure 4-11   Filter for suppressing temporary signal changes

Parameter	Description
p9650	**F-DI changeover tolerance time** (factory setting: 500 ms) Tolerance time to change over the fail-safe digital input for the basic functions.
p9651	**STO debounce time** (factory setting: 1 ms) Debounce time of the fail-safe digital input for the basic functions.
p10002	**Discrepancy monitoring time** (factory setting: 500 ms) Tolerance time to change over the fail-safe digital inputs for the extended functions.
p10017	**Digital inputs debounce time** (factory setting: 1 ms) Debounce time of the fail-safe digital inputs for the extended functions.

Debounce times for standard and safety functions

The debounce time p0724 for "standard" digital inputs has no influence on the fail-safe input signals. Conversely, the same applies: The F-DI debounce time does not affect the signals of the "standard" inputs.

If you use an input as a standard input, set the debounce time using parameter p0724 .

If you use an input as a fail-safe input, set the debounce time as described above.

4.7.2.2 Interconnecting the signal for fail-safe acknowledgment

Precondition

You have selected the extended functions via onboard terminals.

Procedure

To assign the fail-safe acknowledgement signal to a fail-safe input, proceed as follows:

1. Press the "Safety inputs/outputs" button.

2. Press the "Configuration" button.

3. Select a free fail-safe input for fail-safe acknowledgment.

   If there are no free fail-safe inputs available, you have to acknowledge the safety function faults using a different method.
   Also see section: Fail-safe acknowledgment (Page 210).
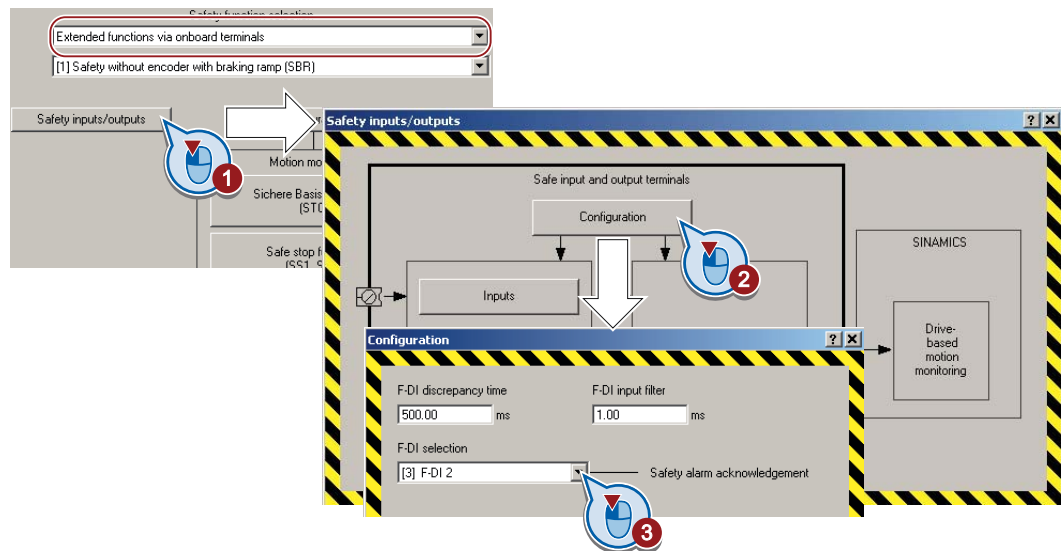
You have interconnected fail-safe acknowledge signal with a fail-safe input.

4.7.3 Setting a fail-safe output

4.7.3.1 Output signal and setting the test mode

Precondition
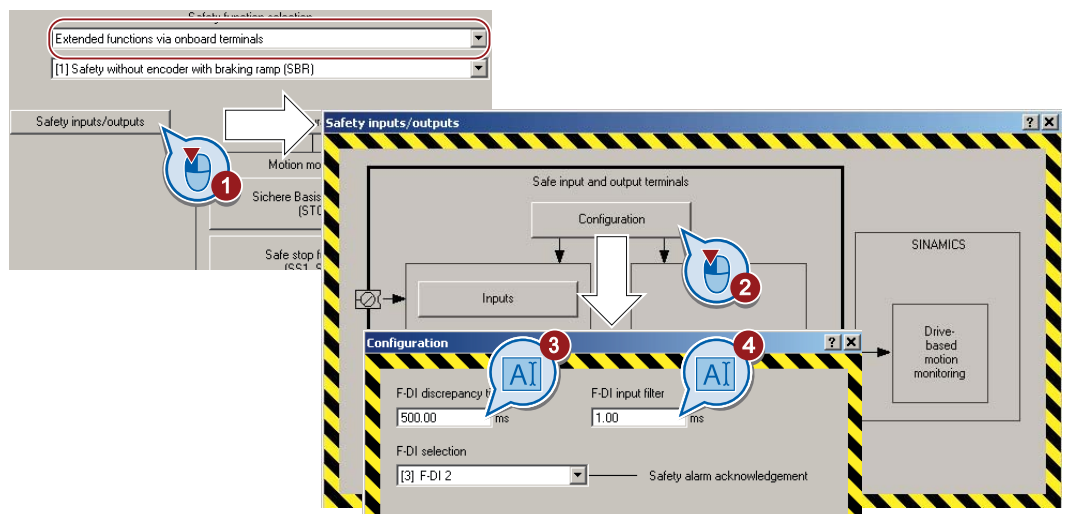
You have selected the extended functions via onboard terminals.

Procedure

To set the fail-safe output, proceed as follows:

1. Press the "Safety inputs/outputs" button.

2. Press the "Output" button.
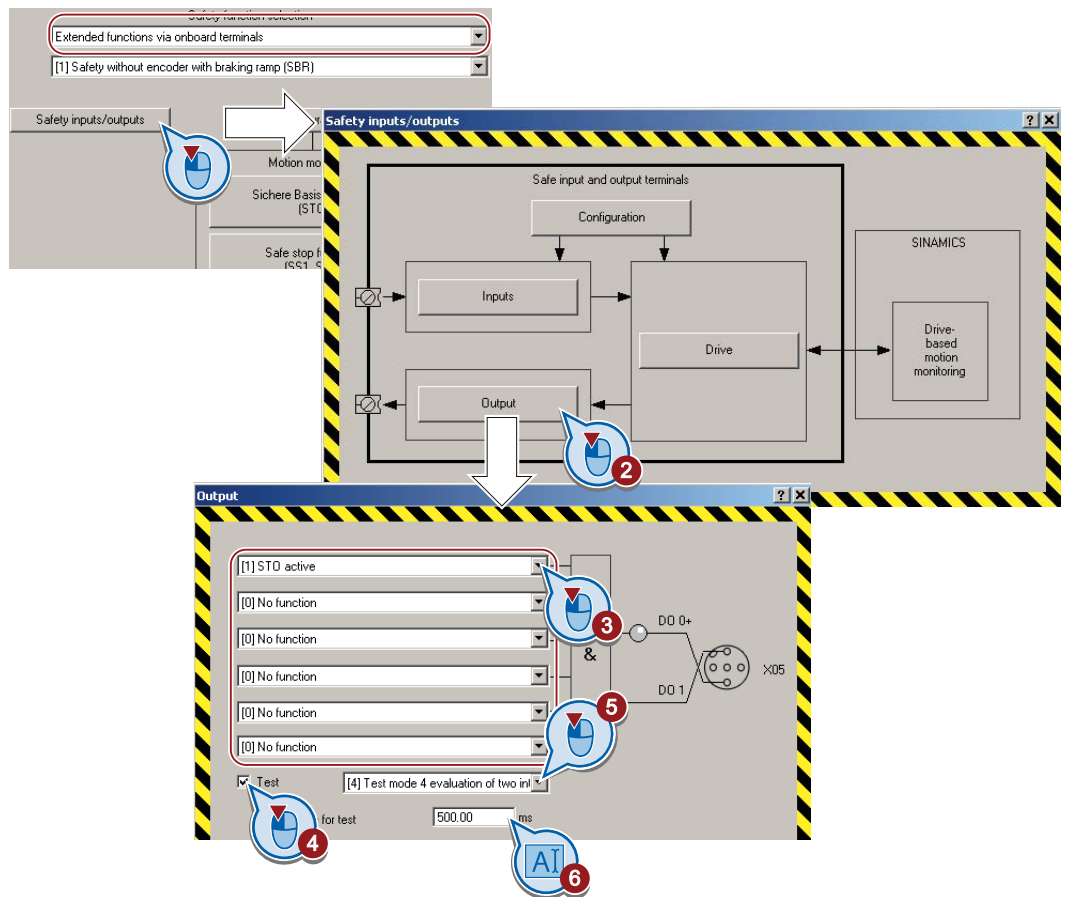
3. Interconnect the status signals of your choice with the fail-safe output.

   The following signals are available:

   – STO active

   – SS1 active

   – SLS active

   – SSM Checkback signal active

   – Safe state

   – Internal event

   – SDI positive active

   – SDI negative active

   The inverter logically combines the status signals according to the following rules:

   – The inverter ignored inputs without interconnection.

   – If none of the inputs is interconnected, then the output signal = 0.

   The inverter forms the "safe state" signal as follows:
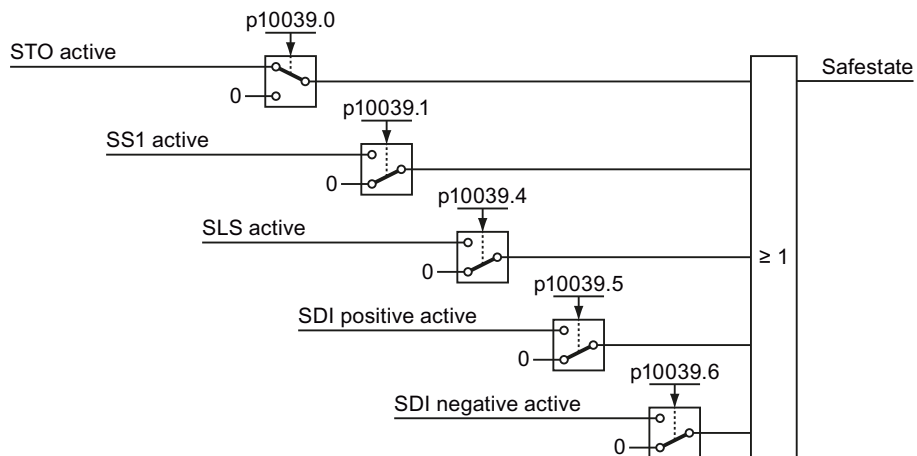
Figure 4-12   The safe state signal in the factory setting

   If you wish to change the "safe state" signal, you must set the parameters in STARTER via the expert list.

4. Activate the test for the fail-safe output.

5. Select the test mode that is compatible with your application.

6. Adjust the wait time.

7. Close the screen forms.

You have defined which signal the inverter transfers via its fail-safe output, and how the inverter tests its fail-safe output.

Description: Test mode of the fail-safe output

To meet the requirements of the standards ISO 13849-1 and IEC 61508 in terms of timely fault detection, the converter must test its fail-safe output regularly - at least once a year - for correct functioning.

Depending on the interconnection of the fail-safe output, in the converter you must set one of the three test modes 2, 3 or 4. For test modes 2 and 3 you must adapt the wait time to your particular application.
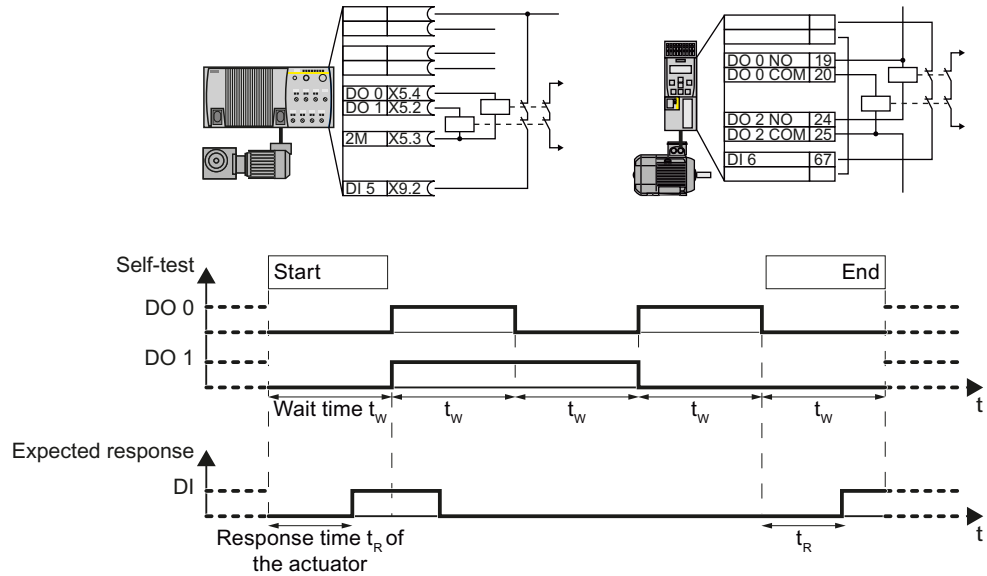
Figure 4-13   Expected response at the digital input for test mode 2
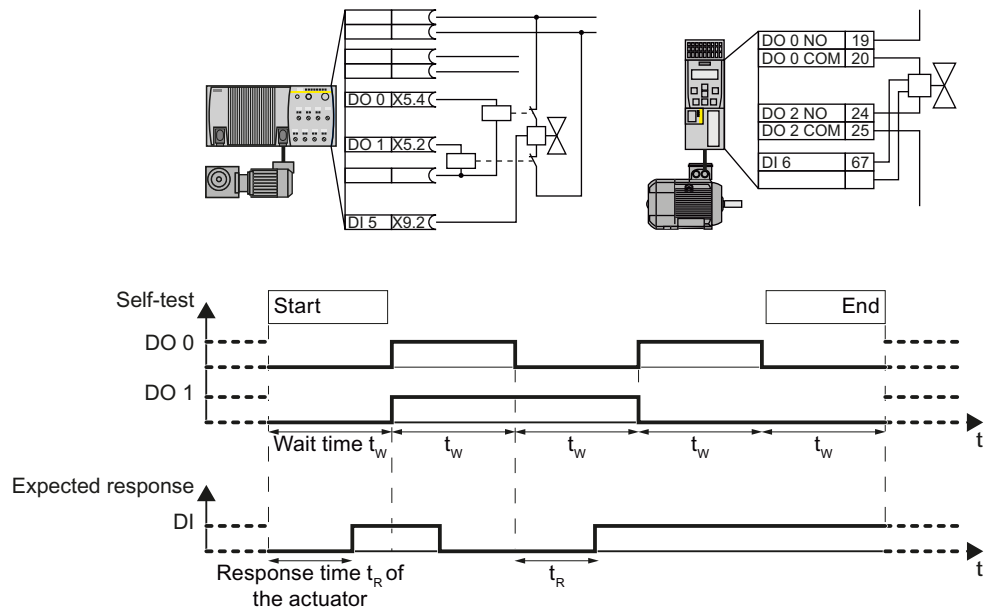
Figure 4-14   Expected response at the digital input for test mode 3

For test mode 4, for actuators without feedback signal, the converter evaluates internal signals.
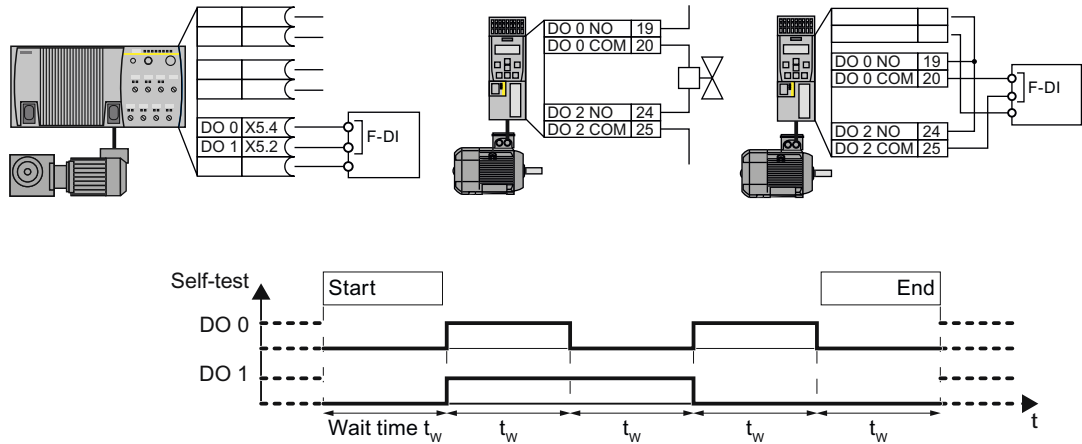
Figure 4-15   Test mode 4

Parameter	Description
p10039	**Safe State signal selection** (factory setting: 0000 0001 bin) Setting the signals for the "Safe State" signal.
p10042	**F-DO signal sources** (Factory setting: 0) Setting the signal sources for F-DO.
p10046	**F-DO feedback signal input activation** (Factory setting: 0000 bin) Activation of the feedback input for the safe digital output.
p10047	**F-DO test mode** (Factory setting: 0100 bin) Setting the test mode for the safe digital output
p10001	**Wait time for the forced checking procedure at DO** (Factory setting: 500 ms) Within this time, for a forced checking procedure of the digital output, the signal must have been detected via the corresponding feedback input (p10047).

4.7.3.2   Setting forced dormant error detection

Precondition

You have selected the extended functions via onboard terminals.

Procedure

To set the forced dormant error detection of the fail-safe output, proceed as follows:

1. Press the "Safety inputs/outputs" button.

2. Press the "Configuration" button.
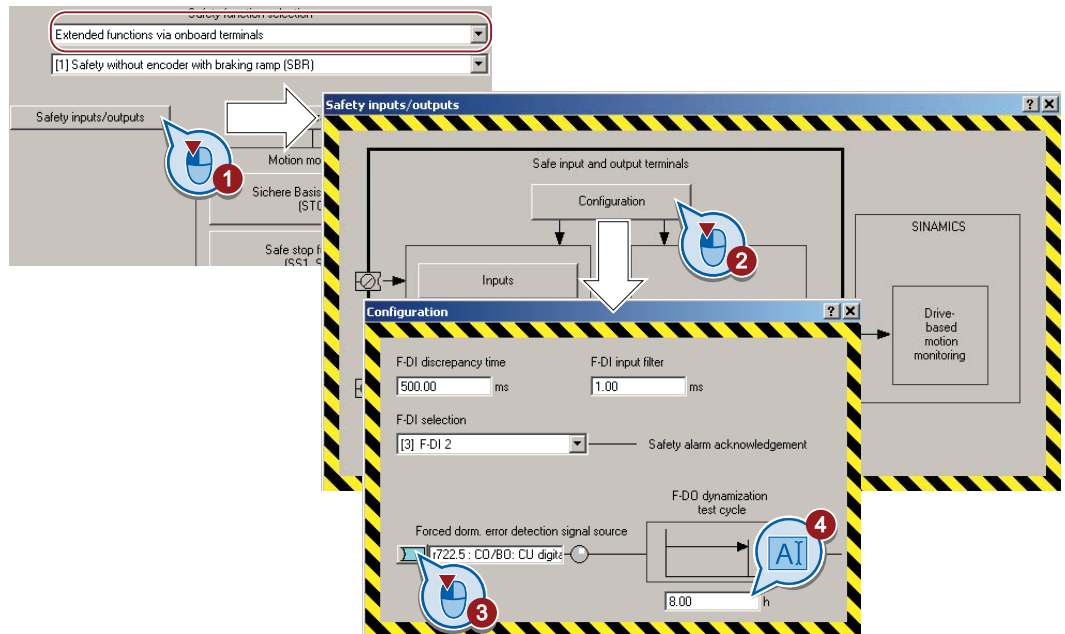
3. Interconnect this signal, for example with a digital input or a control bit in the fieldbus. This signal starts the forced dormant error detection of the fail-safe output and resets the remaining monitoring time to the value ④.

4. Set the monitoring time for the forced dormant error detection.

   The time must be longer than or equal to the time for monitoring the forced dormant error detection of the extended functions. See also Section: (*** NO TRANSLATION IN THIS VERSION! ***) (Page 92).

5. Close the two screen forms.

You have defined which signal the inverter uses to start the forced dormant error detection of its fail-safe output.

Description: Forced checking procedure of the fail-safe output

The forced checking procedure of the fail-safe output is the regular self-test of the converter, in which the converter checks whether the output can be shut down (deactivated).

The converter monitors the regular forced checking procedure of the fail-safe output using a time block.

You must start the forced checking procedure with a signal of your choice.
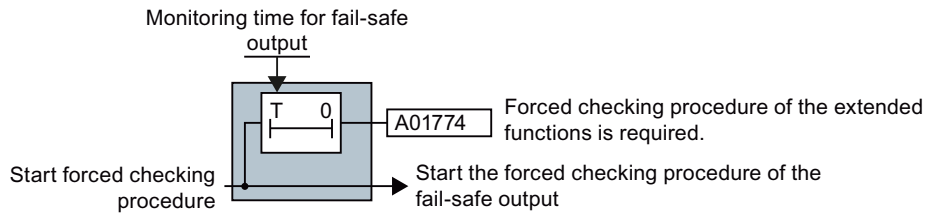
Figure 4-16   Start and monitoring of the forced checking procedure of the fail-safe output

Parameter	Description
p10003	**Forced checking procedure timer** (Factory setting: 8 h) Setting the time to perform the forced checking procedure.
p10007	**Forced checking procedure F-DO signal source** (Factory setting: 0) Select an input terminal to start the forced checking procedure.

4.7.4   Configuring PROFIsafe in the converter

Precondition

You have selected the PROFIsafe interface.

Procedure

To assign a PROFIsafe address to the inverter, proceed as follows:

1. Press the "Configuration" button.

2. Enter the same PROFIsafe address in the hexadecimal format, which you defined in the hardware configuration.
   See also section: STEP 7 example: Configuring PROFIsafe communication (telegram 30) via PROFIBUS (Page 66).
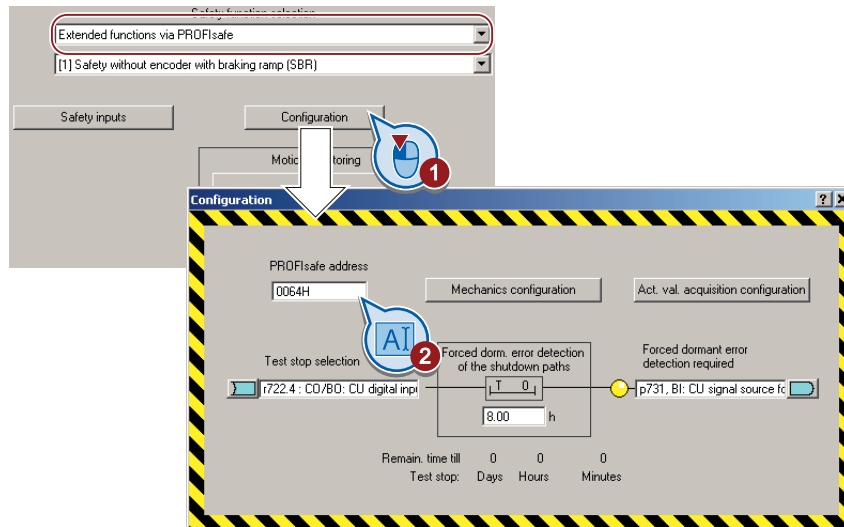
3. Close the screen form.

☐   You have assigned the inverter its PROFIsafe address.

PROFIsafe telegram 30: Factory setting

Telegram 30 is the factory setting in the inverter. If you enable the safety functions with communication via PROFIsafe , then the inverter expects telegram 30 from the higher-level control system.

Set PROFIsafe telegram 900

Precondition

You have selected the extended functions "via PROFIsafe" or "via PROFIsafe and onboard terminals".

Procedure

To set the PROFIsafe telegram 900, proceed as follows:

1. Press the "Safety inputs" button.
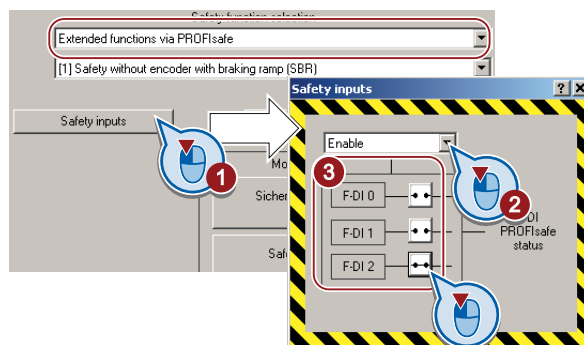
2. Enable telegram 900.

    If you disable this function, the inverter operates with telegram 30.

3. Set which F-DI status of the inverter is transferred via PROFIsafe status word 5 .

Note

The status of the fail-safe inputs is transferred irrespective of whether you use one of the fail-safe inputs to control a fail-safe function.

---

4. Close the screen form.

☐   You have set PROFIsafe telegram 900 in the inverter.

Enabling Shared Device

If you control the inverter safety functions via PROFINET and "Shared Device", you must enable this function in the inverter.

See also Section: STEP 7 example: Configuring Shared Device communication via PROFINET (Page 70).

Procedure

To configure communication via "Shared Device" in the inverter, proceed as follows:

1. In STARTER change to the expert list.

2. In STARTER, set p8929 = 2.

☐   You have configured the communication via "Shared Device" in the inverter.

Starting communication via PROFIsafe

When you connect the converter to the higher-level control system (F-CPU) via the fieldbus for the first time, the central control system sends the PROFIsafe configuration to the converter. After the configuration data have been received in the converter, PROFIsafecommunication starts.

The converter only monitors the communication to the F-CPU after the configuration data have been received from the central control system.

4.7.5 Setting SS1

4.7.5.1 Setting SS1 with braking ramp monitoring

Procedure

To set the SS1 function with braking ramp monitoring, proceed as follows:

1. Select "[1] Safety without encoder with braking ramp (SBR)".

2. Press the "Safe stop functions" button.

3. Set the following:

   – ③ shutdown speed SS1.

   – ④ Delay time:
     If the ramp-down time (OFF3) in your application is less than 10 seconds, then leave the delay time at its factory setting. If SS1 goes into a fault condition during the function test, increase this value until the motor brakes normally.
     If the ramp-down time (OFF3) is set to several minutes, you must extend the delay time to several seconds in order to avoid any unwanted faults when selecting SS1-.

   – ⑤ Monitoring time
     The monitoring time defines the gradient of the monitoring curve when braking the load.
     If the monitoring curve should be parallel to the down ramp of the load, then you must set the following: **Monitoring time = ramp-down time (OFF3) / gear ratio**.
     Gear ratio = load/motor revolutions.
     Example: Gear ratio = 1 / 3 ⇒ Monitoring time = ramp-down time (OFF3) × 3.
     A monitoring time shorter than the above calculated value does not make sense, as the inverter can reduce its monitoring curve faster than the load can be braked.
     The longer you set the monitoring times, the more tolerant the monitoring.

   – ⑥ Reference velocity (reference speed):
     Set the reference speed to the value of the maximum speed.

4. Close the screen form.

You have set the SS1 function with braking ramp monitoring.

Description: SS1 with braking ramp monitoring
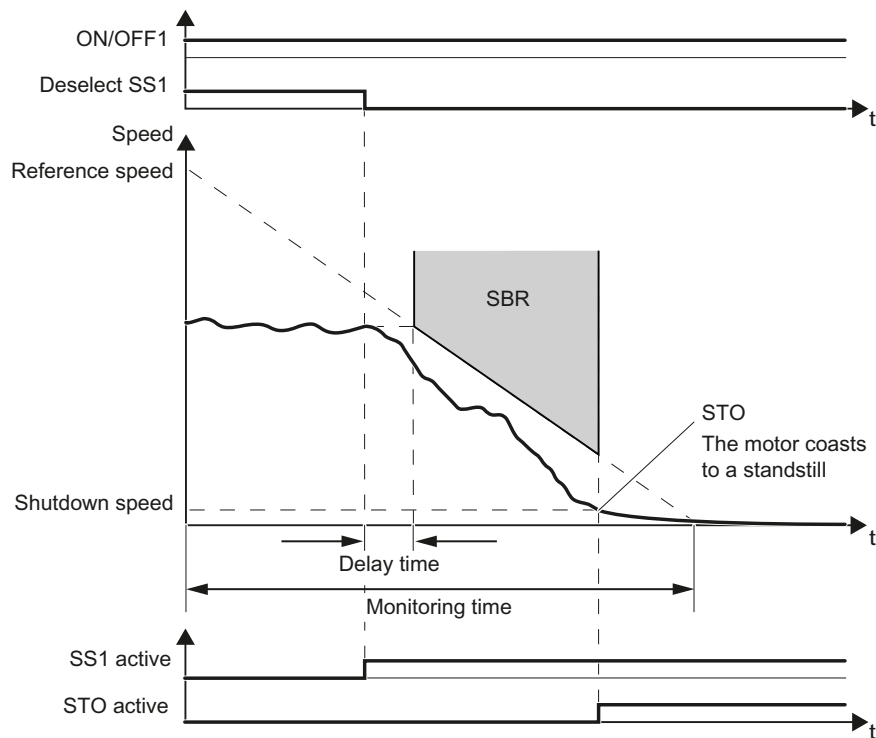
Figure 4-17   SS1 with braking ramp monitoring

Reference speed and monitoring time

The two values define the gradient of the monitoring SBR .

Delay time

The SBR function only starts after an adjustable time. The monitoring starts with the speed setpoint that applied when SS1 was selected.

Braking

The inverter brakes the motor with the OFF3 ramp-down time.

Shutdown speed

The inverter safely switches off the motor torque using the STO function if the speed has reached the shutdown speed.

Parameter	Description	
p9501.00	**1 signal:** Enable extended functions. **0 signal:** Disable extended functions.	
p9506	**Function specification:** (Factory setting: 1)	
	1:	With braking ramp monitoring
	3:	With acceleration monitoring
p9546	**SSM speed limit** (factory setting: 20 rpm) Only relevant to the SS1 function if p9560 = 0.	
p9560	**Shutdown speed** (Factory setting: 10 rpm) If p9560 = 0, the SSM speed limit p9546 applies as the shutdown speed.	
p9581	**Reference speed** (Factory setting: 1500 rpm)	
p9582	**Delay time** (Factory setting: 250 ms)	
p9583	**Monitoring time** (Factory setting: 10 s)	
r9722.1	**1 signal**: SS1 active	
r9723.16	**1 signal**: SAM/SBR active	
p1135	**OFF3 ramp-down time**	
p1226	**Standstill detection, speed threshold** (Factory setting: 20 rpm)	The inverter switches off the motor torque if the speed either fulfills the condition for standstill detection or the shutdown speed p9569 has been reached.
p1227	**Standstill detection monitoring time** (Value depends on the power unit)	

4.7.5.2   Setting SS1 with acceleration monitoring

Procedure
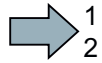
To set the SS1 function with acceleration monitoring, proceed as follows:

1. Select "[3] Safety without encoder with accel_monitoring (SAM)/delay time".

2. Press the "Safe stop functions" button.

3. Set the following:

    – ③ Delay time
    After this time the inverter safely switches off the motor torque – regardless of the actual speed.

    – ④ shutdown speed SS1

    – ⑤ speed tolerance

    – ⑥ shutdown speed acceleration monitoring
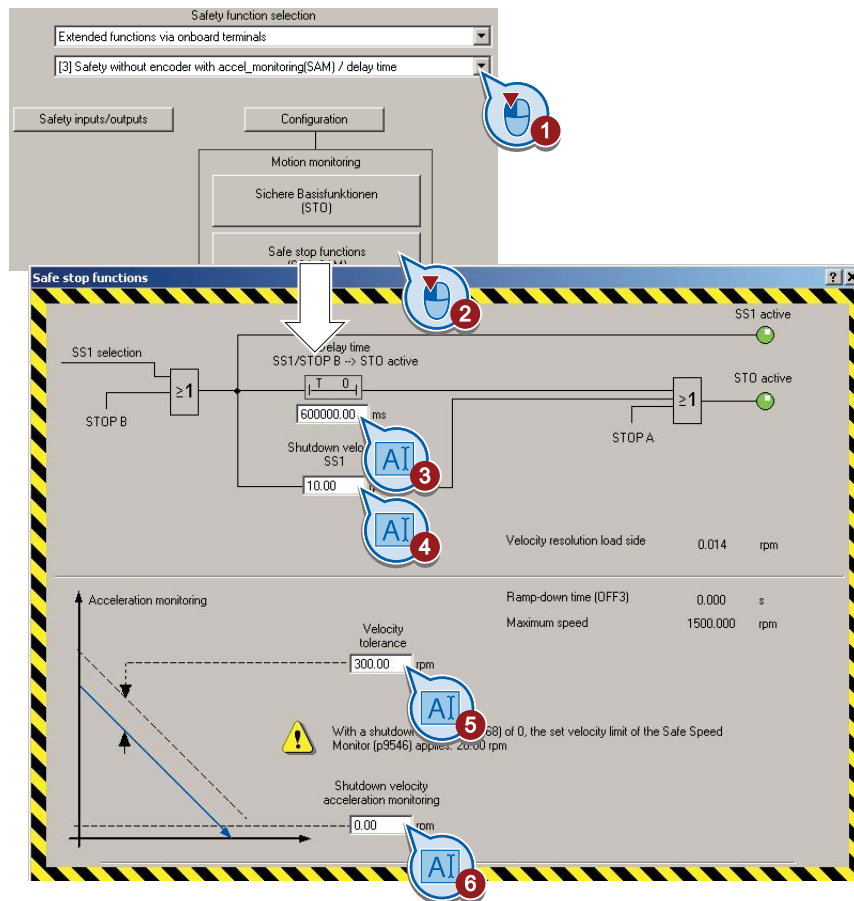
4. Close the screen form.

You have set the SS1 function with acceleration monitoring.

Description: SS1 with acceleration monitoring
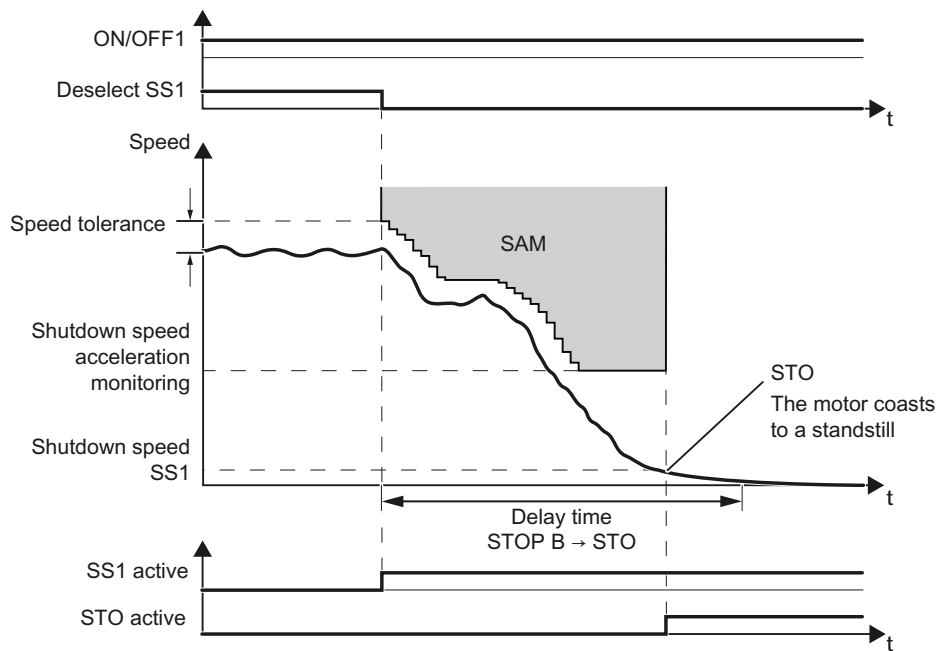
Figure 4-18   SS1 with acceleration monitoring

Speed tolerance

As long as the speed is less, the converter continuously adds the tolerance to the actual speed so that the monitoring tracks the speed.

Shutdown speed acceleration monitoring

The converter reduces the monitoring threshold until it reaches the value of the "Shutdown speed acceleration monitoring".

Shutdown speed SS1 and delay time

The converter safely switches off the motor torque with the function STO if one of the two conditions is fulfilled:

● The actual speed reaches the value of the shutdown speed SS1.

● The delay time has expired.

Parameter	Description	
p9501.00	**1 signal:** Enable extended functions. **0 signal:** Inhibit extended functions.	
p9506	**Function specification:** (Factory setting: 1)	
	3:	With acceleration monitoring
p9548	**Speed tolerance** (Factory setting: 300 rpm)	
p9556	**Delay time STOP B → STO** (Factory setting: 600000 ms)	
p9560	**Shutdown speed SS1** (Factory setting: 10 rpm)	
p9568	**Shutdown speed acceleration monitoring** (Factory setting: 0 rpm)	
r9722.1	**1 signal**: SS1 active	
r9723.16	**1 signal**: SAM/SBR active	
p1226	**Standstill detection, speed threshold** (Factory setting: 20 rpm)	The converter switches off the motor torque if the speed either fulfills the condition for standstill detection or the shutdown speed p9569 has been reached.
p1227	**Standstill detection monitoring time** (Value depends on the power unit)	

4.7.6 Setting SLS

4.7.6.1 Setting the monitoring functions

Procedure

To set the SLS function, proceed as follows:

1. In the main screen form of the extended functions, select one of the two monitoring modes:
   – [1] Safety without encoder with braking ramp (SBR)
   – [3] Safety without encoder with accel_monitoring (SAM)/delay time

2. Select the safety function SLS.

3. Set the following:
   – ③ The delay time only appears if you have not selected brake ramp monitoring. The delay time must be longer than the time, when SLS is selected, that the motor needs to brake with the maximum load from the maximum speed and to the lowest SLS level.
   – ④ Setpoint speed limiting as a % of the speed monitoring. When SLS is active, the inverter limits the speed to this value.
   – ⑤ Speed monitoring. Set the speed to be monitored. The inverter calculates the maximum motor speed based on this value and the gear ratio. If you have not set PROFIsafe as interface, you can only set level 1.
   – ⑥ Set the response when the monitoring responds. Also see section: Stop responses (Page 209).
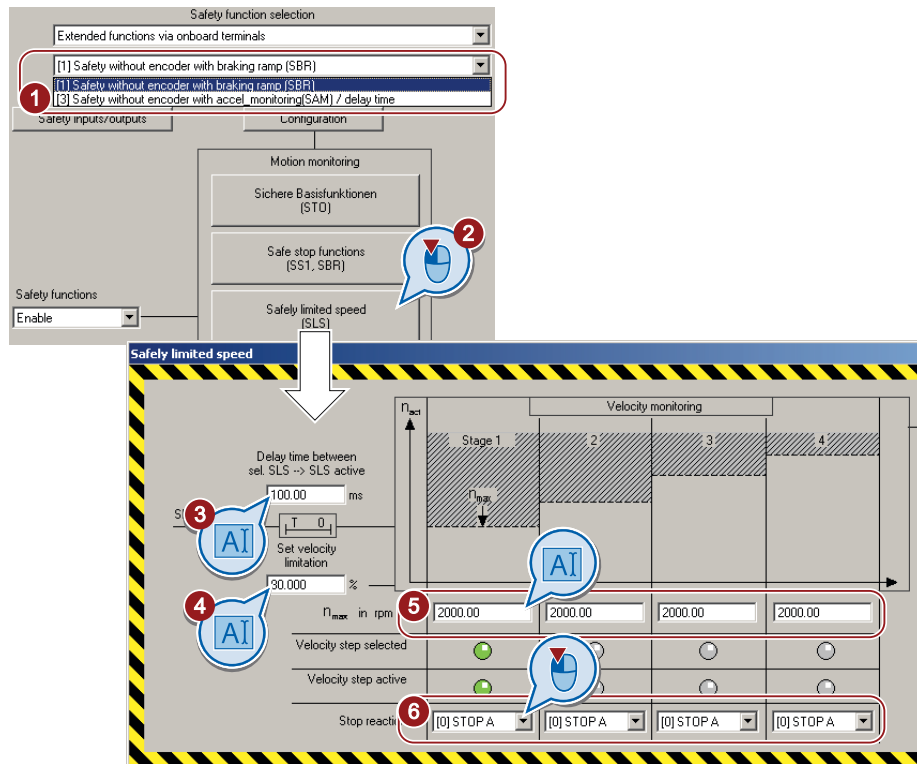
4. Close the screen form.

You have set the SLS function.

Description of the function SLS
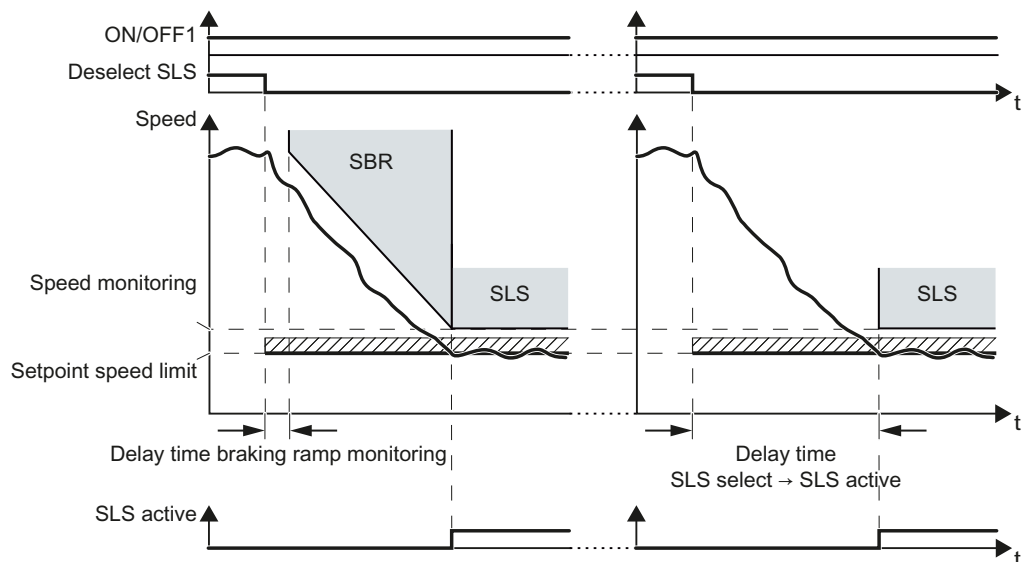
Figure 4-19   Behavior after selecting SLS. Left: with braking ramp monitoring; right: without braking ramp monitoring

After selecting SLS , the converter brakes the motor according to the OFF3 ramp-down time. Setting the braking ramp monitoring is described in Section. Setting SS1 with braking ramp monitoring (Page 113).

Parameter	Description	
p1135	**OFF3 ramp-down time**	
p9501.00	**1 signal:** SLS and enable extended functions. **0 signal:** SLS and inhibit extended functions.	
p9506	**Function specification:** (Factory setting: 1)	
	1:	With braking ramp monitoring
	3:	Without braking ramp monitoring
p9531[0…3]	**Speed monitoring** (Factory setting for all levels: 2000 rpm)	
p9533	**Setpoint speed limiting** (Factory setting: 80 %) The converter limits the setpoint to the value r9733. r9733[0] = p9531[x] × p9533.	
p9551	**Delay time SLS Select → SLS active** (Factory setting: 100 ms) Not active for braking ramp monitoring.	
p9563[0…3]	**SLS-specific stop response** (Factory setting: STOP A)	
	0:	STOP A
	1:	STOP B
p9581	**Reference speed** (Factory setting: 1500 rpm)	
p9582	**Delay time** (Factory setting: 250 ms)	
p9583	**Monitoring time** (Factory setting: 10 s) The gradient of the braking ramp depends on p9581 and p9583 .	
r9722.04	**1 signal:** SLS active **0 signal:** SLS not active	
p1135	**OFF3 ramp-down time**	

4.7.6.2 Settings for acceptance test

In order to be able to approach the monitoring limit of the safety function during the acceptance test, you must temporarily deactivate speed limiting in the inverter.

Starter offers you the possibility to temporarily deactivating speed limiting.

Procedure

To prepare for acceptance, proceed as follows:

1. In the main screen form of the extended functions, select the "Acceptance mode" button.

2. Set the time in which the inverter deactivates its internal speed limiting. During the acceptance test, you must reach the monitored limit value within this time.

After this time expires, the inverter exits the acceptance mode and reactivates its internal speed limiting.

3. Close the screen form.

You have made the preparations for the function to be accepted.

Parameter	
p9558	**Acceptance test mode time limit** (factory setting 40000 ms)
	Maximum time limit: 100 seconds.

4.7.7 Setting SSM

Procedure

To set the SSM function, proceed as follows:

1. In the main screen form of the extended functions, select the SSMsafety function.

2. Set the following in this screen form:

   – ① Disable the hysteresis.

   – ② The behavior when the motor is switched off.

   – ③ The speed to be monitored.

   – You do not need to set the filter time ④ and hysteresis ⑤ until you have enabled the hysteresis ①.
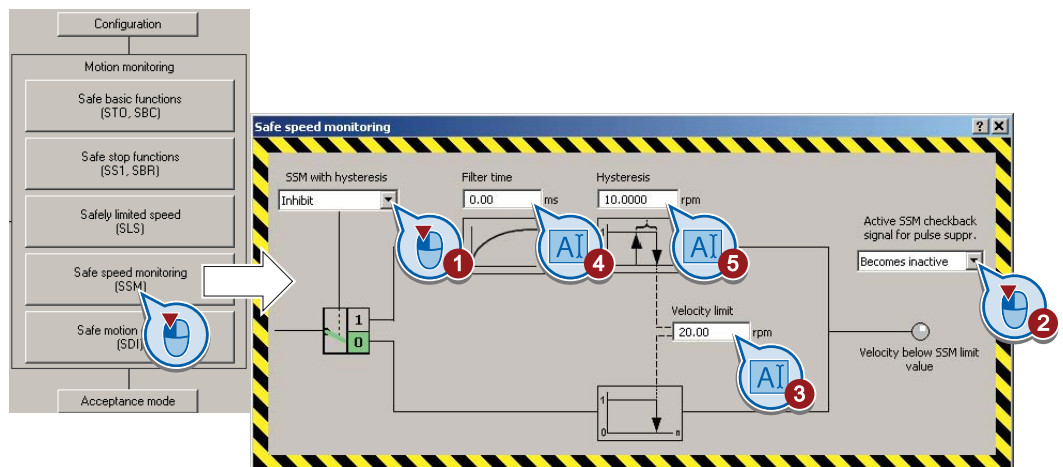
You have set the SSM function.

After commissioning, the SSM function is immediately active. In order to switch on the motor after commissioning SSM , you must observe a particular sequence of signals. See also the section Switching on the motor when SSM is active (Page 190).

Description: the function SSM

Speed monitoring

- When the motor is switched on, the inverter compares the load speed with the speed limit.
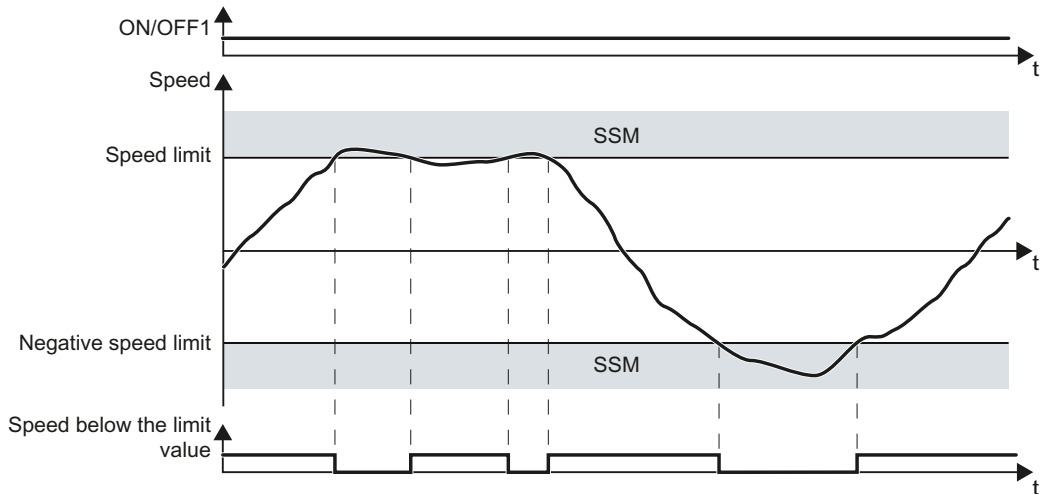
Figure 4-20   Time response of the safety function SSM without hysteresis

Feedback signal SSM when the motor is switched off

You can select whether the inverter monitors the speed when the motor is switched off or not. See also Section: Switching on the motor when SSM is active (Page 190).
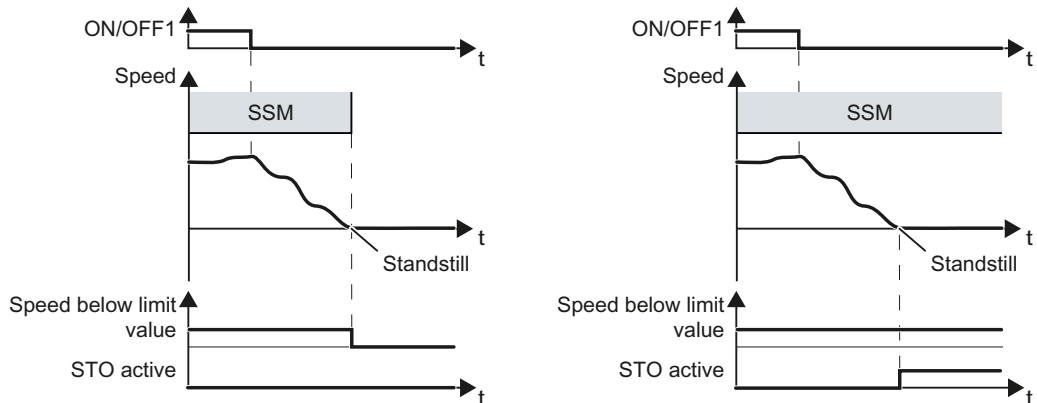
Figure 4-21   Behavior when the motor is switched off. Left: SSM is inactive. Right: SSM remains active

Parameter	Description
p9501.00	**1 signal:** Enable extended functions. **0 signal:** Disable extended functions.
p9501.16	**1 signal:** Enable hysteresis and filtering **0 signal:** Disable hysteresis and filtering
p9509.00	**1 signal:** SSM becomes inactive when the motor is switched off **0 signal:** SSM remains active when the motor is switched off
p9546	**Speed limit** (factory setting: 20 rpm)
r9722.15	**1 signal**: Absolute value of the speed is lower than the speed limit

SSM with hysteresis

If you wish to monitor speeds that are very close to the speed limit, you may find it useful to set the hysteresis.

Speed monitoring

● When the motor is switched on, the inverter compares the load speed with the speed limit, taking the hysteresis into account.
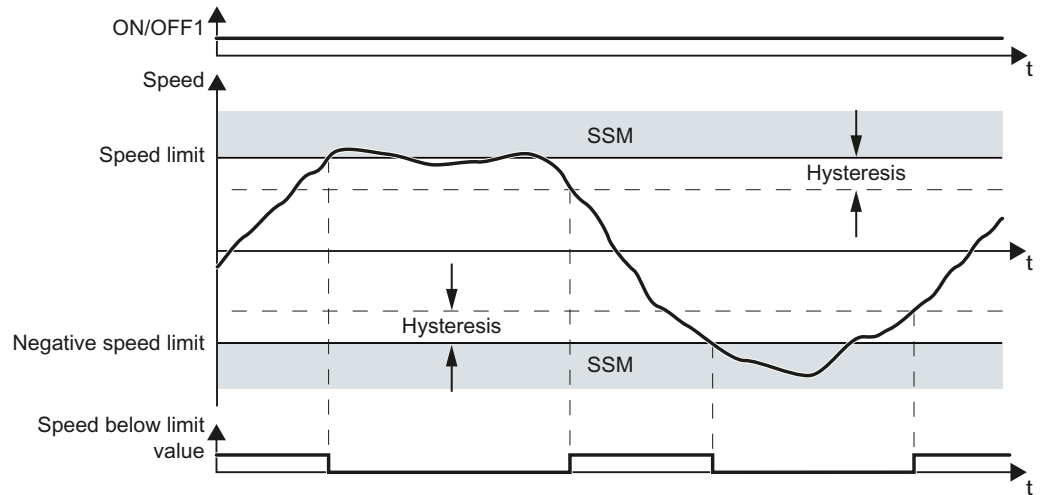
Figure 4-22   Time response of the safety function SSM with hysteresis

Filter

The signal filters smoothes the speed measured by the inverter. Use the filter if you wish to monitor speeds that lie just below the speed limit.
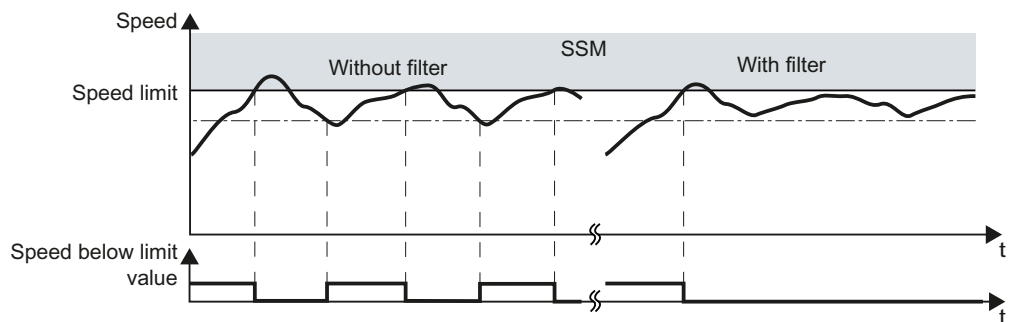
Figure 4-23   Mode of operation of the filter of the SSM function

Parameter	Description
p9501.00	**1 signal:** Enable extended functions. **0 signal:** Disable extended functions.
p9501.16	**1 signal:** Enable hysteresis and filtering **0 signal:** Disable hysteresis and filtering
p9509.00	**1 signal:** SSM becomes inactive when the motor is switched off **0 signal:** SSM remains active when the motor is switched off
p9545	**Filter time** (Factory setting: 0 ms)
p9546	**Speed limit** (Factory setting: 20 rpm)
p9547	**Hysteresis** (Factory setting: 10 rpm)
r9722.15	**1 signal**: Absolute value of the speed is lower than the speed limit

4.7.8   Setting SDI

4.7.8.1   Setting the monitoring functions

Procedure
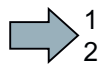
To set the SDI function, proceed as follows:

1. Select the safety function SDI.

2. Set the following in this screen form:

    – ① Enable the function.

    – ② The delay time up to active monitoring.

    – ③ The tolerance for motion in the monitored direction.

    – ④ The response when the monitoring function responds.

      See also Section: Stop responses (Page 209)

    – ⑤ The behavior when the motor is switched off.

      See also Section: Switching off the motor when SDI is active (Page 192)

    – ⑥ ⑦ If you leave this signal interconnection to the factory setting, when SDI is selected, the inverter limits the speed.
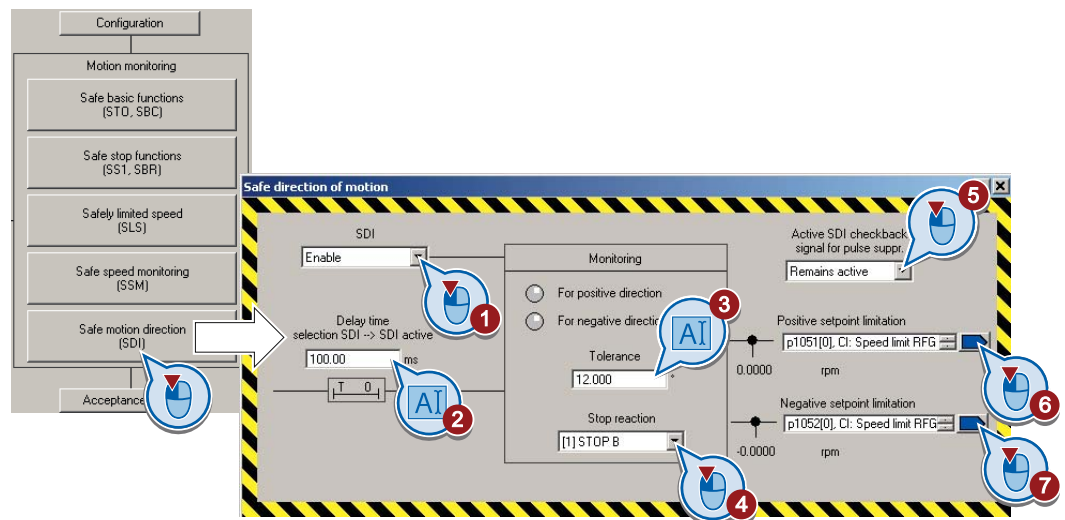
You have set the SDI function.

Description of the function SDI

Time response
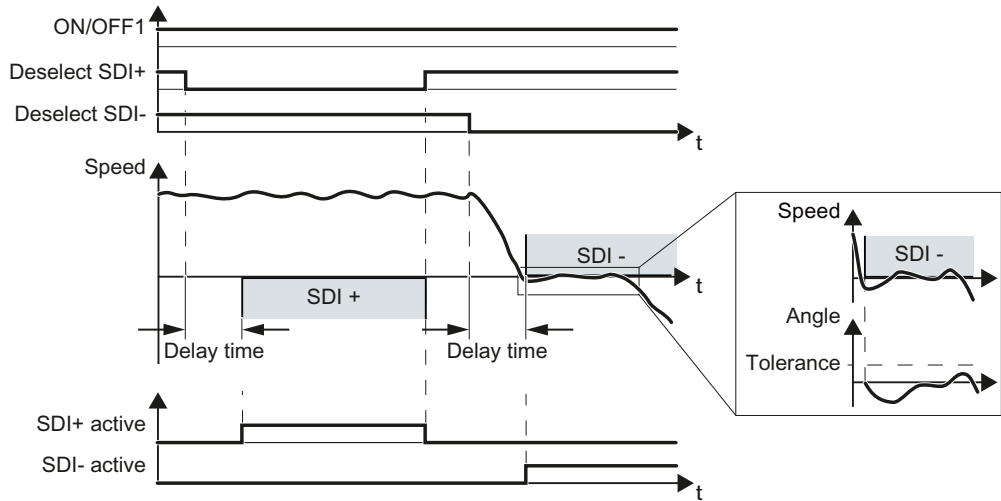
Figure 4-24   Delay time and tolerance

Delay time

If you select SDI , then the converter monitors the selected motor direction of rotation after the delay time expires. When SDI is selected, the delay time must be longer than the time that the motor requires to brake the maximum load from maximum speed down to standstill. The converter brakes the motor with the OFF3 ramp-down time.

Tolerance

The converter permits brief motion in the monitored direction, for example for brief speed overshoots after braking down to standstill. To do this, the converter converts the motor speed into an angle. With the tolerance, you limit the maximum permissible angle in the monitored direction.

Feedback signal SDI when the motor is switched off

You can select whether the converter monitors the speed when the motor is switched off or not. See also Section: Switching on the motor when SDI is active (Page 194).
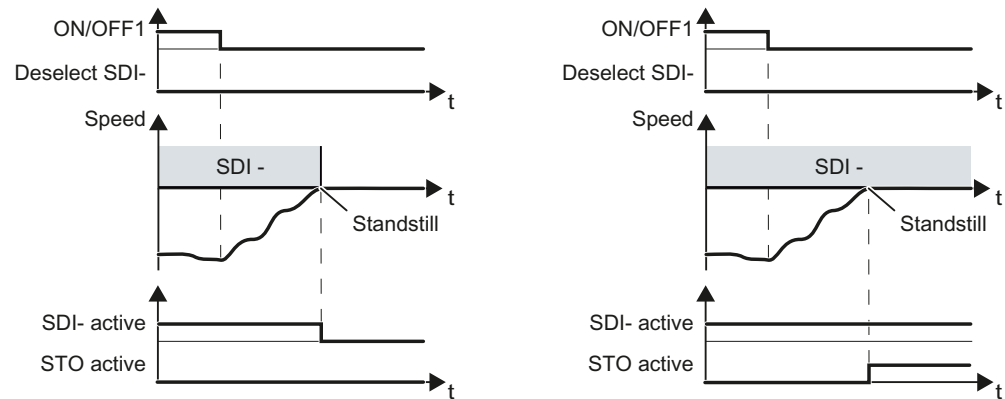
Figure 4-25   Behavior when the motor is switched off. Left: SDI becomes inactive. Right: SDI remains active

Parameter	Description	
p9501.00	**1 signal:** Enable extended functions. **0 signal:** Inhibit extended functions.	
p9501.17	**1 signal:** SDI enable **0 signal:** SDI inhibit	
p9509.08	**1 signal:** SDI becomes inactive when the motor is switched off **0 signal:** SDI remains active when the motor is switched off	
p9564	**Tolerance** (Factory setting: 12 degrees)	
p9565	**Delay time** (Factory setting: 100 ms)	
p9566	**Stop response** (Factory setting: 1)	
	0:	STOP A
	1:	STOP B
r9722.12	**1 signal:** SDI positive active	
r9722.13	**1 signal:** SDI negative active	
p1135	**OFF3 ramp-down time**	

4.7.8.2 Settings for acceptance test

In order to be able to approach the monitoring limit of the safety function during the acceptance test, you must temporarily deactivate speed limiting in the inverter.

Starter offers you the possibility to temporarily deactivating speed limiting.
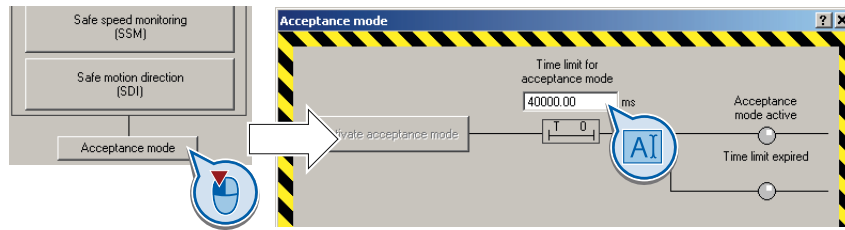
Procedure

To prepare for acceptance, proceed as follows:

1. In the main screen form of the extended functions, select the "Acceptance mode" button.

2. Set the time in which the inverter deactivates its internal speed limiting. During the acceptance test, you must reach the monitored limit value within this time.

   After this time expires, the inverter exits the acceptance mode and reactivates its internal speed limiting.
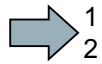

3. Close the screen form.

You have made the preparations for the function to be accepted.

Parameter	
p9558	**Acceptance test mode time limit** (factory setting 40000 ms)
	Maximum time limit: 100 seconds.

4.7.9 Final steps

Activate settings

Procedure

To activate the settings for the safety functions, proceed as follows:

1. Press the "Copy parameters" button, to create a redundant image of your inverter settings.

2. Press the "Activate settings" button.

3. If the password is the factory default, you are prompted to change the password.
   If you try to set a password that is not permissible, the old password will not be changed.

4. Confirm the prompt for saving your settings (copy RAM to ROM).

5. Switch off the inverter supply voltage.

6. Wait until all LEDs on the inverter go dark (no voltage condition).

7. Switch on the inverter supply voltage again.

Your settings are now active.

Parameter	Description
p9700 = 57 hex	**SI copy function** (factory setting: 0) Start copy function SI parameter.
p9701 = AC hex	**Confirm data change** (factory setting: 0)Confirm data change overall.
p0010 = 0	**Drive commissioning parameter filter** 0: Ready
p9761	**Enter a password** (factory setting 0000 hex) Permissible passwords lie in the range 1 … FFFF FFFF.
p9762	**New password**
p9763	**Confirm password**

Checking the assignment of the digital inputs

If you control the safety functions in the inverter using digital inputs, then you must check as to whether these digital inputs have been assigned other functions.

Figure 4-26   Example: Assignment of digital inputs DI 4 and DI 5 with STO

Both, the assignment of digital inputs with the selection of a safety function or with a "standard" function can lead to an unexpected behavior of the drive.

Procedure

To check the assignment of the digital inputs, proceed as follows:

1. In STARTER, select the screen form for the terminals of the digital inputs.

2. Remove all signal interconnections of the digital inputs that you wish to use as fail-safe input F-DI:
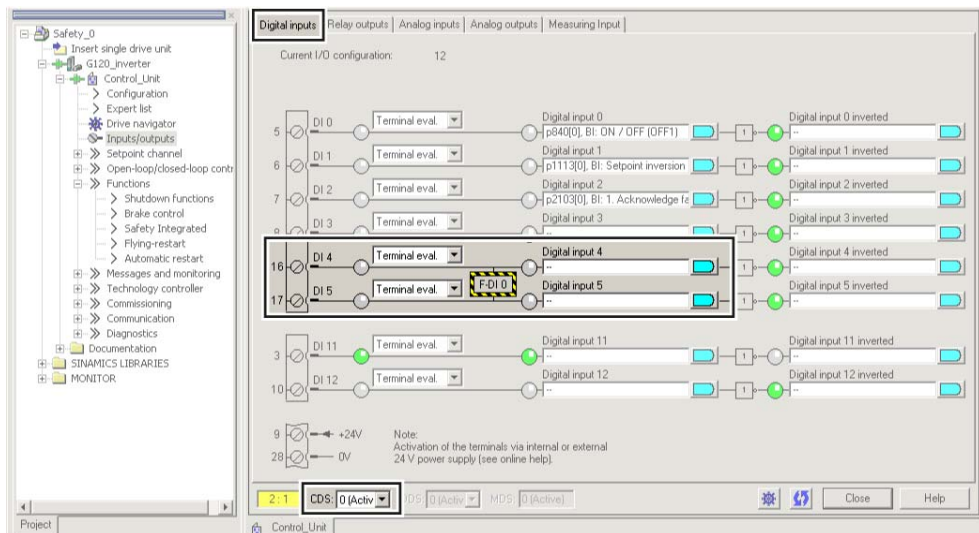
Figure 4-27   Remove pre-assignment of digital inputs DI 4 and DI 5

3. When you use the data set changeover CDS, you must delete the multiple assignment of the digital inputs for all CDS.

You have ensured that the fail-safe inputs of the safety functions do not control other functions in the inverter.

4.8   Offline commissioning

When you set the safety function parameters offline, you have to download them to the inverter. Once you have downloaded them, you have to finish commissioning the safety functions online.

The screens for the safety functions differ from each other slightly depending on whether you work with STARTER online or offline. Follow the descriptions in this manual in order to set all of the necessary parameters in line with the requirements of your application (this also applies when setting the parameters offline).

Setting the safety functions offline

Procedure
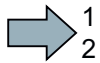
To set the safety functions offline, proceed as follows:

1. Select the safety functions in STARTER.

2. Set the check mark "Copy parameters after download":
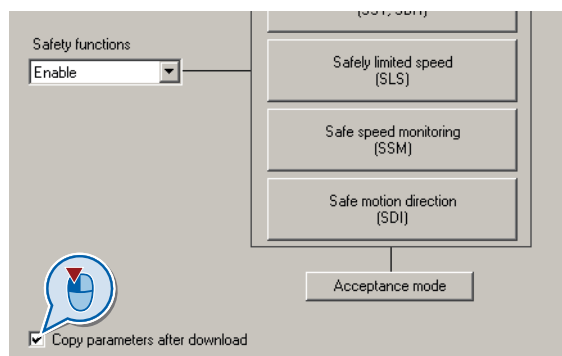
3. Set the safety function parameters offline.
   When doing this, follow the descriptions of the online commissioning, also see Section: Changing settings (Page 74).

4. Once you have finished setting the parameters, save your project by clicking the 💾 button.

You have set the safety functions of the inverter offline, and saved them to your PC or PG.

In the next step, you must transfer the settings from your PC or PG to the inverter.

Loading the settings into an inverter using STARTER

Procedure
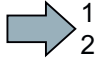
To load the settings to the inverter, proceed as follows:

1. Go online with STARTER and start to download to the inverter using the button ![icon]. After the download, the inverter signals faults. Ignore these faults, as they will be automatically acknowledged by the following steps.

2. Select the screen form for the safety functions.

3. Select the button to change the settings.

4. Activate the settings using the associated button.

5. Save your settings (copy RAM to ROM).

6. Switch off the inverter supply voltage.

7. Wait until all of the LED on the inverter go dark.

8. Switch on the inverter supply voltage again.

The inverter has now accepted your settings.

4.9 Series commissioning

Series commissioning is the process where you transfer the settings of one inverter to a second inverter.

Procedure

To transfer settings from one inverter to another, proceed as follows:

1. Using STARTER , save your project to your PC or PG.

2. Loading your backed up settings to a second inverter:

   Follow the procedure described in the section: Offline commissioning (Page 133).

3. If you control your inverter via PROFIsafe , then adapt the PROFIsafe address.

   For further information, refer to the following sections:

   – Basic functions: Configuring PROFIsafe (Page 80)

   – Extended functions: Configuring PROFIsafe in the converter (Page 110)

4. Perform a reduced acceptance for the safety functions.

   The necessary measures are described in the section: Reduced acceptance (Page 137).

You have transferred the settings of the first inverter to a second inverter.

4.10 Acceptance tests for the safety functions

4.10.1 Acceptance test

Why is acceptance required?

The EC Machinery Directive and ISO 13849-1 require the following:

- You must check safety-related functions and machine parts after commissioning.

  → Acceptance test.

- You must create an "acceptance report" showing the test results.

  → Documentation.

Acceptance test

The acceptance test comprises two parts:

1. Checking whether the safety functions in the inverter are set correctly:
   - Does the speed control govern the configured applications in the machine?
   - Are the set interfaces, times, and monitoring specifications appropriate for the machine configuration?

2. Checking whether the safety-related functions in the machine or system are functioning correctly.

   This part of the acceptance test goes beyond the inverter acceptance test:
   - Is all safety equipment, such as protective door monitoring devices, light barriers, or emergency-off switches, connected and ready for operation?
   - Does the higher-level control respond correctly to the inverter's safety-related checkback signals?
   - Are the inverter settings appropriate for the safety-related function that has been configured in the machine?

Documentation

Documentation consists of the following:

- Describing the safety-related components and functions of the machine or system.
- Logging the acceptance test results.
- Logging the safety function settings.
- Countersigning documentation.

Authorized persons

Authorization within the scope of the acceptance test applies to persons authorized by the machine manufacturer who, on account of their technical qualifications and knowledge of the safety-related functions, are in a position to perform the acceptance test in the correct manner.

4.10.2   Reduced acceptance

A full acceptance test is necessary only after first commissioning. A reduced acceptance test is sufficient when safety functions are expanded.

● The reduced acceptance test is only required for the part of the machine that has been changed as a result of replacement, update or function expansion.

● The acceptance test is only required for the safety functions that you actually use.

Measure	Reduced acceptance	
	Acceptance test	Documentation
Replacing the Control Unit or the inverter	No. Only check the motor's direction of rotation.	• Supplement inverter data • Log the new checksum • Countersignature
Replacing the Power Module		Supplement the hardware version in the inverter data.
Replacing the motor		No change.
Replacing the gear unit		
Replacing the Safe Brake Relay	Yes. Only check the SBC function.	Supplement the hardware version in the inverter data.
Replacing the safety-related peripherals (e.g. Emergency Stop switch).	No. Only check control of the safety functions affected by the components that have been replaced.	No change.
Inverter firmware update.	No.	• Supplement firmware version in the inverter data • Log the new checksum • Countersignature
Changing a single limit (e.g. SLS level).	Yes. Only check the limit value that has been changed.	• Supplement function table • Supplement limit values • Log the new checksum • Countersignature

Measure	Reduced acceptance	
	Acceptance test	Documentation
Functional expansion of the machine (additional drive).	Yes. Only check the safety functions of the new drive.	• Supplement machine overview • Supplement inverter data • Supplement function table • Supplement limit values • Log the new checksum • Countersignature
Functional expansion of a drive (e.g. additional SLS level or new safety function following a firmware update).	Yes. Only check the additional functions.	• Supplement function table • Supplement limit values • Log the new checksum • Countersignature
Transfer of inverter settings to other identical machines by means of series commissioning.	No. Only check control of all safety functions.	• Supplement machine description • Check the checksums • Check the firmware versions

4.10.3 Generating documents for acceptance

STARTER creates a log of the settings of the safety functions, which you can use for your machine documentation.

Procedure

Proceed as follows to create the acceptance documentation for the drive using STARTER:

1. In STARTER, select "Create acceptance documentation":
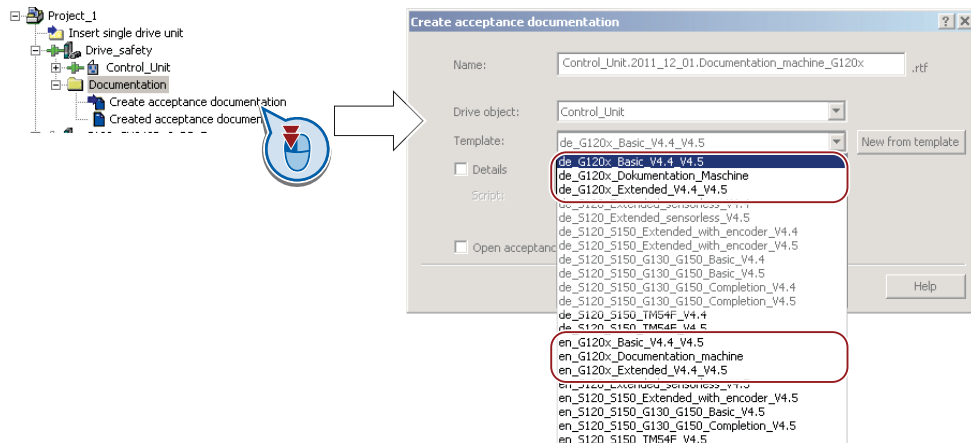
STARTER has templates in German and English.

2. Select the suitable template and create a report for each drive of your machine or system:

   – Template for the machine documentation:

      de_G120x_Dokumentation_Maschine: German template.

      en_G120x_Documentation_machine: English template.

   – Report of the settings for the basic functions, from firmware version V4.4 onwards:

      de_G120x_Basicc_V4.4…: German report.

      en_G120x_Basic_V4.4…: English report.

   – Report of the settings for the extended functions, from firmware version V4.4 onwards:

      Protokoll_de_G120x_Extended_V4.4…: German report.

      Protocol_en_G120x_Extended_V4.4…: English report.

3. You load the created reports for archiving and the machine documentation for further processing:
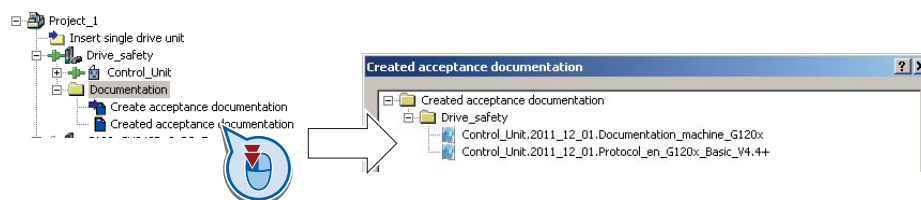
4. Archive the protocols and the machine documentation.

You have generated the documents to accept the safety functions.

The reports and the machine documentation can also be found in Section: Documentation for acceptance (Page 259).

4.10.4   Examples of acceptance tests

For the acceptance test, check whether the safety functions in the inverter have been set correctly. The following acceptance tests are examples which demonstrate the basic procedure. They are not suitable for every possible setting of the inverter.

Recommendations for the acceptance test

- Perform the acceptance test with the maximum possible velocity and acceleration in order to test the expected maximum braking distances and braking times.

- The trace function in the STARTER PC tool can simplify the acceptance test in certain applications: for example, if a drive in the machine is difficult to access. Therefore, we recommend that you use the trace function for some acceptance tests.

- If you are recording a trace for an acceptance test, you should either save or print this trace and attach it to your acceptance protocol.

- If you can carry out the acceptance test without the trace function, there is no need to use this tool.

- The following alarms are issued following each system ramp-up and are not critical for acceptance:
  - A01697
  - A01796

After the acceptance test of the inverter's safety functions, you should also check whether the safety-related functions in the machine or system are functioning correctly. See also: Acceptance test (Page 136).

4.10.4.1 Acceptance test STO (basic functions)
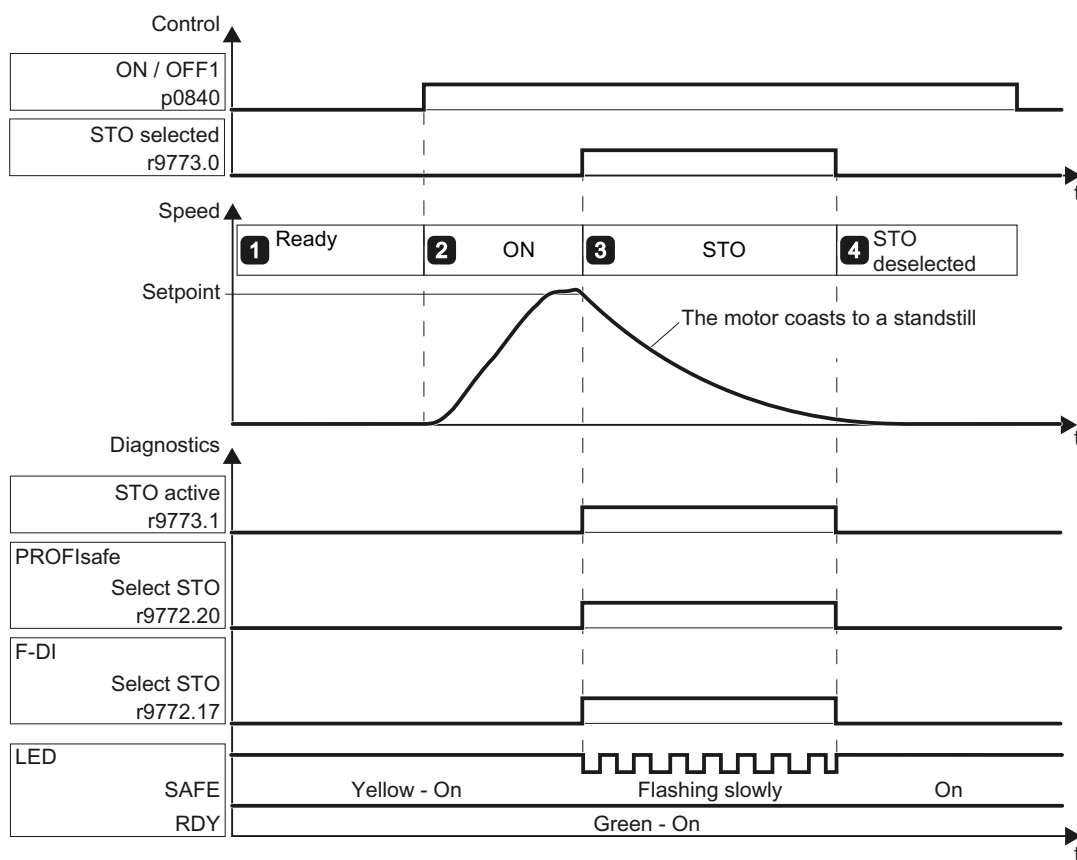
Figure 4-28   Acceptance test for STO (basic functions)

Procedure

To perform an acceptance test of the STO function as part of the basic functions, proceed as follows:

		Status
1.	**The inverter is ready**	
	• The inverter signals neither faults nor alarms of the safety functions (r0945[0…7], r2122[0…7]).	
	• STO is not active (r9773.1 = 0).	
2.	**Switch on motor**	
	2.1. Enter a speed setpoint ≠ 0.	
	2.2. Switch on the motor (ON command).	
	2.3. Check that the correct motor is running.	
3.	**Select STO**	
	3.1. Select STO while the motor is running	
	Test each configured activation, e.g. via digital inputs and PROFIsafe.	

				Status
	3.2.	Check the following:		
		When controlled by PROFIsafe	For control via terminal	
		• The inverter signals the following: "STO selection via PROFIsafe" (r9772.20 = 1)	• The inverter signals the following: "STO Selection via terminal" (r9772.17 = 1)	
		• If a mechanical brake is not available, the motor coasts down. A mechanical brake brakes the motor and holds it to ensure that it remains at a standstill.		
		• The inverter signals neither faults nor alarms of the safety functions (r0945[0…7], r2122[0…7]).		
		• The inverter signals the following: "STO is selected" (r9773.0 = 1). "STO is active" (r9773.1 = 1).		
4.	**Deselect STO**			
	4.1.	Deselect STO.		
	4.2.	Check the following:		
		• STO is not active (r9773.1 = 0).		
		• The inverter signals neither faults nor alarms of the safety functions (r0945[0…7], r2122[0…7]).		

☐ You have performed the acceptance test of the STO function.

4.10.4.2 Acceptance test STO (extended functions)
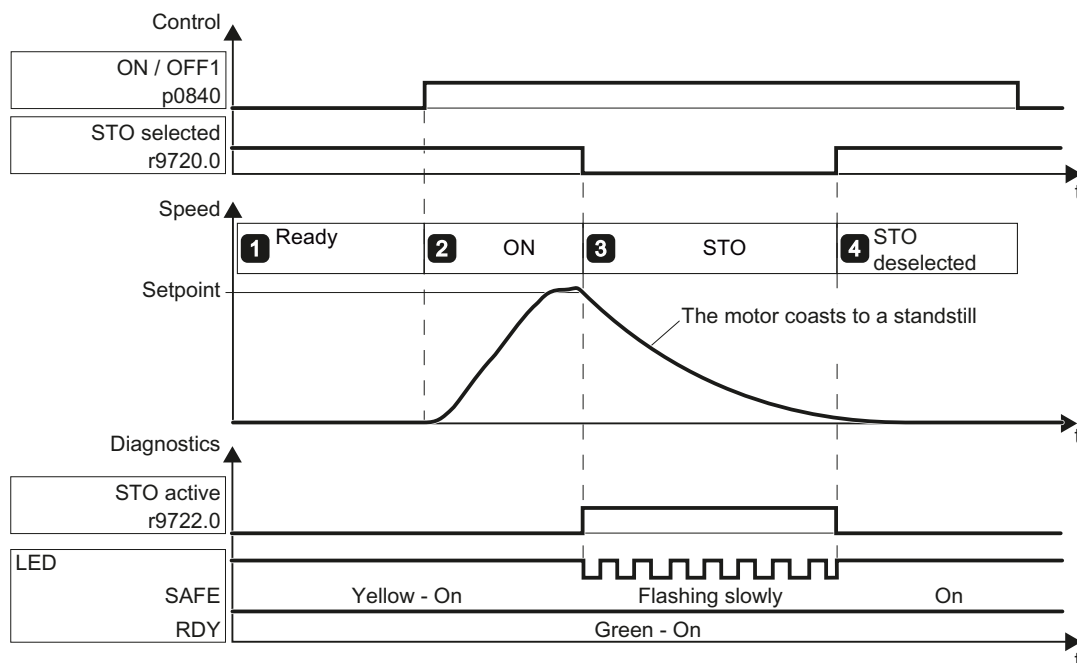
Figure 4-29   Acceptance test for STO (Extended functions)

Procedure

To perform an acceptance test of the STO function as part of the extended functions, proceed as follows:

			Status
1.	**The inverter is ready**		
	•	The inverter signals neither faults nor alarms of the safety functions (r0945[0…7], r2122[0…7]).	
	•	STO is not active (r9722.0 = 0).	
2.	**Switch on motor**		
	2.1.	Enter a speed setpoint ≠ 0.	
	2.2.	Switch on the motor (ON command).	
	2.3.	Check that the correct motor is running.	
3.	**Select STO**		
	3.1.	Select STO while the motor is running.	
	3.2.	Check the following:	
		• If a mechanical brake is not available, the motor coasts down. A mechanical brake brakes the motor and holds it to ensure that it remains at a standstill.	
		• The inverter signals neither faults nor alarms of the safety functions (r0945[0…7], r2122[0…7]).	
		• The inverter signals the following: "STO is active" (r9722.0 = 1).	

			Status
4.	**Deselect STO**		
	4.1.	Deselect STO.	
	4.2.	Check the following:	
		• STO is not active (r9722.0 = 0).	
		• The inverter signals neither faults nor alarms of the safety functions (r0945[0…7], r2122[0…7]).	

☐   You have performed the acceptance test of the STO function.

4.10.4.3   SS1 acceptance test (basic functions)
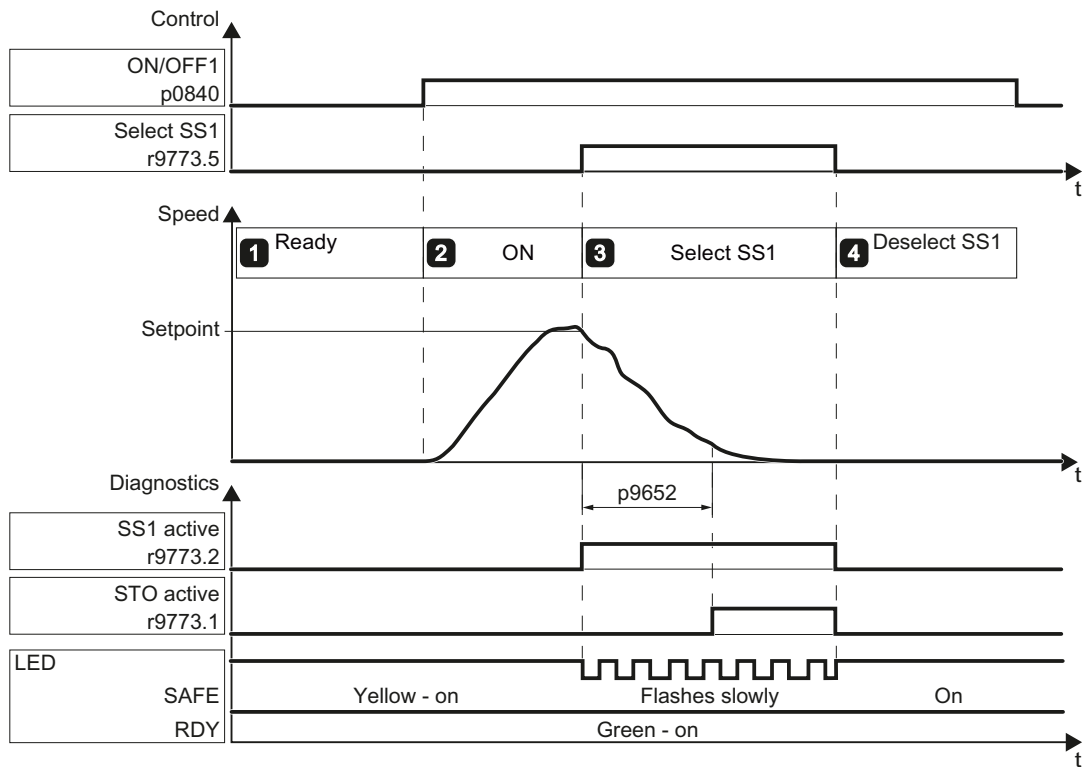
Figure 4-30   SS1 acceptance test for basic functions

Procedure

To perform the acceptance test of the SS1 function, proceed as follows:

		Status
1.	**The inverter is ready**	
	Check the following:	
	• The inverter signals neither faults nor alarms of the safety functions (r0945[0…7], r2122[0…7]).	
	• SS1 is not active (r9773.6 = 0).	

			Status
2.	**Switch on motor**		
	2.1.	Enter a speed setpoint ≠ 0.	
	2.2.	Switch on the motor (ON command).	
	2.3.	Check that the correct motor is running.	
3.	**Select SS1**		
	3.1.	Select SS1 while the motor is switched on. *Test each configured activation, e.g. via digital inputs and PROFIsafe.*	
	3.2.	In your machine, check the following:	
		• The motor brakes on the OFF3 ramp.	
		• SS1 is active (r9773.6 = 1).	
		• After the p9652 time has expired, the inverter signals: "STO is active" (r9773.1 = 1).	
4.	**Deselect SS1**		
	4.1.	Deselect SS1.	
	4.2.	Check the following:	
		• SS1 is not active (r9773.6 = 0).	
		• The inverter signals neither faults nor alarms of the safety functions (r0945[0…7], r2122[0…7]).	

☐   You have completed the acceptance test of the SS1 function.

4.10.4.4 SS1 acceptance test (extended functions)

The two diagrams show the recommended steps to take during the acceptance test. The behavior of the drive differs according to the settings you have made for SS1 :

- Diagram 1: After SS1 has been selected, the inverter monitors the speed using braking ramp monitoring.

- Diagram 2: After SS1 has been selected, the inverter monitors the speed using the acceleration monitoring.
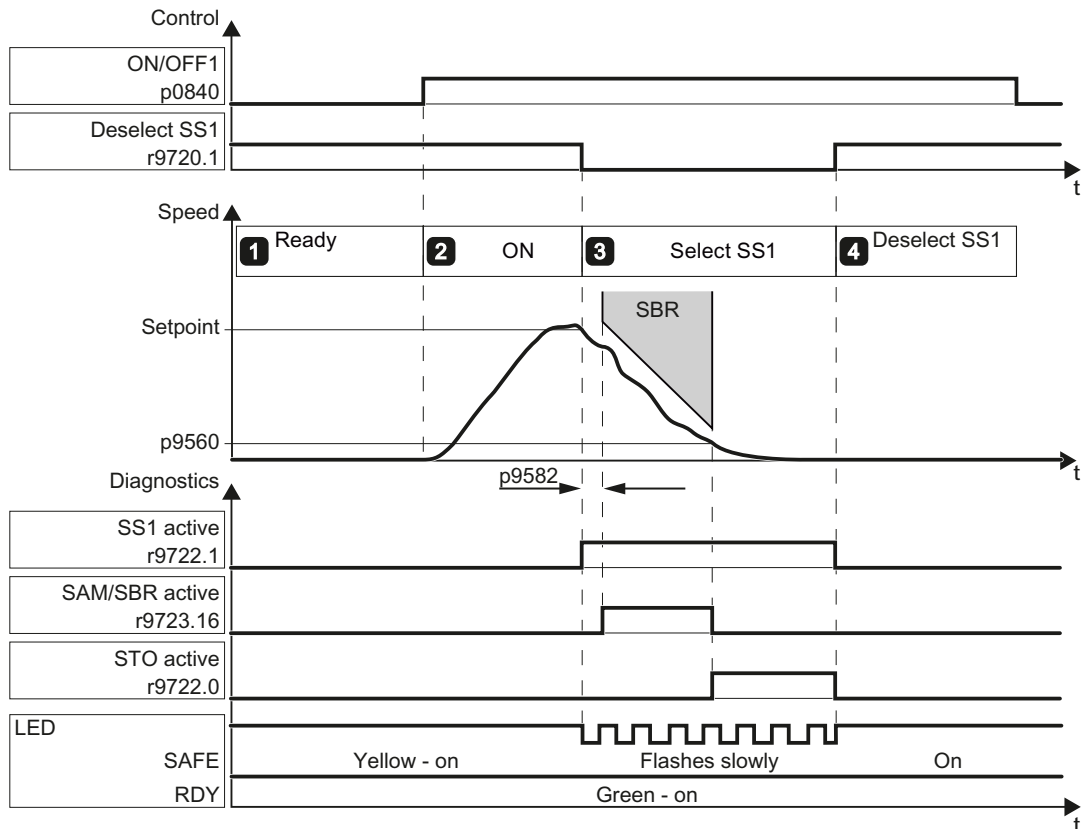
Figure 4-31   Diagram 1 - acceptance test SS1 with braking ramp monitoring
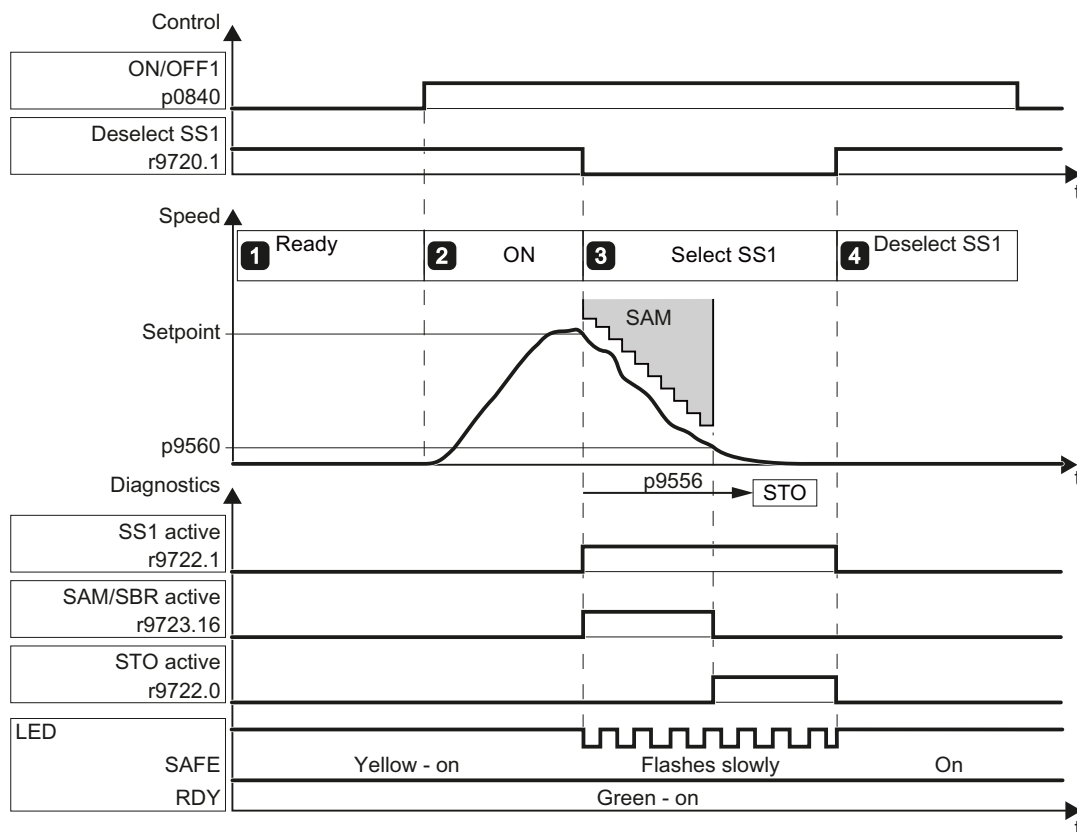
Figure 4-32   Diagram 2 - acceptance test for SS1 with acceleration monitoring

Procedure

To perform the acceptance test of the SS1 function, proceed as follows:

		Status
1.	**The inverter is ready**	
	• The inverter signals neither faults nor alarms of the safety functions (r0945[0…7], r2122[0…7]).	
	• SS1 is not active (r9722.1 = 0).	
	Go online with the STARTER and configure the following trace:	
	• Trigger on variable - bit pattern (r9720.1 = 0)	
	• Record the following values: r9714[0], r9714[1], r9722	
	Display the bits r9722.0/.1	
	• Select the time interval and pretrigger so you can recognize the selection of SS1 and the transition into the subsequent STO state.	
	• Start the trace.	

			Status
2.	**Switch on motor**		
	2.1.	Enter a speed setpoint ≠ 0.	
	2.2.	Switch on the motor (ON command).	
	2.3.	Check that the correct motor is running.	
3.	**Select SS1**		
	3.1.	Select SS1 while the motor is switched on. *Test each configured activation, e.g. via digital inputs and PROFIsafe.*	
	3.2.	Check: The inverter signals neither faults nor alarms of the safety functions (r0945[0…7], r2122[0…7]).	
	3.3.	Analyze the trace.	
		• SS1 is active after selecting SS1 (r9722.1 = 1).	
		• The motor brakes on the OFF3 ramp.	
		• STO becomes active if the speed drops below the shutdown speed p9560 (r9722.0 = 1).	
		• The recorded curves of r9714[0] and r9714[1] are approximately parallel.	
4.	**Deselect SS1**		
	4.1.	Deselect SS1.	
	4.2.	Check the following:	
		• SS1 is not active (r9722.1 = 0).	
		• The inverter signals neither faults nor alarms of the safety functions (r0945[0…7], r2122[0…7]).	

☐   You have completed the acceptance test of the SS1 function.

Example of a trace

① SS1 is selected

② SS1 is active

③ The motor brakes on the OFF3 ramp.

④ The inverter monitors the speed

⑤ STO is active
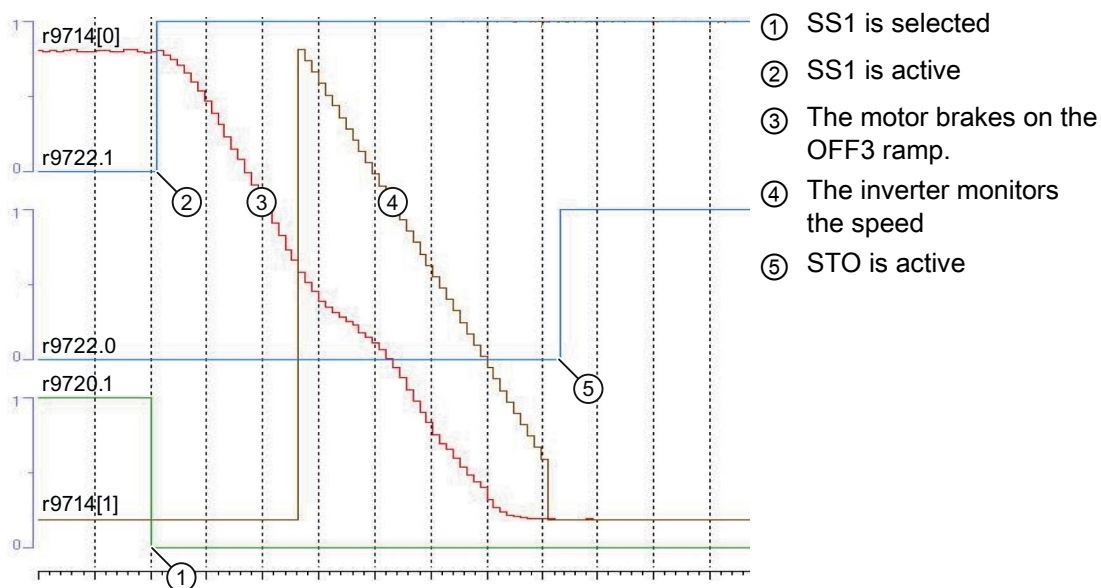
4.10.4.5   SBC acceptance test
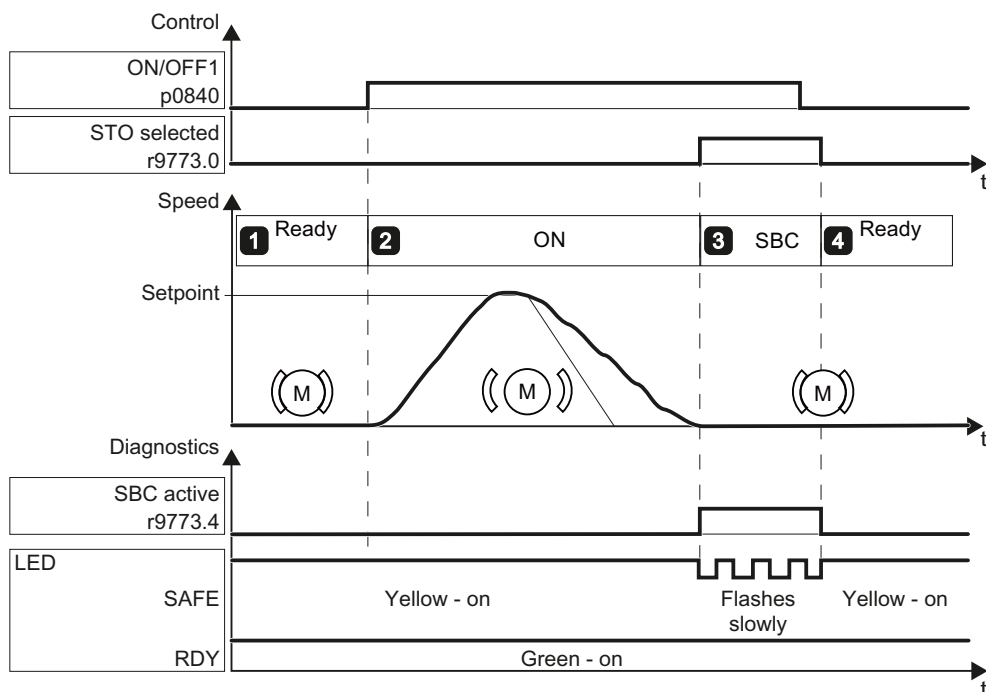
Figure 4-33   Acceptance test for SBC

Procedure

1
2

To perform the acceptance test of the SBC function, proceed as follows:

		Status
1.	**The inverter is ready**	
	• The inverter signals neither faults nor alarms of the safety functions (r0945[0…7], r2122[0…7]).	
	• SBC is not active (r9773.4 = 0).	
2.	**Switch on motor**	
	2.1. Enter a speed setpoint ≠ 0.	
	2.2. Switch on the motor (ON command).	
	2.3. Check that the correct motor is running.	
	2.4. Enter a speed setpoint = 0.	
3.	**Select SBC**	
	3.1. Select the STO function or the SS1 function.	
	3.2. Check: The inverter signals "SBC is active" (r9773.4 = 1).	
4.	**inverter is ready**	
	4.1. Deselect STO.	
	4.2. Check the following:	
	• The inverter signals "SBC is not active" (r9773.4 = 0).	
	• The inverter signals neither faults nor alarms of the safety functions (r0945[0…7], r2122[0…7]).	

You have performed the acceptance test of the SBC function.

4.10.4.6 Acceptance test SLS

The two diagrams show the recommended steps to take during the acceptance test. The behavior of the drive differs according to the settings you have made for SLS :

● Diagram 1: If the speed is excessively high, the drive responds with a STOP A.

● Diagram 2: If the speed is excessively high, the drive responds with a STOP B.
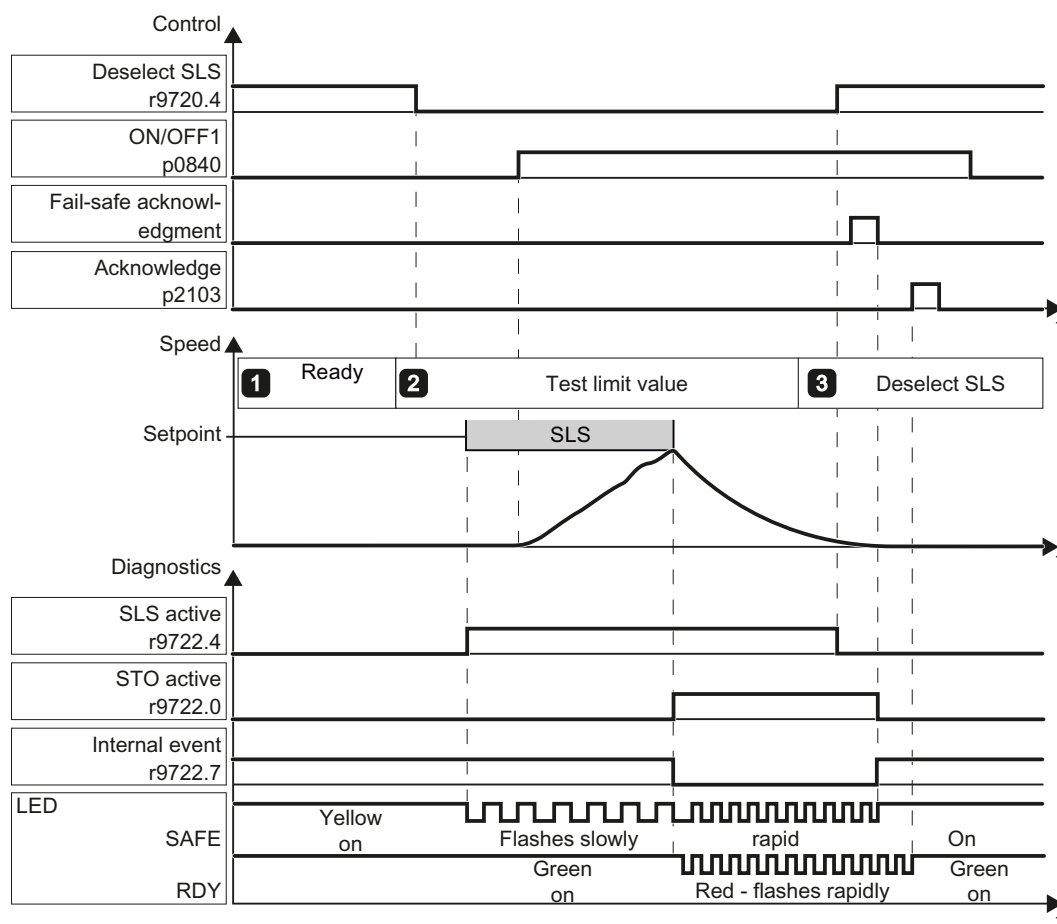
Figure 4-34   Diagram 1 - acceptance test for SLS with stop response STOP A
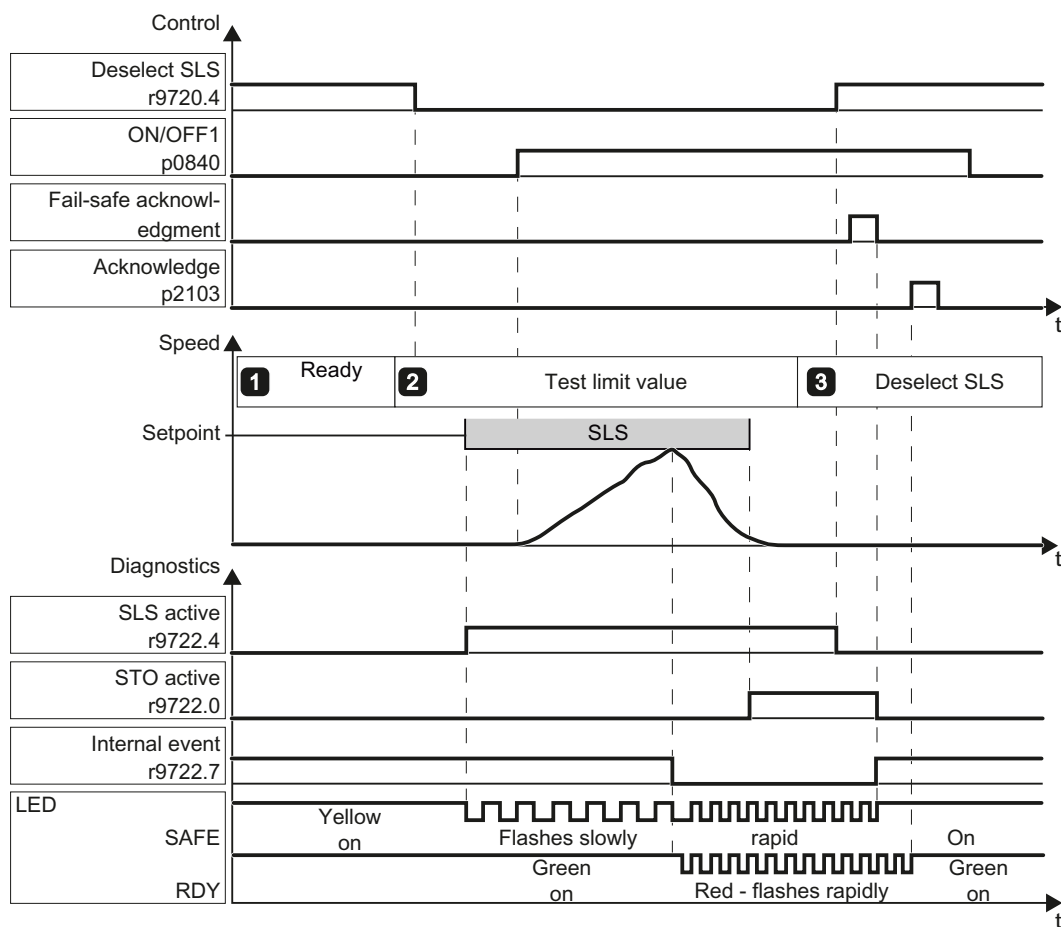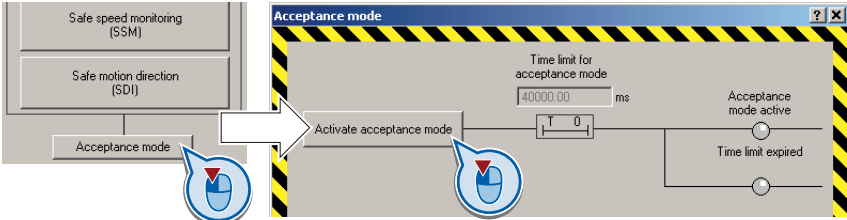
Figure 4-35　Diagram 2 - acceptance test SLS with stop response STOP B

Procedure

To perform the acceptance test of the SLS function, proceed as follows:

		Status
	If you are using multiple SLS levels, repeat the test for each of the SLS levels.	
1.	**The inverter is ready**	
	Check the following:	
	• The inverter signals neither faults nor alarms of the safety functions (r0945[0…7], r2122[0…7]).	
	• SLS is not active (r9722.4 = 0).	
	Go online with the STARTER and configure the following trace:	
	• Trigger on variable - bit pattern (r9722.7 = 0)	
	• Record the following values: r9714[0], r9714[1], r9721, r9722	
	Display the bits r9722.0/.4/.7/.9/.10	
	• Select the time interval and pretrigger so you can recognize when the active SLS limit has been exceeded and the subsequent drive responses.	

			Status
2.	**Switch on motor**		
	2.1.	Enter a speed setpoint > SLS level.	
	2.2.	Select SLS with the SLS level to be tested.	
	2.3.	Activate the acceptance mode: 	
		WARNING **Machine motion hazard** In the following test, speed limitation of the SLS function is deactivated. The increased motor speed can lead to material damage or physical injury. • For this test, secure dangerous machine parts using barriers, for example.	
	2.4.	Switch on the motor within 5 seconds after selecting SLS (ON command). *If you wait longer than 5 seconds for the ON command, then STO is activated. In this case, deselect SLS and then select it again.*	
	2.5.	Check that the correct motor is running.	
		The following tests depend on how you have set the SLS function during commissioning:	
		First diagram: *The inverter responds with STOP A in the event of a limit violation.*	*Second diagram:* *The inverter responds with STOP B in the event of a limit violation.*	
	2.6.	The inverter signals the following: • C01714 and C30714 (safely limited speed exceeded) • C01700 and C30700 (STOP A initiated)	The inverter signals the following: • C01714 and C30714 (safely limited speed exceeded) • C01701 and C30701 (STOP B initiated) • C01700 and C30700 (STOP A initiated)	

				Status
	2.7.	Analyze the trace.		
		• After SLS is selected, the inverter signals "SLS is active" (r9722.4 = 1).		
		• The inverter signals the selected SLS level (r9722.9 and r9722.10).		
		• If r9714[0] exceeds the active SLS limit, the inverter signals an internal event (r9722.7 = 0).		
		STOP A in the event of a limit value violation	*STOP B in the event of a limit value violation*	
		• If r9714[0] exceeds the active SLS limit, the motor coasts down to a standstill (r9722.0 = 1).	• If r9714[0] exceeds the active SLS limit, the motor brakes on the OFF3 ramp (r9722.1 = 1).	
			• After braking, STO is active (r9722.0 = 1).	
3.	**Deselect SLS**			
	3.1.	Deselect SLS.		
	3.2.	Check: SLS is not active (r9722.4 = 0).		
	3.3.	Acknowledge the messages for the safety functions.		

You have performed the acceptance test of the SLS function.

Example of a trace (STOP B in the event of a limit violation)

① SLS is active

② The motor accelerates to the active SLS level

③ The speed exceeds the active SLS level

④ STOP B is active - the motor brakes on the OFF3 ramp

⑤ The inverter monitors the speed

⑥ STOP A as a consequence of STOP B being active
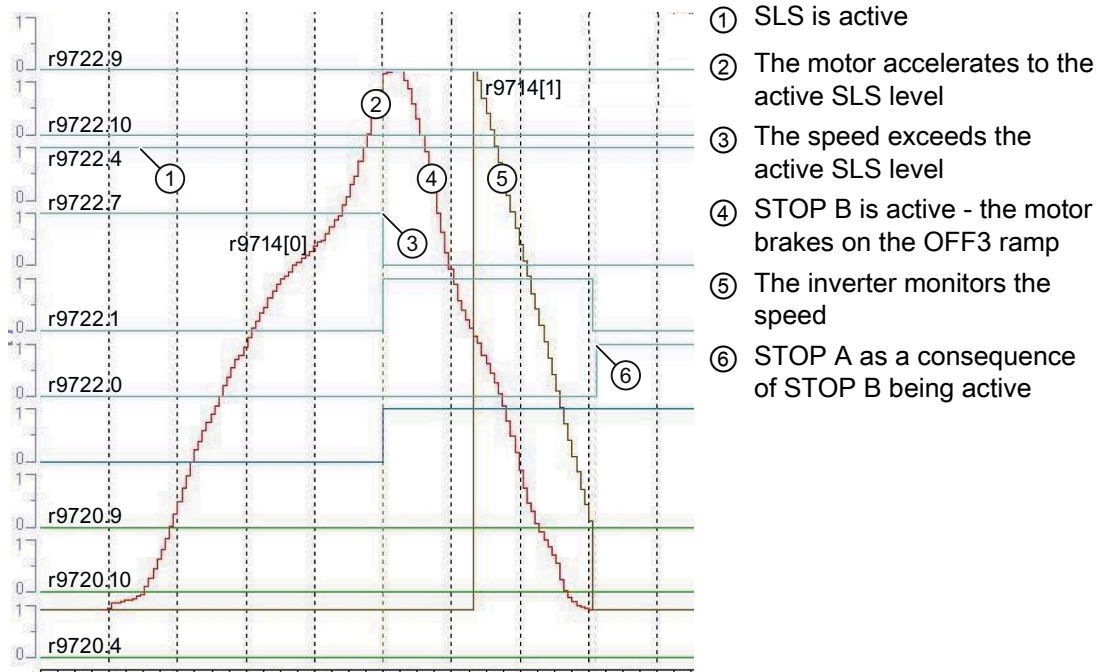
4.10.4.7   SSM acceptance test

The two diagrams show the recommended steps to take during the acceptance test. It differs depending on the settings you have made for SSM :

● Diagram 1: The "speed below limit value" checkback signal remains active when the motor is switched off.

● Diagram 2: The "speed below limit value" checkback signal becomes inactive when the motor is switched off.

The diagrams show the setting "SSM without hysteresis" as an example.
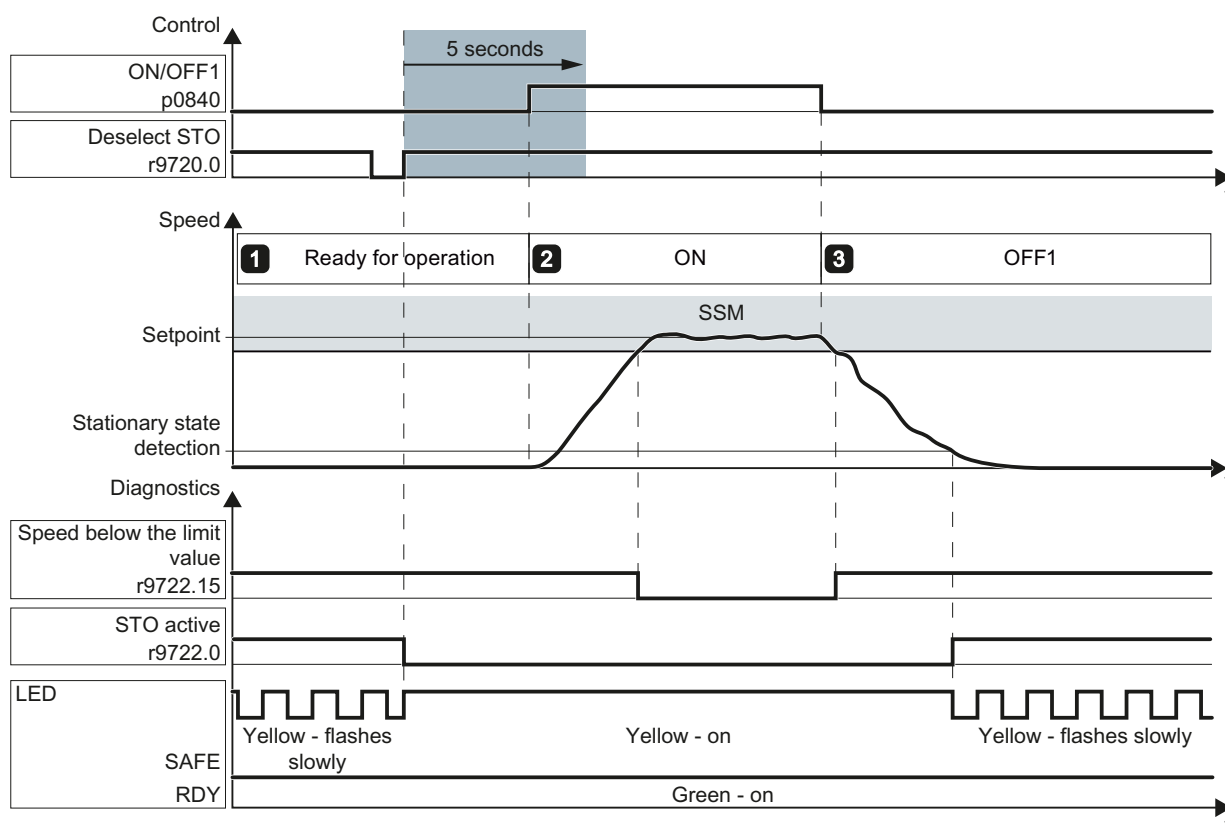
Figure 4-36   Diagram 1 - acceptance test SSM with active feedback signal when the motor is switched off
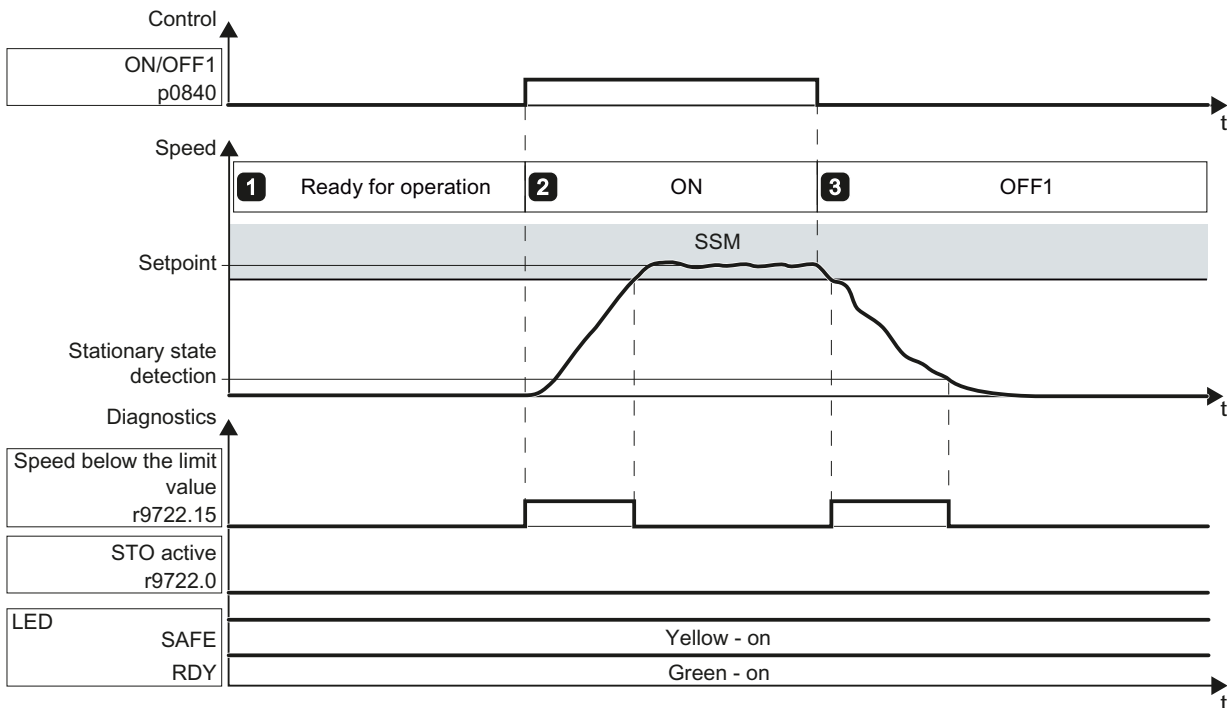
Figure 4-37   Diagram 2 - acceptance test SSM with inactive feedback signal when the motor is switched off

Procedure

1
2

To perform the acceptance test of the SSM function, proceed as follows:

		Status
1.	**The inverter is ready**	
	• Check: The inverter signals neither faults nor alarms of the safety functions (r0945[0…7], r2122[0…7]).	
	Go online with the STARTER and configure the following trace: • Trigger on variable - bit pattern (r9722.15 = 0) • Record the following values: r0899, r9714[0], r9722 Display the following bits: – r0899.11 – r9722.15 • Select the time interval and pretrigger so you can recognize when the level exceeds the SSM limit and subsequently falls below it again.	
2.	**Switch on motor**	
	2.1.	Specify a speed setpoint which is above the SSM limit.	

				Status
	2.2.	*The following procedure depends on how you have set the SSM function during commissioning:*		
		Upper diagram: *The "speed below limit value" checkback signal remains active when the motor is switched off.*	*Lower diagram:* *The "speed below limit value" checkback signal becomes inactive when the motor is switched off.*	
		2.2.1. Select STO.	Switch on the motor (ON command).	
		2.2.2. Deselect STO again.		
		2.2.3. Switch on motor within 5 seconds after deselecting STO (ON command).		
	2.3.	Check that the correct motor is running.		
	2.4.	Wait until the motor speed reaches the setpoint.		
3.	**Switch off the motor**			
	3.1.	Switch the motor off (OFF1 command).		
	3.2.	Analyze the trace:		
		• If r9714[0] > speed limit p9346, then r9722.15 = 0 applies.		
		SSM without hysteresis: • If r9714[0] < speed limit p9546, then r9722.15 = 1 applies.	*SSM with hysteresis:* • If r9714[0] < speed limit p9546 - hysteresis p9547, then r9722.15 = 1 applies.	
		The "speed below limit value" checkback signal remains active when the motor is switched off: • If the motor is switched off (r0899.11 = 0), then r9722.15 = 1 applies.	*The "speed below limit value" checkback signal becomes inactive when the motor is switched off:* • If the motor is switched off (r0899.11 = 0), then r9722.15 = 0 applies.	

☐ You have completed the acceptance test of the SSM function.

Example of a trace

① The motor accelerates

② Speed above the limit value

③ Speed below the limit value

4.10.4.8 Acceptance test SDI

The acceptance test for SDI+ and SDI- is separately described in the following. If you use the SDI function in both directions of rotation, you must carry out both acceptance tests.

SDI can be set with the STOP A and STOP B stop responses. The following diagrams only show the case with the stop response STOP A. The different response of the drive, depending on the stop response set is described in the following tables.

Acceptance test for SDI positive

The two diagrams show the recommended steps to take during the acceptance test. The acceptance test differs depending on how you have set SDI:

● Diagram 1: The "SDI active" feedback signal remains active when the motor is switched off.

● Diagram 2: The "SDI active" feedback signal becomes inactive when the motor is switched off.
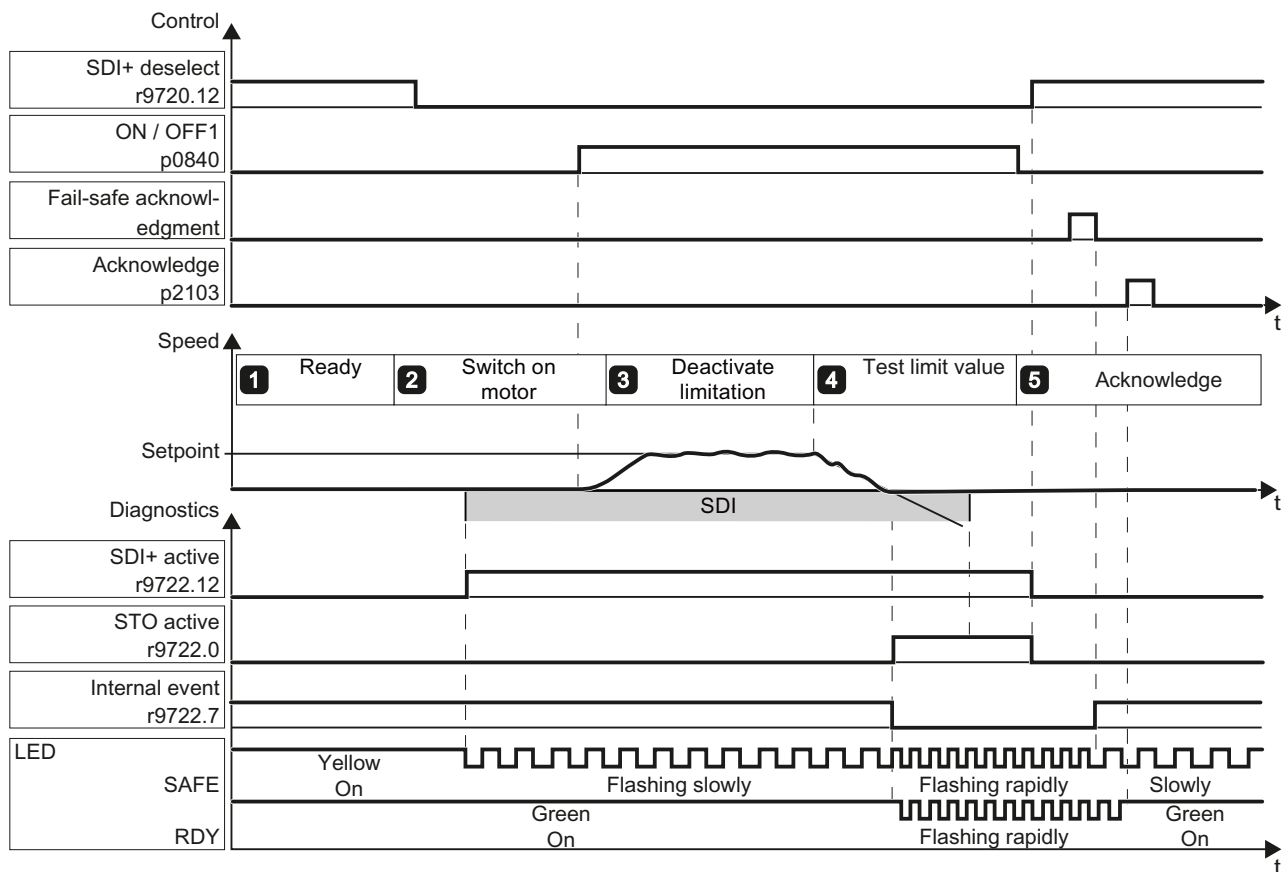
Figure 4-38   Diagram 1 - acceptance for SDI+, "SDI active" remains active when the motor is switched off
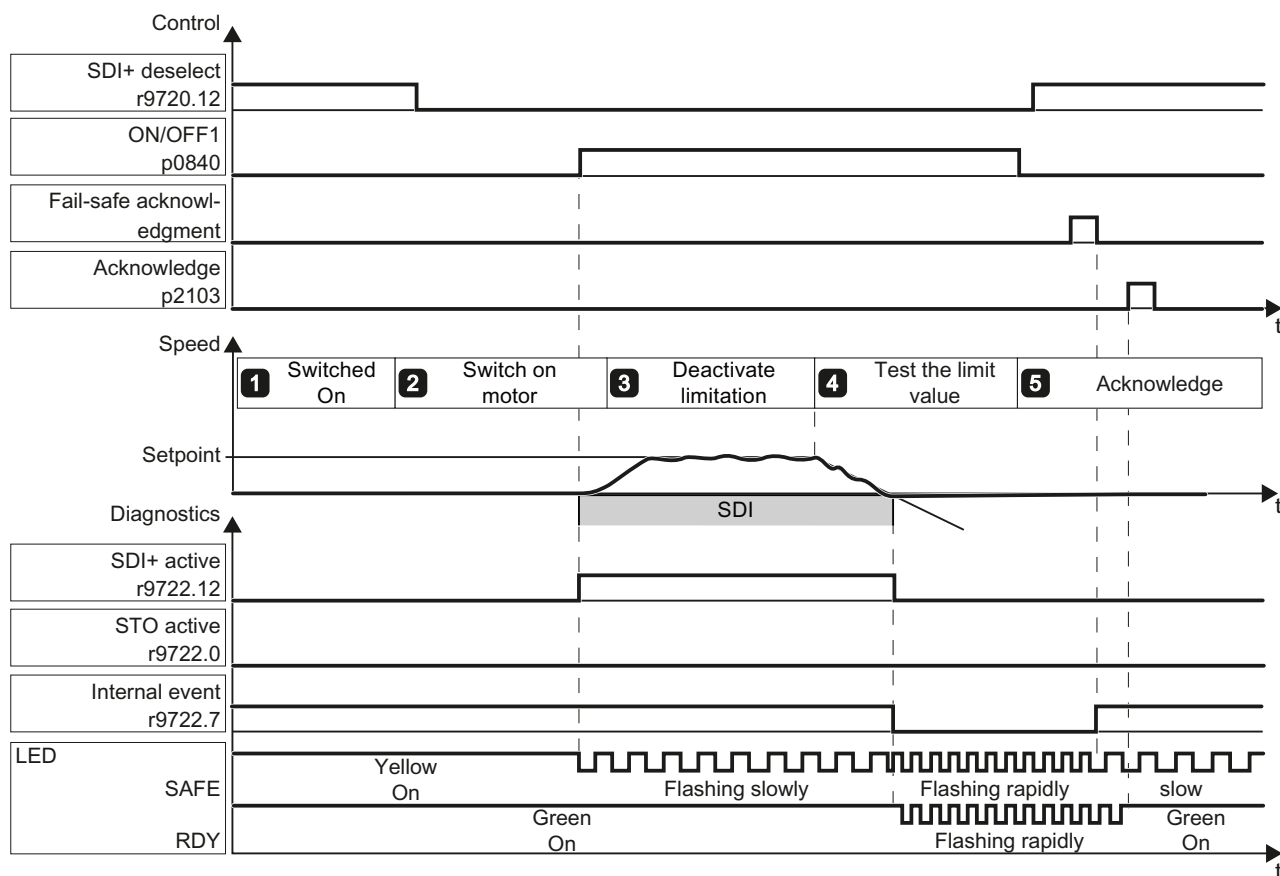
Figure 4-39   Diagram 2 - acceptance for SDI+, "SDI active" becomes inactive when the motor is switched off
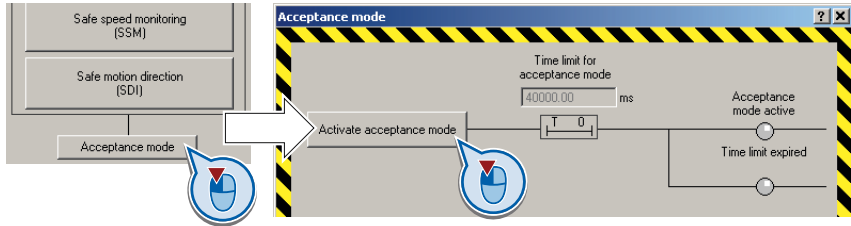
Procedure

1
2
To perform the acceptance test of the SDI function for the positive direction of rotation, proceed as follows:

		Status
1.	**The inverter is ready**	
	Check the following:	
	• The inverter signals neither faults nor alarms of the safety functions (r0945[0…7], r2122[0…7]).	
	• SDI+ is not active (r9722.12 = 0).	
	Go online with the STARTER and configure the following trace:	
	• Trigger on variable - bit pattern (r9722.7 = 0).	
	• Record the following values: r9713[0], r9722	
	Display the bits r9722.0/.1/.7/.12	
	• Select the time interval and pretrigger so you can recognize when the SDI tolerance has been exceeded and the subsequent drive responses.	

				Status
2.	**Switch on motor**			
	2.1.	Enter a positive speed setpoint.		
	2.2.	Select SDI+ so that only positive speeds are permitted.		
	2.3.	*The next steps depend on how you have set the SDI function during commissioning:*		
		First diagram: *The "SDI active" feedback signal remains active when the motor is switched off.*	*Second diagram:* *The "SDI active" feedback signal becomes inactive when the motor is switched off.*	
		Switch on motor within 5 seconds after deselecting SDI (ON command). *If you wait longer than 5 seconds for the ON command, then STO is activated. In this case, deselect SDI and then select it again.*	Switch on the motor (ON command).	
	2.4.	Check that the correct motor is rotating in the expected direction.		
3.	**Deactivate the setpoint limitation for the acceptance test**			
	Activate the Acceptance mode: 			
4.	**Test the set limit value**			
	4.1.	Enter a negative speed setpoint.		
	4.2.	*The following test depends on how you have set the SDI function during commissioning:*		
		STOP A in the event of a limit value violation • The inverter signals the following: – C01716 and C30716 (tolerance for safe direction of motion exceeded) – C01700 and C30700 (STOP A initiated)	*STOP B in the event of a limit value violation* • The inverter signals the following: – C01716 and C30716 (tolerance for safe direction of motion exceeded) – C01701 and C30701 (STOP B initiated) – C01700 and C30700 (STOP A initiated)	
	4.3.	Analyze the trace:		
		• When SDI+ is selected, the inverter signals: SDI+ is active (r9722.12 = 1).		
		• If r9713[0] > SDI tolerance, then the inverter signals an internal event (r9722.7 = 0).		

				Status
		STOP A in the event of a limit value violation	*STOP B in the event of a limit value violation*	
		• The motor coasts down to a standstill (r9722.0 = 1).	• The inverter brakes the motor on the OFF3 ramp (r9722.1 = 1).	
			• After braking, STO is active (r9722.0 = 1).	
5.	**Acknowledge fault**			
	5.1.	Deselect SDI+.		
	5.2.	Check: SDI+ is not active (r9722.12 = 0).		
	5.3.	Acknowledge the messages for the safety functions.		

You have completed the acceptance test of the SDI function for the positive direction of rotation.

Acceptance test for SDI negative

The two diagrams show the recommended steps to take during the acceptance test. The acceptance test differs depending on how you have set SDI:

- Diagram 1: The "SDI active" feedback signal remains active when the motor is switched off.

- Diagram 2: The "SDI active" feedback signal becomes inactive when the motor is switched off.
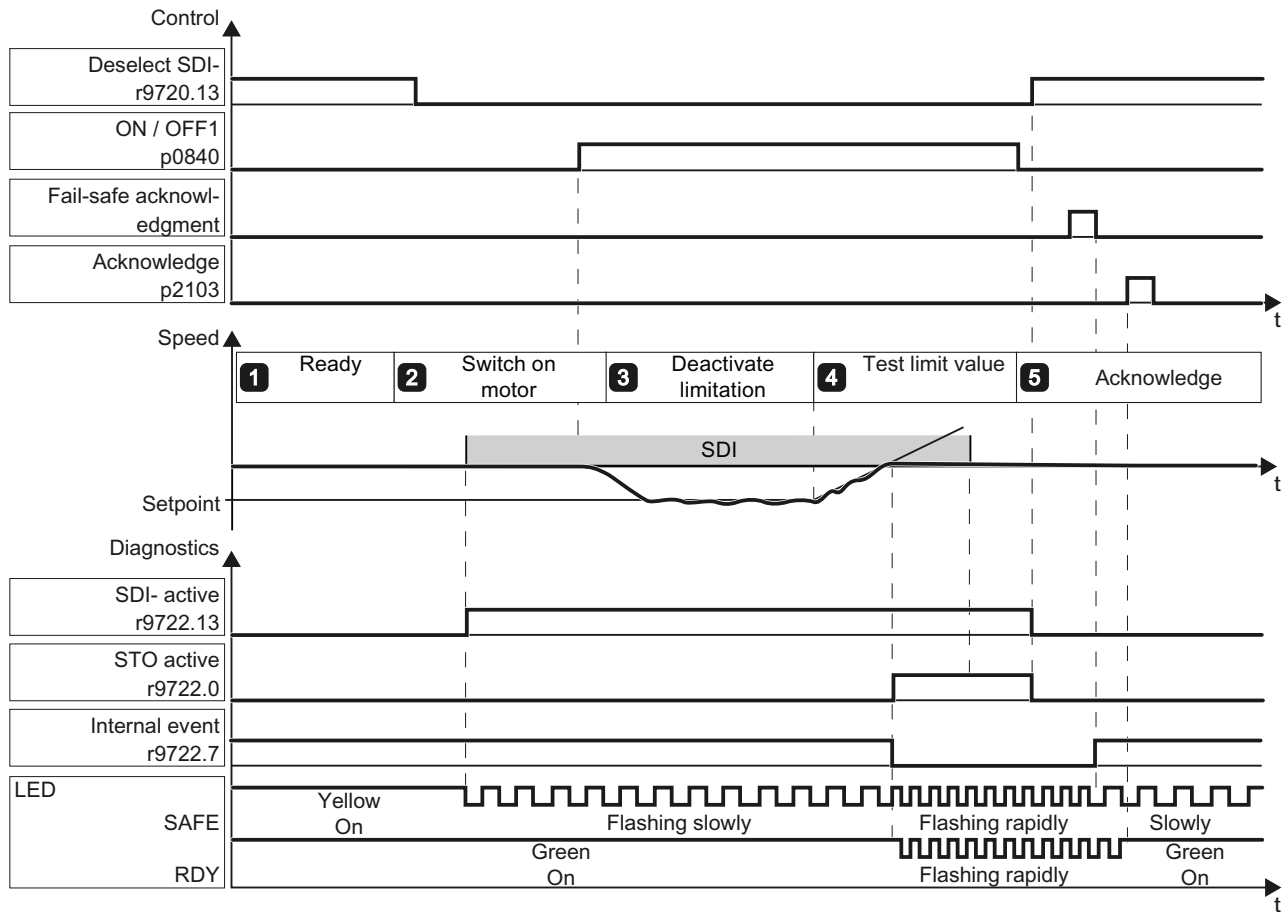
Figure 4-40   Diagram 1 - acceptance for SDI-, "SDI active" remains active when the motor is switched off
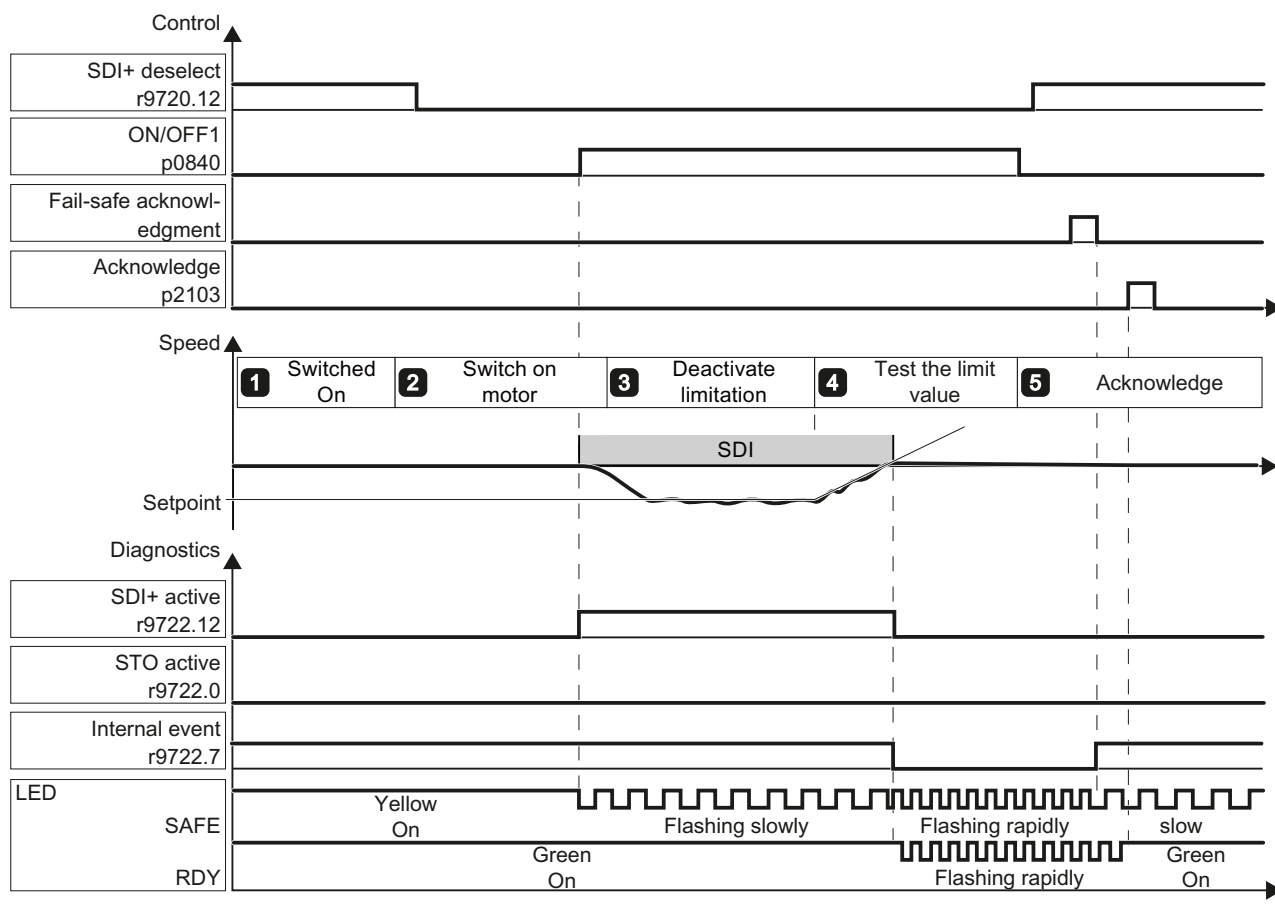
Figure 4-41   Diagram 2 - acceptance for SDI-, "SDI active" becomes inactive when the motor is switched off
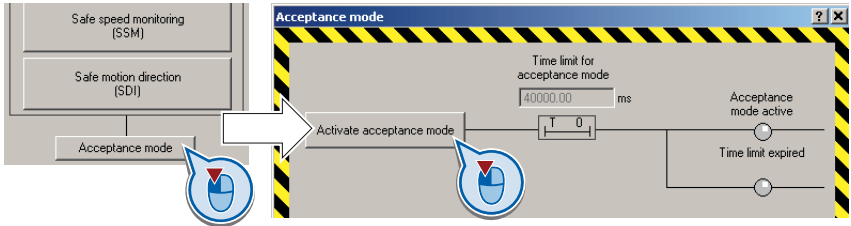
Procedure

To perform the acceptance test of the SDI function for the negative direction of rotation, proceed as follows:

		Status
1.	**The inverter is ready**	
	Check the following:	
	• SDI- is not active (r9722.13 = 0).	
	• The inverter signals neither faults nor alarms of the safety functions (r0945[0…7], r2122[0…7]).	
	Go online with the STARTER and configure the following trace:	
	• Trigger on variable - bit pattern (r9722.7 = 0).	
	• Record the following values: r9713[0], r9722	
	Display the bits r9722.0/.1/.7/.13	
	• Select the time interval and pretrigger so you can recognize when the SDI tolerance has been exceeded and the subsequent drive responses.	

|				Status
2.	**Switch on motor**			
	2.1.	Enter a negative speed setpoint.		
	2.2.	Select SDI- so that only negative speeds are permitted.		
	2.3.	*The next steps depend on what settings you made for SDI during commissioning:*		
		First diagram:	*Second diagram:*	
		The "SDI active" feedback signal remains active when the motor is switched off.	*The "SDI active" feedback signal becomes inactive when the motor is switched off.*	
		Switch on motor within 5 seconds after deselecting SDI (ON command). *If you wait longer than 5 seconds for the ON command, then STO is activated. In this case, deselect SDI and then select it again.*	Switch on the motor (ON command).	
	2.4.	Check that the correct motor is rotating in the expected direction.		
3.	**Deactivate the setpoint limitation for the acceptance test**			
	Activate the Acceptance mode:			
4.	**Test the set limit value**			
	4.1.	Enter a positive speed setpoint.		
	4.2.	*The following test depends on how you have set the SDI function during commissioning:*		
		STOP A in the event of a limit value violation	*STOP B in the event of a limit value violation*	
		The inverter signals the following: • C01716 and C30716 (tolerance for safe direction of motion exceeded) • C01700 and C30700 (STOP A initiated)	The inverter signals the following: • C01716 and C30716 (tolerance for safe direction of motion exceeded) • C01701 and C30701 (STOP B initiated) • C01700 and C30700 (STOP A initiated)	

				Status
	4.3.	Analyze the trace		
		• When SDI- is activated, the inverter signals: SDI- is active (r9722.13 = 1).		
		• If r9713[0] > SDI tolerance, then the inverter signals an internal event (r9722.7 = 0).		
		STOP A in the event of a limit value violation	*STOP B in the event of a limit violation*	
		• The motor coasts down to a standstill (r9722.0 = 1).	• The inverter brakes the motor on the OFF3 ramp (r9722.1 = 1).	
			• After braking, STO is active (r9722.0 = 1).	
5.		**Acknowledge fault**		
	5.1.	Deselect SDI-.		
	5.2.	Check: SDI- is not active (r9722.13 = 0).		
	5.3.	Acknowledge the messages for the safety functions.		

You have completed the acceptance test of the SDI function for the negative direction of rotation.

Example of a trace (STOP B in the event of a limit violation)

① SDI is selected

② The motor starts to rotate

③ The position of the drive deviates from the permissible tolerance

④ STOP B is active - the motor brakes on the OFF3 ramp

⑤ STOP A as a consequence of STOP B being active
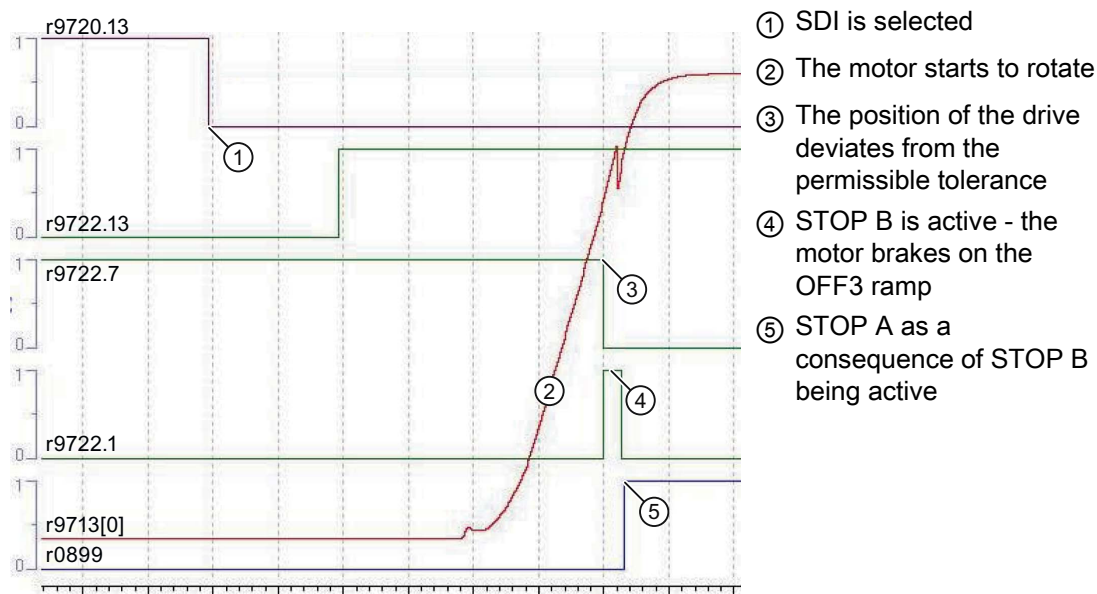
4.10.4.9 Acceptance test for F-DI status in PROFIsafe telegram 900
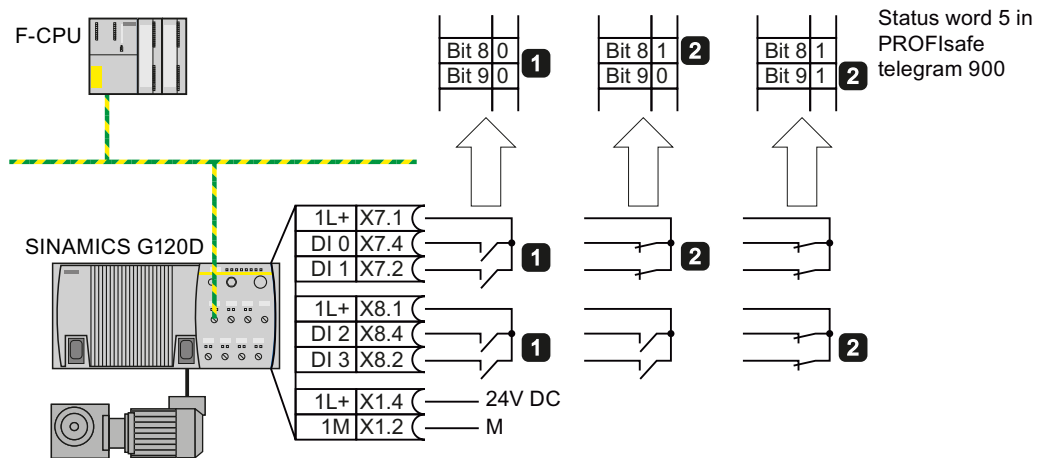
Figure 4-42   Acceptance test for the status of the fail-safe inputs using the example of a SINAMICS G120D

Procedure

To perform the acceptance test of the F-DI status, proceed as follows:

			Status
-	**The inverter is ready**		
	• The inverter signals neither faults nor alarms of the safety functions (r0945[0…7], r2122[0…7]).		
1.	**Check the "Low" status of the fail-safe input**		
	1.1.	Switch the signal of the fail-safe input to be tested to low.	
	1.2.	In status word 5 of the PROFIsafe telegram, check whether the corresponding bit has a value of 0.	
2.	**Check the "High" status of the fail-safe input**		
	2.1.	Switch the signal of the fail-safe input to be tested to high.	
	2.2.	In status word 5 of the PROFIsafe telegram, check whether the corresponding bit has a value of 1.	

You have completed the acceptance test for the F-DI status.

Operation

<div style="text-align: right; font-size: 2em;">5</div>

Overview

This chapter answers the following questions:

- How does the drive respond when you select and deselect one of the safety functions?

- What do I need to observe when the motor is switched off or switched on with a safety function active?

- How do the safety functions mutually influence one another, if you select more than one safety function?

- How does the drive respond to a discrepant input signal?

- How does the drive respond to limit value violations or if internal monitoring functions respond?

5.1 Selecting and deselecting a safety function when the motor is switched on

5.1.1 Safe Torque Off (STO)

Selecting STO

Function

1. The machine control selects the STO safety function via a fail-safe input or via the safe PROFIsafe communication.

2. The inverter then safely switches off the motor torque.
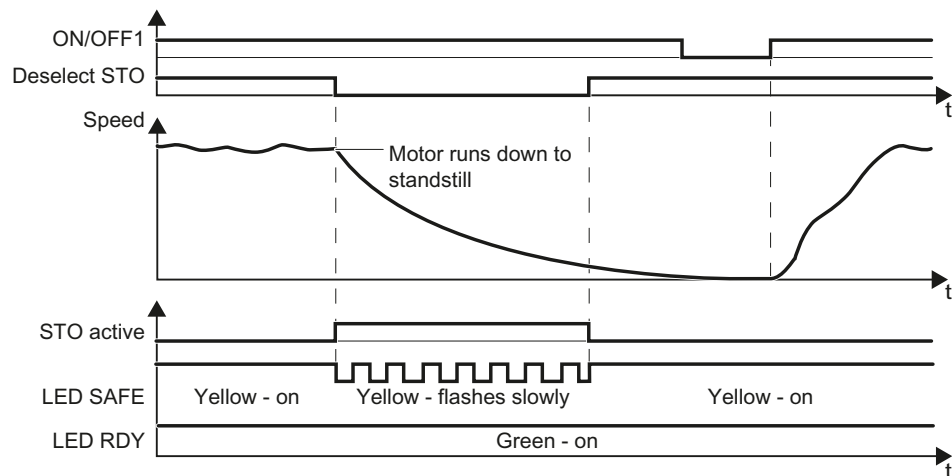
Figure 5-1   Time response of the safety function STO (Safe Torque Off)

Switching on the motor once STO is active

Procedure
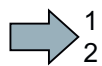
To switch the motor on again once STO is active, proceed as follows:

1. Deselect STO .

2. Switch on the motor: ON/OFF1 = 1.

You have switched on the motor.

5.1.2 Safe Brake Control (SBC)

If you have connected the motor holding brake to the inverter via the Safe Brake Relay, then the SBC function is active under the following conditions:

1. You have activated the "motor holding brake" function in the inverter.

2. You have enabled the SBC function.

3. The STO function is active in the inverter.

The following cases describe how the SBC function becomes active.

Selecting STO when the motor is at a standstill

Function

1. The higher-level control switches the motor off: ON/OFF1 = 0 or OFF3 = 0.

2. When the drive has come to a standstill, the control selects the STO function.
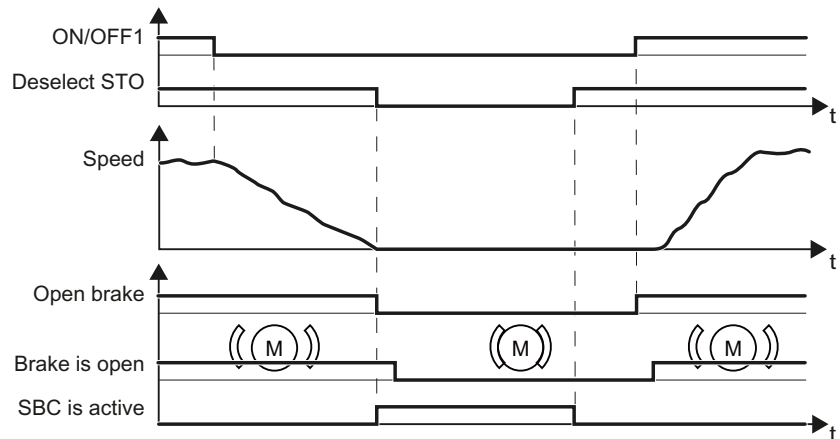
Figure 5-2   Wait until standstill is reached and activate SBC with STO

Before you can switch on the motor again, you must deselect the STO function.

Selecting SS1 when the motor is rotating

Function

1. The higher-level control selects the SS1 function

2. The inverter brakes the motor with the OFF3 ramp-down time.

3. The inverter closes the motor holding brake once the motor is at a standstill.

4. If the standstill monitoring is undershot, or once the delay time has expired, the inverter activates the STO function and controls the brake with the SBC function.
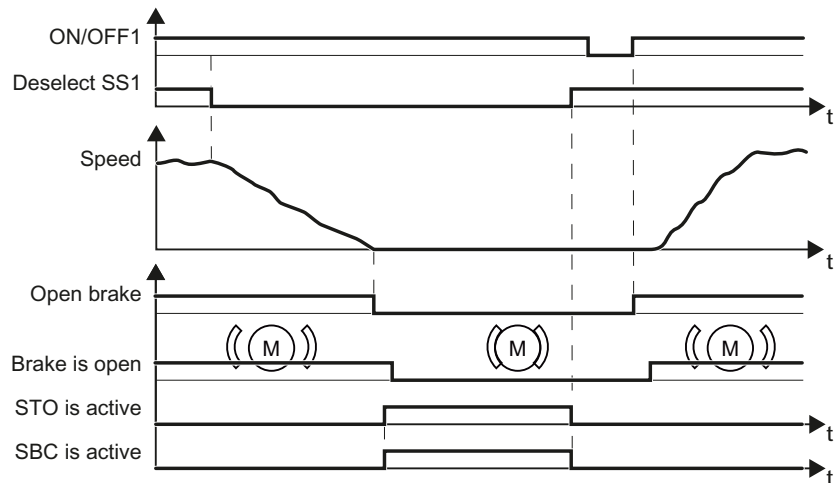
Figure 5-3   When selecting SS1, the motor holding brake closes at standstill

Before you can switch on the motor again, you must deselect the SS1 function.

Selecting STO when the motor is rotating

Function

1. The higher-level control selects the STO function

2. The inverter closes the brake without taking the current speed into consideration.
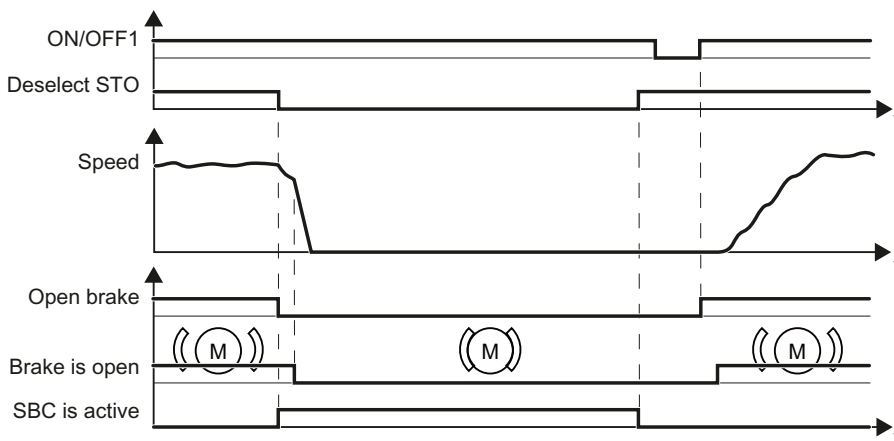
Figure 5-4   The motor holding brake closes after selecting STO

Before you can switch on the motor again, you must deselect the STO function.

5.1.3 Safe Stop 1 (SS1)

5.1.3.1 SS1 without monitoring

Selecting SS1

Function

1. The higher-level control selects the SS1 safety function via a fail-safe input or via the safe PROFIsafe communication.

2. If the motor is switched on when SS1 is selected, the inverter brakes the motor with the OFF3 ramp-down time.

3. After the delay time, the inverter safely switches off the motor torque with the STO safety function.
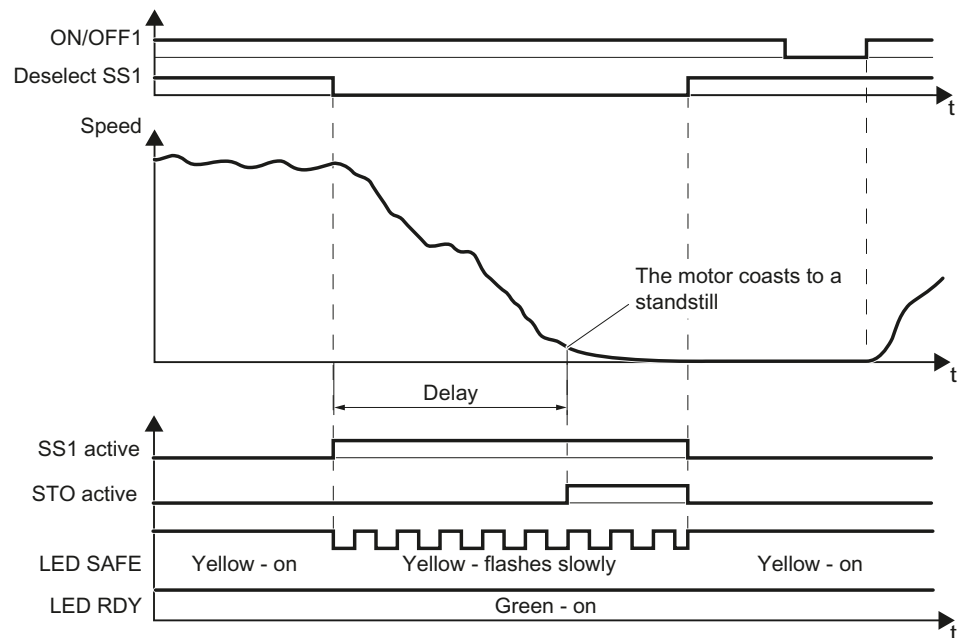
Figure 5-5   Braking behavior and diagnostics of the safety function SS1 (Safe Stop 1)

Switching on the motor once SS1 is active

Procedure

To switch the motor on again once SS1 is active, proceed as follows:

1. Deselect SS1.

2. Switch on the motor: ON/OFF1 = 1.

You have switched on the motor.

5.1.3.2 SS1 with braking ramp monitoring

Selecting SS1

Function

1. The higher-level control selects the SS1 safety function via a fail-safe input or via the safe PROFIsafe communication.

2. If the motor has already been switched off when selecting SS1 , then the inverter safely switches off the motor torque with the safety function STO .

   If the motor is switched on when SS1 is selected, the inverter brakes the motor with the OFF3 ramp-down time. The inverter monitors whether the load speed decreases using the SBRfunction.

3. The inverter safely switches off the motor torque using the STO safety function if the load speed reaches the "standstill monitoring".
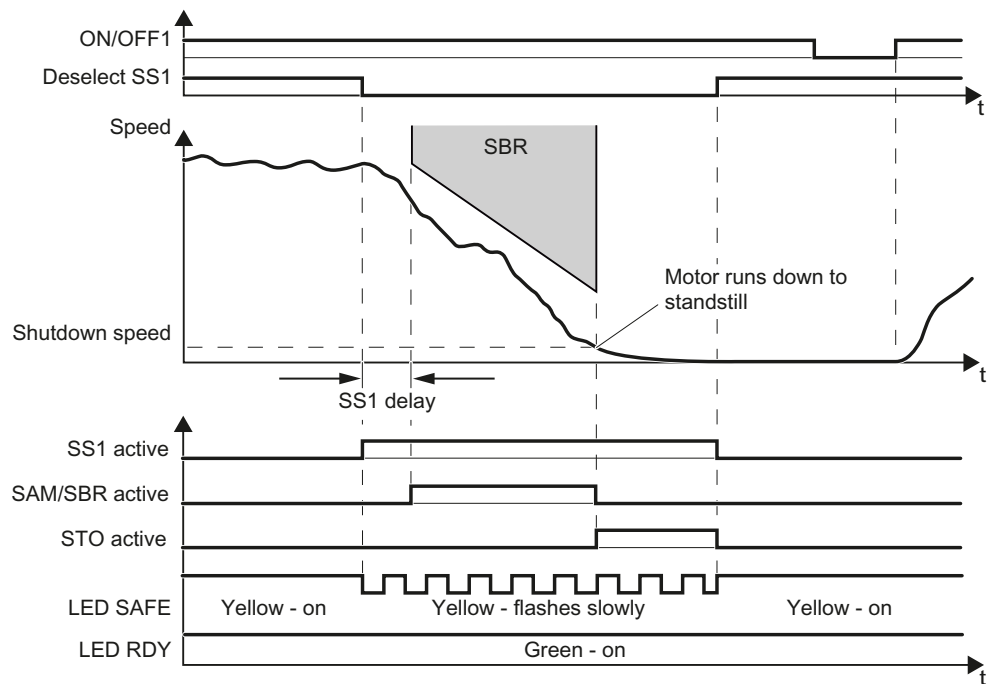
Figure 5-6   Braking behavior and diagnostics of the safety function SS1 (Safe Stop 1)

Switching on the motor once SS1 is active

Procedure

To switch the motor on again once SS1 is active, proceed as follows:

1. Deselect SS1.

2. Switch on the motor: ON/OFF1 = 1.

You have switched on the motor.

5.1.3.3 SS1 with acceleration monitoring

Selecting SS1

Function

1. The higher-level control selects the SS1 safety function via a fail-safe input or via the safe PROFIsafe communication.

2. If the motor has already been switched off when selecting SS1 , then the inverter safely switches off the motor torque with the safety function STO .

   If the motor is switched on when SS1 is selected, the inverter brakes the motor with the OFF3 ramp-down time. The inverter monitors braking using the SAM function (Safe Acceleration Monitor).

3. The inverter safely switches off the motor torque using the STO safety function if the load speed reaches the "standstill monitoring".
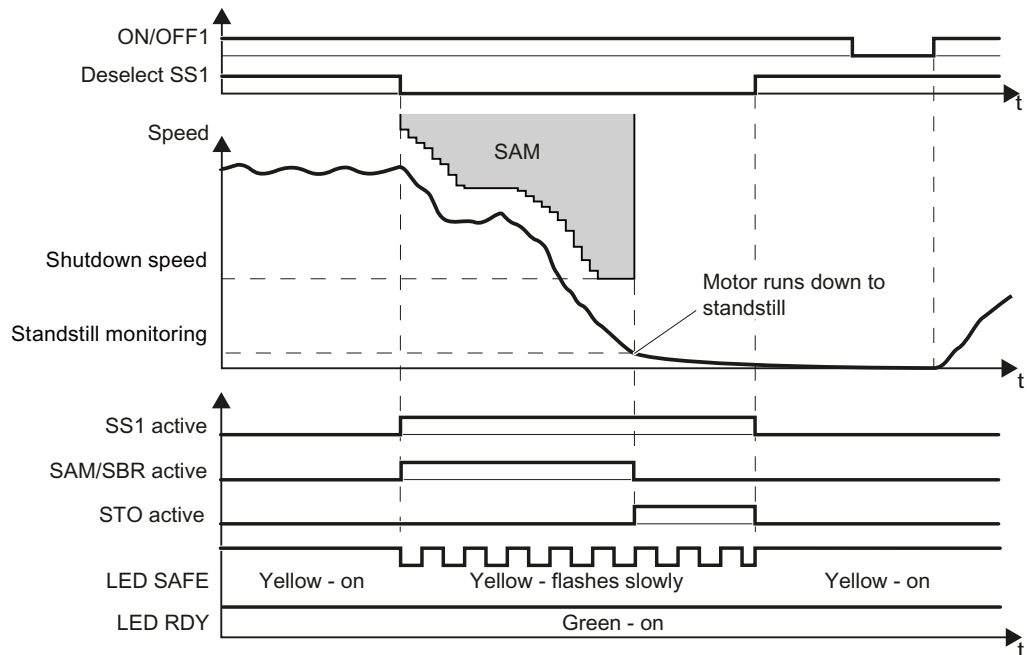
Figure 5-7   Braking behavior and diagnostics of the safety function SS1 (Safe Stop 1)

Switching on the motor once SS1 is active

Procedure

To switch the motor on again once SS1 is active, proceed as follows:

1. Deselect SS1.

2. Switch on the motor: ON/OFF1 = 1.

You have switched on the motor.

5.1.4 Safely Limited Speed (SLS)

5.1.4.1 SLS with braking ramp monitoring

Selecting and deselecting SLS

If the machine control selects the safety function SLS via a fail-safe input or via the safe communication PROFIsafe , then the motor behaves differently depending on the absolute value of the load speed. These two scenarios are described below.

Scenario 1: The absolute value of the load speed is less than the setpoint speed limit.

Function

1. The motor continues to follow the speed setpoint.

2. The inverter monitors the speed after the delay time has expired.
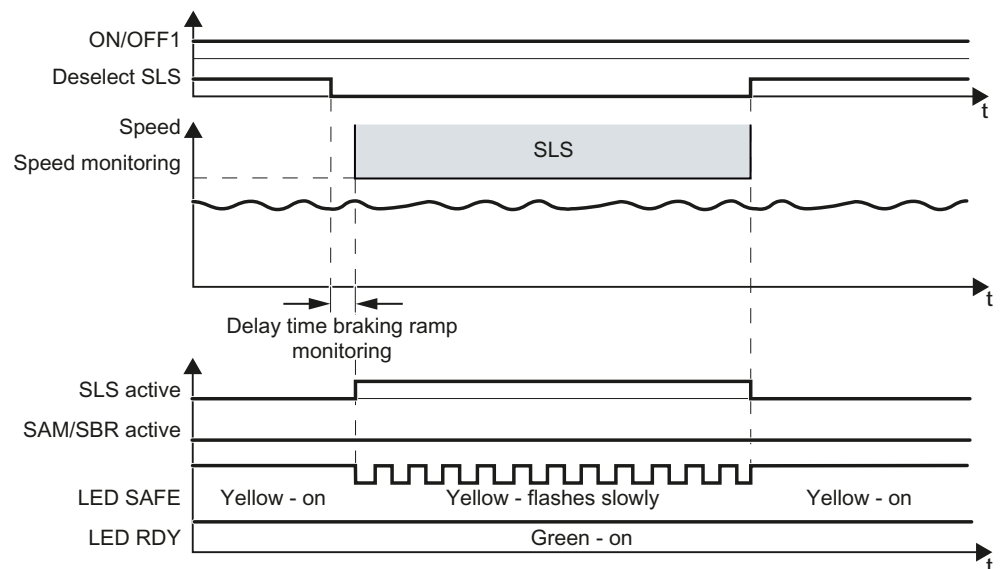
Figure 5-8   Selecting and deselecting the SLS safety function at low speeds

Scenario 2: The absolute value of the load speed is higher than the setpoint speed limit.

Function

1. The inverter brakes the motor.

2. The inverter monitors the speed after the delay time has expired.

3. If you deselect SLS , then the motor accelerates again up to the speed setpoint.
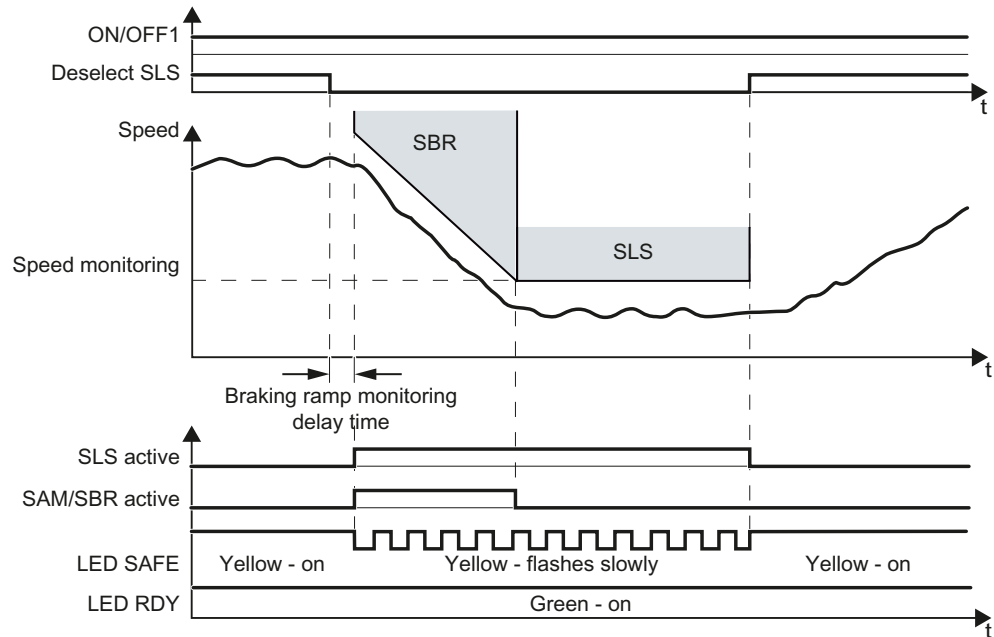
Figure 5-9   Selecting and deselecting the SLS safety function at high speeds

Switching over SLS levels

When SLS is active, you can switch between four different speed monitoring levels (SLSlevels).

Note

Switching over SLSlevels is only possible via PROFIsafe with control word 1. See also Section: Control word 1 and status word 1 (extended functions) (Page 41).

Function

When you switch from a higher to a lower speed monitoring level (SLS level), the following takes place:

1. The inverter brakes the motor.

2. Once the delay time has expired, the inverter monitors the motor speed using the SBR (Safe Safe Brake Ramp) function.

When you switch from one of the lower monitoring limits to a higher speed monitoring limit, then the inverter immediately monitors the speed with the higher SLS level.
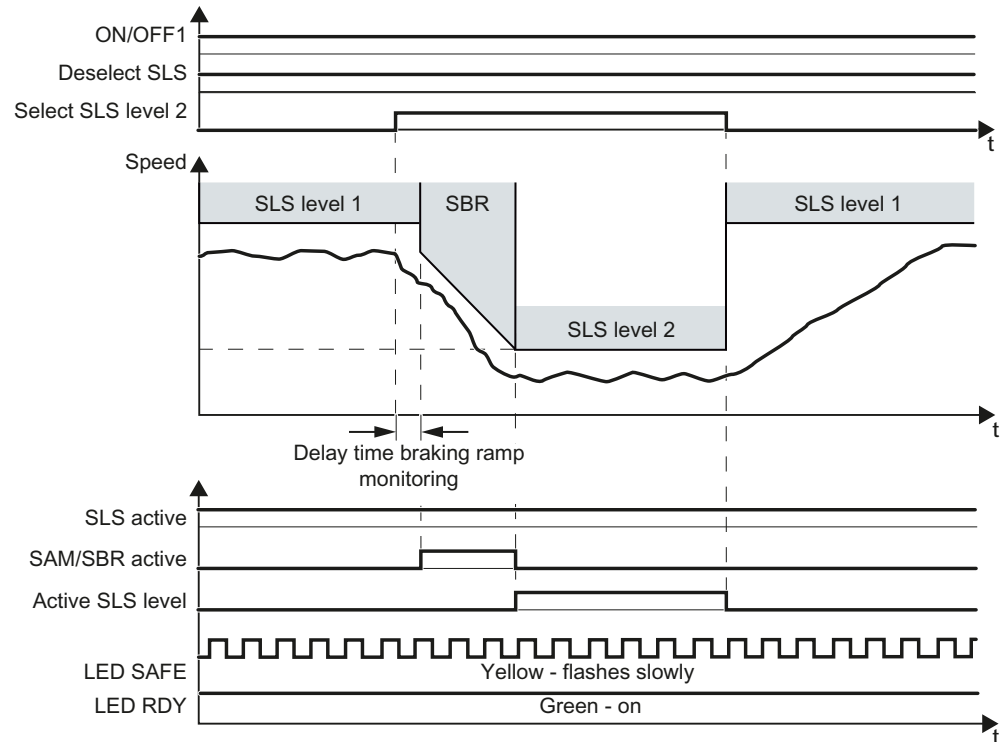
Figure 5-10   Switching between different monitoring thresholds

The converter signals the active SLS level via PROFIsafe to the higher-level control. See also Section: Control word 1 and status word 1 (extended functions) (Page 41).

5.1.4.2 SLS without braking ramp monitoring

Selecting and deselecting SLS

If the machine control selects the safety function SLS via a fail-safe input or via the safe communication PROFIsafe , then the motor behaves differently depending on the absolute value of the load speed. These two scenarios are described below.

Scenario 1: The absolute value of the load speed is less than the setpoint speed limit.

Function

1. The motor continues to follow the speed setpoint.

2. The inverter monitors the speed after the delay time has expired.
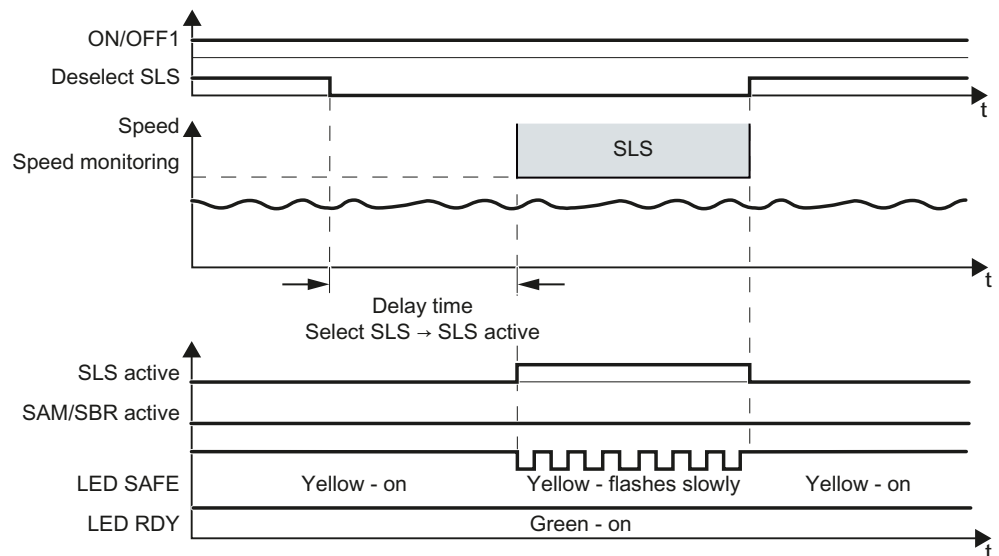
Figure 5-11   Selecting and deselecting the SLS safety function at low speeds

Scenario 2: The absolute value of the load speed is higher than the monitoring threshold.

Function

1. The inverter brakes the motor.

2. The inverter monitors the speed after the delay time has expired.

3. If you deselect SLS , then the motor accelerates again up to the speed setpoint.
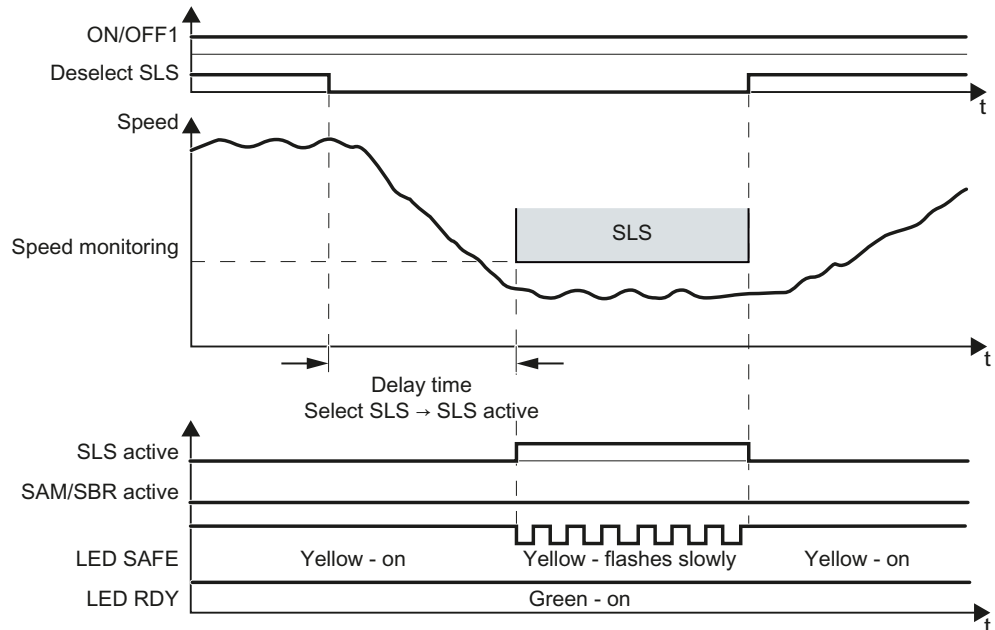
Figure 5-12   Selecting and deselecting the SLS safety function at high speeds

Switching over SLS levels

When SLS is active, you can switch between four different speed monitoring levels (SLSlevels).

Note

Switching over SLSlevels is only possible via PROFIsafe with control word 1. See also Section: Control word 1 and status word 1 (extended functions) (Page 41).

Function

When you switch from a higher to a lower speed monitoring level (SLS level), the following takes place:

1. The inverter brakes the motor.

2. Once the delay time has expired, the inverter monitors the speed using the lower speed monitoring level.

When you switch from one of the lower monitoring limits to a higher speed monitoring limit, then the inverter immediately monitors the speed with the higher SLS level.

Figure 5-13   Switching between different monitoring thresholds

The converter signals the active SLS level via PROFIsafe to the higher-level control. See also Section: Control word 1 and status word 1 (extended functions) (Page 41).

5.1.5   Safe Direction (SDI)

Selecting SDI

Function

1. The higher-level control selects the SDI safety function via a fail-safe input or via the safe PROFIsafe communication.

2. The inverter limits the speed to the permitted direction of rotation. When SDI is selected, if the motor rotates in the impermissible direction, then the inverter brakes the motor down to standstill.

3. After the delay time has expired, the inverter monitors the selected direction of rotation of the motor.

   The inverter tolerates brief motion in the monitored direction of rotation up to an adjustable angle of rotation of the motor shaft.
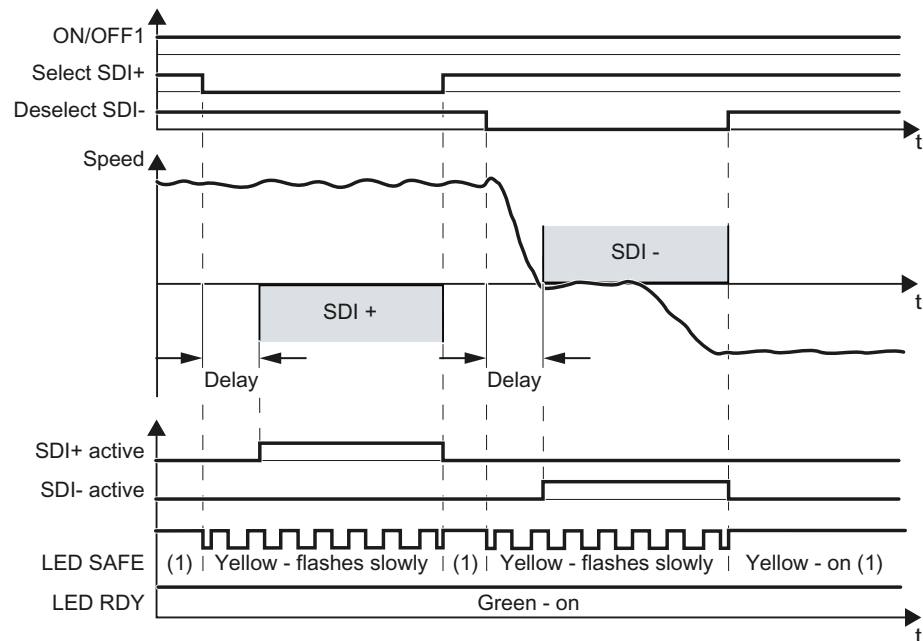
Figure 5-14   Time response of the safety function SDI (Safe Direction)

5.1.6 Safe Speed Monitor (SSM)

Description

The SSM safety function cannot be selected or deselected using external control signals. SSM is active, if all of the following conditions are fulfilled:

● You have enabled one or several extended safety functions .

● For the SSM function, you have set a monitoring speed > 0.

Before you switch on the motor for the first time after a power-on reset, the feedback signal "speed below limit value" of the SSM function is always equal to 0.

When the motor is switched on, the inverter compares the load speed with the speed limit.
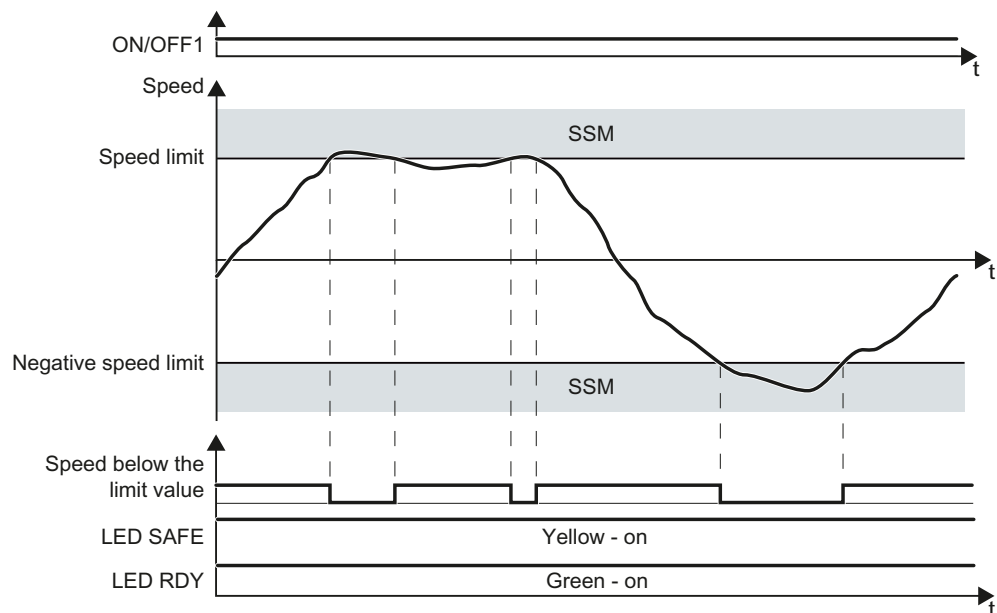
Figure 5-15   Time response of the safety function SSM (Safe Speed Monitor)

5.2 Switching the motor on and off with a safety function active

5.2.1 Switching off the motor when SS1 is active

Description

If you switch off the motor with the SS1 safety function active using the OFF1 or OFF3 command (for example, when limit switches are reached), this does not influence the behavior of the motor. SS1 remains active and the inverter brakes the motor down to standstill detection.

If you switch off the motor with the SS1 safety function active using the OFF2 command, then the behavior of the drive is dependent on the setting of the SS1 safety function:

- SS1 without speed monitoring:

  The inverter switches off the motor torque. The motor then coasts to a standstill. After the delay time, STO is active.

- SS1 with speed monitoring:

  The inverter switches off the motor torque with the STO safety function. The motor then coasts to a standstill.
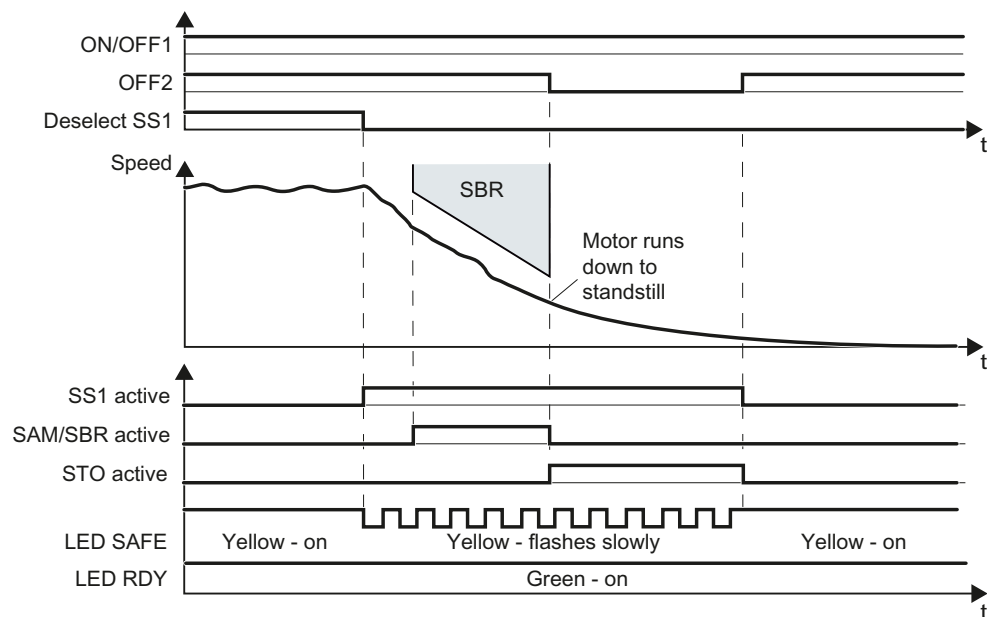
Figure 5-16   OFF2 command when the SS1 safety function is active (example: SS1 with braking ramp monitoring)

5.2.2 Switching off the motor when SLS is active

Description

If you switch off the motor with the SLS function active using the OFF1 or OFF3 command, e.g. when reaching limit switches, the following happens:

1. The converter brakes the motor with the OFF1 or OFF3 ramp-down time.

2. Also while braking, the converter monitors the motor speed.

3. When reaching the standstill monitoring, the converter safely switches off the motor torque with the STO safety function.

4. The motor coasts down to a standstill.
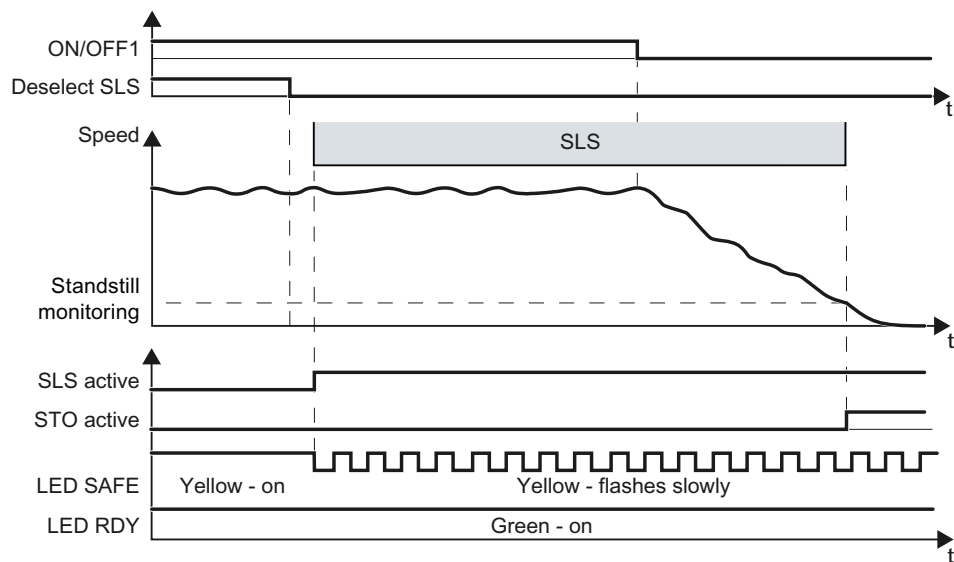
Figure 5-17   OFF1 command when the SLS safety function is active

If you switch off the motor using the OFF2 command, then the converter immediately safely switches off the motor torque using the STO safety function.
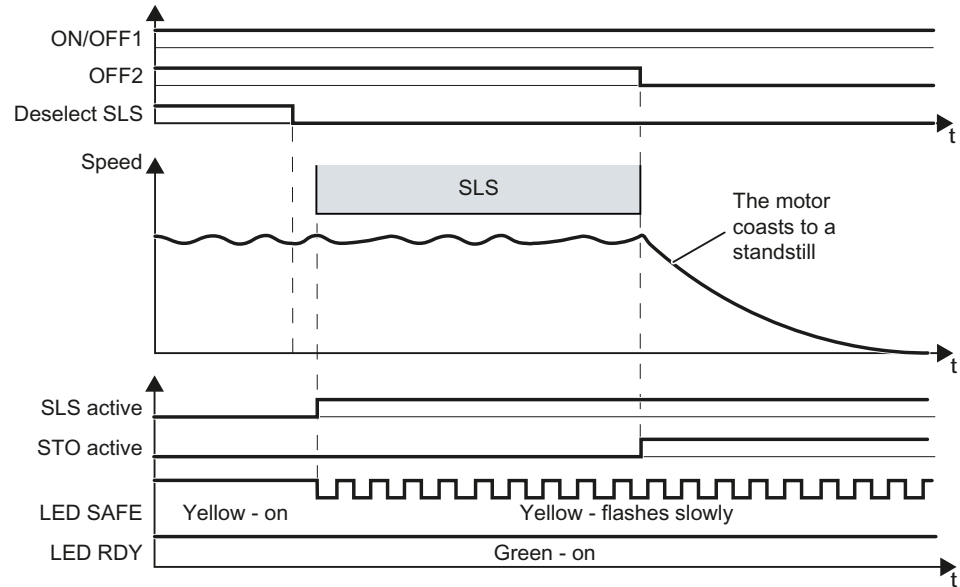
Figure 5-18   OFF2 command while the SLS safety function is active

5.2.3 Switching on the motor when SLS is active

Switching on motor

Procedure

To switch the motor on with SLS active, proceed as follows:

1. Select STO (or SS1).

2. Deselect STO (or SS1).

3. Switch on the motor within 5 seconds (ON command).
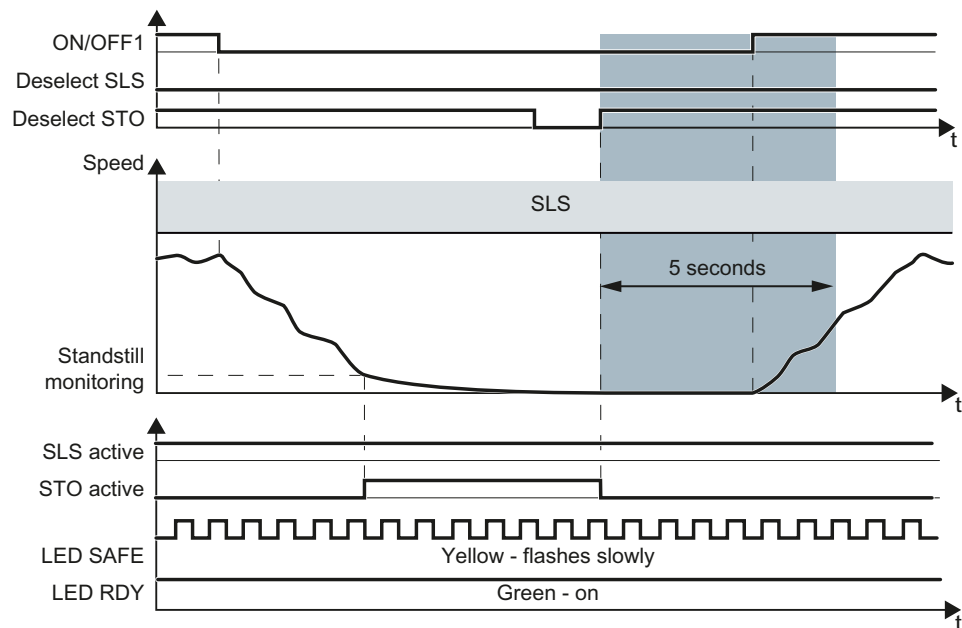
Figure 5-19   Switching the motor off and on (ON/OFF1) when SLS is active

You have switched on the motor.

You have not switched on the motor within 5 seconds

If you do not switch on the motor within 5 seconds, then the inverter goes into the STO state again and no longer responds to the ON command. The inverter outputs the alarm A01795.

Procedure

To switch the motor on, proceed as follows:

1. Select STO (or SS1).

2. Deselect STO (or SS1).

3. Switch on the motor within 5 seconds (ON command).

You have switched on the motor.

5.2.4 Switching off the motor when SSM is active

Description

If you switch off the motor with the SSM function active using the OFF1 or OFF3 command, e.g. when reaching limit switches, the following happens:

1. The inverter brakes the motor with the OFF1 or OFF3 ramp-down time.

2. Also while braking, the inverter monitors the motor speed.

The inverter responds differently depending on the speed at the instant of switch off.

When switching off, the speed is less than the SSMlimit value

You can set the behavior of the inverter after switching-off the motor in two different ways:

1. The feedback signal "SSM active" for pulse inhibit *remains active:*

   When the motor is switched off, the inverter prevents the motor from accelerating by issuing STO . When the motor is switched off, "Status SSM" = 1.

2. The feedback signal "SSM active" for pulse inhibit *becomes inactive:*

   When the motor is switched off, the inverter sets "Status SSM" to 0.
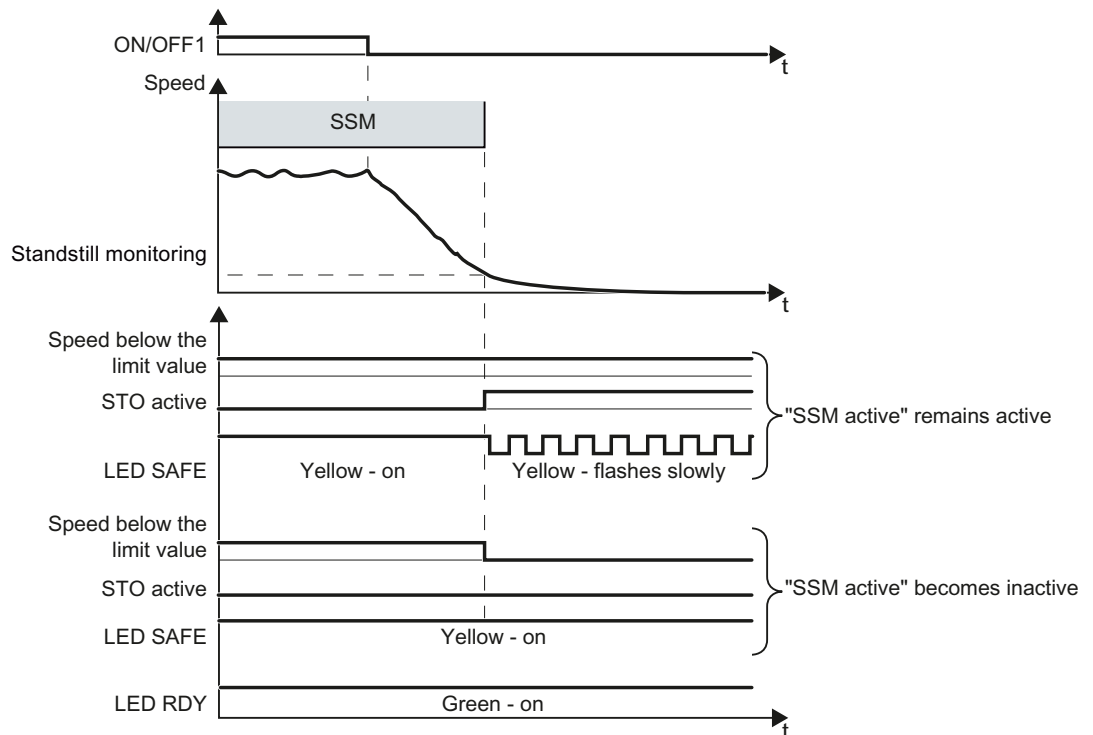
Figure 5-20   OFF1 command when the SSM safety function is active

If you switch off the motor with OFF2, the inverter immediately switches off the motor.
Depending on the selected setting the inverter safely switches off the motor torque with the
STO safety function.
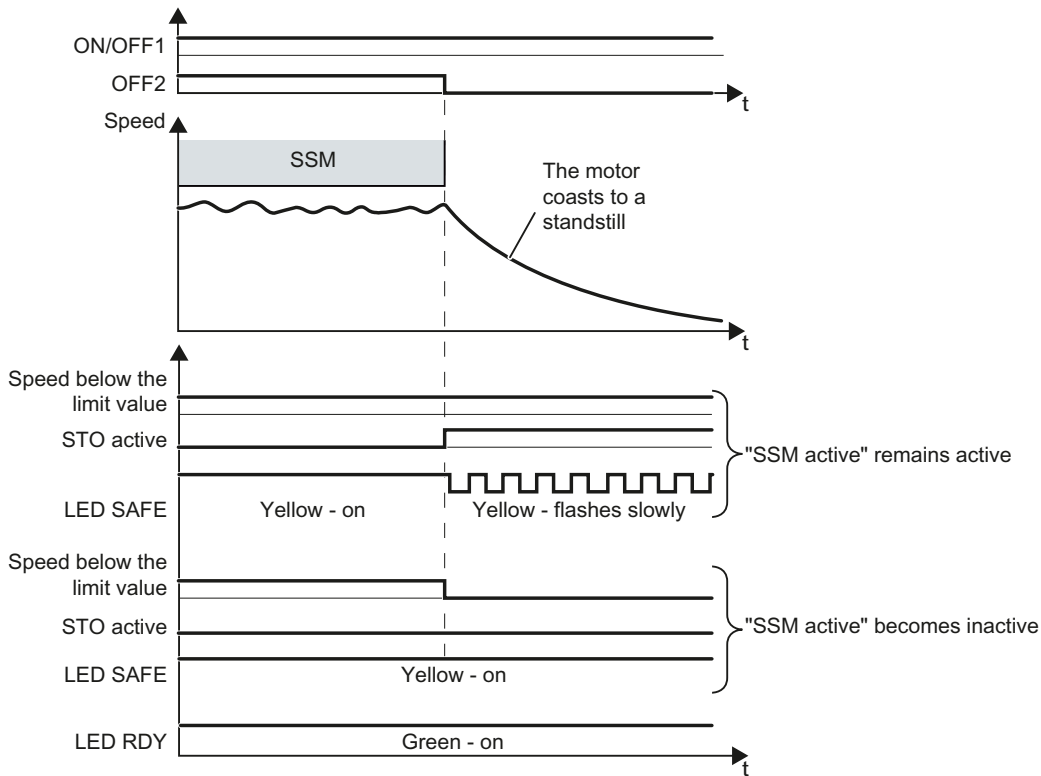
Figure 5-21   OFF2 command when the speed is < the SSM speed limit

When switching off, the speed is greater than the SSM limit value

If the speed is greater than the SSM limit value at the instant when the inverter switches off the motor, then the feedback signal "SSM active" remains at 0.
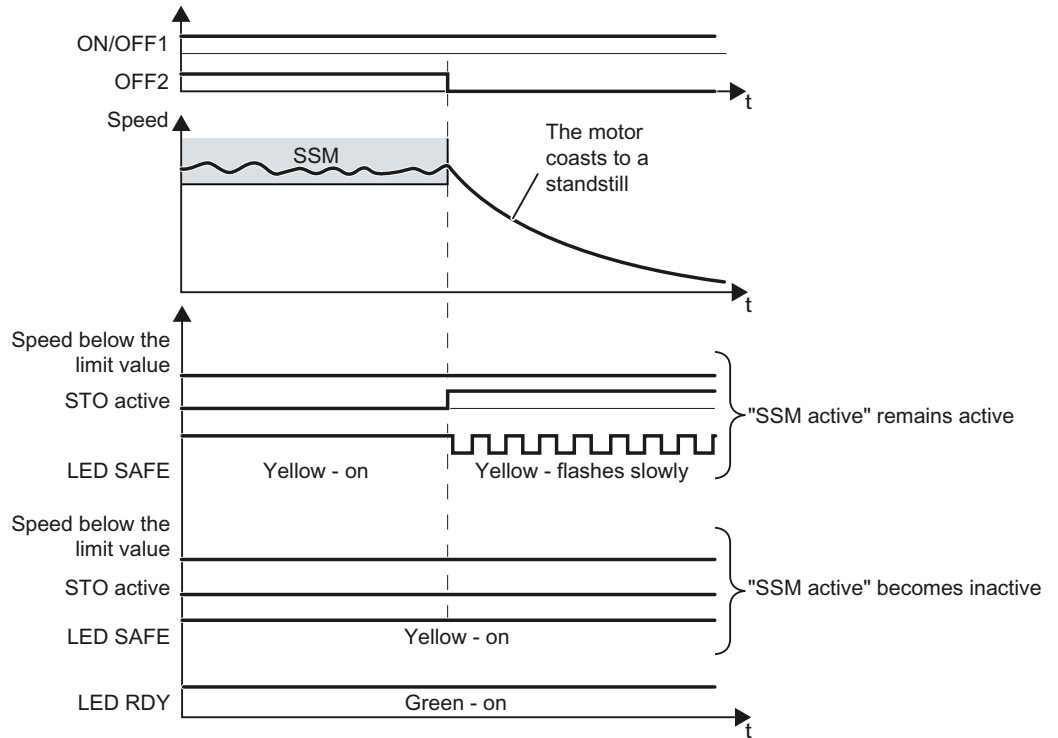
Figure 5-22   OFF2 command when the speed is > the SSM speed limit

5.2.5 Switching on the motor when SSM is active

The procedure for switching on the motor depends on how you have set the SSM function.

The feedback signal "SSM active" for pulse inhibit becomes inactive

Procedure

1
2

To switch the motor on, proceed as follows:

● Switch on the motor.

After switching on, the SSM function becomes active again.
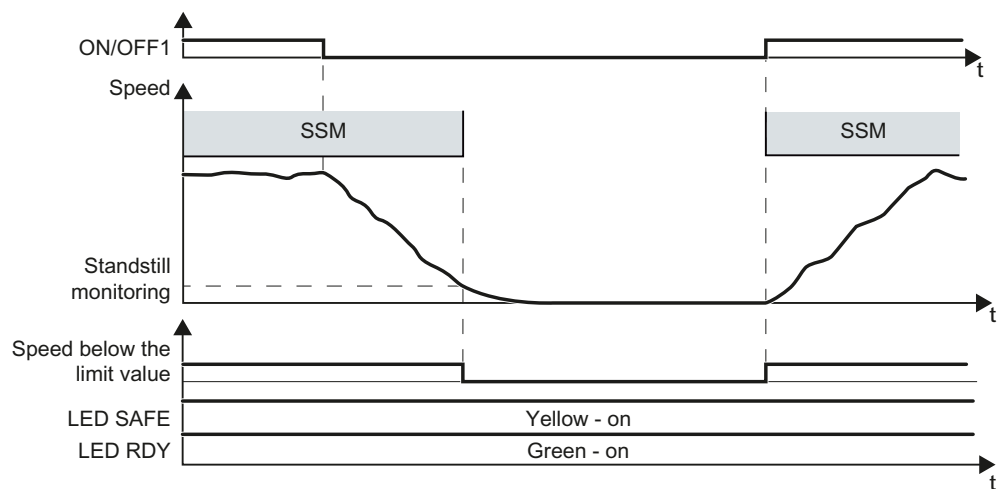
Figure 5-23   Switch on the motor when the SSM function is active, interrupting SSM

You have switched on the motor.

The feedback signal "SSM active" for pulse inhibit remains active

Procedure

To switch the motor on, proceed as follows:

1. Select STO (or SS1) after the motor has been switched off.

2. Deselect STO (or SS1) again before you switch on the motor.

3. Switch on the motor within 5 seconds.
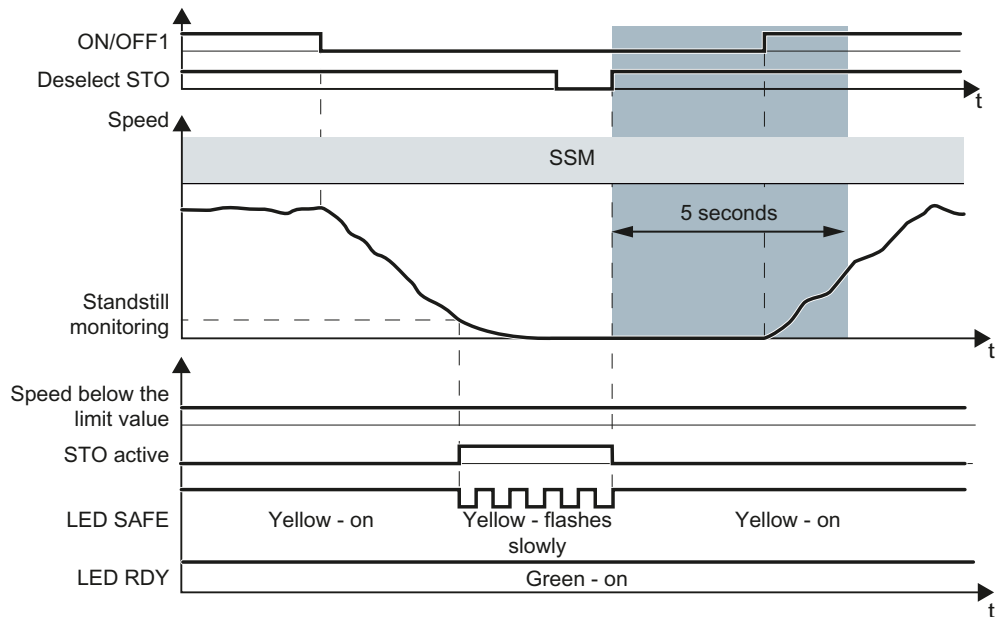
Figure 5-24   Switching on the motor when SSM is active

You have switched on the motor.

You have not switched on the motor within 5 seconds

If you do not switch on the motor within 5 seconds, then the inverter goes into the STOstate again and no longer responds to the ON command. The inverter outputs the alarm A01795.

Procedure

To switch the motor on, proceed as follows:

1. Select STO (or SS1).

2. Deselect STO (or SS1) again.

3. Switch on the motor within 5 seconds.

You have switched on the motor.

5.2.6   Switching off the motor when SDI is active

Description

If you switch off the motor with the SDI function active using the OFF1 or OFF3 command, e.g. when reaching limit switches, the following happens:

1. The converter brakes the motor with the OFF1 or OFF3 ramp-down time until the speed reaches the standstill monitoring threshold.

2. Also while braking, the converter monitors the direction of rotation.

You can set the behavior of the converter after switching-off the motor in two different ways:

1. Feedback signal "SDI active" for pulse inhibit *remains active*
   With this setting, the converter safely switches off the motor torque when reaching the standstill monitoring using the STO safety function. The converter ensures that the motor does not actively accelerate. The "SDI active" signal also remains at 1 for a motor that has been switched off.

2. Feedback signal "SDI active" for pulse inhibit *becomes inactive*
   With this setting the converter switches off the motor torque, but not safely. The system does not safely prevent that the motor actively accelerates. Therefore, the converter sets the "SDI active" signal to 0 when the motor is switched off.
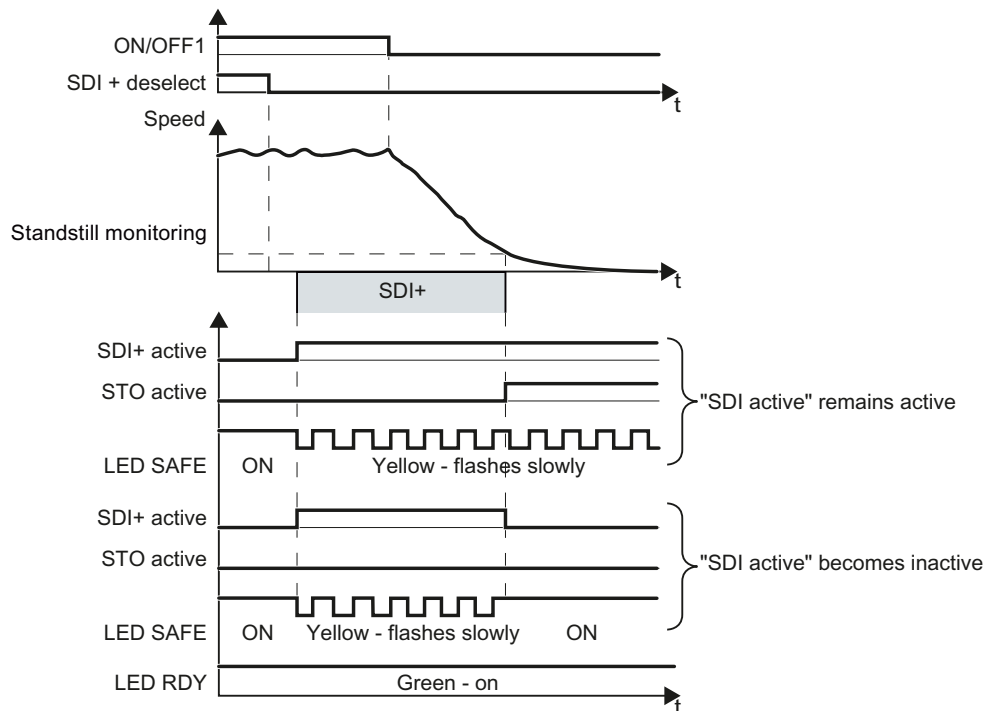
Figure 5-25   OFF1 command when the SDI safety function is active

If you switch the motor off with the OFF2 command when the SDI safety function is active, the converter immediately switches off the motor. Depending on the selected setting, the converter immediately switches off the motor torque with the STO safety function.
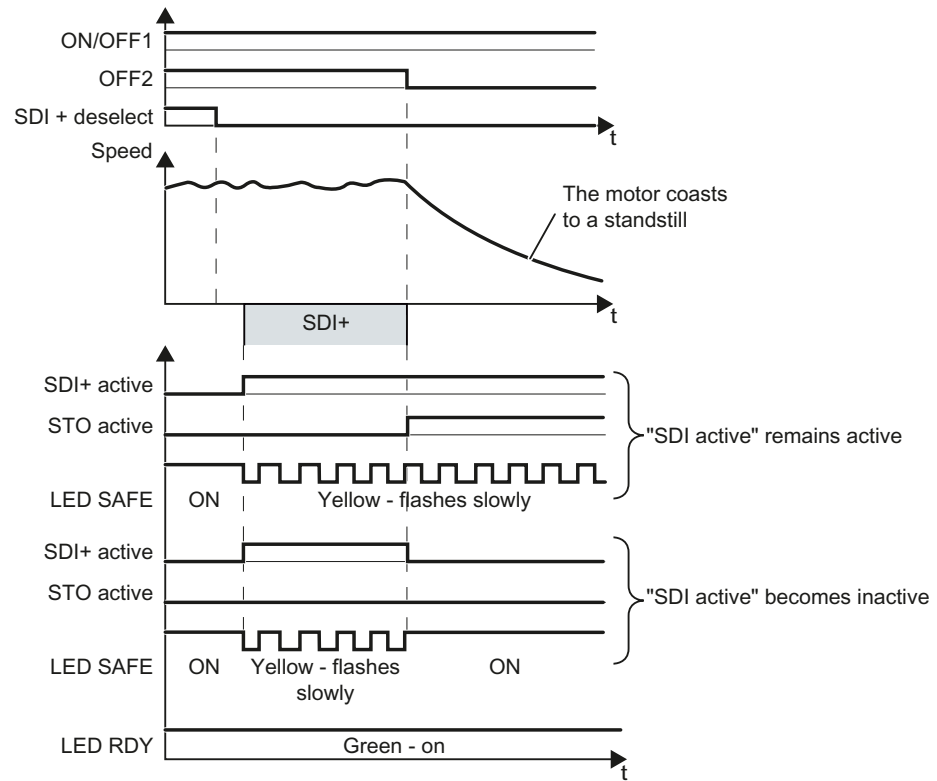
Figure 5-26   OFF2 command while the SDI safety function is active

5.2.7 Switching on the motor when SDI is active

The procedure for switching on the motor depends on how you have set the SDI function.

The feedback signal "SDI active" for pulse inhibit becomes inactive

The function SDI becomes active again as soon as you switch on the motor again.
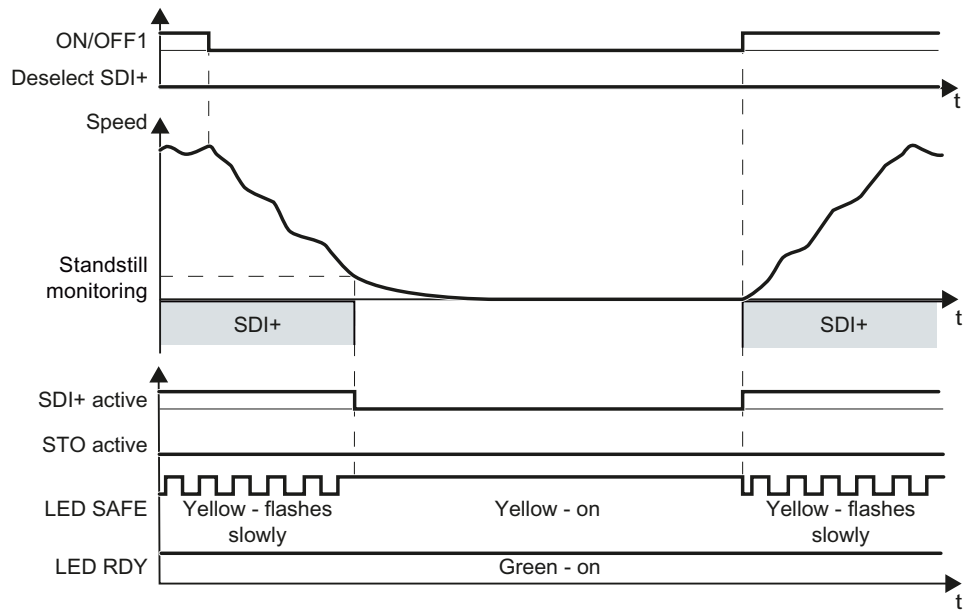
Figure 5-27   Switching the motor off and on again with SDI, active, interrupting the feedback signal from SDI

The feedback signal "SDI active" for pulse inhibit remains active

Procedure

To switch the motor on, proceed as follows:

1. Select STO (or SS1).

2. Deselect STO (or SS1) again before you switch on the motor.

3. Switch on the motor within 5 seconds.
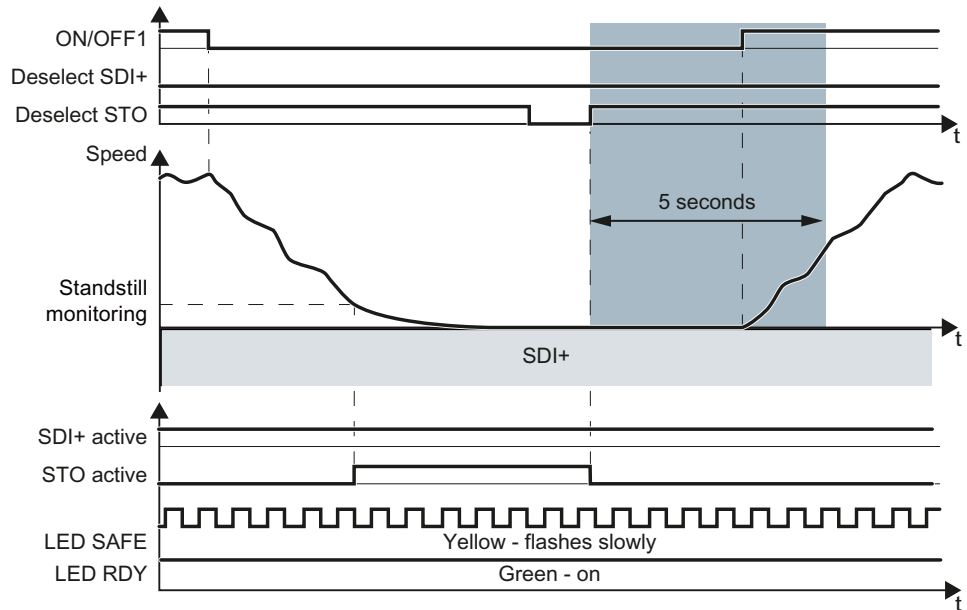
Figure 5-28   Switching the motor off and on with SDI active

You have switched on the motor again.

You have not switched on the motor within 5 seconds

If you do not switch on the motor within 5 seconds, then the inverter goes into the STO state again and no longer responds to the ON command. The inverter outputs the alarm A01795.

Procedure

To switch the motor on, proceed as follows:

1. Select STO (or SS1).

2. Deselect STO (or SS1).

3. Switch on the motor within 5 seconds (ON command).

You have switched on the motor.

5.3 Selecting safety function when a safety function is active

5.3.1 Overview

The table below lists the notes regarding the behavior of your drive if you select more than one safety function at the same time.

Some cases do not affect the behavior of your drive. If, for example, the safety function STO is active, the motor torque remains switched off regardless of which converter function you also select.

Table 5- 1   Interaction between two safety functions

Active function 1	With function 1 active, additionally select function 2:			
	STO	SS1	SLS	SDI
STO	---	No effect	No effect	No effect
SS1	Selecting STO when SS1 is active (Page 197)	---	No effect	No effect
SLS	Selecting STO when SLS is active (Page 198)	Selecting SS1 when SLS is active (Page 201)	---	Selecting SDI when SLS is active (Page 206)
SDI	Selecting STO when SDI is active (Page 199)	Selecting SS1 when SDI is active (Page 202)	Selecting SLS when SDI is active (Page 204)	---
SSM	Selecting STO when SSM is active (Page 200)	Selecting SS1 when SSM is active (Page 203)	Selecting SLS when SSM is active (Page 205)	Selecting SDI when SSM is active (Page 207)

5.3.2   Selecting STO when SS1 is active

Description

Table 5- 2   Interaction between two safety functions

	STO	SS1	SLS	SDI
STO	---	---	---	---
SS1	**STO select when active SS1**	---	---	---
SLS	---	---	---	---
SDI	---	---	---	---
SSM	---	---	---	---
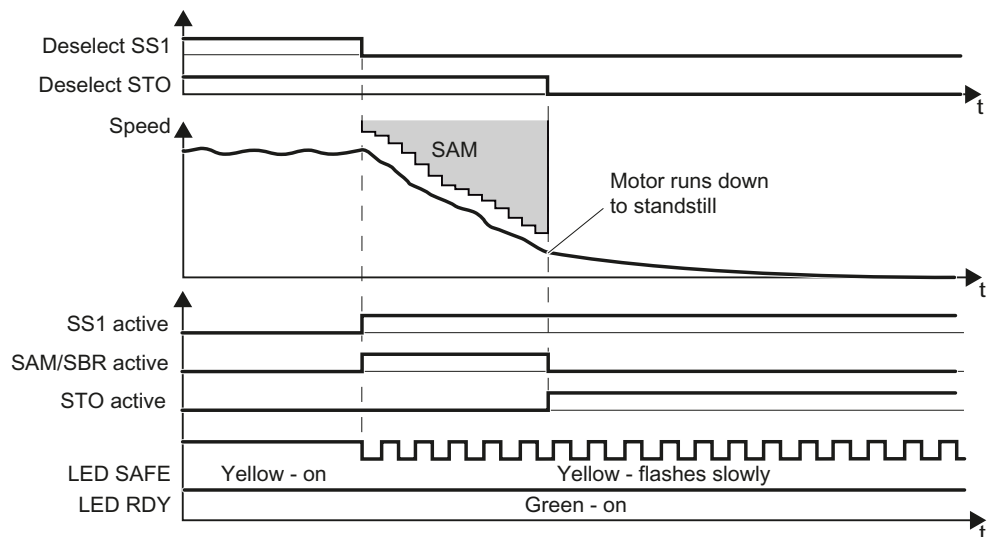
Figure 5-29   Select STO when SS1 is active (as example: SS1 with acceleration monitoring)

5.3.3 Selecting STO when SLS is active

Description

Table 5- 3   Interaction between two safety functions

	STO	SS1	SLS	SDI
STO	---	---	---	---
SS1	---	---	---	---
SLS	**STO select when active SLS**	---	---	---
SDI	---	---	---	---
SSM	---	---	---	---
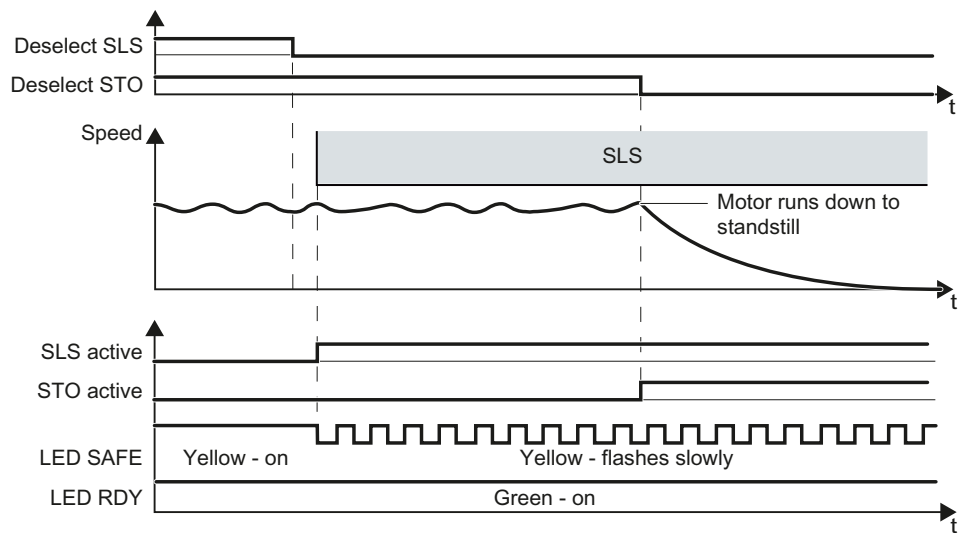
Figure 5-30   STO select when active SLS

5.3.4 Selecting STO when SDI is active

Description

Table 5- 4   Interaction between two safety functions

	STO	SS1	SLS	SDI
STO	---	---	---	---
SS1	---	---	---	---
SLS	---	---	---	---
SDI	**STO select when active SDI**	---	---	---
SSM	---	---	---	---
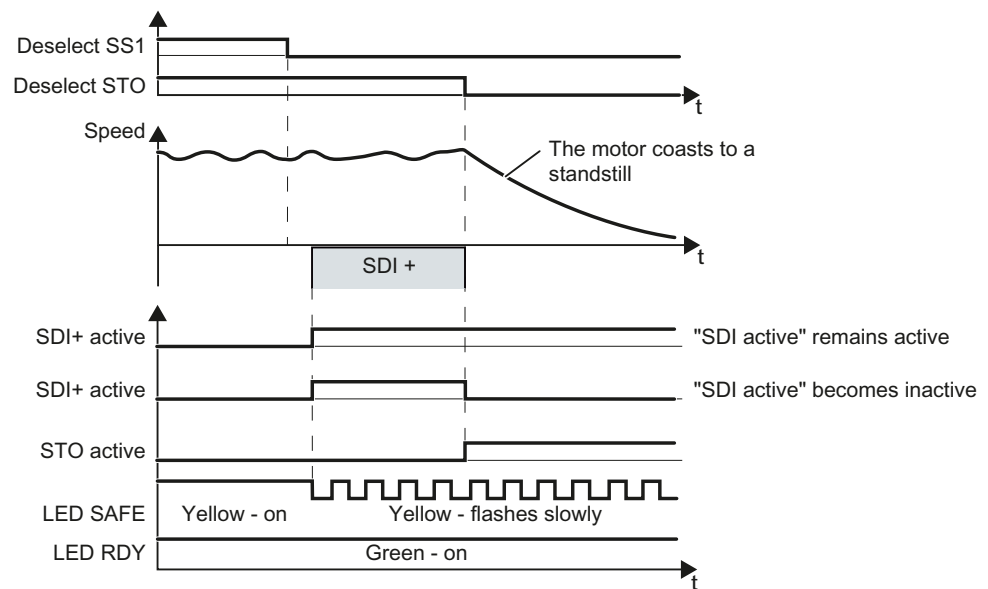
Figure 5-31   STO select when active SDI

5.3.5 Selecting STO when SSM is active

Description

Table 5- 5   Interaction between two safety functions

	STO	SS1	SLS	SDI
STO	---	---	---	---
SS1	---	---	---	---
SLS	---	---	---	---
SDI	---	---	---	---
SSM	**STO select when active SSM**	---	---	---
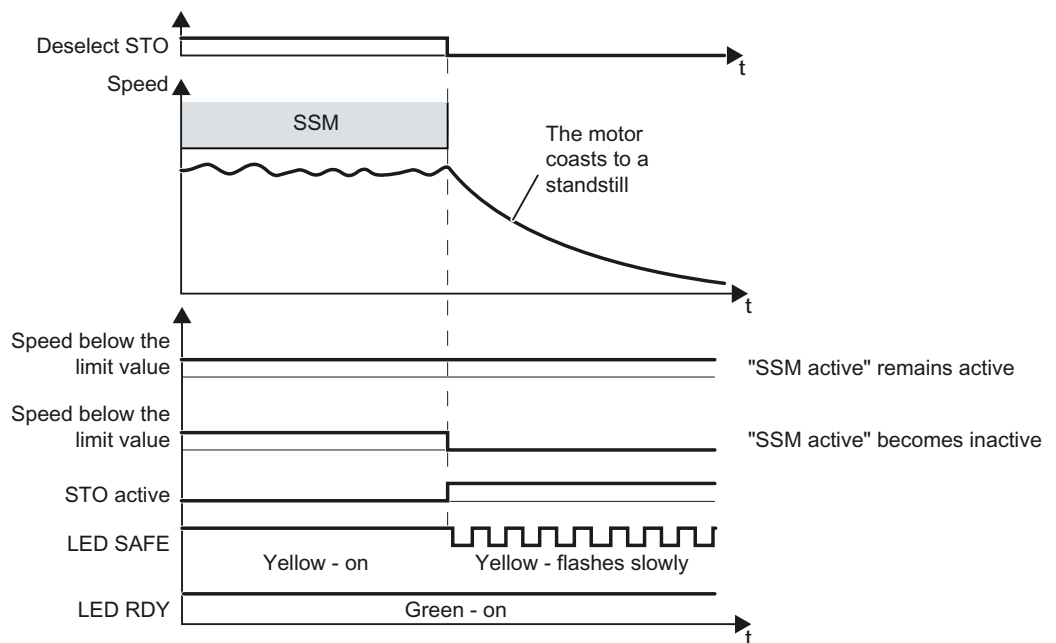
Figure 5-32   STO select when active SSM

5.3.6 Selecting SS1 when SLS is active

Description

Table 5- 6   Interaction between two safety functions

	STO	SS1	SLS	SDI
STO	---	---	---	---
SS1	---	---	---	---
SLS	---	**SS1 select when active SLS**	---	---
SDI	---	---	---	---
SSM	---	---	---	---
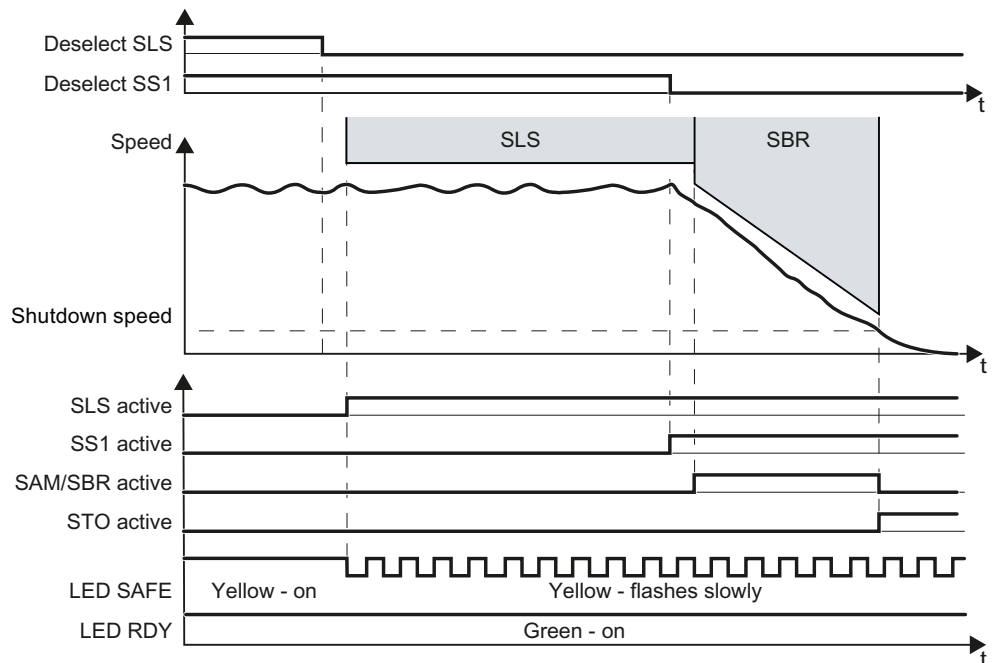
Figure 5-33   SS1 select when SLS is active (as example SS1 with braking ramp monitoring)

5.3.7 Selecting SS1 when SDI is active

Description

Table 5- 7 Interaction between two safety functions

	STO	SS1	SLS	SDI
STO	---	---	---	---
SS1	---	---	---	---
SLS	---	---	---	---
SDI	---	**SS1 select when active SDI**	---	---
SSM	---	---	---	---
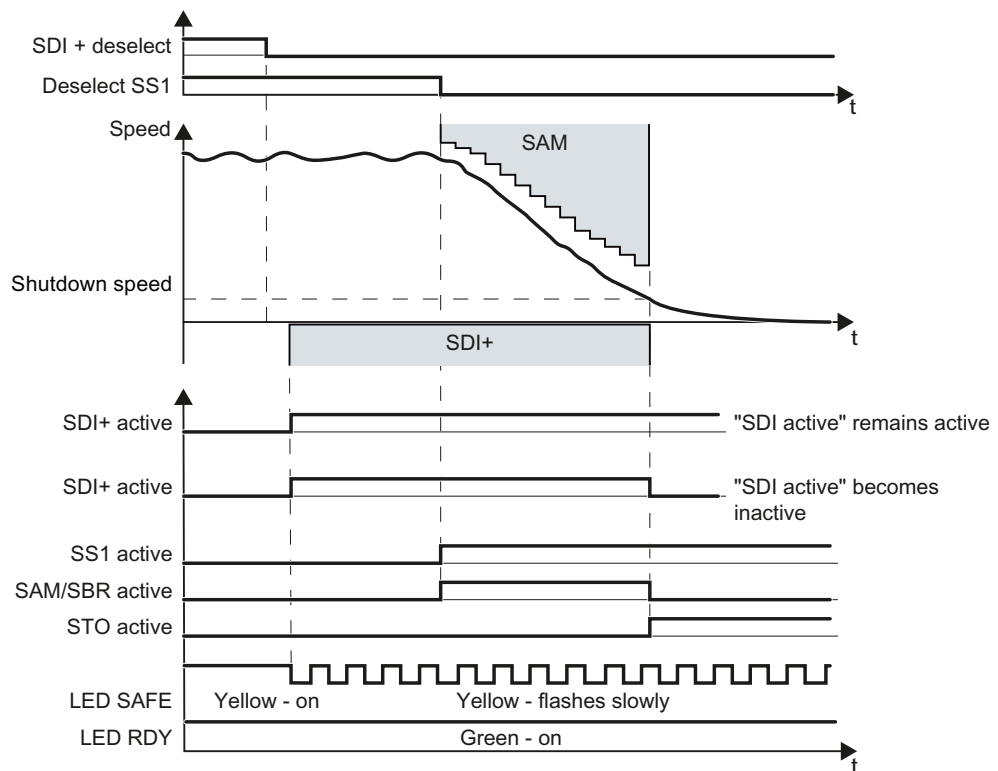
Figure 5-34 Selecting SS1 when SDI is active; example with acceleration monitoring SAM

5.3.8 Selecting SS1 when SSM is active

Description

Table 5- 8   Interaction between two safety functions

	STO	SS1	SLS	SDI
STO	---	---	---	---
SS1	---	---	---	---
SLS	---	---	---	---
SDI	---	---	---	---
SSM	---	SS1 select when active SSM	---	---
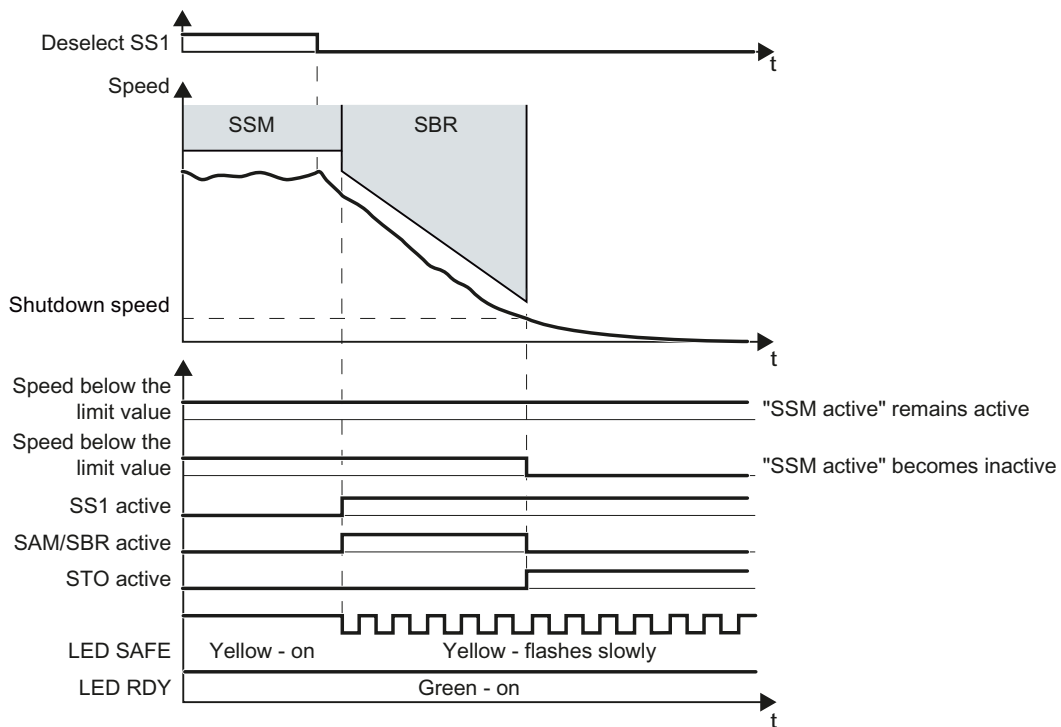
Figure 5-35   Selecting SS1 when SSM is active; using example of SS1 with braking ramp monitoring

5.3.9 Selecting SLS when SDI is active

Description

Table 5- 9   Interaction between two safety functions

	STO	SS1	SLS	SDI
STO	---	---	---	---
SS1	---	---	---	---
SLS	---	---	---	---
SDI	---	---	**SLS select when active SDI**	---
SSM	---	---	---	---
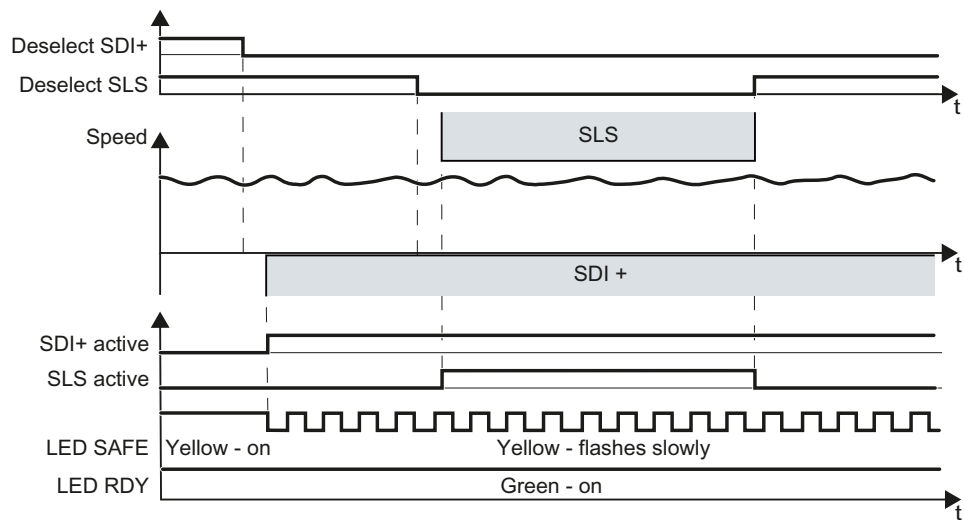
Figure 5-36   SLS select when active SDI

5.3.10 Selecting SLS when SSM is active

Description

Table 5- 10   Interaction between two safety functions

	STO	SS1	SLS	SDI
STO	---	---	---	---
SS1	---	---	---	---
SLS	---	---	---	---
SDI	---	---	---	---
SSM	---	---	SLS select when active SSM	---
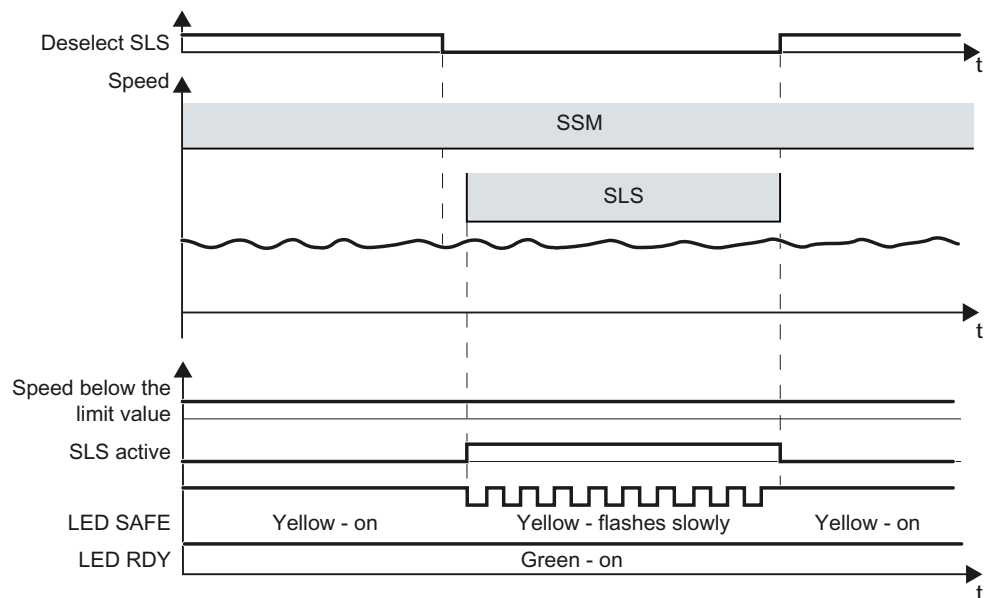
Figure 5-37   SLS select when active SSM

5.3.11 Selecting SDI when SLS is active

Description

Table 5- 11   Interaction between two safety functions

	STO	SS1	SLS	SDI
STO	---	---	---	---
SS1	---	---	---	---
SLS	---	---	---	**SDI select when active SLS**
SDI	---	---	---	---
SSM	---	---	---	---
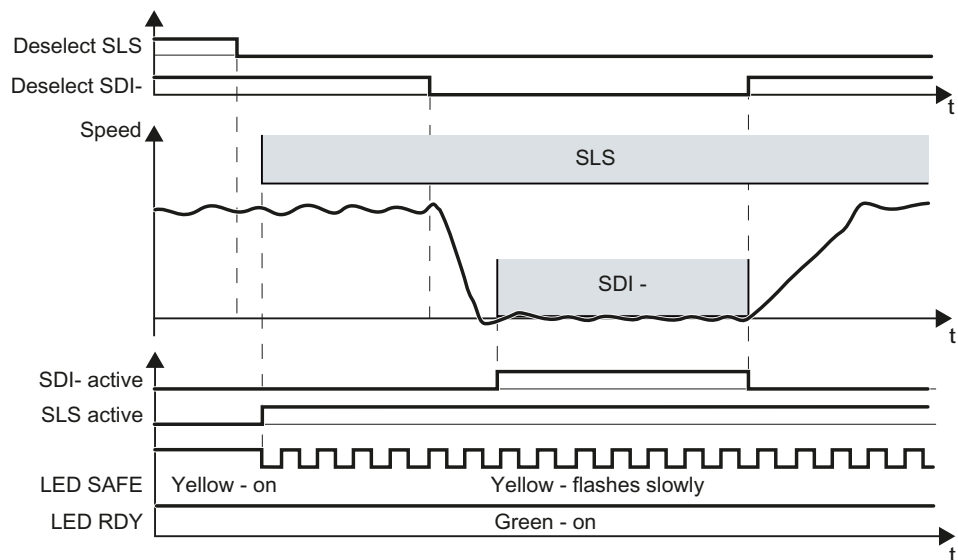
Figure 5-38   SDI select when active SLS

5.3.12 Selecting SDI when SSM is active

Description

Table 5- 12   Interaction between two safety functions

	STO	SS1	SLS	SDI
STO	---	---	---	---
SS1	---	---	---	---
SLS	---	---	---	---
SDI	---	---	---	---
SSM	---	---	---	SDI select when active SSM
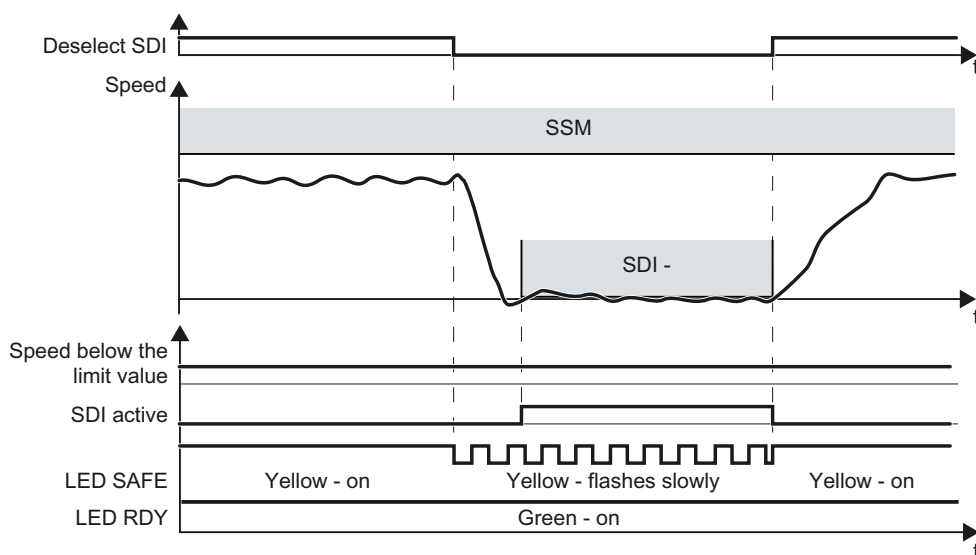
Figure 5-39   SDI select when active SSM

5.4 Faults of the safety functions

The response of the converter to internal faults and limit violations of the safety functions is subject to specific rules.

The following sections provide an overview of the causes, reaction and acknowledgement of safety function faults. This will be followed by a detailed description of the drive behavior for active safety functions.

5.4.1 Cause of fault

Depending on the cause of the fault, the safety function faults trigger various different reactions from the converter.

General faults

These are faults that are assigned to the converter's safety functions, which however do not compromise the fail-safe operation of the converter. For example, these faults may have been caused by any of the following:

- Impermissible parameter value settings (F01659)

- Message "Acceptance test required" (F01650)

General faults do not require any special acknowledgment.

Discrepancy

A discrepancy is a fault in the external wiring of the fail-safe inputs (see Section Response to the discrepancy of an input signal (Page 211)). When a discrepancy occurs, the converter no longer evaluates the F-DI (=zero).

The F-DI remains in the safe state until you acknowledge the converter using a fail-safe signal or using a power-on reset.

Internal event

An "internal event" is a major fault that causes the converter to bring the motor to a standstill as quickly as possible by triggering a STOP reaction. For example, an "internal event" can be caused by one of the following:

- The converter detects an internal fault in its hardware or its firmware on the basis of a data cross-check (F01611).

- The converter identifies when a limit value is violated as a result of an inadmissible motor speed (C01714).

An "internal event" can only be acknowledged in a fail-safe manner.

5.4.2 Stop responses

For an "internal event", the converter responds with a STOP (STOP A, STOP B or STOP F).

Response of the motor in the event of a STOP

STOP A

For a STOP A, the converter safely switches off the torque of the connected motor immediately.

STOP B

For a STOP B, the converter brakes the motor with the OFF3 ramp-down time until standstill is detected. This is then followed by a STOP A .

If you operate the motor with torque control, then the converter switches over the control mode to speed control.

The converter monitors the braking of the motor. The monitoring type corresponds to the monitoring mode of SS1, also see Section Safe Stop 1 (SS1) (Page 18).
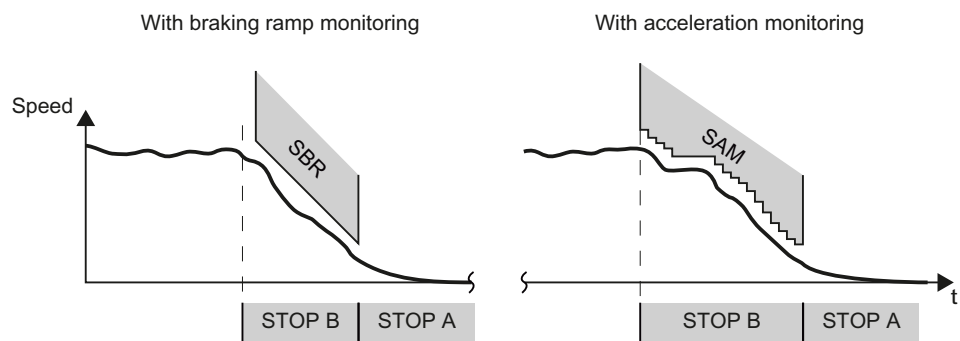
Figure 5-40   Monitoring the speed for a STOP B

If the motor does not follow the defined braking ramp, the converter interrupts the braking of the motor and responds with a STOP A.

STOP F

A STOP F either initiates a STOP A or a STOP B:

- If fault F01611 is the cause of the STOP F, then the converter immediately initiates a STOP A.

- If message C01711 is the cause of the STOP F, then the converter response depends on the active safety function:

    - If no safety function is active, the alarm stops and does not affect motor operation.

    - If STO is active, then the converter initiates aSTOP A.

    - In all other cases, the converter initiates a STOP B.

5.4.3 Fail-safe acknowledgment

You must acknowledge the majority of safety function faults using a fail-safe signal. The following options are available.

- Acknowledging via a fail-safe F-DI input
- Acknowledging via PROFIsafe
- Acknowledging by selecting and deselecting STO
- Acknowledging by switching the power supply on and off

Acknowledging via a fail-safe F-DI input

Procedure

To acknowledge the inverter via a fail-safe F-DI input, proceed as follows:

1. Acknowledge the fault with F-DI = 0 → 1 → 0.
2. Then, acknowledge the inverter with the "standard" acknowledgement signal.

You have acknowledged the inverter in a fail-safe fashion.

Acknowledging via PROFIsafe

Procedure

To acknowledge the inverter via PROFIsafe, proceed as follows:

1. Acknowledge the fault with bit 7 of the control word 0: Bit 7 = 0 → 1 → 0.
2. Then, acknowledge the inverter with the "standard" acknowledgement signal.

You have acknowledged the inverter in a fail-safe fashion.

Acknowledging by selecting and deselecting STO

Procedure

To acknowledge the inverter by selecting and deselecting STO, proceed as follows:

1. Select the STO or SS1 safety function and then deselect again:
   - F-DI = 1 → 0 → 1
     or
   - PROFIsafe control word 1, bit 0 or 1 = 1 → 0 → 1
2. Then, acknowledge the inverter with the "standard" acknowledgement signal.

You have acknowledged the inverter in a fail-safe fashion.

Acknowledging by switching the power supply on and off

You can acknowledge faults by temporarily switching off the power supply to the inverter and then switching it on again (power on reset).

5.5 Response to the discrepancy of an input signal

5.5.1 Discrepancy for Safe Torque Off (STO)

The inverter responds with the active safety function STO to a discrepancy at the fail-safe input.

The behavior of the drive depends on the setting of the inverter.

1st case: Response of the drive for STO of the basic functions

You have selected one of the following settings:

- Basic Functions via onboard terminals
- Basic functions via PROFIsafe and onboard terminals
- Extended functions via PROFIsafe and basic functions via onboard terminals
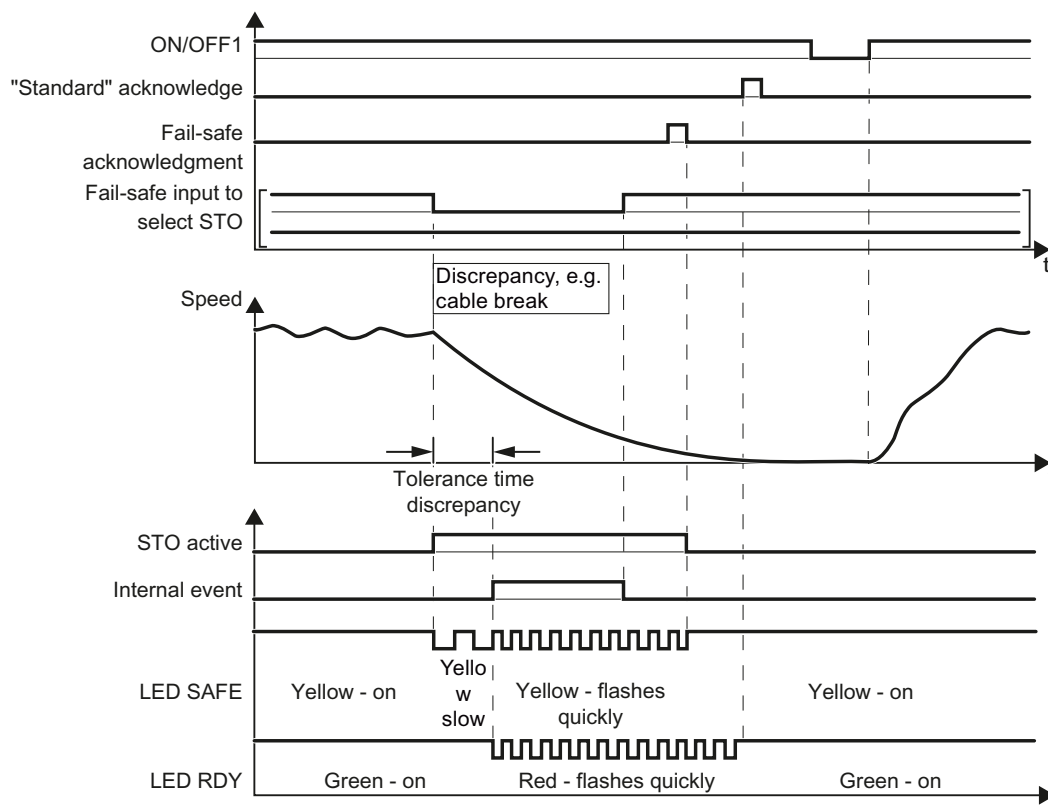
Figure 5-41   Behavior of the inverter for discrepancy of the input signal for STO (example: Cable break in the channel of processor P1)

Inverter messages after the tolerance time has expired:

- Discrepancy (fault F01611 or F30611)
- Internal event (PROFIsafe status word 1, bit 7)

Switching on the motor after a discrepancy

Procedure

To switch the motor on again, proceed as follows:

1. Remove the discrepancy.

2. Acknowledge the internal event.

Selected setting	How can the internal event be acknowledged?		
	F-DI	PROFIsafe	Alternative
Basic functions via onboard terminals	Select and deselect STO (F-DI = 1 → 0 → 1)	---	Power on reset
Basic Functions via PROFIsafe and onboard terminals	Select and deselect STO (F-DI = 1 → 0 → 1)	Select and deselect STO (PROFIsafe control word 1, bit 0 = 1 → 0 → 1) or Select and deselect SS1 (PROFIsafe control word 1, bit 1 = 1 → 0 → 1) or Fail-safe acknowledgment (PROFIsafe control word 1, bit 7 = 0 → 1 → 0)	Power on reset
Extended functions via PROFIsafe and basic functions via onboard terminals	Select and deselect STO (F-DI = 1 → 0 → 1)	Select and deselect STO (PROFIsafe control word 1, bit 0 = 1 → 0 → 1) or Select and deselect SS1 (PROFIsafe control word 1, bit 1 = 1 → 0 → 1) or Fail-safe acknowledgment (PROFIsafe control word 1, bit 7 = 0 → 1 → 0)	Power on reset

3. Acknowledge the inverter with the "standard" acknowledge signal.

4. Issue an OFF1 command (ON/OFF1 = 0).

5. Switch on the motor (ON/OFF1 = 1).

You have acknowledged the discrepancy message, and switched on the motor again.

2nd case: Response of the drive for STO of the extended functions

You have selected the extended functions via onboard terminals.
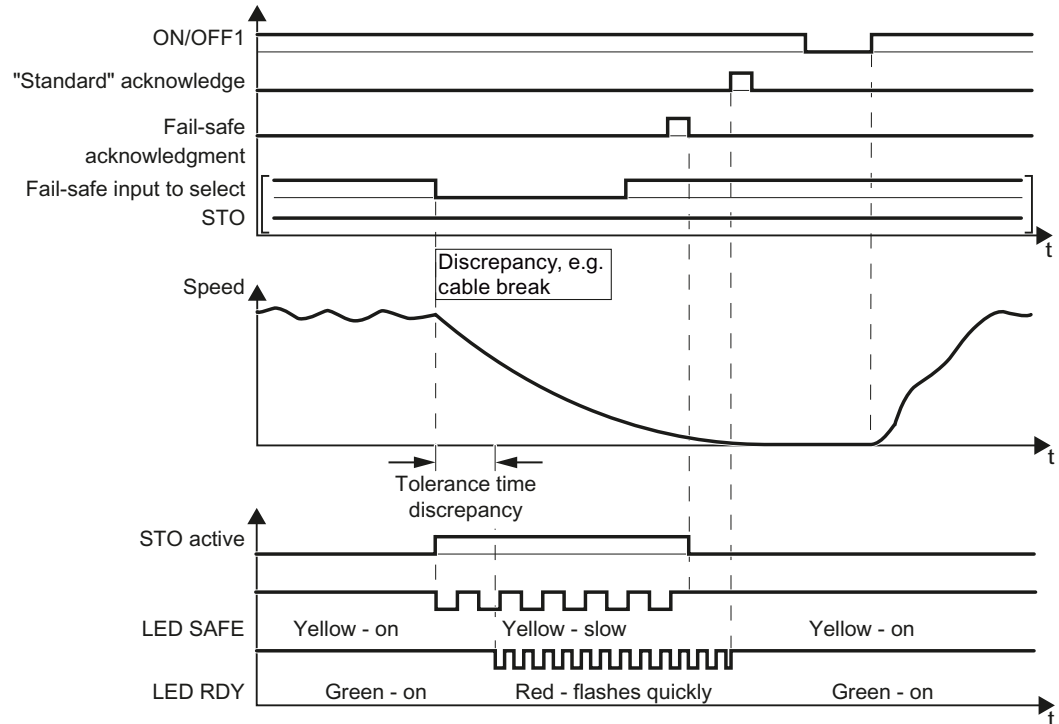
Figure 5-42   Response of safety function STO in the event of a discrepancy

The inverter does not signal an internal event in this case.

After the tolerance time has expired, the inverter signals the discrepancy (fault C01770 or C30770).

Switching on the motor after a discrepancy

Procedure

To switch the motor on again, proceed as follows:

1. Remove the discrepancy.

2. Acknowledge the discrepancy message with a fail-safe acknowledge signal via a fail-safe input: F-DI = 0 → 1 → 0.
   Alternatively: Power on reset.

3. Acknowledge the inverter with the "standard" acknowledge signal.

4. Issue an OFF1 command (ON/OFF1 = 0).

5. Switch on the motor (ON/OFF1 = 1).

You have acknowledged the discrepancy message, and switched on the motor again.

5.5.2 Discrepancy with Safe Stop 1 (SS1)

The inverter responds with the active safety function SS1 to a discrepancy at the fail-safe input.

The behavior of the drive depends on the setting of the inverter.

1st case: Response of the drive for SS1 of the basic functions

You have selected one of the following settings:

- Basic functions via onboard terminals
- Basic functions via PROFIsafe and onboard terminals
- Extended functions via PROFIsafe and basic functions via onboard terminals
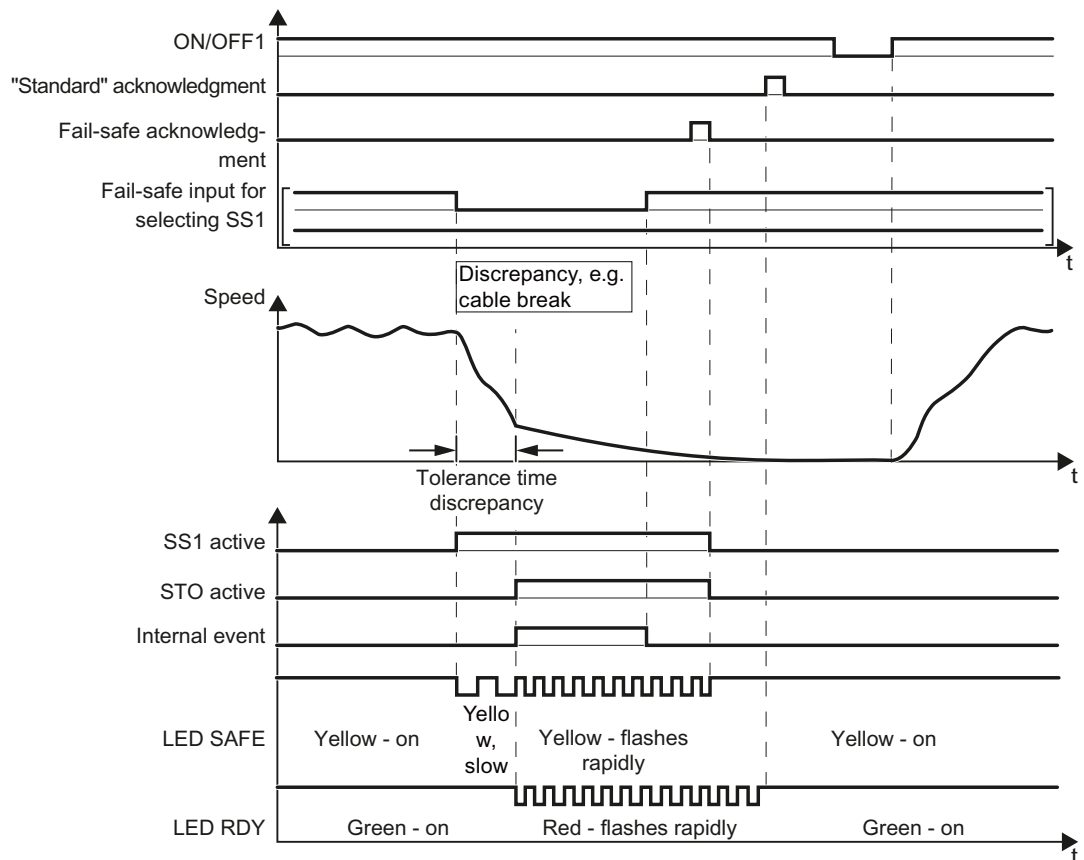
Figure 5-43   Behavior of the inverter for discrepancy of the input signal for SS1 (example: cable break in the channel of processor P1)

Inverter messages after the tolerance time has expired:

- Discrepancy (fault F01611 or F30611)
- Internal event (PROFIsafe status word 1, bit 7)

Switching on the motor after a discrepancy

Procedure

To switch the motor on again, proceed as follows:

1. Remove the discrepancy.

2. Acknowledge the internal event.

Selected setting	How can the internal event be acknowledged?		
	F-DI	PROFIsafe	Alternative
Basic functions via onboard terminals	Select and deselect SS1 (F-DI = 1 → 0 → 1)	---	Power on reset
Basic functions via PROFIsafe and onboard terminals	Select and deselect SS1 (F-DI = 1 → 0 → 1)	Select and deselect STO (PROFIsafe control word 1, bit 0 = 1 → 0 → 1) or Select and deselect SS1 (PROFIsafe control word 1, bit 1 = 1 → 0 → 1) or Fail-safe acknowledgment (PROFIsafe control word 1, bit 7 = 0 → 1 → 0)	Power on reset
Extended functions via PROFIsafe and basic functions via onboard terminals	Select and deselect SS1 (F-DI = 1 → 0 → 1)	Select and deselect STO (PROFIsafe control word 1, bit 0 = 1 → 0 → 1) or Select and deselect SS1 (PROFIsafe control word 1, bit 1 = 1 → 0 → 1) or Fail-safe acknowledgment (PROFIsafe control word 1, bit 7 = 0 → 1 → 0)	Power on reset

3. Acknowledge the inverter with the "standard" acknowledge signal.

4. Issue an OFF1 command (ON/OFF1 = 0).

5. Switch on the motor (ON/OFF1 = 1).

You have acknowledged the discrepancy message, and switched on the motor again.

2nd case: Response of the drive for SS1 of the extended functions

You have selected the extended functions via onboard terminals.
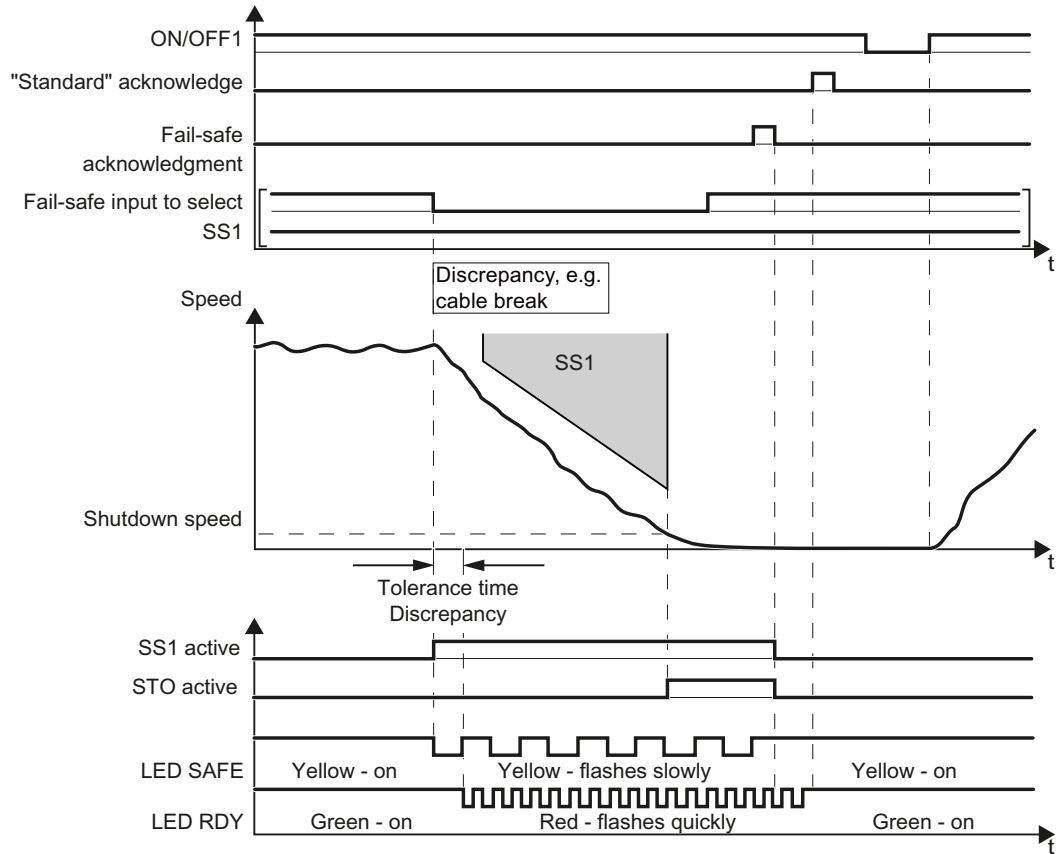
Figure 5-44   Behavior of the inverter for discrepancy of the input signal for SS1 (as example: SS1 with braking ramp monitoring)

The inverter does not signal an internal event in this case.

After the tolerance time has expired, the inverter signals the discrepancy (message C01770 or C30770) but does not interrupt the braking operation for the motor.

Switching on the motor after a discrepancy

Procedure

To switch the motor on again, proceed as follows:

1. Remove the discrepancy.

2. Acknowledge the discrepancy message with the fail-safe acknowledge signal via a fail-safe input: F-DI = 0 → 1 → 0.

   Alternatively: Power on reset.

3. Acknowledge the inverter with the "standard" acknowledge signal.

4. Issue an OFF1 command (ON/OFF1 = 0).

5. Switch on the motor (ON/OFF1 = 1).

You have acknowledged the discrepancy message, and switched on the motor again.

5.5.3 Discrepancy with Safely Limited Speed (SLS)

Drive response

The inverter responds with the active safety function SLS to a discrepancy at the fail-safe input.
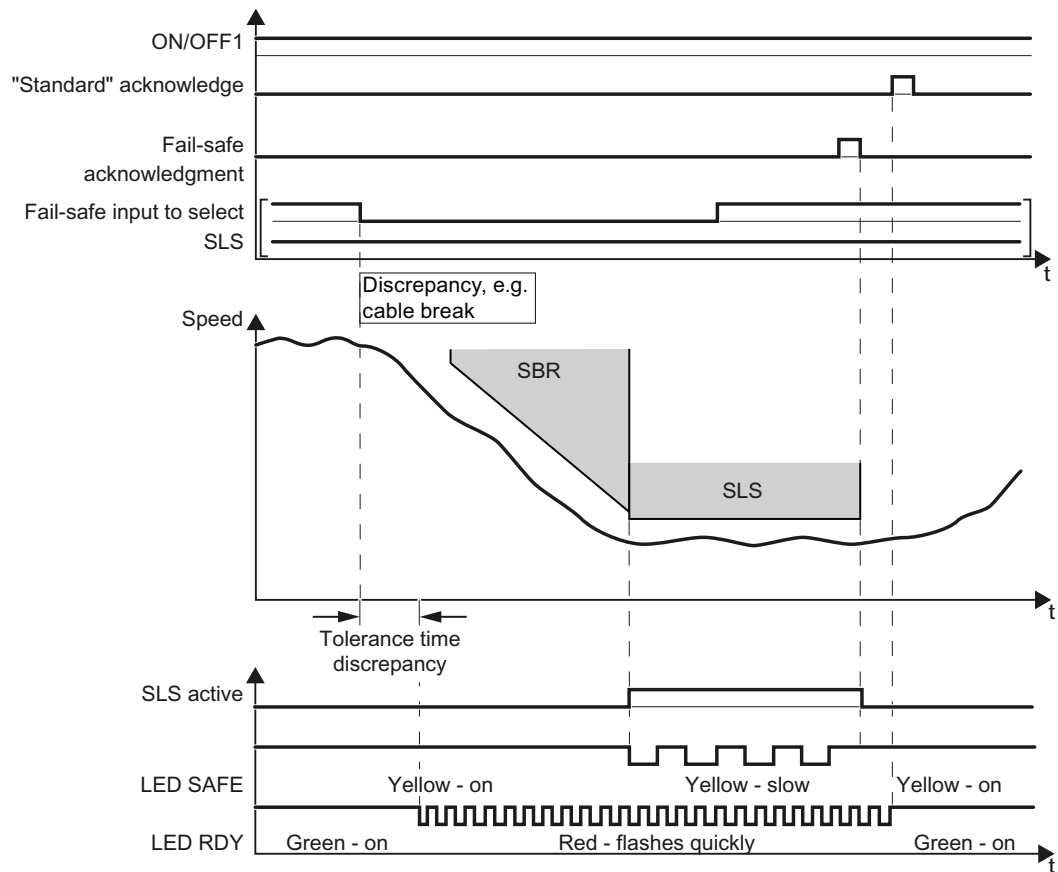
Figure 5-45   Behavior of the inverter for discrepancy of the input signal for SLS

The inverter does not signal an internal event in this case.

After the tolerance time has expired, the inverter signals the discrepancy (alarm C01770 or C30770). The SLS function remains active, and the motor remains switched on.

Deselecting SLS after a discrepancy

Procedure

To deselect SLS, proceed as follows:

1. Remove the discrepancy.

2. Acknowledge the discrepancy message with the fail-safe acknowledge signal via a fail-safe input: F-DI = 0 → 1 → 0.

   Alternatively, you can acknowledge the message in one of the following ways. However, the drive stops in these cases:

   – Select the STO function and then deselect again: F-DI = 1 → 0 → 1.

   – Select the SS1 function and then deselect again: F-DI = 1 → 0 → 1.

   – Switch off the inverter supply voltage and on again (power on reset).

3. Acknowledge the inverter with the "standard" acknowledge signal.

You have acknowledged the discrepancy message and deselected SLS.

5.5.4 Discrepancy for Safe Direction (SDI)

Drive response

The inverter responds with the active safety function SDI to a discrepancy at the fail-safe input.
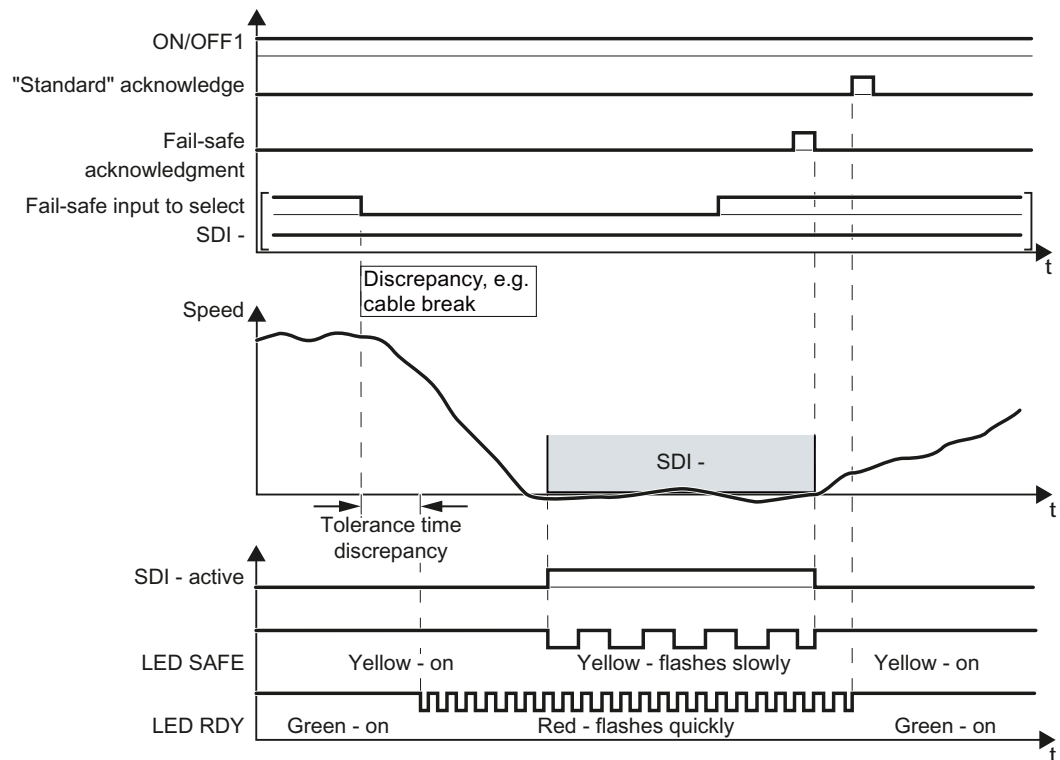
Figure 5-46   Behavior of the inverter for discrepancy of the input signal for SDI (as example SDI -)

The inverter does not signal an internal event in this case.

After the tolerance time has expired, the inverter signals the discrepancy (alarm C01770 or C30770). The SDI function remains active, and the motor remains switched on.

Deselecting SDI after a discrepancy

Procedure

To deselect SDI, proceed as follows:

1. Remove the discrepancy.

2. Acknowledge the discrepancy message with the fail-safe acknowledge signal via a fail-safe input: F-DI = 0 → 1 → 0.

   Alternatively, you can acknowledge the message in one of the following ways. However, the drive stops in these cases:

   – Select the STO function and then deselect again: F-DI = 1 → 0 → 1.

   – Select the SS1 function and then deselect again: F-DI = 1 → 0 → 1.

   – Switch off the inverter supply voltage and on again (power on reset).

3. Acknowledge the inverter with the "standard" acknowledge signal.

You have acknowledged the discrepancy message and deselected SDI.

5.5.5 Signal discrepancy for fail-safe acknowledgment

Drive response
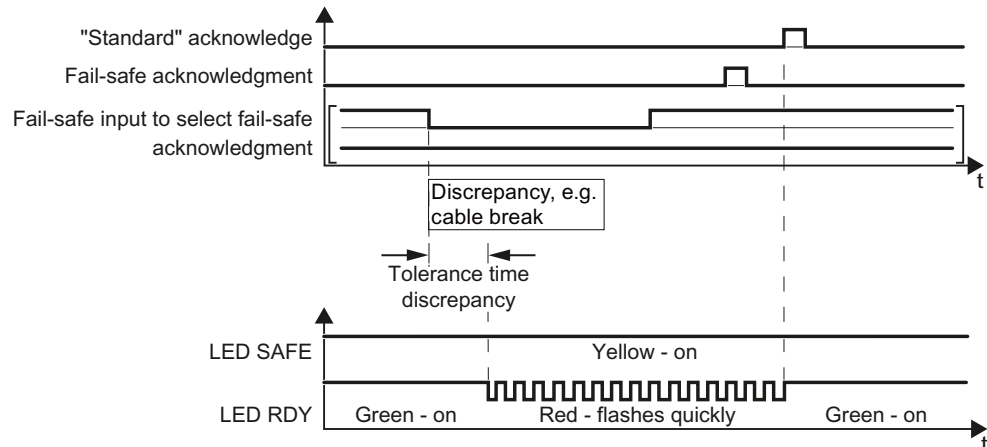
Figure 5-47   Behavior of the inverter for discrepancy of the input signal for fail-safe acknowledgment

The inverter does not signal an internal event in this case.

After the tolerance time has expired, the inverter signals the discrepancy (fault C01770 or C30770).

Acknowledging a discrepancy message

Procedure

To acknowledge the discrepancy message, proceed as follows:

1. Remove the discrepancy.

2. Acknowledge the discrepancy message in one of the following ways:

    – Fail-safe acknowledge signal via a fail-safe input: F-DI = 0 → 1 → 0.

    – Select the STO function and then deselect again: F-DI = 1 → 0 → 1.

    – Select the SS1 function and then deselect again: F-DI = 1 → 0 → 1.

    – Switch off the inverter supply voltage and on again (power on reset).

3. Acknowledge the inverter with the "standard" acknowledge signal.

You have acknowledged the discrepancy message

5.5.6 Discrepancy in the signals transferred via PROFIsafe

Drive response
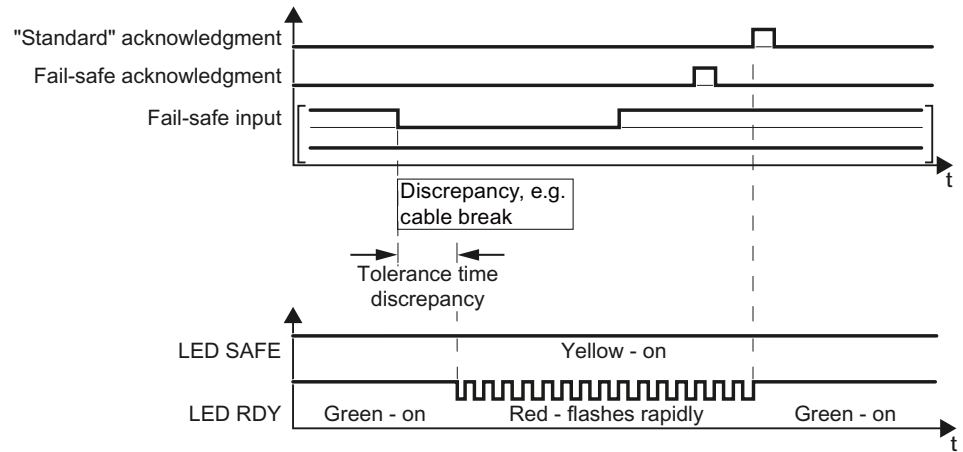
Figure 5-48   Behavior of the inverter in the event of a discrepancy in a fail-safe input in PROFIsafe telegram 900

The inverter does not signal an internal event in this case.

After the tolerance time has expired, the inverter signals the discrepancy (fault C01770 or C30770).

Acknowledging a discrepancy message

Procedure

1
2

To acknowledge the discrepancy message, proceed as follows:

1. Remove the discrepancy.

2. Acknowledge the discrepancy message in one of the following ways:

Selected setting	How can the internal event be acknowledged?		
	F-DI	**PROFIsafe**	**Alternative**
Extended functions via PROFIsafe	---	Select and deselect STO (PROFIsafe control word 1, bit 0 = 1 → 0 → 1) or Select and deselect SS1 (PROFIsafe control word 1, bit 1 = 1 → 0 → 1) or Fail-safe acknowledgment (PROFIsafe control word 1, bit 7 = 0 → 1 → 0)	Power on reset
Extended functions via PROFIsafe and basic functions via onboard terminals	Select and deselect STO (F-DI = 1 → 0 → 1)	Select and deselect STO (PROFIsafe control word 1, bit 0 = 1 → 0 → 1) or Select and deselect SS1 (PROFIsafe control word 1, bit 1 = 1 → 0 → 1) or Fail-safe acknowledgment (PROFIsafe control word 1, bit 7 = 0 → 1 → 0)	Power on reset

3. Acknowledge the inverter with the "standard" acknowledge signal.

You have acknowledged the discrepancy message

5.6 Response to an internal event

5.6.1 Internal event when Safe Torque Off (STO) is active

Drive response
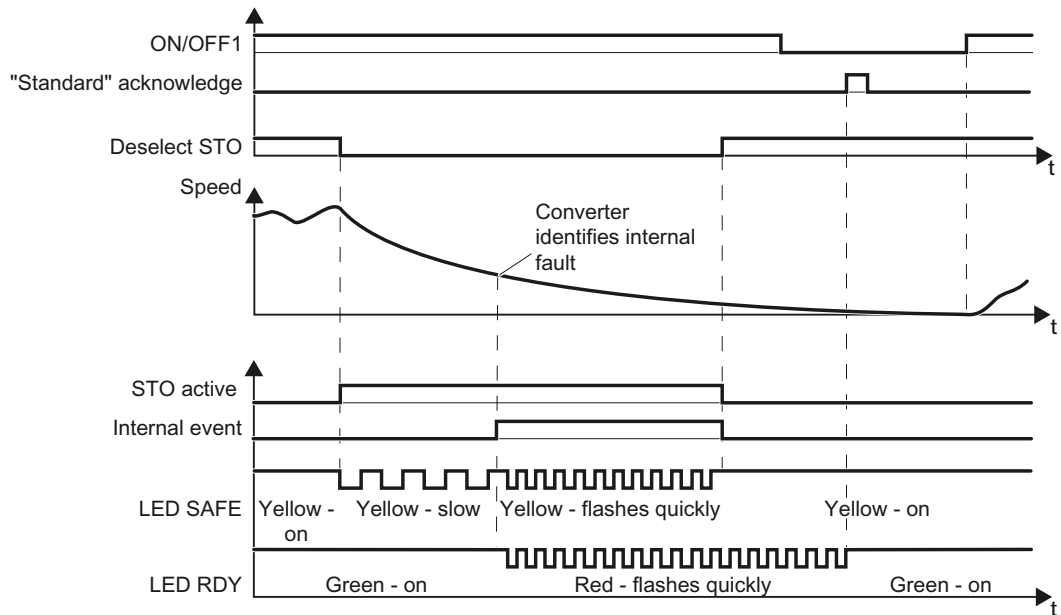
Figure 5-49　Internal event when the STO safety is active

The inverter signals an internal event.

Switching the motor on after an internal event

Procedure

To switch the motor on after an internal event, proceed as follows:

1. Deselect the STO function.

2. Issue an OFF1 command (ON/OFF1 = 0).

3. Acknowledge the inverter with the "standard" acknowledge signal.

4. Switch on the motor (ON/OFF1 = 1).

You have acknowledged the internal event and switched on the motor again.

5.6.2   Internal event when Safe Speed Monitoring (SSM) is active

Internal event when the motion monitoring function is active

If an active safety function with motion monitoring (SS1, SSL, SDI or SSM) is interrupted with an internal event, the inverter responds with a STOP F.

Response of the drive using the SSM function as example

The motor behavior is explained using the SSM function and a STOP B with acceleration monitoring as an example:
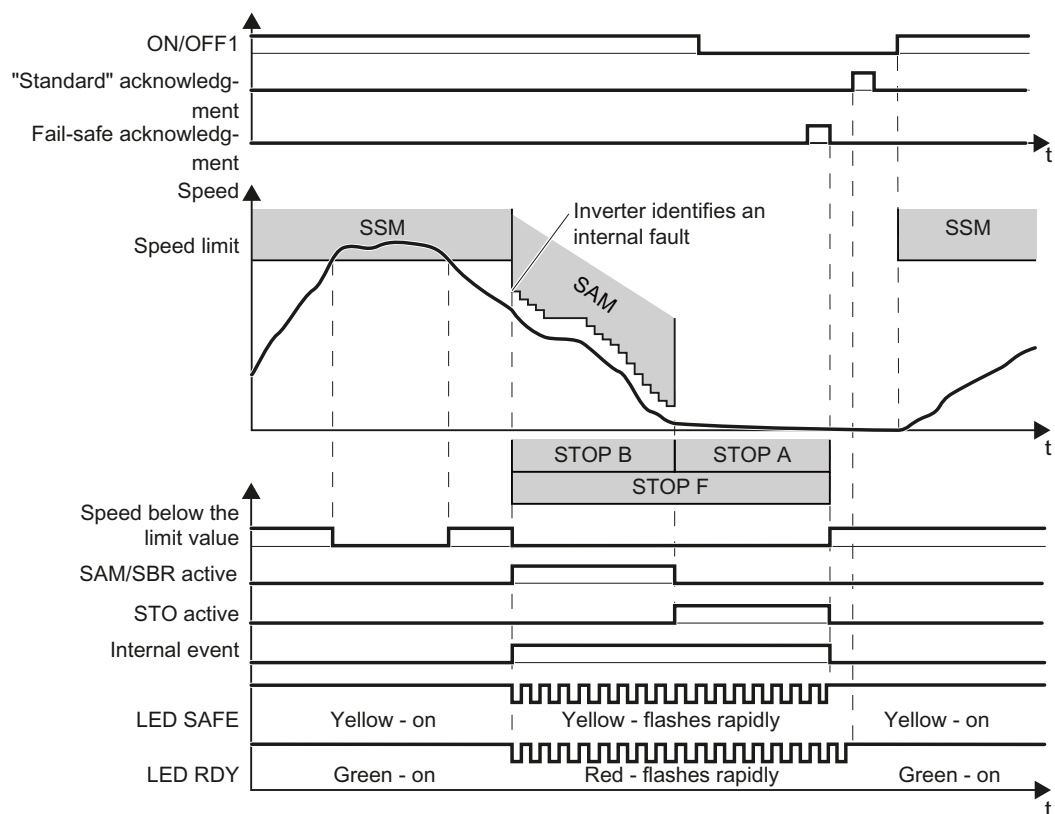
Figure 5-50   Reaction of the SSM safety function to an internal event

Switching the motor on after an internal event

Procedure

To switch the motor in the example above on again, proceed as follows:

1. Issue an OFF1 command (ON/OFF1 = 0).

2. Acknowledge the internal event in one of the following ways:
   – Fail-safe acknowledgment via PROFIsafe control word 0, bit 7 = 0 → 1 → 0.
   – Fail-safe acknowledge signal via a fail-safe input: F-DI = 0 → 1 → 0.
   – Select the STO function and deselect again (PROFIsafe control word 0, bit 0 or F-DI: 1 → 0 → 1).
   – Select the SS1 function and deselect again (PROFIsafe control word 0, bit 1 or F-DI: 1 → 0 → 1).
   – Switch off the inverter supply voltage and on again (power on reset).

3. Acknowledge the inverter with the "standard" acknowledge signal.

4. Switch on the motor (ON/OFF1 = 1).
   Also see section: Switching on the motor when SSM is active (Page 190).

You have acknowledged the internal event and switched on the motor again.

5.6.3 Limit value violation when Safe Stop 1 (SS1) is active

Drive response

If the motion monitoring identifies a fault when SS1 is active, then the inverter safety switches off the motor torque (STOP A).
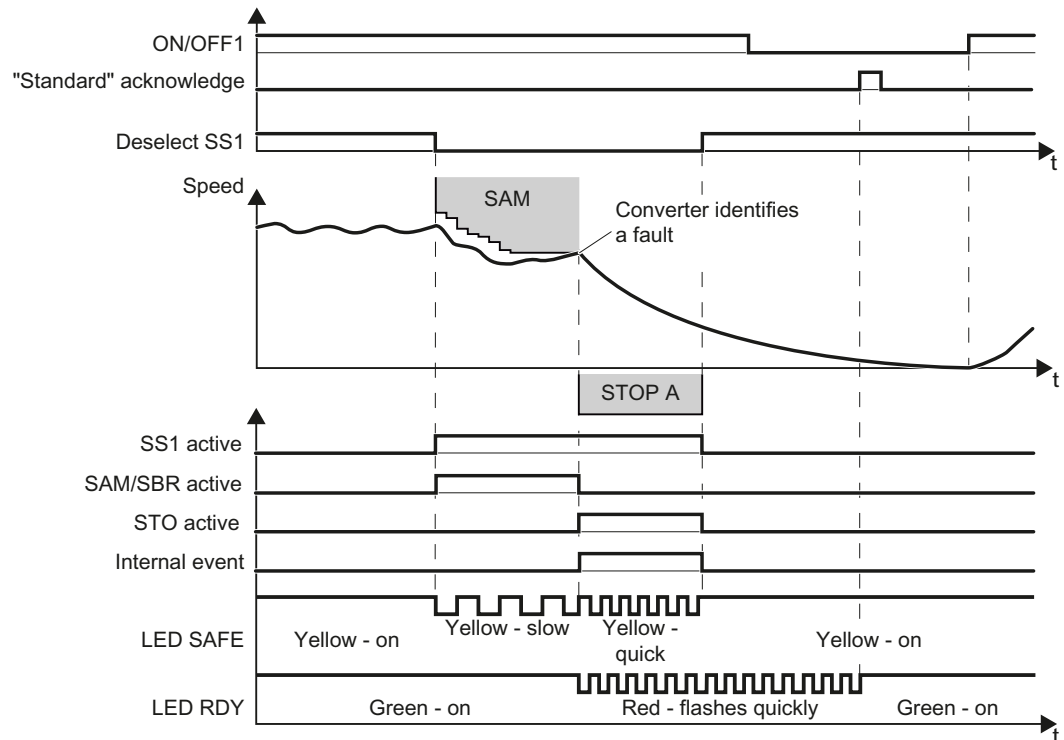
Figure 5-51   General fault response of safety function SS1 (as example: SS1 with acceleration monitoring)

Switching the motor on after an internal event

Procedure

To switch the motor on after an internal event while SS1 is active, proceed as follows:

1. Deselect the SS1 function.

2. Issue an OFF1 command (ON/OFF1 = 0).

3. Acknowledge the inverter with the "standard" acknowledge signal.

4. Switch on the motor again (ON/OFF1 = 1).

You have acknowledged the internal event and switched on the motor again.

5.6.4 Limit value violation when Safely Limited Speed (SLS) is active

Drive response

If the motion monitoring identifies an error when SLS is active, then the inverter either responds with a STOP A or a STOP B. You select the inverter response when commissioning the drive You can find the different STOP versions in the section Stop responses (Page 209).
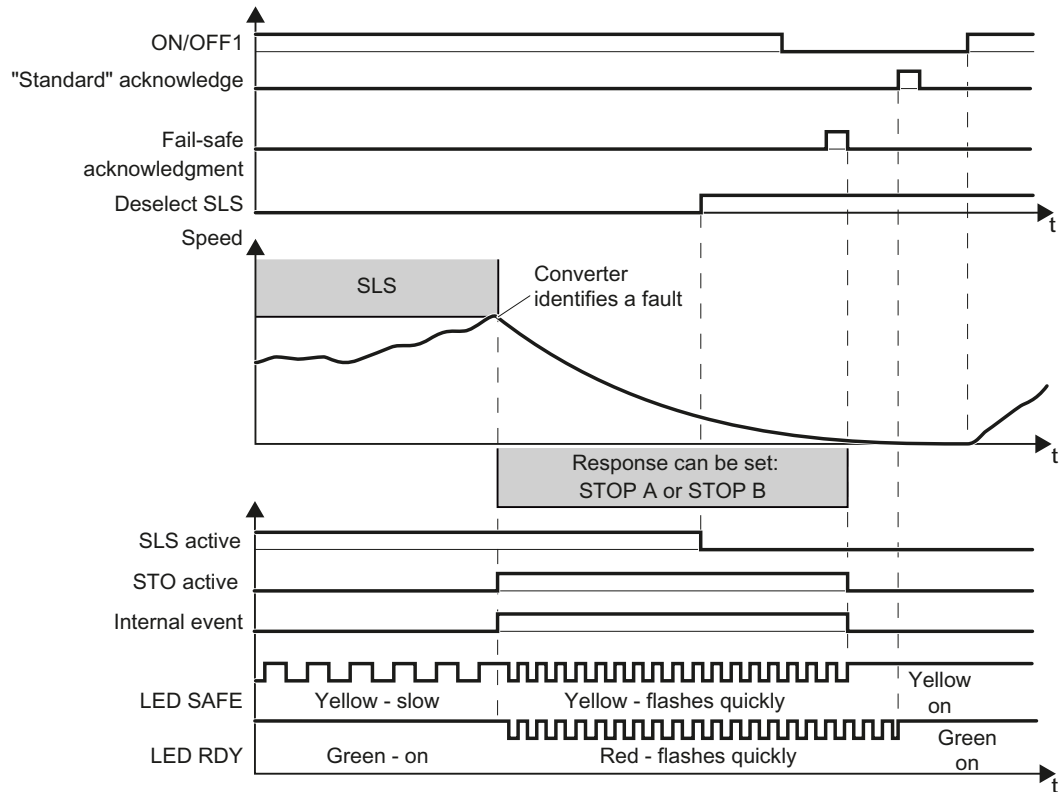
Figure 5-52   Fault response of the SLSsafety function

Switching the motor on after an internal event

Procedure

To switch the motor on after an internal event while SLS is active, proceed as follows:

1. Deselect the SLS function.

2. Issue an OFF1 command (ON/OFF1 = 0).

3. Acknowledge the internal event in one of the following ways:

   – Fail-safe acknowledgment via PROFIsafe control word 0, bit 7 = 0 → 1 → 0.

   – Fail-safe acknowledge signal via a fail-safe input: F-DI = 0 → 1 → 0.

   – Select the STO function and deselect again (PROFIsafe control word 0, bit 0 or F-DI: 1 → 0 → 1).

   – Select the SS1 function and deselect again (PROFIsafe control word 0, bit 1 or F-DI: 1 → 0 → 1).

   – Switch off the inverter supply voltage and on again (power on reset).

4. Acknowledge the inverter with the "standard" acknowledge signal.

5. Switch on the motor (ON/OFF1 = 1).

You have acknowledged the internal event and switched on the motor again.

5.6.5 Limit value violation when Safe Direction (SDI) is active

Drive response

If the motion monitoring identifies an error when SDI is active, then the inverter either responds with a STOP A or a STOP B. You select the inverter response when commissioning the drive You can find the different STOP versions in the section Stop responses (Page 209).
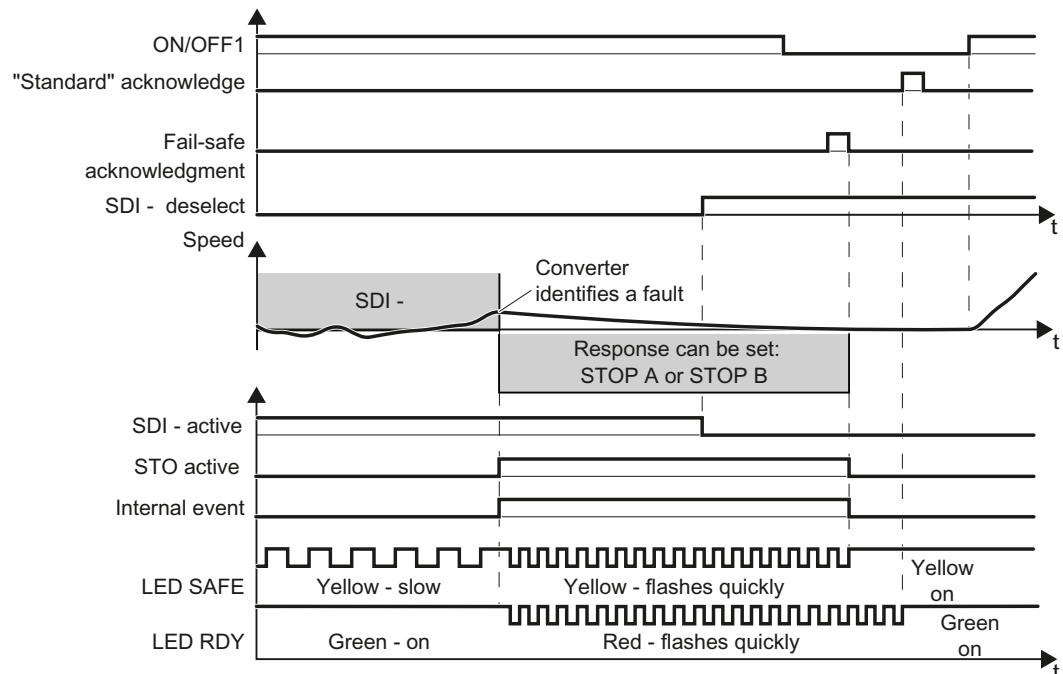
Figure 5-53   Fault response of the SDI safety function

Switching the motor on after an internal event

Procedure

To switch the motor on after an internal event while SDI is active, proceed as follows:

1. Deselect the SDI function.

2. Issue an OFF1 command (ON/OFF1 = 0).

3. Acknowledge the internal event in one of the following ways:

   – Fail-safe acknowledgment via PROFIsafe control word 0, bit 7 = 0 → 1 → 0.

   – Fail-safe acknowledge signal via a fail-safe input: F-DI = 0 → 1 → 0.

   – Select the STO function and deselect again (PROFIsafe control word 0, bit 0 or F-DI: 1 → 0 → 1).

   – Select the SS1 function and deselect again (PROFIsafe control word 0, bit 1 or F-DI: 1 → 0 → 1).

   – Switch off the inverter supply voltage and on again (power on reset).

4. Acknowledge the inverter with the "standard" acknowledge signal.

5. Switch on the motor (ON/OFF1 = 1).

You have acknowledged the internal event and switched on the motor again.

Corrective maintenance   6

6.1   Replacing components of the modular SINAMICS G120/G120D converter

6.1.1   Overview of replacing converter components

Permissible replacement of components

In the event of a long-term function fault, you must replace the Power Module or Control Unit. The inverter's Power Module and Control Unit can be replaced independently of each other.

Replacing the Power Module		Replacing the Control Unit	
Replacement: • Same type • Same power rating	Replacement: • Same type • *Higher* power rating	Replacement: • Same type • Same firmware version	Replacement: • Same type • *higher* firmware version (e.g. replace FW V4.2 by FW V4.3)
	Power Module and motor must be adapted to one another (ratio of motor and Power Module rated power > 1/8)	After replacing the Control Unit, you must restore the inverter's settings.	

⚠ WARNING
Physical injury or material damage as a result of unexpected drive behavior
Replacing inverters of different types can result in an unpredictable drive response.
• In all cases that are not permitted according to the table above, recommission the drive after replacing an inverter.

Device replacement without removable storage medium - only for communication via PROFINET

If you have created a topology in your control, you can use environment detection to replace a defective inverter with a new device of the same type and with the same software release. Recommissioning is not required in this case.

You can either load the inverter settings into the inverter using the memory card or – if you are using a SIMATIC S7 controller with DriveES – using DriveES.

Details of the device replacement without removable storage medium can be found in the Profinet system description (http://support.automation.siemens.com/WW/view/en/19292127).

6.1.2   Replacing a Control Unit with enabled safety function

Replacing a Control Unit with data backup on a memory card

Procedure

To replace the Control Unit, proceed as follows:

1. Disconnect the line voltage to the Power Module and (if installed) the external 24 V supply or the voltage for the digital outputs of the Control Unit.

2. Remove the signal cables from the Control Unit.

3. Remove the defective Control Unit.

4. Mount the new Control Unit on the Power Module. The new Control Unit must have the same order number and the same or higher firmware version as the Control Unit that was replaced.

5. Remove the memory card from the old Control Unit and insert it in the new Control Unit.

6. Reconnect the signal cables of the Control Unit.

7. Connect up the line voltage again.

8. The inverter loads the settings from the memory card.

9. After loading, check whether the inverter outputs Alarm A01028.

   – Alarm A01028:

     The loaded settings are not compatible with the inverter.

     Clear the alarm with p0971 = 1 and recommission the drive.

   – No alarm A01028:

     Perform a **reduced** acceptance test.

     The reduced acceptance test is described in Section Reduced acceptance (Page 137).

You have replaced the Control Unit and transferred the safety function settings from the memory card to the new Control Unit.

Replacing a Control Unit with data backup in the PC

Procedure

To replace the Control Unit, proceed as follows:

1. Disconnect the line voltage to the Power Module and (if installed) the external 24 V supply or the voltage for the digital outputs of the Control Unit.

2. Remove the signal cables of the Control Unit.

3. Remove the defective Control Unit.

4. Mount the new Control Unit on the Power Module.

5. Reconnect the signal cables of the Control Unit.

6. Connect up the line voltage again.

7. Open the project that matches the drive in STARTER.

8. Go online and transfer the settings from the PC to the inverter by pressing the ![button] button. The inverter signals faults after the download. Ignore these faults, as they will be automatically acknowledged by the following steps.

9. In STARTER, select the screen form for the safety functions.

10. Select the "Change settings" button.

11. Select the "Activate settings" button.

12. Save your settings (copy RAM to ROM).

13. Switch off the inverter power supply.

14. Wait until all LED on the inverter go dark.

15. Switch on the inverter power supply again (power on reset).

16. Perform a **reduced** acceptance test, see the section Reduced acceptance (Page 137).

You have replaced the Control Unit and transferred the safety function settings from the PC to the new Control Unit.

Replacing the Control Unit with data backup in the operator panel (BOP-2 or IOP)

Procedure

To replace the Control Unit, proceed as follows:

1. Disconnect the line voltage to the Power Module and (if installed) the external 24 V supply or the voltage for the digital outputs of the Control Unit.

2. Remove the signal cables of the Control Unit.

3. Remove the defective Control Unit.

4. Mount the new Control Unit on the Power Module.

5. Reconnect the signal cables of the Control Unit.

6. Connect up the line voltage again.

7. Attach the operator panel to the Control Unit.

8. Transfer the settings from the operator panel to the inverter, e.g. via menu "EXTRAS" - "FROM BOP" in the BOP-2.

9. Wait until the transfer is complete.

10. After loading, check whether the inverter outputs alarm A01028.

    – Alarm A01028:

      The loaded settings are not compatible with the inverter.

      Clear the alarm with p0971 = 1, and recommission the drive.

    – No alarm A01028: Proceed with the next step.

11. Switch off the inverter power supply.

12. Wait until all LED on the inverter go dark.

13. Switch on the inverter power supply again (power on reset).

    The inverter signals the faults F1650, F1680, and F30680. Ignore these faults, as they will be automatically acknowledged by the following steps.

14. Set p0015 = 95.

15. Set p9761 to the safety password.

16. Set p9701 to AC hex.

17. Set p0010 to 0.

18. Ensure that the settings are protected against power failure, e.g. via menu "EXTRAS" - "RAM-ROM" in the BOP-2.

19. Switch off the inverter power supply.

20. Wait until all LED on the inverter go dark.

21. Switch on the inverter power supply again (power on reset).

22. Perform a **reduced** acceptance test, see the section Reduced acceptance (Page 137).

You have replaced the Control Unit and transferred the safety function settings from the operator panel to the new Control Unit.

6.1.3 Replacing the Control Unit without data backup

If you do not backup the settings, then you must recommission the drive after replacing the Control Unit.

Procedure

To replace the Control Unit without backed-up settings, proceed as follows:

1. Disconnect the line voltage to the Power Module and (if installed) the external 24 V supply or the voltage for the digital outputs of the Control Unit.

2. Remove the signal cables of the Control Unit.

3. Remove the defective Control Unit.

4. Mount the new Control Unit on the Power Module.

5. Reconnect the signal cables of the Control Unit.

6. Connect up the line voltage again.

7. Recommission the drive.

The Control Unit replacement has been completed after the drive has been successfully commissioned.

6.1.4 Replacing a Power Module with enabled safety function

Procedure

To replace the Power Module, proceed as follows:

1. Disconnect the line voltage to the Power Module.
   You must not disconnect the external 24 V supply (if installed) to the Control Unit.

> ⚠ **DANGER**
>
> **Risk of electric shock from touching inverter connections**
>
> After the power supply has been switched off, it takes up to 5 minutes until the capacitors in the inverter have discharged enough for the residual voltage to be non-hazardous.
>
> - Check the voltage at the inverter connections before you carry out any installation work.

2. Remove the connecting cables of the Power Module.

3. Remove the Control Unit from the Power Module.

4. Replace the old Power Module with the new Power Module.

5. Mount the Control Unit onto the new Power Module.

6. Connect up the new Power Module using the connecting cables.

> **NOTICE**
>
> **Material damage from swapping the motor's connection lines**
>
> The direction in which the motor rotates switches if you swap the two phases of the motor line.
>
> - Connect the three phases of the motor lines in the right order.
> - After replacing the Power Module, check the direction in which the motor rotates.

7. Switch on the line supply and, if necessary, the 24 V supply for the Control Unit.

8. Perform a reduced acceptance test, see the Section Reduced acceptance (Page 137).

You have successfully replaced the Power Module.

6.2 Replacing the SINAMICS G120C converter

6.2.1 Overview of how to replace an inverter

You must replace the inverter if it continually malfunctions.

Overview

In the following cases you will need to replace the inverter:

Replacement: • Same fieldbus interface • Same power rating • Same firmware version	Replacement: • Same fieldbus interface • Same power rating • *Higher* firmware version (e.g. replace FW V4.2 by FW V4.3)	Replacement: • Same fieldbus interface • *Higher* power rating • Same firmware version	Replacement: • Same fieldbus interface • *Higher* power rating • *higher* firmware version (e.g. replace FW V4.2 by FW V4.3)
Firmware A Firmware A	Firmware B B > A Firmware A	Firmware A Firmware A	Firmware B B > A Firmware A
		inverter and motor must be adapted to one another (ratio of the motor and inverter rated power > 1/8)	

After you have carried out the replacement, you must restore the inverter's settings.

⚠ **WARNING**

Physical injury or material damage as a result of unexpected drive behavior

Replacing inverters of different types can result in an unpredictable drive response.

• In all cases that are not permitted according to the table above, recommission the drive after replacing an inverter.

Device replacement without removable storage medium - only for communication via PROFINET

If you have created a topology in your control, using the environment detection, you can replace a defective inverter by a new device of the same type and with the identical software release without having to recommission the system.

You can either load the inverter settings into the inverter using the memory card or – if you are using a SIMATIC S7 controller with DriveES – using DriveES.

Details of the device replacement without removable storage medium can be found in the Profinet system description (http://support.automation.siemens.com/WW/view/en/19292127).

6.2.2   Replacing a converter with enabled safety function

Replacing an inverter with data backup on a memory card

Procedure

To replace the inverter, proceed as follows:

1. Disconnect the line voltage to the inverter and (if installed) the external 24 V supply or the voltage for the digital outputs of the inverter.

⚠ DANGER
Death as a result of electric shock!
After the power supply has been switched off, it takes up to 5 minutes until the capacitors in the inverter have discharged enough for the residual voltage to be non-hazardous.
• Check the voltage at the inverter connections before you carry out any installation work.

2. Remove the connecting cables of the inverter.

3. Remove the defective inverter.

4. Install the new inverter.

5. Remove the memory card from the old inverter, and insert this into the new inverter.

6. Connect all of the cables to the inverter.

NOTICE
Damage from swapping the motor's connection lines
The direction in which the motor rotates switches if you swap the two phases of the motor line.
• Connect the three phases of the motor lines in the right order.
• After replacing the Power Module, check the direction in which the motor rotates.

7. Reconnect the line voltage, and (if being used) the external 24 V supply or the voltage for the digital outputs of the inverter.

8. The inverter loads the settings from the memory card.

9. After loading, check whether the inverter outputs Alarm A01028.

   – Alarm A01028:

   The loaded settings are not compatible with the inverter.

   Clear the alarm with p0971 = 1 and recommission the drive.

   – No alarm A01028:

   Perform a **reduced** acceptance test.

   The reduced acceptance test is described in Section Reduced acceptance (Page 137).

You have replaced the inverter and transferred the safety function settings from the memory card to the new inverter.

Replacing an inverter with data backup in the PC

Procedure

1
2

To replace the inverter, proceed as follows:

1. Disconnect the line voltage to the inverter and (if installed) the external 24 V supply or the voltage for the digital outputs of the inverter.

> ⚠ **DANGER**
>
> **Death as a result of electric shock!**
>
> After the power supply has been switched off, it takes up to 5 minutes until the capacitors in the inverter have discharged enough for the residual voltage to be non-hazardous.
> - Check the voltage at the inverter connections before you carry out any installation work.

2. Remove the connecting cables of the inverter.

3. Remove the defective inverter.

4. Install the new inverter.

5. Connect all of the cables to the inverter.

> **NOTICE**
>
> **Damage from swapping the motor's connection lines**
>
> The direction in which the motor rotates switches if you swap the two phases of the motor line.
> - Connect the three phases of the motor lines in the right order.
> - After replacing the Power Module, check the direction in which the motor rotates.

6. Reconnect the line voltage, and (if being used) the external 24 V supply or the voltage for the digital outputs of the inverter.

7. Open the project that matches the drive in STARTER.

8. Go online and transfer the settings from the PC into the inverter by pressing the ⬇ button.
   The inverter signals faults after the download. Ignore these faults, as they will be automatically acknowledged by the following steps.

9. In STARTER, select the screen form for the safety functions.

10. Select the "Change settings" button.

11. Select the "Activate settings" button.

12. Save your settings (copy RAM to ROM).

13. Switch off the inverter power supply.

14. Wait until all LED on the inverter go dark.

15. Switch on the inverter power supply again (power on reset).

16. Perform a **reduced** acceptance test, see the section Reduced acceptance (Page 137).

☐ You have replaced the inverter and transferred the safety function settings from the PC to the new inverter.

Replacing the inverter with data backup in the operator panel (BOP-2 or IOP)

Procedure

To replace the inverter, proceed as follows:

1. Disconnect the line voltage to the inverter and (if installed) the external 24 V supply or the voltage for the digital outputs of the inverter.

⚠ DANGER
Death as a result of electric shock!
After the power supply has been switched off, it takes up to 5 minutes until the capacitors in the inverter have discharged enough for the residual voltage to be non-hazardous. • Check the voltage at the inverter connections before you carry out any installation work.

2. Remove the connecting cables of the inverter.

3. Remove the defective inverter.

4. Install the new inverter.

5. Connect all of the cables to the inverter.

NOTICE
Damage from swapping the motor's connection lines
The direction in which the motor rotates switches if you swap the two phases of the motor line. • Connect the three phases of the motor lines in the right order. • After replacing the Power Module, check the direction in which the motor rotates.

6. Reconnect the line voltage and (if being used) the external 24 V supply or the voltage for the digital outputs of the inverter.

7. Attach the operator panel to the inverter.

8. Transfer the settings from the operator panel to the inverter, e.g. via menu "EXTRAS" - "FROM BOP" in the BOP-2.

9. Wait until the transfer is complete.

   The inverter signals faults after the download. Ignore these faults, as they will be automatically acknowledged by the following steps.

10. Switch off the inverter power supply.

11. Wait until all LED on the inverter go dark.

12. Switch on the inverter power supply again (power on reset).

13. Perform a **reduced** acceptance test, see the section Reduced acceptance (Page 137).

You have replaced the inverter and transferred the safety function settings from the operator panel to the new inverter.

6.2.3 Replacing a converter without data backup

If the settings have not been backed up, after replacing the inverter, you must recommission the drive.

Procedure
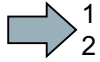
To replace the inverter, proceed as follows:

1. Disconnect the line voltage to the inverter and (if installed) the external 24 V supply or the voltage for the digital outputs of the inverter.

2. Remove the connecting cables of the inverter.

3. Remove the defective inverter.

4. Install the new inverter.

5. Connect all of the cables to the inverter.

6. Reconnect the line voltage, and (if being used) the external 24 V supply or the voltage for the digital outputs of the inverter.

7. Recommission the drive.

Inverter commissioning has been completed after it has been commissioned.

Alarms and faults

<div style="text-align: right; font-size: 3em;">7</div>

Syntax for faults and alarms

F12345	Fault 12345
A67890	Alarm 67890
C01700	Message 1700 for safety functions
	These messages are either alarms or faults, see the following table.

The table in this manual only contains the alarms and faults of the safety functions. The complete list of all alarms and faults of the inverter, detailed causes and remedial measures can be found in the List Manual.

Signal	Cause	Remedy
	For further information, please refer to the List Manual.	
F01600	STOP A is initiated.	1. SelectSTO and then deselect again. 2. If it cannot be acknowledged, replace the Control Unit.
F01611	Defect in a monitoring channel. More detailed information is provided by fault value r0949.	The complete list of the fault values is provided in the List Manual. 0: Stop request from processor 2. 1 … 999: Fault in data cross-check between processor 1 and processor 2. Details and remedy: Please refer to the List Manual. 1000: The check timer has expired. Within the time of approx. 5 x p9650, one of the following events has occurred: • Too many signal changes at the F-DI • Too frequent selection of STO via PROFIsafe (also as a follow-up response) Remedy: • Check the F-DI wiring (contact problems). • Resolve the contact problems or faults at the PROFIBUS master/PROFINET controller. 1001, 1002: Initialization error, change timer/check timer. • Remedy: Power on reset 2000: Status of the STO selection for the two monitoring channels is different. 2001: Checkback signal of the safe pulse suppression for the two monitoring channels is different. 2003: Status of the STO terminal at processor 1 and processor 2 is different. Remedy for 2000, 2001, and 2003:

Signal	Cause	Remedy
	For further information, please refer to the List Manual.	
		• Check the F-DI changeover tolerance time. Increase the value (p9650).
		• Check the F-DI wiring (contact problems).
		• Check the causes of the STO selection in r9772.
		6000: Internal software fault
		• Power on reset
		• Upgrade firmware to later version
		• Replace Control Unit
		6064: Target address and PROFIsafe address differ (F_Dest_Add).
		• Check the value of the F_Dest_Add F-parameter in the inverter
		• Check the PROFIsafe address at processor 1 (p9610) and processor 2 (p9810).
		6065: Target address invalid (F_Dest_Add).
		• The target address must not be 0 or FFFF.
		6066: Source address invalid (F_Source_Add).
		• The source address must not be 0 or FFFF.
		6067: Watchdog time value invalid (F_WD_Time).
		• The watchdog time value must not be 0.
		6165: Fault in reception of the PROFIsafe telegram. This fault can also arise if the inverter has received an inconsistent or out-of-date PROFIsafe telegram after a power on reset or after the PROFIBUS/PROFINET line has been connected.
		• Check the configuration and communication in the inverter.
		• Check the value of the F_WD_Time F-parameter in the inverter. Increase the value.
		6166: Time monitoring fault in reception of the PROFIsafe telegram.
		• Check the configuration of the communication in the inverter.
		• Check the setting of the F_WD_Time value in the inverter. Increase the value.
		• Evaluate the diagnostic information in the F host.
		• Check the PROFIsafe connection.
A01620, F01620	Safe torque off active	Not necessary.
A01621, F01621	Safe Stop 1 active	Not necessary.
F01625	Sign-of-life error in the Safety data	1. Select STO, and then deselect again. 2. If it cannot be acknowledged, replace the Control Unit.
A01631	Motor holding brake / SBC configuration does not make sense	Check and correct the parameterization of the motor holding brake: The following settings can result in this message: • p1215 = 0 and p9602 = 1. • p1215 = 3 and p9602 = 1.

Signal	Cause	Remedy
	For further information, please refer to the List Manual.	
F01649	Internal software error	1. Switch off the Control Unit power supply and then on again. 2. If it cannot be acknowledged, replace the Control Unit.
F01650	Acceptance test required	See Section Acceptance tests for the safety functions (Page 136).
F01651	Synchronization, safety time slices unsuccessful.	1. Switch off the Control Unit power supply and then on again. 2. If it cannot be acknowledged, replace the Control Unit.
F01653	PROFIBUS configuration error	Check the PROFIBUS configuration of the safety slot on the master side and on the Control Unit.
A01654	PROFIBUS configuration differs	Check the PROFIsafe configuring in the higher-level control. • Alarm value r2124 = 1: In the higher-level F control, remove the PROFIsafe configuring, or enable PROFIsafe in the drive. • Alarm value r2124 = 2: In the higher-level F control, configure the appropriate PROFIsafe telegram.
F01655	Alignment of monitoring functions	Communication between processor 1 and processor 2 is impaired or has failed. Remedy: • Power on reset • Check whether the control cabinet is EMC-compliant.
F01658	PROFIsafe telegram number unsuitable	The PROFIsafe telegram number in p60022 is not suitable for the enabled safety functions. Check the following: • If PROFIsafe is not enabled (p9601.3 = 0), PROFIsafe telegrams must not be selected in p60022. • If PROFIsafe is enabled (p9601.3 = 1), you must select a PROFIsafe telegram in p60022. • If transfer of the F-DI via PROFIsafe is selected (p9501.30 = 1), you must select telegram 900 in p60022.
F01660	Safety functions not supported	Use a Power Module that supports the safety functions.
F01661	Simulation of the safety inputs active	Exit the simulation of the digital inputs of the Control Unit for the F-DI (p0795).
F01662	Error, internal communications	1. Switch off the Control Unit power supply and then on again. 2. Contact Technical Support if it cannot be acknowledged.
F01663	Copying the SI parameters rejected	1. Set p9700 = 0. 2. Check: p9501 ≠ 0 and/or p9601 ≠ 0. If this is the case, then correct both parameters. 3. Start the copy function again by entering the corresponding value into p9700.

Signal	Cause	Remedy
	For further information, please refer to the List Manual.	
F01655	Aligning the monitoring functions	1. Check that the control cabinet design and cable routing are in compliance with EMC regulations. 2. Switch off the Control Unit power supply and then on again.
F01656	Motor Module parameter error	1. Recommission the safety functions. 2. If this is not successful, then replace the Control Unit.
F01658	PROFIsafe telegram number unsuitable	Set the telegram number so that it matches the safety functions that have been enabled. • If p9601.3 = 0, then p60022 must be = 0. • If p9601.3 = 1, then p60022 must be > 0. • If p9501.30 = 1, then p60022 must be = 900.
F01659	Write task for parameter rejected	Check the setting of the safety functions. You can find possible reasons for the message in the List Manual.
F01665	System is defective	1. Switch off the Control Unit power supply and then on again. 2. Contact Technical Support if it cannot be acknowledged.
A01666, F01666	Static 1 signal at the F-DI for safe acknowledgement	Set the signal at the F-DI to acknowledge the safety functions for a logical 0 signal.
F01680	Checksum error safe monitoring functions	1. Check the safety-relevant parameters. 2. Power on reset
F01681	Incorrect parameter value	Correct the parameter value: Fault value (r0949) yyyyxxxx decimal, yyyy = supplementary information, xxxx = parameter
F01682	Monitoring function not supported	De-select the monitoring function involved (p9501, p9601, p9801).
F01683	SLS enable missing	1. Enable the SLS function (p9501.0). 2. Save the setting (copy RAM to ROM). 3. Power on reset
F01690	Data backup problem involving the NVRAM	Please contact Technical Support.
F01692	Parameter value not permitted for encoderless	1. From r0949, read out the (decimal) parameter number with the incorrect value. 2. Correct the parameter value of the checksums.
A01693, F01693	Safety parameter settings changed, warm restart/POWER ON required.	1. Save the parameters so that they are protected against power failure (RAM → ROM). 2. Switch off the Control Unit power supply and then on again.
A01696	Select the motion monitoring function test when powering up	Deselect the forced dormant error detection of the extended functions and then select again.
A01697, F01697	Forced dormant error protection of the extended functions is required	Start the forced dormant error detection. The signal source to initiate this is parameterized in p9705.
A01698	Commissioning mode active	Not necessary.
A01699	Forced dormant error protection of the basic functions is required	Deselect STO, and then select again.
C01700 (fault)	STOP A initiated	Generally, this fault is a consequence of C01701, C01706, C01714 or C01716.

Signal	Cause	Remedy
	For further information, please refer to the List Manual.	
C01701 (fault)	STOP B initiated	Generally, this fault is a consequence of C01706, C01714 or C01716.
C01706 (alarm or fault) [1]	SAM/SBR limit exceeded	1. Check the motor braking response. 2. Adapt the tolerance for the parameterization of the "safe braking ramp".
C01711 (alarm) [1]	Defect in a monitoring channel Fault value r2124 provides more detailed information.	The complete list of the r2124 fault values is provided in the List Manual. 0 … 999: Fault in data cross-check between processor 1 and processor 2. Remedy: Please refer to the List Manual. 1000: Check (watchdog) timer has expired. • Too many signal changes at the F-DI Remedy: • Check the F-DI wiring (contact problems). 1001: Initialization error of the check timer. • Remedy: Power on reset • Upgrade inverter firmware 1005: Pulses already canceled for test stop selection. 1011: Acceptance test status between the monitoring channels differ. • Diagnostics in the List Manual under r9571. 1020: Cyclic communication failure between the monitoring channels. • Remedy: Power on reset • Replace the Control Unit or the inverter. 1040: Pulses in active encoderless monitoring functions canceled. • Deselect the active safety function. Select and then deselect STO. • When the SLS monitoring function is active, you must switch on the motor within 5 s of deselecting STO. 1041: Current value too low for encoderless actual value acquisition. • Reduce the minimum current (p9588). 1042: Current or voltage plausibility error. • Increase the ramp-up and ramp-down time (p1120/p1121). • Check whether the current and speed control settings are correct (torque-forming, field-forming current and actual speed value must not fluctuate). • Reduce the dynamic response of the setpoint. • Increase the minimum current (p9588). 1043: Too many acceleration processes. • Increase the voltage tolerance (p9589). • Increase the ramp-up and ramp-down time (p1120/p1121). • Check whether the current and speed control settings are correct (torque-forming, field-forming current and

Signal	Cause	Remedy
	For further information, please refer to the List Manual.	
		actual speed value must not fluctuate).
		• Reduce the dynamic response of the setpoint.
		1044: Actual current value plausibility error.
		6000 … 6166: The significance of the message values is described in the safety fault F01611 with the fault value r0949.
C01712 (alarm) [1]	Defect when processing F-IO	1. Check the F-DI wiring. 2. Check the setting of the safety functions. 3. Perform an acceptance test.
C01714 (alarm) [1]	Safely limited speed exceeded	1. Check the speed setpoint received from the higher-level control. 2. Check the SLS limits.
C01716 (fault)	Tolerance for safe direction of motion exceeded	Check the tolerance setting for the SDI function.
C01770 (fault)	Discrepancy error of the fail-safe inputs or outputs.	Check the F-DI wiring.
A01772	Test stop fail-safe inputs/outputs active.	The alarm automatically disappears after successfully ending or canceling (error) the forced dormant error detection (test stop).
F01773	Test stop error	1. Check the fail-safe output wiring. 2. Start the forced dormant error detection.
A01774	Test stop required	The time to carry out the forced dormant error detection (test stop) has expired (p10003). Start the forced dormant error detection of the fail-safe output.
A01795	Wait time after exiting safe pulse suppression expired	The wait time of 5 seconds has expired, and the motor was not switched on. See also the sections: • Switching on the motor when SLS is active (Page 186) • Switching on the motor when SSM is active (Page 190) • Switching on the motor when SDI is active (Page 194)
A01796	Waiting for communication	• Check the operating state of the F host. • Check the communication connection to the F host.
C01798 (alarm)	Test stop running	Not necessary. The inverter withdraws the message after the forced dormant error detection has been completed.
C01799 (alarm)	Acceptance test mode active	Not necessary. The inverter withdraws the message after the end of the acceptance test mode.
F30600	STOP A initiated. More detailed information is provided by fault value r0949	1. Select STO. 2. Deselect STO. 3. If it cannot be acknowledged, replace the Control Unit.
F30611	Defect in a monitoring channel. More detailed information is provided by fault value r0949.	Fault values and remedies are described under fault F01611.
A30620, F30620	Safe torque off active	Not necessary.
A30621, F30621	Safe Stop 1 active	Not necessary.

Signal	Cause	Remedy
	For further information, please refer to the List Manual.	
F30625	Sign-of-life error in the Safety data	1. Select STO. 2. Deselect STO. 3. If it cannot be acknowledged, replace the Control Unit.

F30630	Brake control defective	1. Check the following:
		   – p1278 = 0.
		   – Motor holding brake connection
		   – Motor holding brake function
		   – EMC-compliant control cabinet design and cable routing
		2. Select STO, and then deselect again.

F30631		
F30649	Internal software error	1. Switch off the Control Unit power supply and then on again. 2. Contact Technical Support if it cannot be acknowledged.
F30650	Acceptance test required	See Section Acceptance tests for the safety functions (Page 136).
F30651	Synchronization with Control Unit unsuccessful.	1. Switch off the Control Unit power supply and then on again. 2. Contact Technical Support if it cannot be acknowledged.
F30655	Aligning the monitoring functions	1. Check that the control cabinet design and cable routing are in compliance with EMC regulations. 2. Switch off the Control Unit power supply and then on again.
F30656	Motor Module parameter error	1. Recommission the safety functions. 2. If this is not successful, then replace the Control Unit.
F30659	Write task for parameter rejected	Check the following: • Password • Only restore factory settings with the safety functions inhibited
F30662	Error, internal communications	1. Switch off the Control Unit power supply and then on again. 2. Contact Technical Support if it cannot be acknowledged.
F30664	Fault during power-up	Power on reset. Contact Technical Support if it cannot be acknowledged.
F30665	System is defective	1. Switch off the Control Unit power supply and then on again. 2. If it cannot be acknowledged, replace the Control Unit.
A30666, F30666	Static 1 signal at the F-DI for safe acknowledgement	Set the F-DI input to a 0 signal for acknowledging the safety functions.
F30672	Control Unit software incompatible	The Control Unit being used does not support the safety functions. Use the appropriate Control Unit.
F30680	Checksum error safe monitoring functions	1. Check the setting of the safety functions. 2. Switch off the Control Unit power supply and then on again.
F30681	Incorrect parameter value	Correct the parameter value: Fault value (r0949) yyyyxxxx decimal, yyyy = supplementary information, xxxx = parameter
F30682	Monitoring function not supported	De-select the monitoring function involved (p9501, p9601, p9801).

Signal	Cause	Remedy
	For further information, please refer to the List Manual.	
F30683	SLS enable missing	1. Enable the SLS function (p9501.0). 2. Save the setting (copy RAM to ROM). 3. Switch off the Control Unit power supply and then on again.
F30692	Parameter value incorrect for encoderless	Correct the parameter value.
A30693, F30693	Safety parameter settings changed, warm restart/POWER ON required.	1. Save the settings so that they are protected against power failure (RAM → ROM). 2. Switch off the Control Unit power supply and then on again.
C30700 (fault)	STOP A initiated	Generally, this fault is a consequence of C30701, C30706, C30714 or C30716.
C30701 (fault)	STOP B initiated	Generally, this fault is a consequence of C30706, C30714 or C30716.
C30706 (alarm or fault) [1]	SAM/SBR limit exceeded	1. Check the motor braking response. 2. Adapt the tolerance for the parameterization of the "safe braking ramp".
C30711 (alarm) [1]	Defect in a monitoring channel. Fault value r2124 provides more detailed information.	Diagnostics for the fault values and remedies are described under message C01711.
C30712 (alarm) [1]	Defect when processing F-IO	1. Check the F-DI wiring. 2. Check the setting of the safety functions. 3. Perform an acceptance test.
C30714 (alarm) [1]	Safely limited speed exceeded	1. Check the speed setpoint received from the higher-level control. 2. Check the SLS limits.
C30716 (fault)	Tolerance for safe direction of motion exceeded	Check the tolerance for the "SDI" function.
30730		
C30770 (fault)	Discrepancy error of the fail-safe inputs or outputs.	Check the F-DI wiring.
C30798 (alarm)	Test stop running	Not necessary. The inverter withdraws the message after the forced dormant error detection has been completed.
C30799 (alarm)	Acceptance test mode active	Not necessary. The inverter withdraws the message after the end of the acceptance test mode.
[1] If the safety functions of the inverter have been enabled, then this alarm initiates a STOP response and an inverter fault.		

System properties

8

Response times following activation

The response times depend on the following conditions:

- Safety function setting
    - Basic function
    - Extended function
- Fieldbus
    - PROFIBUS or PROFINET
    - Isochronous or non-isochronous communication
- Control: Fail-safe input or PROFIsafe
- Hardware: The CU250S-2 Control Unit differs from the other inverters described in this manual.

The response times in the tables below apply from the point at which the fail-safe input signal changes or the PROFIsafe telegram is received.

Response times of the STO function in the case of control via PROFIsafe

Table 8- 1   Response times of the STO basic function

| | SINAMICS G120 with Control Unit CU250S-2 | | | | All other inverters | |
| | Isochronous communication | | Non-isochronous communication | | Non-isochronous communication | |
	Typical	Worst-case scenario	Typical	Worst-case scenario	Typical	Worst-case scenario
PROFIBUS	10 ms + p2064[4]		10 ms + p2048		14 ms	
PROFINET	10 ms + p2064[4]		10 ms + p2048 + bus cycle time		14 ms + bus cycle time	

Table 8- 2   Response times of the STO extended function

	SINAMICS G120 with Control Unit CU250S-2				All other inverters	
	Isochronous communication		Non-isochronous communication		Non-isochronous communication	
	Typical	Worst-case scenario	Typical	Worst-case scenario	Typical	Worst-case scenario
PROFIBUS	50 ms + p2064[4]	54 ms + p2064[4]	50 ms + p2048	54 ms + p2048	54 ms	58 ms
PROFINET	50 ms + p2064[4]	54 ms + p2064[4]	50 ms + p2048 + bus cycle time	54 ms + p2048 + bus cycle time	54 ms + bus cycle time	58 ms + bus cycle time

p2064[4]: Setpoint acquisition time. The controller transfers this part of the bus configuration to the inverter
at the beginning of cyclic operation.

p2048: Sampling time for process data communication (PZD). Factory setting = 4 ms.

Bus cycle time: The inverter's response time for a cyclic data exchange via PROFINET.

Response times of the STO function in the case of control via a fail-safe input

Table 8- 3   STO response times

	Typical	Worst-case scenario
STO basic function	4 ms + t_E [1]	14 ms + t_E [1]
STO extended function	50 ms + t_E [1]	54 ms + t_E [1]
[1]	t_E = debounce time + 1 ms (if debounce time > 0)	

[1] t_E = debounce time + 1 ms (if debounce time > 0)
t_E = 2 ms (if debounce time = 0)
A description of the debounce time is provided in one of the following sections, according to how you set the STO safety function:

- STO as a basic function: Setting the filter for fail-safe inputs (Page 81).
- STO as an extended function: Setting the filter for fail-safe inputs (Page 99).

Response time after interruption in PROFIsafe communication

If the PROFIsafe telegram does not appear before the end of the PROFIsafe monitoring time F_WD_Time, the inverter responds as follows:

- The inverter signals one of the following faults:
  - Fault F01611 (basic functions are enabled)
  - Message C01711 (extended functions are enabled)

  The inverter receives the F_WD_Time monitoring time from the fail-safe controller (F-CPU). See also the section STEP 7 example: Configuring PROFIsafe communication (telegram 30) via PROFIBUS (Page 66).

- The inverter selects the STO function.

Response times when limit values are violated

Table 8- 4   Time until the response is initiated

Function	Response	Typical	Worst case
SLS	STOP A or STOP B	67 ms [2]	113 ms [2]
SDI	STOP A or STOP B		
SSM	Signal change into the "Status SSM"		
[2]	If you switch on the motor when a safety function is active, the inverter detects a limit value violation at the earliest after the "delay time actual value acquisition" has expired, also refer to Section: Setting encoderless actual value sensing (Page 97).		

Certifications

The safety functions of the converter fulfill the following requirements:

● Category 3 to EN 954-1 and ISO 13849-1

● Performance level (PL) d according to EN ISO 13849-1

● Safety integrity level 2 (SIL 2) to IEC 61508

Probability of failure

The probability of failure of safety functions must be specified by the machine manufacturer in the form of a PFH value (Probability of Failure per Hour) in accordance with IEC 61508, IEC 62061, and ISO 13849-1.

The integrated converter safety functions are only ever part of a complete machine safety function. A complete safety function comprises the following components, for example:

● A dual-channel sensor for detecting an open protective door.

● A central fail-safe controller for processing the sensor signal further.

● A converter for safely stopping (SS1) a motor on account of the open protective door.

IEC 62061 explains how to calculate the PFH_D value for the complete safety function from the PFH_D values of the components used for the safety function.

The following applies for the integrated converter safety function:

Safety function	PFH_D
STO, SS1, SLS, SDI, SSM	$5×10^{-8}$

We provide a free tool in the Internet to calculate the PFH_D value of a complete machine: Safety Evaluation Tool (www.siemens.com/safety-evaluation-tool).

Duration of use

You may not operate converters with integrated safety functions for longer than 20 years. The period of 20 years starts from the delivery date and, for example, cannot be extended by a proof test; this also applies if at some stage you decommission the converter.

Test interval

You must test the safety-relevant circuits of the inverter at least once every year. This process is also known as "forced dormant error detection".

Information on the procedure can be found in the section: (*** NO TRANSLATION IN THIS VERSION! ***) (Page 92).

Appendix

A

A.1 Firmware version 4.6

Table A- 1   New functions and function changes in Firmware 4.6

Function		SINAMICS							
			G120					G120D	
		G120C	CU230P-2	CU240B-2	CU240E-2	CU250S-2 Vektor	CU250S-2 Servo	CU240D-2	CU250D-2
1	Support for the new Power Modules • PM240-2 IP20 FSB … FSC • PM240-2 in through-hole technology FSB ... FSC	-	✓	✓	✓	✓	✓	-	-
2	Support for the new Power Modules • PM230 in through-hole technology FSD ... FSF	-	✓	✓	✓	✓	-	-	-
3	Motor data preassignment for the 1LA/1LE motors via code number • During basic commissioning with the operator panel, set the motor data using a code number	✓	✓	✓	✓	✓	✓	✓	✓
4	Extension to communication via CANopen • CAN velocity, ProfilTorque, SDO channel for each axis, system test with CodeSys, suppression of ErrorPassiv alarm	✓	✓	-	-	✓	✓	-	-
5	Extension to communication via BACnet • Multistate value objects for alarms, commandable AO objects, objects for configuring the PID controller	-	✓	-	-	-	-	-	-
6	Communication via Ethernet/IP	✓	✓	-	✓	✓	✓	✓	✓
7	Skip frequency band for analog input • A symmetrical skip frequency band can be set for each analog input around the 0 V range.	✓	✓	✓	✓	✓	✓	✓	-
8	Changing the control of the motor holding brake	✓	-	✓	✓	✓	✓	✓	-
9	Safety function SBC (Safe Brake Control) • Secure control of a motor holding brake when using the "Safe Brake Module" option	-	-	-	-	✓	✓	-	-
10	Safety function SS1 (Safe Stop 1) without speed monitoring	-	-	-	-	✓	✓	-	-
11	Straightforward selection of standard motors • Selection of 1LA... and 1LE... motors with an operator panel using a list containing code numbers	✓	✓	✓	✓	✓	✓	✓	✓
12	Firmware update via memory card	✓	✓	✓	✓	✓	✓	✓	✓

	Function	SINAMICS							
				G120				G120D	
13	Safety info channel • BICO source r9734.0...14 for the status bits of the extended safety functions	-	-	-	✓	✓	✓	✓	✓
14	Diagnostic alarms for PROFIBUS	✓	✓	✓	✓	✓	✓	✓	✓

A.2 Documentation for acceptance

A.2.1 Machine documentation

Machine or system description

Designation	…
Type	…
Serial number	…
Manufacturer	…
End customer	…

Block diagram of the machine or system:
      …
                  …
                            …
                                      …
                                                …
                                                          …
                                                                    …	

Converter data

Table A- 2   Hardware version of the safety-related converter

Labeling the drive	Order number and hardware version of the converter
…	…
…	…

Function table

Table A- 3   Active safety functions depending on the operating mode and safety equipment

Operating mode	Safety equipment	Drive	Selected safety function	Checked
…	…	…	…	
…	…	…	…	
Example:				
Production	*Protective door closed*	*Conveyor belt*	*---*	*---*
	Protective door open	*Conveyor belt*	*SS1 (braking in 2 seconds)*	
	Emergency Stop button active	*Conveyor belt*	*STO*	
Setting up	*Protective door closed*	*Conveyor belt*	*---*	*---*
	Protective door open	*Conveyor belt*	*SLS level 1 (300 rpm)*	
	Emergency Stop button active	*Conveyor belt*	*STO*	

Logging the settings

File name of the log:
…
…

Data backup

Data	Storage medium			Holding area
	Archiving type	Designation	Date	
Logs	…	…	…	…
PLC program	…	…	…	…
Circuit diagrams	…	…	…	…

Countersignatures

Commissioning engineer

This confirms that the tests and checks have been carried out properly.

Date	Name	Company/dept.	Signature
…	…	…	…

Machine manufacturer

This confirms that the settings documented above are correct.

Date	Name	Company/dept.	Signature
…	…	…	…

A.2.2 Log the settings for the basic functions, firmware V4.4 ... V4.6

Drive = <pDO-NAME_v>

Table A- 4 Firmware version

Name	Number	Value
Control Unit firmware version	r18	<r18_v>
SI version, safety functions integrated in the drive (processor 1)	r9770	<r9770_v>

Table A- 5 Monitoring cycle

Name	Number	Value
SI monitoring clock cycle (processor 1)	r9780	<r9780_v>

Table A- 6 Checksums

Name	Number	Value
SI reference checksum SI parameters (processor 1)	p9799	<p9799_v>
SI reference checksum SI parameters (processor 2)	p9899	<p9899_v>

Table A- 7 Settings of the safety functions

Name		Number	Value
SI enable, functions integrated in the drive		p9601	<p9601_v>
Only for the CU250S-2 Control Unit	SI enable safe brake control	p9602	<p9602_v>
SI PROFIsafe address		p9610	<p9610_v>
SI F-DI changeover, tolerance time		p9650	<p9650_v>
SI STO debounce time		p9651	<p9651_v>
Only for the CU250S-2 Control Unit	SI Safe Stop 1 delay time	p9652	<p9652_v>
SI forced dormant error detection timer		p9659	<p9659_v>

Table A- 8 Safety logbook

Name	Number	Value
SI checksum to check changes	r9781[0]	<r9781[0]_v>
SI checksum to check changes	r9781[1]	<r9781[1]_v>
SI change control time stamp	r9782[0]	<r9782[0]_v>
SI change control time stamp	r9782[1]	<r9782[1]_v>

A.2.3 Log the settings for the extended functions, firmware V4.4 ... V4.6

Drive = <pDO-NAME_v>

Table A- 9   Firmware version

Name	Number	Value
Control Unit firmware version	r18	<r18_v>
SI motion, version safe motion monitoring functions	r9590	<r9590_v>
SI Version safety functions integrated in the drive	r9770	<r9770_v>

Table A- 10   Monitoring cycle

Name	Number	Value
SI monitoring clock cycle	r9780	<r9780_v>

Table A- 11   Checksums

Name	Number	Value
SI Motion reference checksum SI parameters (processor 2)	p9399[0]	<p9399[0]_v>
	p9399[1]	<p9399[1]_v>
SI reference checksum SI parameters (processor 1)	p9799	<p9799_v>
SI Motion reference checksum SI parameters (processor 1)	p9729[0]	<p9729[0]_v>
	p9729[1]	<p9729[1]_v>
	p9729[2]	<p9729[2]_v>
SI reference checksum SI parameters (processor 2)	p9899	<p9899_v>

Table A- 12   Safety functions

Name	Number	Value
SI motion, enable safety-related functions	p9501	<p9501_v>
SI Motion function specification	p9506	<p9506_v>
SI Motion function configuration	p9507	<p9507_v>
SI Motion response during pulse suppression	p9509	<p9509_v>
SI motion, gearbox, motor/load, denominator	p9521	<p9521_v>
SI motion, gearbox, motor/load, numerator	p9522	<p9522_v>
SI Motion SLS limit values, limit value SLS1	p9531[0]	<p9531[0]_v>
SI Motion SLS limit values, limit value SLS2	p9531[1]	<p9531[1]_v>
SI Motion SLS limit values, limit value SLS3	p9531[2]	<p9531[2]_v>
SI Motion SLS limit values, limit value SLS4	p9531[3]	<p9531[3]_v>
SI Motion SLS speed setpoint limiting	p9533	<p9533_v>
SI motion, actual value comparison tolerance (crosswise)	p9542	<p9542_v>
SI Motion SSM filter time	p9545	<p9545_v>
SI Motion SSM speed limit	p9546	<p9546_v>

Name		Number	Value
SI Motion SSM speed hysteresis		p9547	<p9547_v>
SI Motion SAM actual speed tolerance		p9548	<p9548_v>
SI Motion SLS changeover delay time		p9551	<p9551_v>
SI Motion pulse suppression delay time		p9556	<p9556_v>
SI Motion acceptance test mode time limit		p9558	<p9558_v>
SI Motion forced dormant error detection timer		p9559	<p9559_v>
SI Motion pulse suppression shutdown velocity		p9560	<p9560_v>
SI Motion SLS-specific stop response, limit value SLS1		p9563[0]	<p9563[0]_v>
SI Motion SLS-specific stop response, limit value SLS2		p9563[1]	<p9563[1]_v>
SI Motion SLS-specific stop response, limit value SLS3		p9563[2]	<p9563[2]_v>
SI Motion SLS-specific stop response, limit value SLS4		p9563[3]	<p9563[3]_v>
SI Motion SDI tolerance		p9564	<p9564_v>
SI Motion SDI delay time		p9565	<p9565_v>
SI Motion SDI stop response		p9566	<p9566_v>
SI Motion SAM speed limit		p9568	<p9568_v>
SI Motion acceptance test mode		p9570	<p9570_v>
SI Motion braking ramp reference value		p9581	<p9581_v>
SI Motion braking ramp delay time		p9582	<p9582_v>
SI Motion braking ramp monitoring time		p9583	<p9583_v>
From firmware V4.5	SI Motion fault tolerance actual value acquisition encoderless	p9585	<p9585_v>
SI Motion delay time of the evaluation encoderless		p9586	<p9586_v>
SI Motion encoderless actual value acquisition filter time		p9587	<p9587_v>
SI Motion actual value acquisition encoderless minimum current		p9588	<p9588_v>
SI Motion voltage tolerance acceleration		p9589	<p9589_v>
SI enable, functions integrated in the drive		p9601	<p9601_v>
Only for the CU250S-2 Control Unit	Enable safe brake control	p9602	<p9602_v>
SI PROFIsafe address		p9610	<p9610_v>
SI F-DI changeover, tolerance time		p9650	<p9650_v>
SI STO debounce time		p9651	<p9651_v>
Only for the CU250S-2 Control Unit	Safe Stop 1 delay time	p9652	<p9652_v>
SI forced dormant error detection timer		p9659	<p9659_v>
SI discrepancy monitoring time		p10002	<p10002_v>
SI acknowledgment internal event F-DI		p10006	<p10006_v>
SI digital inputs debounce time		p10017	<p10017_v>
SI STO input terminal		p10022	<p10022_v>
SI SS1 input terminal		p10023	<p10023_v>
SI SLS input terminal		p10026	<p10026_v>
SI SDI positive input terminal		p10030	<p10030_v>
SI SDI negative input terminal		p10031	<p10031_v>
SI F-DI monitoring status		r10049	<r10049_v>
SI PROFIsafe F-DI transfer		p10050	<p10050_v>

Table A- 13   Fail-safe output in SINAMICS G120D with CU240/250D-2 DP/PN F and in SINAMICS G120 with CU250S-2

Name	Number	Value
SI wait time for test stop at DO	p10001	<p10001_v>
SI forced dormant error detection timer	p10003	<p10003_v>
SI forced dormant error detection F-DO signal source	p10007	<p10007_v>
SI safe state signal selection	p10039	< p10039_v>
SI F-DO 0 signal sources	p10042[0]	<p10042[0]_v>
	p10042[1]	<p10042[1]_v>
	p10042[2]	<p10042[2]_v>
	p10042[3]	<p10042[3]_v>
	p10042[4]	<p10042[4]_v>
	p10042[5]	<p10042[5]_v>
SI F-DO feedback signal input activation	p10046	<p10046_v>
SI F-DO test stop mode	p10047	<p10047_v>

Table A- 14   Safety logbook

Name	Number	Value
SI checksum to check changes	r9781[0]	<r9781[0]_v>
SI checksum to check changes	r9781[1]	<r9781[1]_v>
SI change control time stamp	r9782[0]	<r9782[0]_v>
SI change control time stamp	r9782[1]	<r9782[1]_v>

A.3 Standards and specifications

A.3.1 General information

A.3.1.1 Aims

Manufacturers and operating companies of equipment, machines, and products are responsible for ensuring the required level of safety. This means that plants, machines, and other equipment must be designed to be as safe as possible in accordance with the current state of the art. To ensure this, companies describe in the various standards the current state of the art covering all aspects relevant to safety. When the relevant Standards are observed, this ensures that state-of-the-art technology has been utilized and, in turn, the erector/builder of a plant or a manufacturer of a machine or a piece of equipment has fulfilled his appropriate responsibility.

Safety systems are designed to minimize potential hazards for both people and the environment by means of suitable technical equipment, without restricting industrial production and the use of machines more than is necessary. The protection of man and environment must be assigned equal importance in all countries, which is it is important that rules and regulations that have been internationally harmonized are applied. This is also designed to avoid distortions in the competition due to different safety requirements in different countries.

There are different concepts and requirements in the various regions and countries of the world when it comes to ensuring the appropriate degree of safety. The legislation and the requirements of how and when proof is to be given and whether there is an adequate level of safety are just as different as the assignment of responsibilities.

The most important thing for manufacturers of machines and companies that set up plants and systems is that the legislation and regulations in the country where the machine or plant is being operated apply. For example, the control system for a machine that is to be used in the US must fulfill local US requirements even if the machine manufacturer (OEM) is based in the European Economic Area (EEA).

A.3.1.2 Functional safety

Safety, from the perspective of the object to be protected, cannot be split-up. The causes of hazards and, in turn, the technical measures to avoid them can vary significantly. This is why a differentiation is made between different types of safety (e.g. by specifying the cause of possible hazards). "Functional safety" is involved if safety depends on the correct function.

To ensure the functional safety of a machine or plant, the safety-related parts of the protection and control devices must function correctly. In addition, the systems must behave in such a way that either the plant remains in a safe state or it is brought into a safe state if a fault occurs. In this case, it is necessary to use specially qualified technology that fulfills the requirements described in the associated Standards. The requirements to achieve functional safety are based on the following basic goals:

● Avoiding systematic faults

● Controlling systematic faults

● Controlling random faults or failures

Benchmarks for establishing whether or not a sufficient level of functional safety has been achieved include the probability of hazardous failures, the fault tolerance, and the quality that is to be ensured by minimizing systematic faults. This is expressed in the Standards using different terms. In IEC/EN 61508, IEC/EN 62061 "Safety Integrity Level" (SIL) and EN ISO 13849-1 "Categories" and "Performance Level" (PL).

Safety Integrated Function Manual, SINAMICS G120 and G120C

266   Function Manual, 01/2013, FW V4.6, A5E03052391B AD

A.3.2 Safety of machinery in Europe

The EU Directives that apply to the implementation of products are based on Article 95 of the EU contract, which regulates the free exchange of goods. These are based on a new global concept ("new approach", "global approach"):

- EU Directives only specify general safety goals and define basic safety requirements.

- Technical details can be defined by means of standards by Standards Associations that have the appropriate mandate from the commission of the European Parliament and Council (CEN, CENELEC). These standards are harmonized in line with a specific directive and listed in the official journal of the commission of the European Parliament and Council. Legislation does not specify that certain standards have to be observed. When the harmonized Standards are observed, it can be assumed that the safety requirements and specifications of the Directives involved have been fulfilled.

- EU Directives specify that the Member States must mutually recognize domestic regulations.

The EU Directives are equal. This means that if several Directives apply for a specific piece of equipment or device, the requirements of all of the relevant Directives apply (e.g. for a machine with electrical equipment, the Machinery Directive and the Low-Voltage Directive apply).

A.3.2.1 Machinery Directive

The basic safety and health requirements specified in Annex I of the Directive must be fulfilled for the safety of machines.

The protective goals must be implemented responsibly to ensure compliance with the Directive.

Manufacturers of a machine must verify that their machine complies with the basic requirements. This verification is facilitated by means of harmonized standards.

A.3.2.2 Harmonized European Standards

The two Standards Organizations CEN (Comité Européen de Normalisation) and CENELEC (Comité Européen de Normalisation Électrotechnique), mandated by the EU Commission, drew-up harmonized European standards in order to precisely specify the requirements of the EC directives for a specific product. These standards (EN standards) are published in the official journal of the commission of the European Parliament and Council and must be included without revision in domestic standards. They are designed to fulfill basic health and safety requirements as well as the protective goals specified in Annex I of the Machinery Directive.

When the harmonized standards are observed, it is "automatically assumed" that the Directive is fulfilled. As such, manufacturers can assume that they have observed the safety aspects of the Directive under the assumption that these are also covered in this standard. However, not every European Standard is harmonized in this sense. Key here is the listing in the official journal of the commission of the European Parliament and Council.

The European Safety of Machines standard is hierarchically structured. It is divided into:

- A standards (basic standards)

- B standards (group standards)

- C standards (product standards)

Type A standards/basic standards

A standards include basic terminology and definitions relating to all types of machine. This includes EN ISO 12100-1 (previously EN 292-1) "Safety of Machines, Basic Terminology, General Design Principles".

A standards are aimed primarily at the bodies responsible for setting the B and C standards. The measures specified here for minimizing risk, however, may also be useful for manufacturers if no applicable C standards have been defined.

Type B standards/group standards

B standards cover all safety-related standards for various different machine types. B standards are aimed primarily at the bodies responsible for setting C standards. They can also be useful for manufacturers during the machine design and construction phases, however, if no applicable C standards have been defined.

A further sub-division has been made for B standards:

- Type B1 standards for higher-level safety aspects (e.g. ergonomic principles, safety clearances from sources of danger, minimum clearances to prevent parts of the body from being crushed).

- Type B2 standards for protective safety devices are defined for different machine types (e.g. EMERGENCY STOP devices, two-hand operating circuits, interlocking elements, contactless protective devices, safety-related parts of controls).

Type C standards/product standards

C standards are product-specific standards (e.g. for machine tools, woodworking machines, elevators, packaging machines, printing machines etc.). Product standards cover machine-specific requirements. The requirements can, under certain circumstances, deviate from the basic and group standards. Type C/product standards have the highest priority for machine manufacturers who can assume that it fulfills the basic requirements of Annex I of the Machinery Directive (automatic presumption of compliance). If no product standard has been defined for a particular machine, type B standards can be applied when the machine is constructed.

A complete list of the standards specified and the mandated draft standards are available on the Internet at the following address:

http://www.newapproach.org/

Recommendation: Due to the rapid pace of technical development and the associated changes in machine concepts, the standards (and C standards in particular) should be checked to ensure that they are up to date. Please note that the application of a particular standard may not be mandatory provided that all the safety requirements of the applicable EU directives are fulfilled.

A.3.2.3   Standards for implementing safety-related controllers

If the functional safety of a machine depends on various control functions, the controller must be implemented in such a way that the probability of the safety functions failing is sufficiently minimized. EN ISO 13849-1 (formerly EN 954-1) and EN IEC61508 define principles for implementing safety-related machine controllers which, when properly applied, ensure that all the safety requirements of the EC Machinery Directive are fulfilled. These standards ensure that the relevant safety requirements of the Machinery Directive are fulfilled.
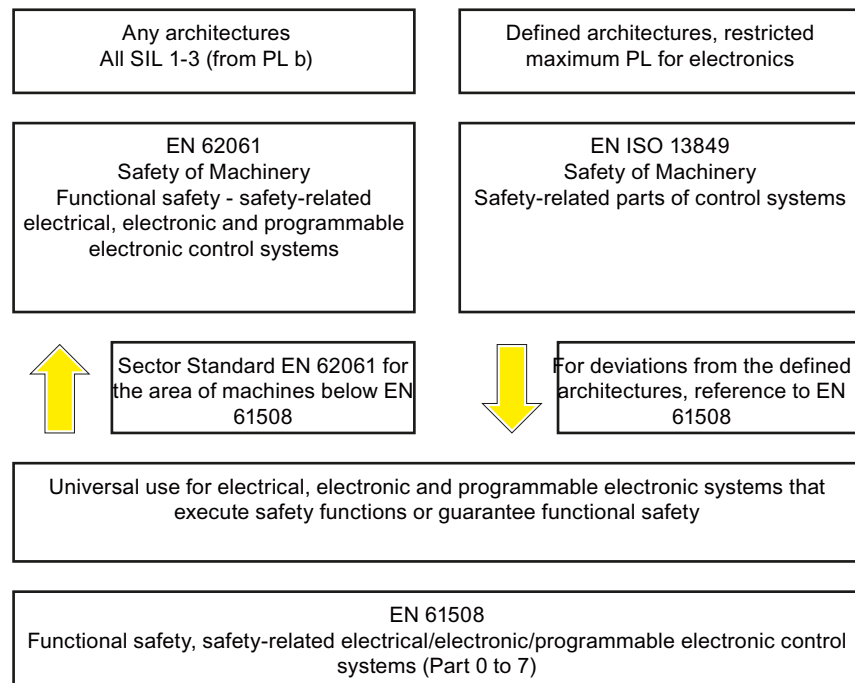
Figure A-1   Standards for implementing safety-related controllers

The application areas of EN ISO 13849-1, EN 62061, and EN 61508 are very similar. To help users make an appropriate decision, the IEC and ISO associations have specified the application areas of both standards in a joint table in the introduction to the standards. EN ISO 13849-1 or EN 62061 should be applied depending on the technology (mechanics, hydraulics, pneumatics, electrics, electronics, programmable electronics), risk classification and architecture.

	Systems for executing safety-related control functions	EN ISO 13849-1	EN 62061
A	Non-electrical (e.g. hydraulic, pneumatic)	X	Not covered
B	Electromechanical (e.g. relay and/or basic electronics)	Restricted to the designated architectures (see comment 1) and max. up to PL = e	All architectures and max. up to SIL 3
C	Complex electronics (e.g. programmable electronics)	Restricted to the designated architectures (see comment 1) and max. up to PL = d	All architectures and max. up to SIL 3
D	A standards combined with B standards	Restricted to the designated architectures (see comment 1) and max. up to PL = e	X See comment 3
E	C standards combined with B standards	Restricted to the designated architectures (see comment 1) and max. up to PL = d	All architectures and max. up to SIL 3
F	C standards combined with A standards or C standards combined with A standards and B standards	X See comment 2	X See comment 3
"X" indicates that the point is covered by this standard. Comment 1: Designated architectures are described in Annex B of EN ISO 13849-1 and provide a simplified basis for the quantification. Comment 2: For complex electronics: Using designated architectures in compliance with EN ISO 13849-1 up to PL = d or every architecture in compliance with EN 62061. Comment 3: For non-electrical systems: Use components that comply with EN ISO 13849-1 as sub-systems.			

A.3.2.4 DIN EN ISO 13849-1 (replaces EN 954-1)

A qualitative analysis according to DIN EN 13849-1 is not sufficient for modern control systems due to their technology. Among other things, DIN EN ISO 13849-1 does not take into account time behavior (e.g. test interval and/or cyclic test, lifetime). This results in the probabilistic approach in DIN EN ISO 13849-1 (probability of failure per unit time).

DIN EN ISO 13849-1 is based on the known categories of EN 954-1. It now also takes into account complete safety functions and all the devices required to execute these. With DIN EN ISO 13849-1, safety functions are investigated from a quantitative perspective going beyond the qualitative basis of EN 954-1. Performance levels (PL), which are based on the categories, are used. The following safety-related characteristic quantities are required for devices/equipment:

- Category (structural requirement)
- PL: Performance level
- $MTTF_d$: Mean time to dangerous failure

- DC: Diagnostic coverage
- CCF: Common cause failure

The standard describes how the performance level (PL) is calculated for safety-related components of the controller on the basis of designated architectures. In the event of any deviations from this, EN ISO 13849-1 refers to EN 61508.

When combining several safety-related parts to form a complete system, the standard explains how to determine the resulting PL.

Note

DIN EN ISO 13849-1 and machinery directive

Since May 2007, DIN EN ISO 13849-1 has been harmonized as part of the Machinery Directive.

A.3.2.5 EN 62061

EN 62061 (identical to IEC 62061) is a sector-specific standard subordinate to IEC/EN 61508. It describes the implementation of safety-related electrical machine control systems and looks at the complete life cycle, from the conceptual phase to decommissioning. The standard is based on the quantitative and qualitative analyses of safety functions,

whereby it systematically applies a top-down approach to implementing complex control systems (known as "functional decomposition"). The safety functions derived from the risk analysis are sub-divided into sub-safety functions, which are then assigned to real devices, sub-systems, and sub-system elements. Both the hardware and software are covered. EN 62061 also describes the requirements placed on implementing application programs.

A safety-related control systems comprises different sub-systems. From a safety perspective, the sub-systems are described in terms of the SIL claim limit and PFH_D characteristic quantities.

Programmable electronic devices (e.g. PLCs or variable-speed drives) must fulfill EN 61508. They can then be integrated in the controller as sub-systems. The following safety-related characteristic quantities must be specified by the manufacturers of these devices.

Safety-related characteristic quantities for subsystems:

- SIL CL: SIL claim limit

- PFH_D:
  Probability of dangerous failures per hour
- T1:
  Lifetime

Simple sub-systems (e.g. sensors and actuators) in electromechanical components can, in turn, comprise sub-system elements (devices) interconnected in different ways with the characteristic quantities required for determining the relevant PFH_D value of the sub-system.

Safety-related characteristic quantities for subsystem elements (devices):

- λ:
  Failure rate

- B10 value: For elements that are subject to wear

- T1:
  Lifetime

For electromechanical devices, a manufacturer specifies a failure rate λ with reference to the number of operating cycles. The failure rate per unit time and the lifetime must be determined using the switching frequency for the particular application.

Parameters for the sub-system, which comprises sub-system elements, that must be defined during the design phase:

- T2:
  Diagnostic test interval

- β:
  Susceptibility to common cause failure

- DC:
  Diagnostic coverage

The PFH_D value of the safety-related controller is determined by adding the individual PFH_D values for subsystems.

The user has the following options when setting up a safety-related controller:

- Use devices and sub-systems that already comply with EN ISO 13849-1, IEC/EN 61508, or IEC/EN 62061. The standard provides information specifying how qualified devices can be integrated when safety functions are implemented.

- Develop own subsystems:

  – Programmable, electronic systems and complex systems: Application of EN 61508 or EN 61800-5-2.

  – Simple devices and subsystems: Application of EN 62061.

EN 62061 does not include information about non-electric systems. The standard provides detailed information on implementing safety-related electrical, electronic, and programmable electronic control systems. EN ISO 13849-1 must be applied for non-electric systems.

Note

Function examples

Details of simple sub-systems that have been implemented and integrated are now available as "functional examples".

Note

EN 62061 and machinery directive

IEC 62061 has been ratified as EN 62061 in Europe and harmonized as part of the Machinery Directive.

A.3.2.6 Series of standards EN 61508 (VDE 0803)

This series of standards describes the current state of the art.

EN 61508 is not harmonized in line with any EU directives, which means that an automatic presumption of conformity for fulfilling the protective requirements of a directive is not implied. The manufacturer of a safety-related product, however, can also use EN 61508 to fulfill basic requirements of European directives in accordance with the latest conceptual design, for example, in the following cases:

- If no harmonized standard exists for the application in question. In this case, the manufacturer can use EN 61508, although no presumption of conformity exists here.

- A harmonized European standard (e.g. EN 62061, EN ISO 13849, EN 60204-1) references EN 61508. This ensures that the appropriate requirements of the directives are fulfilled ("standard that is also applicable"). When manufacturers apply EN 61508 properly and responsibly in accordance with this reference, they can use the presumption of conformity of the referencing standard.

EN 61508 covers all the aspects that must be taken into account when E/E/PES systems (**e**lectrical, **e**lectronic, and **p**rogrammable **e**lectronic **S**ystem) are used in order to execute safety functions and/or to ensure the appropriate level of functional safety. Other hazards (e.g. electric shock) are, as in EN ISO 13849, not part of the standard.

EN 61508 has recently been declared the "International Basic Safety Publication", which makes it a framework for other, sector-specific standards (e.g. EN 62061). As a result, this standard is now accepted worldwide, particularly in North America and in the automotive industry. Today, many regulatory bodies already stipulate it (e.g. as a basis for NRTL listing).

Another recent development with respect to EN 61508 is its system approach, which extends the technical requirements to include the entire safety installation from the sensor to the actuator, the quantification of the probability of hazardous failure due to random hardware failures, and the creation of documentation covering all phases of the safety-related lifecycle of the E/E/PES.

A.3.2.7 Risk analysis/assessment

Risks are intrinsic in machines due to their design and functionality. For this reason, the Machinery Directive requires that a risk assessment be performed for each machine and, if necessary, the level of risk reduced until the residual risk is less than the tolerable risk. To assess these risks, the following standards must be applied:

- EN ISO 12100-1 "Safety of Machinery - basic terminology, general principles for design"

- EN ISO 13849-1 (successor to EN 954-1) "Safety-related parts of control systems"

EN ISO 12100-1 focuses on the risks to be analyzed and the design principles for minimizing risk.

The risk assessment is a procedure that allows hazards resulting from machines to be systematically investigated. Where necessary, the risk assessment is followed by a risk reduction procedure. When the procedure is repeated, this is known as an iterative process. This can help eliminate hazards (as far as this is possible) and can act as a basis for implementing suitable protective measures.

The risk assessment involves the following:

- Risk analysis

    – Determines the limits of the machine (EN ISO 12100-1)

    – Identification of the hazards (EN ISO 12100-114)

    – Estimating the level of risk (EN 1050 Paragraph 7)

- Risk evaluation

As part of the iterative process to achieve the required level of safety, a risk assessment is carried out after the risk estimation. A decision must be made here as to whether the residual risk needs to be reduced. If the risk is to be further reduced, suitable protective measures must be selected and applied. The risk assessment must then be repeated.
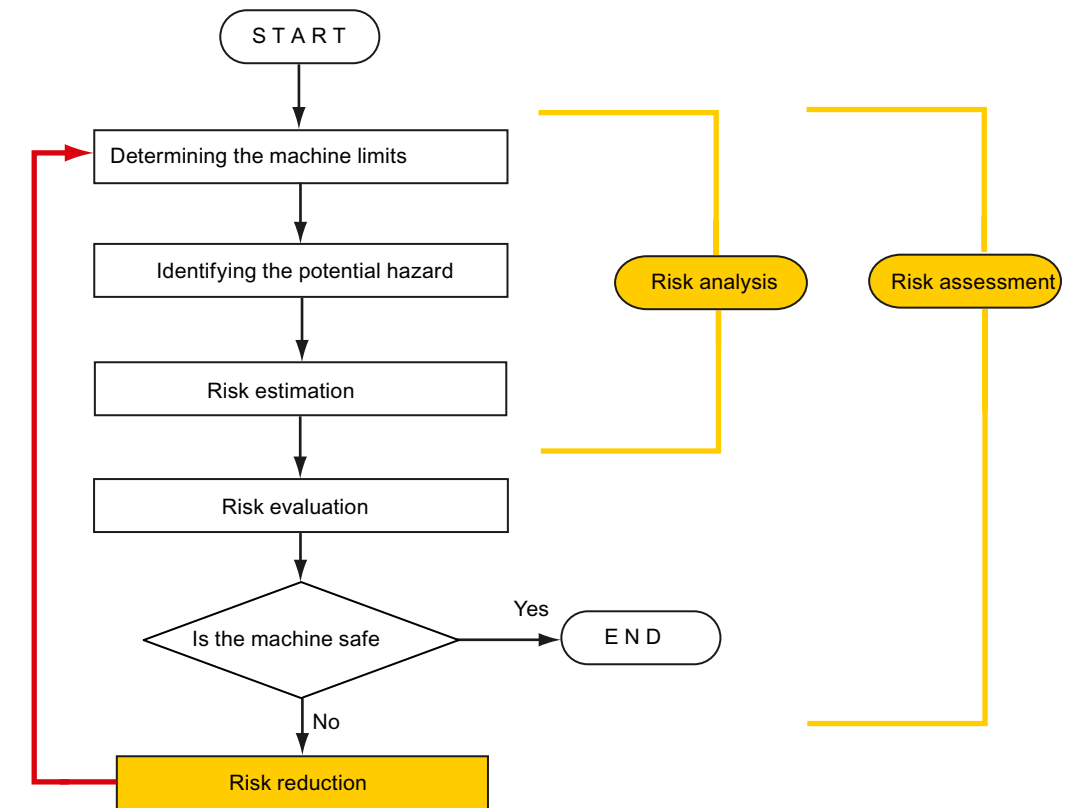
Figure A-2   Iterative process for achieving safety

Risks must be reduced by designing and implementing the machine accordingly (e.g. by means of controllers or protective measures suitable for the safety-related functions).

If the protective measures involve the use of interlocking or control functions, these must be designed according to EN ISO 13849-1. For electrical and electronic controllers, EN 62061 can be used as an alternative to EN ISO 13849-1. Electronic controllers and bus systems must also comply with IEC/EN 61508.

A.3.2.8   Risk reduction

Risk reduction measures for a machine can be implemented by means of safety-related control functions in addition to structural measures. To implement these control functions, special requirements must be taken into account, graded according to the magnitude of the risk. These are described in EN ISO 13849-1 or, in the case of electrical controllers (particularly programmable electronics), in EN 61508 or EN 62061. The requirements regarding safety-related controller components are graded according to the magnitude of the risk and the level to which the risk needs to be reduced.

EN ISO 13849-1 defines a risk flow chart that instead of categories results in hierarchically graduated Performance Levels (PL).

IEC/EN 62061 uses "Safety Integrity Level" (SIL) for classification purposes. This is a quantified measure of the safety-related performance of a controller. The required SIL is also determined in accordance with the risk assessment principle according to ISO 12100 (EN 1050). Annex A of the standard describes a method for determining the required Safety Integrity Level (SIL).

Regardless of which standard is applied, steps must be taken to ensure that all the machine controller components required for executing the safety-related functions fulfill these requirements.

A.3.2.9 Residual risk

In today's technologically advanced world, the concept of safety is relative. The ability to ensure safety to the extent that risk is ruled out in all circumstances – "zero-risk guarantee" – is practically impossible. The residual risk is the risk that remains once all the relevant protective measures have been implemented in accordance with the latest state of the art.

Residual risks must be clearly referred to in the machine/plant documentation (user information according to EN ISO 12100-2).

A.3.3   Machine safety in the USA

A key difference between the USA and Europe in the legal requirements regarding safety at work is that, in the USA, no legislation exists regarding machinery safety that is applicable in all of the states and that defines the responsibility of the manufacturer/supplier. A general requirement exists stating that employers must ensure a safe workplace.

A.3.3.1   Minimum requirements of the OSHA

The Occupational Safety and Health Act (OSHA) from 1970 regulates the requirement that employers must offer a safe place of work. The core requirements of OSHA are specified in Section 5 "Duties".

The requirements of the OSH Act are managed by the "Occupational Safety and Health Administration" (also known as OSHA). OSHA employs regional inspectors who check whether or not workplaces comply with the applicable regulations.

The OSHA regulations are described in OSHA 29 CFR 1910.xxx ("OSHA Regulations (29 CFR) PART 1910 Occupational Safety and Health"). (CFR: Code of Federal Regulations.)

http://www.osha.gov

The application of standards is regulated in 29 CFR 1910.5 "Applicability of standards". The concept is similar to that used in Europe. Product-specific standards have priority over general standards insofar as they cover the relevant aspects. Once the standards are fulfilled, employers can assume that they have fulfilled the core requirements of the OSH Act with respect to the aspects covered by the standards.

In conjunction with certain applications, OSHA requires that all electrical equipment and devices that are used to protect workers be authorized by an OSHA-certified, "Nationally Recognized Testing Laboratory" (NRTL) for the specific application.

In addition to the OSHA regulations, the current standards defined by organizations such as NFPA and ANSI must be carefully observed and the extensive product liability legislation that exists in the US taken into account. Due to the product liability legislation, it is in the interests of manufacturing and operating companies that they carefully maintain the applicable regulations and are "forced" to fulfill the requirement to use state-of-the-art technology.

Third-party insurance companies generally demand that their customers fulfill the applicable standards of the standards organizations. Self-insured companies are not initially subject to this requirement but, in the event of an accident, they must provide verification that they have applied generally-recognized safety principles.

A.3.3.2   NRTL listing

To protect employees, all electrical equipment used in the USA must be certified for the planned application by a "Nationally Recognized Testing Laboratory" (NRTL) certified by the OSHA. NRTLs are authorized to certify equipment and material by means of listing, labeling, or similar. Domestic standards (e.g. NFPA 79) and international standards (e.g. IEC/EN 61508 for E/E/PES systems) are the basis for testing.

A.3.3.3 NFPA 79

Standard NFPA 79 (Electrical Standard for Industrial Machinery) applies to electrical equipment on industrial machines with rated voltages of less than 600 V. A group of machines that operate together in a coordinated fashion is also considered to be one machine.

For programmable electronics and communication buses, NFPA 79 states as a basic requirement that these must be listed if they are to be used to implement and execute safety-related functions. If this requirement is fulfilled, then electronic controls and communication buses can also be used for Emergency Stop functions, Stop Categories 0 and 1 (refer to NFPA 79 9.2.5.4.1.4). Like EN 60204-1, NFPA 79 no longer specifies that the electrical energy must be disconnected by electromechanical means for emergency stop functions.

The core requirements regarding programmable electronics and communication buses are: system requirements (see NFPA 79 9.4.3)

1. Control systems that contain software-based controllers must:

   – In the event of a single fault
     (a) cause the system to switch to a safe shutdown mode
     (b) prevent the system from restarting until the fault has been rectified
     (c) prevent an unexpected restart

   – Offer the same level of protection as hard-wired controllers

   – Be implemented in accordance with a recognized standard that defines the requirements for such systems.

2. IEC 61508, IEC 62061, ISO 13849-1, ISO 13849-2 and IEC 61800-5-2 are specified as suitable standards in a note.

Underwriter Laboratories Inc. (UL) has defined a special category for "Programmable Safety Controllers" for implementing this requirement (code NRGF). This category covers control devices that contain software and are designed for use in safety-related functions.

A precise description of the category and a list of devices that fulfill this requirement can be found on the Internet at the following address:

http://www.ul.com → certifications directory → UL Category code/ Guide information → search for category "NRGF"

TUV Rheinland of North America, Inc. is also an NRTL for these applications.

A.3.3.4 ANSI B11

ANSI B11 standards are joint standards developed by associations such as the Association for Manufacturing Technology (AMT) and the Robotic Industries Association (RIA).

The hazards of a machine are evaluated by means of a risk analysis/assessment. The risk analysis is an important requirement in accordance with NFPA 79, ANSI/RIA 15.06, ANSI B11.TR-3 and SEMI S10 (semiconductors). The documented findings of a risk analysis can be used to select a suitable safety system based on the safety class of the application in question.

A.3.4   Machine safety in Japan

The situation in Japan is different from that in Europe and the US. Legislation such as that prescribed in Europe does not exist. Similarly, product liability does not play such an important role as it does in the US.

Instead of legal requirements to apply standards have been defined, an administrative recommendation to apply JIS (Japanese Industrial Standard) is in place: Japan bases its approach on the European concept and uses basic standards as national standards (see table).

Table A- 15   Japanese standards

ISO/IEC number	JIS number	Comment
ISO12100-1	JIS B 9700-1	Earlier designation TR B 0008
ISO12100-2	JIS B 9700-2	Earlier designation TR B 0009
ISO14121- 1 / EN1050	JIS B 9702	
ISO13849-1	JIS B 9705-1	
ISO13849-2	JIS B 9705-1	
IEC 60204-1	JIS B 9960-1	Without annex F or route map of the European foreword
IEC 61508-0 to -7	JIS C 0508	
IEC 62061		JIS number not yet assigned

A.3.5 Equipment regulations

In addition to the requirements of the guidelines and standards, company-specific requirements must be taken into account. Large corporations in particular (e.g. automobile manufacturers) make stringent demands regarding automation components, which are often listed in their own equipment specifications.

Safety-related issues (e.g. operating modes, operator actions with access to hazardous areas, EMERGENCY STOP concepts, etc.) should be clarified with customers early on so that they can be integrated in the risk assessment/risk reduction process.

A.3.6 Other safety-related issues

A.3.6.1 Additional references

- Safety Integrated: The Safety System for Industry (5th Edition and supplement), order no. 6ZB5 000-0AA01-0BA1

- Safety Integrated - Terms and Standards - Machine Safety Terminology (Edition 04/2007), order no. E86060-T1813-A101-A1

A.3.6.2 Information sheets issued by the Employer's Liability Insurance Association

Safety-related measures to be implemented cannot always be derived from directives, standards, or regulations. In this case, supplementary information and explanations are required.

Some regulatory bodies issue publications on an extremely wide range of subjects.

Information sheets covering the following areas are available, for example:

- Process monitoring in production environments

- Axes subject to gravitational force

- Roller pressing machines

- Lathes and turning centers - purchasing/selling

These information sheets issued by specialist committees can be obtained by all interested parties (e.g. to provide support in factories, or when regulations or safety-related measures for plants and machines are defined). These information sheets provide support for the fields of machinery construction, production systems, and steel construction.

You can download the information sheets from the following Internet address (website is in German, although some of the sheets are available in English):

http://www.bg-metall.de/

First select the menu item "Service and Contact", then the Link "Downloads" and finally the category "Information sheets of the specialist committees".

A.4 Additional information on the inverter

A.4.1 Manuals for your inverter

Table A- 16   Manuals for your converter

Information depth	Manual	Contents	Available languages	Download or order number
++	**Getting Started Guide** for the following converters: • SINAMICS G120 with Control Units CU230P-2; CU240B-2; CU240E-2 • SINAMICS G120 with CU250S-2 Control Unit • SINAMICS G120C • SINAMICS G120D	Installing the converter and commissioning.	English, German, Italian, French, Spanish, Chinese	Download manuals (http://support.automation. siemens.com/WW/view/en/ 22339653/133300) **SINAMICS Manual Collection** Documentation on DVD, order number 6SL3097-4CA00-0YG0
+++	**Operating instructions** for the following converters: • SINAMICS G120 with the Control Units CU240B-2; CU240E-2 • SINAMICS G120 with the Control Unit CU250S-2 (vector mode) • SINAMICS G120 with the Control Unit CU250S-2 (servo mode) • SINAMICS G120C • SINAMICS G120D with the Control Unit CU240D-2 • SINAMICS G120D with the Control Unit CU250D-2	Installing the converter and commissioning. Description of the converter functions.		
+++	**Function Manual for Safety Integrated**	(this manual)	English, German	

Information depth	Manual	Contents	Available languages	Download or order number
+++	**List Manual** for the following converters: • SINAMICS G120 with the Control Units CU240B-2; CU240E-2 • SINAMICS G120 with the Control Unit CU250S-2 • SINAMICS G120C • SINAMICS G120D with the Control Units CU240D-2, CU250D-2	Complete list of all parameters, alarms and faults. Graphic function diagrams.	English, German, Chinese	
+	**Getting Started Guide** for the following SINAMICS G120 Power Modules: • PM240, PM250 and PM260 • PM240-2	Installing the Power Module	English	
+	**Installation Instructions** for reactors, filters and braking resistors	Installing components		
+++	**Hardware Installation Manual** for the following SINAMICS G120 Power Modules: • PM240 • PM240-2 • PM250 • PM260	Installing power modules, reactors and filters. Maintaining power modules.	English, German	
+++	**Operating Instructions** for the following Operator Panels: • BOP-2 • IOP	Operating Operator Panels, door mounting kit for mounting of IOP.		

A.4.2 Configuring support

Table A- 17   Support when configuring and selecting the converter

Manual or tool	Contents	Available languages	Download or order number
Catalog D 31	Ordering data and technical information for the standard SINAMICS G converters	English, German, Italian, French, Spanish	Everything about SINAMICS G120 (www.siemens.en/sinamics-g120)
Online catalog (Industry Mall)	Ordering data and technical information for all SIEMENS products	English, German	
SIZER	The overall configuration tool for SINAMICS, MICROMASTER and DYNAVERT T drives, motor starters, as well as SINUMERIK, SIMOTION controls and SIMATIC Technology	English, German, Italian, French	You obtain SIZER on a DVD (Order number: 6SL3070-0AA00-0AG0) and in the Internet: Download SIZER (http://support.automation.siemens.com/WW/view/en/10804987/130000)
Configuration Manual	Selecting geared motors, motors, converters and braking resistor based on calculation examples	English, German	Configuration Manual (http://support.automation.siemens.com/WW/view/en/37728795)

The TÜV-approved "Safety Evaluation Tool" for the standards IEC 62061 and ISO 13849-1 helps you to evaluate the safety functions of your machine. This online tool provides you with a standards-compliant report that can be integrated in the documentation as proof of safety:

Safety Evaluation Tool (www.siemens.com/safety-evaluation-tool).

A.4.3 Product Support

If you have further questions

You can find additional information on the product and more in the Internet under: Product support (http://support.automation.siemens.com/WW/view/en/4000024).

In addition to our documentation, under this address we offer our complete knowledge base online: You can find the following information:

● Actual product information (Update), FAQ (frequently asked questions), downloads.

● The Newsletter contains the latest information on the products you use.

● The Knowledge Manager (Intelligent Search) helps you find the documents you need.

● Users and specialists from around the world share their experience and knowledge in the Forum.

● You can find your local representative for Automation & Drives via our contact database under "Contact & Partner".

● Information about local service, repair, spare parts and much more can be found under "Services".

A.5 Mistakes and improvements

If you come across any mistakes when reading this manual or if you have any suggestions for how it can be improved, then please send your suggestions to the following address or by E-mail:

Siemens AG
Drive Technologies
Motion Control Systems
Postfach 3180
91050 Erlangen, Germany

E-mail (mailto:documentation.standard.drives@siemens.com)

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