

# SIEMENS



# SINAMICS

SINAMICS G120, G120C, G120D, G110M, SIMATIC ET 200pro FC-2 inverters

Safety functions integrated in the drive - Safety Integrated

Function Manual

Edition

04/2015

Answers for industry.



# SIEMENS

## SINAMICS

### SINAMICS G120 Safety Integrated - SINAMICS G110M, G120, G120C, G120D and SIMATIC ET 200pro FC-2

Function Manual

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Edition 04/2015, firmware V4.7 SP3




04/2015, FW V4.7 SP3

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## Legal information

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 <b>WARNING</b>
indicates that death or severe personal injury <b>may</b> result if proper precautions are not taken.
 <b>CAUTION</b>
indicates that minor personal injury can result if proper precautions are not taken.
<b>NOTICE</b>
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# Change history

## Significant changes with respect to the Manual, Edition 04/2014

The functions in firmware V4.7 SP3	In Chapter
PM240-2 FSD and FSE Power Modules with integrated basic function STO (SIL 3 and PL e) via terminals.	Overview (Page 57) Wiring examples according to SIL 3 and PL e (Page 76) Commissioning (Page 89) System properties (Page 351) Acceptance test STO (basic functions) (Page 367)
The new version of the PM230 Power Modules allow the basic STO function to be used.	Restrictions when using safety functions (Page 26)

Corrections	In Chapter
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Supplements and revised descriptions	In Chapter
Commissioning with Startdrive	Commissioning (Page 89)
Response times of safety functions SS1 and SBC added	Response times after selection (Page 357)
SIRIUS 3TK28 safety relay replaced by SIRIUS 3SK1	SIRIUS 3SK1 safety relay (Page 68)



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# Fundamental safety instructions

## 1.1 General safety instructions

 <b>WARNING</b>
<b>Risk of death if the safety instructions and remaining risks are not carefully observed</b> If the safety instructions and residual risks are not observed in the associated hardware documentation, accidents involving severe injuries or death can occur. <ul style="list-style-type: none"><li>• Observe the safety instructions given in the hardware documentation.</li><li>• Consider the residual risks for the risk evaluation.</li></ul>

 <b>WARNING</b>
<b>Danger to life or malfunctions of the machine as a result of incorrect or changed parameterization</b> As a result of incorrect or changed parameterization, machines can malfunction, which in turn can lead to injuries or death. <ul style="list-style-type: none"><li>• Protect the parameterization (parameter assignments) against unauthorized access.</li><li>• Respond to possible malfunctions by applying suitable measures (e.g. EMERGENCY STOP or EMERGENCY OFF).</li></ul>

## 1.2 Industrial security

### Note

#### Industrial security

Siemens provides products and solutions with industrial security functions that support the secure operation of plants, solutions, machines, equipment and/or networks. They are important components in a holistic industrial security concept. With this in mind, Siemens' products and solutions undergo continuous development. Siemens recommends strongly that you regularly check for product updates.

For the secure operation of Siemens products and solutions, it is necessary to take suitable preventive action (e.g. cell protection concept) and integrate each component into a holistic, state-of-the-art industrial security concept. Third-party products that may be in use should also be considered. For more information about industrial security, visit this address (<http://www.siemens.com/industrialsecurity>).

To stay informed about product updates as they occur, sign up for a product-specific newsletter. For more information, visit this address (<http://support.automation.siemens.com>).

### WARNING

#### **Danger as a result of unsafe operating states resulting from software manipulation**

Software manipulation (e.g. by viruses, Trojan horses, malware, worms) can cause unsafe operating states to develop in your installation which can result in death, severe injuries and/or material damage.

- Keep the software up to date.  
You will find relevant information and newsletters at this address (<http://support.automation.siemens.com>).
- Incorporate the automation and drive components into a holistic, state-of-the-art industrial security concept for the installation or machine.  
You will find further information at this address (<http://www.siemens.com/industrialsecurity>).
- Make sure that you include all installed products into the holistic industrial security concept.

# Introduction

## 2.1 About this manual

### Who requires this manual and why?

This manual describes the safety functions integrated in the inverter for variable-speed applications.

The manual is aimed primarily at machine and plant manufacturers, commissioning engineers, and service personnel.

### What are drive-integrated safety functions?

"Safety" functions have, in comparison to "standard" drive functions, an especially low error rate. Performance level (PL) and safety integrity level (SIL) of the corresponding standards are a measure of the error rate.

As a consequence, the safety functions are suitable for use in safety-related applications to minimize risk. An application is safety-related if the risk analysis of the machine or the system indicates a special hazard potential in the application.

"Integrated in the drive" means that the safety functions are integrated in the inverter and can be executed without requiring additional external components.

What inverters are described?

	Fixed speed applications		Variable speed applications					Motion control applications					
	SIMATIC ET 200S Motor starter	ET 200pro FC-2	SIMATIC ET 200pro FC-2	G110M	G120C	G120D	G120	SINAMICS G110D	G130	G150	SINAMICS S110	S120	S150
<b>Integrated safety functions according to IEC 61800-5-2</b>													
STO Safe Torque Off	Yes		Yes					Yes	Yes		Yes		
SS1 Safe Stop 1	-	-	-	-	-		Yes	-	Yes		Yes		
SBC Safe Brake Control	-	-	-	-	-	-	Yes <sup>2)</sup>	-	Yes <sup>3)</sup>		Yes <sup>4)</sup>	Yes <sup>3)</sup>	
SBT Safe Brake Test	-	-	-	-	-	-	-	-	Yes		-	Yes	
SLS Safely-Limited Speed	-	-	-	-	-		Yes	-	Yes		Yes		
SSM Safe Speed Monitor	-	-	-	-	-		Yes	-	Yes		Yes		
SDI Safe Direction	-	-	-	-	-		Yes	-	Yes		Yes		
SOS Safe Operating Stop	-	-	-	-	-	-	-	-	Yes		Yes		
SS2 Safe Stop 2	-	-	-	-	-	-	-	-	Yes		Yes		
SLP Safely-Limited Position	-	-	-	-	-	-	-	-	Yes		-	Yes	Yes
<b>Fail-safe interfaces</b>													
PROFIBUS / PROFIsafe	Yes	Yes <sup>5)</sup>	Yes <sup>5)</sup>	Yes				-	Yes		Yes		
PROFINET / PROFIsafe	Yes	Yes <sup>5)</sup>	Yes <sup>5)</sup>	Yes				-	Yes		Yes		
Safety inputs	Yes <sup>5)</sup>		Yes <sup>5)</sup>	Yes				Yes <sup>5)</sup>	Yes		Yes, external components required in certain cases		
Safety outputs	-	-	-	-	-	Yes	Yes <sup>8)</sup>	-	Yes, with TM54F		Yes	Yes, with TM54F	
<b>Certifications</b>													
EN ISO 13849-1: 2006	Cat. 4 / PL e		Cat. 3 / PLd				Cat. 3 / PL d/e <sup>7)</sup>	-	Cat. 3 / PLd <sup>6)</sup>		Cat. 3 / PL d <sup>6)</sup>		
EN 61508: 2010	SIL 3		SIL 2				SIL 2/3 <sup>7)</sup>	-	SIL 2 <sup>6)</sup>		SIL 2 <sup>6)</sup>		
NFPA 79	Yes		-	-	-	-	-	-	-		Yes		-
NRTL listed	Yes		-	-	-	-	-	-	-		-	Yes <sup>1)</sup>	-

Contents of the manual

- 1) Only for SINAMICS S120 Booksize
- 2) Only for CU250S-2 Control Units with Safe Brake Relay
- 3) For chassis and cabinet modules with Safe Brake Adapter
- 4) With Safe Brake Relay
- 5) With external components
- 6) SBT: Cat 2 / PL d, SIL 1
- 7) STO via terminals of the PM240-2 Power Module Cat 3 / PL e, SIL 3  
STO via the Control Unit terminals and all other safety functions: Cat. 3 / PL d, SIL 2
- 8) Only with CU250S-2 Control Units

Figure 2-1 Products with drive-integrated safety functions



### What applications are described?

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

- Introductory and simplified description of the inverter safety functions
- Controlling the safety functions via safety inputs or PROFIsafe
- Commissioning and acceptance test of the safety functions
- Response of the inverter with active safety functions
- Replacing an inverter where the safety functions are enabled.
- Diagnostics of 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 423).

### What is the meaning of the symbols in the manual?



An operating instruction starts here.



This concludes the operating instruction.

## 2.2 Guide through the manual

Chapter	In this chapter, you will find answers to the following questions:
Description (Page 21)	<ul style="list-style-type: none"> <li>• What are basic functions and what are extended functions?</li> <li>• Which safety functions does the inverter have?</li> <li>• Which interfaces does the inverter have to select the safety functions?</li> <li>• What preconditions, restrictions and recommendations apply when using the safety functions?</li> <li>• How do the safety functions basically work?</li> </ul>
Installing (Page 43)	<ul style="list-style-type: none"> <li>• Which sequence is recommended when installing the inverter?</li> <li>• What options are available to connect the inverter to the higher-level control system via PROFIsafe?</li> <li>• How are the PROFIsafe control words and status words assigned?</li> <li>• How do you wire the safety-related inputs and outputs of the inverter?</li> <li>• What differences are there when wiring inside and outside the control cabinet?</li> <li>• How do you connect a monitored motor holding brake?</li> </ul>
Commissioning (Page 89)	<ul style="list-style-type: none"> <li>• Which sequence is recommended when commissioning the inverter?</li> <li>• Which tool do you require for commissioning?</li> <li>• How do you restore the factory setting of the safety functions?</li> <li>• In SINAMICS G120, is it permissible to use the safety functions according to SIL 2 and SIL 3 together?</li> <li>• How do you commission the safety functions?</li> <li>• How do you configure communications via PROFIsafe in the inverter?</li> <li>• How do you transfer safety function parameters to other inverters?</li> <li>• Why is it necessary to "Accept safety functions"?</li> <li>• What does accepting safety functions involve?</li> </ul>
Operation (Page 197)	<ul style="list-style-type: none"> <li>• How do you maintain the guaranteed probability of failure of the safety functions over the usage period?</li> <li>• How does the drive respond when selecting or deselecting a safety function?</li> <li>• How do you switch on a motor with a safety function active?</li> <li>• How does the drive respond to a discrepant signal at a safety-related input?</li> <li>• How does the drive respond to limit value violations or if internal monitoring functions respond?</li> <li>• How do you acknowledge safety function faults?</li> <li>• How do the safety functions mutually influence one another?</li> <li>• What do the alarm and fault messages of the safety functions mean?</li> </ul>
Corrective maintenance (Page 317)	<ul style="list-style-type: none"> <li>• How do you maintain the operational safety of the plant or machine?</li> <li>• How do you replace defective components in the inverter or the inverter itself?</li> <li>• How do you ensure that after a replacement the safety functions still function?</li> </ul>

Chapter	In this chapter, you will find answers to the following questions:
System properties (Page 351)	<ul style="list-style-type: none"> <li>• How long may you operate the inverter?</li> <li>• In which time intervals must you initiate the inverter self test?</li> <li>• What is the probability of failure of the inverter safety functions?</li> <li>• In which time does the drive respond when selecting a safety function?</li> <li>• When a safety function is active, in which time does the drive respond to a motor malfunction?</li> <li>• According to which standards are the inverter safety function certified?</li> <li>• Where can you find certifications for the inverter?</li> <li>• What is the technical data of the Safe Brake Relay?</li> </ul>
Appendix (Page 365)	<ul style="list-style-type: none"> <li>• What does a typical acceptance for a safety function look like?</li> <li>• As machine builder or company operating a machine, which standards and regulations must you comply with?</li> <li>• Where can you find additional information about the inverter?</li> </ul>



## Description

### 3.1 About this chapter

#### What can you find in this Chapter?

In this chapter, you will find answers to the following questions:






- What are basic functions and what are extended functions?
- What safety functions does my inverter have?
- Which interfaces to select the safety functions does my inverter have?
- Which preconditions, restrictions and recommendations apply when using the safety functions?
- How do the safety functions basically work?

### 3.2 Basic functions and extended functions

The safety functions integrated in the drive are split up according to basic functions and extended functions.

<b>Safety functions integrated in the drive</b>	
<b>Basic functions</b>	<b>Extended functions</b>
<p>The basic functions prevent hazardous motion using one or several of the following measures:</p> <ul style="list-style-type: none"> <li>• The energy feed to the motor is safely switched off</li> <li>• The energy feed to the motor holding brake is safely switched off</li> </ul> <p>The following basic functions are available:</p> <ul style="list-style-type: none"> <li>• Safe Torque Off (STO)</li> <li>• Safe Brake Control (SBC)</li> <li>• Safe Stop 1 (SS1) without speed monitoring</li> </ul> <p>Each of the inverters described in this manual has one or several of the basic functions.</p>	<p>Extended functions include several basic functions and additional functions to safely monitor the motor speed:</p> <ul style="list-style-type: none"> <li>• STO and SBC basic functions</li> <li>• Safe Stop 1 (SS1) with speed monitoring</li> <li>• Safely Limited Speed (SLS)</li> <li>• Safe Direction (SDI)</li> <li>• Safe Speed Monitor (SSM)</li> </ul> <p>Whether an inverter has extended functions generally depends on the Control Unit hardware. The corresponding inverters have an "F" at the end of the product name, e.g. Control Unit CU240E-2 F. For SINAMICS G120 with a CU250S-2 Control Unit, you require a license for the extended functions.</p>

Table 3- 1 Inverters with safety functions integrated in the drive

Inverter	Basic functions		Extended functions	
	STO	SS1, SBC	SS1, SDI, SLS	SSM, SLS with switchable SLS levels
 SINAMICS G110M	Available with all product versions	--- <sup>1)</sup>	---	
 SINAMICS G120C	Available with all product versions	---	---	
 SINAMICS G120	Available with all CU240E-2 and CU250S-2 Control Units	Available with all CU250S-2 Control Units	Available with the following Control Units: CU240E-2 F CU240E-2 DP-F CU240E-2 PN-F CU250S-2 <sup>2)</sup> CU250S-2 DP <sup>2)</sup> CU250S-2 PN <sup>2)</sup> CU250S-2 CAN <sup>2)</sup>	Available with the following Control Units: CU240E-2 DP-F CU240E-2 PN-F CU250S-2 DP <sup>2)</sup> CU250S-2 PN <sup>2)</sup>
 SINAMICS G120D	Available with all Control Units	---	Available with the following Control Units: CU240D-2 DP-F CU240D-2 PN-F CU240D-2 PN-F PP CU240D-2 PN-F FO CU250D-2 DP-F CU250D-2 PN-F CU250D-2 PN-F PP CU250D-2 PN-F FO	
 SIMATIC ET 200pro FC-2	Available	---	---	

<sup>1)</sup> ---: Not available

<sup>2)</sup> Requires a license for the safety functions

### 3.3 Interfaces to select the safety functions

Depending on the particular inverter, the interfaces of the safety functions are safety inputs and outputs (F-DI, F-DO), the safety-related PROFIsafe fieldbus communication and a safety output to control a brake.

Inverter	F-DI	F-DO	PROFIsafe	Safety output for a brake	
	SINAMICS G110M with Control Unit ...				
	CU240M USS	1	--- <sup>1)</sup>	---	---
	CU240M DP CU240M PN	1	---	Telegram 30 <sup>3)</sup>	---
	SINAMICS G120C USS SINAMICS G120C CAN				
	1	---	---	---	
	SINAMICS G120C DP SINAMICS G120C PN	1	---	Telegram 30 <sup>3)</sup>	---
	SINAMICS G120 with Control Unit ...				
	CU240E-2	1 + 1 <sup>5)</sup>	---	---	---
	CU240E-2 DP CU240E-2 PN	1 + 1 <sup>5)</sup>	---	Telegram 30 <sup>3)</sup>	---
	CU240E-2 F	3 + 1 <sup>5)</sup>	---	---	---
	CU240E-2 DP-F CU240E-2 PN-F	3 + 1 <sup>5)</sup>	---	Telegram 30 <sup>3)</sup> , Telegram 900 <sup>4)</sup>	---
	CU250S-2 CU250S-2 CAN	3 + 1 <sup>5)</sup>	1	---	Available with Safe Brake Relay
	CU250S-2 DP CU250S-2 PN	3 + 1 <sup>5)</sup>	1	Telegram 30 <sup>3)</sup> , Telegram 900 <sup>4)</sup>	Available with Safe Brake Relay
	SINAMICS G120D with Control Unit ...				
	CU240D-2 DP CU240D-2 PN	1	---	Telegram 30 <sup>3)</sup>	---
	CU240D-2 DP-F CU240D-2 PN-F CU240D-2 PN-F PP CU240D-2 PN-F FO CU250D-2 DP-F CU250D-2 PN-F CU250D-2 PN-F PP CU250D-2 PN-F FO	3	1	Telegram 30 <sup>3)</sup> , Telegram 900 <sup>4)</sup>	---
		SIMATIC ET 200pro FC-2			
		Via ET 200pro system <sup>2)</sup>	---	Via ET 200pro system <sup>2)</sup>	---

<sup>1)</sup> --- Not available

<sup>2)</sup> The inverter evaluates the F0 rail in the backplane bus of the ET 200pro system using an internal safety-related input. The ET-200pro F-RSM and F-Switch modules control the F0 rail.

<sup>3)</sup> Telegram 30 for control and for the status feedback signal from the safety functions

<sup>4)</sup> Telegram 900: Function as for telegram 30 and additional feedback signal of the F-DI status

<sup>5)</sup> An additional safety-relevant input for the STO on the PM240-2 FSD and FSE Power Modules



## 3.4 Preconditions when using the safety functions

### Risk assessment

A risk analysis and assessment of the plant or machine is required before using the safety functions integrated in the drive.

The risk analysis and assessment must verify the following:

- The safety function integrated in the drive is suitable as a protective measure to minimize risks associated with the machine.
- The accepted probability of failure of the protective measure must be greater or equal to the certified probability of failure of the safety function integrated in the drive.

See also: Certification (Page 354)

### Motors and control modes

You can use the basic functions without any restrictions:

- For all control modes: U/f control and speed control with and without encoder
- With synchronous and induction motors
- For group drives, which involves the simultaneous operation of several motors connected to one inverter

It is only permissible that you use the extended functions under the following preconditions:

- With induction motors for all control modes
- With SIEMOSYN synchronous motors only with U/f control
- For group drives

### Encoderless safety functions

The safety functions integrated in the drive do not use an encoder.

"Encoderless" means the following:

- You do not require an encoder to use the safety functions integrated in the drive.
- If the inverter has an encoder connection, the inverter uses the encoder signal to control (closed loop) the motor. The safety functions ignore the encoder signal.

### Taking into account the slip of induction motors

The speed of the motor shaft is relevant for the functional safety in or on a machine. However, the extended functions monitor the electrical speed of the motor against the limit values that have been set.

If you use encoderless safety functions with an induction motor, you must take into account the motor slip when setting the speed monitoring.

### 3.5 Restrictions when using safety functions

#### Not permitted: Operation with pulling loads

It is not permissible that you use the encoderless safety functions in applications involving pulling loads, e.g. in hoisting gear, elevators and unwinders.



**! WARNING**

**Death or severe injury as a result of an undesirably accelerating load**

The encoderless actual value sensing does not identify all faults and errors in the closed-loop motor control. As a consequence, encoderless safety functions, cannot identify whether a pulling load undesirably accelerates the drive due to a fault in the closed-motor control.

- Never use safety functions with encoderless speed monitoring for drives with pulling loads.

#### What options are there for monitoring the speed for pulling loads?

- You can implement speed monitoring in machines with pulling loads in one the following ways:
  - Select a drive with safety functions that use an encoder, for example SINAMICS S120.
  - Implement the speed monitoring in the higher-level control by using a suitable measuring system to acquire the speed/velocity.
- Coupled electric drives, e.g. test stands and winders/unwinders comprise a driving and a driven drive. Using the extended functions in the drive that has a driving function in a coupled drive system. In the case of a fault, the drive with the driving function identifies when a limit value is violated.

#### Not permitted: Motors with different pole pair numbers

**! WARNING**

**Death or serious injury due to unexpected high speeds**

If you use the "Drive data set" function to switch over motors with different pole pair numbers, then the calculated, safety-related speed differs from the mechanical speed of the motor shaft. As a consequence, the motor shaft can accelerate above the configured monitoring limits of the safety function. This can result in death or severe injury.

- When using the "drive data set" function, only switch between motors with the same pole pair number.

#### Monitoring the speed of motors with different pole pair numbers

Implement the speed monitoring in the higher-level control by using a suitable measuring system to acquire the velocity or speed.

## Critical applications

If a safety function is not enabled in the inverter, then you can use the following critical applications without any restrictions.

If a safety function is enabled in the inverter, then several applications can result in faults in the safe actual value sensing. For active or enabled safety functions, faults and errors in the safety-related actual value sensing initiate a stop response: Messages C01711, C30711 with default values 1040 ff.

The stop response does not result in an unsafe drive state, but in a lower drive availability.

Critical application	Remedy
Motor data identification during commissioning	Only commission the safety functions after the motor data identification has been completed.
Setpoint change as step function	Set the ramp-function generator times to values > 0.5 s.
Reversing the speed	If you are using an inverter with position control, then you must set the position controller and the travel profile so that there is absolutely no overshoot in the speed/velocity characteristic. Within 1 s, only one acceleration and one braking ramp are permitted. The cycle $0 \rightarrow n_{set} \rightarrow -n_{set} \rightarrow 0$ must be at least 2 s long.
Load change as step function	Do not use the safety functions.
Continuous operation at speeds < 5 % of the rated speed	
Switching-on the inverter with the motor rotating ("flying restart" function)	Avoid using the "flying restart" function when a safety function is active. Temporarily deactivate the safety function until the "flying restart" function has been successfully completed. It is not permissible that you use the "flying restart" function if you are using the SSM function. It is not possible to deactivate SSM using a control signal.
Operating an inverter at the current limit	Select and dimension the drive so that the inverter current limit does not respond. After commissioning, check that the inverter does not reach its current or torque limits – even at full load.
Braking a motor using the "DC braking" or "Compound braking" functions	Avoid using the "DC braking" or "Compound braking" functions when a safety function is active. If you require one of these two braking functions, then in the risk assessment, you must carefully check as to whether you may deactivate the safety function while braking. If yes, then deactivate the safety function until braking has been completed. It is not permissible that you use the braking functions if you are using the SSM function. It is not possible to deactivate SSM using a control signal.

### Inadmissible SINAMICS G120 Power Modules

When using the following Power Modules, you may not / cannot use all of the integrated safety functions.

Power Module	Restriction
PM230 in degree of protection IP55	Article numbers 6SL3223-0DE . . . . <b>A</b> . . : The integrated safety functions are not possible.
	Article numbers 6SL3223-0DE . . . . <b>G</b> . . : The basic STO function is possible.
PM230 in degree of protection IP20 and Push Through	Article numbers 6SL321 . -1NE . . . . <b>L</b> . . : The integrated safety functions are not possible.
	Article numbers 6SL321 . -1NE . . . . <b>G</b> . . : The basic STO function is not possible.
PM240 FSGX	Article numbers 6SL3224-0XE41- . UA0: Only the basic STO, SBC and SS1 functions are permissible.

## 3.6 Recommendations for stable operation

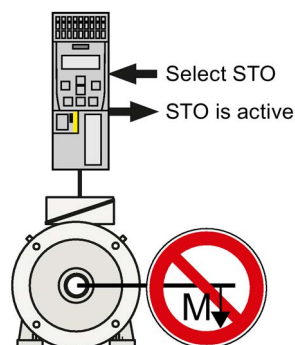
The following preconditions must be satisfied to ensure disturbance-free inverter operation with the extended functions enabled:

- Motor and inverter are adequately dimensioned for this application:
  - The inverter is operated below its current limit.
  - The rated currents of the motor and inverter must not differ by more than a factor of 5:  

$$\text{Inverter rated current} / \text{motor rated current} < 5 \text{ (r0207[0] / p0305 < 5)}$$
- Before commissioning the safety functions, optimally set the closed-loop control:
  - Carry out motor data identification at standstill.
  - Carry out a rotating measurement.
  - Avoid multiple speed overshoots when settling after a setpoint change.
  - Avoid reversing the motor within less than 2 s.

## 3.7 Safe Torque Off (STO)

### How does the STO safety function work?



The inverter with active STO function prevents machine components from inadvertently starting.

Table 3- 2 The principle of operation of STO

	Safe Torque Off (STO)	Standard inverter functions linked with STO
1.	The inverter recognizes the selection of STO via a safety-relevant input or via the PROFIsafe safe communication.	---
2.	The inverter prevents energy from being fed to the motor. When STO is active, the motor does not generate any torque.	If you use a motor holding brake, the inverter closes the brake.
3.	The inverter signals that "STO is active" via a safety-relevant output or via the PROFIsafe safe communication.	---

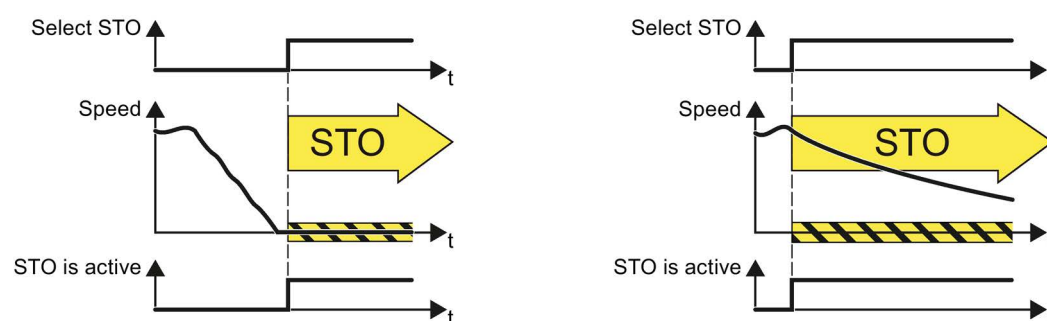


Figure 3-1 Functionality of STO when motor is rotating and at a standstill

If the motor is still rotating when STO is selected, then it coasts down to standstill.

### The STO safety function is standardized

The STO function is defined in IEC/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)."

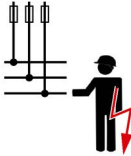
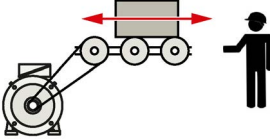
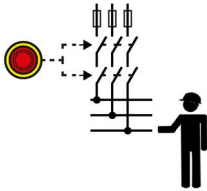
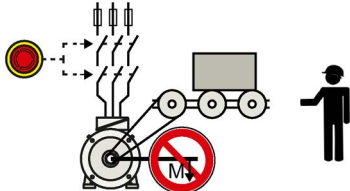
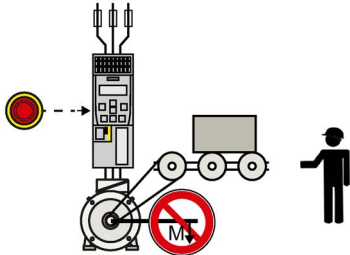
The STO inverter function complies with what is defined in the standard.

3.7 Safe Torque Off (STO)

The distinction between Emergency Off and Emergency Stop

"Emergency Off" and "Emergency Stop" are commands that minimize different risks in the machine or plant.

The STO function is suitable for achieving an emergency stop but not an emergency off.

<p>Risk:</p>	<p>Risk of electric shock:</p> 	<p>Risk of unexpected motion:</p> 
<p>Measure to minimize risk:</p>	<p><b>Safe switch off</b> Switching off the electric power supply for the installation, either completely or partially.</p>	<p><b>Safely stop and safely prevent re-starting</b> Stopping or preventing the dangerous movement</p>
<p>Command:</p>	<p><b>Emergency Off</b></p>	<p><b>Emergency Stop</b></p>
<p>Classic solution:</p>	<p>Switch of the power supply:</p> 	<p>Switch-of the drive power supply:</p> 
<p>Solution with the STO safety function integrated in the drive:</p>	<p>STO is not suitable for safely switching of an electric voltage.</p>	<p>Select STO:</p>  <p>It is permissible that you switch of the inverter supply voltage as well. However, switching off the voltage is not required as a risk-reduction measurement.</p>

### Application examples for the STO function

The STO function is suitable for applications where the motor is already at a standstill or will come to a standstill in a short, safe period of time through friction. STO does not shorten the run-on of machine components with high inertia.

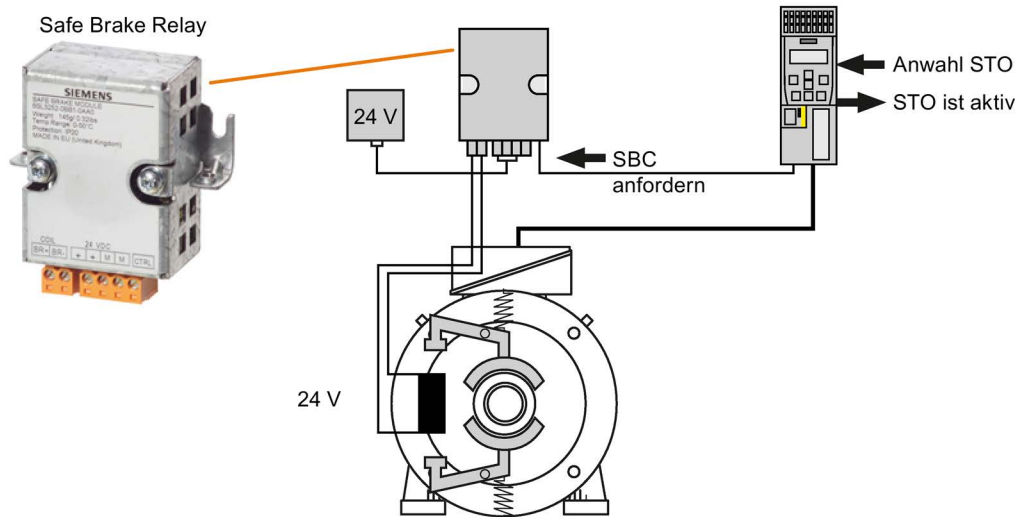
Examples	Possible solution
When the Emergency Stop button is pressed, a stationary motor should not unintentionally start.	<ul style="list-style-type: none"><li>• Wire the Emergency Stop button to a safety-related input of the inverter.</li><li>• Select STO via the safety-related input.</li></ul>
A central emergency stop button must prevent the unintentional acceleration of several motors that are at a standstill.	<ul style="list-style-type: none"><li>• Evaluate the Emergency Stop button in a central control.</li><li>• Select STO via PROFIsafe.</li></ul>

### 3.8 Safe Brake Control (SBC)

#### How does the SBC safety function work?

An inverter equipped with the SBC function monitors the cables to an electromagnetic brake and when requested, safely shuts down the 24 V control of the brake.

You must supplement the inverter with a Safe Brake Relay for the SBC function.



The brake can be integrated in the motor or externally mounted.

Table 3-3 The principle of operation of SBC

	Safe Brake Control (SBC)		Standard brake functions
1.	When the STO function is active, the inverter requests the SBC function via the connecting cable to the Safe Brake Relay. The Safe Brake Relay safely switches off the supply voltage for the connected brake.	<p>The diagram shows the timing of SBC activation. It includes signals for 'Select STO', 'Speed', 'STO is active', and 'SBC'. 'Select STO' is a step function that goes high. 'Speed' is a curve that starts at a high value and decays towards zero. 'STO is active' is a step function that goes high. 'SBC' is a step function that goes high after 'STO is active' and remains high until 'Speed' reaches zero. There are also two unlabeled step functions that go high at the start and low at the end of the sequence.</p>	The brake closes. The brake maintains the motor shaft in position.
2.	The inverter signals that "STO is active" via a safety output or via the PROFIsafe safe communication.		

The safety-related brake control does not mean that the brake keeps the load in position. The SBC function is not able to identify as to whether the brake is mechanically worn, for example.



### The SBC safety function is standardized

The SBC function is defined in IEC/EN 61800-5-2:

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

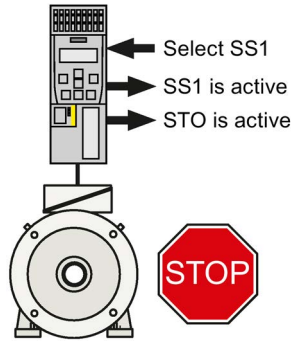
The SBC inverter function complies with what is defined in the standard.

### Application example for the SBC function

Example	Possible solution
After a hoisting gear stops, the inverter must close the brake in order to minimize the risk of the load falling.	<ul style="list-style-type: none"><li>• Connect the motor holding brake to the inverter via Safe Brake Relay.</li><li>• Select STO when the drive stops.</li></ul>

### 3.9 Safe Stop 1 (SS1)

#### How does SS1 function?



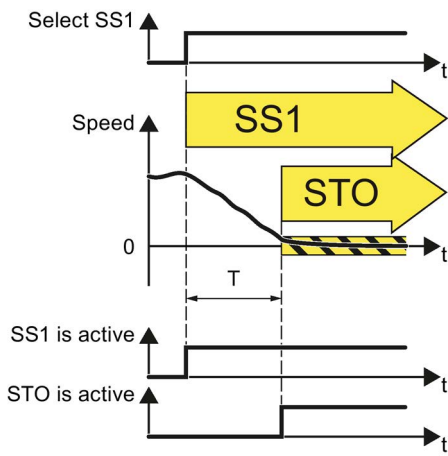
When the SS1 function is active, the inverter reduces the kinetic energy of the machine components to the lowest possible level.

The principle of operation of SS1 differs depending on whether you use SS1 with basic functions or with extended functions.

#### SS1 of the basic functions

Table 3- 4 Principle of operation of SS1, selected when the motor is rotating

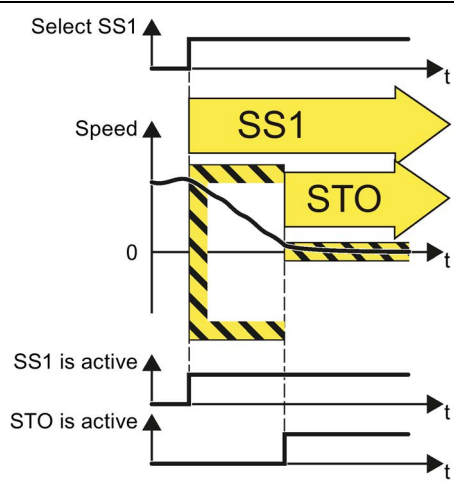
	Safe Stop 1 (SS1)	Standard inverter functions linked with SS1
1.	The inverter recognizes the selection of SS1 via a safety-related input or via the PROFIsafe safe communication.	---
2.	SS1 starts a safety timer T. The inverter signals "SS1 is active".	The inverter brakes the motor along the OFF3 ramp.
3.	After the timer expires, the inverter safely switches off the motor torque with the STO function. The inverter signals that "STO is active" via a safety-related output or via the PROFIsafe safe communication.	---



## SS1 of the extended functions

Table 3- 5 Principle of operation of SS1, selected when the motor is rotating

Safe Stop 1 (SS1)		Standard inverter functions linked with SS1
1.	The inverter recognizes the selection of SS1 via a safety-related input or via the PROFIsafe safe communication.	---
2.	The inverter monitors as to whether the motor speed decreases. The inverter signals "SS1 is active".	The inverter brakes the motor along the OFF3 ramp.
3.	If the motor speed is low enough, the inverter safely switches off the motor torque using STO. The inverter signals that "STO is active" via a safety-related output or via the PROFIsafe safe communication.	---



## The SS1 safety function is standardized

The SS1 function is defined in IEC/EN 61800-5-2:

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

or

[2] Initiate motor deceleration and activate the STO function after an application-specific time delay."

Inverter function SS1 of the extended functions satisfies the definition [1] of the standard.

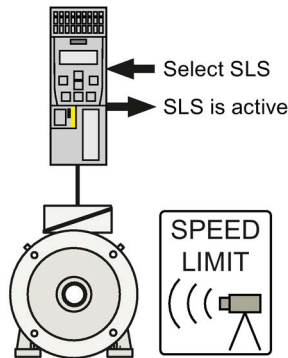
Inverter function SS1 of the basic functions satisfies the definition [2] the standard.

## 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 restarts.	<ul style="list-style-type: none"> <li>Select SS1 in the inverter using a safety-related input or via PROFIsafe.</li> </ul>

### 3.10 Safely Limited Speed (SLS)

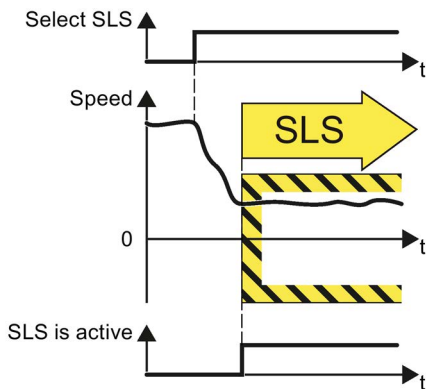
How does SLS function?



An inverter with active SLS function can reduce the velocity or speed of a machine component and monitor it without having to interrupt machining operation.

Table 3- 6 Principle of operation of SLS, selected when the motor is rotating

Safely Limited Speed (SLS)		Standard inverter functions linked with SLS
1.	The inverter recognizes the selection of SLS via a safety input or via the PROFIsafe safe communication.	---
2.	SLS allows a motor to reduce its possibly inadmissibly high speed within a defined time – or to reduce it along a defined braking ramp.	The inverter limits the speed set-point to values below the SLS monitoring. If the motor rotates faster than the SLS monitoring value, then the inverter brakes the motor along the OFF3 ramp.
3.	The inverter monitors the absolute actual speed against the set SLS monitoring. The inverter signals that "SLS is active" via a safety output or via the PROFIsafe safe communication. If the motor speed exceeds the SLS monitoring, the inverter responds with a "safe stop" and brakes the motor as quickly as possible.	The inverter limits the speed set-point to values below the SLS monitoring.



#### The SLS safety function is standardized

The SLS function is defined in IEC/EN 61800-5-2:

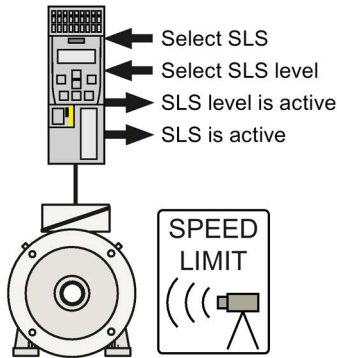
"The SLS function prevents the motor from exceeding the defined speed limit."

The SLS inverter function complies with what is defined in the standard.

**Application examples for the SLS function**

Examples	Possible solution
Setup mode: The machine operator must enter the dangerous area of a machine and manually introduce material into a machine part.	<ul style="list-style-type: none"><li>• Select SSL in the inverter via a safety input or via PROFIsafe.</li><li>• The inverter limits and monitors the speed of the machine part.</li></ul>
A turning machine must not exceed a specific maximum torque in order to protect the drill chuck from damage.	

Functional expansion: selecting SLS levels



Expansion of the SLS function to include several SLS levels:

- The speed monitoring of the SLS function can be extended to include a maximum of 4 different SLS levels.
- The inverter requires additional safety-related signals to select an SLS level and to signal back which SLS level is active.

It is only possible to select SLS levels via PROFIsafe.

The switchover from a higher SLS level 2 to a lower SLS level 1 is described as example.

Table 3- 7 Switching over from SLS level 2 to SLS level 1

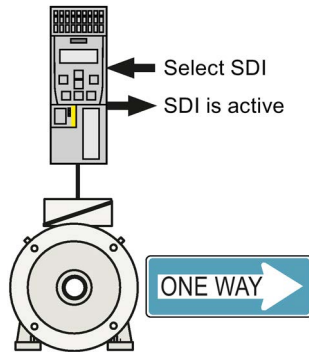
Safely Limited Speed (SLS)		Standard inverter functions linked with SLS
1.	The inverter signals "SLS level 2 is active" via the safety-related PROFIsafe communication.	The inverter limits the speed set-point to values below SLS level 2.
2.	The inverter recognizes the selection of SLS level 1 via the safety-related PROFIsafe communication.	
3.	SLS allows a motor to reduce its possibly inadmissibly high speed within a defined time – or to reduce it along a defined braking ramp.	The inverter limits the speed set-point to values below SLS level 1. If the motor rotates faster than the SLS monitoring value, then the inverter brakes the motor along the OFF3 ramp.
4.	The inverter monitors the absolute actual speed against SLS level 1. The inverter signals "SLS level 1 is active" via the safety-related PROFIsafe communication.	The inverter limits the speed set-point to values below SLS level 1.

Application example for selecting SLS levels

Examples	Possible solution
Depending on the diameter of the saw blade, a circular saw must not exceed a specific maximum speed.	<ul style="list-style-type: none"> <li>• Select SLS and the corresponding SLS level in the inverter via PROFIsafe.</li> </ul>

## 3.11 Safe Direction (SDI)

### How does SDI function?



The inverter with active SDI function prevents that a machine component moves in the inhibited direction.

Table 3- 8 Principle of operation of SDI, selected when the motor is rotating

	Safe Direction (SDI)		Standard inverter functions linked with SDI
1.	The inverter recognizes the selection of SDI via a safety input or via the PROFIsafe safe communication.	<p>The diagram shows three signals over time (t). The top signal, 'Select SDI', transitions from low to high. The middle signal, 'Speed', shows a motor rotating in the inhibited direction (indicated by a hatched area) before being limited to a lower speed setpoint (indicated by a yellow arrow labeled 'SDI'). The bottom signal, 'SDI is active', transitions from low to high.</p>	---
2.	SDI allows a motor to stop moving in the inhibited direction of rotation within a defined time – or along a defined braking ramp.		<p>The inverter limits the speed setpoint to values in the selected direction of rotation.</p> <p>If the motor rotates in the inhibited direction, then the inverter brakes the motor along the OFF3 ramp.</p>
3.	<p>The inverter monitors the direction of the actual speed.</p> <p>The inverter signals that "SDI is active" via a safety output or via the PROFIsafe safe communication.</p> <p>If the motor rotates in the inhibited direction, the inverter responds with a "safe stop" and brakes the motor as quickly as possible.</p>		<p>The inverter limits the speed setpoint to values in the selected direction of rotation.</p>

### The SDI safety function is standardized

The SDI function is defined in IEC/EN 61800-5-2:

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

The SDI inverter function complies with what is defined in the standard.

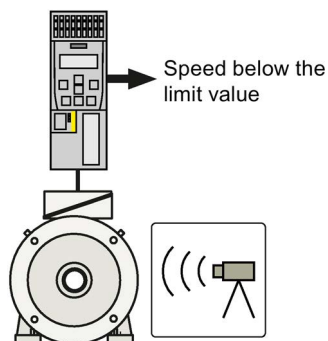
### Application examples

Example	Possible solution
When replacing the pressure cylinders of the plates, it is only permissible that the drive moves in the safe direction.	<ul style="list-style-type: none"><li>• Select SDI in the inverter via a safety input or via PROFIsafe.</li><li>• In the inverter, inhibit the direction of rotation that is not permitted.</li></ul>
After a protective device to detect a jammed door responds, a rolling shutter gate may only move in the opening 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.	



## 3.12 Safe Speed Monitoring (SSM)

### How does SSM function?



The inverter with active SSM function signals whether the velocity or speed of a machine component is above or below a limit value.

Table 3-9 The principle of operation of SSM

	Safe Speed Monitoring (SSM)	Standard inverter functions linked with SSM
1.	The SSM function cannot be selected or deselected using external control signals, in the appropriate setting, it is always active.	
2.	The inverter compares the motor speed with an adjustable limit value.	
3.	If the speed is less than the limit value, the inverter signals "Speed below limit value" via a safety output or via safety-related PROFIsafe communication.	

### The SSM safety function is standardized

The SSM function is defined in IEC/EN 61800-5-2:

"The SSM function supplies a safe output signal to indicate whether the motor speed is below a specified limit value."

The SSM inverter function complies with what is defined in the standard.

### Application example

Example	Possible solution
A centrifuge may only filled below a certain minimum velocity.	The inverter safely monitors the centrifuge speed and enables the process to advance to the next step using the status bit "Speed below limit value" via PROFibus.

*Description*

---

*3.12 Safe Speed Monitoring (SSM)*

# Installing

## 4.1 About this chapter

### What can you find in this Chapter?

In this chapter, you will find answers to the following questions:

- Which sequence is recommended when installing the inverter?
- What are the options to connect the inverter to the higher-level control system via PROFIsafe?
- How are the PROFIsafe control words and status words assigned?
- How do I wire up the safety-related inputs and outputs of my inverter?
- What differences are there when wiring inside and outside the control cabinet?
- How do I connect a motor holding brake that is to be monitored in the inverter?

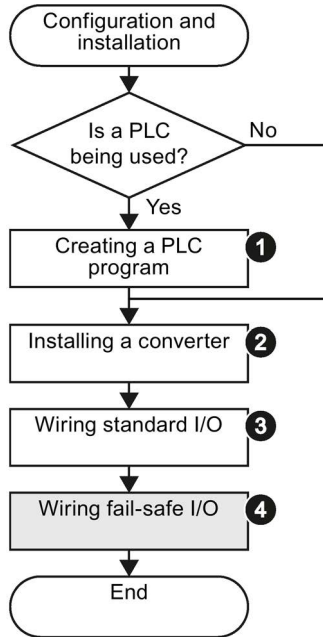
## 4.2 Sequence when installing an inverter with safety functions

### Procedure



1 The following overview shows the procedure for installing integrated safety functions in an inverter. 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.
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. Connect the safety-related inputs and outputs  
→ in this manual: Control via safe inputs (Page 57).  
→ in this manual: Evaluation using safety-related outputs (Page 84).

■ You have installed the inverter and prepared it for commissioning.

## 4.3 Connection via PROFIsafe

### 4.3.1 Overview of PROFIsafe connections

#### Communication via PROFIsafe

For communication via PROFIsafe, you must connect the inverter to a central fail-safe control (F-CPU) via either PROFIBUS or PROFINET.

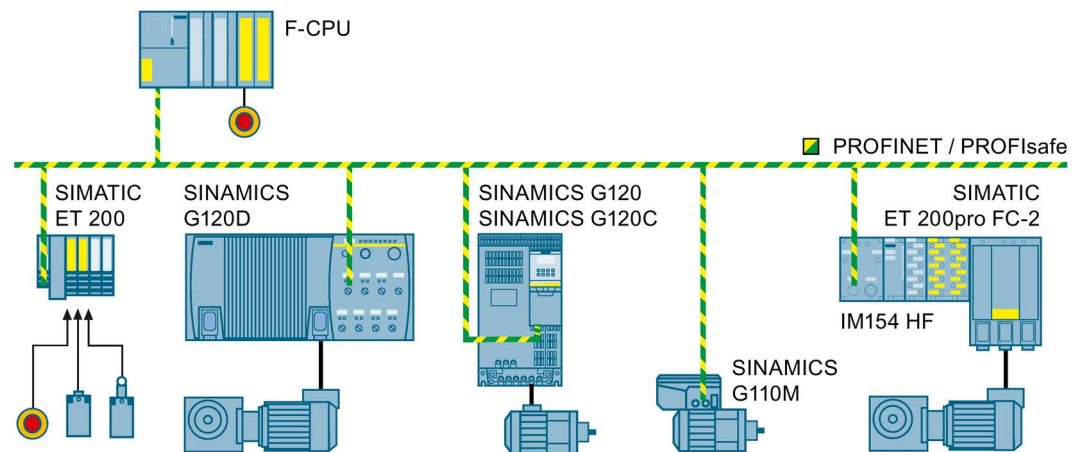


Figure 4-1 PROFIsafe communication between an F-CPU and an inverter, e.g. via PROFINET

### SIMATIC ET 200pro FC-2

The SIMATIC ET 200pro FC-2 converter does not have its own PROFIsafe interface. The central F-CPU controls the safety functions of the ET 200pro FC-2 via a "High Feature" interface module and the PROFIsafe "F-Switch" module.

The F-Switch module switches the "F0" and "F1 rails" in the backplane bus of the ET-200pro system. The inverter evaluates the F0 rail using an internal, safety-related input.

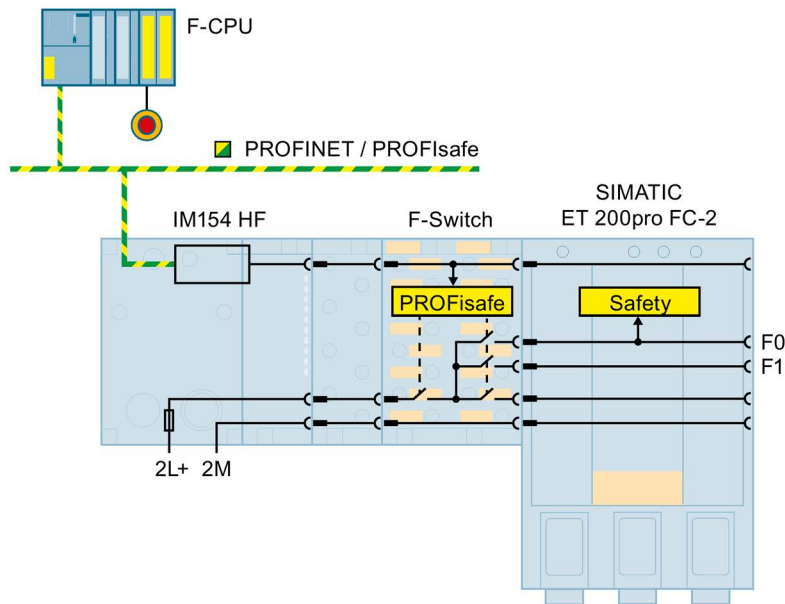


Figure 4-2 F-Switch to connect PROFIsafe of the ET 200pro FC-2 converter, e.g. via PROFINET

Additional information on the ET 200pro system and the F-Switch module is available in the "SIMATIC distributed ET 200pro I/O system" Operating instructions. See also Section: Manuals for your inverter (Page 423).

Additional possibilities of installing the F-Switch module are listed in the Internet: FAQ (<http://support.automation.siemens.com/WW/view/en/26694409>).

## PROFIsafe communication within the SIMATIC ET 200pro

The SIMATIC-ET-200pro system allows safe communication limited to the system itself to be established:

- The ET-200pro system is node on the PROFIBUS or PROFINET.
- Within the ET-200pro system, the interface module with integrated fail-safe control (IM154 F-CPU) controls the inverter safety functions via PROFIsafe.

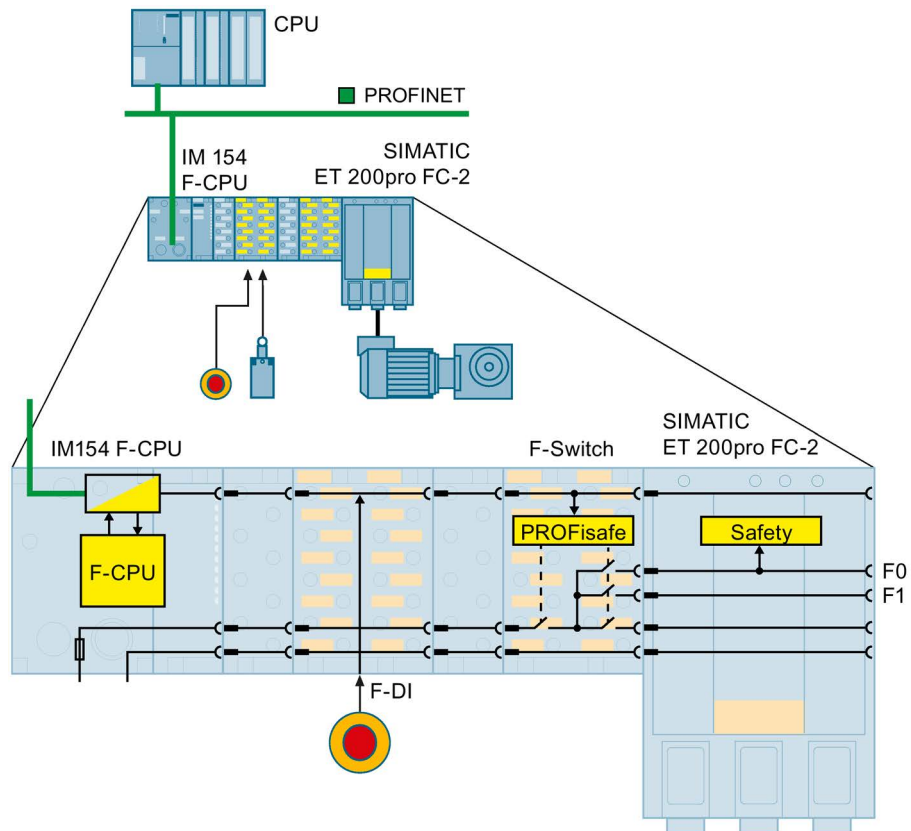


Figure 4-3 Safe communications between IM154 F-CPU and inverters within an ET 200pro, e.g. connected to PROFINET

### Shared Device

The PROFINET "Shared Device" function allows two controls to access the same PROFINET IO device, e.g. on a SIMATIC ET 200 I/O system or on an inverter. Typical applications for "Shared Device" are systems, in which a standard CPU and a fail-safe CPU are used as separate controllers:

- The fail-safe controller (F-CPU) is responsible for the safety functions in the inverter or in the SIMATIC ET 200 I/O system.
- The standard controller transfers all other signals.

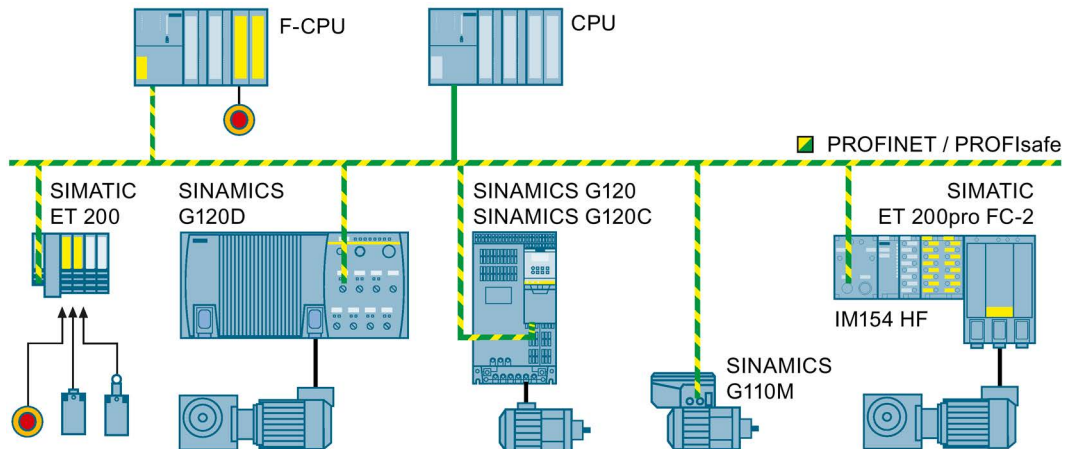


Figure 4-4 Shared device is possible with every inverter

You can find additional information in the Internet: Which controls support the Shared Device function (<http://support.automation.siemens.com/WW/view/en/44383955>).



## PROFIsafe communication I-slave ↔ slave

An I-slave is a CPU, which is integrated in a fieldbus as intelligent slave. The option of using an F-CPU as I-slave is only possible with PROFIBUS.

The SIMATIC ET 200pro FC-2 converter permits I-slave-slave communication. On one hand, the F-CPU is a slave connected to PROFIBUS, and on the other hand, controls the inverter safety functions via PROFIsafe.

PROFIsafe communications between SINAMICS inverters and an I-slave is not possible.

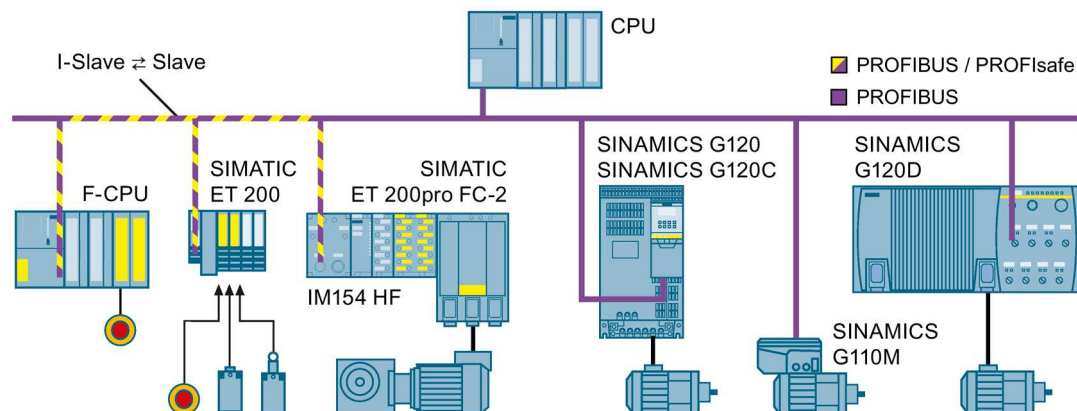


Figure 4-5 The I-slave-slave communication is only possible with ET 200pro FC-2

### 4.3.2 PROFIsafe telegrams

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

Table 4- 1 PROFIsafe telegrams

Overview using PROFINET / PROFIsafe as example	Telegram	Process data (PZD)	
		PZD1	PZD2
	<b>Telegram 30</b> PZD 1/1	S_STW1	---
		S_ZSW1	---
	<b>Telegram 900</b> PZD 2/2	S_STW1	S_STW5
		S_ZSW1	S_ZSW5
<p>The higher-level control selects the safety functions in the inverter via the control word S_STW1. The inverter uses the status word S_ZSW1 to report the status of the safety functions to the controller.</p> <p>Telegram 900 of the PROFIsafe profile also contains control and status word 5. The inverter uses status word S_ZSW5 to transfer the state of the safety digital inputs to the control.</p>			

S\_STW: Safety control word; S\_ZSW: Safety status word

### 4.3.3 Control word 1 and status word 1 (basic functions)

Table 4- 2 Control word 1 (bit 0 ... 15)

Byte	Bit	Function	Comment	
0	0	STO	0	Select STO
			1	Deselect STO
	1	SS1	0	Select SS1
			1	Deselect SS1
	2 ... 6	<i>Not relevant</i>		
7	Internal Event ack	0	Do not acknowledge faults	
		1 → 0	Acknowledge "Internal event" for a 1 → 0 signal change	
1	8 ... 15	<i>Not relevant</i>		

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

Byte	Bit	Function	Comment	
0	0	Power removed	0	STO is not active
			1	STO is active
	1	SS1 active	0	SS1 is not active
			1	SS1 is active
	2 ... 6	<i>Not relevant</i>		
7	Internal Event	0	Fault-free operation	
		1	The inverter signals an "internal event"	
1	8 ... 15	<i>Not relevant</i>		

### 4.3.4 Control word 1 and status word 1 (extended functions)

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

Byte	Bit	Function	Comment			
0	0	STO	0	Select STO		
			1	Deselect STO		
	1	SS1	0	Select SS1		
			1	Deselect SS1		
	2, 3	Not relevant				
	4	SLS	0	Select SLS		
			1	Deselect SLS		
	5, 6	Not relevant				
7	Internal event ack	0	Do not acknowledge faults			
		1 → 0	Acknowledge "Internal event" for a 1 → 0 signal change			
1	0	Not relevant				
	1	SLS level bit 0	Select SLS level	Bit 2	Bit 1	
				Level 1	0	0
	2	SLS level bit 1		Level 2	0	1
				Level 3	1	0
	3			Level 4	1	1
				Not relevant		
	4	SDI positive	0	Select SDI with positive direction of rotation		
1			Deselect SDI with positive direction of rotation			
5	SDI negative	0	Select SDI with negative direction of rotation			
		1	Deselect SDI with negative direction of rotation			
6, 7	Not relevant					

Table 4- 5 Status word 1 (bit 0 ... 15)

Byte	Bit	Function	Comment			
0	0	Power removed	0	STO is not active		
			1	STO is active		
	1	SS1 active	0	SS1 is not active		
			1	SS1 is active		
	2, 3	<i>Not relevant</i>				
	4	SLS active	0	SLS is not active		
			1	SLS is active		
	5, 6	<i>Not relevant</i>				
7	Internal Event	0	Fault-free operation			
		1	The inverter signals an "internal event"			
1	0	<i>Not relevant</i>				
	1	SLS level bit 0	SLS level is active		Bit 2	Bit 1
				Level 1	0	0
	2	SLS level bit 1		Level 2	0	1
				Level 3	1	0
				Level 4	1	1
	3	<i>Not relevant</i>				
	4	SDI positive active	0	SDI positive direction of rotation is not active		
			1	SDI positive direction of rotation is active		
	5	SDI negative active	0	SDI negative direction of rotation is not active		
1			SDI negative direction of rotation is active			
6	<i>Not relevant</i>					
7	Status SSM	0	Absolute value of the speed is greater than the SSM limit value			
		1	Absolute value of the speed is less than the SSM limit value			

### 4.3.5 Control word 5 and status word 5

Table 4-6 Control word 5 (bit 0 ... 15)

Byte	Bit	Function	Comment
0 ... 1	0 ... 7	<i>Reserved</i>	Assign the value 0 to the reserved bits.

Table 4-7 Status word 5 (bit 0 ... 15)

Byte	Bit	Function	Comment	SINAMICS G120	SINAMICS G120D	
0	0 ... 7	<i>Reserved</i>	-			
1	0	<b>Status of safety-related inputs</b>	0	LOW signal (0 V)	At terminals 5 and 6	At pins X7.2 and X7.4
			1	HIGH signal (24 V)		
	1		0	LOW signal (0 V)	At terminals 7 and 8	At pins X8.2 and X8.4
			1	HIGH signal (24 V)		
	2		0	LOW signal (0 V)	At terminals 16 and 17	At pins X9.2 and X9.4
			1	HIGH signal (24 V)		
	3 ... 7	<i>Reserved</i>	-			

An overview of the safety-related inputs can be found in section Overview (Page 57).

When one of the two following conditions is satisfied, the inverter sets the particular bit 0 ... 2 in byte 1 of status word 5 to zero, independent of the voltage levels connected:

- The corresponding safety input is not used.
- The inverter has deactivated the corresponding safety-related input as a result of discrepant input signals.

### 4.3.6 Example: Assignment of control and status word in the safety program of the control

#### Assignment of the inverter to input and output addresses of the control

By configuring the higher-level control, you assign the control word and the status word in the PROFIsafe profile of the inverter to specific input and output addresses in the control.

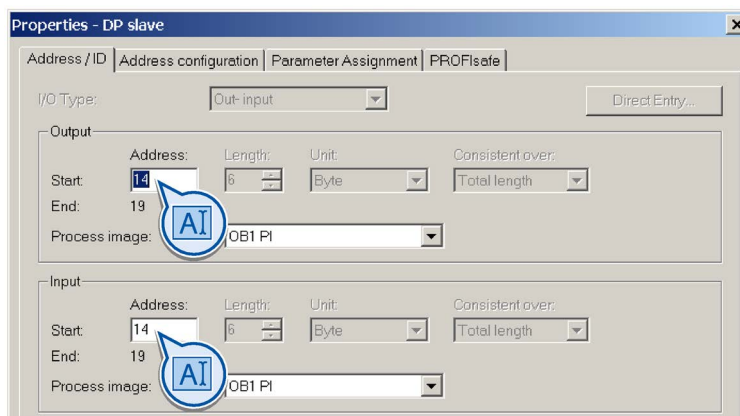


Figure 4-6 Example: in the control, assign the initial address 14 for the inverter

#### Control the inverter using the control program

This results in the following assignments between the I/O addresses and inverter signals for this example:

Table 4- 8 Control word 1

I/O address	Meaning	Comment	
A14.0	Select STO	0	Select STO
		1	Deselect STO
A14.1	Select SS1	0	Select SS1
		1	Deselect SS1
A14.4	Select SLS	0	Select SLS
		1	Deselect 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
		1	Deselect SDI positive
A15.5	Select SDI negative	0	Select SDI negative
		1	Deselect SDI negative

Table 4- 9 Status word 1

I/O address	Meaning	Comment	
E14.0	Power removed	0	The motor torque has not yet been switched off safely.
		1	The motor torque has been switched off safely.
E14.1	SS1 active	0	SS1 is not active
		1	SS1 is active
E14.4	SLS active	0	SLS is not active
		1	SLS is active
E14.7	Internal event	0	Fault-free operation
		1	The inverter 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	0	SDI positive direction of rotation is not active
		1	SDI positive direction of rotation is active
E15.5	SDI negative active	0	SDI negative direction of rotation is not active
		1	SDI negative direction of rotation is active
E15.7	Status SSM	0	Absolute value of the speed is greater than the SSM limit value
		1	Absolute value of the speed is less than the SSM limit value



## 4.4 Control via safe inputs

### 4.4.1 Overview

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



The SIMATIC ET 200pro FC-2 converter does not have directly accessible safety-related inputs. If you wish to control the safety function of this inverter via an input within the ET-200pro station, then you require an F-RSM module or F-switch.

Wiring examples are provided in the next section: Wiring examples according to SIL 2 and PL d (Page 61).

### Assignment of safety-related inputs

Table 4- 10 SINAMICS G120C

	Terminal strip	Digital input	Safety-related input
	16	DI 4	F-DI 0
	17	DI 5	

Table 4- 11 SINAMICS G120 with CU240E-2, CU240E-2 DP or CU240E-2 PN Control Unit

	Terminal strip on the Control Unit		
	Terminals	Digital input	Safety-related input
	16	DI 4	F-DI 0
	17	DI 5	

4.4 Control via safe inputs

Table 4- 12 SINAMICS G120 with Control Units  
CU240E-2 F, CU240E-2 DP-F or CU240E-2 PN-F,  
CU250S-2, CU250S-2 CAN, CU250S-2 DP or CU250S-2 PN


	Terminal strip on the Control Unit			
	Terminals	Digital input	Safety-related inputs	
			Basic functions	Extended functions
	5	DI 0	---	F-DI 0
	6	DI 1		F-DI 1
	7	DI 2		
	8	DI 3	F-DI 0	F-DI 2
	16	DI 4		
	17	DI 5		

Table 4- 13 SINAMICS G120 with PM240-2 Power Module


	Terminals of the safety-related input on the PM240-2 FSD and FSE Power Modules
	STO_A STO_B

Table 4- 14 SINAMICS G120D with Control Units CU240D-2 DP and CU240D-2 PN,  
SINAMICS G110M




	Connector.pin	Digital input	Safety-related input
	X09.4	DI 4	F-DI 0
	X09.2	DI 5	
	X08.4	DI 2	F-DI 0
	X08.2	DI 3	

Table 4- 15 SINAMICS G120D with Control Units  
 CU240D-2 DP-F, CU240D-2 PN-F, CU240D-2 PN-F PP and CU240D-2 PN-F FO,  
 CU250D-2 DP-F, CU250D-2 PN-F, CU250D-2 PN-F PP and CU250D-2 PN-F FO

	Connector.pin	Digital input	Safety-related inputs	
			Basic functions	Extended functions
	X07.4	DI 0	-	F-DI 0
	X07.2	DI 1		F-DI 1
	X08.4	DI 2		
	X08.2	DI 3		
	X09.4	DI 4	F-DI 0	F-DI 2
	X09.2	DI 5		

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

### Which devices are you allowed to connect?

The safety-related input is designed for the following devices:

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

### Signal states

The inverter expects signals with the same state at its safety-related input:

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

### Fault detection

The inverter evaluates deviations in the two signals of the safety-related 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

### **Bright and dark test**

The inverter filters signal changes using bright and dark tests at its safety-related inputs:

- SIL 2 / PL d: the safety-related inputs of the inverter have an adjustable software filter.
- SIL 3 / PL e: a fixed hardware filter suppresses signal changes  $\leq 4$  ms at the safety-related input of the PM240-2 (FSD, FSE) Power Module.

### **Special measures when establishing connections**

When routing cables over longer distances, e.g. between remote control cabinets, you have the following options to reduce the risk of damaged cables of your plant or machine:

- Use shielded cables with grounded shield.
- Lay signal cables in steel pipes.

## 4.4.2 Wiring examples according to SIL 2 and PL d

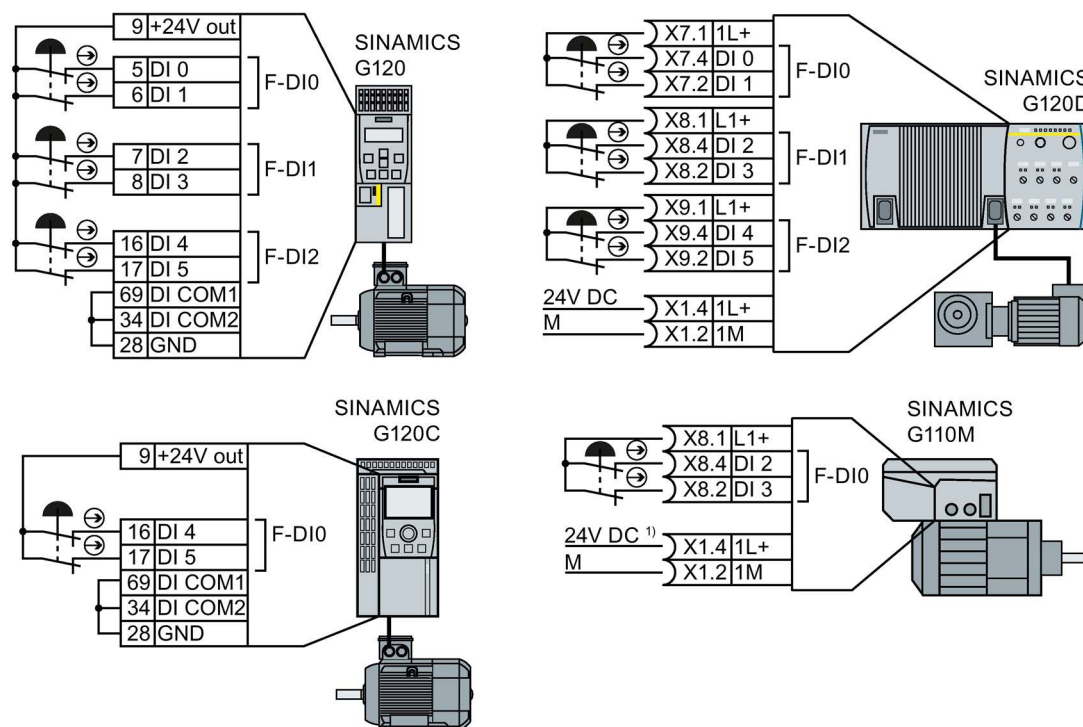
On the following pages you will find examples for wiring safety-related inputs corresponding to PL d according to EN 13849-1 and SIL 2 according to IEC 61508.

In order to reduce the scope of the examples, not all of the SINAMICS inverters are listed in each wiring example.

### 4.4.2.1 Electromechanical sensor

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

#### The inverter provides the supply voltage



<sup>1)</sup> The 24 V supply is not required when using the G110M "24 V Power Module" option

Figure 4-7 Connecting an electromechanical sensor to the inverter power supply

External power supply

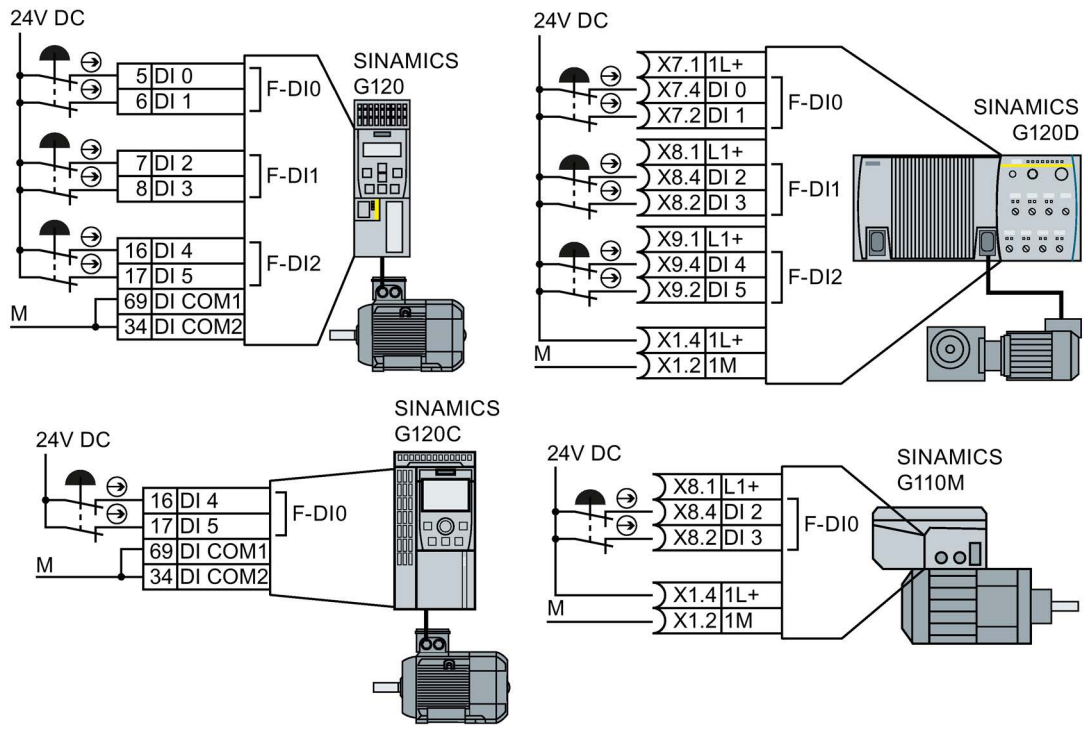


Figure 4-8 Connecting an electromechanical sensor to an external power supply

## SIMATIC ET 200pro

The SIMATIC ET 200pro FC-2 converter does not have its own inputs. You require the F-RSM module if you wish to control the ET 200pro FC-2 safety functions directly via a sensor.

The F-RSM module evaluates the sensor, and switches the "F0 rail" in the backplane bus of the ET-200pro system. Via an internal safety-related input, the F0-rail selects a safety function in the inverter.

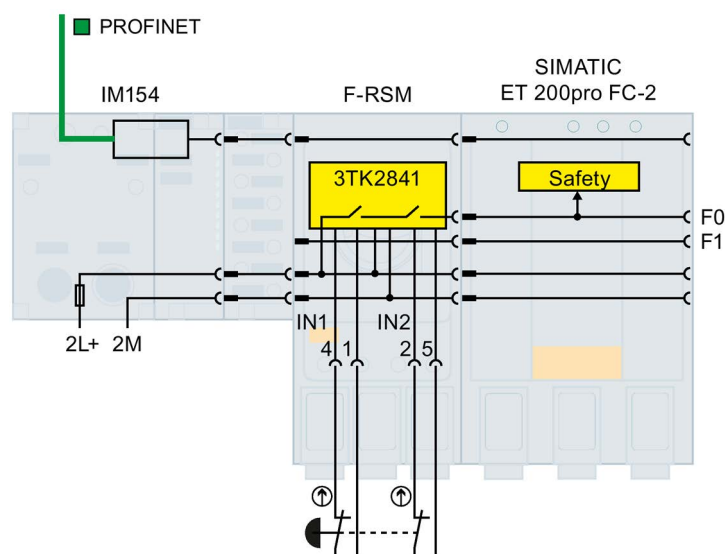


Figure 4-9 Directly controlling the safety functions in the ET 200pro FC-2 converter via the F-RSM module

Additional ways of using the F-RSM module are provided in the Internet: FAQ (<http://support.automation.siemens.com/WW/view/en/26694409>).

### 4.4.2.2 Series-connected electromechanical sensors

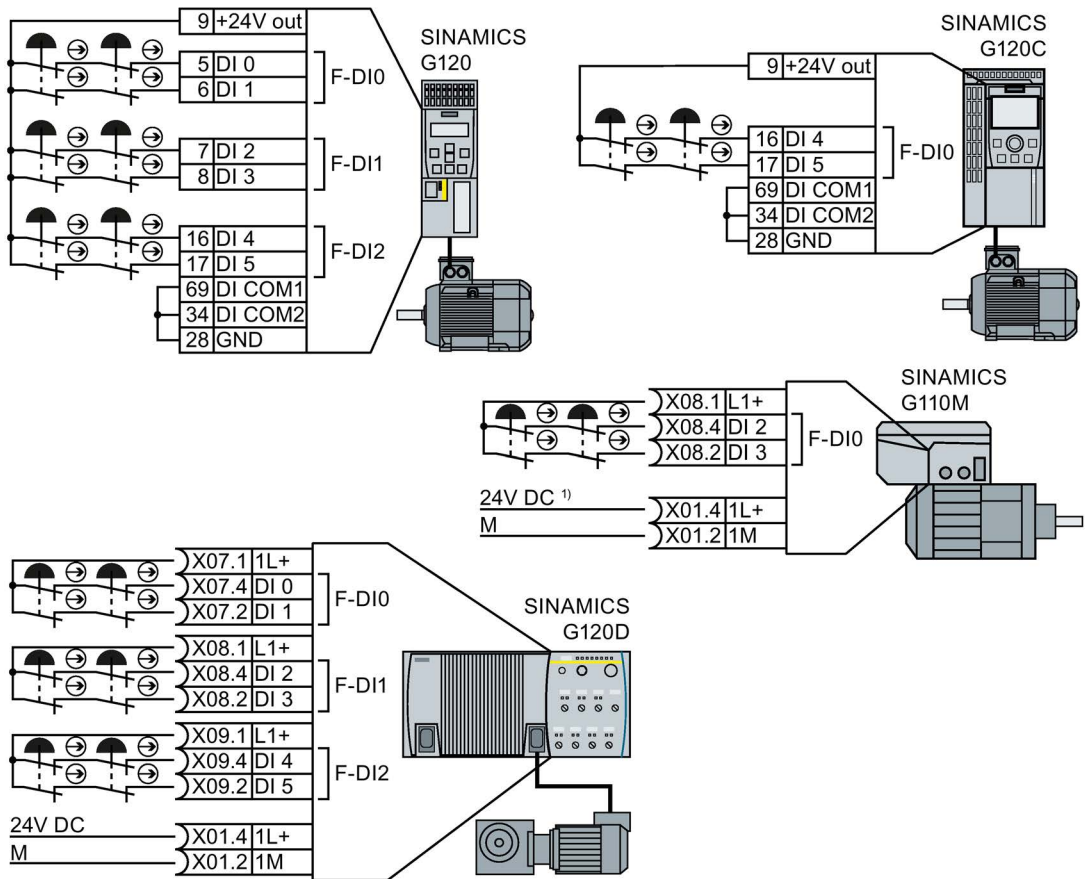
You can connect electromechanical sensors, for example, Emergency Stop command devices, position switches in series.

If the sensors are simultaneously opened, then sensor faults can only be identified with some restrictions. In this case, you must individually test the function of each sensor at regular intervals, but at least once a year.

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

#### The inverter provides the supply voltage

Connect the 24 V supply of the inverter to the sensors and connect the reference potentials of the inputs used to GND.



1) The 24 V supply is not required when using the G110M "24 V Power Module" option

Figure 4-10 Connecting electromechanical sensors to the inverter 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.

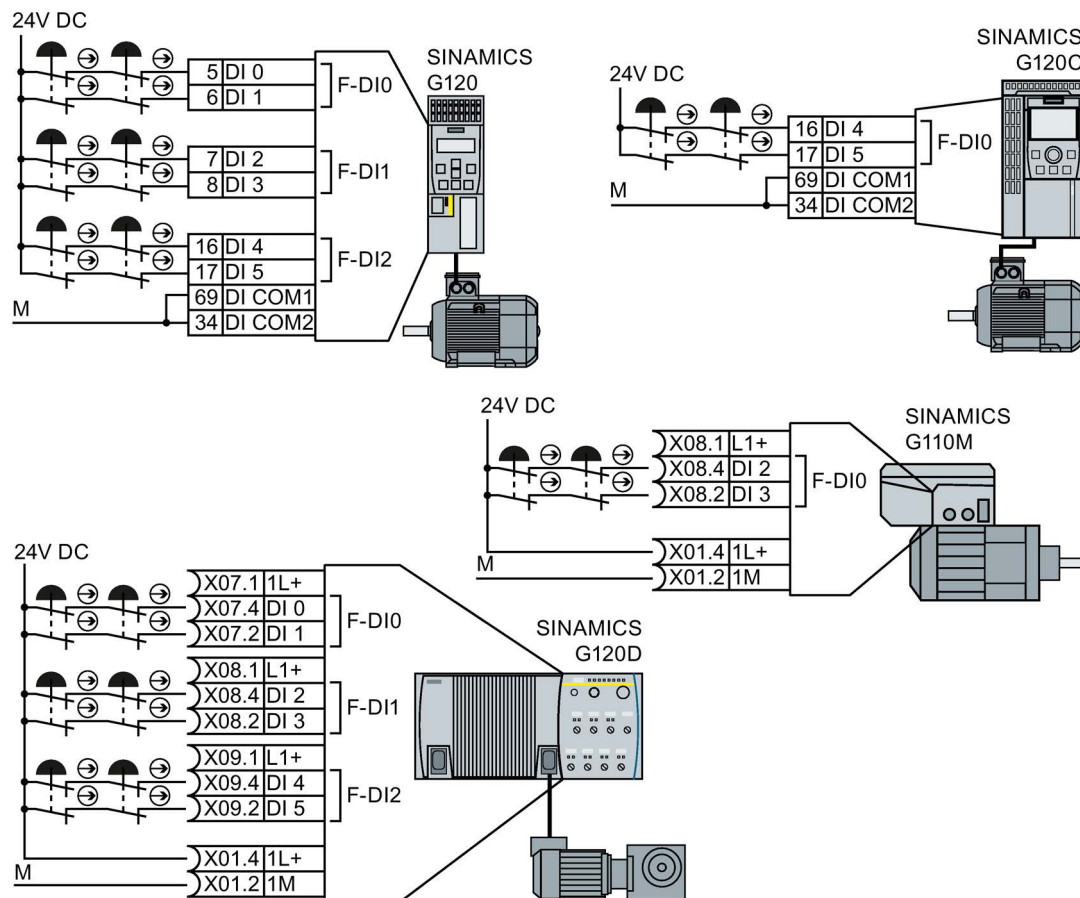


Figure 4-11 Connecting electromechanical sensors to an external power supply in series

### 4.4.2.3 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.

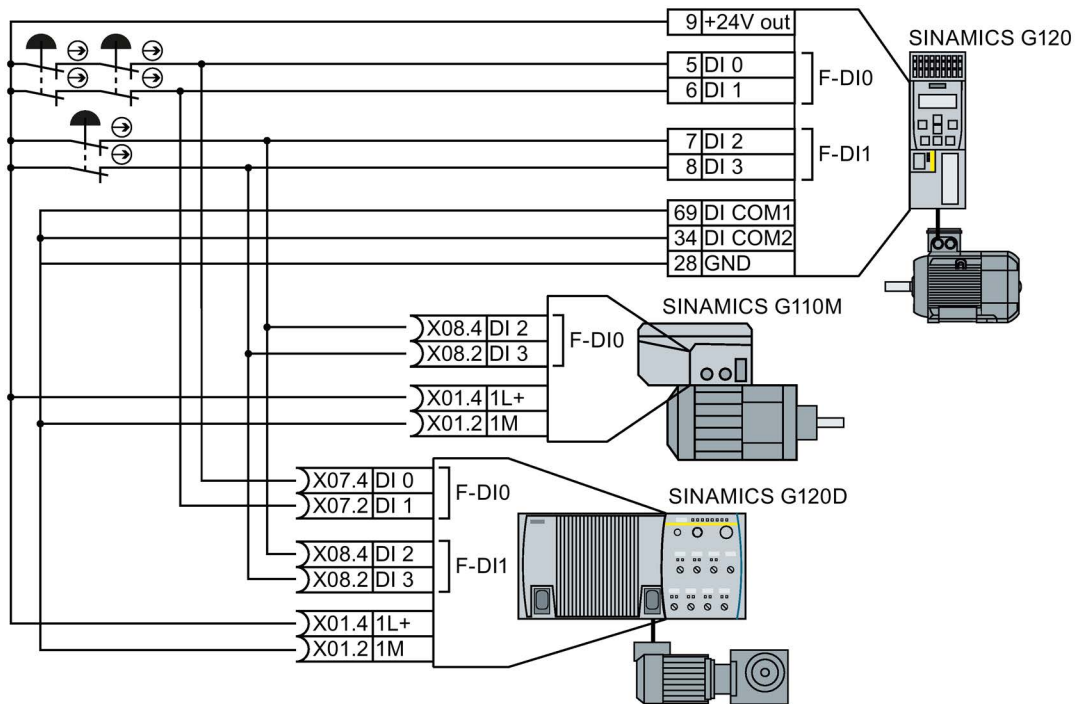


Figure 4-12 Simultaneous activation of several converters with converter power supply

## 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.

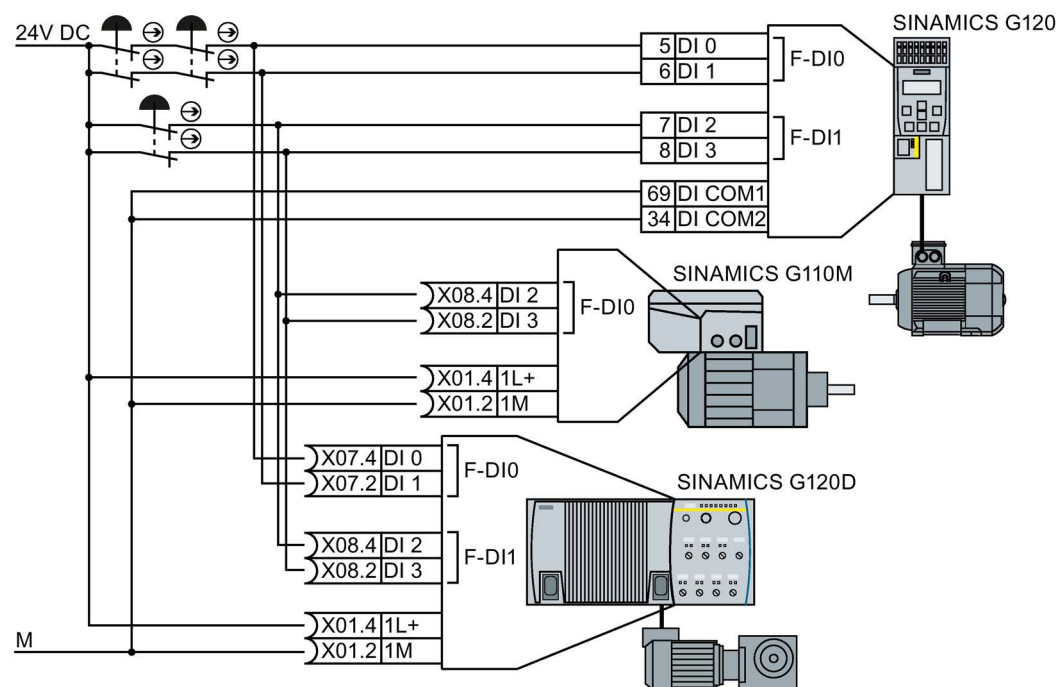


Figure 4-13 Simultaneous activation of several converters with external power supply

### 4.4.2.4 SIRIUS 3SK1 safety relay

The wiring examples listed below are implemented using safety relays with relay enable circuits. Safety relays with semiconductor enabling circuits can also be used.

The diagrams only show the interconnection between the safety relay and a SINAMICS G120 inverter as example. Information on completely wiring up the safety relay is provided in the appropriate product documentation: SIRIUS 3SK1 safety relays (<https://support.industry.siemens.com/cs/ww/en/ps/16381/man>).

### Components in the same control cabinet

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

Assuming that the upstream, preprocessing device switches the output being used twice, in a control cabinet you can wire the safety relay and the inverter through a single-channel cable connection. The two terminals of the safety-related input must be connected to each other at the inverter.

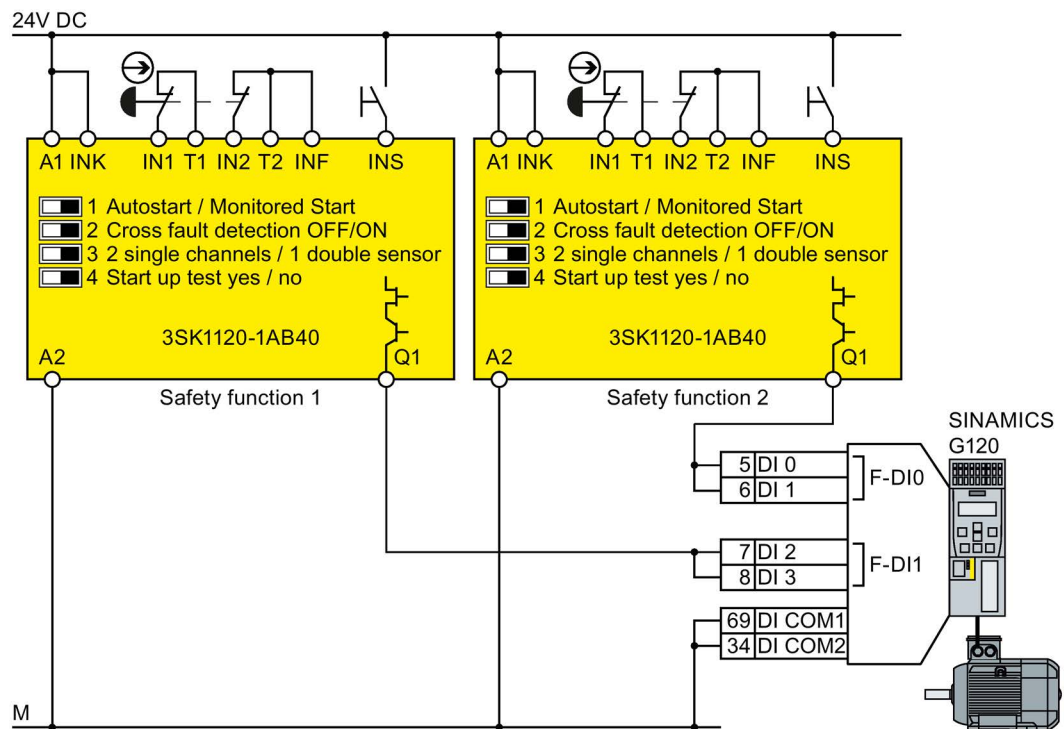


Figure 4-14 Wiring an inverter and safety relay in a control cabinet

## Components in separate control cabinets

If the components are located in separate control cabinets, the wiring between the safety relay and safety-related inputs in the inverter 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.

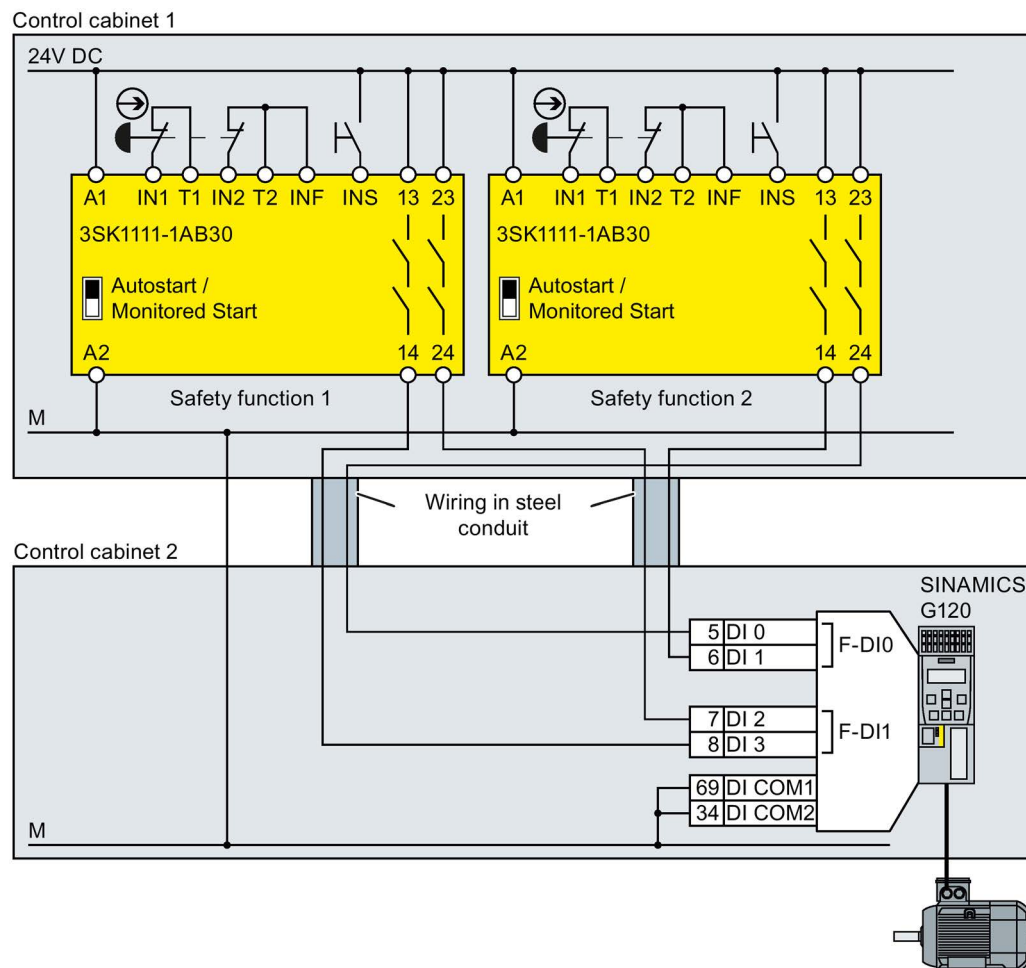


Figure 4-15 Wiring an inverter and safety relay in separate control cabinets

### 4.4.2.5 3RK3 Modular Safety System

It is permissible to use the following outputs to control safety-related inputs in the inverter:

- The safety-related outputs in the MSS Basic central module of the modular 3RK3 safety system
- The safety-related outputs in the EM 2/4F-DI 2F-DO expansion module.

It is not permissible that you use the safety-related relay outputs of the EM 2/4F-DI 1/2F-RO expansion module, as internally these only have a single-channel configuration.

The diagrams only show the wiring between the modular 3RK3 safety system and as example, a SINAMICS G120 inverter. Information on completely wiring the modular 3RK3 safety system is provided 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 designed and wired correctly does not contain any damaged wiring or cross circuits.

In the upstream, preprocessing device, if you only use outputs with two switches in series, then it is permissible that you wire the safety relay to the inverter via a single-channel cable connection. The two terminals of the safety-related input must be connected to each other at the inverter.

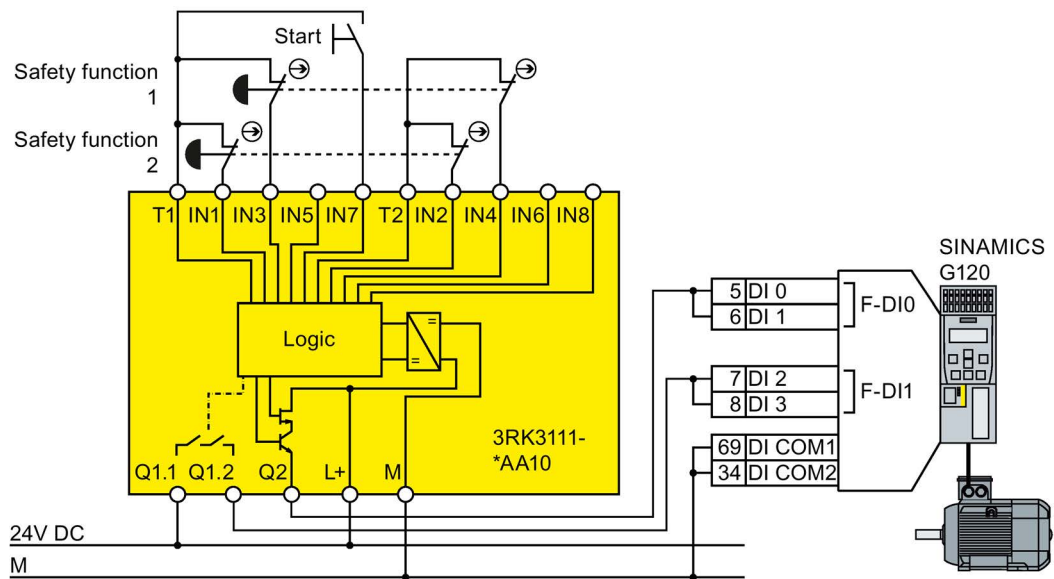


Figure 4-16 Wiring an inverter and modular safety system within a control cabinet

## Components in separate control cabinets

For configurations and designs in separate control cabinets, route cables between the modular safety system and the inverter so that they are protected against cross circuits and short circuits.

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

If you want to use the safety-related outputs of the 3RK3 central unit for transferring signals via two channels, inverter discrepancy monitoring must be adapted to the different switching times of the electronic output and relay contact.

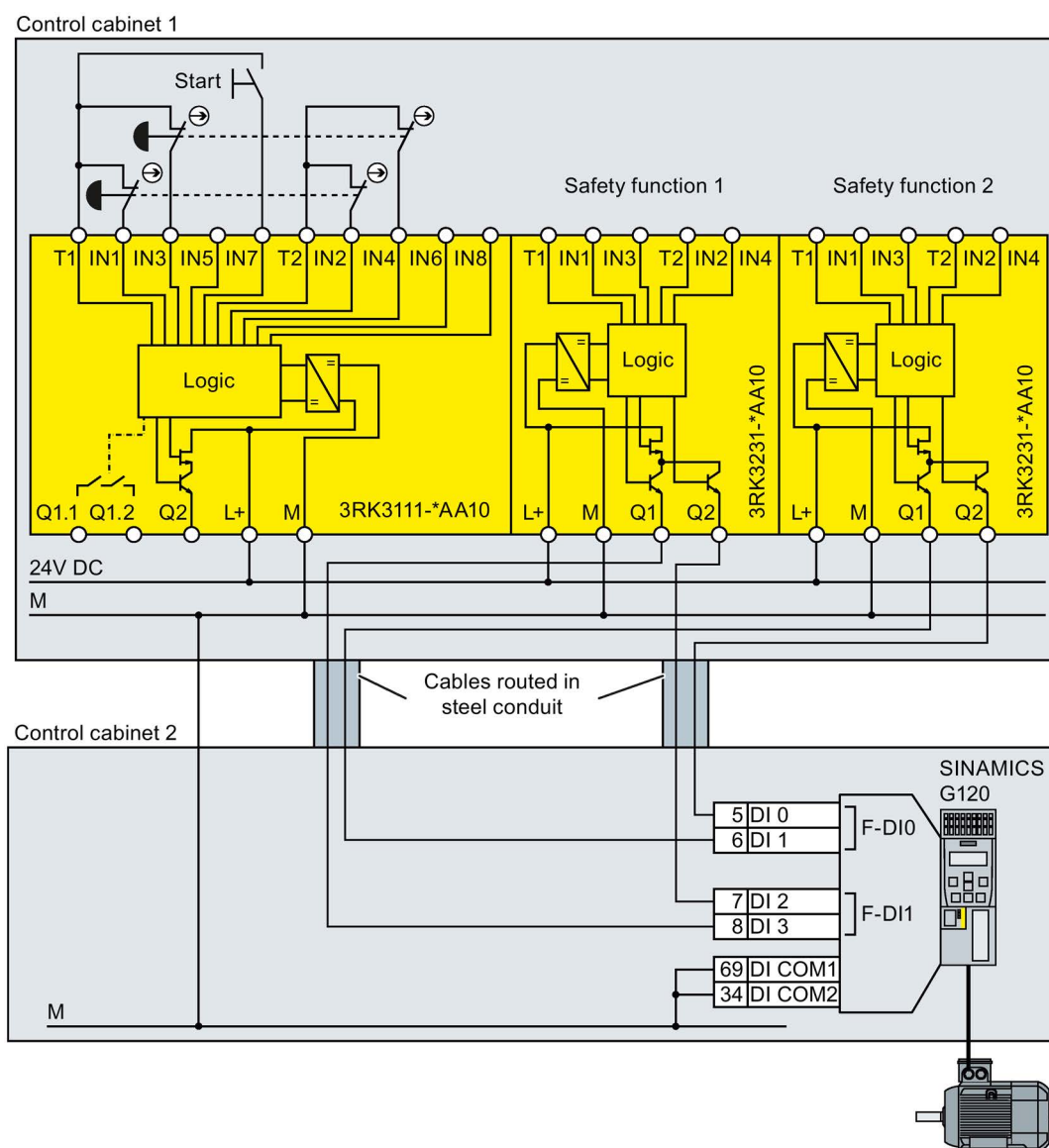


Figure 4-17 Wiring inverter and modular safety system in separate control cabinets

### 4.4.2.6 S7-300 I/O modules

Safety outputs that switch to P potential are required for activating the safety 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 the interconnection between I/O module and a SINAMICS G120 inverter as example. Information on completely wiring I/O modules is provided 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 designed and wired correctly does not contain any damaged wiring or cross circuits.

Under the assumption that the preprocessing devices switch the output used twice (involves two contacts in series), within a control cabinet you can interconnect the I/O module SM326 and inverter through a single channel cable connection. The two terminals of the safety-related input must be connected to each other at the inverter.

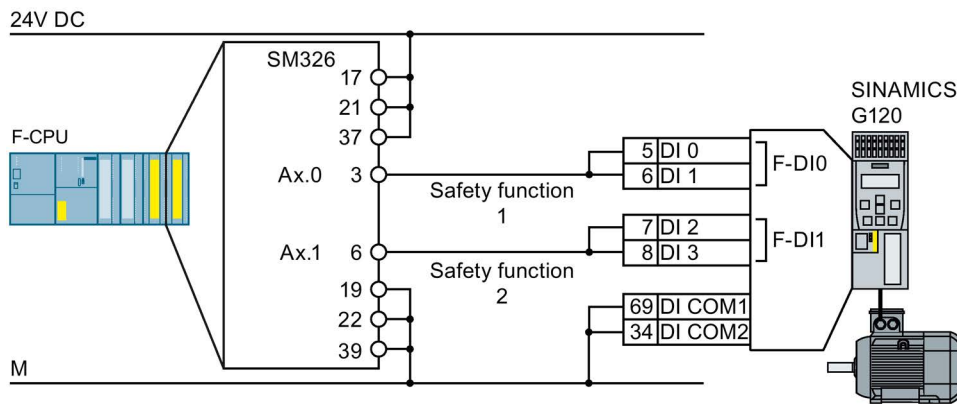


Figure 4-18 Interconnecting the inverter and SM326 I/O module within the same control cabinet



## 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 inverter 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.

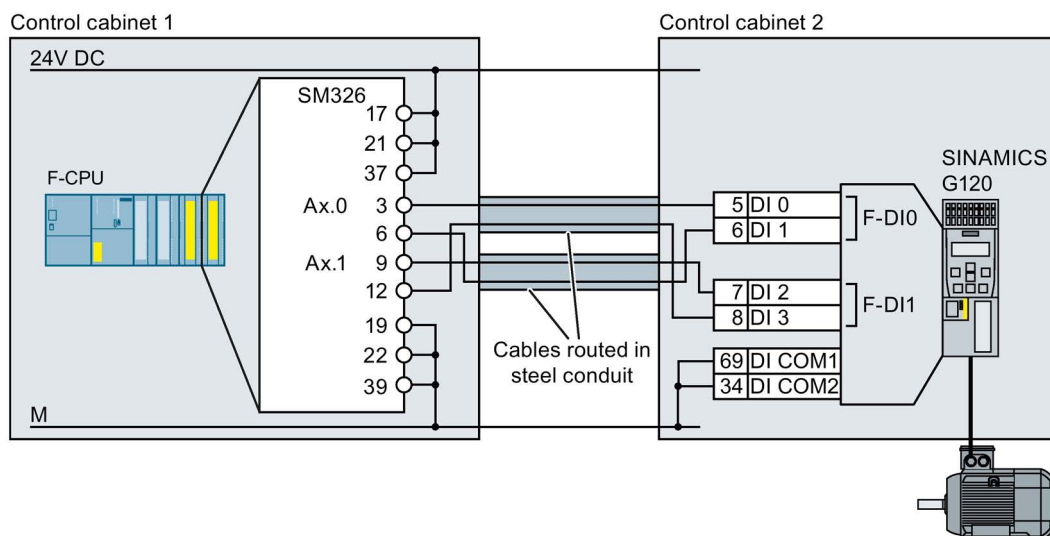


Figure 4-19 Interconnecting the inverter and SM326 I/O module in separate control cabinets

### 4.4.2.7 ET 200 I/O modules

Safety outputs that switch to P potential are required for activating the safety 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 relay module is controlled via a fail-safe ET 200S output module.

The diagrams only show the interconnection between I/O modules and a SINAMICS G120 inverter as example. Information on completely wiring I/O modules is provided 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 designed and wired correctly does not contain any damaged wiring or cross circuits.

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

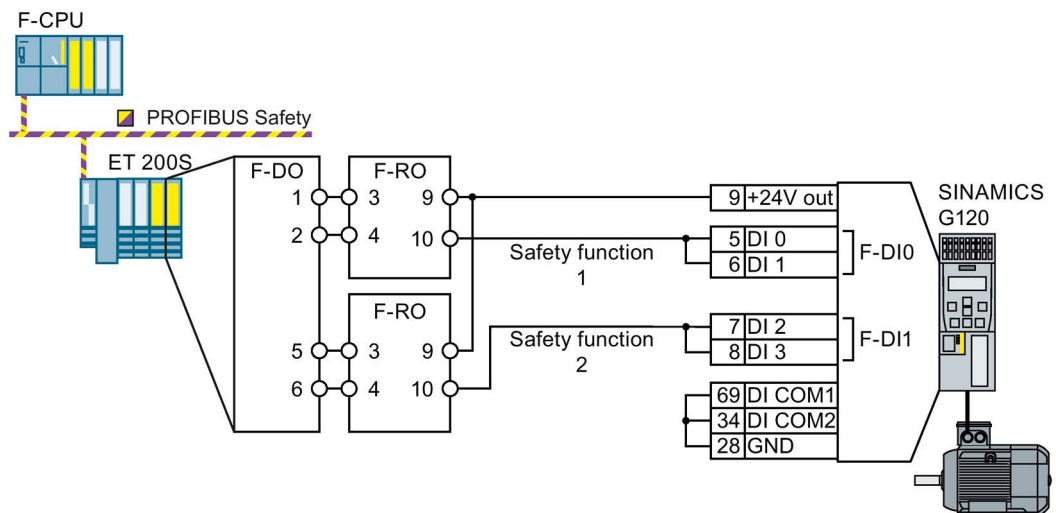


Figure 4-20 Interconnecting the inverter and I/O modules within the same control cabinet

## 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 inverter 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.

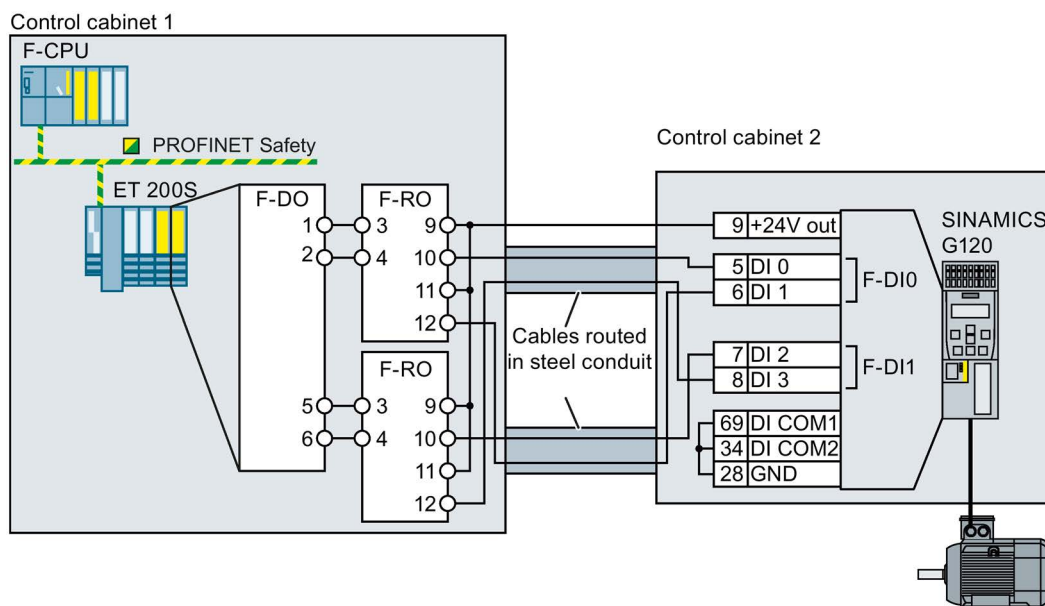
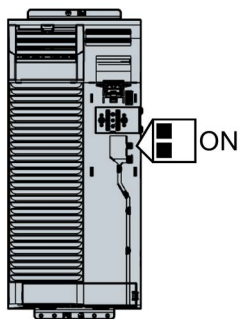


Figure 4-21 Interconnecting the inverter and I/O modules in separate control cabinets

### 4.4.3 Wiring examples according to SIL 3 and PL e

Wiring examples for the STO function corresponding to PL e according to EN 13849-1 and SIL 3 according to IEC 61508 are provided on the following pages.



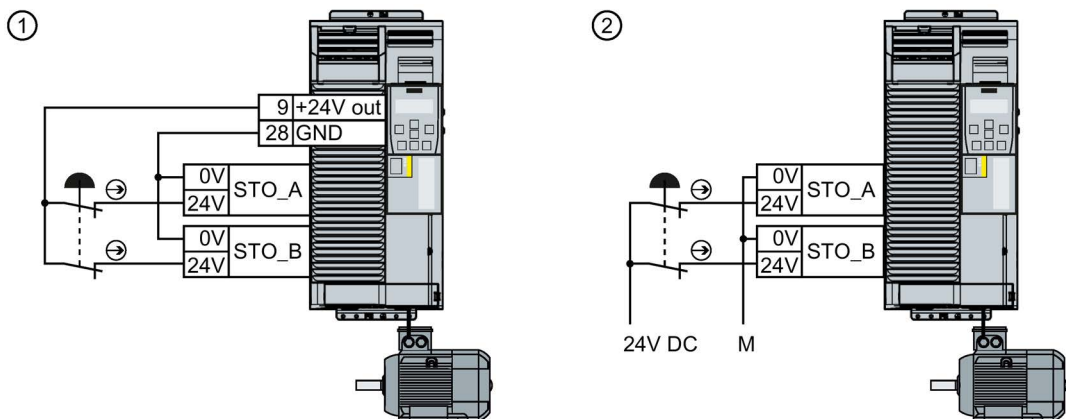
The following preconditions apply when using the STO safety function according to SIL 3:

- You are using a PM240-2 Power Module (FSD and FSE)
- You control the STO safety function using the terminals of the PM240-2 Power Module.
- Both switches on the Power Module are in the “ON” position.

#### 4.4.3.1 Electromechanical sensor

##### Connecting an electromechanical sensor

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



- ① Power supply voltage from terminal 9 of the Control Unit
- ② External power supply

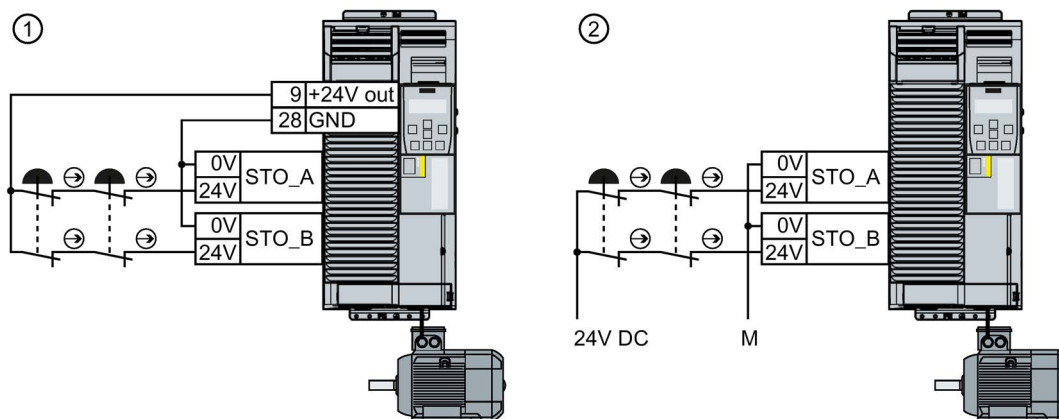
Figure 4-22 Connecting an electromechanical sensor

### Connecting several electromechanical sensors in series

You can connect electromechanical sensors in series, e.g. Emergency Stop command devices and position switches.

If the sensors are simultaneously opened, then sensor faults can only be identified with some restrictions. In this case, you must individually test the function of each sensor at regular intervals and at least once every three months.

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



① The inverter provides the supply voltage

② External power supply

Figure 4-23 Connecting several electromechanical sensors in series

### Controlling several inverters simultaneously

You may control the safety functions of several inverters simultaneously with one or several safety sensors connected in series.

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

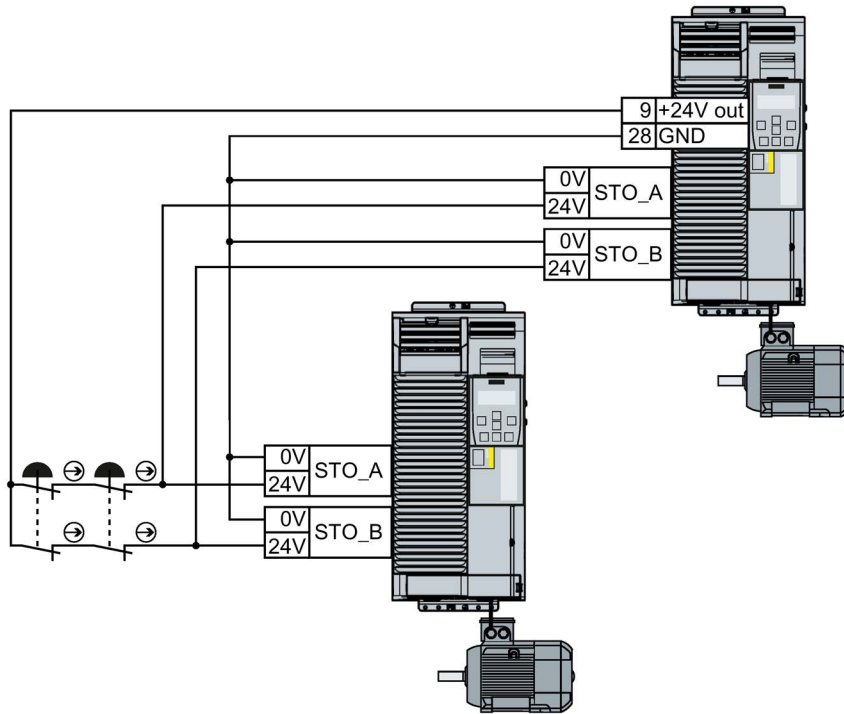


Figure 4-24 Controlling several inverters in parallel with the power supply from the inverter

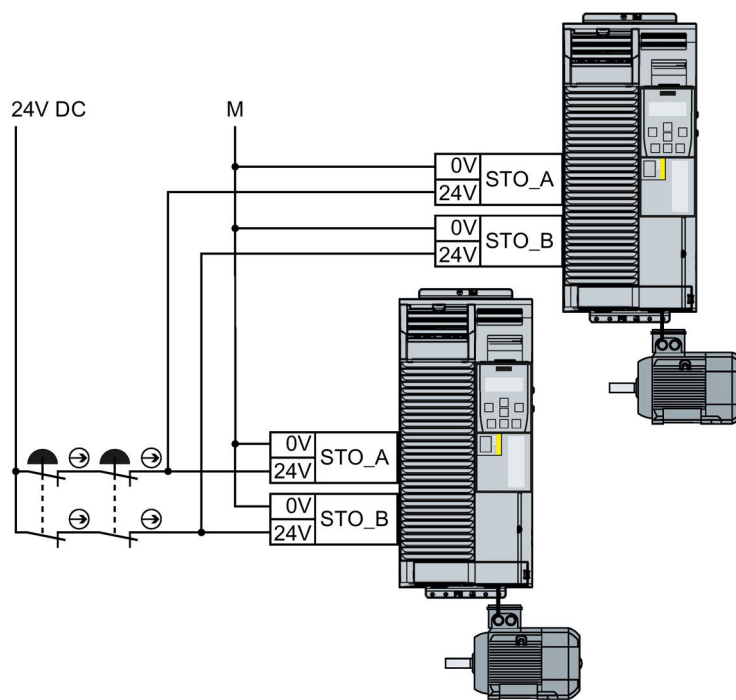


Figure 4-25 Controlling several inverters in parallel with an external power supply

### 4.4.3.2 SIRIUS 3SK1 safety relay

The typical wiring examples subsequently described are based on safety relays with relay enable circuits. Safety relays with semiconductor enable circuits can also be used.

The diagrams only show how the safety relay and inverter are interconnected. Information on completely wiring the safety relay is provided in the product 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 designed and wired correctly does not contain any damaged wiring or cross circuits.

Under the assumption that the upstream, preprocessing device switches the output being used twice, within a control cabinet, you can wire up the safety relay and the inverter through a single-channel cable connection. The two terminals of the safety-related input must be connected to each other at the inverter.

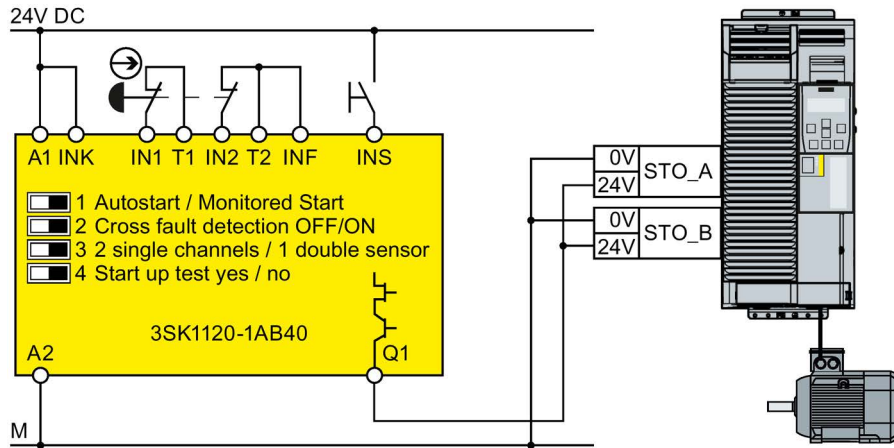


Figure 4-26 Wiring the inverter and safety relay within a control cabinet



## Components in separate control cabinets

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

Transfer the two signals for controlling a safety function via conductors in separate cables.

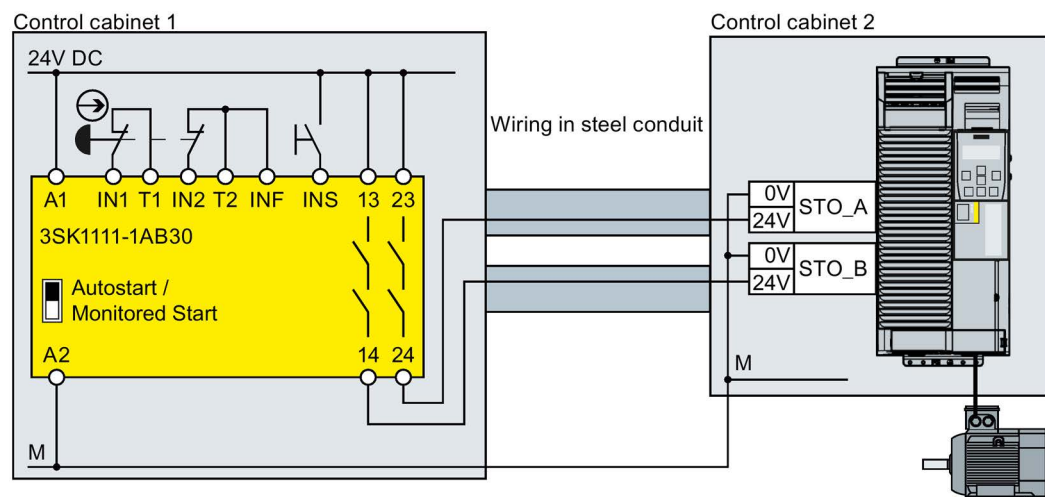


Figure 4-27 Wiring inverters and safety relays in separate control cabinets

### 4.4.3.3 3RK3 Modular Safety System

You may use the following outputs to control the safety-related inputs in the inverter:

- The safety-related outputs in the MSS Basic central module of the 3RK3 modular safety system
- The safety-related outputs in the EM 2/4F-DI 2F-DO expansion module.

It is not permissible to use the safety-related relay outputs of the EM 2/4F-DI 1/2F-RO expansion module as these only have an internal single-channel structure.

The diagrams only show the wiring between the modular 3RK3 safety system and the inverter. Information on completely wiring the modular 3RK3 safety system is provided 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 designed and wired correctly does not contain any damaged wiring or cross circuits.

In the upstream, preprocessing device, if you only use outputs with two switches in series, then you may wire the safety relay to the inverter via a single-channel cable connection. The two terminals of the safety-related input must be connected to each other at the inverter.

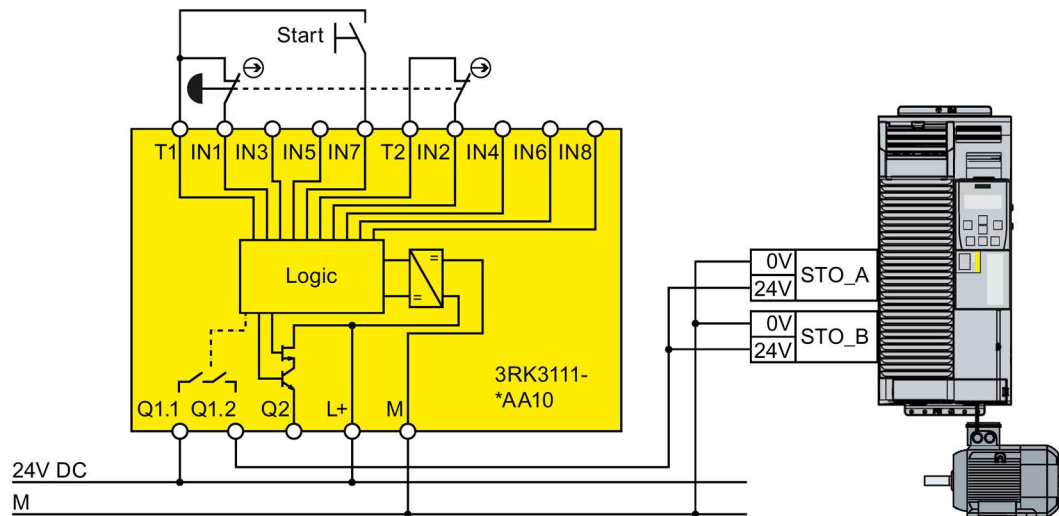


Figure 4-28 Wiring inverters and modular safety system within one control cabinet

## Components in separate control cabinets

When installed in separate control cabinets, route the cables between the modular safety system and the inverter, protected against cross and short-circuits.

Transfer the two signals for activating a safety function via wires in separate lines. In the example, the first conductor transfers the signals for terminal STO\_B. The second conductor transfers the signals for terminal STO\_A.

If you want to use the safety-related outputs of the 3RK3 central unit for transferring signals via two channels, inverter discrepancy monitoring must be adapted to the different switching times of the electronic output and relay contact.

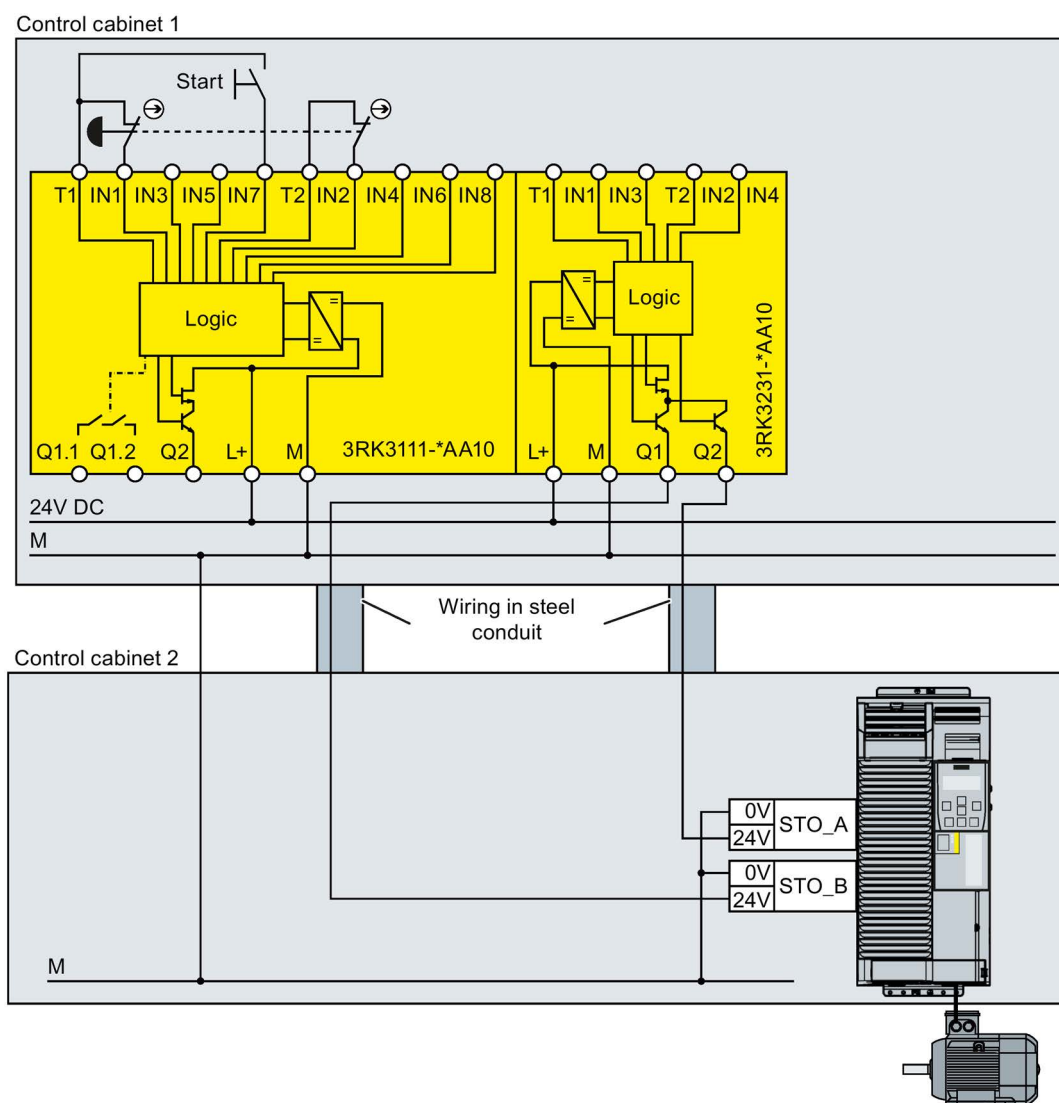


Figure 4-29 Wiring inverters and modular safety systems in separate control cabinets

## 4.5 Evaluation using safety-related outputs

### 4.5.1 Overview

In the factory setting of the inverter, the safety 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 safety output.

Table 4- 16 inverters for cabinet-free installation (IP65)



SINAMICS G120D with Control Unit		Connector. Pin	Digital output	Safety output	Read back input	
	CU240D-2 DP-F	X5.4	DO 0	F-DO 0	X9.2	DI 5
	CU240D-2 PN-F	X5.2	DO 1			
	CU240D-2 PN-F PP	X5.3	2M			
	CU250D-2 DP-F					
CU250D-2 PN-F						
CU250D-2 PN-F PP						

Table 4- 17 Inverter for installation in a control cabinet (IP20)

SINAMICS G120 with Control Unit		Terminal strip	Digital output	Safety output	Read back input	
	CU250S-2	18: NC	DO 0	F-DO 0	67	DI 6
	CU250S-2 DP	19: NO				
	CU250S-2 PN	20: COM	DO 2			
	CU250S-2 CAN	23: NC				
	24: NO					
		25: COM				

Most applications require NO contacts for a safety output.  
 If your application requires it, instead of NO contacts, you can also use the two NC contacts of the inverter. The safe state of the output is always the quiescent state of the two relays.

### What devices can be connected?

The safety output is designed for the following devices:

- Direct connection of a safety input.
- Connection of two relays.

The two signals of the safety output each have the same state:

- High signal or NO contact closed: Safety output is active.
- Low signal or NO contact open: Safety output is not active.

## 4.5.2 Connecting the safety output for SINAMICS G120D

### Connecting a relay

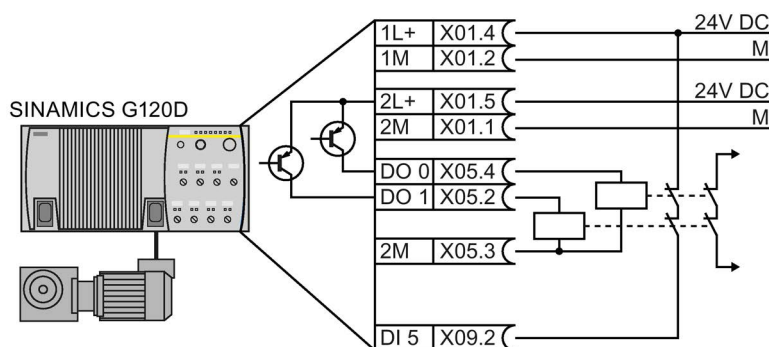


Figure 4-30 Connecting a relay at the F-DO

### Connecting an actuator with feedback signal

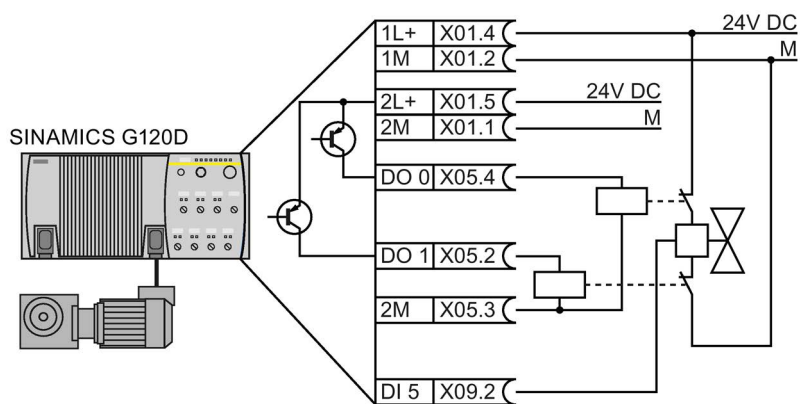


Figure 4-31 Connecting an F-DO to an actuator

### Connecting with a safety-related input

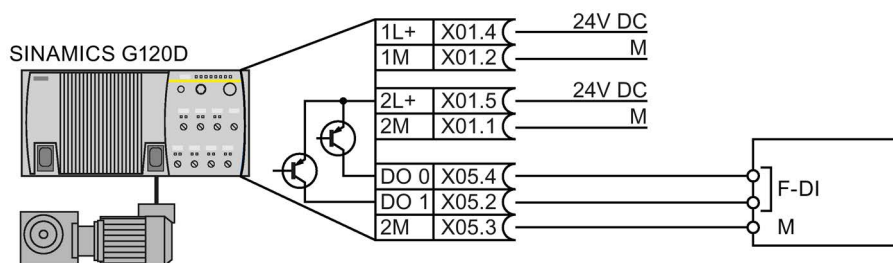


Figure 4-32 Connecting an F-DO with an F-DI

### 4.5.3 Connecting the safety output for SINAMICS G120

#### Connecting a relay

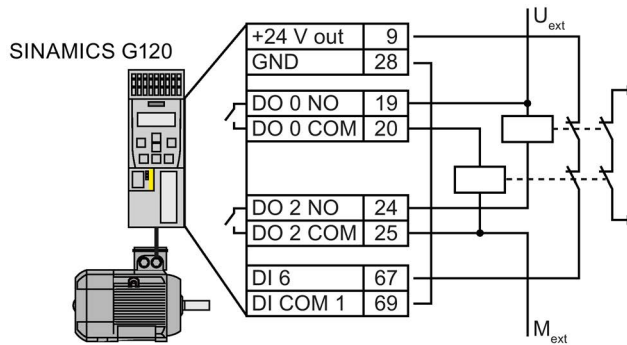


Figure 4-33 Connecting a relay at the F-DO

#### Connecting an actuator with feedback signal

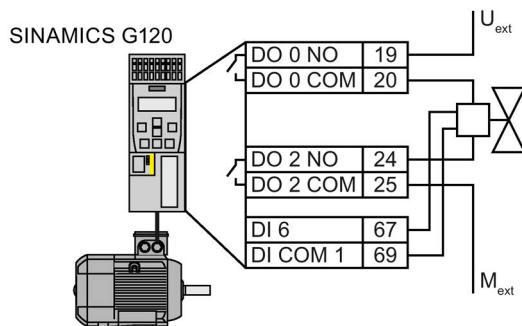


Figure 4-34 Connecting an F-DO to an actuator

#### Connecting with a safety-related input

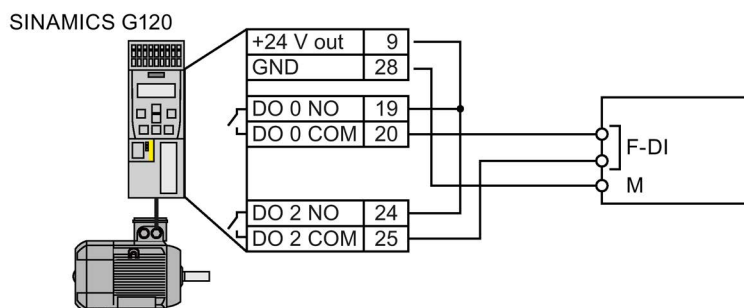


Figure 4-35 Connecting an F-DO with an F-DI

The connected safety-related input F-DI must monitor its input signals for discrepancy.

## 4.6 Connecting a motor holding brake to a Safe Brake Relay

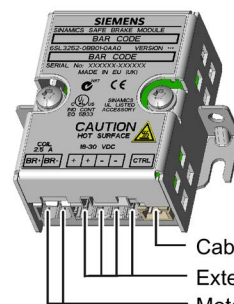
The Safe Brake Relay serves as an interface between the Power Module and the motor's brake coil.

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

- On a mounting plate
- On the control cabinet wall
- At the shield connection kit of the inverter

Additional information is provided in 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

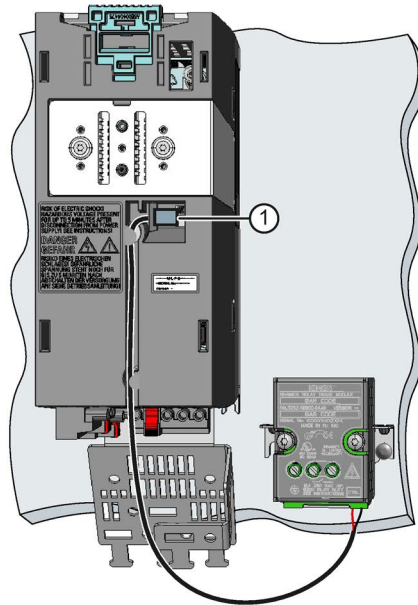
Connecting the Safe Brake Relay with the inverter and motor holding brake

Procedure

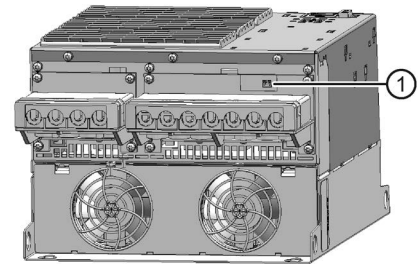


To connect a motor holding brake via the Safe Brake Relay proceed as follows:

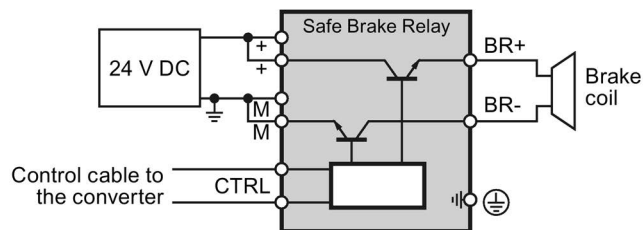
Power Modules FSA ... FSC:



Power Modules FSD ... FSF



1. Connect the prefabricated cable of the Safe Brake Relay that is provided to the front 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

## 5.1 About this chapter

### What can you find in this Chapter?

In this chapter, you will find answers to the following questions:

- Which sequence is recommended when commissioning the inverter?
- What tool do I need for commissioning?
- How do I restore the factory settings of the safety functions?
- In SINAMICS G120, is it permissible to jointly use the safety functions according to SIL 2 and SIL 3?
- How do I commission the safety functions?
- How do I configure communication via PROFIsafe in the inverter?
- How do I transfer the parameters of the safety functions to other inverters?
- Why is it necessary to "Accept safety functions"?
- What does accepting the safety functions involve?

## 5.2 Commissioning guidelines

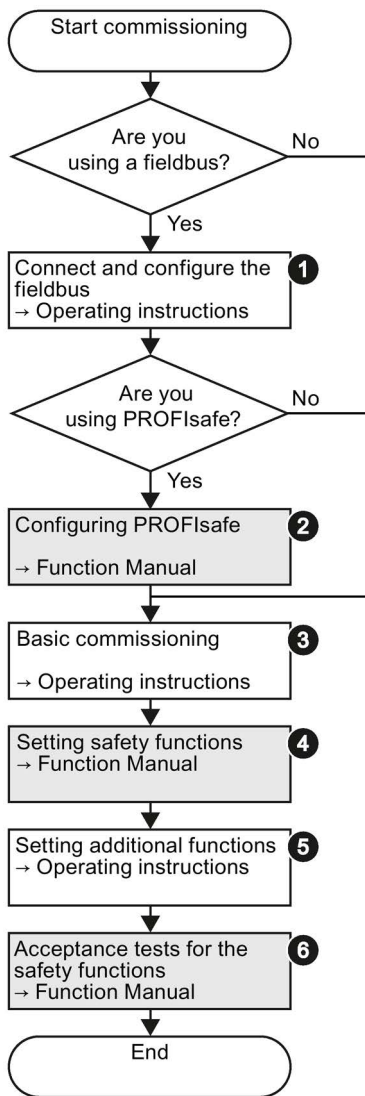
The following overview shows the procedure when commissioning an inverter with integrated safety functions.

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

### 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 PROFI-safe communication in the higher-level control system.
  - in this manual: Configure PROFI-safe in the higher-level control system (Page 91).
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 195)



You have commissioned the inverter with integrated safety functions.

## 5.3 Configure PROFI-safe in the higher-level control system

Information on how to configure PROFI-safe communication between a higher-level control system and inverter is provided in the Internet:

- Configuring a PROFI-safe telegram with Drive ES Basic  
(<http://support.automation.siemens.com/WW/view/en/64326460>)
- Controlling SINAMICS G120 via PROFI-safe, displaying inverter messages on an HMI  
(<http://support.automation.siemens.com/WW/view/en/61450312>)
- Configuring communication via Shared Device  
(<http://support.automation.siemens.com/WW/view/de/50207311>)

## 5.4 Commissioning tools

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

Table 5- 1 PC-based commissioning tools

Download	Article number	More information
STARTER ( <a href="http://support.automation.siemens.com/WW/view/en/26233208">http://support.automation.siemens.com/WW/view/en/26233208</a> )	6SL3072-0AA00-0AG0	Guided tour ( <a href="http://support.automation.siemens.com/WW/view/en/21110668">http://support.automation.siemens.com/WW/view/en/21110668</a> )
Startdrive ( <a href="http://support.automation.siemens.com/WW/view/en/68034568">http://support.automation.siemens.com/WW/view/en/68034568</a> )	6SL3072-4CA02-1XG0	Tutorial ( <a href="http://support.automation.siemens.com/WW/view/en/73598459">http://support.automation.siemens.com/WW/view/en/73598459</a> )

### Commissioning: Online or offline

With STARTER and Startdrive, you can work offline (without connection to the inverter) as well as also online. We recommend the following procedure:

- STARTER: Commission the safety functions online:

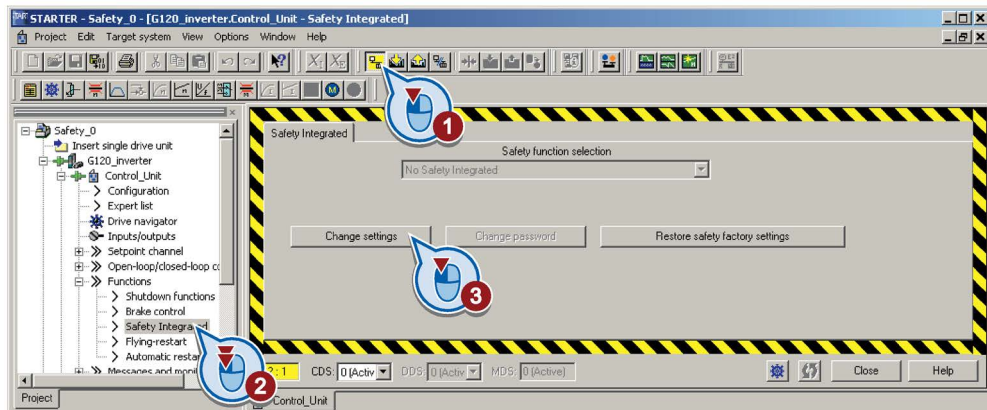


Figure 5-1 In STARTER, go online and change the safety function settings

This manual provides a detailed description of the online commissioning procedure. Information on what you must take into account when commissioning offline is provided in Section: Offline commissioning using STARTER (Page 192).

- Startdrive: Commission the safety functions online.

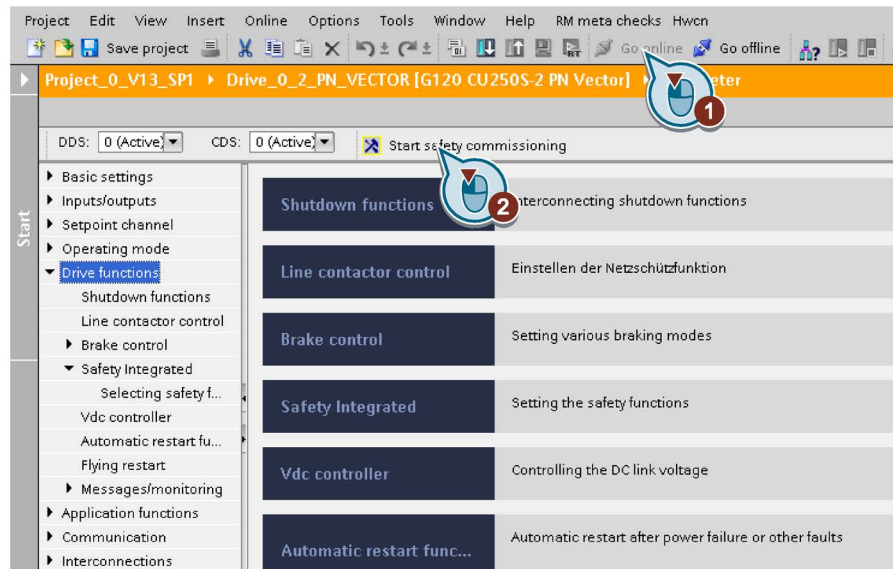


Figure 5-2 In Startdrive go online, and change the settings of the safety functions

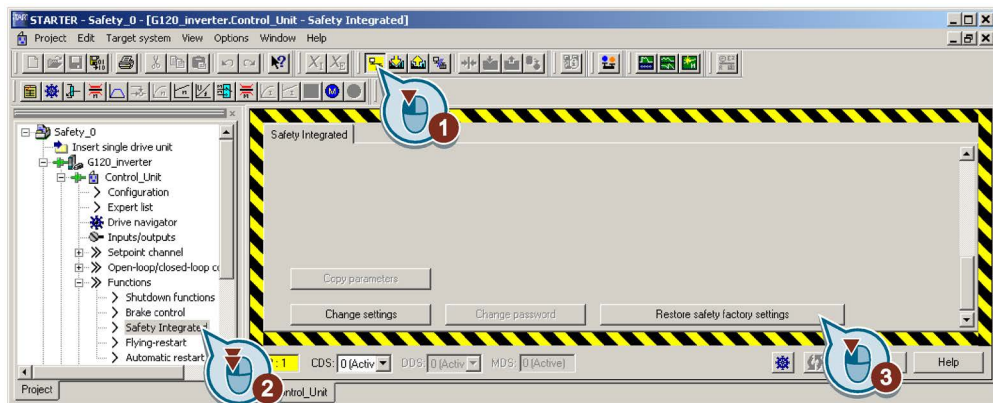
Exception: The PROFIsafe interface can only be configured offline.

## 5.5 Resetting the safety functions to the factory setting

### Procedure with STARTER

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

- 2
1. Go online.
2. Open the screen form of the safety functions.
3. Select the button to restore the factory settings.

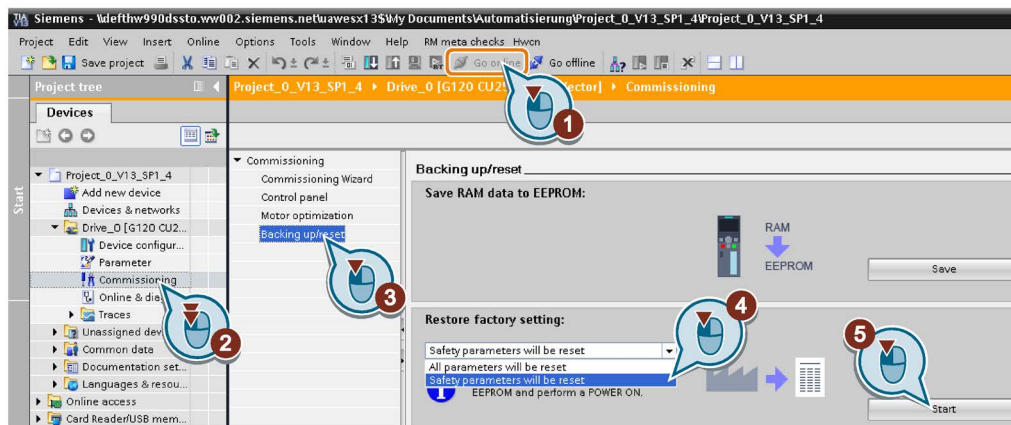


4. Enter the password, for the safety functions.
  5. Confirm that the parameters have been saved (RAM to ROM).
  6. Go offline.
  7. Switch off the inverter supply voltage.
  8. Wait until all LEDs on the inverter go dark.
  9. Switch on the inverter supply voltage again.
- You have restored the safety functions in the inverter to the factory settings.

### Procedure with Startdrive

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

1. Go online.



2. Select "Commissioning".
3. Select "Backing up/reset".
4. Select "Safety parameters are reset".
5. Click the "Start" button.
6. Enter the password,for the safety functions.
7. Confirm that the parameters have been saved (RAM to ROM).
8. Go offline.
9. Switch off the inverter supply voltage.
- 10.Wait until all LEDs on the inverter go dark.
- 11.Switch on the inverter supply voltage again.

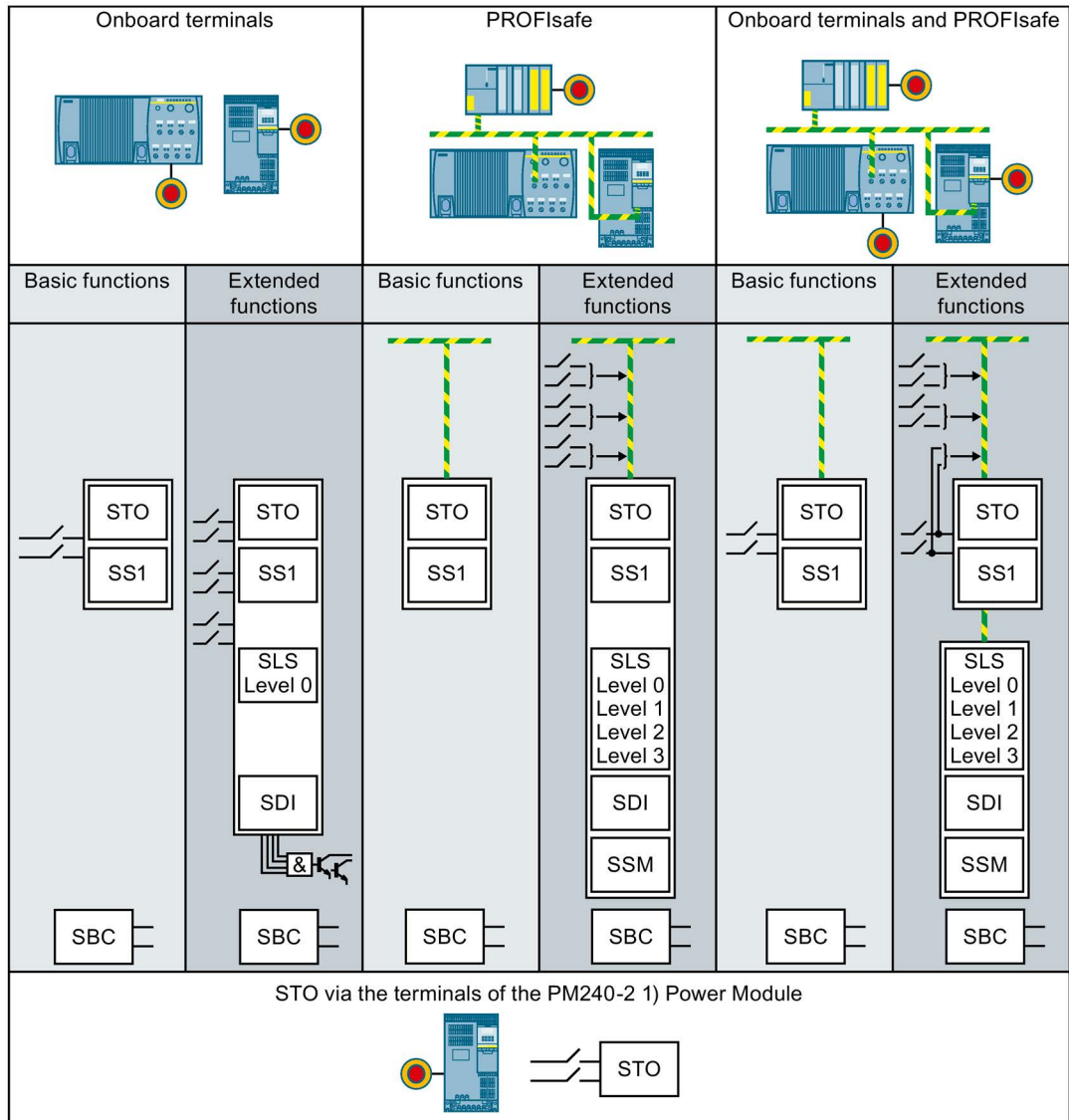
■ You have restored the safety functions in the inverter to the factory settings.

Parameter	Description	
p0010	<b>Drive commissioning parameter filter</b>	
	0	Ready
	30	Parameter reset
p9761	<b>SI password entry</b> (factory setting: 0000 hex) Permissible passwords lie in the range 1 ... FFFF FFFF.	
p9762	<b>New SI password</b>	
p9763	<b>Confirm SI password</b> Confirm the new Safety Integrated password.	
p0970	<b>Reset drive parameters</b>	
	5	Starts a safety parameter reset. After the reset, the inverter sets p0970 = 0.

## 5.6 Configuring safety functions

You define the following when configuring the safety functions:

- Which safety functions are available?
- Which interfaces are available for the safety functions?



- 1) There are three options for the "STO via Power Module terminals" function:
- You use the "STO via terminals of the Power Module" function together with the basic functions.
  - You use the "STO via terminals of the Power Module" function together with the extended functions.
  - You use the "STO via terminals of the Power Module" function as single safety function.

Figure 5-3 Overview of the possible configurations



Selected configuration		Functional scope of the configuration
Onboard terminals	Basic functions	<ul style="list-style-type: none"> <li>Select STO via F-DI.</li> </ul> Additionally, with CU250S-2: <ul style="list-style-type: none"> <li>Select SS1 via F-DI.</li> <li>Control the motor holding brake via SBC.</li> </ul>
	Extended functions	<ul style="list-style-type: none"> <li>Select safety functions via F-DI.</li> <li>Only one monitoring limit of SLS can be used (SLS level 0).</li> </ul> In addition, for inverters with safety-related output: <ul style="list-style-type: none"> <li>Evaluate the status of the safety functions via a safety-related output.</li> </ul>
PROFIsafe	Basic functions:	<ul style="list-style-type: none"> <li>Select STO via PROFIsafe.</li> </ul> Additionally, with CU250S-2: <ul style="list-style-type: none"> <li>Select SS1 via PROFIsafe.</li> <li>Control the motor holding brake via SBC.</li> </ul>
	Extended functions	<ul style="list-style-type: none"> <li>Select safety functions via PROFIsafe.</li> <li>All four monitoring limits of SLS can be used (SLS levels 0 ... 3)</li> <li>Evaluate the state of the safety-related inputs via PROFIsafe.</li> </ul>
PROFIsafe and onboard terminal	Basic functions	<ul style="list-style-type: none"> <li>Select STO via F-DI as well as also via PROFIsafe.</li> </ul> Additionally, with CU250S-2: <ul style="list-style-type: none"> <li>Select SS1 via F-DI or PROFIsafe.</li> <li>Control the motor holding brake via SBC.</li> </ul>
	Extended functions	<ul style="list-style-type: none"> <li>Select safety functions via PROFIsafe.</li> <li>Additionally select STO via F-DI.</li> <li>All four monitoring limits of SLS can be used (SLS levels 0 ... 3)</li> <li>Evaluate the state of the safety-related inputs via PROFIsafe.</li> </ul> Additionally, with CU250S-2: <ul style="list-style-type: none"> <li>Select SS1 basic function via F-DI.</li> <li>Control the motor holding brake via SBC.</li> </ul>
STO via Power Module terminals		Select STO via the terminals of the PM240-2 FSD or FSE Power Module.

## 5.6.1 Configuring using STARTER

### 5.6.1.1 Configuring safety functions

#### Procedure with STARTER



To configure the safety functions, proceed as follows:

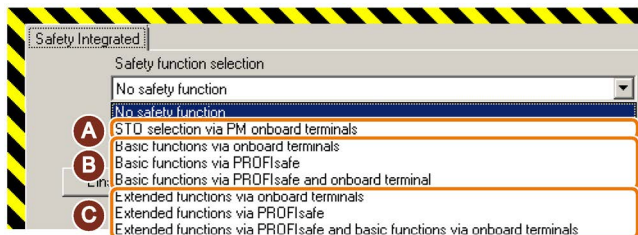
1. Go online.
2. Select the "Safety Integrated" function
3. Select "Change settings".



4. Define the configuration of the safety functions:

- (A) This option is only available with a PM240-2 FSD and FSE Power Module.

Select this option if you only wish to use STO via the terminals of the PM240-2.



- (B) If you only wish to use the basic functions of the inverter, select the interface that is appropriate for your particular application.
- (C) If you wish to use the extended safety functions, then select the interface that is appropriate for your particular application.

5.  If you selected the onboard terminals as interface, you have completed the configuration of the safety functions.  
To continue commissioning, you must set the basic functions or the extended functions.

For control via PROFIsafe, you must configure the PROFIsafe interface.

Parameter	Description			
p0010 = 95	<b>Drive commissioning parameter filter</b> Safety Integrated commissioning			
p9601	<b>Enable functions integrated in the drive</b> (factory setting: 0000 bin)			
		Functions that have been enabled:		Functions that have been enabled:
	0 hex	None	80 hex	STO via Power Module terminals
	1 hex	Basic functions via onboard terminals	81 hex	<ul style="list-style-type: none"> <li>Basic functions via onboard terminals</li> <li>STO via Power Module terminals</li> </ul>
	4 hex	Extended functions via onboard terminals	84 hex	<ul style="list-style-type: none"> <li>Extended functions via onboard terminals</li> <li>STO via Power Module terminals</li> </ul>
	8 hex	Basic functions via PROFIsafe	88 hex	<ul style="list-style-type: none"> <li>Basic functions via PROFIsafe</li> <li>STO via Power Module terminals</li> </ul>
	9 hex	<ul style="list-style-type: none"> <li>Basic functions via PROFIsafe</li> <li>Basic functions via onboard terminal</li> </ul>	89 hex	<ul style="list-style-type: none"> <li>Basic functions via PROFIsafe</li> <li>Basic functions via onboard terminals</li> <li>STO via Power Module terminals</li> </ul>
	C hex	Extended functions via PROFIsafe	8C hex	<ul style="list-style-type: none"> <li>Extended functions via PROFIsafe</li> <li>STO via Power Module terminals</li> </ul>
	D hex	<ul style="list-style-type: none"> <li>Extended functions via PROFIsafe</li> <li>Basic functions via onboard terminals</li> </ul>	8D hex	<ul style="list-style-type: none"> <li>Extended functions via PROFIsafe</li> <li>Basic functions via onboard terminals</li> <li>STO via Power Module terminals</li> </ul>
p9761	<b>Enter a password</b> (factory setting: 0000 hex) Permissible passwords lie in the range 1 ... FFFF FFFF.			
p9762	<b>New password</b>			
p9763	<b>Confirm password</b>			

### 5.6.1.2 Configuring PROFIsafe via basic functions

Telegram 30 is preset as default in the inverter.

#### Setting the PROFIsafe address

You must set the PROFIsafe addresses in the inverter and in the higher-level control system to the same value.

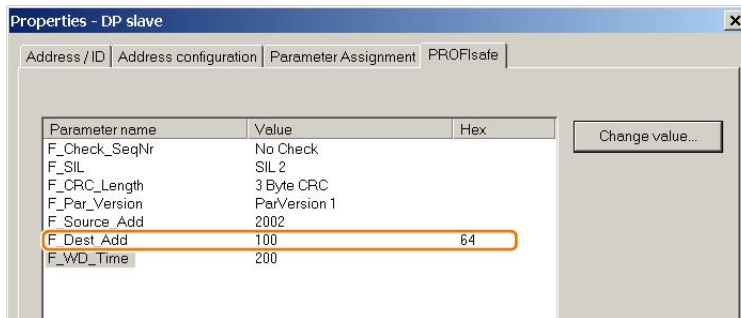


Figure 5-4 Example: PROFIsafe address 64 hex of the inverter in the STEP 7 hardware configuration

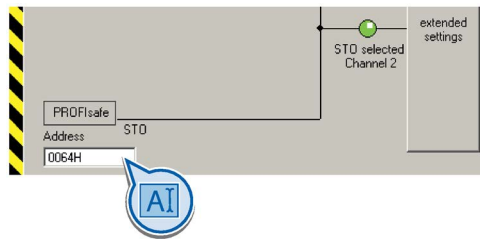


Figure 5-5 Setting the PROFIsafe address using STARTER

The PROFIsafe address of the inverter must be unique in the higher-level control system and within the network itself.

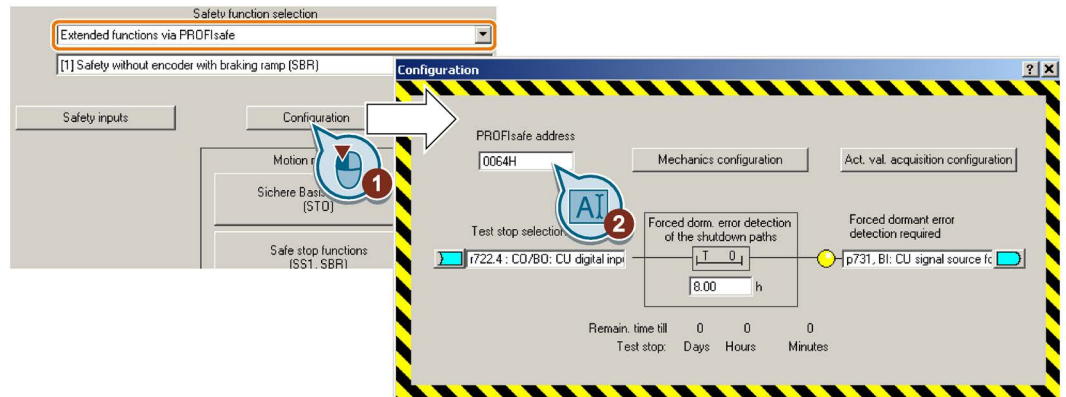
Parameter	Description
p9610	<b>PROFIsafe address</b> (factory setting: 0000 hex)

### 5.6.1.3 Configuring PROFIsafe via extended functions

Telegram 30 is preset in the inverter as default.

#### Setting the PROFIsafe address

- ➔ 1 To set the PROFIsafe address, proceed as follows:
- 2 1. Press the "Configuration" button.
  2. Enter the same PROFIsafe address in hexadecimal format that you defined in the hardware configuration.



3. Close the screen form.

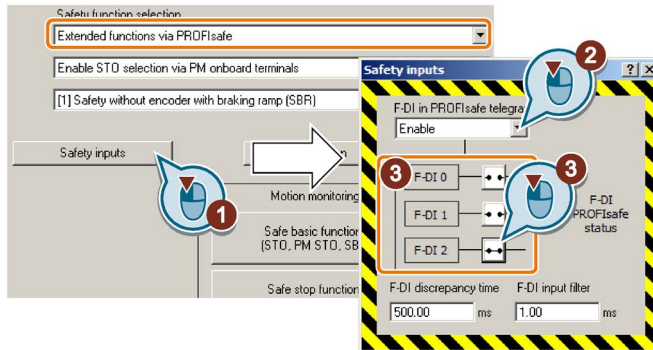
- You have set the PROFIsafe address.

Parameter	Description
p9610	PROFIsafe address (Factory setting: 0000 hex)

Configuring telegram 900

Procedure

- ➔ 1 Proceed as follows to configure PROFIsafe telegram 900:  
 2 1. Press the "Safety inputs" button.



2. Enable telegram 900.  
 3. Set which F-DI status of the inverter is transferred via PROFIsafe status word 5 .

**Note**

You can transfer the status of a safety-related input via PROFIsafe, and simultaneously use the same input to also control a fail-safe function.

4. Close the screen form.

■ You have configured the PROFIsafe telegram 900 in the inverter.

Also see Section: Control word 5 and status word 5 (Page 54).

Parameter	Description	
p9501.30	<b>Enable F-DI in PROFIsafe telegram</b> (Factory setting: 0 bin) 0 signal: F-DI is inhibited in the PROFIsafe telegram 1 signal: F-DI is enabled in PROFIsafe telegram	
p10050	<b>Transfer PROFIsafe F-DI</b> (Factory setting: 0000 bin)	
	Bit 0	0 signal: No transfer 1 signal: PROFIsafe status word 5 transfers the status of F-DI 0
	Bit 1	0 signal: No transfer 1 signal: PROFIsafe status word 5 transfers the status of F-DI 1
	Bit 2	0 signal: No transfer 1 signal: PROFIsafe status word 5 transfers the status of F-DI 2
You can find the settings for the discrepancy time and the signal filter of the safety-related inputs in Section: Setting the filter for safety inputs (Page 142)		

## 5.6.2 Configuring with Startdrive

### 5.6.2.1 Configuring safety functions

#### Precondition

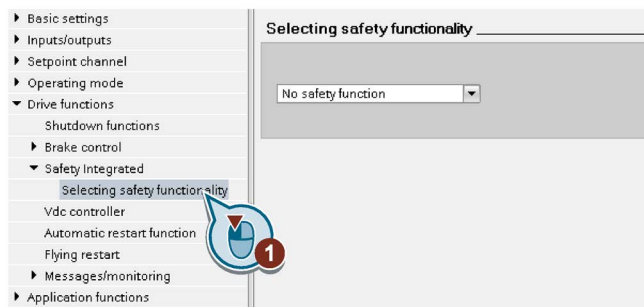
You are offline with Startdrive.

#### Procedure with Startdrive

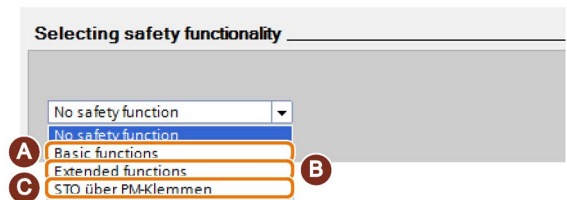


Proceed as follows to configure the safety functions:

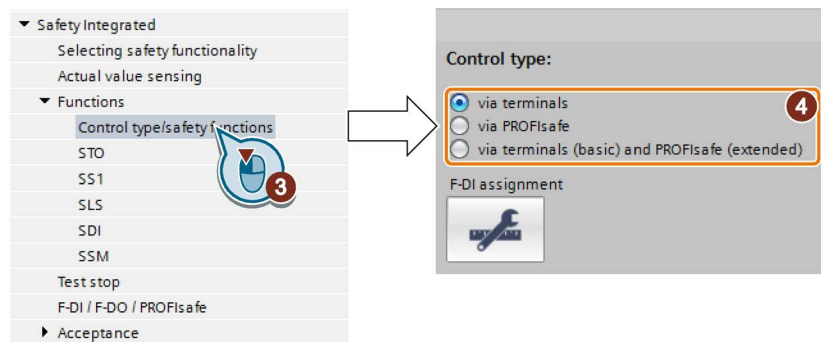
1. Select "Select safety functionality".



2. Define the configuration of the safety functions:
  - (A) You want to exclusively use the basic inverter functions.
  - (B) You want to use the extended safety functions.



- (C) This option is now available with a PM240-2 FSD and FSE Power Module. Select this option if you only want to use STO via the terminals of the PM240-2.
3. If you selected the basic functions or the extended functions, then you must define how the safety functions are controlled.



4. Define the interface for controlling the safety functions.

5.  If you wish to control the safety functions via terminals, then you have completed the configuration.

To continue commissioning, you must set the basic functions or the extended functions.

You must configure the PROFIsafe interface for control via PROFIsafe.

Parameter	Description			
p0010 = 95	<b>Drive commissioning parameter filter</b> Safety Integrated commissioning			
p9601	<b>Enable functions integrated in the drive</b> (factory setting: 0000 bin)			
		Functions that have been enabled:		Functions that have been enabled:
	0 hex	None	80 hex	STO via Power Module terminals
	1 hex	Basic functions via onboard terminals	81 hex	<ul style="list-style-type: none"> <li>Basic functions via onboard terminals</li> <li>STO via Power Module terminals</li> </ul>
	4 hex	Extended functions via onboard terminals	84 hex	<ul style="list-style-type: none"> <li>Extended functions via onboard terminals</li> <li>STO via Power Module terminals</li> </ul>
	8 hex	Basic functions via PROFIsafe	88 hex	<ul style="list-style-type: none"> <li>Basic functions via PROFIsafe</li> <li>STO via Power Module terminals</li> </ul>
	9 hex	<ul style="list-style-type: none"> <li>Basic functions via PROFIsafe</li> <li>Basic functions via onboard terminal</li> </ul>	89 hex	<ul style="list-style-type: none"> <li>Basic functions via PROFIsafe</li> <li>Basic functions via onboard terminals</li> <li>STO via Power Module terminals</li> </ul>
	C hex	Extended functions via PROFIsafe	8C hex	<ul style="list-style-type: none"> <li>Extended functions via PROFIsafe</li> <li>STO via Power Module terminals</li> </ul>
	D hex	<ul style="list-style-type: none"> <li>Extended functions via PROFIsafe</li> <li>Basic functions via onboard terminals</li> </ul>	8D hex	<ul style="list-style-type: none"> <li>Extended functions via PROFIsafe</li> <li>Basic functions via onboard terminals</li> <li>STO via Power Module terminals</li> </ul>
p9761	<b>Enter a password</b> (factory setting: 0000 hex) Permissible passwords lie in the range 1 ... FFFF FFFF.			
p9762	<b>New password</b>			
p9763	<b>Confirm password</b>			



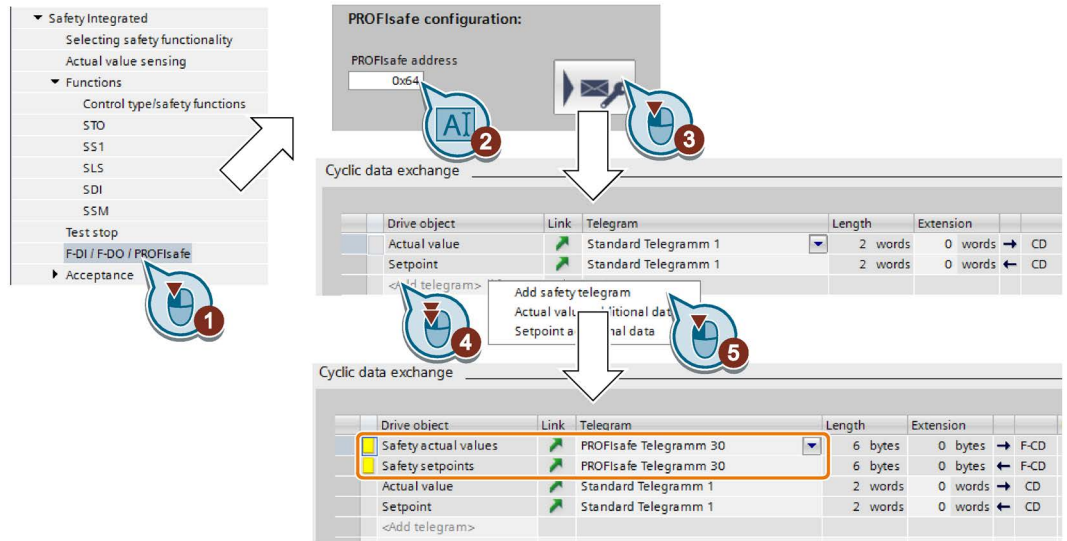
## 5.6.2.2 Configuring PROFIsafe

### Precondition

You are offline with Startdrive.

### Procedure

- ➔ 1 Proceed as follows to set the PROFIsafe address and telegram 30:  
2 1. Select "F-DI / F-DO / PROFIsafe".



2. Enter the same address as hexadecimal value that you defined in the hardware configuration for the higher-level control system.
3. Press the "Telegram configuration" button.  
Startdrive opens "Properties" of the cyclic data transfer.
4. Select "Add telegram".
5. Insert a "Safety telegram".

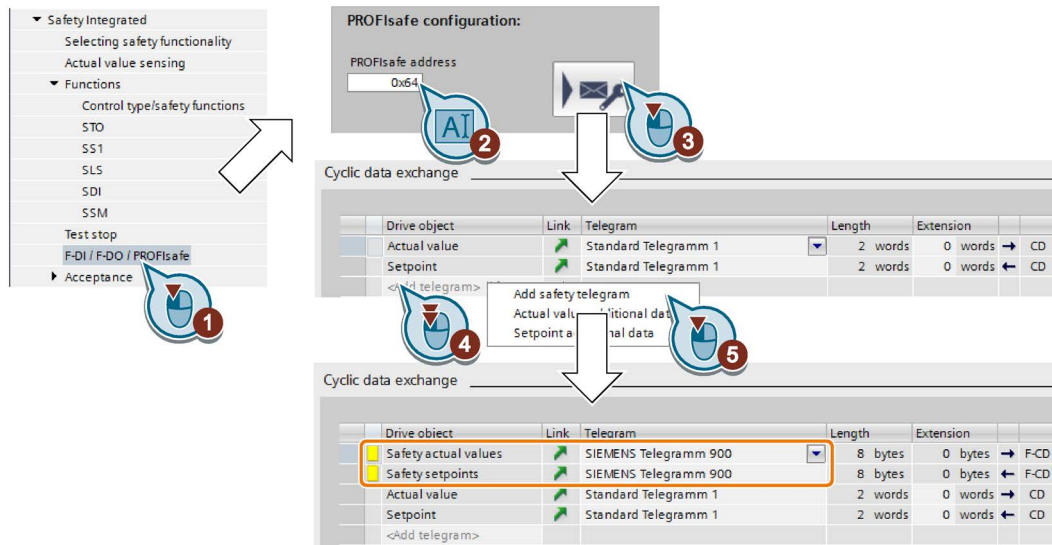
- You have established communication between the inverter and higher-level control (F-CPU) via PROFIsafe telegram 30.

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

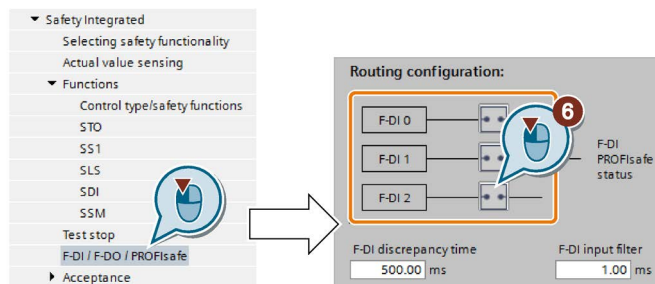
Configuring telegram 900

Procedure

- ➔ 1 Proceed as follows to configure PROFIsafe telegram 900:
- 2 1. Select "F-DI / F-DO / PROFIsafe".



- 2. Press the "Telegram configuration" button.  
Startdrive opens the "Properties" of the cyclic data exchange.
- 3. Select "Add telegram".
- 4. Insert a "Safety telegram"
- 5. Set telegram 900.
- 6. Set which F-DI status of the inverter is transferred via PROFIsafe status word 5 .



Note

You can transfer the status of a safety-related input via PROFIsafe and simultaneously use the same input to control a fail-safe function.

- You have configured PROFIsafe telegram 900.  
See also Section: Control word 5 and status word 5 (Page 54).

Parameter	Description	
p9501.30	<b>Enable F-DI in PROFIsafe telegram</b> (Factory setting: 0 bin) 0 signal: F-DI is inhibited in the PROFIsafe telegram 1 signal: F-DI is enabled in PROFIsafe telegram	
p10050	<b>Transfer PROFIsafe F-DI</b> (Factory setting: 0000 bin)	
	Bit 0	0 signal: No transfer 1 signal: PROFIsafe status word 5 transfers the status of F-DI 0
	Bit 1	0 signal: No transfer 1 signal: PROFIsafe status word 5 transfers the status of F-DI 1
	Bit 2	0 signal: No transfer 1 signal: PROFIsafe status word 5 transfers the status of F-DI 2
You can find the settings for the discrepancy time and the signal filter of the safety-related inputs in Section: Setting the filter for safety inputs (Page 142)		

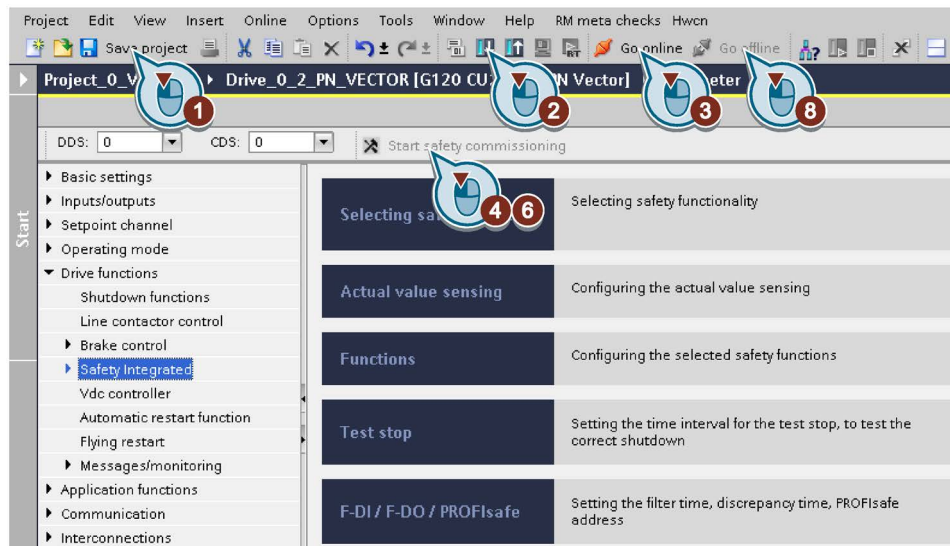
### 5.6.2.3 Activate settings

#### Loading the settings into the drive

##### Procedure



- 1 Proceed as follows to activate the safety functions settings in the drive:
1. Save the project.
2. Select "Load to device".



3. Connect Startdrive online with the drive.
  4. Press the "Start safety commissioning" button.
  5. Enter the password for the safety functions.  
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.
  6. Select the "Exit safety commissioning" button.
  7. Confirm the prompt for saving your settings (copy RAM to ROM).
  8. Disconnect the online connection.
  9. Switch off the inverter supply voltage.
  10. Wait until all LEDs on the inverter go dark (no voltage condition).
  11. Switch on the inverter supply voltage again.
- Your settings are now active.

<b>Parameter</b>	<b>Description</b>
p9700 = D0 hex	<b>SI copy function</b> (factory setting: 0) Start the SI parameter copy function.
p9701 = DC hex	<b>Confirm data change</b> (factory setting: 0) Confirm the SI basic parameter change.
p0010 = 0	<b>Drive commissioning parameter filter</b> 0: Ready
p0971 = 1	<b>Save parameter</b> 1: Save the drive object (copy from RAM to ROM) After the inverter has saved the parameters in a non-volatile fashion, then p0971 = 0.

## 5.7 Setting basic functions

### 5.7.1 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.

#### Precondition

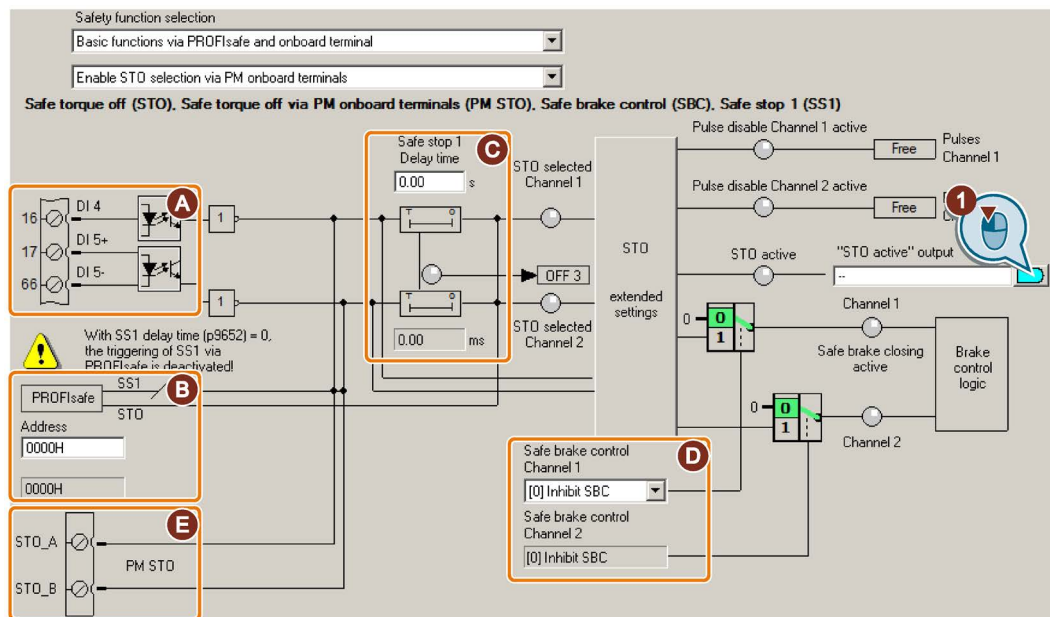
You are online with STARTER or Startdrive.

#### Procedure with STARTER and Startdrive



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

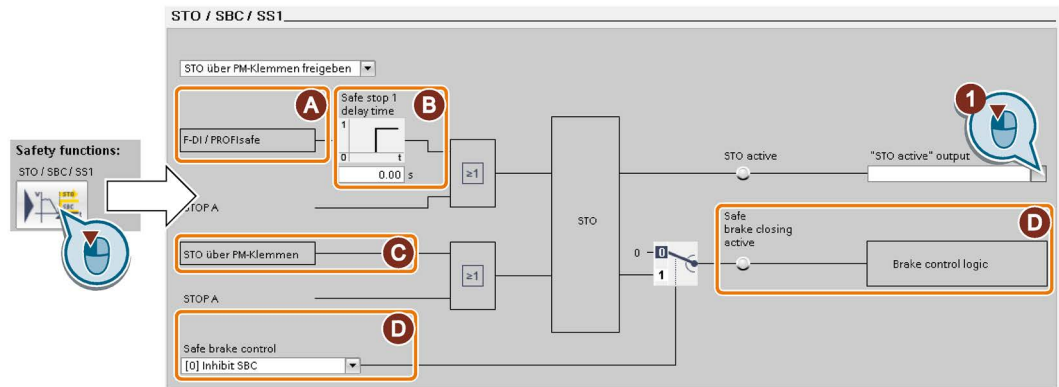
1. Select the button for the feedback signal.



The screen form varies depending on the inverter and the interface that has been selected.

- (A) Input terminal or connector for SINAMICS inverters, F0 rail for SIMATIC ET 200pro FC-2.
- (B) PROFIsafe interface
- (C), (D) Delay time for SS1 and enable SBC for an inverter with CU250S-2 Control Unit
- (E) Select STO via the terminals of the Power Module for a PM240-2 FSD and FSE

Figure 5-6 Interconnecting "STO active" in STARTER



The screen form varies depending on the inverter and the interface that has been selected.

- (A) Control type
- (B) Delay time for SS1 and enable of SBC for an inverter with CU250S-2 Control Unit
- (C) Select STO via the terminals of the Power Module for a PM240-2 FSD and FSE
- (D) Enable SBC for an inverter with CU250S-2 Control Unit

Figure 5-7 Interconnecting "STO active" in Startdrive

2. Select the signal that matches your particular application.

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

Parameter	Description
r9773.01	<b>1 signal:</b> STO is active in the drive

### 5.7.2 Setting the filter for safety inputs

You must set the input filter and the simultaneity monitoring of the safety-related input for all SINAMICS inverters, where the safety-related input F-DI evaluates two redundant signals.

For SIMATIC ET 200pro FC, the input signal for STO is received from the F0 rail of the backplane bus of the ET-200pro system. As a consequence, the simultaneity monitoring is not applicable for this inverter.

#### Requirement

You are online with STARTER or Startdrive online.

#### Procedure with STARTER and Startdrive



To set the input filter and simultaneity monitoring of the safety-related input, proceed as follows:

1. Navigate to the filter settings.

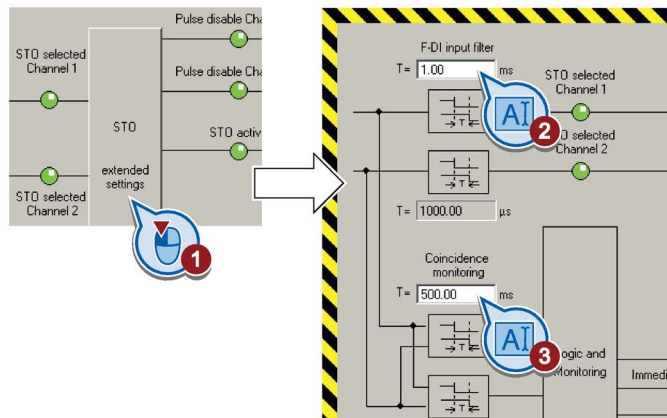


Figure 5-8 Input filter and simultaneity monitoring in STARTER

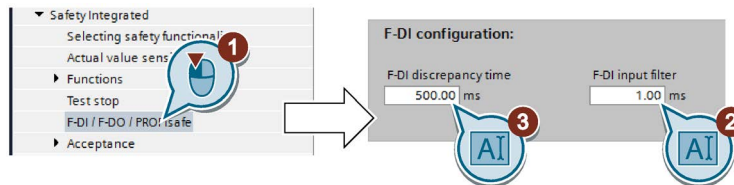


Figure 5-9 Input filter and simultaneity monitoring in Startdrive

2. Set the debounce time for the F-DI input filter.
3. Set the discrepancy for the simultaneity monitoring.
4. Only applies to STARTER: Close the screen form.



You have set the input filter and the simultaneity monitoring of the safety-related input.



## Description of the signal filter

The following are available for the signal processing of the safety-related inputs:

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

## Tolerance time for the simultaneity 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 safety-related 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.

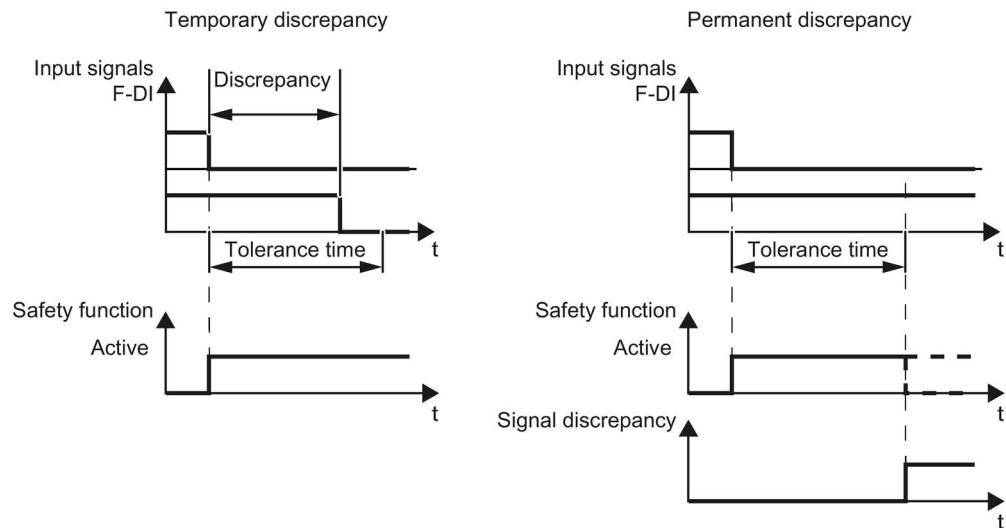


Figure 5-10 Tolerance regarding discrepancy

### Filter to suppress short signals

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

- When you interconnect a safety-related input of the inverter with an electromechanical sensor, contact bounce may result in signal changes occurring, to which the inverter responds.
- Several control modules test their safety-related outputs using bit pattern tests (light/darkness tests) to identify faults due to either short-circuiting or cross circuiting. When you interconnect a safety-related input of the inverter with a safety-related 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 safety-related input signals too many signal changes within a certain time, then the inverter responds with a fault.

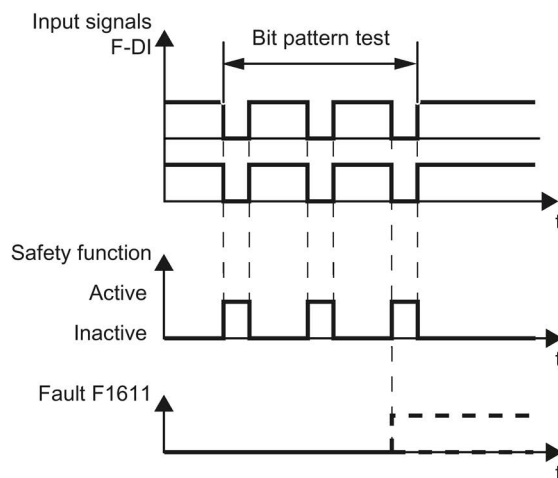


Figure 5-11 Inverter response to a bit pattern test

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.

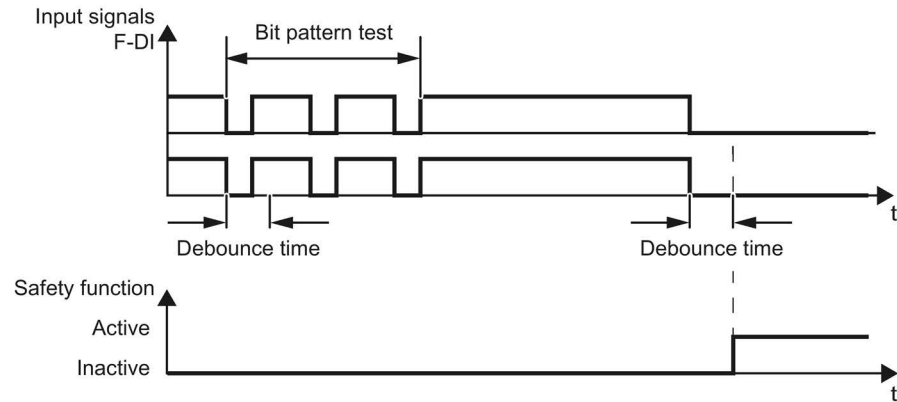


Figure 5-12 Filter for suppressing temporary signal changes

Parameter	Description
p9650 <sup>1)</sup>	<b>F-DI switchover discrepancy time</b> (factory setting: 500 ms) Tolerance time to switch over the safety-related input for the basic functions.
p9651	<b>STO debounce time</b> (factory setting: 1 ms) Debounce time of the safety-related input for the basic functions.

<sup>1)</sup> For SIMATIC ET 200pro FC-2, the tolerance time is always 0 ms.

#### Debounce times for standard and safety functions

The debounce time p0724 for "standard" digital inputs does not influence the safety-related 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 safety-related input, set the debounce time as described above.

### 5.7.3 Setting the forced checking procedure (test stop)

#### Requirement

You are online with STARTER or Startdrive online.

#### Procedure with STARTER and Startdrive



To set the forced checking procedure (test stop) of the basic functions, proceed as follows:

1. Select the screen form for setting the forced checking procedure.

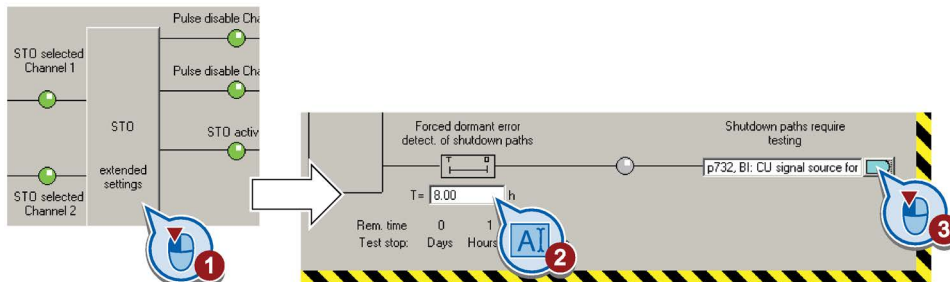


Figure 5-13 Setting the forced checking procedure with STARTER

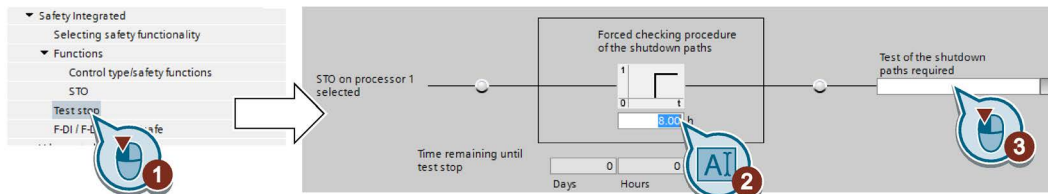


Figure 5-14 Setting the forced checking procedure with Startdrive

2. Set the monitoring time to a value to match your application.
3. Using this signal, the inverter signals that a forced checking procedure (test stop) is required.

Interconnect this signal with an inverter signal of your choice.

4. Only applies to STARTER: Close the screen form.

■ You have set the forced checking procedure (test stop) for the basic functions.

## Description

The forced checking procedure (test stop) of the basic functions is an inverter self test. The inverter checks its circuits to switch off the torque. If you are using the Safe Brake Relay, for a forced checking procedure, the inverter also checks the circuits of this component.

You start the forced checking procedure each time that the STO function is selected.

Using a timer block, the inverter monitors as to whether the forced checking procedure is regularly performed.

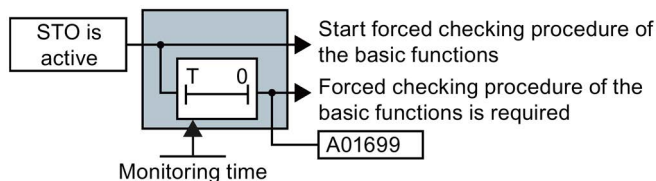


Figure 5-15 Starting and monitoring the forced checking procedure (test stop)

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

### 5.7.4 Set STO via the terminals of the PM240-2 Power Module

#### Precondition

You are online with STARTER or Startdrive.

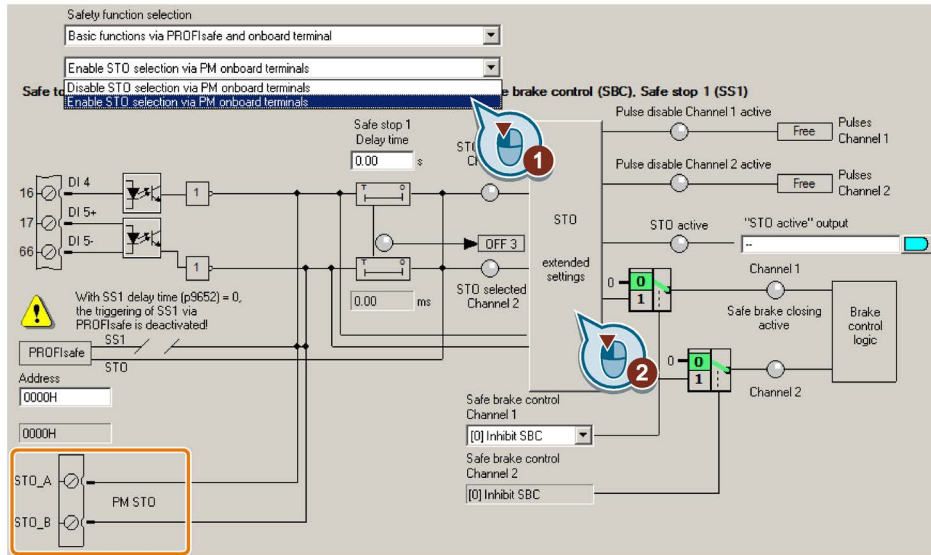
#### Procedure with STARTER



1 Proceed as follows, to set the "STO via the terminals of the PM240-2 Power Module" function:

1. Select "Enable STO selection via the PM onboard terminals".

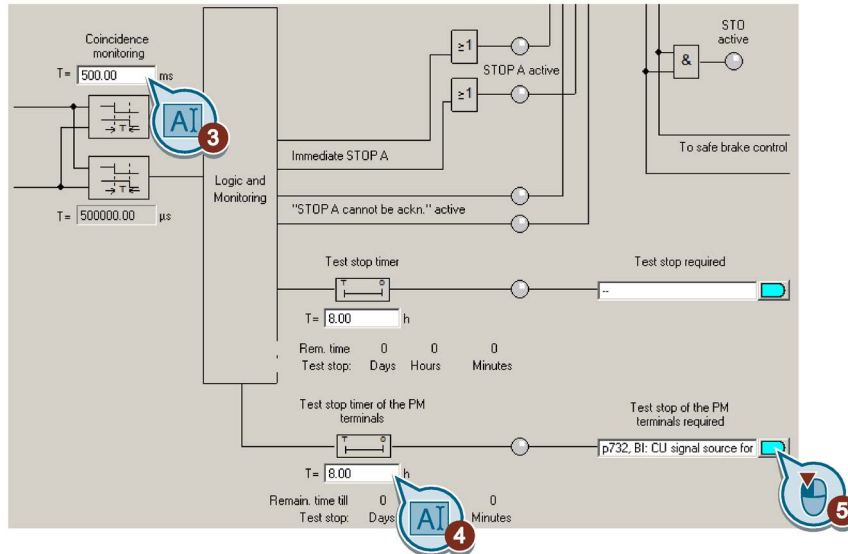
Terminals STO\_A and STO\_B of the Power Module appear in STARTER.



2. Press the "STO extended settings" button.

3. Set the discrepancy time (simultaneity monitoring) of the terminals at the Power Module.

The setting is not only applicable for the Power Module terminals, but also for the safety-related input on the Control Unit to select STO. See also: Setting the filter for safety inputs (Page 112).

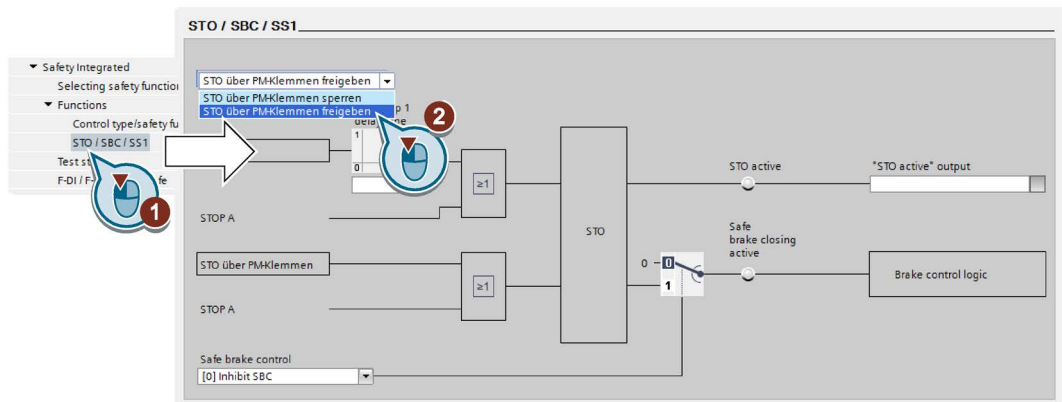


4. Set the monitoring time to a value to match your application.
5. Using this signal, the inverter signals that a forced checking procedure (a test stop) is required for the Power Module terminals.
6. Close the screen forms.

You have set the "STO via the terminals of the PM240-2 Power Module" function

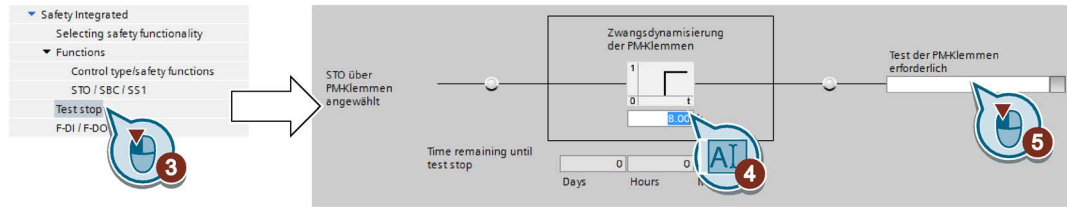
#### Procedure with Startdrive

1. Select "STO / SBC / SS1".
2. Select "Enable STO via the PM terminals".



3. Select "Test stop"
4. Set the monitoring time to a value to match your application.

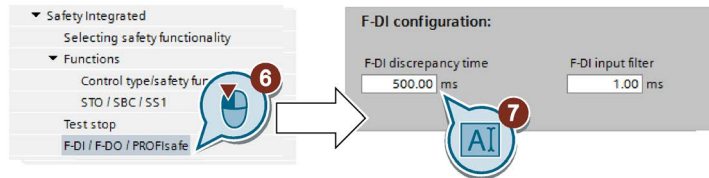
- Using this signal, the inverter signals that a forced checking procedure (a test stop) is required for the Power Module terminals.



- Select "F-DI / F-DO / PROFIsafe".
- Set the discrepancy time (simultaneity monitoring) of the terminals on the Power Module.

The setting not only applies for the terminals of the Power Module, but also for the safe-related input on the Control Unit for selecting STO. Also see: Setting the filter for safety inputs (Page 112).

The "F-DI input filter" has no significance for the terminals on the Power Module.



■ You have set the “STO via the terminals of the PM240-2 Power Module” function

Parameter	Description
p9601.7	<b>Enable functions integrated in the drive</b> (factory setting: 0) 1 signal: STO via the Power Module terminals has been enabled
p9650	<b>F-DI switchover discrepancy time</b> (Factory setting: 500 ms)
p9661	<b>Forced checking procedure STO via PM terminals time</b> (Factory setting: 8 h)
r9662	<b>Forced checking procedure STO via PM terminals remaining time</b>
r9773.30	<b>SI status</b> 1 signal: The terminals on the Power Module must be subject to a forced checking procedure (test stop)



## 5.7.5 Setting the delay time for SS1

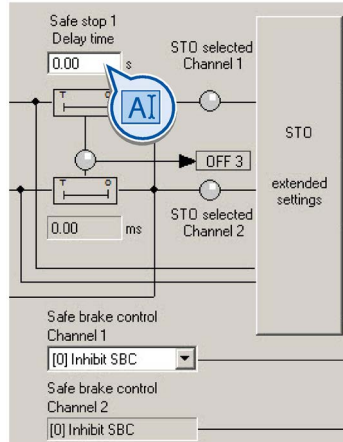
### Precondition

You are online with STARTER or Startdrive.

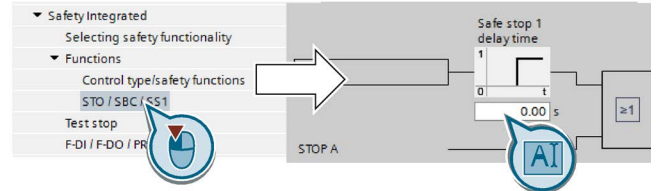
### Procedure

Set a delay time > OFF3 ramp down time.

Set SS1 using STARTER:



Set SS1 using Startdrive:



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

Description: the SS1 function without monitoring the speed

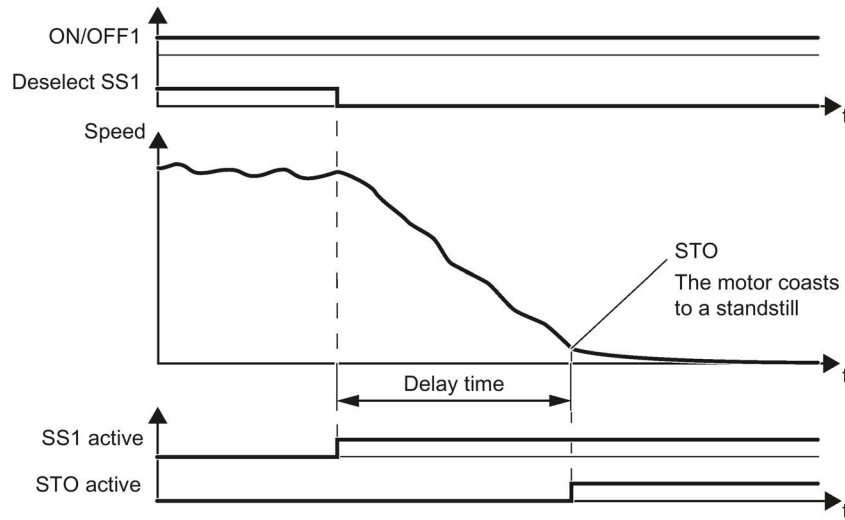


Figure 5-16 SS1 without monitoring the speed

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.

## 5.7.6 Enabling SBC

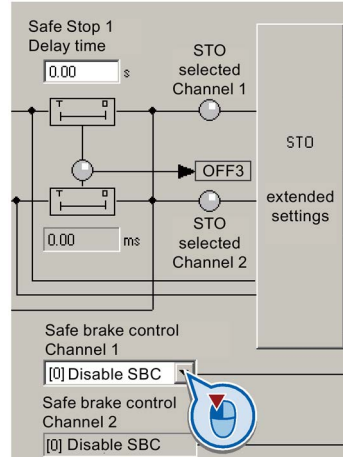
### Precondition

You are online with STARTER or Startdrive.

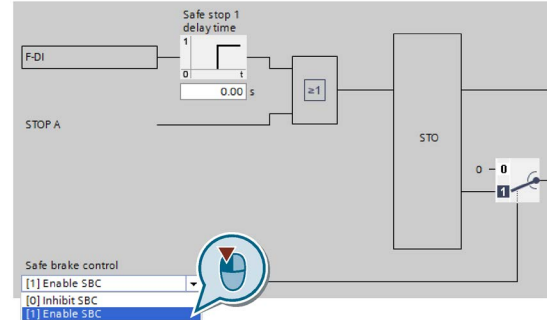
### Procedure

Set "[1] enable SBC".

Enable SBC using STARTER:



Enable SBC using Startdrive:



Parameter	Description
p9602	<b>Enable safe brake control</b> 0: SBC is locked 1: SBC is enabled

### 5.7.7 Final steps when commissioning online

#### Activate settings

##### Requirement

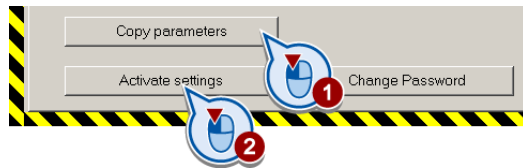
You are online with STARTER or Startdrive online.

##### Procedure with STARTER



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.



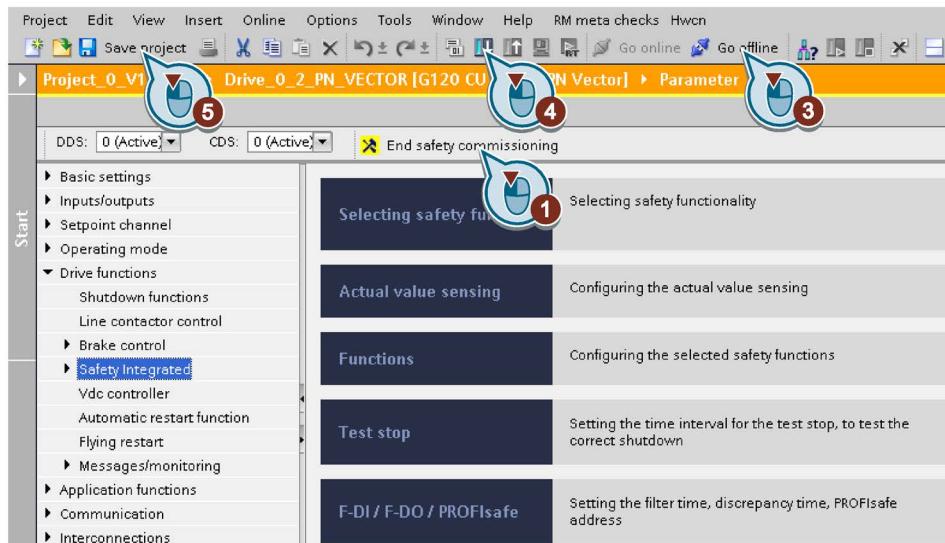
Your settings are now active.

### Procedure with Startdrive



To activate the settings of the safety functions in the drive, proceed as follows:

1. Click the "End safety commissioning" button.



2. Confirm the prompt for saving your settings (copy RAM to ROM).
3. Disconnect the online connection.
4. Select the "Load from device (software)" button.
5. Save the project.
6. Switch off the inverter supply voltage.
7. Wait until all LEDs on the inverter go dark (no voltage condition).
8. Switch on the inverter supply voltage again.

■ Your settings are now active.

Parameter	Description
p9700 = D0 hex	<b>SI copy function</b> (factory setting: 0) Start the SI parameter copy function.
p9701 = DC hex	<b>Confirm data change</b> (factory setting: 0) Confirm SI Basic parameter change
p0010 = 0	<b>Drive commissioning parameter filter</b> 0: Ready
p0971 = 1	<b>Save parameter</b> 1: Save the drive object (copy from RAM to ROM) After the inverter has saved the parameters in a non-volatile fashion, then p0971 = 0.

### Checking the connection of digital inputs

The simultaneous connection of digital inputs with a safety function and a "standard" function may lead to the drive behaving in unexpected ways.

If you control the safety functions in the inverter using digital inputs, you must check whether these digital inputs are connected to a "standard" function.

#### Procedure with STARTER

➔ 1 Proceed as follows to check as to whether the safety-related inputs are only used for the safety functions:  
2

1. In the project navigator, select the inputs/outputs.
2. Select the screen for the digital inputs.
3. Remove all digital input interconnections that you use as safety-related input F-DI:

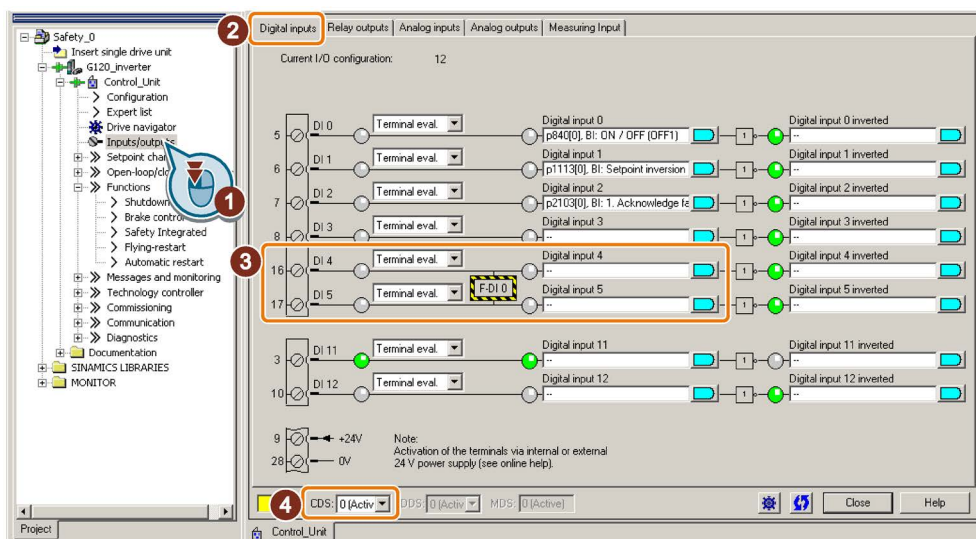


Figure 5-17 Removing the DI 4 and DI 5 digital-input connections

4. You must delete the digital input connections for all CDS if you use the switchover of the command data sets (CDS).

You can find a description of the CDS switchover in the operating instructions.

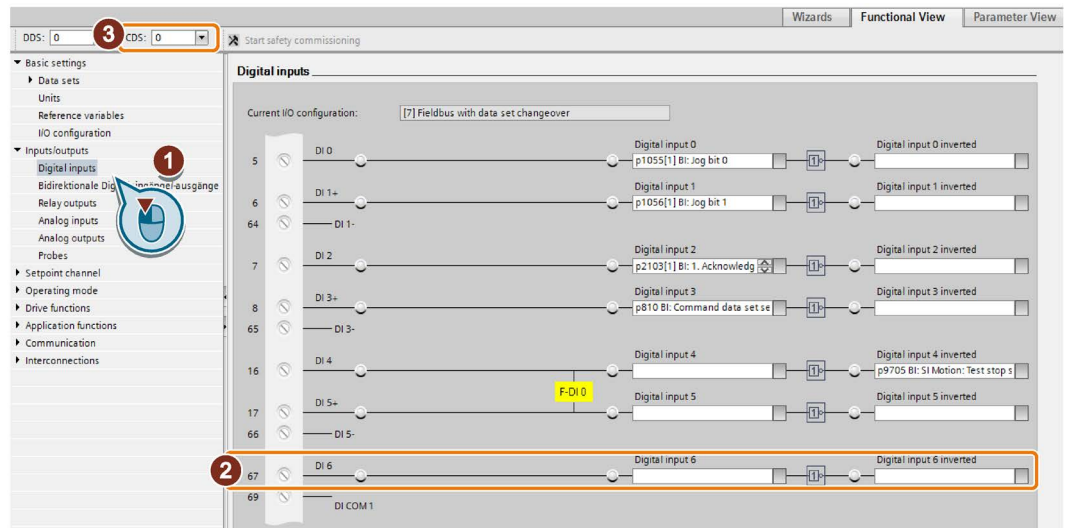
- You have ensured that the safety-related inputs only control safety functions in the inverter.

### Procedure with Startdrive



1 Proceed as follows to check as to whether the safety-related inputs are only used for the safety functions:

1. Select the screen for the digital inputs.
2. Remove all digital input interconnections that you use as safety-related input F-DI:



3. You must delete the digital input connections for all CDS if you use the switchover of the command data sets (CDS).

You can find a description of the CDS switchover in the operating instructions.



You have ensured that the safety-related inputs only control safety functions in the inverter.

### Checking the interconnection of the feedback signal input for the safety-related output

The interconnection of the feedback signal input with a "standard" function may lead to the drive behaving in unexpected ways.

#### Preconditions

- You use the safety-related output of the inverter.
- You use one of the test modes 2 or 3, where the inverter evaluates the status of the connected actuator via a digital input.

You must check as to whether this digital input is assigned a "standard" function.

#### Procedure with STARTER



In order to prevent that the feedback signal input of the safety-related output unintentionally controls the "standard" functions in the inverter, proceed as follows:

1. Select the inputs/outputs in the project navigator of STARTER.
2. Select the screen for the digital inputs.
3. Remove the interconnection of the digital input that you use as feedback signal input for the safety-related output:
  - SINAMICS G120 with CU250S-2 Control Unit: Digital input DI 6 (see diagram).
  - SINAMICS G120D: Digital input DI 5.
4. If you use the CDS data set switchover, remove the interconnection of the feedback signal input for all CDS.

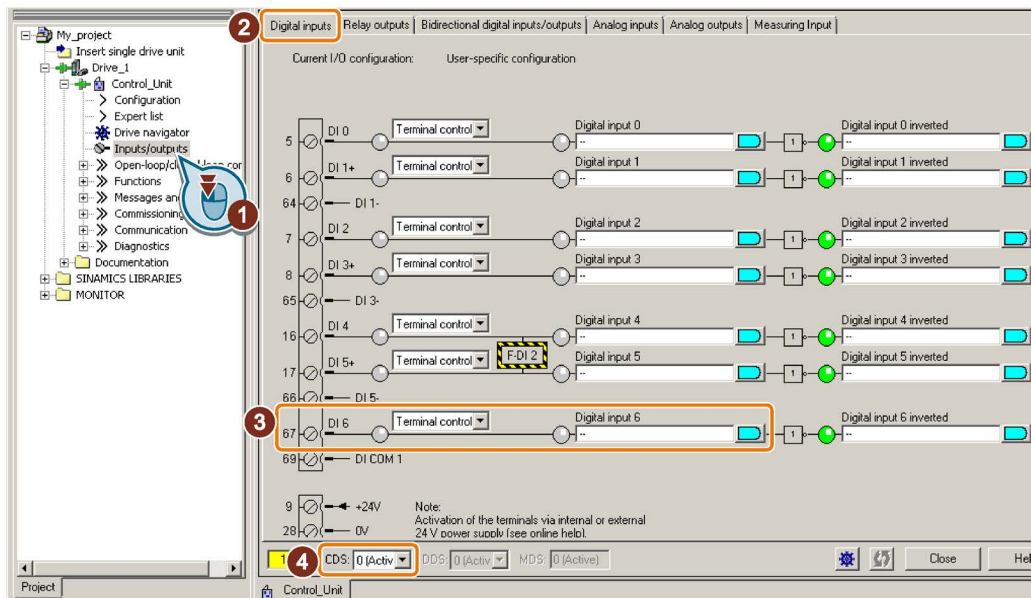


Figure 5-18 Removing the interconnection of the feedback signal input DI 6 for the CU250S-2

- You have now prevented that the feedback signal input of the safety-related output controls "standard" functions in the inverter.



### Procedure with Startdrive

➔ 1 In order to prevent that the feedback signal input of the safety-related output unintentionally controls the "standard" functions in the inverter, proceed as follows:  
2

1. Select the digital inputs.
2. Remove the interconnection of the digital input that you use as feedback signal input for the safety-related output:
  - SINAMICS G120 with CU250S-2 Control Unit: Digital input DI 6 (see diagram).
  - SINAMICS G120D: Digital input DI 5.
3. If you are using several command data sets (CDS), then remove the interconnection of the feedback signal input for all CDS.

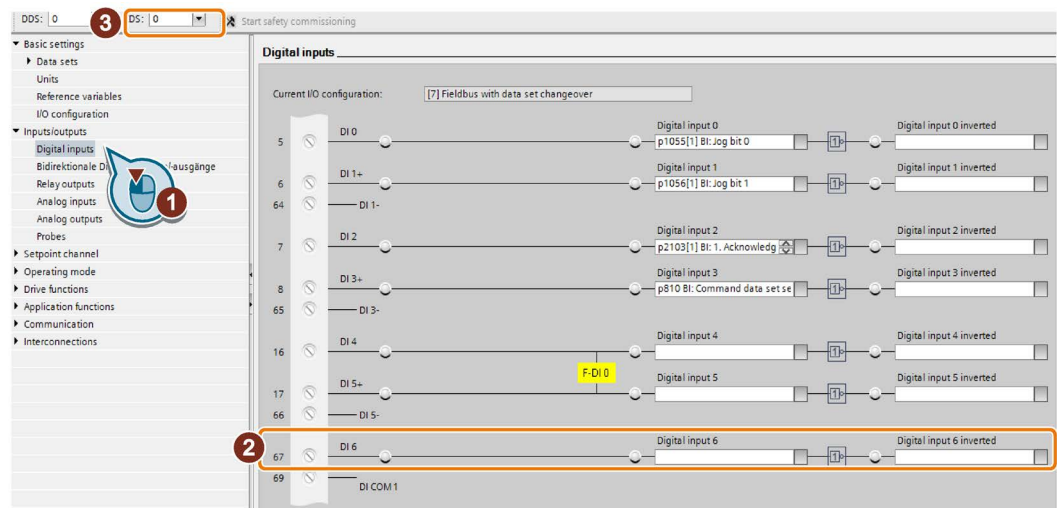


Figure 5-19 Removing the interconnection of the feedback signal input DI 6 for the CU250S-2

■ You have now prevented that the feedback signal input of the safety-related output controls "standard" functions in the inverter.

## 5.8 Setting extended functions

### Overview when setting the extended functions

To set all extended functions, proceed as follows:

1. Define the basic settings for all of the safety functions. See Section: Basic settings (Page 130).
2. If necessary, interconnect the safety-related inputs and outputs. See sections:
  - Setting safety inputs (Page 140)
  - Setting a safety output (Page 153).
3. Adapt the safety functions that you are using to suit your application. See Sections:
  - Setting SS1 (Page 161)
  - Setting SLS (Page 170)
  - Setting SSM (Page 175)
  - Setting SDI (Page 179)
4. Complete commissioning. See also Section: Final steps when commissioning online (Page 185).

### 5.8.1 Basic settings

#### 5.8.1.1 Enabling the safety functions

For most of the safety functions in the inverter, you can only enable them together.

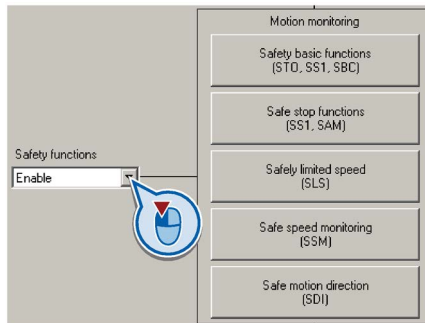
If you are not using one of the safety functions that has been enabled, then you must permanently set the signal to select this function to a 1-signal:

- When controlling via PROFIsafe:
  - In the higher-level control, set the corresponding bit in control word 1 to 1, see also: PROFIsafe telegrams (Page 50).
- When controlling via safety-related inputs:
  - In the inverter, set the corresponding signal to "Statically deselected", see also: Interconnecting a safety function with a safety input (Page 140).

#### Precondition

You are online with STARTER or Startdrive.

### Procedure with STARTER

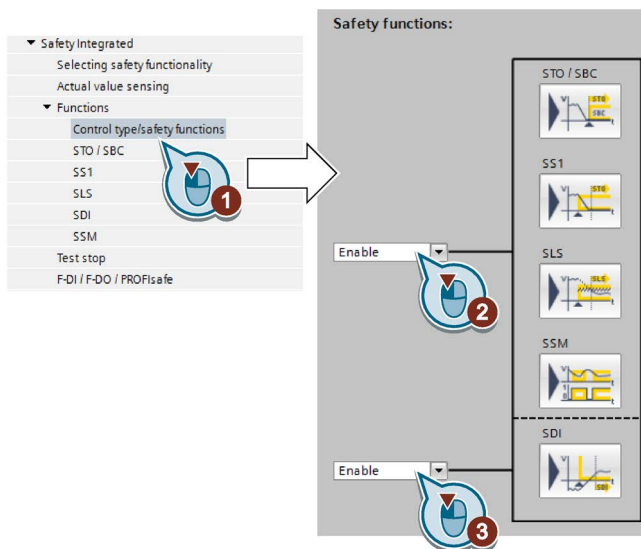


Enable the safety functions.

### Procedure with Startdrive



Proceed as follows to enable the safety functions:



1. Select "Control type/safety functions".

2. Enable safety functions STO ... SSM.

You must always set these safety functions, even if you only use the SDI function.

3. If you are using the SDI function, then enable SDI.

■ You have enabled the safety functions in the inverter.

Parameter	Description	
p9501	<b>Enable safety functions</b>	
	.00	1 signal: Enable the extended functions (without SDI)
	.17	1 signal: Enable SDI

5.8.1.2 Setting the forced dormant error detection (test stop)

**Precondition**

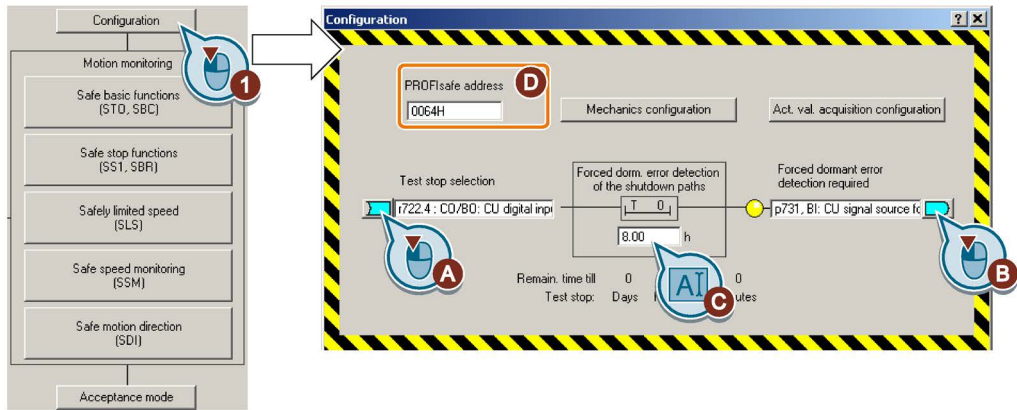
You are online with STARTER or Startdrive.

**Procedure with STARTER**



To set the forced checking procedure (test stop) of the extended functions, proceed as follows:

1. Select the “Configuration“ button:

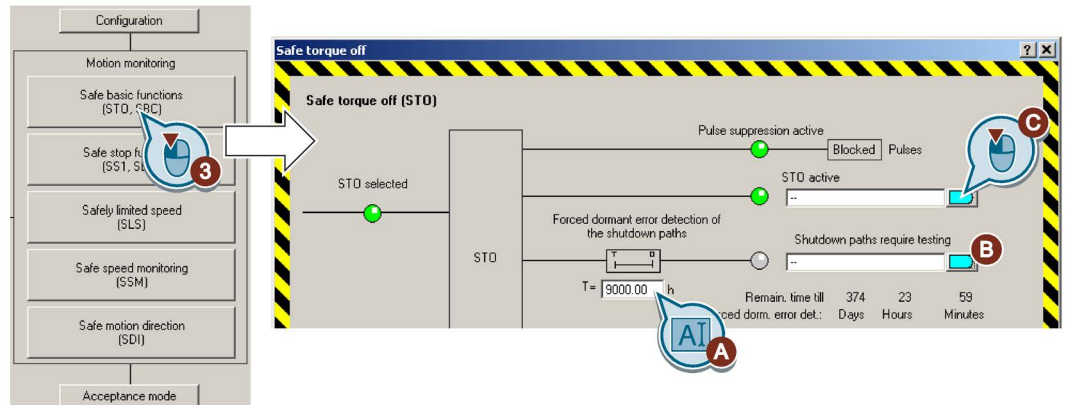


Set the following:

- (A) This signal starts the forced checking procedure (test stop) and sets the remaining time of the monitoring to the value (C). Interconnect this signal, for example, with a digital input or a bit in the fieldbus control word.
- (B) With this signal, you must carry out a forced checking procedure (test stop) as soon as possible. Interconnect this signal, for example with a digital output of your choice or a status bit in the fieldbus.
- (C) Time up to the next test stop.
- (D) This entry field is only visible if you selected PROFIsafe as interface. See also Section:Configuring PROFIsafe via extended functions (Page 101).

2. Close the screen form.

3. Press the "Safe basic functions" button:



Set the following:

- **(A)** Set the monitoring time to the maximum value (9000 hours). This means that the forced checking procedure monitoring for the basic functions is deactivated.
- This monitoring is not required when using the extended functions, as the forced checking procedure for the extended functions also includes the forced checking procedure for the basic functions.
- **(B)** Setting not required.
- **(C)** If required, interconnected the status of the STO function, e.g. with a digital output of your choice.

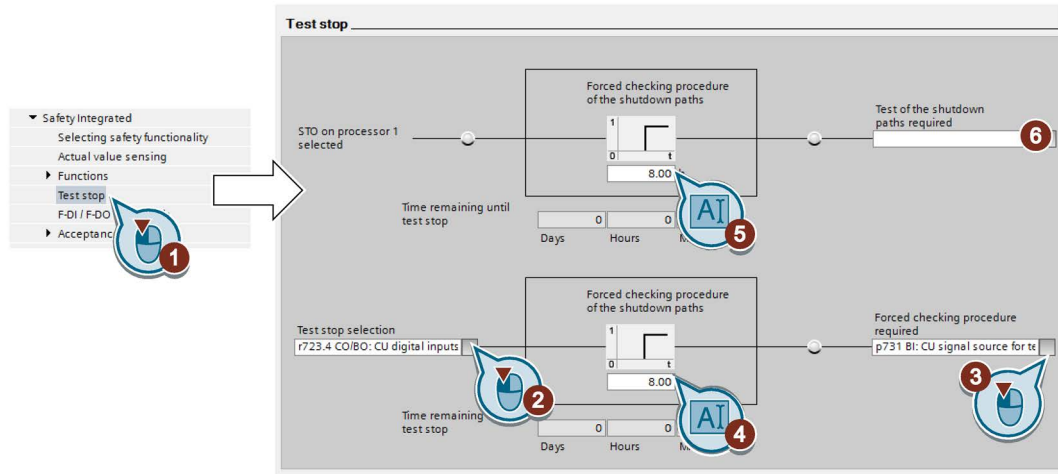
4. Close the screen form.

- You have set the forced checking procedure (test stop) of the extended functions.

**Procedure with Startdrive**

➔ 1 To set the forced checking procedure (test stop) of the extended functions, proceed as follows:

1. Select "Test stop":



2. This signal starts the forced checking procedure (test stop) and resets the remaining time of the monitoring to the value ④. Interconnect this signal, for example, with a digital input or a bit in the fieldbus control word.
3. For this signal, you must carry out a forced checking procedure (test stop) as quickly as possible. Interconnect this signal, for example with a digital output of your choice or a status bit in the fieldbus.
4. Time until the next test stop.
5. Set the monitoring time to the maximum value (9000 hours). This means that the forced checking procedure monitoring for the basic functions is deactivated.

This monitoring is not required when using the extended functions, as the forced checking procedure for the extended functions also includes the forced checking procedure for the basic functions.

6. Setting not required

- You have set the forced forced checking procedure (test stop) of the extended functions.

## Description

The forced dormant error detection (test stop) of the extended functions is an inverter self test. The inverter checks its circuits to monitor the speed and to switch off the torque.

Using a timer block, the inverter monitors as to whether the forced dormant error detection is regularly performed.

You must start the forced dormant error detection with a signal of your choice.

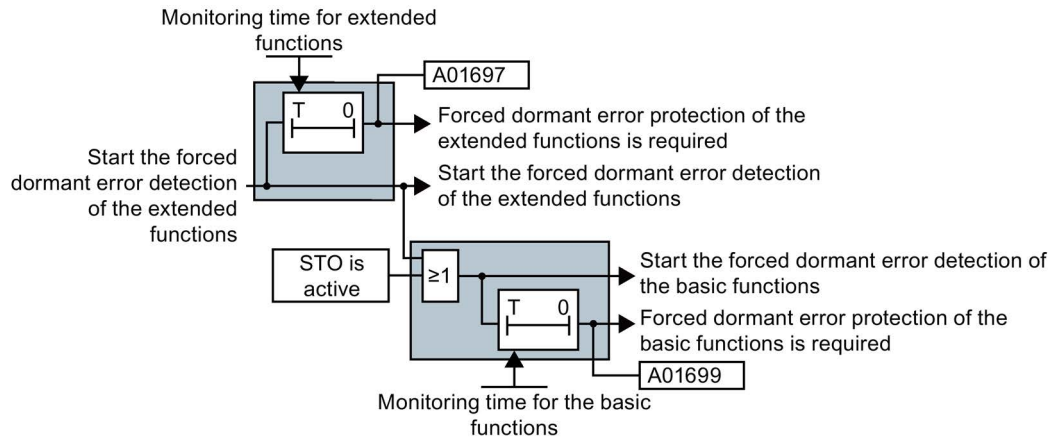


Figure 5-20 Starting and monitoring the forced dormant error detection (test stop)

Parameter	Description
p9559	<b>Forced dormant error detection timer</b> (Factory setting: 8 h) Monitoring time for the forced dormant error detection of the extended functions.
p9659	<b>Forced dormant error detection timer</b> (Factory setting: 8 h) Monitoring time for the forced dormant error detection of the basic functions.
r9660	<b>Forced dormant error detection remaining time</b> Displays the remaining time up to performing the forced dormant error detection of the basic functions.
p9705	<b>Forced dormant error detection signal source</b> (Factory setting: 0) Signal source for the forced dormant error detection of the basic functions and the extended functions.
r9723.0	<b>1 signal: Forced dormant error detection of the extended functions is necessary</b> Signal for the higher-level control.
r9765	<b>Forced dormant error detection remaining time</b> Displays the remaining time up to performing the forced dormant error detection of the extended functions.
r9773.31	<b>1 signal: Forced dormant error detection of the basic functions is required</b>

### 5.8.1.3 Setting encoderless actual value sensing

**Precondition**

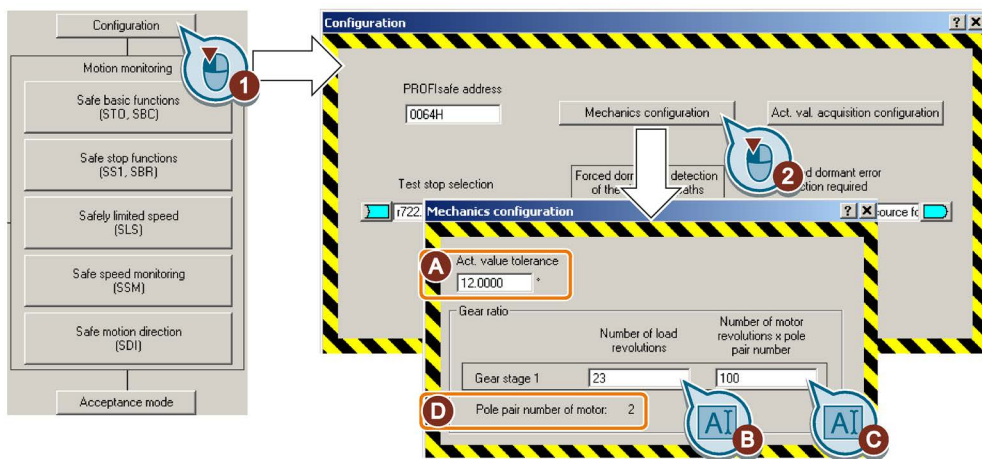
You are online with STARTER or Startdrive.

**Procedure with STARTER**



To set the encoderless actual value sensing, proceed as follows:

1. Press the "Configuration" button.
2. Press the "Mechanical configuration" button.



Set the following:

- **(A) Actual value tolerance:**  
In most cases, you do not have to change this value. If, in operation, the inverter issues message C01711 or C30711 (fault value 3 or 44 ... 57), increase this value step-by-step until the message no longer occurs.  
**Note:** If you increase this value, the speed monitoring of the inverter becomes less sensitive to limit violations.
- **(B), (C) Gearbox ratio:**  
Read the motor pole pair number (D), and enter the data of your machine according to the following table.

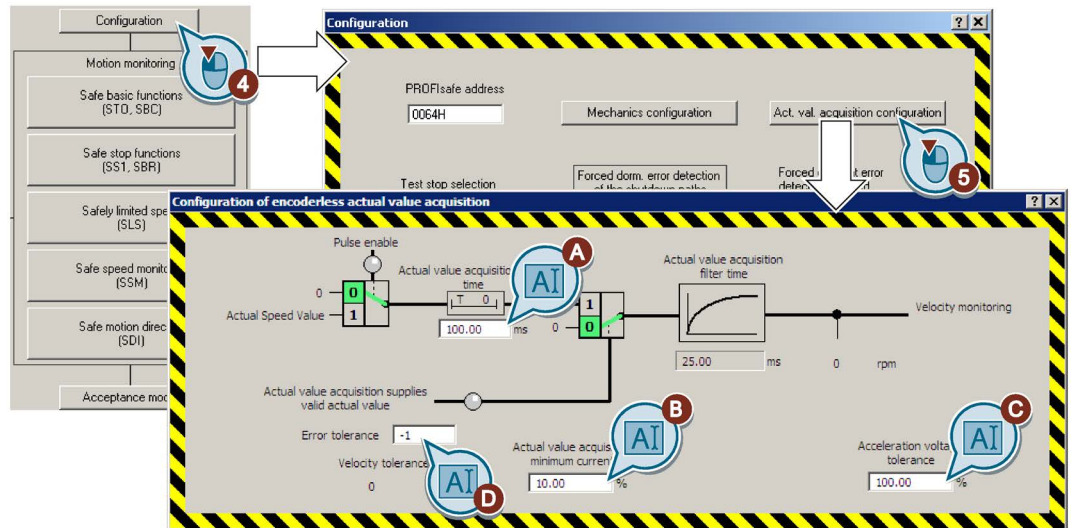
	Number of load revolutions	Number of motor revolutions
Without gear	Value (B) = 1	Value (C) = number of pole pairs (D)
Gearbox with speed ratio Load/motor = L/M	Value (B) = L	Value (C) = M x number of pole pairs (D)

- **Example:** The drive has a gearbox with a load/motor speed ratio = 23/50  
⇒ Value (B) = 23, value (C) = 50 × number of pole pairs (D)

3. Close the screen forms.
4. Press the "Configuration" button.



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



Set the following:

- **(A) 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).
- **(B) Minimum current actual value sensing:**  
In most cases you do not have to change this setting. If the inverter responds with a fault when the current drawn by the motor is low, then reduce these values in 1 % increments until the fault no longer occurs.
- **(C) 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%.
- **(D) 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.

6. Close the screen forms.

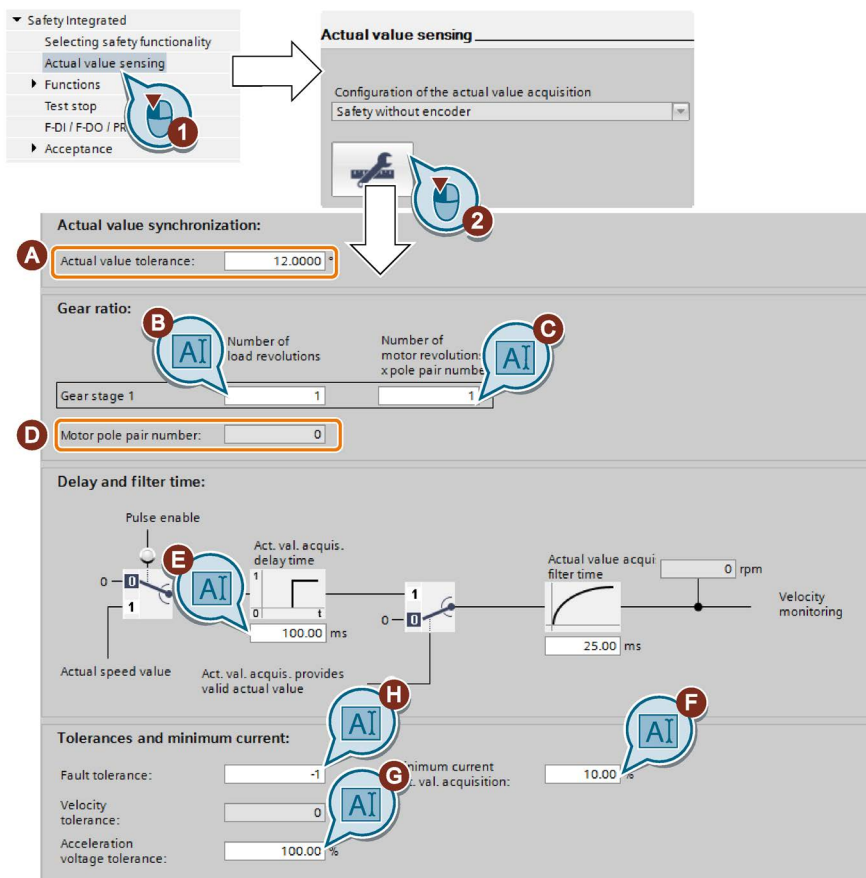
- You have set the encoderless actual value sensing.

**Procedure with Startdrive**



To set the encoderless actual value sensing, proceed as follows:

1. Press the "Actual value sensing" button.
2. Select the "Configuration actual value sensing" button.



Set the following:

- **(A) Actual value tolerance:**  
In most cases you do not have to change this value. If, in operation, the inverter issues message C01711 or C30711 (fault value 3 or 44 ... 57), increase this value step-by-step until the message no longer occurs.  
**Note:** If you increase this value, the speed monitoring of the inverter becomes less sensitive to limit violations.
- **(B), (C) Gearbox ratio:**  
Read the number of pole pairs (D) of the motor, and set the data of your machine according to the following table.

	Number of load revolutions	Number of motor revolutions
Without gear	Value (B) = 1	Value (C) = number of pole pairs (D)
Gearbox with speed ratio load/motor = L/M	Value (B) = L	Value (C) = M x number of pole pairs (D)

- **Example:** The drive has a gearbox with a load/motor speed ratio = 23/50  
 ⇒ Value (B) = 23, value (C) = 50 × number of pole pairs (D)
- **(E) 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).
- **(F) Minimum current actual value sensing:**  
 In most cases you do not have to change the 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.
- **(G) 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%.
- **(H) 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.

3. Close the screen form.



You have set the encoderless actual value sensing.

Parameter	Description
p9521	<b>Number of load revolutions</b> (Factory setting: 1) Denominator for the gearbox ratio between the motor and load.
p9522	<b>Number of motor revolutions</b> (Factory setting: 2000 rpm) Numerator for the gearbox ratio between the motor and load.
p9542	<b>Actual value tolerance</b> (Factory setting: 12 °) Tolerance for the crosswise comparison of the actual position between processor 1 and 2.
p9585	<b>Fault tolerance</b> (Factory setting: -1) Tolerance of the plausibility monitoring of current and voltage angle.
p9586	<b>Delay time actual value sensing</b> (Factory setting: 100 ms) Delay time for evaluating the encoderless actual value sensing after the motor has been switched on.
p9588	<b>Minimum current actual value sensing</b> (Factory setting: 10 %) Minimum current for encoderless actual value sensing (1 % ± 10 mA).
p9589	<b>Voltage tolerance acceleration</b> (Factory setting: 100 %) Acceleration limit to filter discontinuity in the velocity.

## 5.8.2 Setting safety inputs

### 5.8.2.1 Interconnecting a safety function with a safety input

#### Preconditions

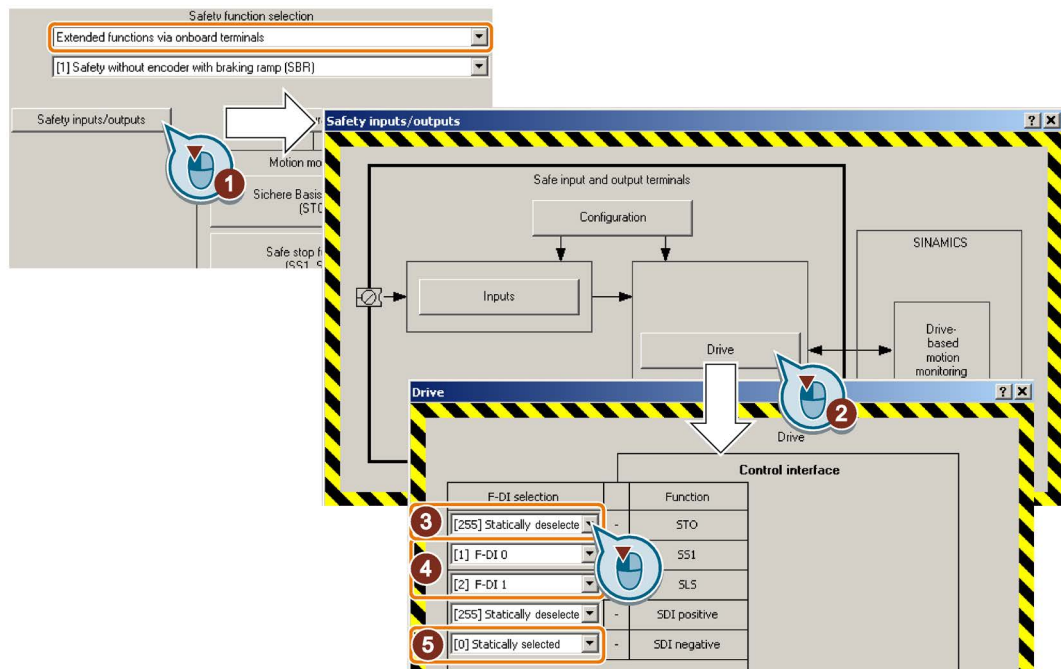
- You are online with STARTER or Startdrive.
- You have selected the extended functions via onboard terminals.

#### Procedure with STARTER



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

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



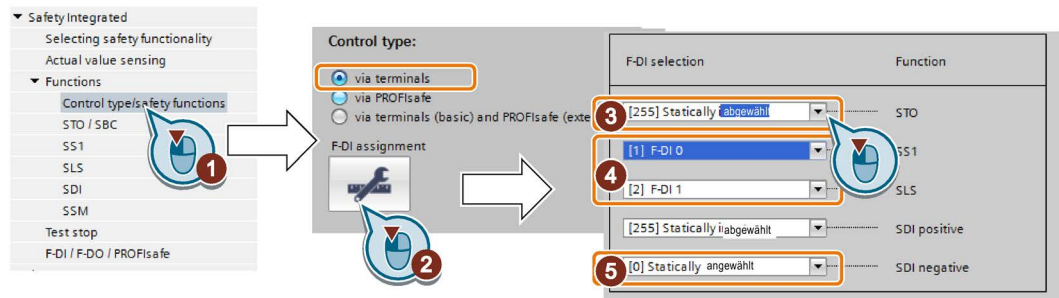
3. If you do not use a safety function, then set the associated "Select F-DI" = "[255] statically deselected".
4. Interconnect the safety-related inputs with the corresponding safety functions.
5. If a safety function should always be active, set the associated "Select F-DI" = "[0] Statically active".
6. Close the screen forms.



You have assigned specific safety functions to the safety-related inputs.

### Procedure with Startdrive

- ➔ 1 To interconnect the safety-related inputs with safety functions, proceed as follows:
- 2 1. Select "Control type/safety functions".
  2. Press the "F-DI assignment" button.



3. If you do not use a safety function, set the associated "Select F-DI" = "[255] statically deselected".
4. Interconnect the safety-related inputs with the corresponding safety functions.
5. If a safety function should always be active, set the associated "Select F-DI" = "[0] statically active".
6. Close the screen form.

Parameter	Description	
p10022	<b>STO input terminal</b> (Factory setting: 0)	0: Statically selected
p10023	<b>SS1 input terminal</b> (Factory setting: 0)	1: F-DI 0
p10026	<b>SLS input terminal</b> (Factory setting: 0)	2: F-DI 1
p10030	<b>SDI positive input terminal</b> (Factory setting: 0)	3: F-DI 2
p10031	<b>SDI negative input terminal</b> (Factory setting: 0)	255: Statically deselected

### 5.8.2.2 Setting the filter for safety inputs

#### With STARTER: Control via onboard terminals

**Preconditions**

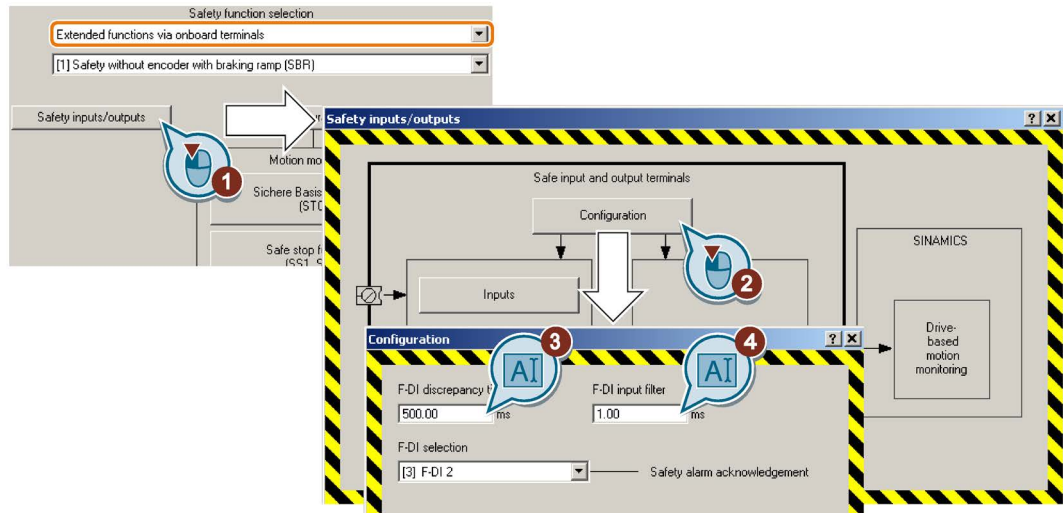
- You are online with STARTER.
- You have selected the extended functions via onboard terminals.

**Procedure**



To set the filters for the safety-related inputs, proceed as follows:

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



3. The discrepancy time (simultaneity monitoring) tolerates signal changes at the safety-related input that do not occur simultaneously.
4. The input filter suppresses brief signal changes.
5. Close the screen forms.

■ You have set the filter for the safety-related inputs.

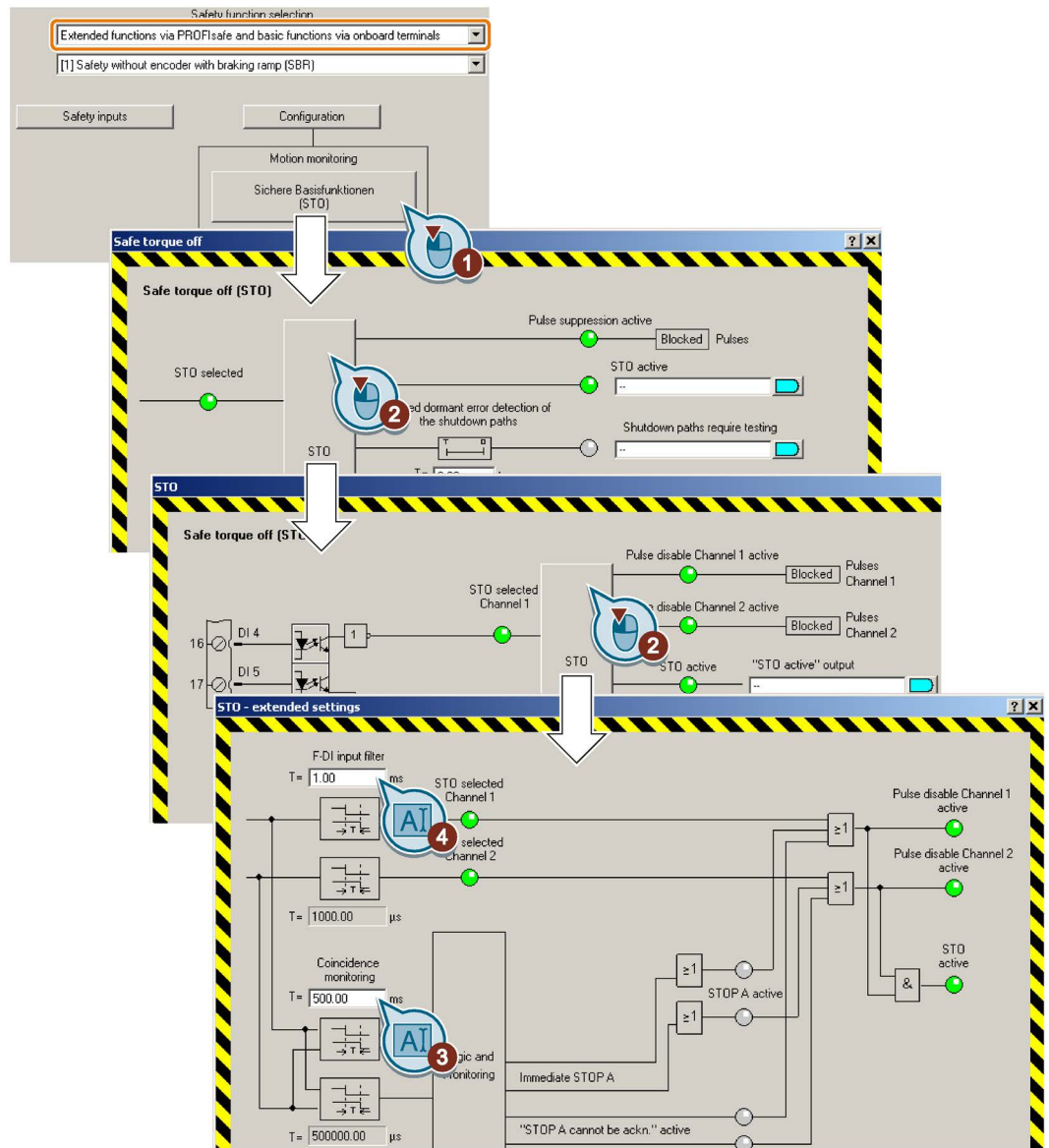
#### With STARTER: Control via PROFIsafe and onboard terminals

**Preconditions**

- You are online with STARTER.
- You have selected the extended functions via PROFIsafe and onboard terminals.

**Procedure**

- ➔ 1 To set the filters for the safety-related inputs, proceed as follows:
- 2 1. Press the "Safety basic functions" button.
  - 2 2. Press the "STO" button in the following two screen forms.



3. The discrepancy time (simultaneity monitoring) tolerates signal changes at the safety-related input that do not occur simultaneously.
4. The input filter suppresses brief signal changes.
5. Close the screen forms.

■ You have set the filter for the safety-related inputs.

### With Startdrive

#### Preconditions

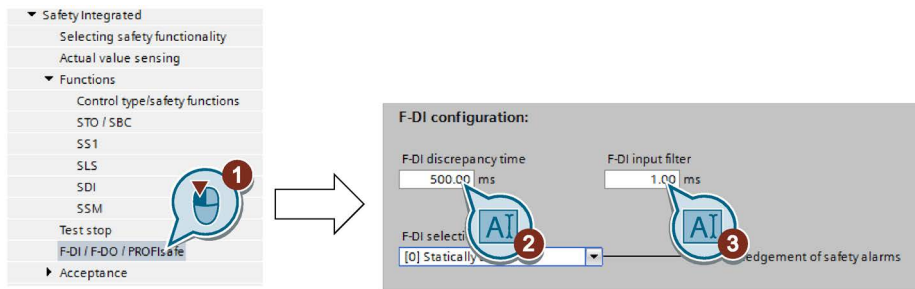
- You are online with Startdrive.
- You have selected one of the two following settings:
  - Extended functions via onboard terminals
  - Extended functions via PROFIsafe and onboard terminals

#### Procedure



To set the filters for the safety-related inputs, proceed as follows:

1. Select "F-DI / F-DO / PROFIsafe".



2. The discrepancy time (simultaneity monitoring) tolerates signal changes at the safety-related input that do not occur simultaneously.
3. The input filter suppresses brief signal changes

■ You have set the filter for the safety-related inputs.



## Description of the signal filter

The following are available for the signal processing of the safety-related 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 safety-related 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.

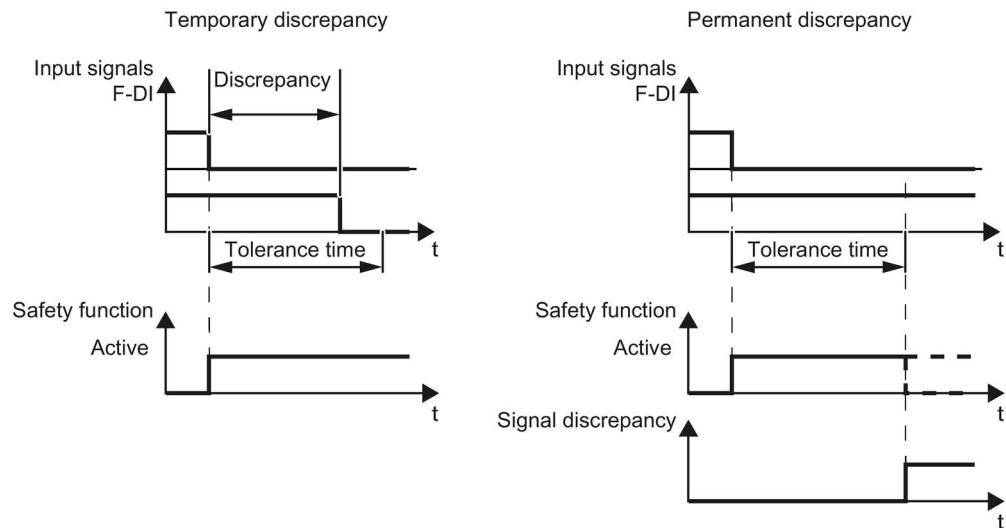


Figure 5-21 Tolerance regarding discrepancy

**Filter to suppress short signals**

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

- When you interconnect a safety-related input of the inverter with an electromechanical sensor, contact bounce may result in signal changes occurring, to which the inverter responds.
- Several control modules test their safety-related outputs using bit pattern tests (light/darkness tests) to identify faults due to either short-circuiting or cross circuiting. When you interconnect a safety-related input of the inverter with a safety-related 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 safety-related input signals too many signal changes within a certain time, then the inverter responds with a fault.

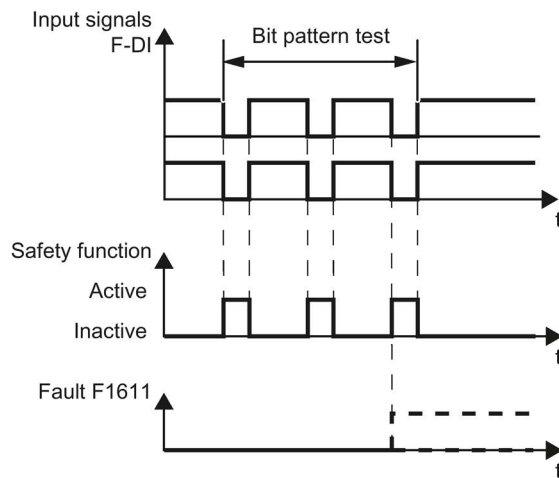


Figure 5-22 Inverter response to a bit pattern test

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.

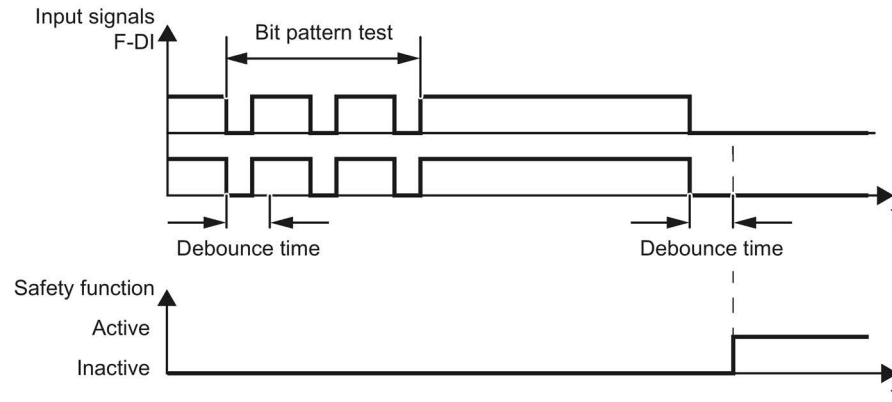


Figure 5-23 Filter for suppressing temporary signal changes

Parameter	Description
p9650	<b>F-DI switchover discrepancy time</b> (Factory setting: 500 ms) Tolerance time to switch over the safety input for the basic functions.
p9651	<b>STO debounce time</b> (factory setting: 1 ms) Debounce time of the safety input for the basic functions.
p10002	<b>F-DI switchover discrepancy time</b> (Factory setting: 500 ms) Tolerance time to switch over the safety inputs for the extended functions.
p10017	<b>Digital inputs debounce time</b> (factory setting: 1 ms) Debounce time of the safety inputs for the extended functions.

#### Debounce times for standard and safety functions

The debounce time p0724 for "standard" digital inputs does not influence the signals of the safety inputs F-DI. 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 safety input, set the debounce time as described above.

### 5.8.2.3 Interconnecting the signal for fail-safe acknowledgment

#### Preconditions

- You are online with STARTER or Startdrive.
- You have selected the extended functions via onboard terminals.

#### Procedure with STARTER

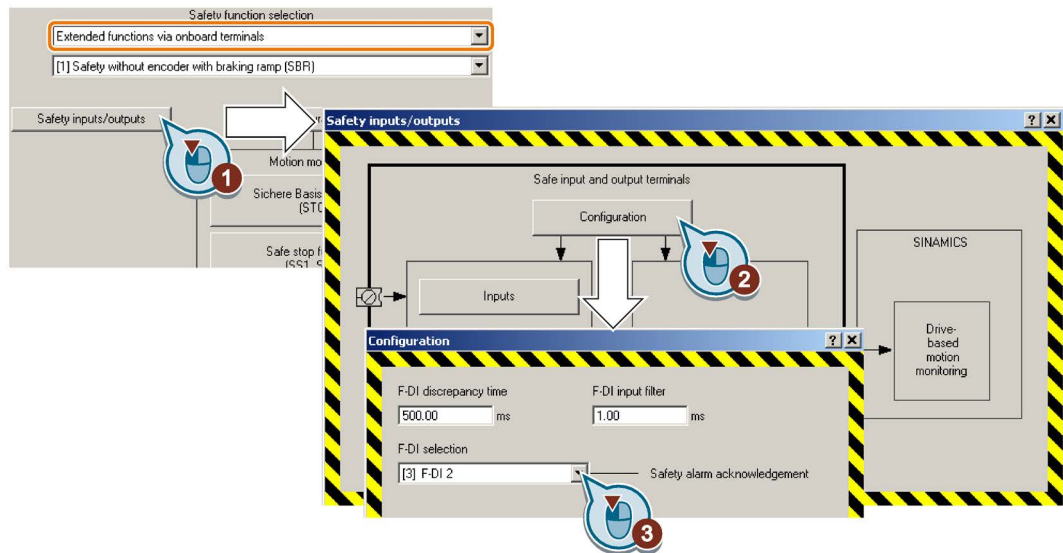


To assign the fail-safe acknowledgement signal to a safety-related input, proceed as follows:

1. Press the "Safety inputs/outputs" button.
2. Press the "Configuration" button.
3. Select a free safety-related input for fail-safe acknowledgment.

If there are no free safety-related inputs available, you have to acknowledge the safety function faults using a different method.

Also see section: Acknowledging using a fail-safe signal (Page 286).



4. Close the screen forms.

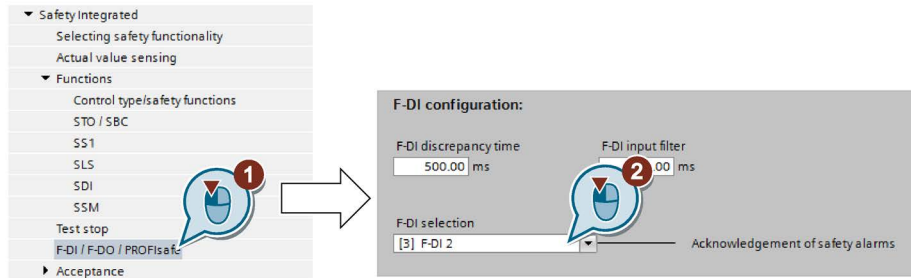
■ You have interconnected the fail-safe acknowledge signal with a safety-related input.

### Procedure with Startdrive



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

1. Select "F-DI / F-DO / PROFIsafe".



2. Select a free safety-related input for the fail-safe acknowledgment signal.

If there are no free safety-related inputs available, you have to acknowledge the safety function faults using a different method.

Also see section: Acknowledging using a fail-safe signal (Page 286).

- You have interconnected the fail-safe acknowledge signal with a safety-related input.

### 5.8.3 Setting STO via the terminals of the PM240-2 Power Module

**Precondition**

You are online with STARTER or Startdrive.

**Procedure with STARTER**

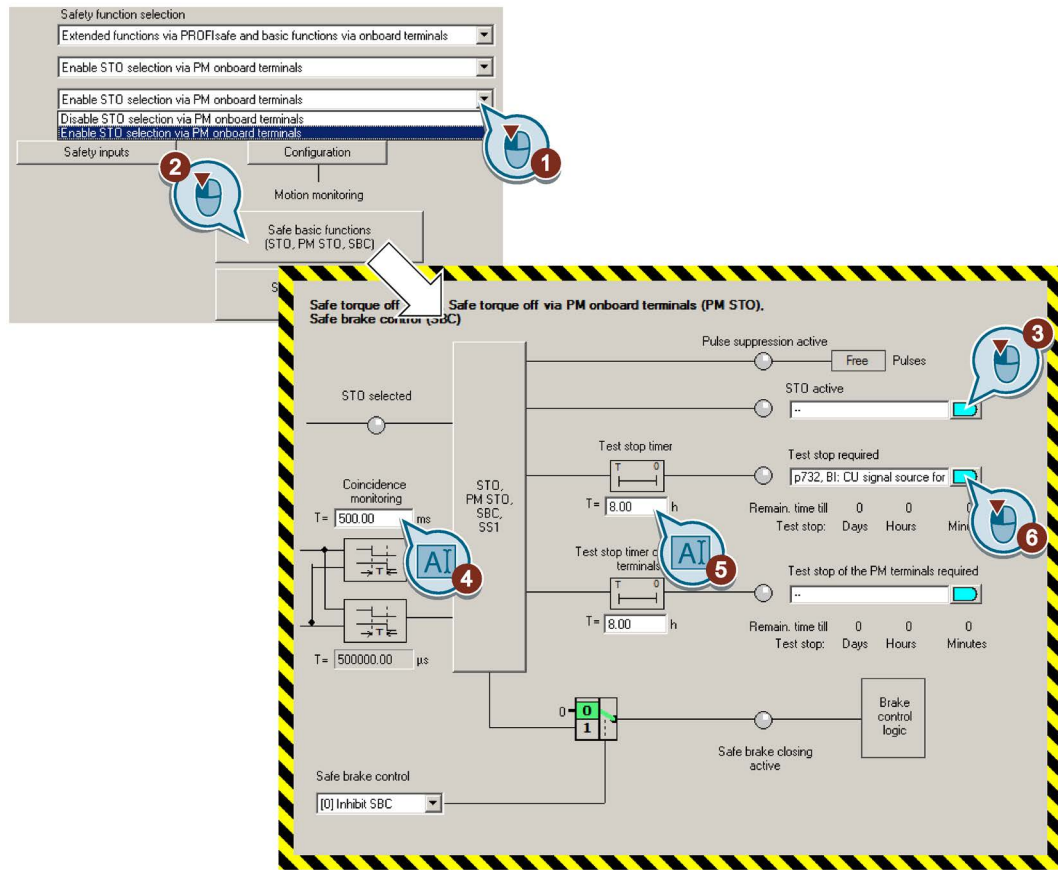


Proceed as follows to set the "STO via the terminals of the PM240-2 Power Module" function:

1. Select "Enable STO selection via PM onboard terminals".

The "Safety basic functions (PM STO)" button appears in STARTER.

2. Press the "Safety basic functions (PM STO)" button.



3. If required, in the higher-level control, interconnect the feedback signal "STO active".
4. Set the discrepancy time (simultaneity monitoring) of the terminals on the Power Module.  
The setting not only applies for the terminals of the Power Module, but also for selecting the basic STO function via F-DI. See also: Setting the filter for safety inputs (Page 142).
5. Set the monitoring time to a value to match your application.
6. Using this signal, the inverter signals that a forced checking procedure (a test stop) is required for the Power Module terminals.
7. Close the screen forms.

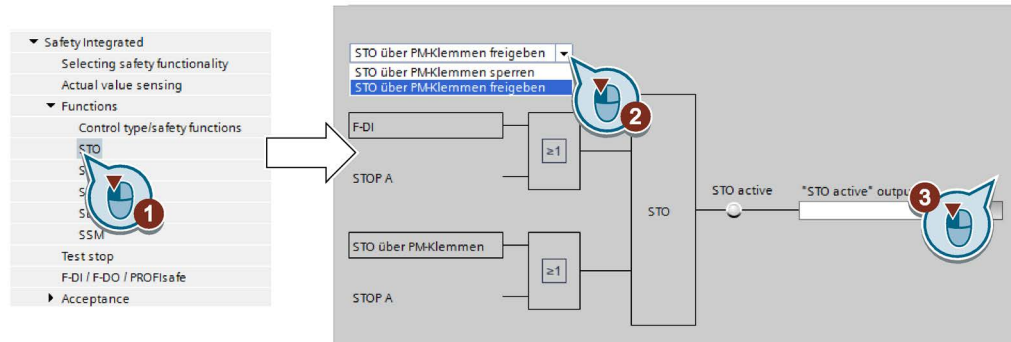


You have set the "STO via the terminals of the PM240-2 Power Module" function.

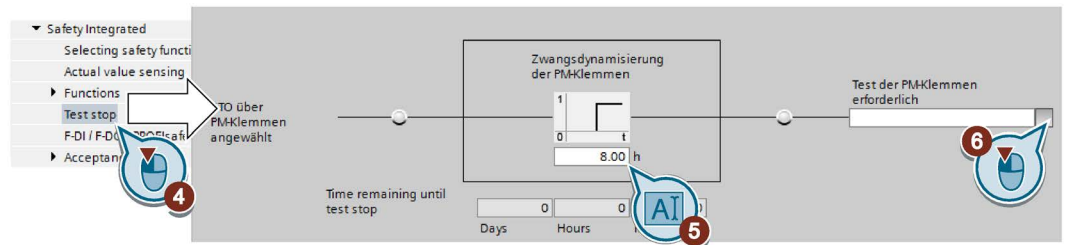
### Procedure with Startdrive

➔ 1 Proceed as follows to set the "STO via the terminals of the PM240-2 Power Module" function:  
2

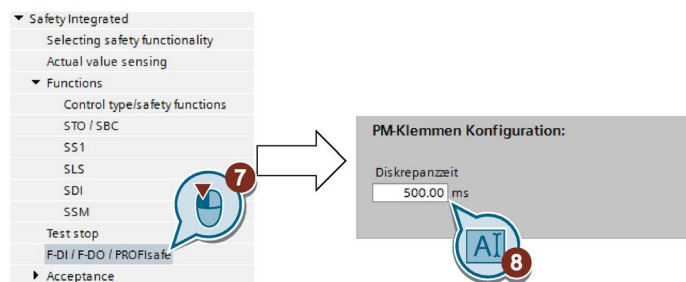
1. Select "STO".
2. Select "Enable STO via PM terminals".



3. If required in the higher-level control, interconnect the feedback signal "STO active".
4. Select "Test stop".



5. Set the monitoring time to a value to match your application.
6. Using this signal, the inverter signals that a forced checking procedure (a test stop) is required for the Power Module terminals.
7. Select "F-DI / F-DO / PROFIsafe".



8. Set the discrepancy time (simultaneity monitoring) of the terminals on the Power Module.

The setting is not only applies for the Power Module terminals, but also for selecting the basic STO function via F-DI. See also: Setting the filter for safety inputs (Page 142).

■ You have set the "STO via the terminals of the PM240-2 Power Module" function.

Parameter	Description	
p9601.7	<b>Enable functions integrated in the drive</b> (factory setting: 0) 1 signal: STO via the Power Module terminals has been enabled	
p9650	<b>F-DI switchover discrepancy time</b> (Factory setting: 500 ms)	
p9661	<b>Forced checking procedure STO via PM terminals time</b> (Factory setting: 8 h)	
r9662	<b>Forced checking procedure STO via PM terminals remaining time</b>	
r9773	<b>SI status</b>	
	.1	1 signal: STO is active in the drive
	.30	1 signal: The forced checking procedure (test stop) of the terminals on the Power Module is required.



## 5.8.4 Setting a safety output

### 5.8.4.1 Setting the forced dormant error detection (test stop)

#### Requirements

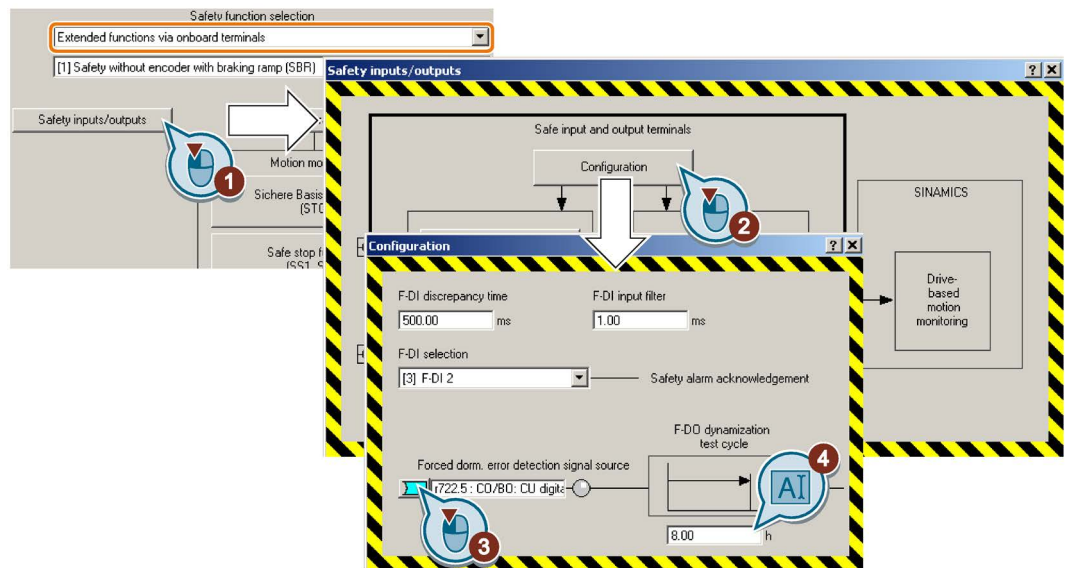
- You are online with STARTER or Startdrive.
- You have selected the extended functions via onboard terminals.

#### Procedure with STARTER



1 To set the forced dormant error detection (test stop) of the safety-related 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 (test stop) of the safety-related output and resets the remaining monitoring time to the value ④.

We recommend that the safety-related output is tested together with the forced dormant error detection of the safety functions. To do this, interconnect the signal source with the same signal as the forced checking procedure of the safety functions. See also Section: Setting the forced dormant error detection (test stop) (Page 132).

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: Setting the forced dormant error detection (test stop) (Page 132).

5. Close the two screen forms.



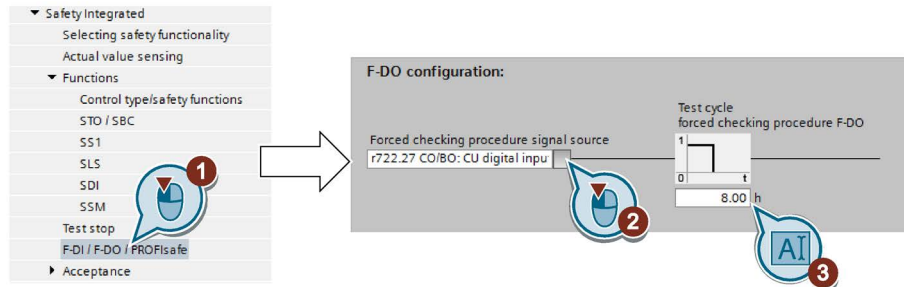
You have defined which signal the inverter uses to start the forced dormant error detection (test stop) of its safety-related output.

**Procedure with Startdrive**



To set the forced dormant error detection (test stop) of the safety-related output, proceed as follows:

1. Select "F-DI / F-DO / PROFIsafe".



2. Interconnect this signal, for example with a digital input or a control bit in the fieldbus. This signal starts the forced checking procedure (test stop) of the safety-related output and resets the remaining monitoring time to the value ④.

We recommend that the safety-related output is tested together with the forced dormant error detection of the safety functions. To do this, interconnect the signal source with the same signal as the forced checking procedure of the safety functions. See also Section: Setting the forced dormant error detection (test stop) (Page 132).

3. 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: Setting the forced dormant error detection (test stop) (Page 132).



You have defined which signal the inverter uses to start the forced dormant error detection (test stop) of its safety-related output.

**Description: Forced dormant error detection of the safety output**

The forced dormant error detection of the safety output is the regular self-test of the inverter, in which the inverter checks whether the output can be shut down (deactivated).

The inverter monitors the regular forced dormant error detection of the safety output using a timer element.

You must start the forced dormant error detection with a signal of your choice.

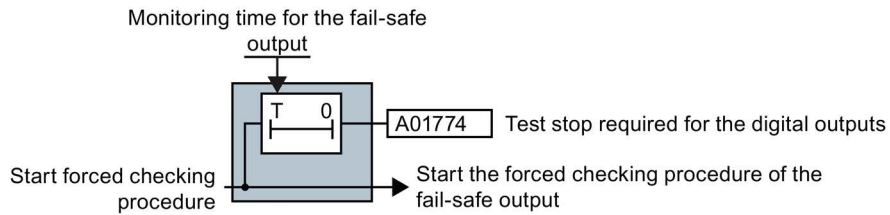


Figure 5-24 Start and monitoring of the forced dormant error detection of the safety output

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

### 5.8.4.2 Output signal and setting the test mode

**Requirements**

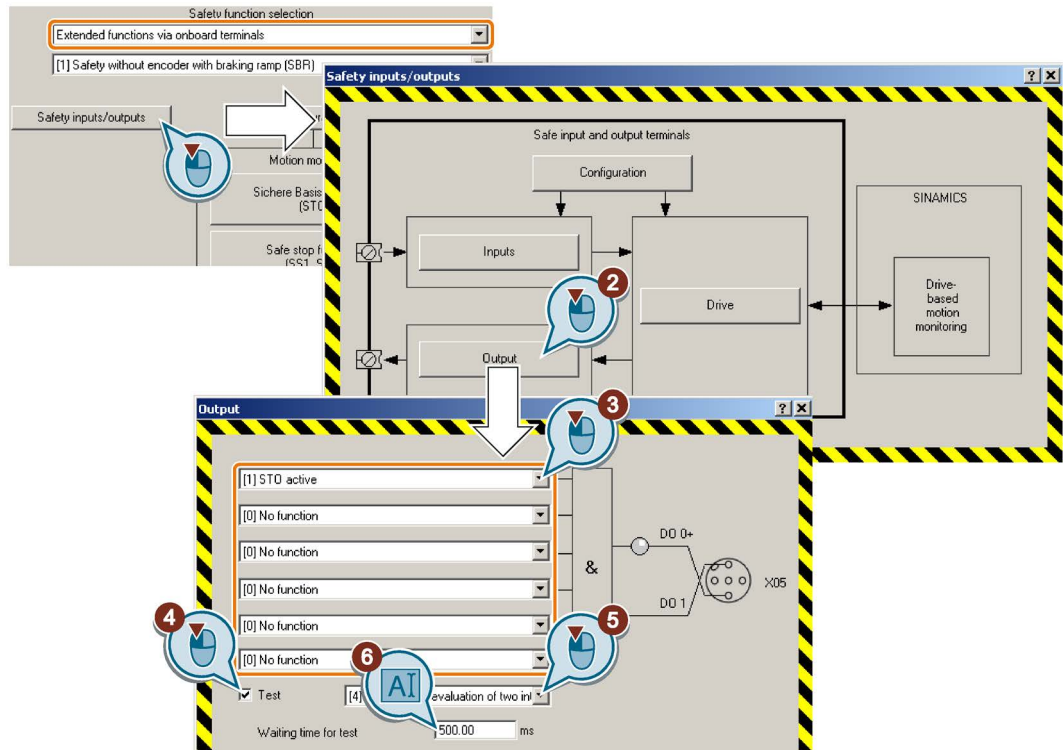
- You are online with STARTER or Startdrive.
- You have selected the extended functions via onboard terminals.

**Procedure with STARTER**



To set the safety-related 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 "Safestate" signal is described below.

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.

4. Activate the test for the safety-related output.
5. Select the test mode that is compatible with your application.

6. Adjust the wait time. The following lower limits apply for the setting:

- The wait time must be longer than the response time  $t_R$  of the connected actuator.
- The wait time must be longer than or equal to 24 ms.
- The wait time must be longer than the time for the input filter of the feedback input (p10017).

See also: Setting the filter for safety inputs (Page 142).

7. Close the screen forms.

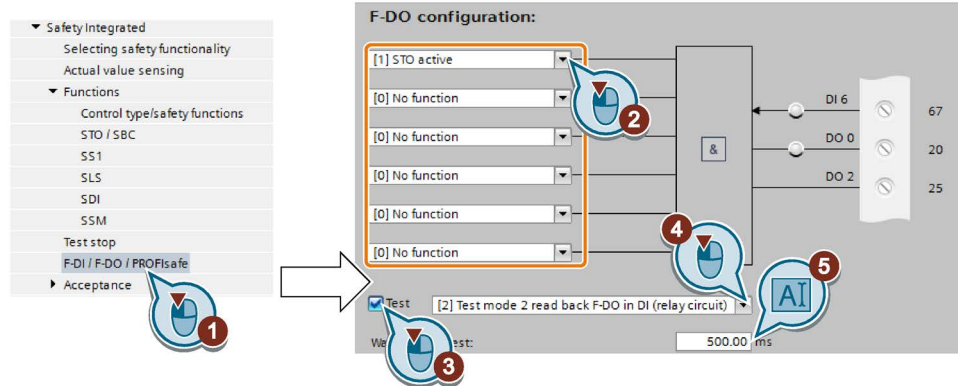
- You have defined which signal the inverter transfers via its safety output, and how the inverter tests its safety-related output.

### Procedure with Startdrive



To set the safety-related output, proceed as follows:

1. Select "F-DI / F-DO / PROFIsafe".



2. Interconnect the status signals of your choice with the fail-safe output. The "Safestate" signal is described below.

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.

3. Activate the test for the safety-related output.

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

5. Adjust the wait time. The following lower limits apply for the setting:

- The wait time must be longer than the response time  $t_R$  of the connected actuator.
- The wait time must be longer than or equal to 24 ms.
- The wait time must be longer than the time for the input filter of the feedback input (p10017).

See also: Setting the filter for safety inputs (Page 142).

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

**Signal "Safestate"**

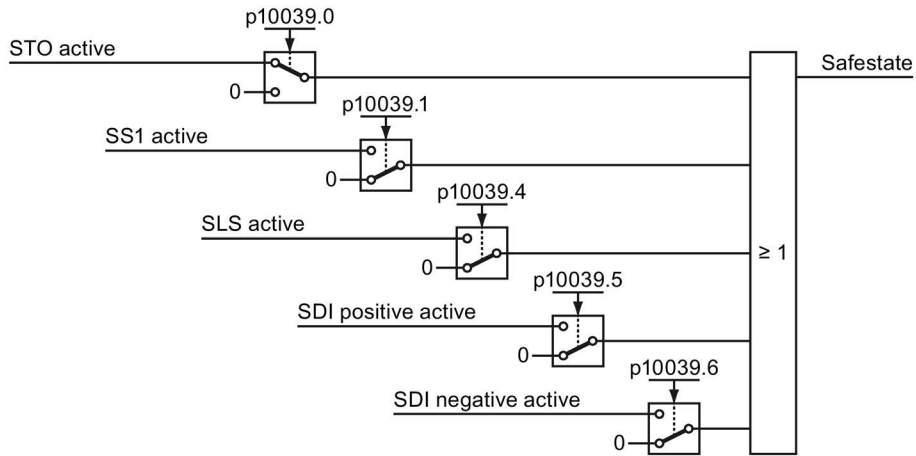


Figure 5-25 The Safestate signal in the factory setting

You must set parameter p10039 in order to adapt the "Safestate" signal.

- STARTER: p10039 can only be accessed via the expert list
- Startdrive: p10039 can only be accessed via the parameter view

**The test mode of the safety-related output**

Using its adjustable test mode, the inverter checks as to whether the safety output can be shut down.

The test mode is aligned according to the interconnection of the safety-related output. For test modes 2 and 3, you must adapt the appropriate wait time to your particular application.

### Test mode 2

For test mode 2, the inverter switches off the two outputs one after the other, and evaluates the feedback via a digital input.

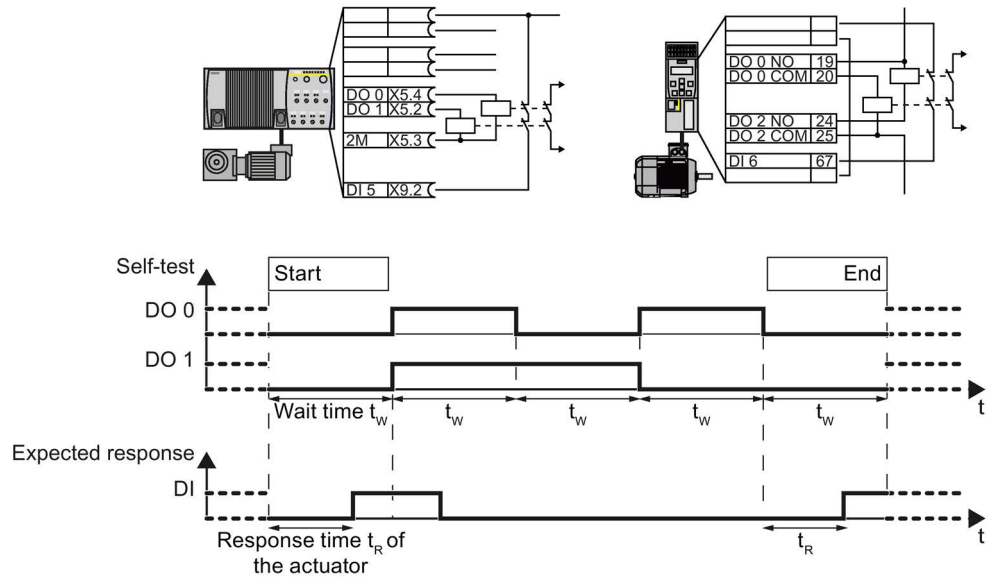


Figure 5-26 Expected response at the digital input for test mode 2

### Test mode 3

When testing the safety-related output, the inverter switches off the two outputs one after the other and evaluates the feedback via a digital input.

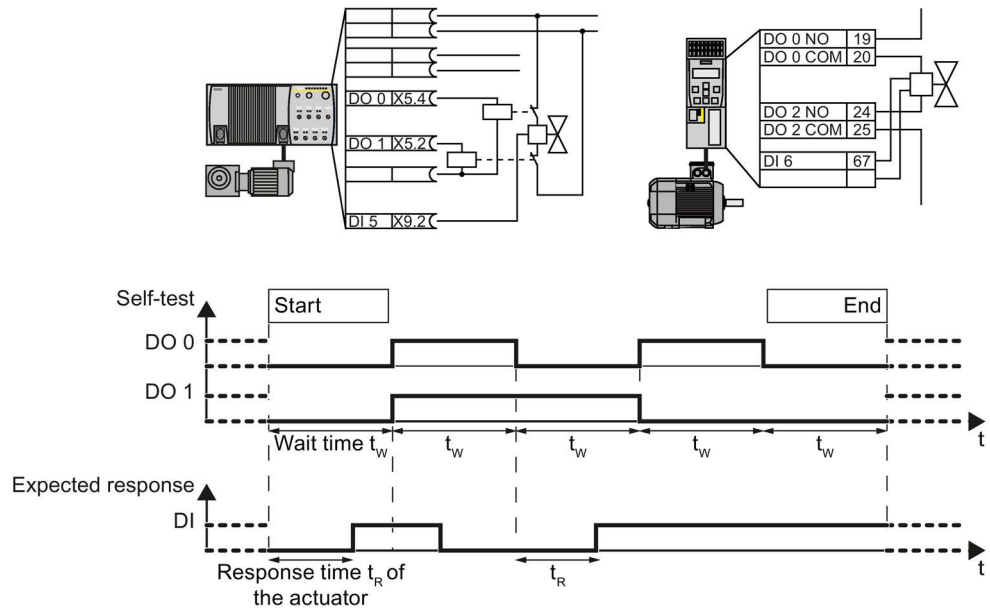


Figure 5-27 Expected response at the digital input for test mode 3

**Test mode 4**

When testing the safety-related output, the inverter switches off the two outputs one after the other.

SINAMIC G120D inverters monitor their transistor outputs using internal signals.

For SINAMICS G120, the connected safety-related input F-DI must monitor its input signals for discrepancy.

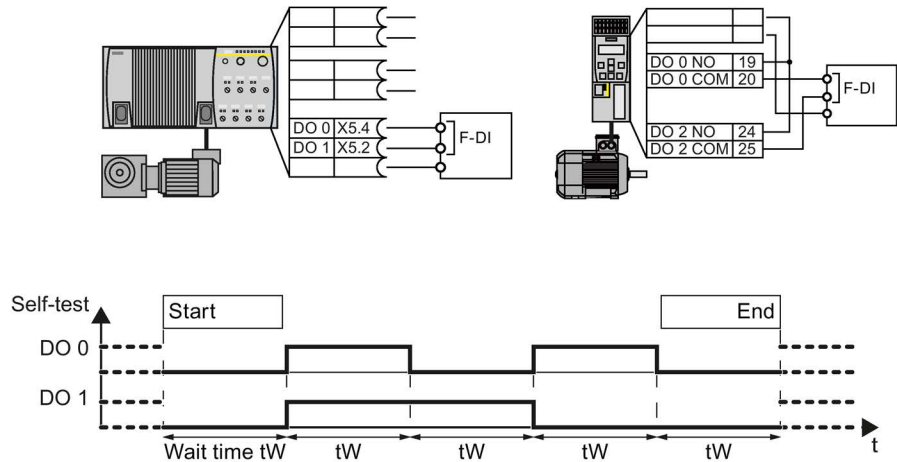


Figure 5-28 Test mode 4

Parameter	Description
p10039	<b>Safe State signal selection</b> (factory setting: 0000 0001 bin) Setting the signals for the "Safe State" signal.
p10042[0...5]	<b>F-DO signal sources</b> (Factory setting: 0) Setting the 6 signal sources for F-DO.
p10046	<b>F-DO feedback signal input activation</b> (Factory setting: 0000 bin) Activation of the feedback input for the safety-related output.
p10047	<b>F-DO test mode</b> (Factory setting: 0100 bin) Setting the test mode for the safety-related output
p10001	<b>Wait time for the forced checking procedure at DO</b> (Factory setting: 500 ms) Within this time, for a forced dormant error detection of the digital output, the signal must have been detected via the corresponding feedback input (p10047). The inverter always waits for a minimum of 24 ms.



## 5.8.5 Setting SS1

### Monitoring modes

You can select between two different monitoring modes of the SS1 function.

Braking ramp monitoring	Acceleration monitoring
<ul style="list-style-type: none"> <li>• Using the SBR (Safe Brake Ramp) function, the inverter monitors whether the motor speed decreases.</li> <li>• 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 that was applicable when SS1 was selected.</li> <li>• When the standstill monitoring threshold is fallen below, the inverter safely switches off the motor torque (STO).</li> </ul>	<ul style="list-style-type: none"> <li>• The inverter monitors the motor speed using the SAM (Safe Acceleration Monitor) function.</li> <li>• The inverter prevents the motor from re-accelerating by continuously adjusting the monitoring threshold to the decreasing speed.</li> <li>• The inverter reduces the monitoring threshold until the "Shutdown speed" has been reached.</li> <li>• The inverter safely switches off the motor torque (STO) if one of the following conditions is fulfilled: <ul style="list-style-type: none"> <li>– The inverter detects that the motor is stationary.</li> <li>– The maximum time until the torque is switched off has expired.</li> </ul> </li> </ul>

### 5.8.5.1 Setting SS1 with braking ramp monitoring

#### Requirement

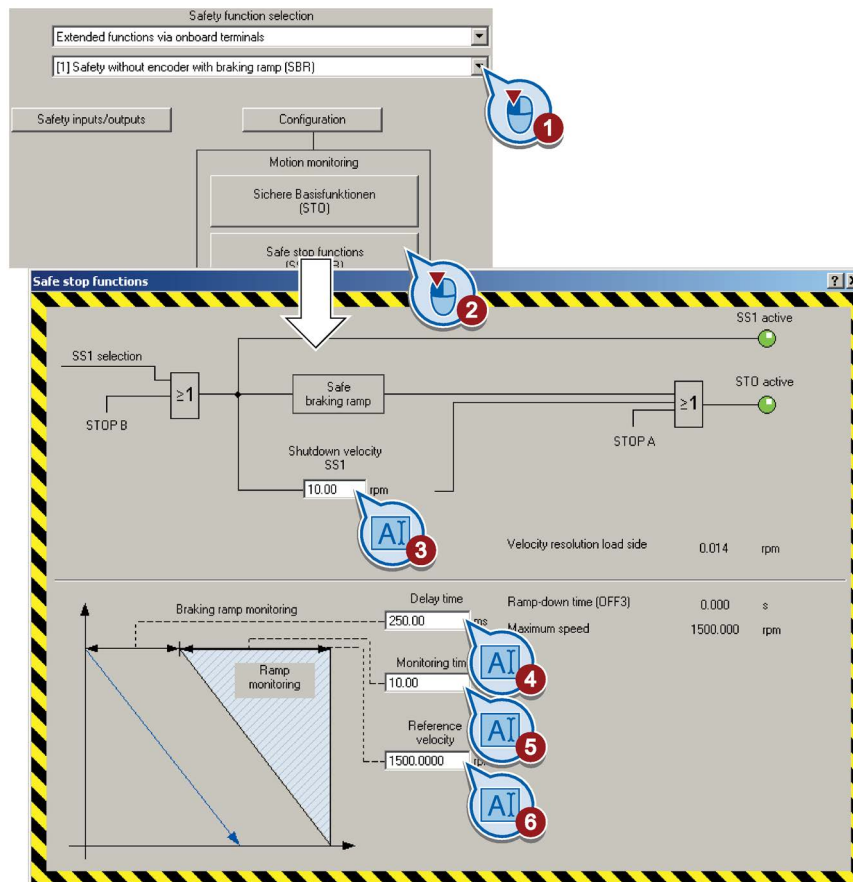
You are online with STARTER or Startdrive.

#### Procedure with STARTER



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. The shutdown speed SS1 is a condition for the transition into the STO function.
4. 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 without a fault.  
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. 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  $\Rightarrow$  monitoring time = ramp-down time (OFF3)  $\times$  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. Set the reference speed to the value of the maximum speed.
7. Close the screen form.

■ You have set the SS1 function with braking ramp monitoring.

### Procedure with Startdrive

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

1. Press the button for the SS1 function.
2. Select "with SBR".

The figure consists of three screenshots from a software interface. The first screenshot shows a 'Safety functions' menu with 'SS1' selected. The second screenshot shows the 'with SBR' configuration screen, which includes a logic diagram with components like 'F-DI / PROFIsafe', 'STOP B', 'STOP A', and 'SS1 active'. The third screenshot shows a detailed graph of the 'Ramp monitoring' function, with a blue curve representing the monitoring time. The graph is annotated with callouts 5, 6, and 7. To the right of the graph are several input fields: 'Delay time' (250.00 ms), 'Ramp-down time (OFF3)' (0.000 s), 'Monitoring time' (10.00 s), 'Reference speed' (1500.0000 rpm), and 'Maximum speed' (1500.000 rpm). A warning icon and text at the bottom state: 'The settings in this screen form apply for the safety functions SS1 and SLS.'

3. The shutdown speed SS1 is a condition for the transition into the STO function.
4. Press the "SBR" button.
5. 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 without a fault. 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.
6. 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.

7. Set the reference speed to the value of the maximum speed.
8. Close the screen forms.

■ You have set the SS1 function with braking ramp monitoring.

**Description: SS1 with braking ramp monitoring**

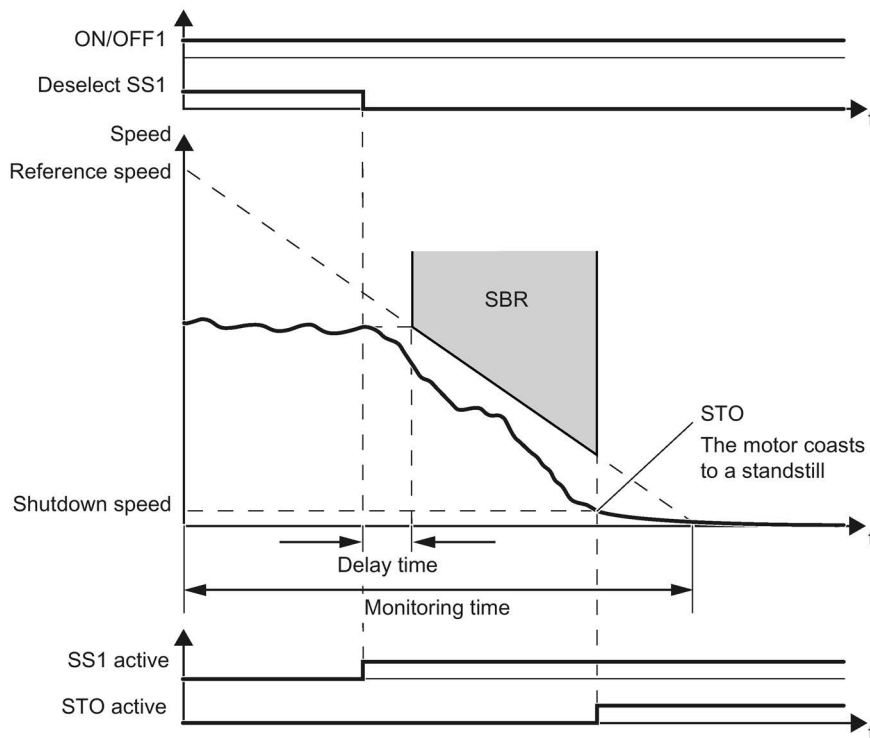


Figure 5-29 SS1 with braking ramp monitoring

**Reference speed and monitoring time**

The two values define the gradient of the SBR monitoring .

**Delay time**

The SBR function only starts after an adjustable time. To begin with, the inverter monitors 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	<b>1 signal:</b> Enable extended functions. <b>0 signal:</b> Disable extended functions.	
p9506	<b>Function specification:</b> (Factory setting: 1)	
	1:	With braking ramp monitoring
	3:	With acceleration monitoring
p9546	<b>SSM speed limit</b> (factory setting: 20 rpm) Only relevant to the SS1 function if p9560 = 0.	
p9560	<b>Shutdown speed</b> (Factory setting: 10 rpm)	
p9581	<b>Reference speed</b> (Factory setting: 1500 rpm)	
p9582	<b>Delay time</b> (Factory setting: 250 ms)	
p9583	<b>Monitoring time</b> (Factory setting: 10 s)	
r9722.1	<b>1 signal:</b> SS1 active	
r9714	<b>Speed diagnostics</b> [rpm]	
	[0]	<b>Load-side speed actual value</b> Electrical speed of the motor. For induction motors, the mechanical speed is obtained from the electrical speed and slip.
	[1]	<b>Actual SAM/SBR speed limit</b>
r9723.16	<b>1 signal:</b> SAM/SBR active	
p1135	<b>OFF3 ramp-down time</b>	
p1226	<b>Standstill detection, speed threshold</b> (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	<b>Standstill detection monitoring time</b> (Value depends on the power unit)	

### 5.8.5.2 Setting SS1 with acceleration monitoring

#### Requirement

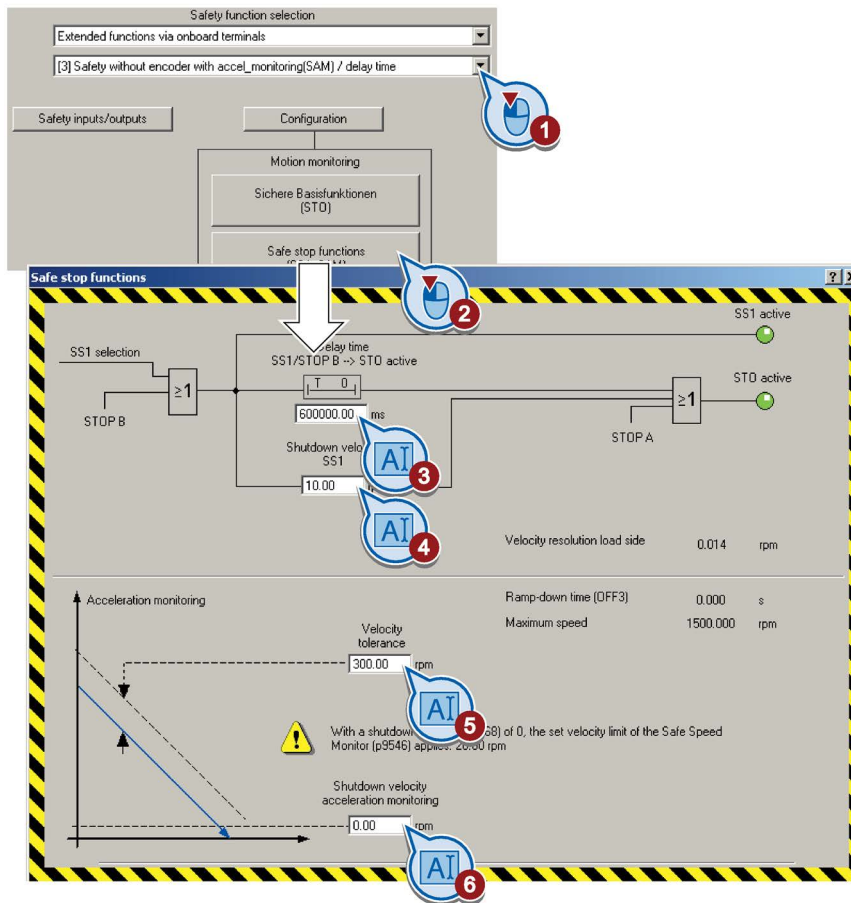
You are online with STARTER or Startdrive.

#### Procedure with STARTER



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. After the "delay time", the inverter safely switches off the motor torque – regardless of the actual speed.
4. The "shutdown speed SS1" is a condition for the transition into the STO function.
5. The "speed tolerance" is used to track the monitoring to the actual speed.
6. The "shutdown speed acceleration monitoring" is a condition for the transition into the STO function.
7. Close the screen form.



You have set the SS1 function with acceleration monitoring.

### Procedure with Startdrive

- ➔ 1 To set the SS1 function with acceleration monitoring, proceed as follows:
- 2 1. Press the button for the SS1 function.
  2. Select "with SAM/delay time".

The image shows a multi-step configuration process for the SS1 function. It starts with a 'Safety functions' menu where SS1 is selected. This leads to a configuration screen for 'with SAM/ delay time' which includes a logic diagram with callouts 1 through 5. Callout 1 points to the SS1 selection, 2 to the 'with SAM/ delay time' dropdown, 3 to the 'Shutdown speed SS1' field (set to 10.00 rpm), 4 to the 'STOP A' input, and 5 to the 'Delay time SS1/STOP B' field (set to 600000.00 ms). Below this is an 'Acceleration monitoring' screen with callouts 6 and 7. Callout 6 points to the 'Velocity tolerance' field (set to 300.00 rpm) and callout 7 points to the 'Shutdown speed acceleration monitoring' field (set to 0.00 rpm). A warning icon and text note that with a shutdown speed of 0, the speed limit of the Safe Speed Monitor is effective at 20.00 rpm. A final note states that the settings apply for the safety function SS1.

3. After the "delay time", the inverter safely switches off the motor torque – regardless of the actual speed.
  4. The "shutdown speed SS1" is a condition for the transition into the STO function.
  5. Press the "SAM" button.
  6. The "speed tolerance" is used to track the monitoring to the actual speed.
  7. The "shutdown speed acceleration monitoring" is a condition for the transition into the STO function.
  8. Close the screen forms.
- You have set the SS1 function with acceleration monitoring.

**Description: SS1 with acceleration monitoring**

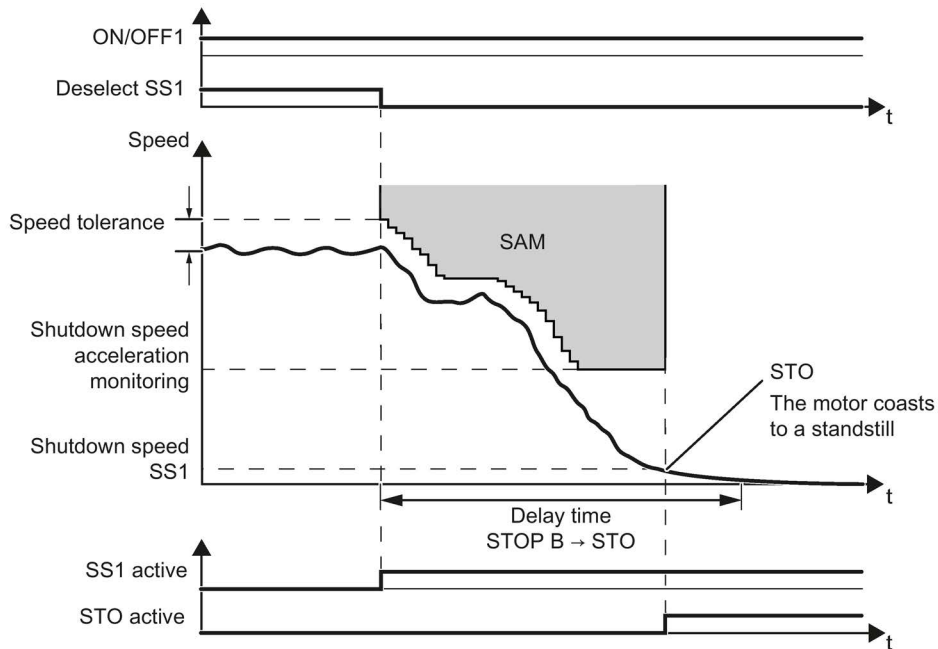


Figure 5-30 SS1 with acceleration monitoring

**Speed tolerance**

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

**Shutdown speed acceleration monitoring**

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

**Shutdown speed SS1 and delay time**

The inverter safely switches off the motor torque with the STO function 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	<b>1 signal:</b> Enable extended functions. <b>0 signal:</b> Disable extended functions.	
p9506	<b>Function specification:</b> (Factory setting: 1)	
	3:	With acceleration monitoring
p9548	<b>Speed tolerance</b> (Factory setting: 300 rpm)	
p9556	<b>Delay time STOP B → STO</b> (Factory setting: 600000 ms)	
p9560	<b>Shutdown speed SS1</b> (Factory setting: 10 rpm)	
p9568	<b>Shutdown speed acceleration monitoring</b> (Factory setting: 0 rpm)	
r9714	<b>Speed diagnostics</b> [rpm]	
	[0]	<b>Load-side speed actual value</b> Electrical speed of the motor. For induction motors, the mechanical speed is obtained from the electrical speed and slip.
	[1]	<b>Actual SAM/SBR speed limit</b>
r9722.1	<b>1 signal:</b> SS1 active	
r9723.16	<b>1 signal:</b> SAM/SBR active	
p1226	<b>Standstill detection, speed threshold</b> (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	<b>Standstill detection monitoring time</b> (Value depends on the power unit)	

## 5.8.6 Setting SLS

### 5.8.6.1 Setting the monitoring functions

#### Requirement

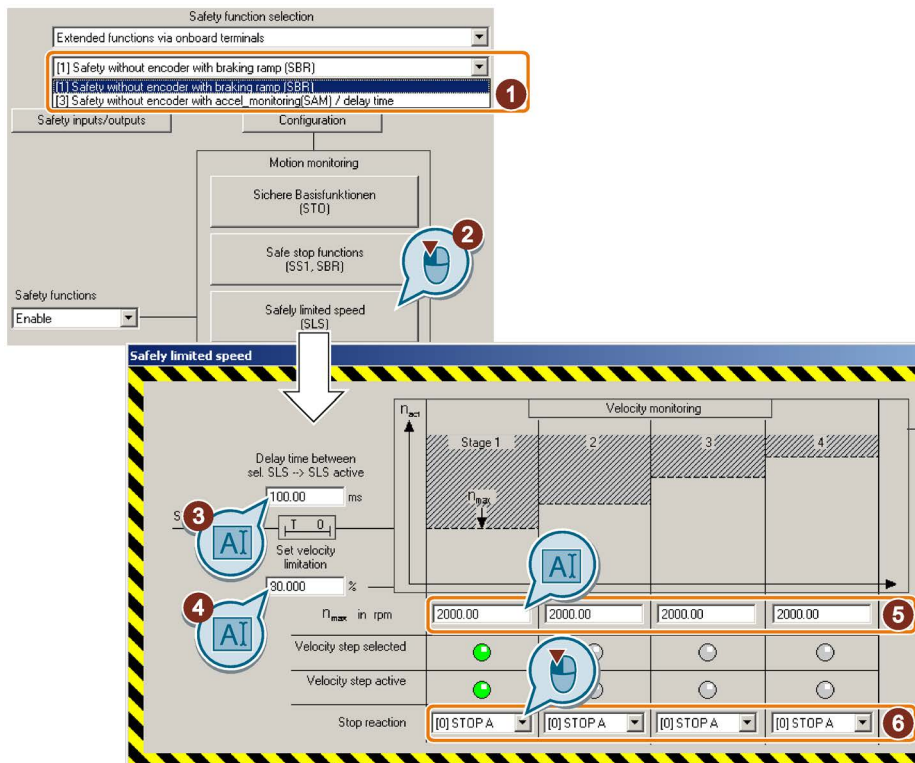
You are online with STARTER or Startdrive.

#### Procedure with STARTER



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 SLS safety function.



3. The delay time only appears if you have selected acceleration monitoring (SAM). 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 down to the lowest SLS level.
4. Setpoint speed limiting as a % of the currently selected SLS level. The inverter limits the speed to this value when SLS is active.
5. Load speed to be monitored. Levels 2 ... 4 are only possible when PROFIsafe is selected as interface.

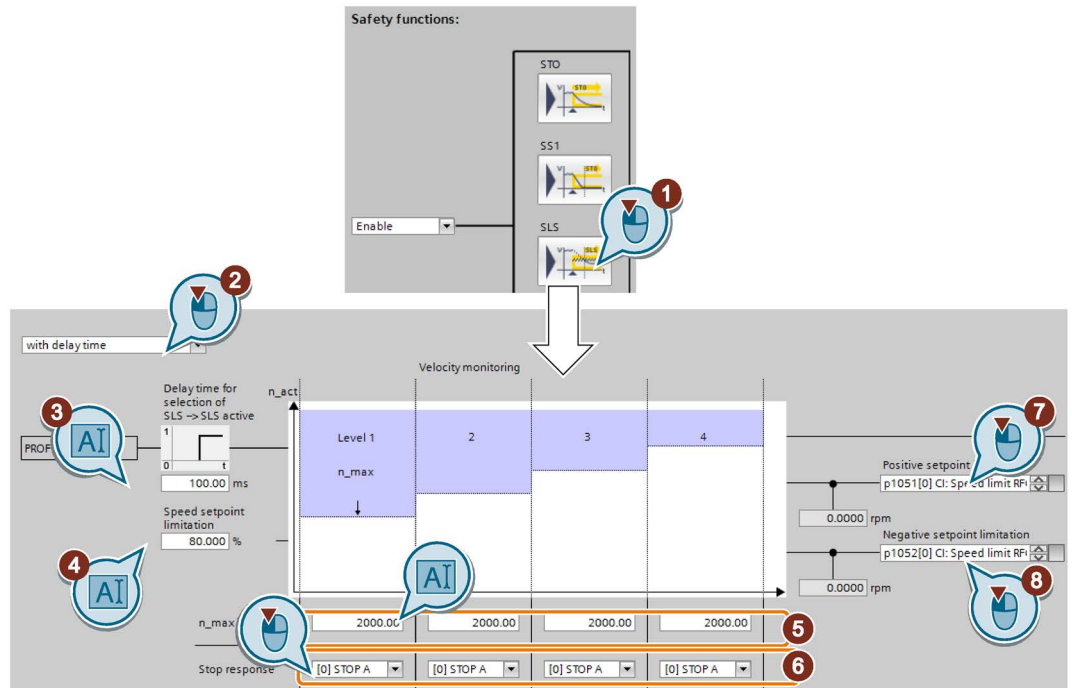
6. Response when the monitoring function responds.  
See also section: Stop responses (Page 280).

7. Close the screen form.

■ You have set the SLS function.

### Procedure with Startdrive

- ➔ 1 To set the SLS function, proceed as follows:  
2 1. Press the button for the SLS function.



2. Select between one of the two monitoring modes:

- with delay time
- with SBR

3. If you have selected "with delay time"

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 down to the lowest SLS level.

If you have selected "with SBR": Press the button to set the safe braking ramp (SBR), also see: Setting SS1 with braking ramp monitoring (Page 162).

4. Setpoint speed limiting as a % of the currently selected SLS level, see also ⑦, ⑧.

5. Load speed to be monitored.

Levels 2 ... 4 are only possible when PROFIsafe is selected as interface.

6. Response when the monitoring function responds.

See also section: Stop responses (Page 280).

7. If you leave this signal interconnection at the factory setting, when SLS is selected, the inverter limits the speed setpoint in the positive direction.

8. If you leave this signal interconnection at the factory setting, when SLS is selected, the inverter limits the speed setpoint in the negative direction.
  9. Close the screen form.
- You have set the SLS function.

**Description of the SLS function**

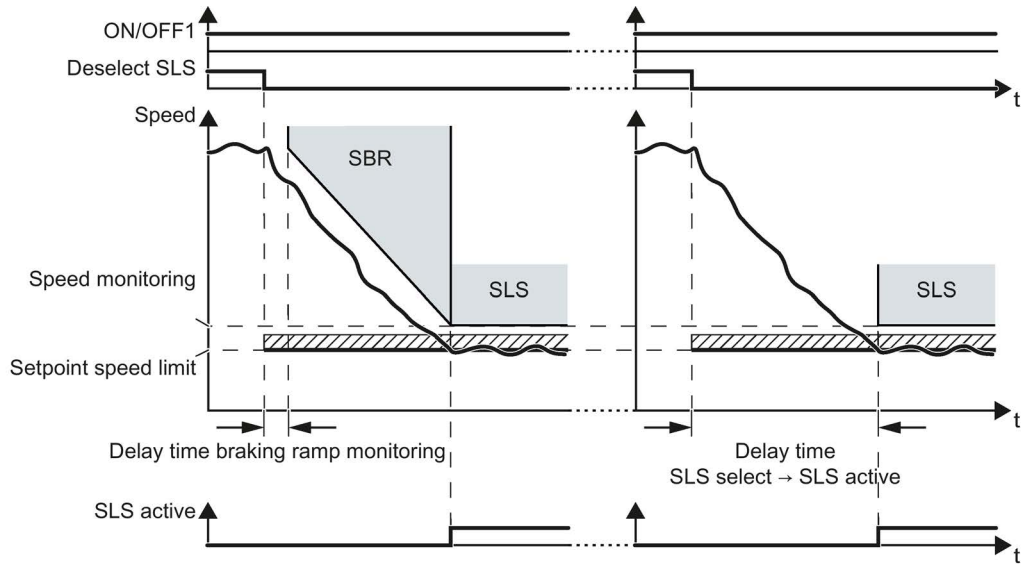


Figure 5-31 Behavior after selecting SLS. Left: with braking ramp monitoring; right: without braking ramp monitoring

After selecting SLS, the inverter 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 162).

Parameter	Description
p1051	<b>Speed limit RFG positive direction of rotation</b> (Factory setting depends on the Control Unit)
p1052	<b>Speed limit RFG negative direction of rotation</b> (Factory setting depends on the Control Unit)
p1135	<b>OFF3 ramp-down time</b>
p9501.00	<b>1 signal:</b> Enable SLS and extended functions. <b>0 signal:</b> Inhibit SLS and extended functions.
p9506	<b>Function specification:</b> (Factory setting: 1)
	1: With braking ramp monitoring
	3: Without braking ramp monitoring
p9531[0...3]	<b>Speed monitoring</b> (Factory setting for all levels: 2000 rpm)
p9533	<b>Setpoint speed limiting</b> (Factory setting: 80 %) The inverter limits the setpoint to the value r9733. $r9733[0] = p9531[x] \times p9533$ .
p9551	<b>Delay time SLS selection → SLS active</b> (Factory setting: 100 ms) Not active for braking ramp monitoring.
p9563[0...3]	<b>SLS-specific stop response</b> (Factory setting: STOP A)
	0: STOP A
	1: STOP B
p9581	<b>Reference speed</b> (Factory setting: 1500 rpm)
p9582	<b>Delay time</b> (Factory setting: 250 ms)
p9583	<b>Monitoring time</b> (Factory setting: 10 s) The gradient of the braking ramp depends on p9581 and p9583.
r9714	<b>Speed diagnostics [rpm]</b>
	[0] <b>Load-side speed actual value</b> Electrical speed of the motor. For induction motors, the mechanical speed is obtained from the electrical speed and slip.
	[1] <b>Actual SAM/SBR speed limit</b>
	[2] <b>Actual SLS speed limit</b>
r9722.04	<b>1 signal:</b> SLS active <b>0 signal:</b> SLS not active
r9733	<b>Effective setpoint speed limiting</b>
	[0] Positive setpoint limitation
	[1] Negative setpoint limitation
	[2] Absolute setpoint speed limitation

### 5.8.6.2 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 of the inverter.

STARTER offers you the possibility to temporarily deactivating speed limiting.

#### Requirement

You are online with STARTER or Startdrive.

#### Procedure with STARTER and Startdrive



To prepare for acceptance, proceed as follows:

1. Open the screen form for the "Acceptance mode".

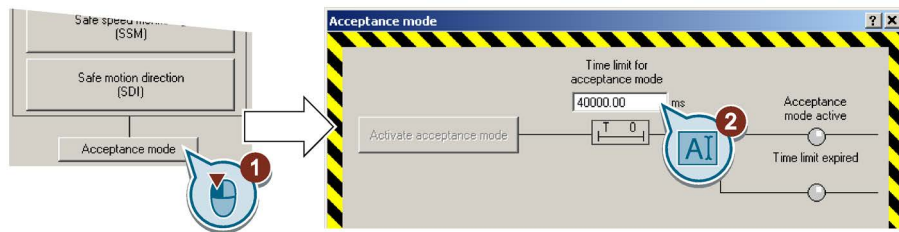


Figure 5-32 Set the time for the acceptance mode in STARTER

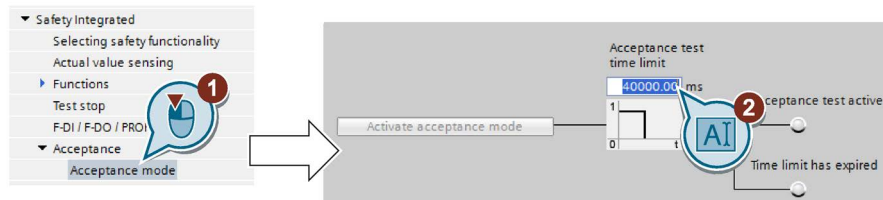


Figure 5-33 Set the time for the acceptance mode in Startdrive

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. Only applies to STARTER: Close the screen form.



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

Parameter	
p9558	<b>Acceptance test mode time limit</b> (factory setting 40000 ms) Maximum time limit: 100 seconds.

## 5.8.7 Setting SSM

### Requirement

You are online with STARTER or Startdrive.

### Procedure with STARTER and Startdrive

➔ 1 To set the SSM function, proceed as follows:

1. Open the screen form for the SSM safety function.

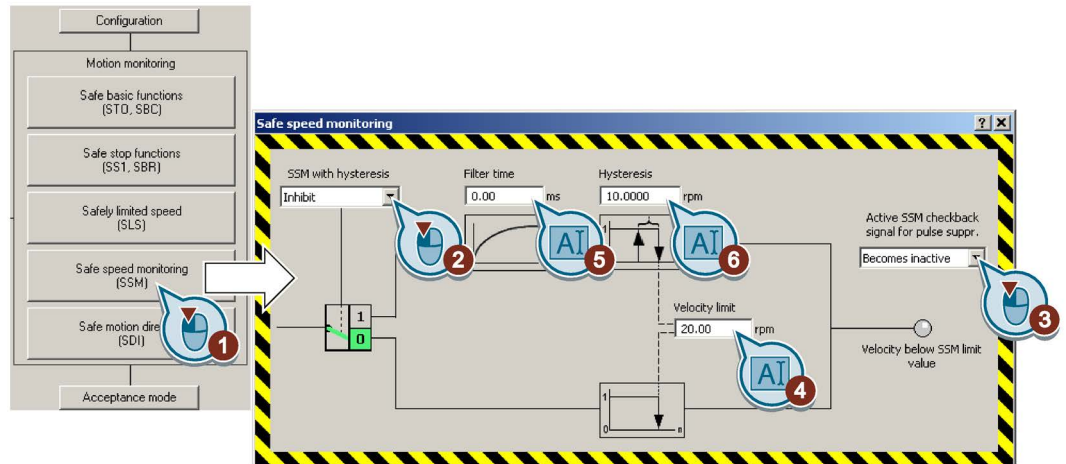


Figure 5-34 Open the screen form for SSM in STARTER

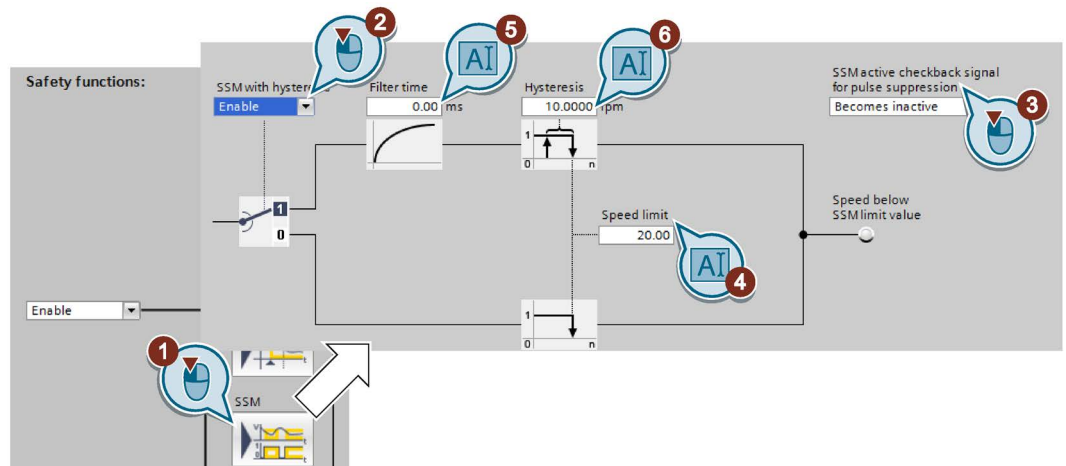


Figure 5-35 Open the screen form for SSM in Startdrive

2. Selects the function with or without hysteresis.
3. Set the behavior when the motor is switched off.

If you have set the SSM feedback signal for pulse cancellation as "remains active", when switching on the motor, you must maintain a specific signal sequence. See also Section: Switching on the motor when SSM is active (Page 264).

4. Set the speed to be monitored.

5. You only have to set the filter time when the hysteresis ② is enabled.

6. You only have to set the hysteresis when hysteresis is enabled ②.

■ You have set the SSM function.

The SSM function is active immediately after commissioning has been completed.

### SSM without hysteresis

#### Speed monitoring

- When the motor is switched on, the inverter compares the load speed with the speed limit.

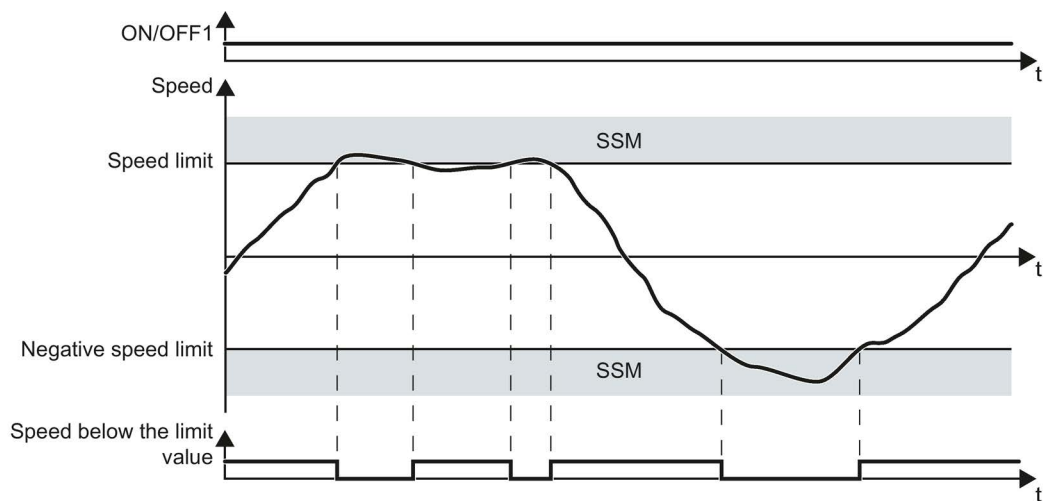


Figure 5-36 Time response of the SSM safety function without hysteresis

Parameter	Description
p9501.00	<b>1 signal:</b> Enable extended functions. <b>0 signal:</b> Disable extended functions.
p9501.16	<b>1 signal:</b> Enable hysteresis and filtering <b>0 signal:</b> Disable hysteresis and filtering
p9546	<b>Speed limit</b> (Factory setting: 20 rpm)
r9714[0]	<b>Load-side speed actual value</b> [rpm] Electrical speed of the motor. For induction motors, the mechanical speed is obtained from the electrical speed and slip.
r9722.15	<b>1 signal:</b> 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.

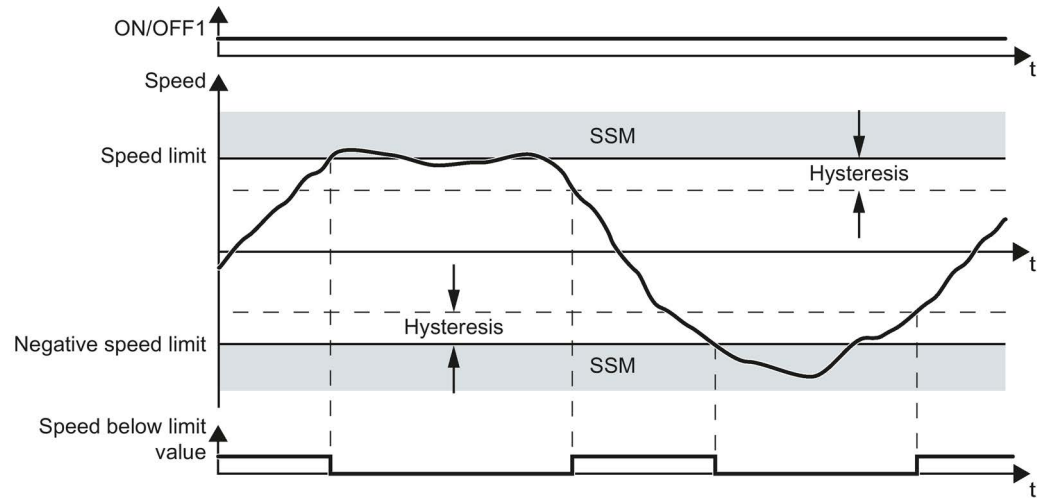


Figure 5-37 Time response of the SSM safety function with hysteresis

### Filter

The signal filters smooths the speed measured by the inverter. Use the filter if you wish to monitor speeds that lie just below the speed limit.

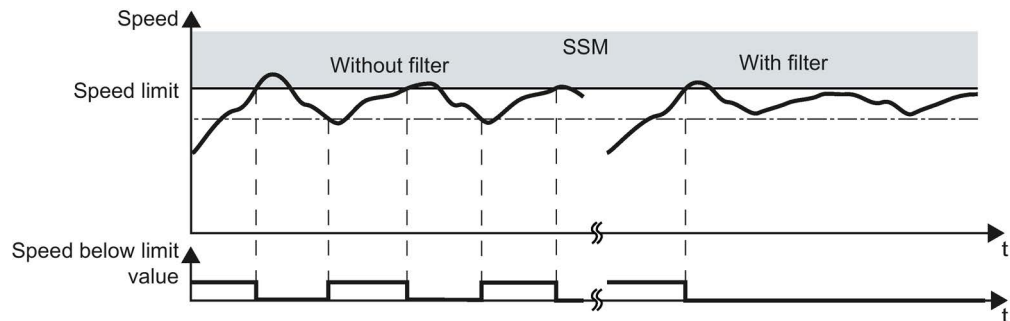


Figure 5-38 Mode of operation of the filter of the SSM function

Parameter	Description
p9501.00	<b>1 signal:</b> Enable extended functions. <b>0 signal:</b> Disable extended functions.
p9501.16	<b>1 signal:</b> Enable hysteresis and filtering <b>0 signal:</b> Disable hysteresis and filtering
p9545	<b>Filter time</b> (Factory setting: 0 ms)
p9546	<b>Speed limit</b> (Factory setting: 20 rpm)
p9547	<b>Hysteresis</b> (Factory setting: 10 rpm)
r9714[0]	<b>Load-side speed actual value</b> [rpm] Electrical speed of the motor. For induction motors, the mechanical speed is obtained from the electrical speed and slip.
r9722.15	<b>1 signal:</b> Absolute value of the speed is lower than the speed limit

### Feedback signal SSM when the motor is switched off

You can select as to whether the SSM function should remain active when the motor is switched off.

The following occurs if SSM remains active:

- With the motor switched off, the inverter freezes the "Speed below limit value" signal.
- When the motor is switched off, STO is active.

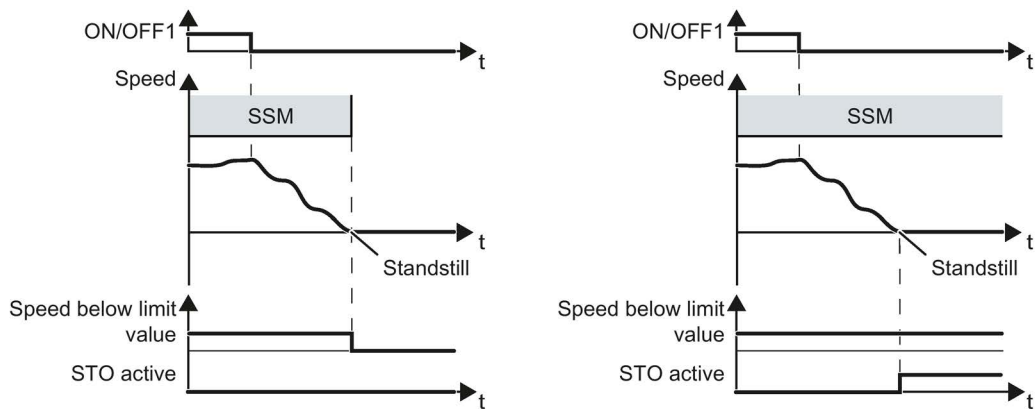


Figure 5-39 Feedback signal SSM when the motor is switched off  
Left: SSM becomes inactive. Right: SSM remains active

See also Section: Switching off the motor when SSM is active (Page 259).

Parameter	Description
p9509.00	<b>1 signal:</b> SSM becomes inactive when the motor is switched off <b>0 signal:</b> SSM remains active when the motor is switched off

## 5.8.8 Setting SDI

### 5.8.8.1 Setting the monitoring functions

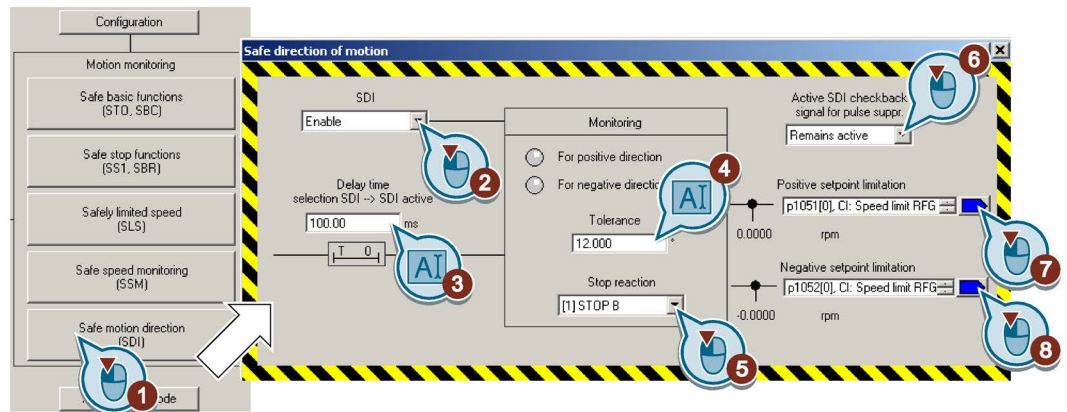
#### Requirement

You are online with STARTER or Startdrive.

#### Procedure with STARTER

- ➔ 1 Proceed as follows to set the SDI function:  
2

1. Press the button for SDI.



2. Enable the function.
3. Delay time up to active monitoring.
4. Tolerance for motion in the monitored direction.
5. Response when the monitoring function responds.  
See also Section: Stop responses (Page 280).
6. The response when the motor is switched off.  
See also Section: Switching off the motor when SDI is active (Page 269).
7. If you leave this signal interconnection at the factory setting, when SDI- is selected, the inverter limits the speed.
8. If you leave this signal interconnection at the factory setting, when SDI+ is selected, the inverter limits the speed.
9. Close the screen form.

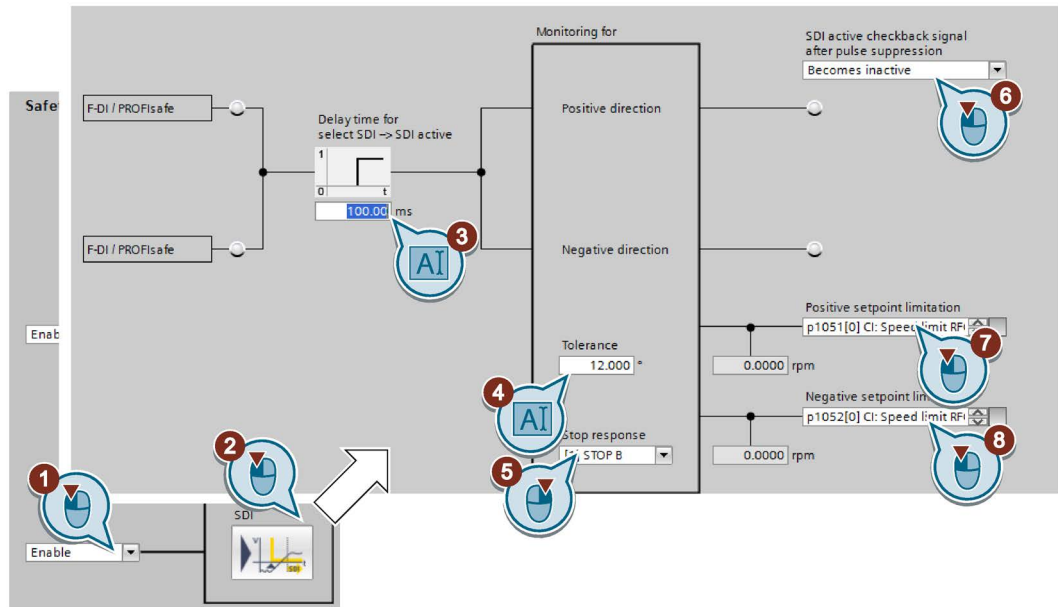
■ You have set the SDI function.

**Procedure with Startdrive**



Proceed as follows to set the SDI function:

1. Enable the SDI safety function.
2. Press the button for the SDI safety function



3. Delay time up to active monitoring.
4. Tolerance for motion in the monitored direction.
5. Response when the monitoring function responds.  
See also Section: Stop responses (Page 280).
6. Behavior when the motor is switched off.  
See also Section: Switching off the motor when SDI is active (Page 269).
7. If you leave this signal interconnection at the factory setting, when SDI- is selected, the inverter limits the speed setpoint.
8. If you leave this signal interconnection at the factory setting, when SDI+ is selected, the inverter limits the speed setpoint.
9. Close the screen form.

■ You have set the SDI function.

## The SDI function

### Time response

If you select SDI, the inverter limits the speed or velocity setpoint to a value of zero in the inhibited direction of rotation.

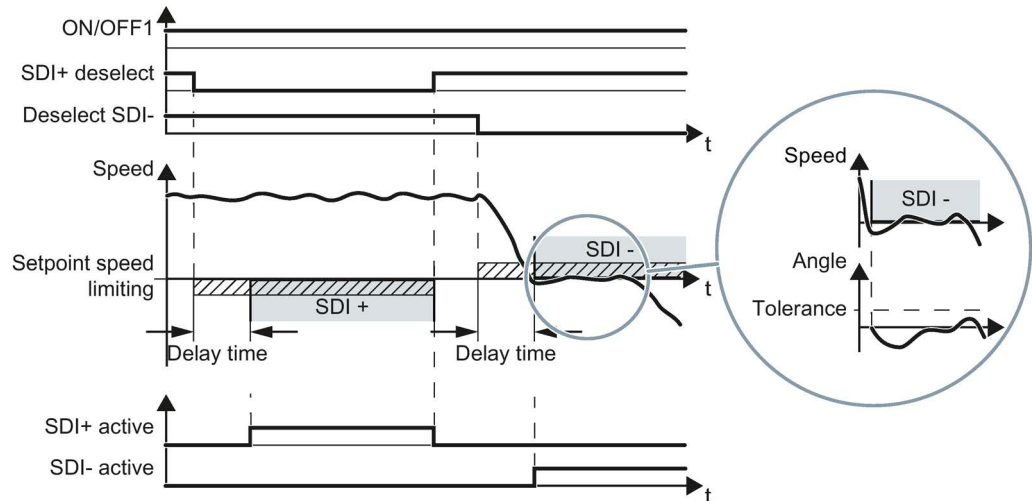


Figure 5-40 Delay time and tolerance

### Delay time

The inverter monitors the direction of rotation of the motor after the delay time has expired. 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 inverter brakes the motor with the OFF3 ramp-down time.

### Tolerance

The inverter permits brief motion in the monitored direction, for example for brief speed overshoots after braking down to standstill. To do this, the inverter 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 as to whether the SDI function should remain active when the motor is switched off.

- With the motor switched off, the inverter freezes the "SDI active" signal.
- When the motor is switched off, STO is active.

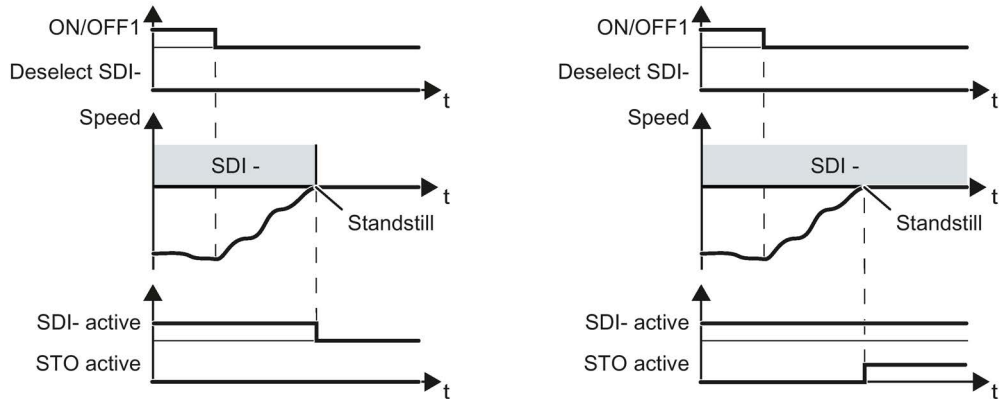


Figure 5-41 Feedback signal SDI when the motor is switched off  
 Left: SDI becomes inactive. Right: SDI remains active

See also Section: Switching off the motor when SDI is active (Page 269).

Parameter	Description
p1051	<b>Speed limit RFG positive direction of rotation</b> (Factory setting depends on the Control Unit)
p1052	<b>Speed limit RFG negative direction of rotation</b> (Factory setting depends on the Control Unit)
p1135	<b>OFF3 ramp-down time</b>
p9501.00	<b>1 signal:</b> Enable extended functions. <b>0 signal:</b> Disable extended functions.
p9501.17	<b>1 signal:</b> Enable SDI <b>0 signal:</b> Inhibit SDI
p9509.08	<b>1 signal:</b> SDI becomes inactive when the motor is switched off <b>0 signal:</b> SDI remains active when the motor is switched off
p9564	<b>Tolerance</b> (Factory setting: 12 degrees)
p9565	<b>Delay time</b> (Factory setting: 100 ms)
p9566	<b>Stop response</b> (Factory setting: 1)
	0: STOP A
	1: STOP B
r9714[0]	<b>Load-side speed actual value [rpm]</b> Electrical speed of the motor. For induction motors, the mechanical speed is obtained from the electrical speed and slip.
r9722.12	<b>1 signal:</b> SDI positive active
r9722.13	<b>1 signal:</b> SDI negative active
r9733	<b>Effective setpoint speed limiting</b>
	[0] Positive setpoint limitation
	[1] Negative setpoint limitation
	[2] Absolute setpoint speed limitation

### 5.8.8.2 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 of the inverter.

STARTER offers you the possibility to temporarily deactivating speed limiting.

#### Requirement

You are online with STARTER or Startdrive.

#### Procedure with STARTER and Startdrive



To prepare for acceptance, proceed as follows:

1. Open the screen form for the "Acceptance mode".



Figure 5-42 Set the time for the acceptance mode in STARTER

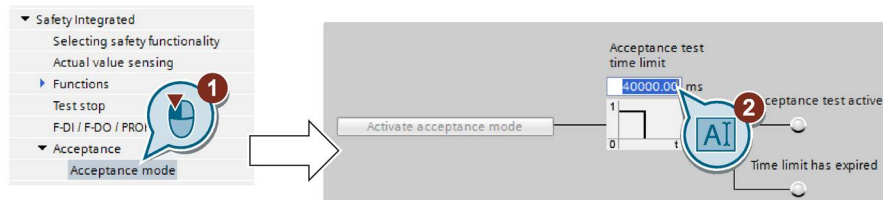


Figure 5-43 Set the time for the acceptance mode in Startdrive

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. Only applies to STARTER: Close the screen form.



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

Parameter	
p9558	<b>Acceptance test mode time limit</b> (factory setting 40000 ms) Maximum time limit: 100 seconds.



## 5.8.9 Final steps when commissioning online

### Activate settings

#### Requirement

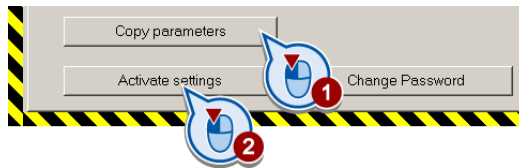
You are online with STARTER or Startdrive online.

#### Procedure with STARTER



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

2 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.

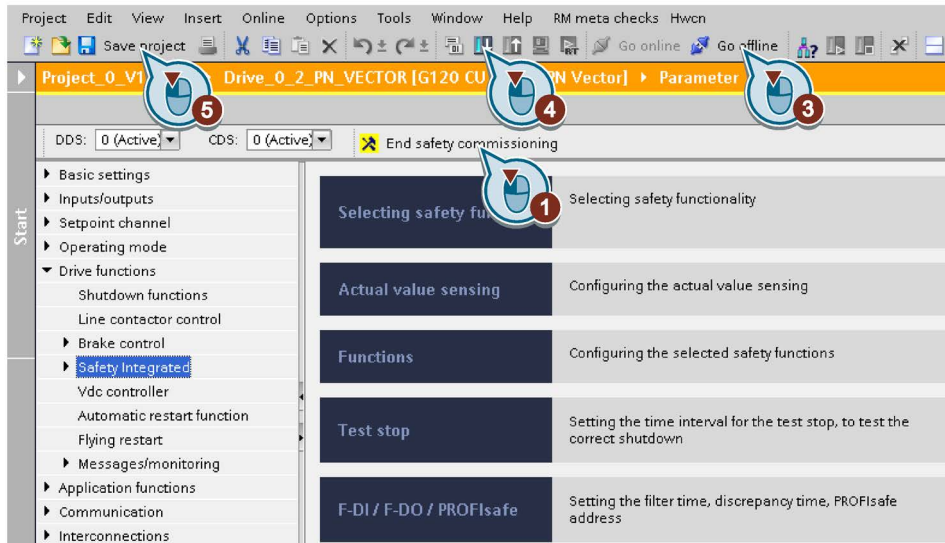
■ Your settings are now active.

**Procedure with Startdrive**



To activate the settings of the safety functions in the drive, proceed as follows:

1. Click the "End safety commissioning" button.



2. Confirm the prompt for saving your settings (copy RAM to ROM).
3. Disconnect the online connection.
4. Select the "Load from device (software)" button.
5. Save the project.
6. Switch off the inverter supply voltage.
7. Wait until all LEDs on the inverter go dark (no voltage condition).
8. Switch on the inverter supply voltage again.



Your settings are now active.

Parameter	Description
p9700 = 57 hex	<b>SI copy function</b> (factory setting: 0) Start SI parameter copy function.
p9701 = AC hex	<b>Confirm data change</b> (factory setting: 0) Confirm total data change.
p0010 = 0	<b>Drive commissioning parameter filter</b> 0: Ready
p0971 = 1	<b>Save parameter</b> 1: Save the drive object (copy from RAM to ROM) After the inverter has saved the parameters in a non-volatile fashion, then p0971 = 0.

## Checking the connection of digital inputs

The simultaneous connection of digital inputs with a safety function and a "standard" function may lead to the drive behaving in unexpected ways.

If you control the safety functions in the inverter using digital inputs, you must check whether these digital inputs are connected to a "standard" function.

### Procedure with STARTER



1 Proceed as follows to check as to whether the safety-related inputs are only used for the safety functions:

1. In the project navigator, select the inputs/outputs.
2. Select the screen for the digital inputs.
3. Remove all digital input interconnections that you use as safety-related input F-DI:

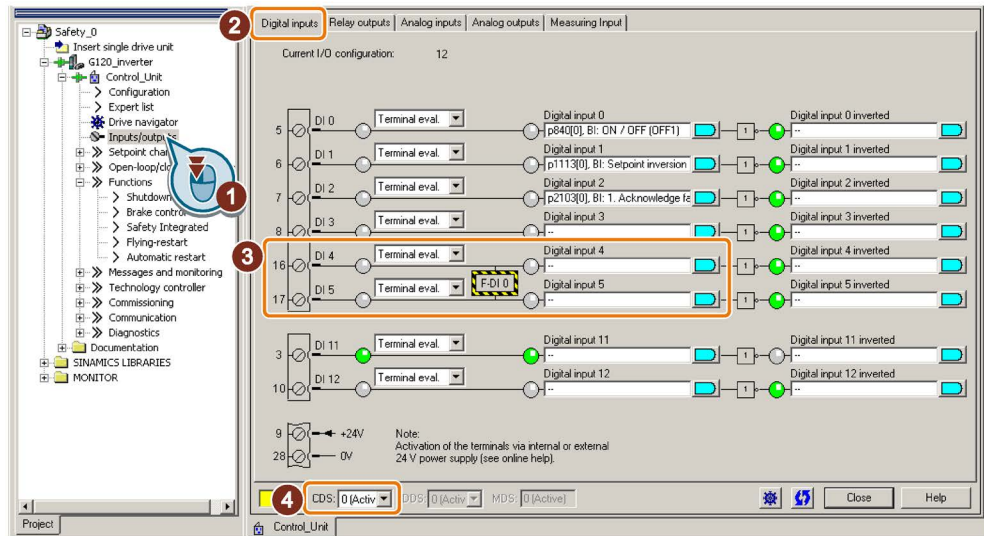


Figure 5-44 Removing the DI 4 and DI 5 digital-input connections

4. You must delete the digital input connections for all CDS if you use the switchover of the command data sets (CDS).

You can find a description of the CDS switchover in the operating instructions.



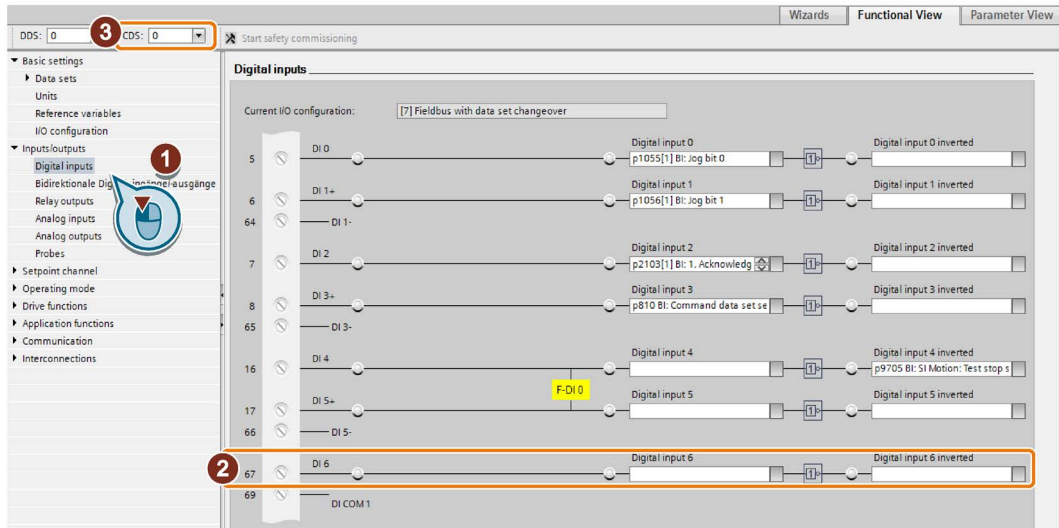
You have ensured that the safety-related inputs only control safety functions in the inverter.

**Procedure with Startdrive**



1 Proceed as follows to check as to whether the safety-related inputs are only used for the safety functions:

1. Select the screen for the digital inputs.
2. Remove all digital input interconnections that you use as safety-related input F-DI:



3. You must delete the digital input connections for all CDS if you use the switchover of the command data sets (CDS).

You can find a description of the CDS switchover in the operating instructions.



You have ensured that the safety-related inputs only control safety functions in the inverter.

## Checking the interconnection of the feedback signal input for the safety-related output

The interconnection of the feedback signal input with a "standard" function may lead to the drive behaving in unexpected ways.

### Preconditions

- You use the safety-related output of the inverter.
- You use one of the test modes 2 or 3, where the inverter evaluates the status of the connected actuator via a digital input.

You must check as to whether this digital input is assigned a "standard" function.

### Procedure with STARTER



1 In order to prevent that the feedback signal input of the safety-related output unintentionally controls the "standard" functions in the inverter, proceed as follows:

1. Select the inputs/outputs in the project navigator of STARTER.
2. Select the screen for the digital inputs.
3. Remove the interconnection of the digital input that you use as feedback signal input for the safety-related output:
  - SINAMICS G120 with CU250S-2 Control Unit: Digital input DI 6 (see diagram).
  - SINAMICS G120D: Digital input DI 5.
4. If you use the CDS data set switchover, remove the interconnection of the feedback signal input for all CDS.

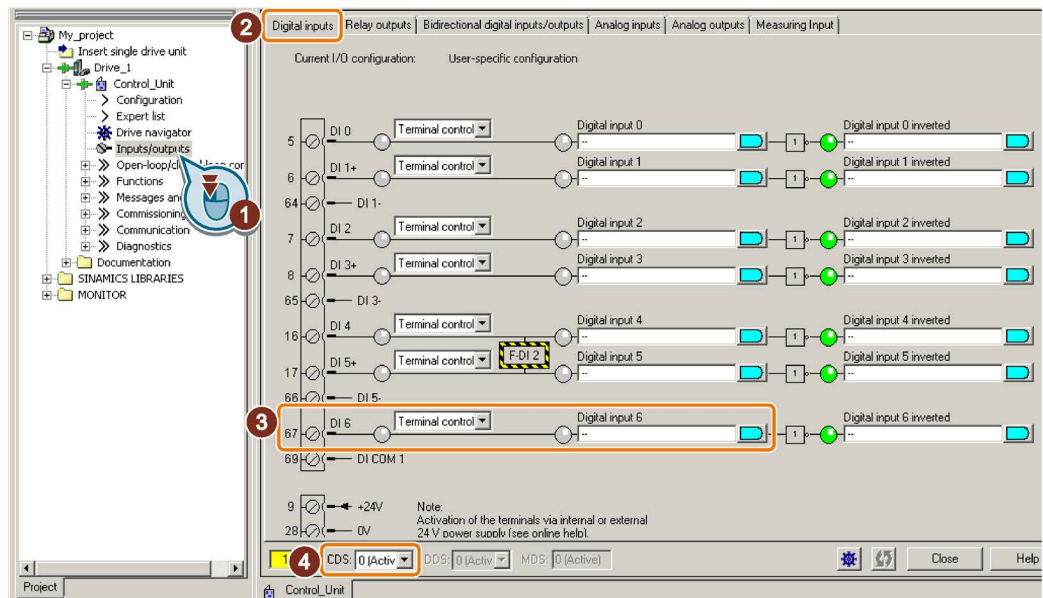


Figure 5-45 Removing the interconnection of the feedback signal input DI 6 for the CU250S-2

- You have now prevented that the feedback signal input of the safety-related output controls "standard" functions in the inverter.

**Procedure with Startdrive**



In order to prevent that the feedback signal input of the safety-related output unintentionally controls the "standard" functions in the inverter, proceed as follows:

1. Select the digital inputs.
2. Remove the interconnection of the digital input that you use as feedback signal input for the safety-related output:
  - SINAMICS G120 with CU250S-2 Control Unit: Digital input DI 6 (see diagram).
  - SINAMICS G120D: Digital input DI 5.
3. If you are using several command data sets (CDS), then remove the interconnection of the feedback signal input for all CDS.

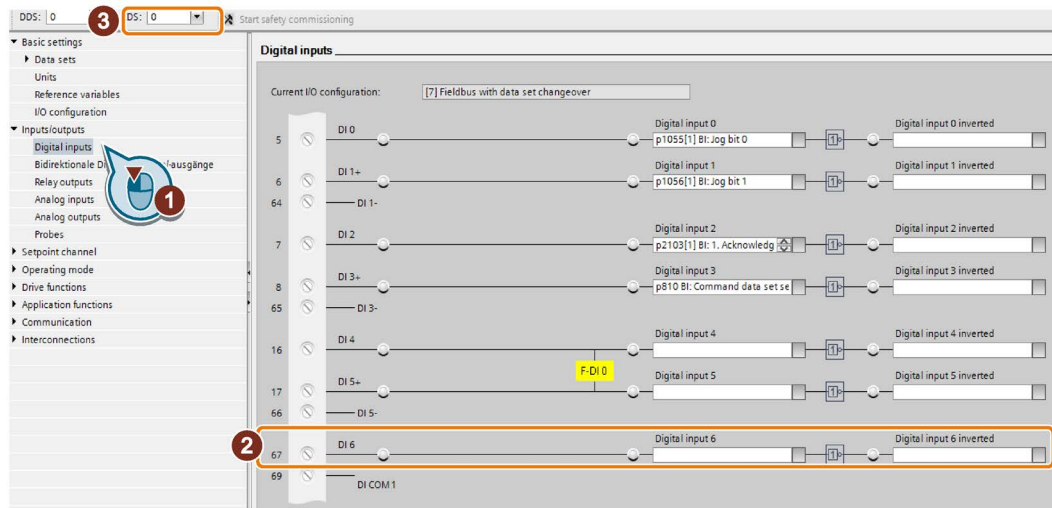


Figure 5-46 Removing the interconnection of the feedback signal input DI 6 for the CU250S-2



You have now prevented that the feedback signal input of the safety-related output controls "standard" functions in the inverter.

## 5.9 Activating Shared Device

### Enabling Shared Device

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

#### Requirement

You are online with STARTER or Startdrive.

#### Procedure with STARTER and Startdrive



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

1. In STARTER change to the expert list, or in Startdrive, to the parameter view.
2. Set p8929 = 2.



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

## 5.10 Starting communication via PROFIsafe

### 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.

## 5.11 Offline commissioning using STARTER

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).

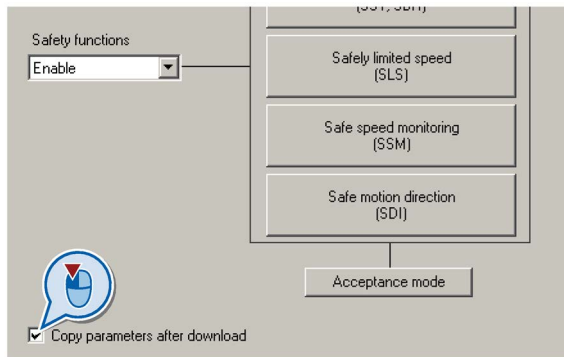
### Setting the safety functions offline


#### Procedure



1 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: Configuring safety functions (Page 98).
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



1 Proceed as follows to load the settings from the STARTER project to the inverter:

- 2 1. Go online with STARTER and start to download to the inverter using the button .  
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 LEDs on the inverter go dark.
8. Switch on the inverter supply voltage again.

 The inverter has taken the settings from the STARTER project.

## 5.12 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. 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 using STARTER (Page 192).

3. If you control your inverter via PROFIsafe, you have to modify the PROFIsafe address. See also: Configuring safety functions (Page 96).

4. Perform a reduced acceptance for the safety functions.

The necessary measures are described in Section: Offline commissioning using STARTER (Page 192).



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

### See also

Reduced acceptance after a component has been replaced and a firmware change (Page 350)

## 5.13 Acceptance tests for the safety functions

### 5.13.1 Acceptance test

#### What is an acceptance?

The machine manufacturer is responsible in ensuring that his plant or machine functions perfectly. As a consequence, after commissioning, the machine manufacturer must check those functions or have them checked by specialist personnel, which represent an increased risk of injury to personnel or material damage. This acceptance or validation is, for example, also specified in the European machinery directive and essentially comprises two parts:

- Checking the safety-relevant functions and machine parts.  
→ **Acceptance test.**
- Generate an "Acceptance report" that describes the test results.  
→ **Documentation.**

Supply information for the validation, e.g. the harmonized European standards EN ISO 13849-1 and EN ISO 13849-2.

#### Acceptance test of the machine or plant

The acceptance test checks whether the safety-relevant functions in the plant or machine function correctly. The documentation of the components used in the safety functions can also provide information about the necessary tests.

Testing the safety-related functions includes e.g. the following:

- Are 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 as expected to the safety-relevant feedback signals of the inverter?
- Do the inverter settings match the configured safety-relevant function in the machine?

#### Acceptance test of the inverter

The acceptance test of the inverter is a part of the acceptance test of the entire machine or plant.

The acceptance test of the inverter checks whether the integrated drive safety functions are set up correctly for the planned safety function of the machine.

You can find examples for the acceptance test of integrated drive safety functions in section: Examples of acceptance tests (Page 366).

**Documentation of the inverter**

The following must be documented for the inverter:

- The results of the acceptance test.
- The settings of the integrated drive safety functions.

The commissioning tool STARTER logs the settings of the integrated drive functions, if necessary. See also Section: Documentation for acceptance (Page 398).

The documentation must be signed.

**Who may perform the acceptance test of the inverter?**

Personnel from the machine manufacturer, who, on account of their technical qualifications and knowledge of the safety functions, are in a position to perform the acceptance test in the correct manner are authorized to perform the acceptance testing of the inverter.

**5.13.2 Reduced acceptance test after expanding the function**

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

Table 5- 2 Reduced acceptance test after expanding the function

Measure	Acceptance test	Documentation
Changing a single limit (e.g. SLS level).	Check the modified limit value.	<ul style="list-style-type: none"> <li>• Supplement function table</li> <li>• Log modified settings</li> <li>• Log the new checksum</li> <li>• Countersignature</li> </ul>
Functional expansion of the machine (additional drive).	Check the safety functions of the new drive.	<ul style="list-style-type: none"> <li>• Supplement machine overview</li> <li>• Supplement article number and firmware version of the drive</li> <li>• Supplement function table</li> <li>• Log the settings of the new drive</li> <li>• Log the new checksum</li> <li>• Countersignature</li> </ul>
Functional expansion of a drive (e.g. additional SLS level or new safety function following a firmware update).	Check the additional functions.	<ul style="list-style-type: none"> <li>• Supplement function table</li> <li>• Log modified settings</li> <li>• Log the new checksum</li> <li>• Countersignature</li> </ul>
Transfer of inverter settings to other identical machines by means of series commissioning.	Check the control and feedback signal of all safety functions.	<ul style="list-style-type: none"> <li>• Supplement machine description</li> <li>• Log modified settings</li> <li>• Check the checksums</li> <li>• Check the firmware versions</li> </ul>

See also Section: Reduced acceptance after a component has been replaced and a firmware change (Page 350).

## 6.1 About this chapter

### What can you find in this Chapter?

In this chapter, you will find answers to the following questions:

- What do I have to do to maintain the guaranteed failure probability of the safety functions during the usage time?
- 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 does the drive respond to a discrepant signal at a safety-related input?
- How does the drive respond to limit value violations or if internal monitoring functions respond?
- How do I acknowledge safety function faults?
- How do the safety functions mutually influence one another, if I select more than one safety function?
- What do the alarm and fault messages of the safety functions mean?

## 6.2 Regularly testing the safety functions

### Safety functions according to SIL 2 to IEC 61508 and to PI d according to EN ISO 13849

You must initiate the following function tests as a minimum once per year in order to maintain the assured failure probability of the safety functions:

- The inverter must test its safety-related input if you are using a safety input.
  - Testing safety inputs (Page 199)
- The inverter must test its safety functions:
  - Testing the basic functions (Page 200)
  - Testing the extended functions (Page 202)
- The inverter must test its safety output if you are using a safety-related output.
  - Testing a safety output (Page 204)

### Safety functions according to SIL 3 to IEC 61508 and to PI e according to EN ISO 13849

You must initiate the following function tests at least once every three months in order to maintain the guaranteed failure probability of the STO function via the terminals of the PM240-2 (FSD, FSE) Power Module:

- The inverter must test the safety-related input on the Power Module.
  - Testing safety inputs (Page 199)
- The inverter must test the STO function via the Power Module terminals.
  - Testing the basic functions (Page 200)

## 6.2.1 Testing safety inputs

### Testing sensors and safety inputs

The inverter tests its safety-related inputs and the connected sensors with a signal change at the inputs. We recommend that you test the safety-related inputs together with the forced dormant error detection (test stop).

#### Procedure



1 To test the safety-related inputs, proceed as follows:

1. Actuate the relevant sensor.
2. Check the following:
  - The expected safety function is active.
  - The inverter signals a fault.



You have checked the safety-related inputs.

Inverter signals	Parameter	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
Internal event	r9722.7	✓	---	✓
STO active (basic functions)	r9773.1	✓	---	✓
STO active (extended functions)	r9722.0	✓	---	✓
SS1 active (basic functions)	r9773.6	✓	---	✓
SS1 active (extended functions)	r9722.1	✓	---	✓
SLS active	r9722.4	✓	---	✓
SDI+ active	r9722.12	✓	---	✓
SDI- active	r9722.13	✓	---	✓

### 6.2.2 Testing the basic functions

#### Time

The inverter monitors as to whether the self test (= forced dormant error detection, test stop) is regularly started.

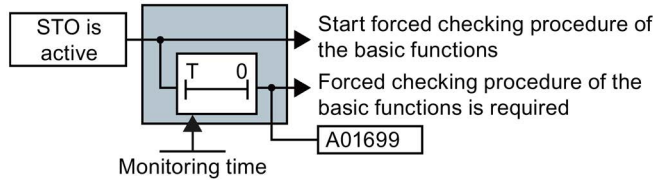


Figure 6-1 Starting and monitoring the forced dormant error detection (test stop)

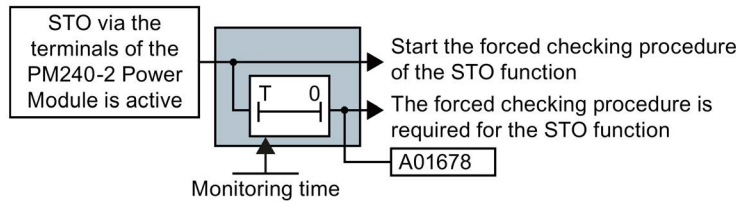


Figure 6-2 Start and monitoring of the forced checking procedure (test stop) for STO via the terminals of the Power Module

In the case of alarms A01699 and A01678, you must initiate a self test at the next opportunity, e.g.

- When the drives are at a standstill after the system has been switched on.
- When a protective door is opened.
- At specified regular intervals before the monitoring time expires.

Inverter signals	Parameter	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
STO active (basic functions)	r9773.1	✓	---	✓
STO deselection (basic functions)	r9773.0	✓	✓	---
STO cause, selection via terminal on the Power Module	r9772.25	---	---	---
Forced checking procedure (test stop) is required for the STO function via the terminals on Power Module	r9773.30	---	---	---
Forced checking procedure (test stop) required for the basic functions	r9773.31	---	---	---



**Carry out a forced checking procedure of the basic functions****Preconditions**

- STO is not active.
- The motor is switched on (ON/OFF1 = 1), and is at a standstill (speed setpoint = 0).

**Procedure**

To start the forced dormant error detection, proceed as follows:

1. Select the STO function.
2. The inverter checks its safety-related circuits. This check takes several milliseconds.
3. Deselect the STO function.
4. Check that alarm A01699 is no longer present.

- You have performed the forced dormant error detection.

**Carry out a forced checking procedure of the STO function via the Power Module terminals****Requirements**

- STO is not active.
- The motor is switched on (ON/OFF1 = 1), and is at a standstill (speed setpoint = 0).

**Procedure**

To start the forced dormant error detection, proceed as follows:

1. Select the STO function via the terminals of the PM240-2 Power Module.
2. The inverter checks its safety-related circuits. This check takes several milliseconds.
3. Deselect the STO function.
4. Check that alarm A01678 is no longer active.

- You have performed the forced dormant error detection.

### 6.2.3 Testing the extended functions

#### Time

The inverter monitors as to whether the self test (= forced dormant error detection, test stop) is regularly started.

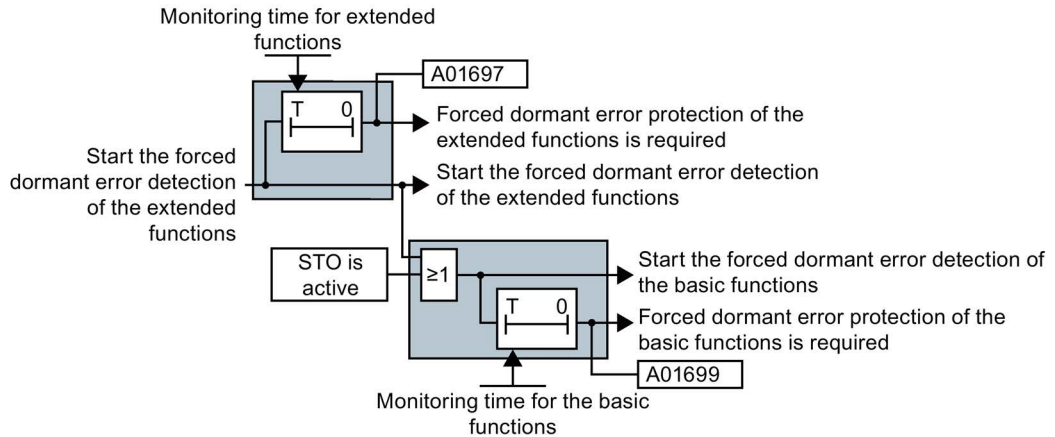


Figure 6-3 Starting and monitoring the forced dormant error detection (test stop)

If the inverter outputs alarm A01699 or A01697, you must initiate a forced dormant error detection at the next opportunity, e.g.:

- When the system is switched on.
- At specified regular intervals before the monitoring time expires.

Inverter signals	Parameter	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
STO active (basic functions)	r9773.1	✓	---	✓
STO cause, selection via terminal on the Power Module	r9772.25	---	---	---
STO active (extended functions)	r9722.0	✓	---	✓
Forced checking procedure (test stop) required for the basic functions	r9773.31	---	---	---
Forced checking procedure (test stop) required for the extended functions	r9723.0	---	---	---
Start forced dormant error detection (extended functions)	p9705	---	---	---

## Performing a forced checking procedure (test stop)

When testing the extended functions, the inverter switches the motor into a no-torque condition.

### Preconditions

- STO is not active.

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

- The motor is switched on (ON/OFF1 = 1), and is at a standstill (speed setpoint = 0).

### Procedure



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

1. Start the forced dormant error detection using a signal of your choice, for example a digital input.
2. The inverter checks its safety-related circuits. During the check, the inverter outputs alarms C01798 and C30798. This check takes several milliseconds.
3. Set the signal to start the forced dormant error detection to zero.
4. Check that neither alarm A01699 nor alarm A01697 is active.
5. Check the safety-related inputs of the inverter, also see: Testing safety inputs (Page 199).
6. Check the safety-related output of the inverter, also see: Testing a safety output (Page 204).



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

### 6.2.4 Testing a safety output

#### Time of the test

The inverter monitors that the test is regularly performed using a time block.

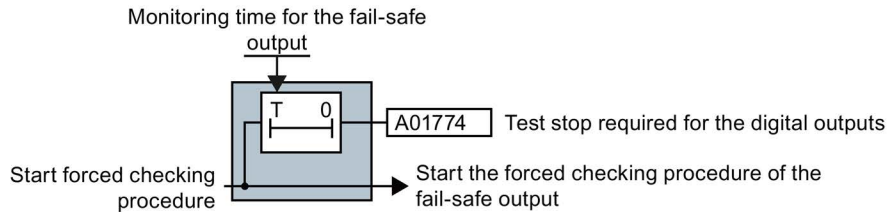


Figure 6-4 Start and monitoring of the forced dormant error detection (test stop) of the safety-related output

If the inverter outputs alarm A01774, you must initiate the test at the next opportunity, e.g.:

- When the system is switched on.
- At specified regular intervals before the monitoring time expires.

Inverter signals	Parameter	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
Forced checking procedure (test stop) required for the extended functions	r9723.0	---	---	---
Start forced checking procedure (test stop) of the safety-related output	p10007	---	---	---

### Testing the safety-related output and the connected actuator

The inverter tests its safety-related output and the connected actuator with a signal change at the output.

#### Procedure



To test the safety-related output, proceed as follows:

1. Switch on the motor (ON/OFF1 command = 1).

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

2. Start the test using a signal of your choice, for example a digital input.
3. The inverter briefly switches off the safety-related output. This test takes several milliseconds.
4. Set the signal to start the forced dormant error detection to zero.
5. Check that alarm A01774 is no longer present.



You have checked the safety-related output.

The response of the safety-related output depends on the test stop mode that has been selected.

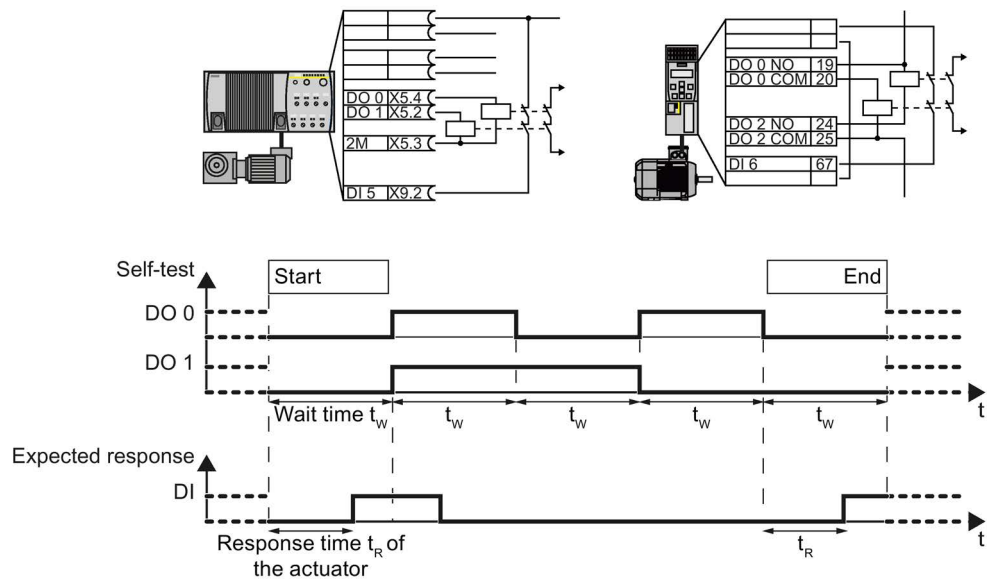


Figure 6-5 Test stop mode 2

6.2 Regularly testing the safety functions

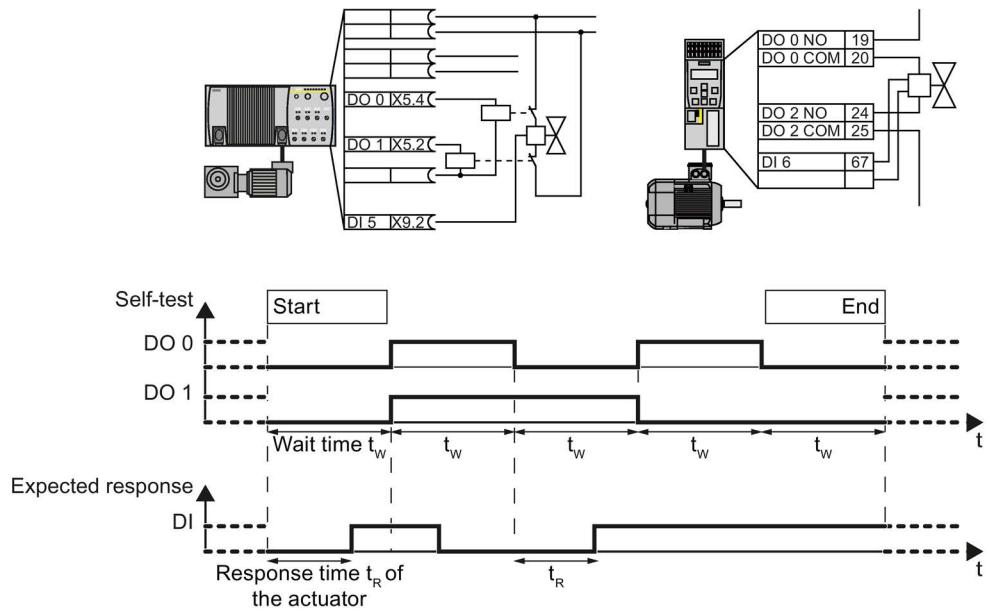


Figure 6-6 Test stop mode 3

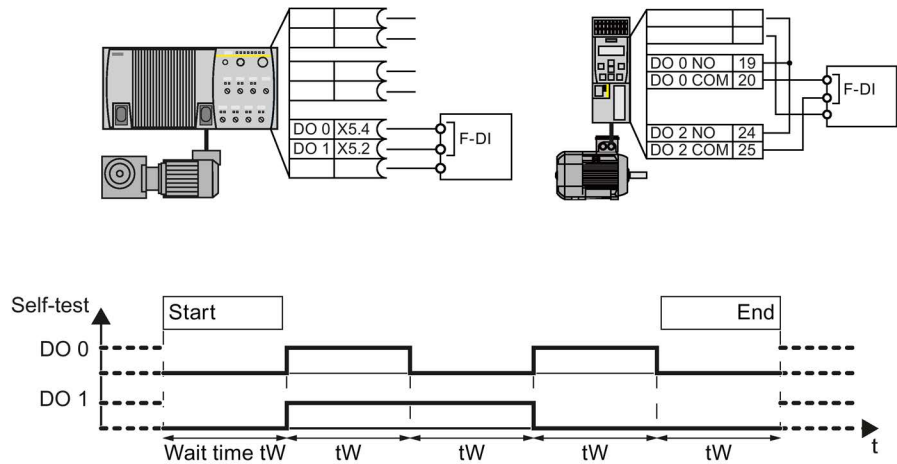


Figure 6-7 Test stop mode 4

## 6.3 Safe Torque Off (STO)

### 6.3.1 Overview

#### What can you find in this Chapter?

The relevant operating cases for the STO function are described in this chapter.

Table 6- 1 Operating cases for the STO function when the motor is switched on (ON/OFF1 = 1)

Selecting and deselecting STO	→ Selecting and deselecting STO when the motor is switched on (Page 208)
Discrepancy in the input signal	The safety input to select STO identifies an error. → Response to a discrepancy when STO is active (Page 210)

Table 6- 2 Switching the motor on and off when STO is active or not active

	Switching on the motor (ON/OFF1 = 0 → 1)	Switching off the motor (ON/OFF1, OFF2 or OFF3 = 1 → 0)
STO is not active	If STO is not active, then there are no restrictions for switching on and switching off the motor.	
STO is active	The active STO function prevents the motor from being switched on.	The motor is always switched off when STO is active. The OFF1, OFF2 and OFF3 signals have no effect.

### 6.3.2 Selecting and deselecting STO when the motor is switched on

#### Select STO

**Function**

1. The machine control selects the STO safety function via a safety-related input or via PROFIsafe (safety-related bus communication).
2. The inverter then safely switches off the motor torque.

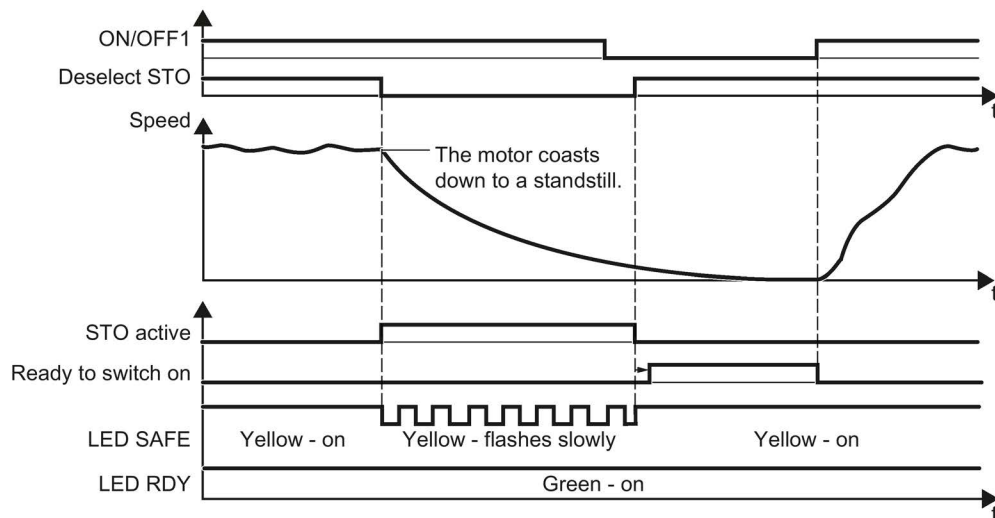


Figure 6-8 Time response of the STO safety function (Safe Torque Off)

Inverter signals	Parameters	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
STO active (basic functions)	r9773.1	✓	---	✓
STO deselection (basic functions)	r9773.0	✓	✓	---
STO active (extended functions)	r9722.0	✓	---	✓
Deselect STO (extended functions)	r9720.0	✓	✓	---
Ready to switch on	r0052.0	---	---	---
ON/OFF1	r0054.0	---	---	---



## Switching on the motor once STO is active

### Procedure



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

1. Deselect STO.
2. After deselecting STO, wait until the inverter is "ready to switch on".

Alternatively: After deselecting STO, wait a certain time before switching on. We recommend a wait time of 200 ms.

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



You have switched on the motor.

### 6.3.3 Response to a discrepancy when STO is active

The inverter responds to a discrepancy at the safety-related input by activating safety function STO.

The inverter response depends on the wiring and the setting of the inverter:

- You are using the basic functions according to SIL 2 → case 1.
- You are using the extended functions → case 2.
- You are using the STO function according to SIL 3 via the terminals at the PM240-2 Power Module → case 3.

#### Case 1: 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

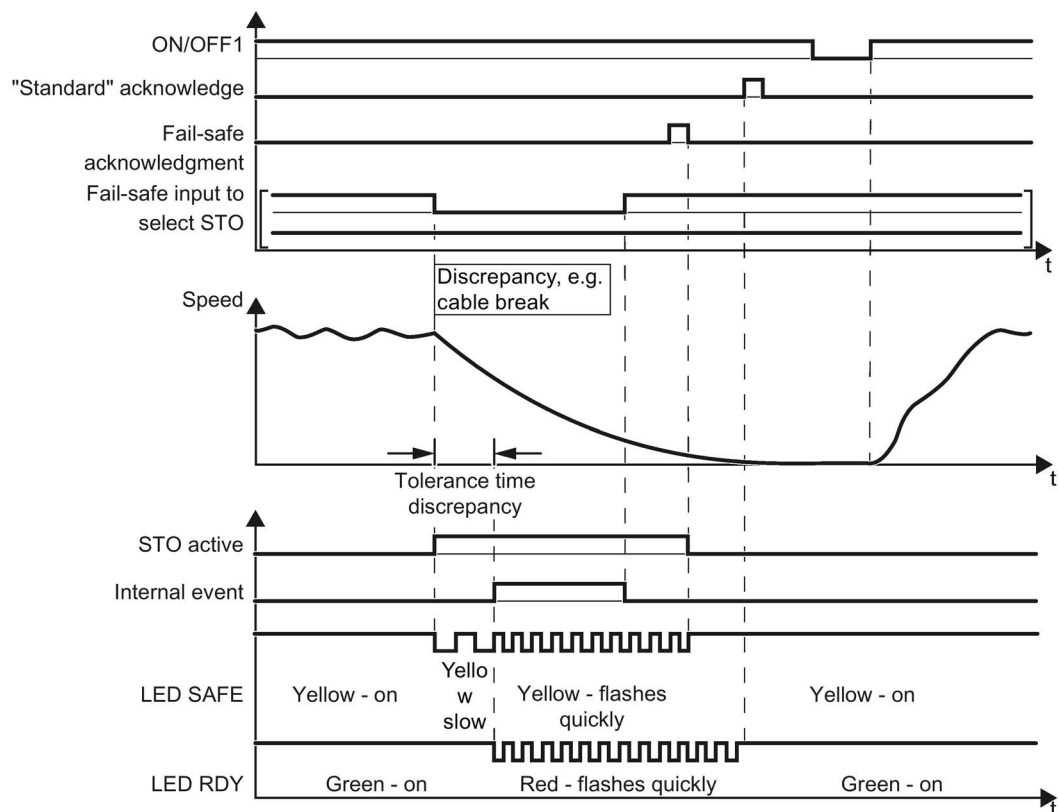


Figure 6-9 Inverter response for discrepancy of the input signal for STO (example: Cable break in the channel of processor P1)

Inverter messages after the tolerance time has expired:

- Discrepancy (fault F01611 or F30611 with fault values r0949 = 2000 or 2002)
- The inverter sets the error bit of the safety functions (= internal event).

Independent of the voltage levels available, the inverter sets the evaluation of the discrepant F-DI into the safe state (= zero) until you acknowledge the inverter using a fail-safe signal or you switch off the power supply voltage and switch it on again.

Inverter signal	Parameter	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
Internal event	r9722.7	✓	---	✓
STO active (basic functions)	r9773.1	✓	---	✓
STO deselection (basic functions)	r9773.0	✓	✓	---
"Standard" acknowledgment	p2103	---	---	---
Fail-safe acknowledgment	r9720.7	✓	✓	---
ON/OFF1	r0054.0	---	---	---

**Case 1: 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)	---	Switch off the power supply voltage and switch on again.
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)	Switch off the power supply voltage and switch on again.
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)	Switch off the power supply voltage and switch on again.

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.

**Case 2: Response of the drive for STO of the extended functions**

You have selected the extended functions via onboard terminals.

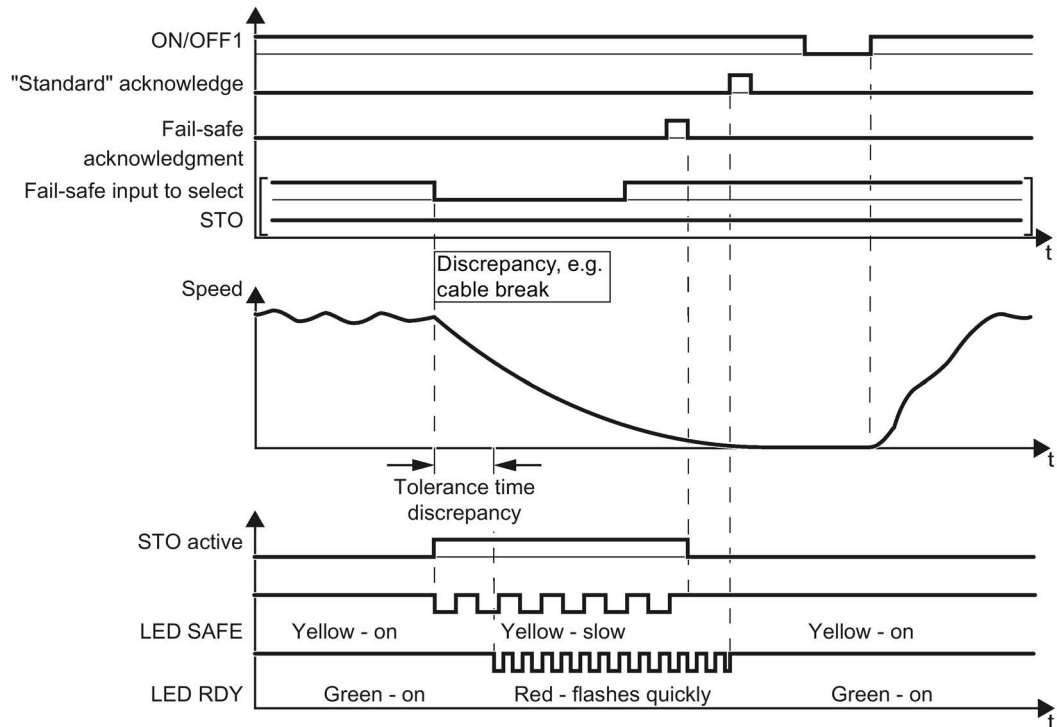


Figure 6-10 Response of safety function STO in the event of a discrepancy

The inverter does not set the error bit of the safety functions (= internal event).

After the tolerance time has expired, the inverter signals the discrepancy (fault C01770 or C30770).

Inverter signal	Parameter	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
Internal event	r9722.7	✓	---	✓
STO active (extended functions)	r9722.0	✓	---	✓
Deselect STO (extended functions)	r9720.0	✓	✓	---
"Standard" acknowledgment	p2103	---	---	---
Fail-safe acknowledgment	r9720.7	✓	✓	---
ON/OFF1	r0054.0	---	---	---

**Case 2: Switching on the motor after a discrepancy**

**Procedure**



- 1 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 safety-related input: F-DI = 0 → 1 → 0.  
 Alternatively: Switch off the power supply voltage and switch on again.
    3. Acknowledge the inverter using the "standard" acknowledgment 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.

**Example 3: Response of the drive for STO via the terminals at the PM240-2 Power Module**

You have selected the basic functions via the terminals of the PM240-2 Power Module.

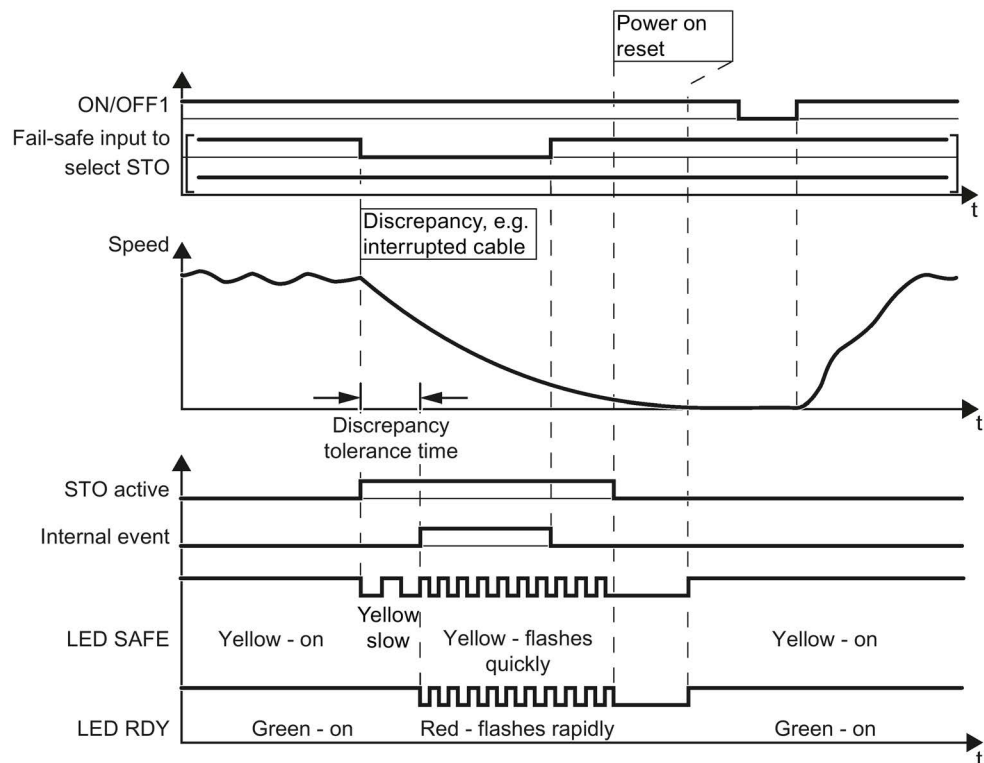


Figure 6-11 Response of safety function STO in the event of a discrepancy at the input of the PM240-2 Power Module

Inverter messages after the tolerance time has expired:

- Discrepancy (fault F01600 or F30600 with fault value r0949 = 1030)
- The inverter sets the fault bit of the safety functions (= internal event).

Inverter signal	Parameter	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
Internal event	r9722.7	✓	---	✓
STO active (basic functions)	r9773.1	✓	---	✓
STO deselection (basic functions)	r9773.0	✓	✓	---
STO cause, selection via terminal on the Power Module	r9772.25	---	---	---
"Standard" acknowledgment	p2103	---	---	---
Fail-safe acknowledgment	r9720.7	✓	✓	---
ON/OFF1	r0054.0	---	---	---

**Example 3: Switch 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

Selected setting	How can the internal event be acknowledged?		
	F-DI <sup>1)</sup>	PROFIsafe	Alternative
Basic functions via onboard terminals	Select and deselect STO (F-DI = 1 → 0 → 1)	---	Switch off the power supply voltage and switch on again.
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)	Switch off the power supply voltage and switch on again.
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)	Switch off the power supply voltage and switch on again.

<sup>1)</sup> The message cannot be acknowledged using the terminals on the PM240-2 Power Module.

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.



## 6.4 Safe Brake Control (SBC)

### 6.4.1 Selecting and deselecting SBC when the motor is switched on

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.

#### 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.

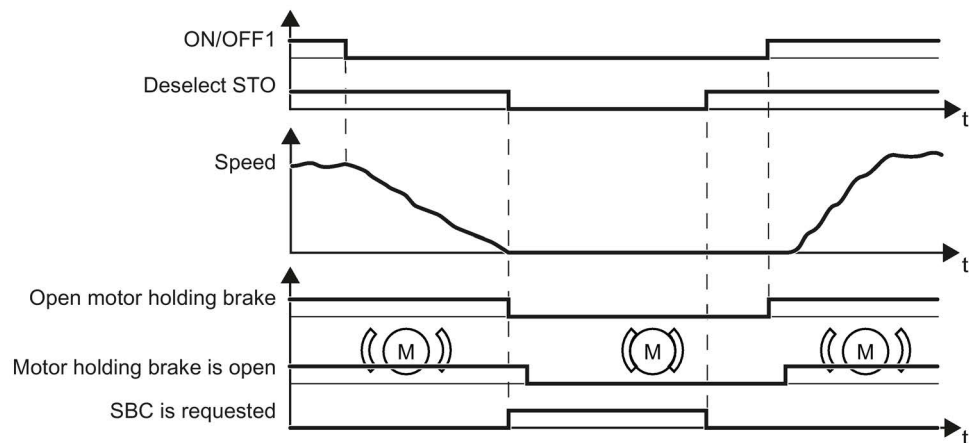


Figure 6-12 Wait until standstill is reached and activate SBC with STO

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

Inverter signal	Parameter	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
STO deselection (basic functions)	r9773.0	✓	✓	---
Deselect STO (extended functions)	r9720.0	✓	✓	---
SBC requested (basic functions)	r9773.4	---	---	---
ON/OFF1	r0054.0	---	---	---
Release motor holding brake	r0899.12	---	---	---
Close motor holding brake	r0899.13	---	---	---

### 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.

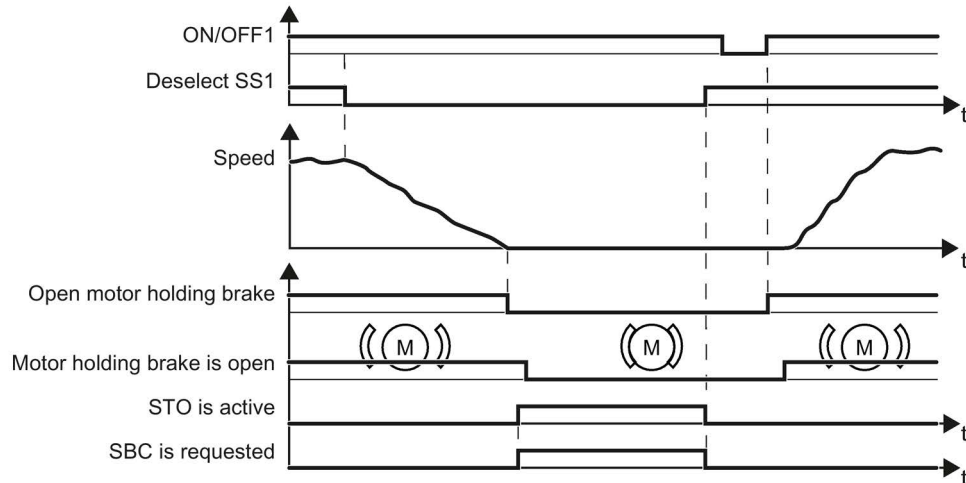


Figure 6-13 When selecting SS1, the motor holding brake closes at standstill

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

Inverter signal	Parameter	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
STO active (basic functions)	r9773.1	✓	---	✓
STO active (extended functions)	r9722.0	✓	---	✓
Deselect STO (extended functions)	r9720.0	✓	✓	---
SBC requested (basic functions)	r9773.4	---	---	---
Deselect SS1 (basic functions)	r9773.5	✓	✓	---
Deselect SS1 (extended functions)	r9720.1	✓	✓	---
ON/OFF1	r0054.0	---	---	---
Release motor holding brake	r0899.12	---	---	---
Close motor holding brake	r0899.13	---	---	---

## 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.

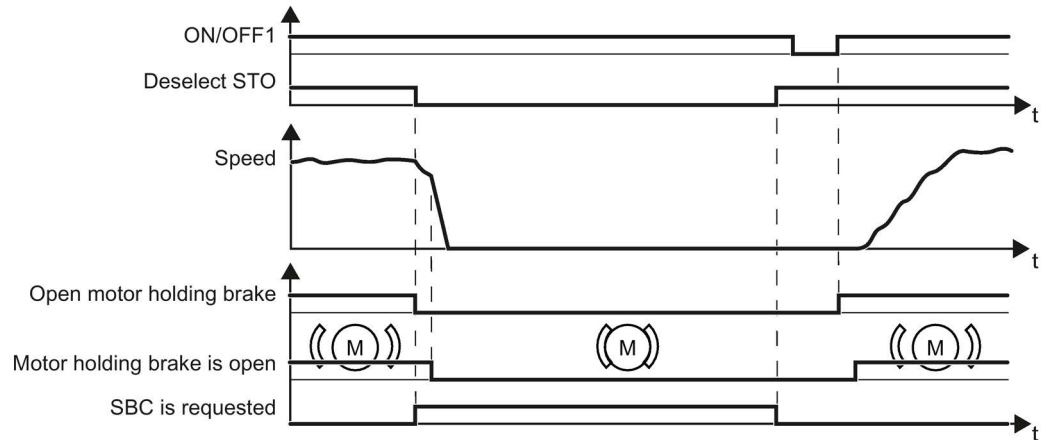


Figure 6-14 The motor holding brake closes after selecting STO

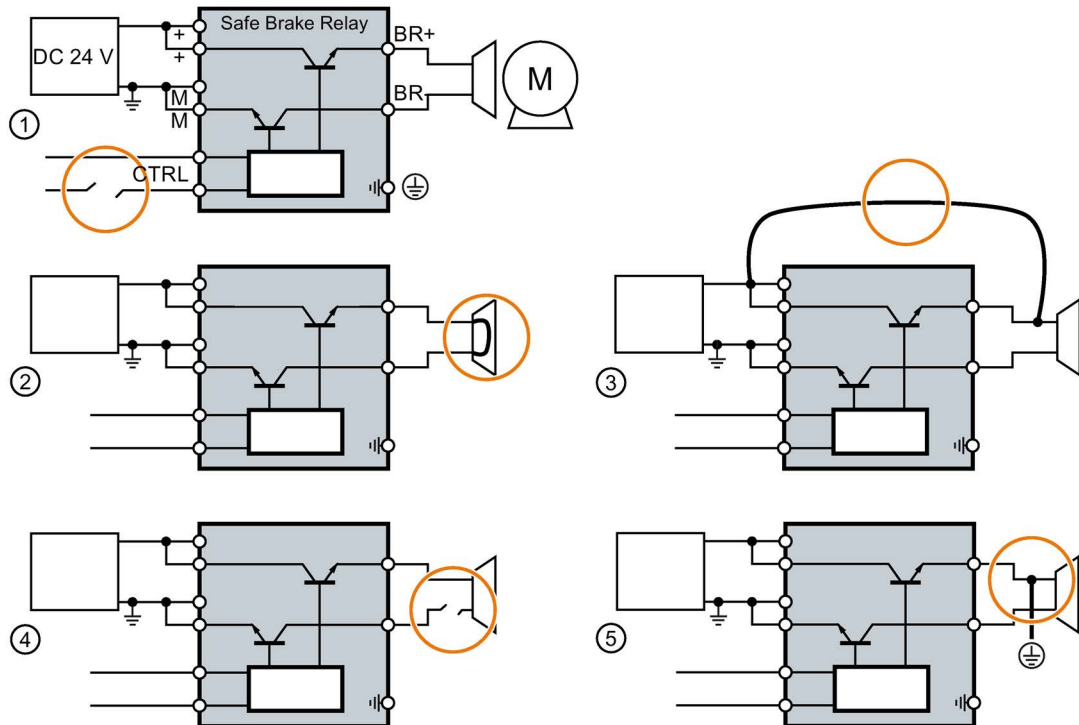
Before you can switch on the motor again, you must deselect the STO function.

Inverter signal	Parameter	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
STO deselection (basic functions)	r9773.0	✓	✓	---
Deselect STO (extended functions)	r9720.0	✓	✓	---
SBC requested (basic functions)	r9773.4	---	---	---
ON/OFF1	r0054.0	---	---	---
Release motor holding brake	r0899.12	---	---	---
Close motor holding brake	r0899.13	---	---	---

### 6.4.2 Response to faults in the brake control

#### Faults in the brake control

When opening or closing the brake, the inverter identifies faults in the brake cable and in the brake winding.



- ① Control cable from the inverter to the Safe Brake Relay is interrupted
- ② Short-circuit in the brake winding
- ③ Cross circuit between the brake cable and the 24 V supply voltage
- ④ Brake cable is interrupted
- ⑤ Ground fault on the brake cable

Figure 6-15 Examples of faults in the brake control

#### Drive response

If the inverter detects a fault in the brake control, it responds with a STOP A (message F01630 or F30630) and closes the brake.

## 6.5 Safe Stop 1 (SS1)

### 6.5.1 Overview

#### What can you find in this Chapter?

The relevant operating cases for the SS1 function are described in this chapter.

Table 6- 3 Response of the SS1 function when the motor is switched on (ON/OFF1 = 1)

Select and deselect SS1	→ Selecting and deselecting SS1 when the motor is switched on (Page 222)
Discrepancy in the input signal	The safety input to select SS1 identifies an error. → Response to a discrepancy when SS1 is active (Page 230)
Limit value violation	The speed of the motor violates the SS1 monitoring that has been set. → Limit value violation when SS1 is active (Page 235) The basic SS1 function does not monitor the motor speed. The limit value violation is not relevant in this particular case.

Table 6- 4 Switching the motor on and off when SS1 is active or not active

	Switching on the motor (ON/OFF1 = 0 → 1)	Switching off the motor (ON/OFF1, OFF2 or OFF3 = 1 → 0)
SS1 is not active	If SS1 is not active, then there are no restrictions for switching on and switching off the motor.	
SS1 is active	The active SS1 function prevents the motor from being switched on.	The drive response depends on the signal that you use to switch off the motor. → Switching off the motor when SS1 is active (Page 228)

## 6.5.2 Selecting and deselecting SS1 when the motor is switched on

### 6.5.2.1 SS1 basic function

#### Select SS1

##### Function

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

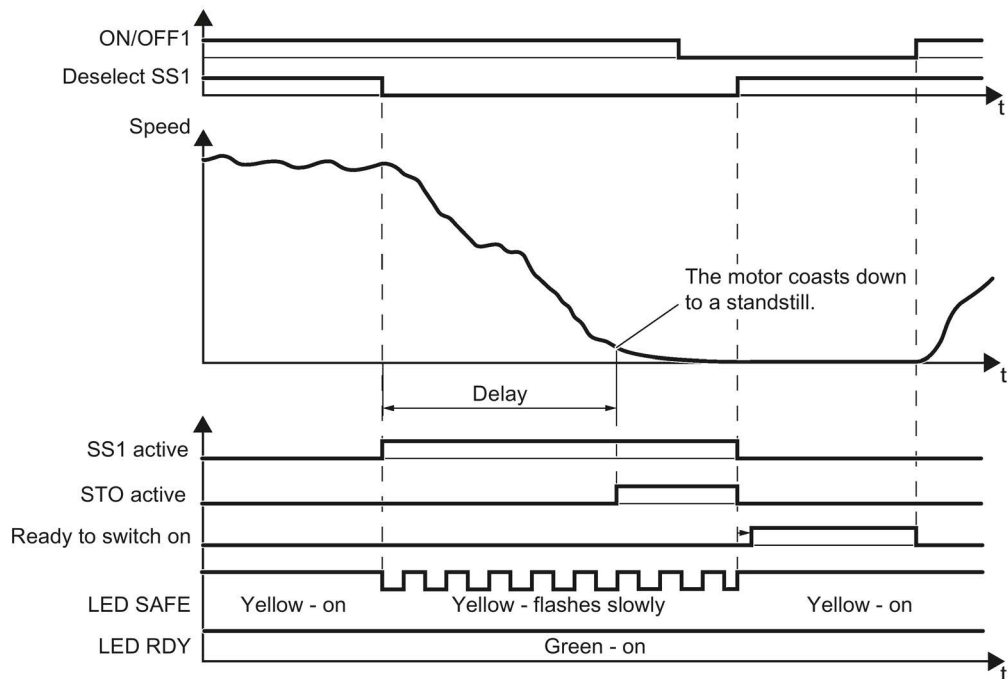


Figure 6-16 Braking behavior and diagnostics of the safety function SS1 (Safe Stop 1)

Inverter signal	Parameter	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
STO active (basic functions)	r9773.1	✓	---	✓
SS1 active (basic functions)	r9773.6	✓	---	✓
Deselect SS1 (basic functions)	r9773.5	✓	✓	---
Ready to switch on	r0052.0	---	---	---
ON/OFF1	r0054.0	---	---	---

## Switching on the motor once SS1 is active

### Procedure



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

- 2 1. Deselect SS1.
2. After deselecting SS1, wait until the inverter is "ready to switch on".

Alternatively: After deselecting SS1, wait a certain time before switching on. We recommend a wait time of 200 ms.

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



You have switched on the motor.

### 6.5.2.2 Extended function SS1 with acceleration monitoring

#### Select SS1

##### Function

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

3. The inverter safely switches off the motor torque using the STO safety function if the load speed reaches the "standstill monitoring".

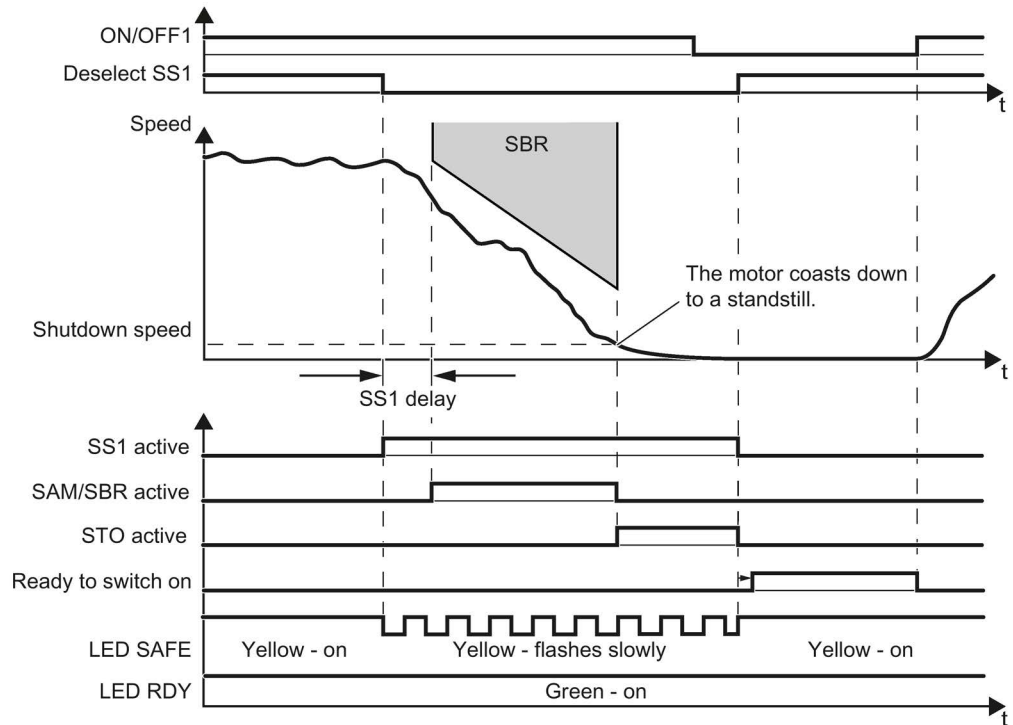


Figure 6-17 Braking behavior and diagnostics of the safety function SS1 (Safe Stop 1)



Inverter signal	Parameter	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
STO active (extended functions)	r9722.0	✓	---	✓
SS1 active (extended functions)	r9722.1	✓	---	✓
Deselect SS1 (extended functions)	r9720.1	✓	✓	---
SAM/SBR active	r9723.16	---	---	---
Ready to switch on	r0052.0	---	---	---
ON/OFF1	r0054.0	---	---	---

### Switching on the motor once SS1 is active

#### Procedure



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

- 2 1. Deselect SS1.
2. After deselecting SS1, wait until the inverter is "ready to switch on".

Alternatively: After deselecting SS1, wait a certain time before switching on. We recommend a wait time of 200 ms.

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

■ You have switched on the motor.

### 6.5.2.3 Extended function SS1 with acceleration monitoring

#### Select SS1

##### Function

1. The higher-level control selects the SS1 safety function via a safety-related input or via the PROFIsafe safe 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 with the STO safety function if one of the two conditions is fulfilled:
  - The actual speed reaches the value of the "standstill monitoring".
  - The delay time has expired.

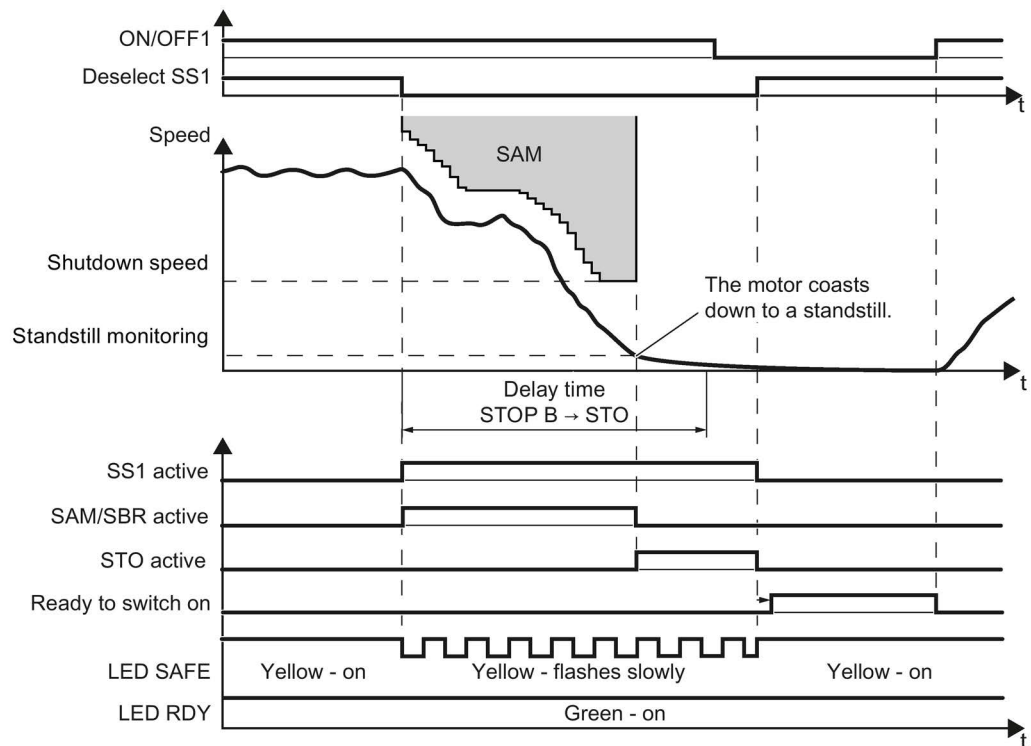


Figure 6-18 Braking behavior and diagnostics of the safety function SS1 (Safe Stop 1)

Inverter signal	Parameter	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
STO active (extended functions)	r9722.0	✓	---	✓
SS1 active (extended functions)	r9722.1	✓	---	✓
Deselect SS1 (extended functions)	r9720.1	✓	✓	---
SAM/SBR active	r9723.16	---	---	---
Ready to switch on	r0052.0	---	---	---
ON/OFF1	r0054.0	---	---	---

### Switching on the motor once SS1 is active

#### Procedure



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

1. Deselect SS1.
2. After deselecting SS1, wait until the inverter is "ready to switch on".

Alternatively: After deselecting SS1, wait a certain time before switching on. We recommend a wait time of 200 ms.

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

■ You have switched on the motor.

### 6.5.3 Switching off the motor when SS1 is active

#### Description

If you switch the motor off with the OFF1 or OFF3 command while the SS1 safety function is active, for example when limit switches are reached, this does not affect how the motor behaves. SS1 remains active and the inverter brakes the motor until the standstill detection threshold is reached.

If you switch off the motor with the safety SS1 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.

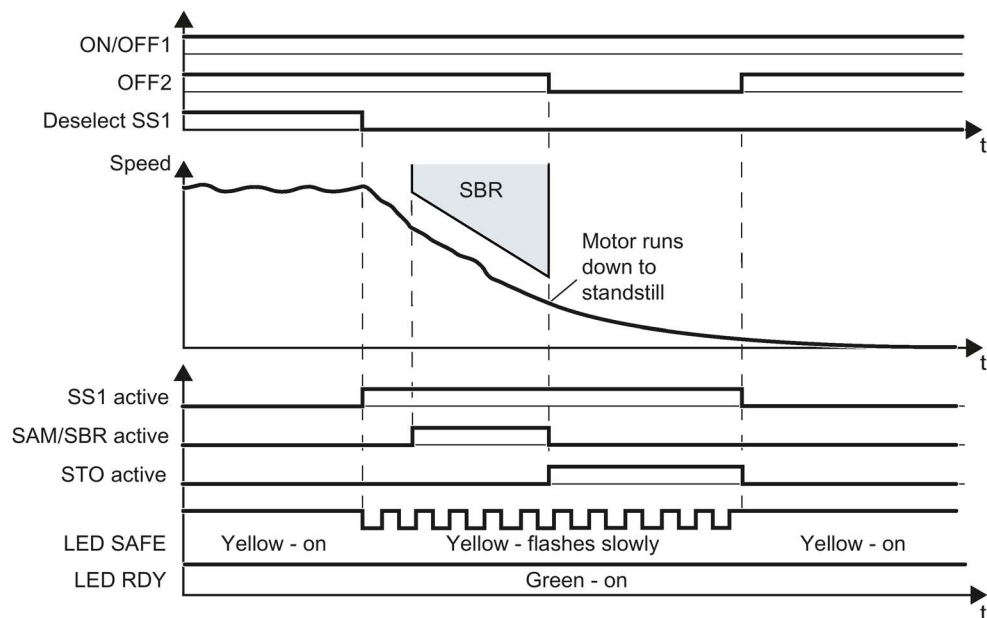


Figure 6-19 OFF2 command when the SS1 safety function is active (example: SS1 with braking ramp monitoring)

Inverter signal	Parameters	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
STO active (extended functions)	r9722.0	✓	---	✓
Deselect SS1 (basic functions)	r9773.5	✓	✓	---
SS1 active (extended functions)	r9722.1	✓	---	✓
Deselect SS1 (extended functions)	r9720.1	✓	✓	---
SAM/SBR active	r9723.16	---	---	---
ON/OFF1	r0054.0	---	---	---
OFF2	r0054.1	---	---	---

### 6.5.4 Response to a discrepancy when SS1 is active

The inverter responds with the active safety function SS1 to a discrepancy at the safety-related input.

The behavior of the drive depends on the setting of the inverter.

#### 1. 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

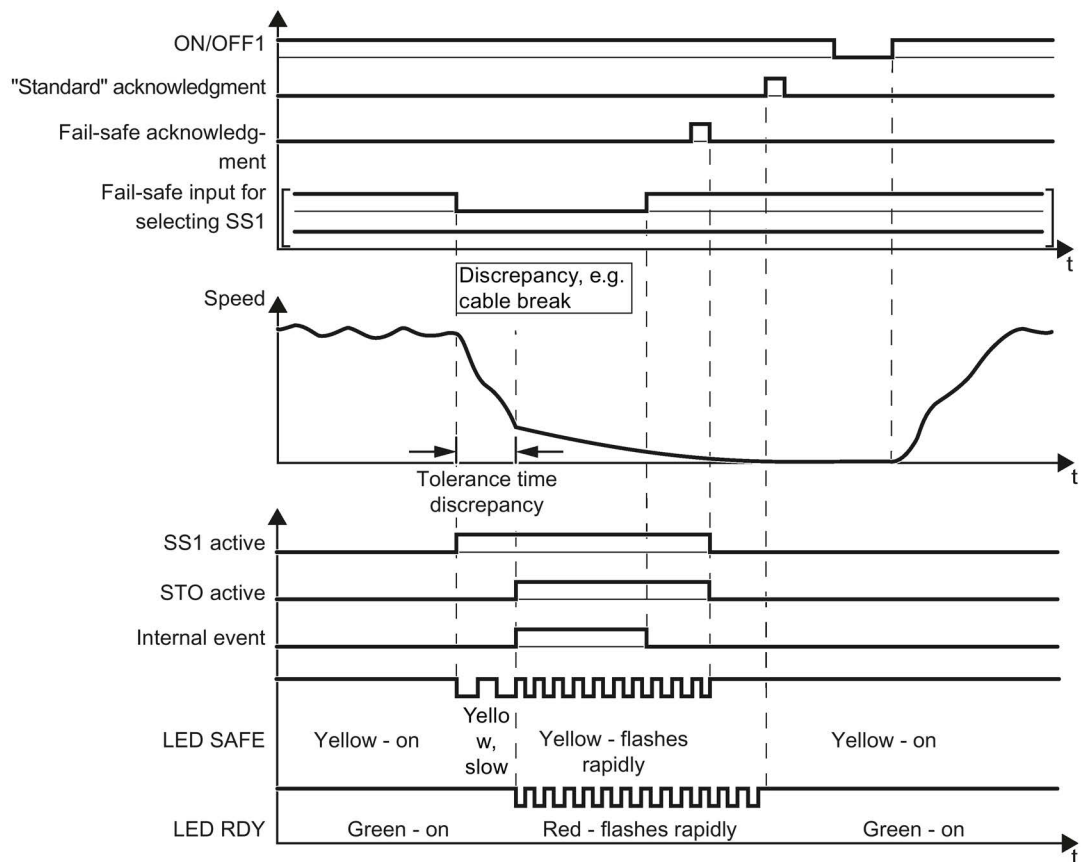


Figure 6-20 Inverter response for discrepancy of the input signal for SS1 (example: cable break in the channel of processor P1)

Inverter messages after the tolerance time has expired:

- Discrepancy (fault F01611 or F30611 with fault value r0949 = 2002)
- The inverter sets the error bit of the safety functions (= internal event).

Independent of the voltage levels available, the inverter sets the evaluation of the discrepant F-DI into the safe state (= zero) until you acknowledge the inverter using a fail-safe signal or you switch off the power supply voltage and switch it on again.

Inverter signal	Parameters	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
Internal event	r9722.7	✓	---	✓
STO active (basic functions)	r9773.1	✓	---	✓
SS1 active (basic functions)	r9773.6	✓	---	✓
Deselect SS1 (basic functions)	r9773.5	✓	✓	---
"Standard" acknowledgment	p2103	---	---	---
Fail-safe acknowledgment	r9720.7	✓	✓	---
ON/OFF1	r0054.0	---	---	---

**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)	---	Switch off the power supply voltage and switch on again.
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)	Switch off the power supply voltage and switch on again.
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)	Switch off the power supply voltage and switch on again.

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.



## 2. case: Response of the drive for SS1 of the extended functions

You have selected the extended functions via onboard terminals.

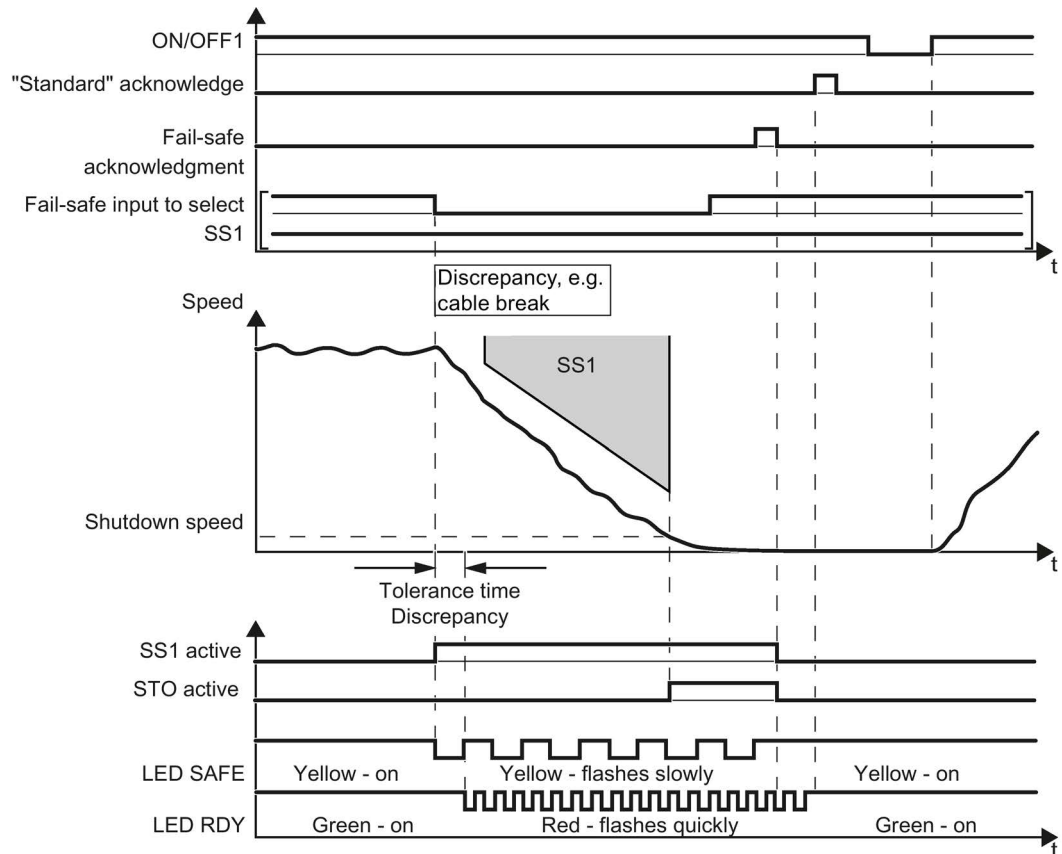


Figure 6-21 Inverter response for discrepancy of the input signal for SS1 (as example: SS1 with braking ramp monitoring)

The inverter does not set the error bit of the safety functions (= internal event).

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.

Inverter signal	Parameter	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
STO active (extended functions)	r9722.0	✓	---	✓
SS1 active (extended functions)	r9722.1	✓	---	✓
Deselect SS1 (extended functions)	r9720.1	✓	✓	---
SAM/SBR active	r9723.16	---	---	---
"Standard" acknowledgment	p2103	---	---	---
Fail-safe acknowledgment	r9720.7	✓	✓	---
ON/OFF1	r0054.0	---	---	---

## 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 safety-related input: F-DI = 0 → 1 → 0.

Alternatively: Switch off the power supply voltage and switch on again.

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.

### 6.5.5 Limit value violation when SS1 is active

#### Drive response

If motion monitoring detects a fault when SS1 is active, the inverter safely switches off the motor torque (STOP A).

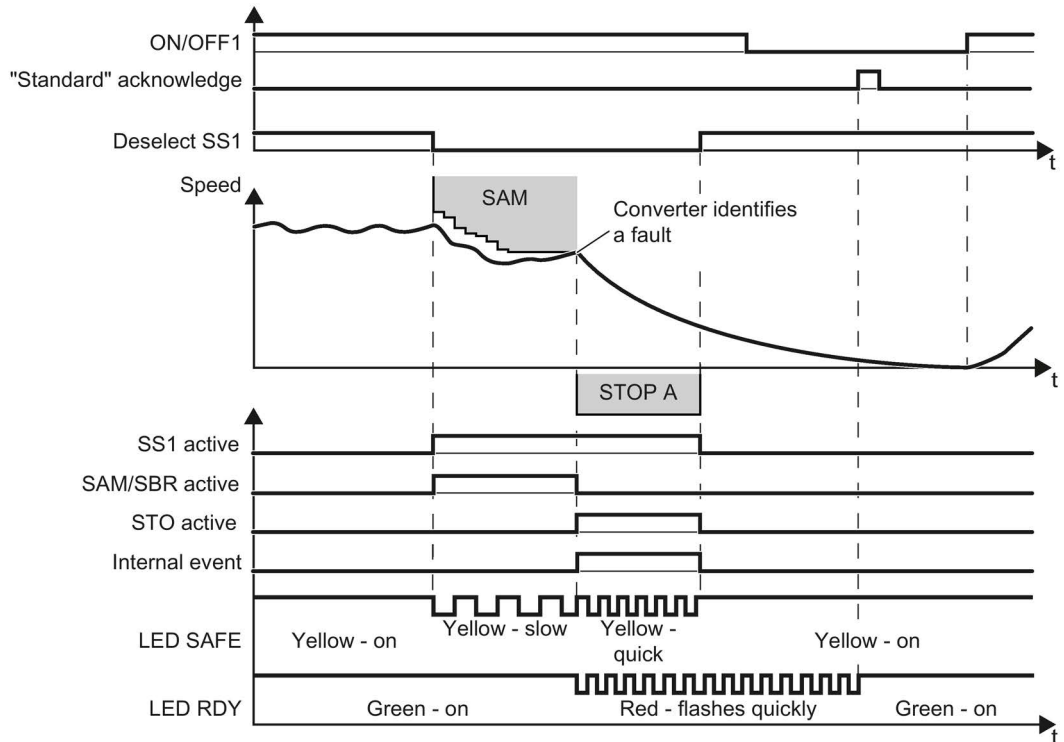


Figure 6-22 General fault response of safety function SS1 (as an example: SS1 with acceleration monitoring)

Inverter signal	Parameter	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
Internal event	r9722.7	✓	---	✓
STO active (extended functions)	r9722.0	✓	---	✓
SS1 active (extended functions)	r9722.1	✓	---	✓
Deselect SS1 (extended functions)	r9720.1	✓	✓	---
SAM/SBR active	r9723.16	---	---	---
"Standard" acknowledgment	p2103	---	---	---
ON/OFF1	r0054.0	---	---	---

## Switching the motor on after an internal event

### Procedure



1 To switch the motor on after an internal event while SS1 is active, proceed as follows:

1. Deselect function SS1.
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.

## 6.6 Safely Limited Speed (SLS)

### 6.6.1 Overview

#### What can you find in this Chapter?

The relevant operating cases for the SLS function are described in this chapter.

Table 6- 5 Response of the SLS function when the motor is switched on (ON/OFF1 = 1)

Selecting and deselecting SLS	→ Selecting and deselecting SLS when the motor is switched on (Page 238)
Switching over SLS levels when SLS is active	Switching over from a higher SLS level to a lower SLS level (and vice versa). → Switching over SLS levels (Page 244)
Discrepancy in the input signal	The safety input to select SLS identifies an error. → Response to a discrepancy when SLS is active (Page 253)
Limit value violation	The speed of the motor exceeds the set SLS limit value. → Limit value violation when SLS is active (Page 255)

Table 6- 6 Switching the motor on and off when SLS is active or not active

	Switching on the motor (ON/OFF1 = 0 → 1)	Switching off the motor (ON/OFF1, OFF2 or OFF3 = 1 → 0)
SLS is not active	If SLS is not active, then there are no restrictions for switching on and switching off the motor.	
SLS is active	If your application requires that SLS always remains active, then you must take into account several special issues when switching on the motor. → Switching on the motor when SLS is active (Page 251).	The drive response depends on the signal that you use to switch off the motor. → Switching off the motor when SLS is active (Page 249)

### 6.6.2 Selecting and deselecting SLS when the motor is switched on

#### Selecting SLS when the motor is switched on

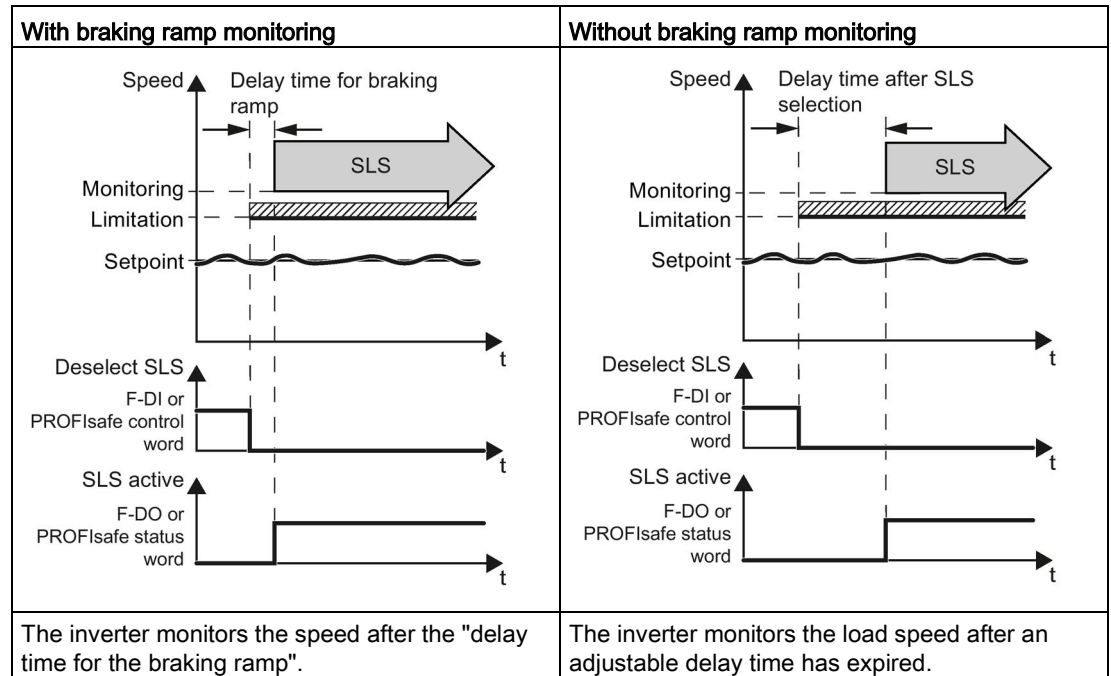
As soon as the inverter detects the selection of SLS via a safety input or via the PROFIsafe safe communication, the following happens:

- The inverter 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 inverter monitors motor braking using the SMR (Safe Brake Ramp) function or not.

With braking ramp monitoring	Without braking ramp monitoring
<p>After the adjustable "Delay time for braking ramp" has elapsed, the inverter uses the SBR (Safe Brake Ramp) function to determine whether the speed has decreased.</p> <p>The inverter switches from SBR to SLS as soon as one of the following two conditions is fulfilled:</p> <ul style="list-style-type: none"> <li>• The SBR monitoring ramp has reached the value of the speed monitoring. This case is shown in the diagram above.</li> <li>• The actual load speed reaches the value of the speed monitoring and the "delay time for braking ramp" has expired.</li> </ul>	<p>The inverter monitors the load speed after an adjustable delay time has expired.</p>
<p>Advantages:</p> <ul style="list-style-type: none"> <li>• Already during braking, the inverter detects as to whether the load speed decreases too slowly.</li> <li>• The feedback signal "SLS active" generally comes earlier than for the alternative acceleration monitoring.</li> </ul>	<p>Advantage:</p> <ul style="list-style-type: none"> <li>• Commissioning is simplified, because instead of the SBR subfunction of the alternative brake ramp monitoring, you only have to set the delay time.</li> </ul>

### Selecting SLS at low motor speeds

If the motor speed when selecting SLS is less than the SLS limit, then the drive responds as follows:



### Deselect SLS

If the higher-level controller deselects SLS, then the inverter deactivates limiting and monitoring.

### 6.6.2.1 SLS with braking ramp monitoring

#### Selecting and deselecting SLS

If the machine control selects the SLS safety function via a safety-related input or via the PROFIsafe safe communication, 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.

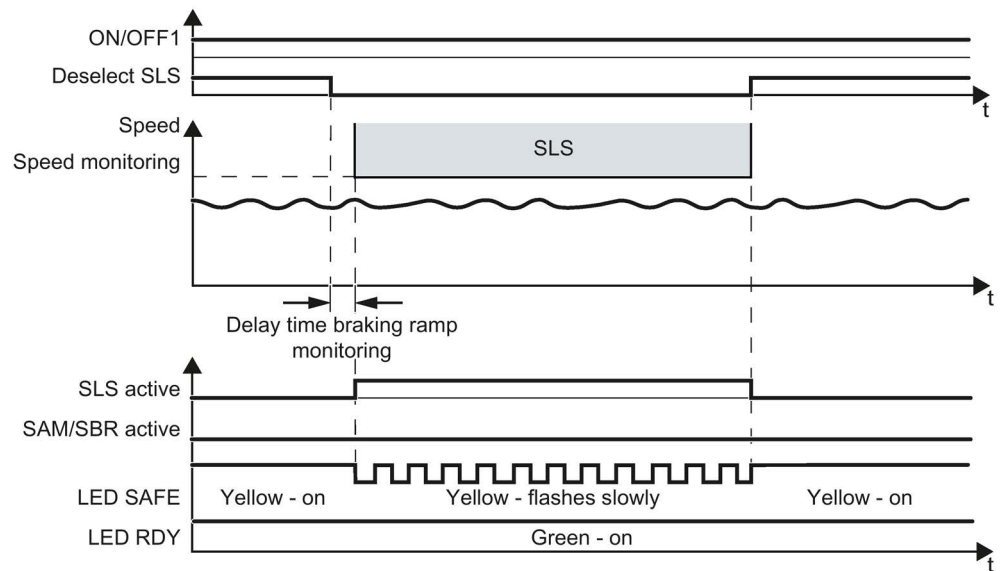


Figure 6-23 Selecting and deselecting the SLS safety function at low speeds



**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.

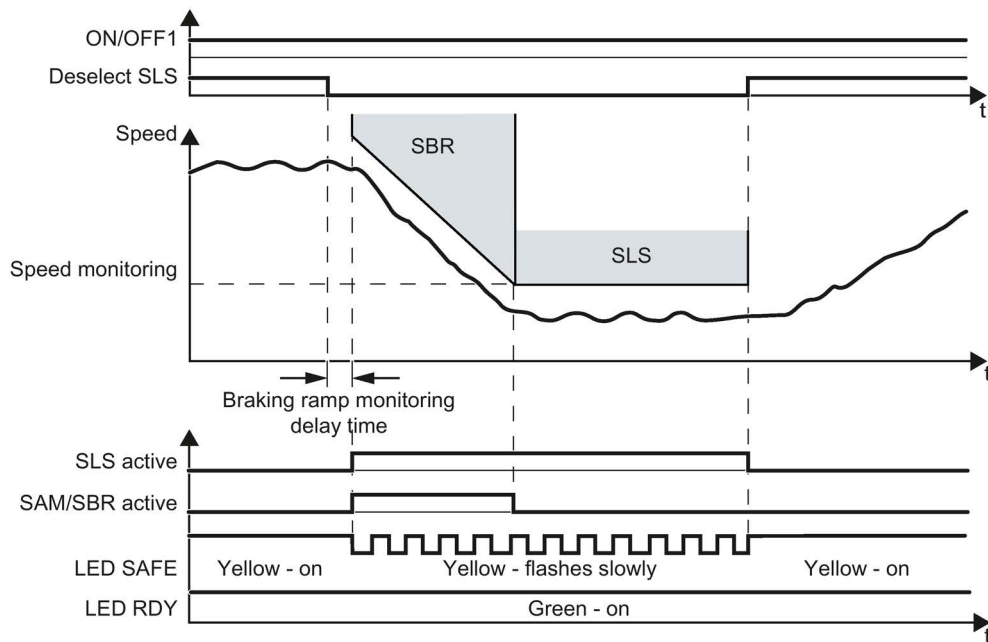


Figure 6-24 Selecting and deselecting the SLS safety function at high speeds

**Signals**

Inverter signal	Parameter	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
SLS active	r9722.4	✓	---	✓
Deselect SLS	r9720.4	✓	✓	---
SAM/SBR active	r9723.16	---	---	---
ON/OFF1	r0054.0	---	---	---

### 6.6.2.2 SLS without braking ramp monitoring

#### Selecting and deselecting SLS

If the machine control selects the SLS safety function via a safety-related input or via the PROFIsafe safe communication, 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.

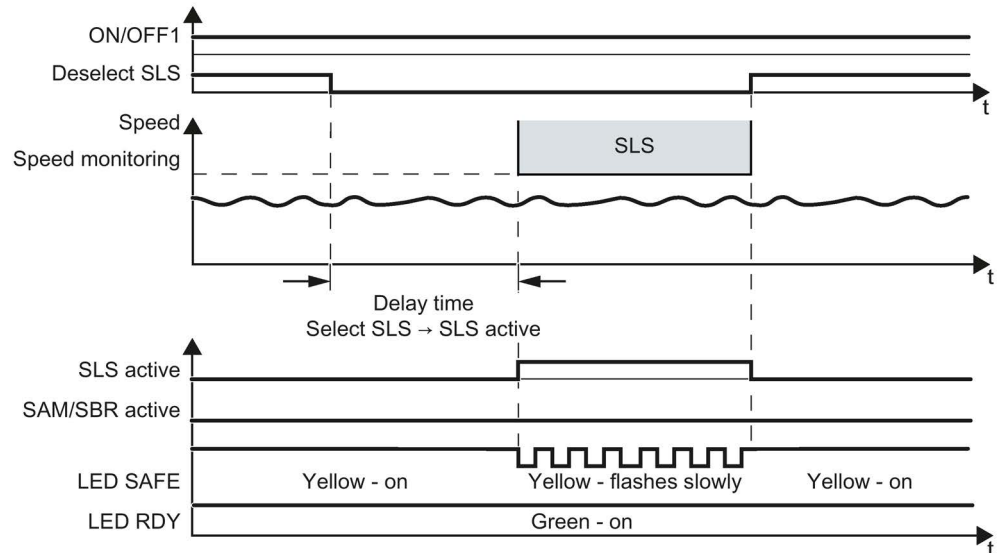


Figure 6-25 Selecting and deselecting the SLS safety function at low speeds

**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.

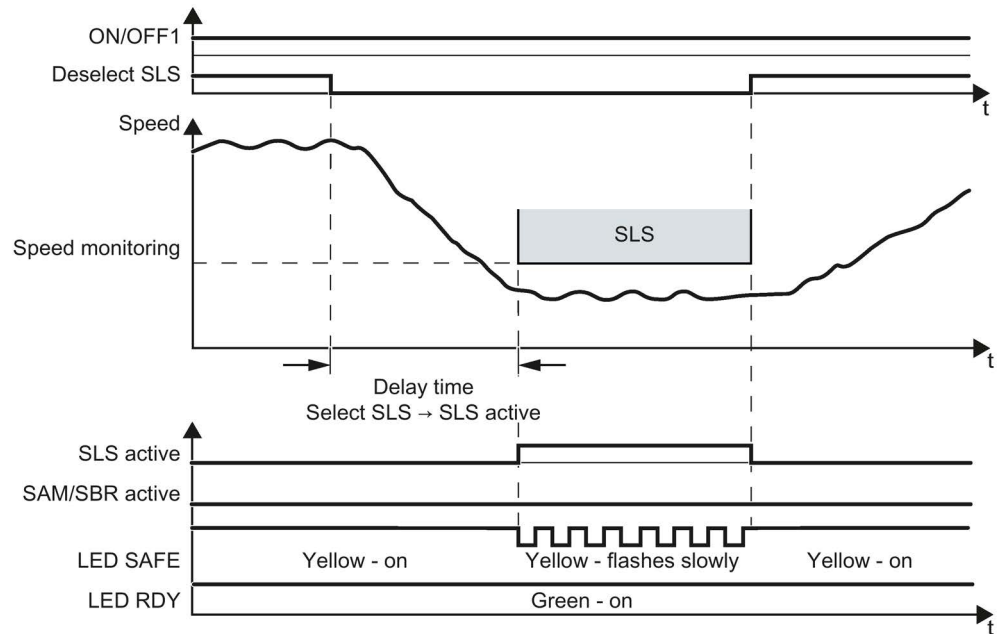


Figure 6-26 Selecting and deselecting the SLS safety function at high speeds

**Signals**

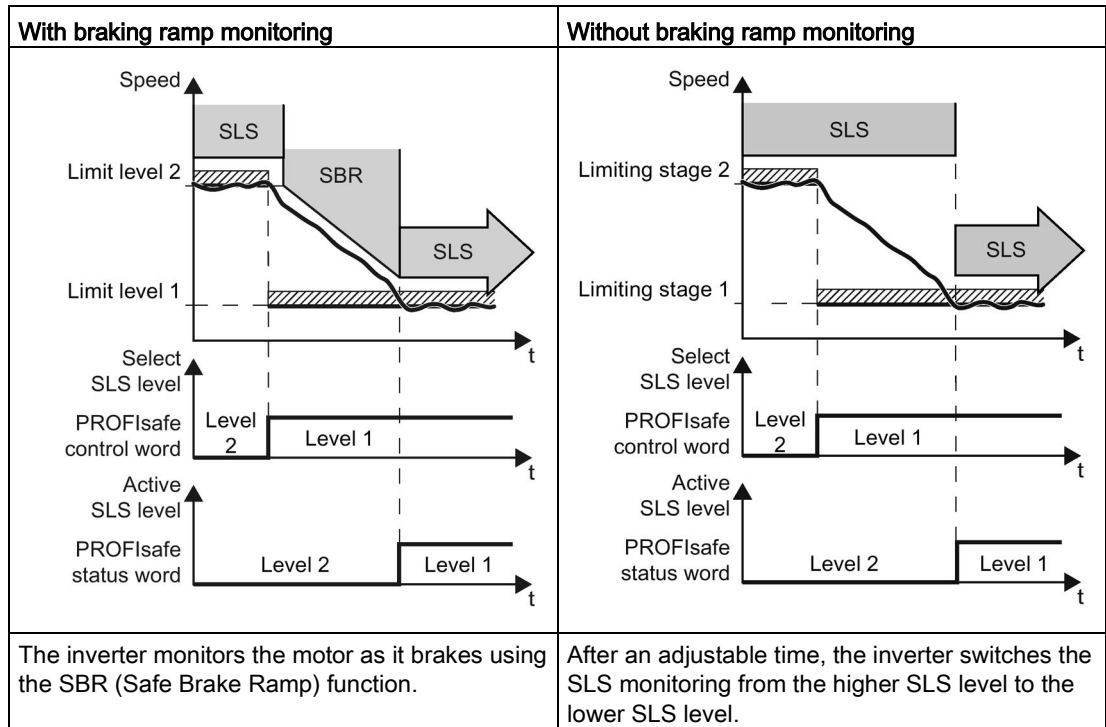
Inverter signal	Parameters	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
SLS active	r9722.4	✓	---	✓
Deselect SLS	r9720.4	✓	✓	---
SAM/SBR active	r9723.16	---	---	---
ON/OFF1	r0054.0	---	---	---

### 6.6.3 Switching over SLS levels

#### Overview

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

The drive response when switching over to a lower SLS level depends on whether you have selected SLS with or without braking ramp monitoring.



### 6.6.3.1 SLS with braking ramp monitoring

#### Switching over SLS levels

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

---

**Note**

Switching over SLS levels is only possible via PROFIsafe with control word 1. See also Section: Control word 1 and status word 1 (extended functions) (Page 52).

---

**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 Brake Ramp) function.
3. The inverter switches from SBR monitoring to SLS monitoring as soon as one of the following two conditions is fulfilled:
  - The SBR monitoring ramp has reached the value of the SLS monitoring. This case is shown in the diagram above.
  - The load speed has decreased down to the value SLS monitoring and the "delay time for braking ramp" has expired.

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

6.6 Safely Limited Speed (SLS)

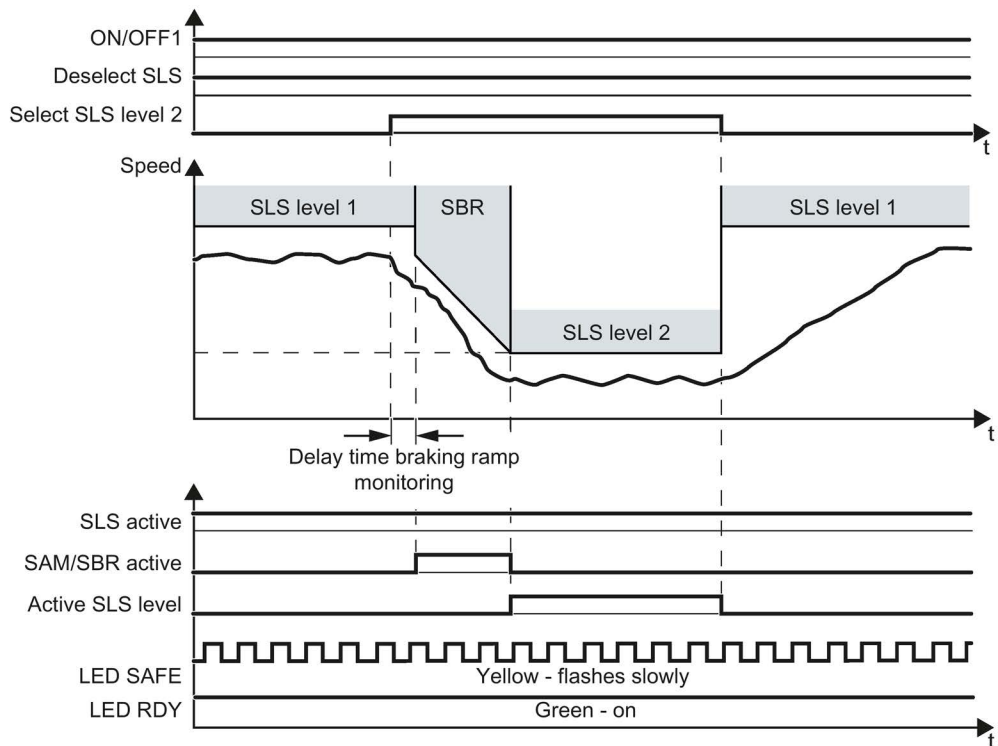


Figure 6-27 Switching between different monitoring thresholds

Inverter signal	Parameter	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
SLS active	r9722.4	✓	---	✓
Deselect SLS	r9720.4	✓	✓	---
SLS level active	r9722.9, r9722.10	✓	---	✓
Select SLS level	r9720.9, r9720.10	✓	✓	---
SAM/SBR active	r9723.16	---	---	---
ON/OFF1	r0054.0	---	---	---

The inverter 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 52).

### 6.6.3.2 SLS without braking ramp monitoring

#### Switching over SLS levels

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

#### Note

Switching over SLS levels is only possible via PROFIsafe with control word 1. See also Section: Control word 1 and status word 1 (extended functions) (Page 52).

#### 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 level to a higher speed monitoring level, then the inverter immediately monitors the speed with the higher SLS level.

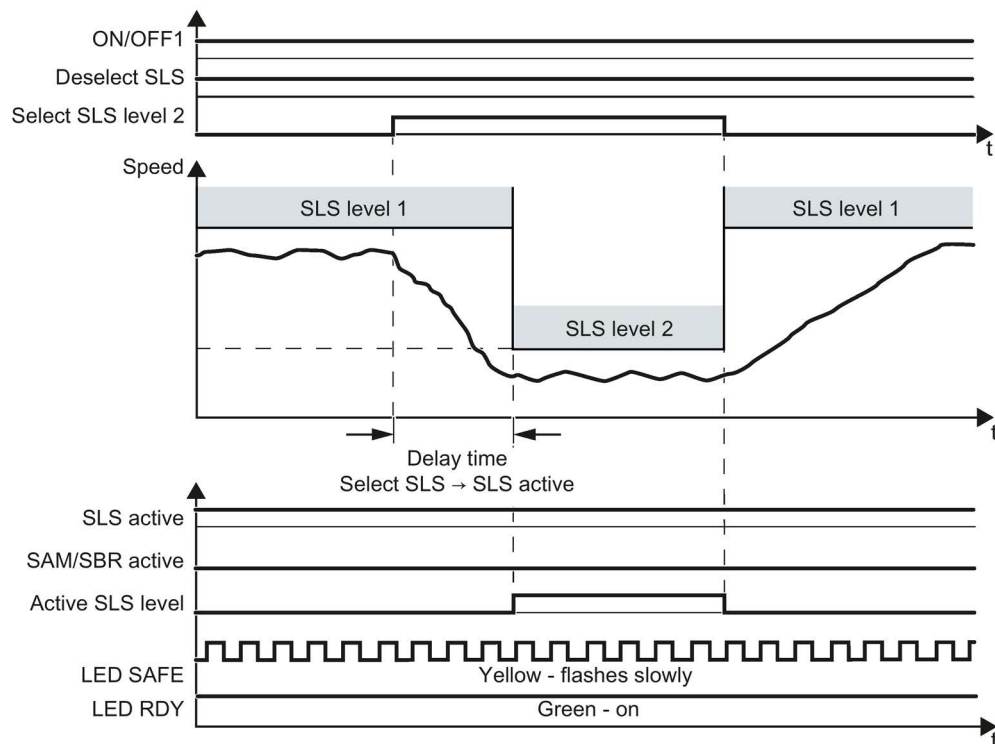


Figure 6-28 Switching between different monitoring thresholds

Inverter signal	Parameter	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
SLS active	r9722.4	✓	---	✓
Deselect SLS	r9720.4	✓	✓	---
SLS level active	r9722.9, r9722.10	✓	---	✓
Select SLS level	r9720.9, r9720.10	✓	✓	---
SAM/SBR active	r9723.16	---	---	---
ON/OFF1	r0054.0	---	---	---

The inverter 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 52).



## 6.6.4 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 inverter brakes the motor with the OFF1 or OFF3 ramp-down time.
2. Also while braking, the inverter monitors the motor speed.
3. When reaching the standstill monitoring, the inverter safely switches off the motor torque with the STO safety function.
4. The motor coasts down to a standstill.

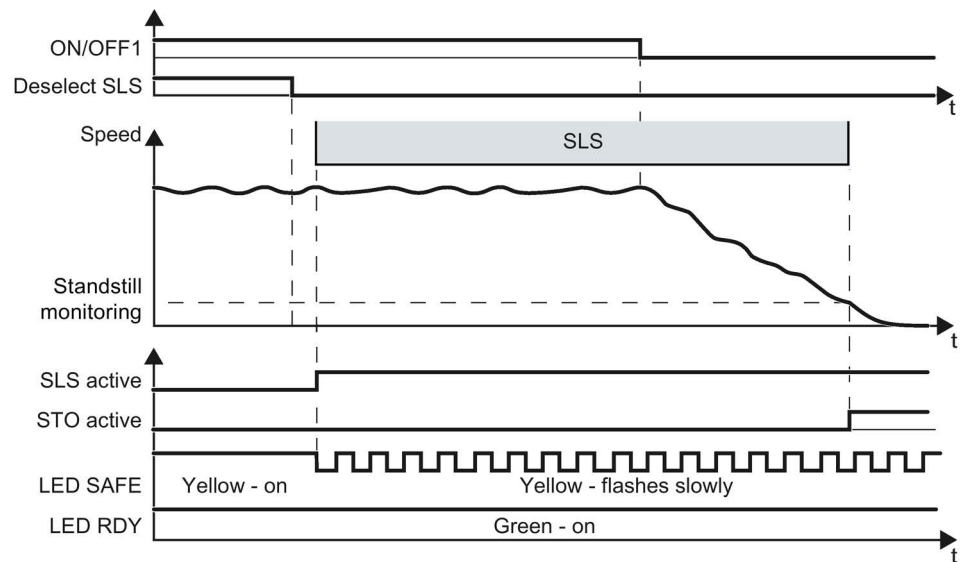


Figure 6-29 OFF1 command when the SLS safety function is active

6.6 Safely Limited Speed (SLS)

If you switch off the motor using the OFF2 command, then the inverter immediately safely switches off the motor torque using the STO safety function.

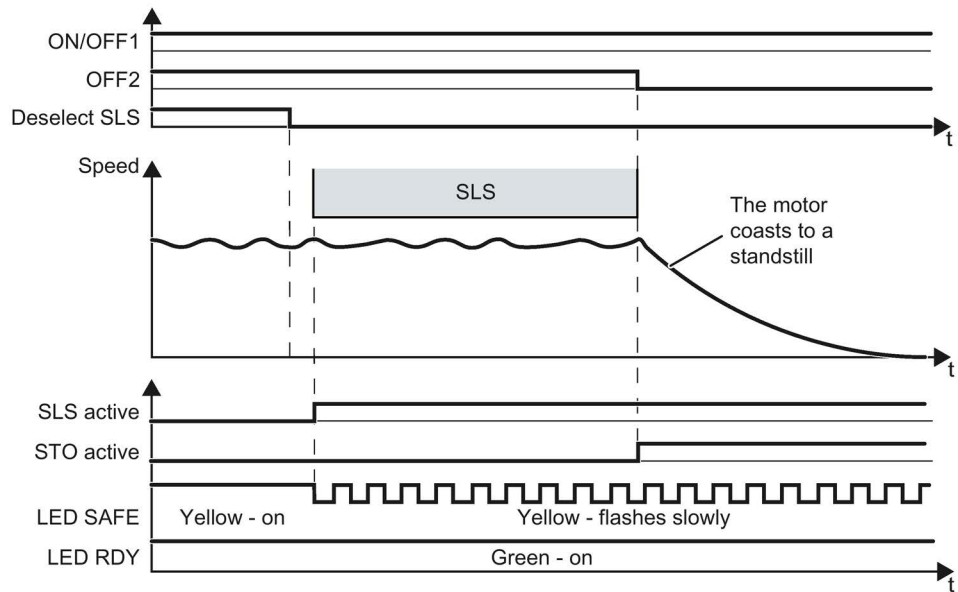


Figure 6-30 OFF2 command when the SLS safety function is active

Inverter signal	Parameter	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
STO active (extended functions)	r9722.0	✓	---	✓
SLS active	r9722.4	✓	---	✓
Deselect SLS	r9720.4	✓	✓	---
ON/OFF1	r0054.0	---	---	---
OFF2	r0054.1	---	---	---

### 6.6.5 Switching on the motor when SLS is active

#### Switch 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. After deselecting STO, wait until the inverter is "ready to switch on".

Alternatively: After deselecting STO, wait a certain time before switching on. We recommend a wait time of 200 ms.

4. Switch on motor within 5 s after deselecting STO (ON command).

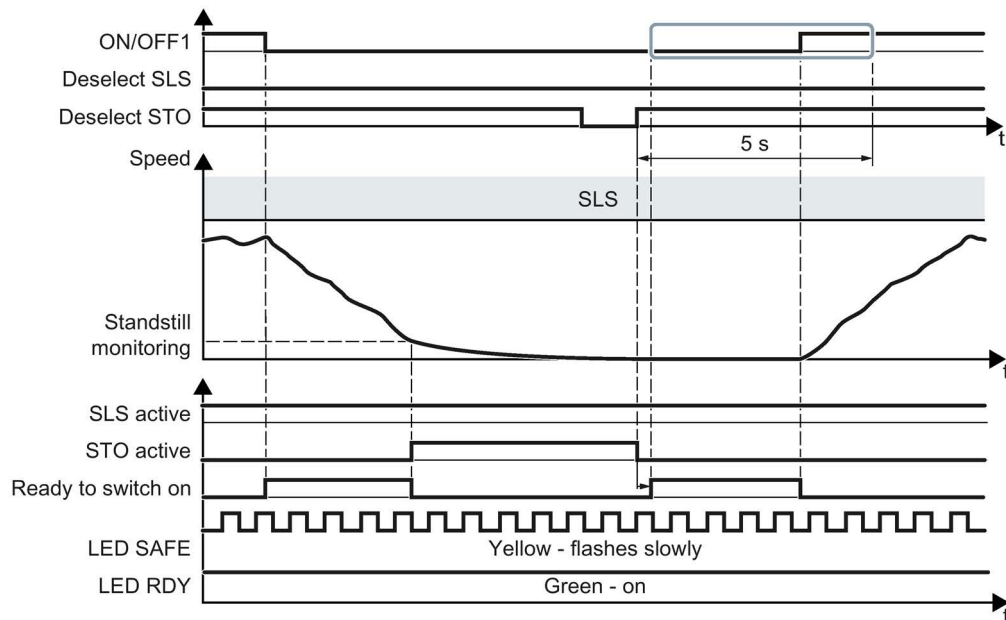


Figure 6-31 Switching the motor off and on (ON/OFF1) when SLS is active

■ You have switched on the motor.

Inverter signal	Parameter	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
STO active (extended functions)	r9722.0	✓	---	✓
Deselect STO (extended functions)	r9720.0	✓	✓	---
SLS active	r9722.4	✓	---	✓
Deselect SLS	r9720.4	✓	✓	---
Ready to switch on	r0052.0	---	---	---
ON/OFF1	r0054.0	---	---	---

**You have not switched on the motor within 5 seconds**

If you do not switch on the motor within 5 seconds after deselecting STO, the following happens:

- The inverter goes back into the STO state.
- The inverter no longer responds to the ON command.
- The inverter outputs Alarm A01795.

To switch on the motor you must repeat the procedure described above.

## 6.6.6 Response to a discrepancy when SLS is active

### Drive response

The inverter responds with the active SLS safety function to a discrepancy at the safety-related input.

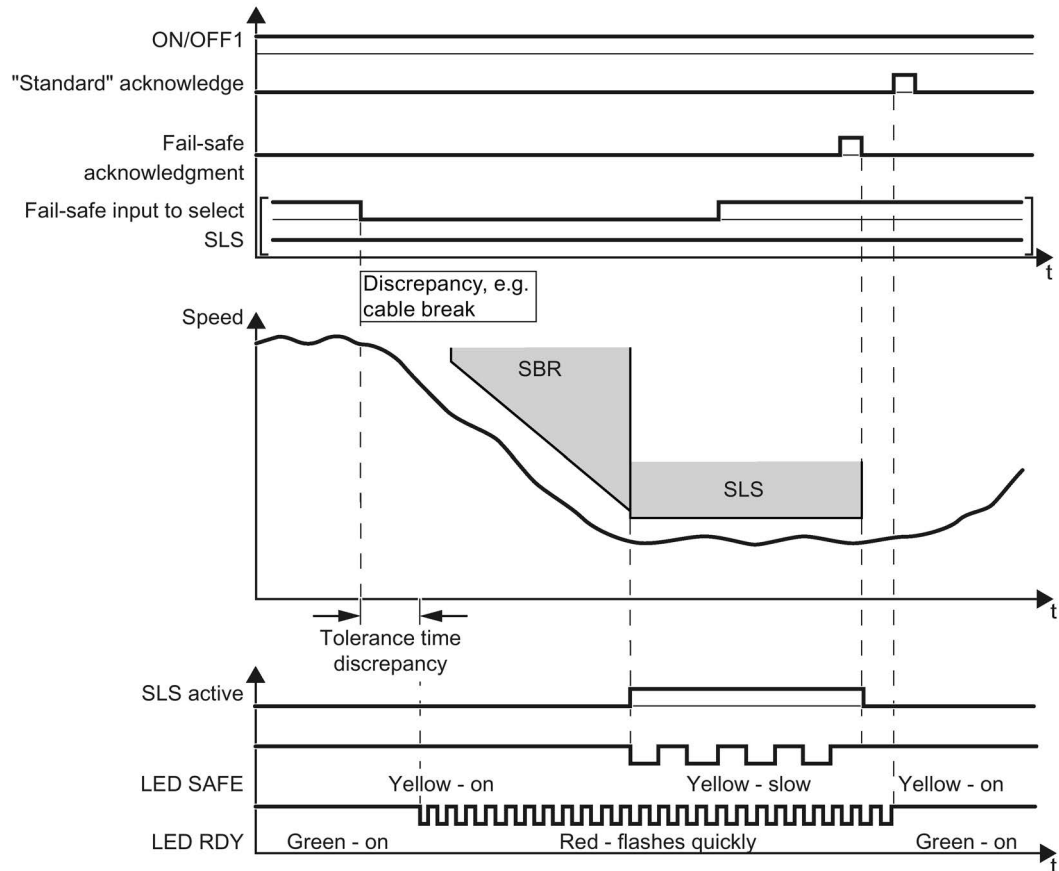


Figure 6-32 Behavior of the inverter for discrepancy of the input signal for SLS

The inverter does not set the error bit of the safety functions (= internal event).

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.

Independent of the voltage levels available, the inverter sets the evaluation of the discrepant F-DI into the safe state (= zero) until you acknowledge the inverter using a fail-safe signal or you switch off the power supply voltage and switch it on again.

Inverter signal	Parameters	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
SLS active	r9722.4	✓	---	✓
Deselect SLS	r9720.4	✓	✓	---
"Standard" acknowledgment	p2103	---	---	---
Fail-safe acknowledgment	r9720.7	✓	✓	---
ON/OFF1	r0054.0	---	---	---

### 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 safety-related 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 power supply voltage and on again.

3. Acknowledge the inverter with the "standard" acknowledge signal.



You have acknowledged the discrepancy message and deselected SLS.

### 6.6.7 Limit value violation when SLS is active

#### Drive response

When motion monitoring detects a fault when SLS is active, the inverter responds by triggering a STOP A or STOP B. The inverter response is parameterized during commissioning. The various STOP variants are described in the section Stop responses (Page 280).

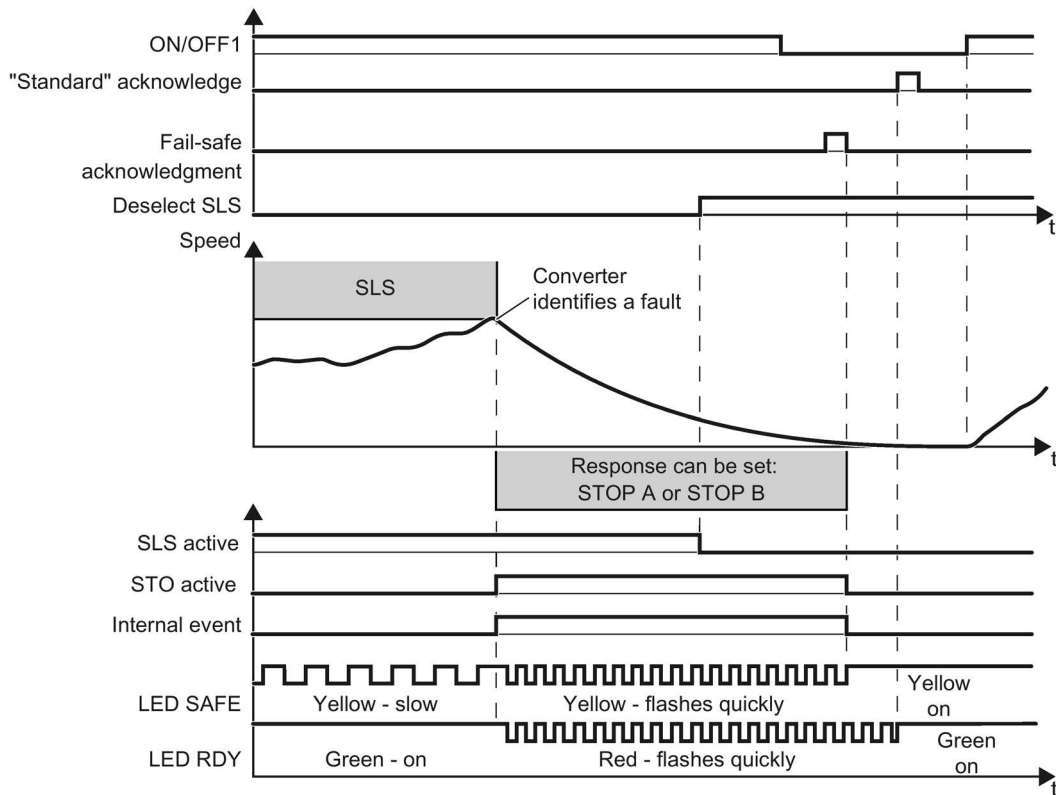


Figure 6-33 Limit value violation of safety function SLS. Example with STOP A as fault response

Inverter signal	Parameter	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
Internal event	r9722.7	✓	---	✓
STO active (extended functions)	r9722.0	✓	---	✓
SLS active	r9722.4	✓	---	✓
Deselect SLS	r9720.4	✓	✓	---
"Standard" acknowledgment	p2103	---	---	---
Fail-safe acknowledgment	r9720.7	✓	✓	---
ON/OFF1	r0054.0	---	---	---

### 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 using PROFIsafe control word 0, bit 7 = 0 → 1 → 0
  - Fail-safe acknowledge signal via a safety-related 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 power supply voltage and on again.
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.



## 6.7 Safe Speed Monitor (SSM)

### 6.7.1 Overview

#### What can you find in this Chapter?

The relevant operating cases for the SSM function are described in this chapter.

Table 6- 7 Response of the SSM function when the motor is switched on (ON/OFF1 = 1)

Feedback signal	The SSM function signals as to whether the motor speed is above or below the set SSM limit value. → Selecting SSM when the motor is switched on (Page 258)
-----------------	---

Table 6- 8 Switching the motor on and off when SSM is active or not active

	Switching on the motor (ON/OFF1 = 0 → 1)	Switching off the motor (ON/OFF1, OFF2 or OFF3 = 1 → 0)
SSM is not active	If SSM is not active, then there are no restrictions for switching on and switching off the motor.	
SSM is active	If SSM is active, you must take into account several special issues when switching on the motor. → Switching on the motor when SSM is active (Page 264).	The drive response depends on the signal that you use to switch off the motor. → Switching off the motor when SSM is active (Page 259)

### 6.7.2 Selecting SSM when the motor is switched on

#### Description

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

- You have enabled one or several extended safety functions.
- For the SSM function, you have set a monitoring speed of > 0.

After switching on the power supply voltage, initially the inverter always sets the feedback signal "Speed below limit value" of the SSM function to 0.

When the motor is switched on, the inverter compares the load speed with the speed limit.

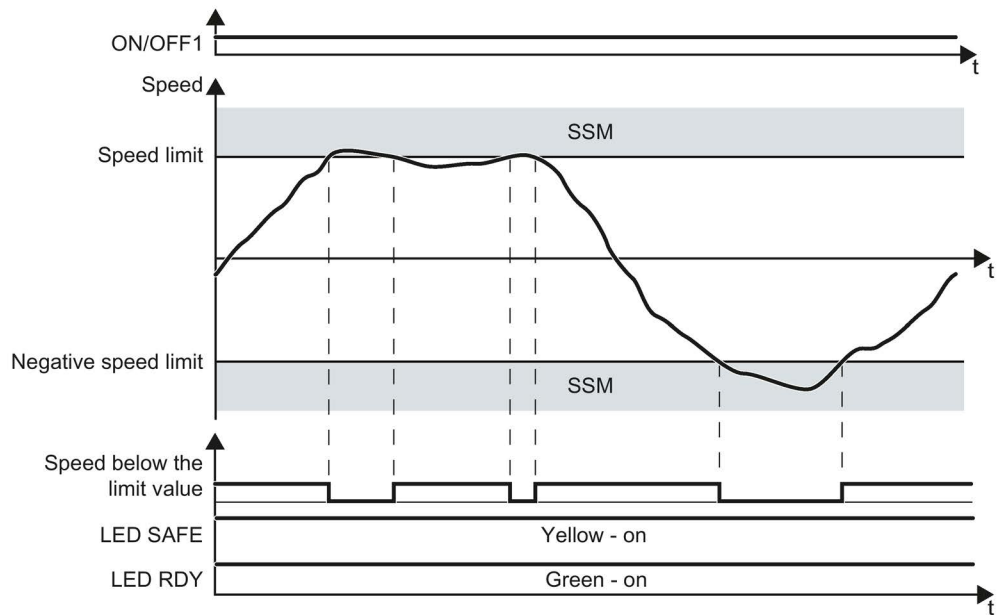


Figure 6-34 Time response of the safety function SSM (Safe Speed Monitor)

Inverter signal	Parameter	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
SSM feedback signal active (speed below limit value)	r9722.15	✓	---	✓
ON/OFF1	r0054.0	---	---	---

### 6.7.3 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 SSM limit value

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

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

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

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

When the motor is switched off, the inverter sets "Status SSM" = 0.

The inverter brakes the motor down to a standstill using the OFF1 or OFF3 command and then switches it off.

6.7 Safe Speed Monitor (SSM)

If the "SSM active" feedback signal should remain active when the pulses are inhibited, then the inverter safely switches off the motor torque using the safety function STO.

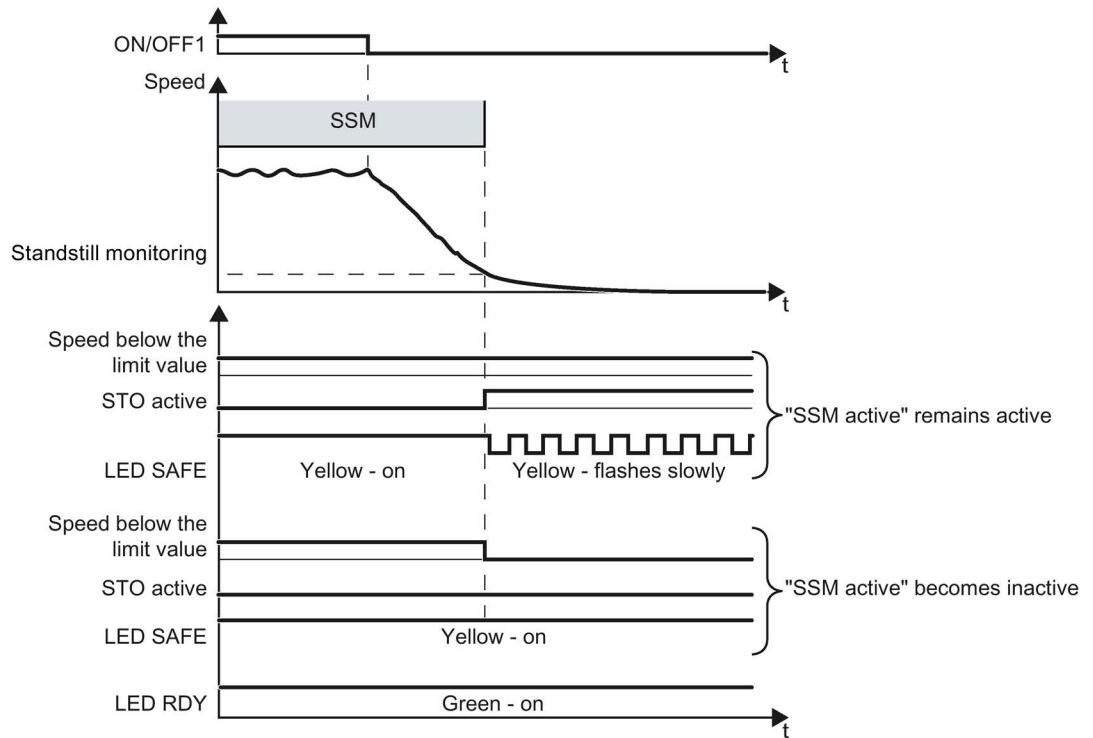


Figure 6-35 OFF1 command when the SSM safety function is active

The inverter immediately switches off the motor with the OFF2 command.

If the "SSM active" feedback signal should remain active when the pulses are inhibited, then the inverter safely switches off the motor torque using the safety function STO.

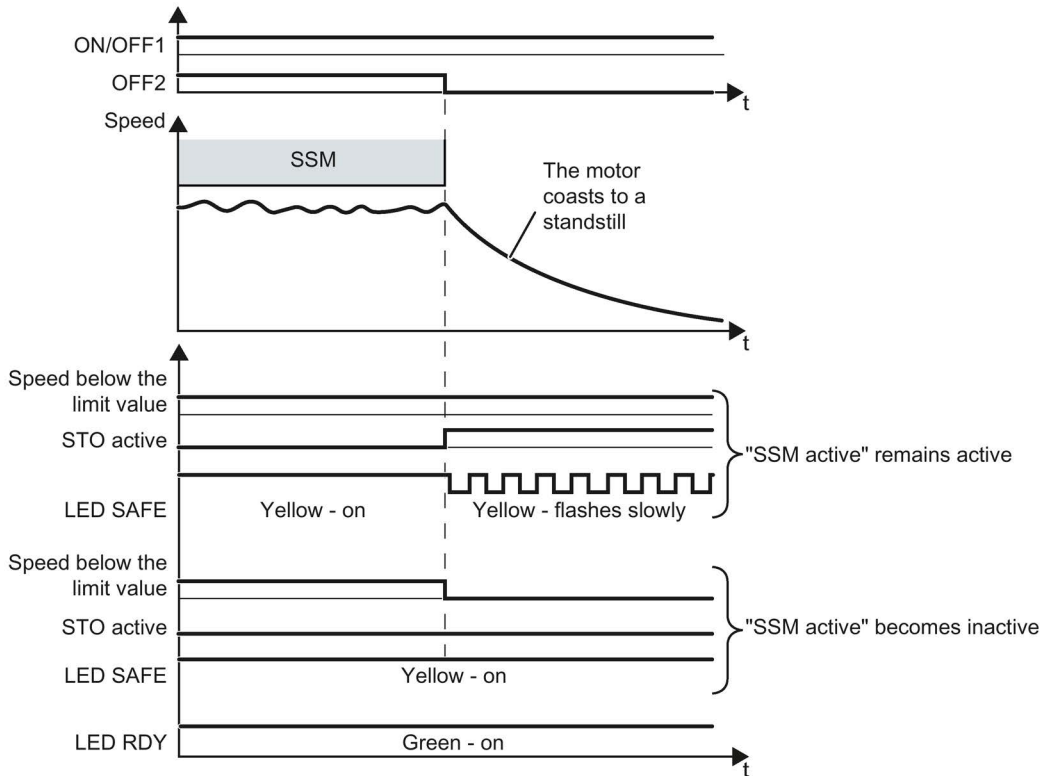


Figure 6-36 OFF2 command when the SSM safety function is active

Inverter signal	Parameter	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
STO active (extended functions)	r9722.0	✓	---	✓
SSM feedback signal active (speed below limit value)	r9722.15	✓	---	✓
ON/OFF1	r0054.0	---	---	---
OFF2	r0054.1	---	---	---

**When switching off, the speed is higher than the SSM limit value**

The inverter brakes the motor down to a standstill using the OFF1 or OFF3 command and then switches it off.

If the "SSM active" feedback signal should remain active when the pulses are inhibited, then the inverter safely switches off the motor torque using the safety function STO.

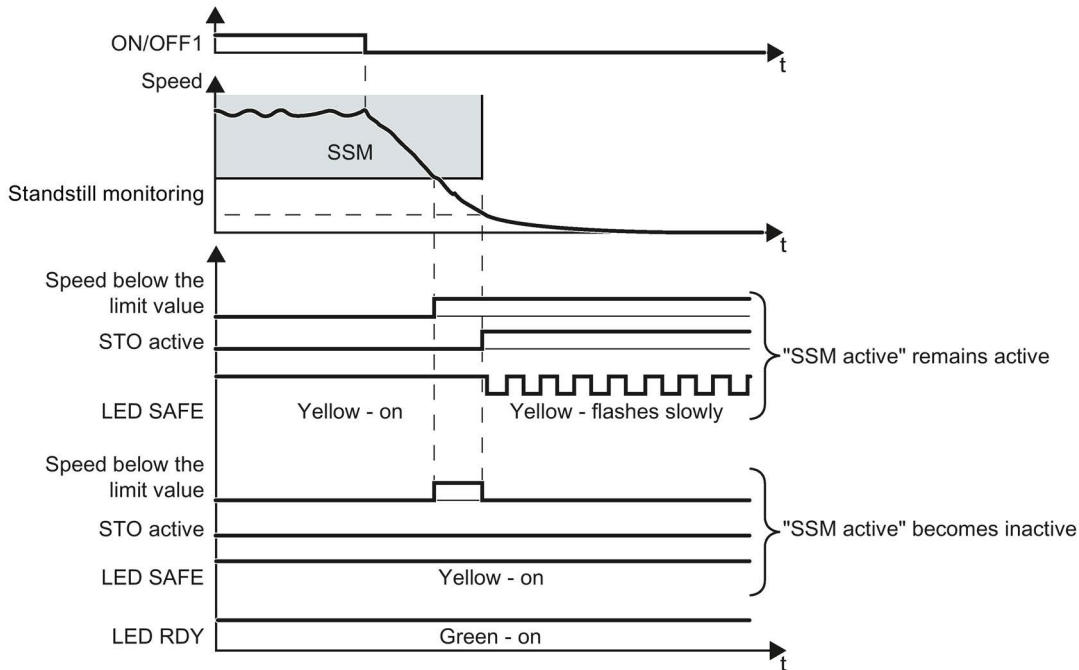


Figure 6-37 OFF1 command when the SSM safety function is active

The inverter immediately switches off the motor with the OFF2 command.

If the "SSM active" feedback signal should remain active when the pulses are inhibited, then the inverter safely switches off the motor torque using the safety function STO.

The feedback signal "SSM active" remains = 0.

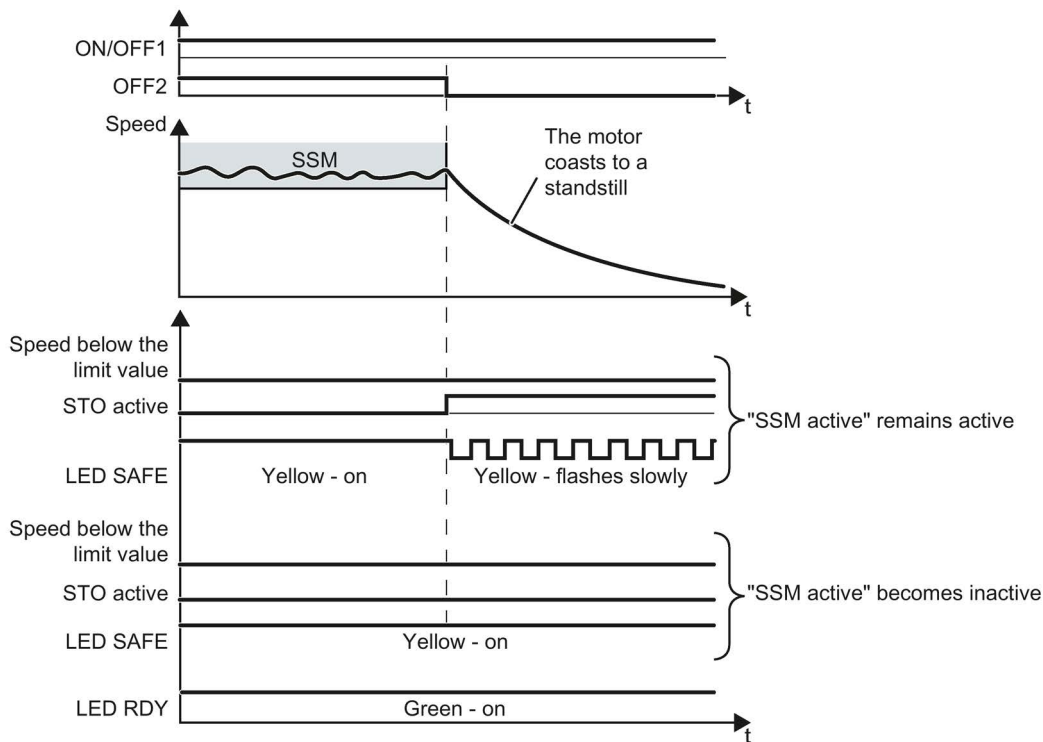


Figure 6-38 OFF2 command when the SSM safety function is active

Inverter signal	Parameter	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
STO active (extended functions)	r9722.0	✓	---	✓
SSM feedback signal active (speed below limit value)	r9722.15	✓	---	✓
ON/OFF1	r0054.0	---	---	---
OFF2	r0054.1	---	---	---

### 6.7.4 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

With this setting, the SSM function does not influence switching on the motor. SSM is active when you switch on the motor.

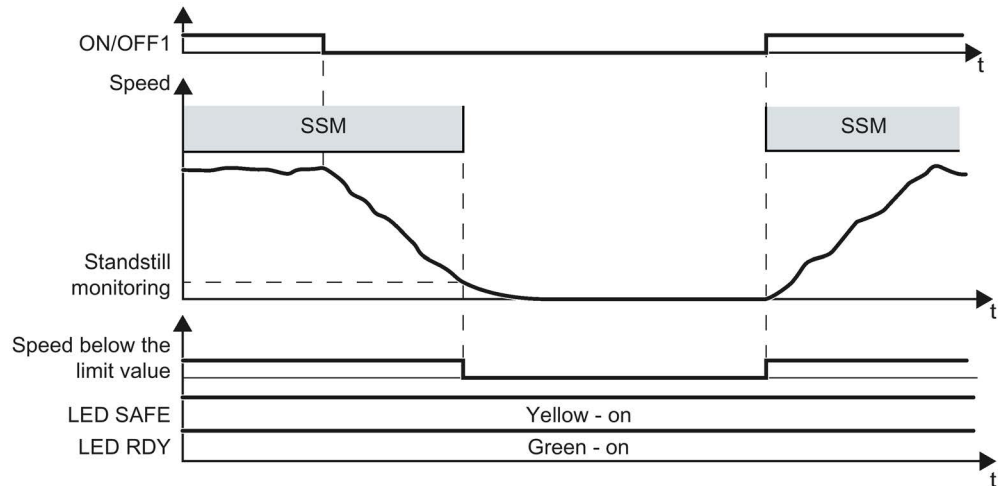


Figure 6-39 Switching on the motor when the SSM function is active, interrupting SSM

Inverter signal	Parameter	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
SSM feedback signal active (speed below limit value)	r9722.15	✓	---	✓
ON/OFF1	r0054.0	---	---	---



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

With this setting, you must maintain a certain sequence before switching on the motor.

#### Procedure



1 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. After deselecting STO, wait until the inverter is "ready to switch on".

Alternatively: After deselecting STO, wait a certain time before switching on. We recommend a wait time of 200 ms.

4. Switch on motor within 5 s after deselecting STO (ON command).

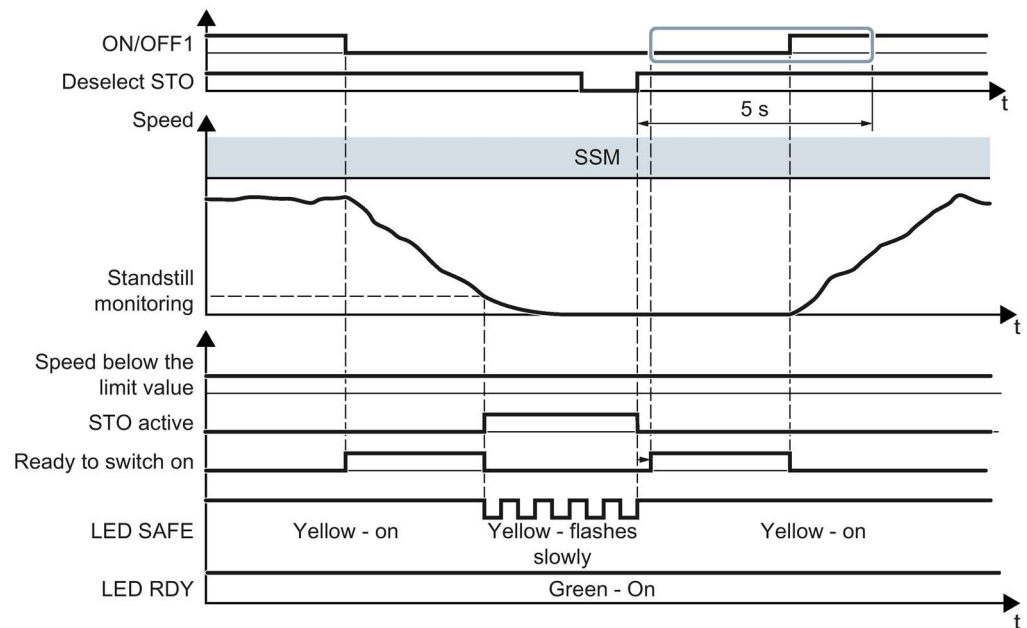


Figure 6-40 Switching on the motor when SSM is active

■ You have switched on the motor.

Inverter signal	Parameter	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
STO active (extended functions)	r9722.0	✓	---	✓
Deselect STO (extended functions)	r9720.0	✓	✓	---
SSM feedback signal active (speed below limit value)	r9722.15	✓	---	✓
ON/OFF1	r0054.0	---	---	---
Ready to switch on	r0052.0	---	---	---

### **You have not switched on the motor within 5 seconds**

If you do not switch on the motor within 5 seconds after deselecting STO, the following happens:

- The inverter goes back into the STO state.
- The inverter no longer responds to the ON command.
- The inverter outputs Alarm A01795.

To switch on the motor you must repeat the procedure described above.

## 6.8 Safe Direction (SDI)

### 6.8.1 Overview

#### What can you find in this Chapter?

The relevant operating cases for the SDI function are described in this chapter.

Table 6- 9 Response of the SDI function when the motor is switched on (ON/OFF1 = 1)

Selecting and deselecting SDI	→ Selecting and deselecting SDI when the motor is switched on (Page 268)
Discrepancy in the input signal	The safety input to select SDI identifies an error. → Response to a discrepancy when Safe Direction is active (SDI) (Page 274)
Limit value violation	The motor rotates in the monitored direction. → Limit value violation when Safe Direction (SDI) is active (Page 276)

Table 6- 10 Switching the motor on and off when SDI is active or not active

	Switching on the motor (ON/OFF1 = 0 → 1)	Switching off the motor (ON/OFF1, OFF2 or OFF3 = 1 → 0)
SDI is not active	If SDI is not active, then there are no restrictions for switching on and switching off the motor.	
SDI is active	If your application requires that SDI always remains active, then you must take into account several special issues when switching on the motor. → Switching on the motor when SDI is active (Page 271).	The drive response depends on the signal that you use to switch off the motor. → Switching off the motor when SDI is active (Page 269)

### 6.8.2 Selecting and deselecting SDI when the motor is switched on

#### Select SDI

**Function**

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

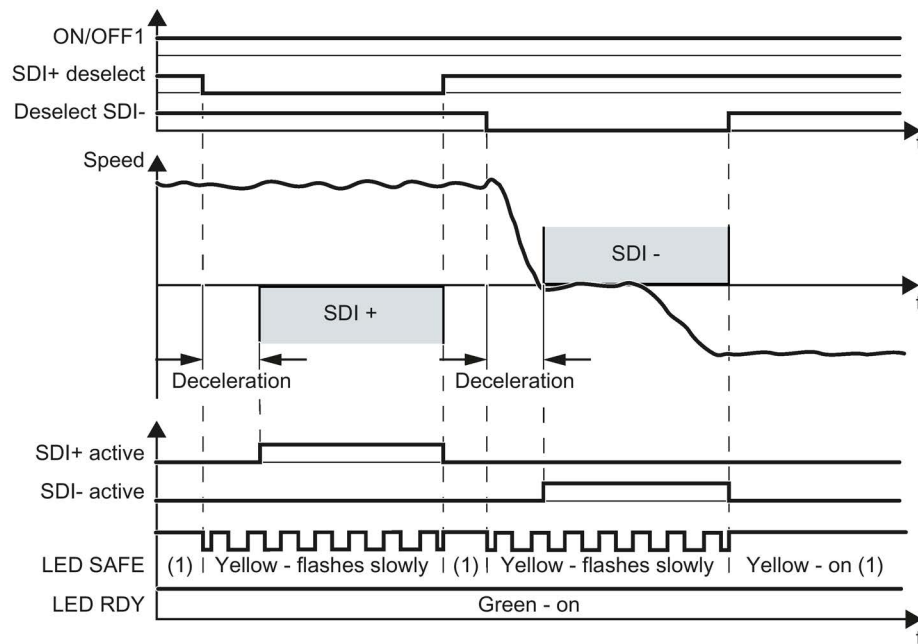


Figure 6-41 Time response of the safety function SDI (Safe direction)

Inverter signal	Parameters	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
SDI+ active	r9722.12	✓	---	✓
SDI+ deselect	r9720.12	✓	✓	---
SDI- active	r9722.13	✓	---	✓
Deselect SDI-	r9720.13	✓	✓	---
ON/OFF1	r0054.0	---	---	---

### 6.8.3 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 inverter brakes the motor with the OFF1 or OFF3 ramp-down time until the speed reaches the standstill monitoring threshold.
2. Also while braking, the inverter monitors the direction of rotation.

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

1. Feedback signal "SDI active" for pulse inhibit *remains active*  
 With this setting, the inverter safely switches off the motor torque when reaching the standstill monitoring using the STO safety function. The inverter 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 inverter inverter off the motor torque, but not safely. The system does not safely prevent that the motor actively accelerates. Therefore, the inverter sets the "SDI active" signal to 0 when the motor is switched off.

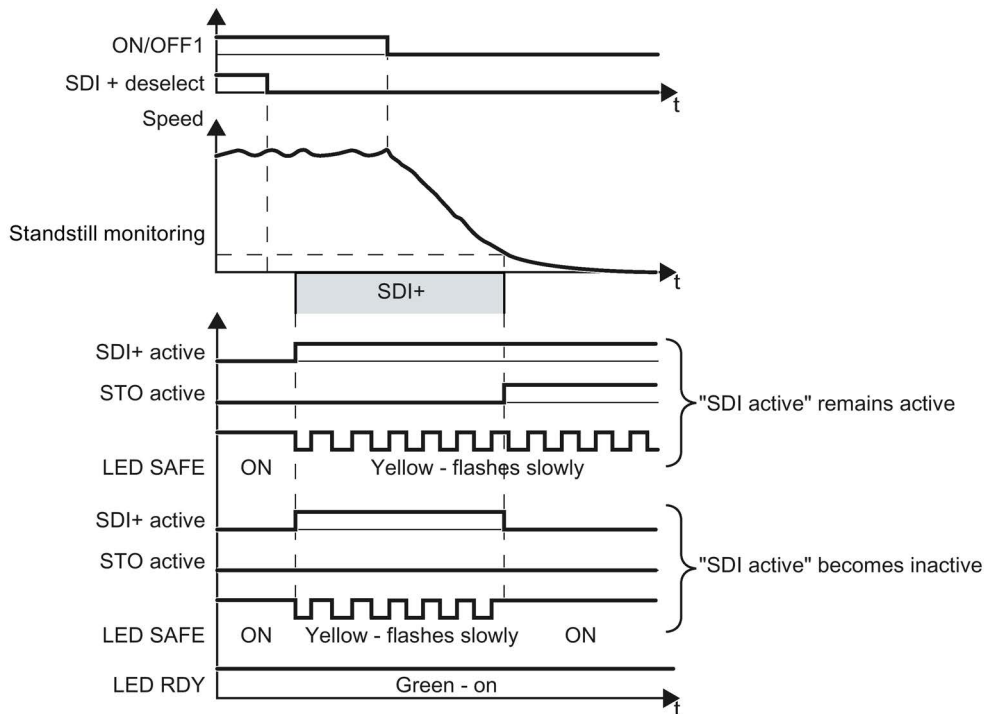


Figure 6-42 OFF1 command when the SDI safety function is active

If you switch the motor off with the OFF2 command when the SDI safety function is active, the inverter immediately switches off the motor. Depending on the selected setting, the inverter immediately switches off the motor torque with the STO safety function.

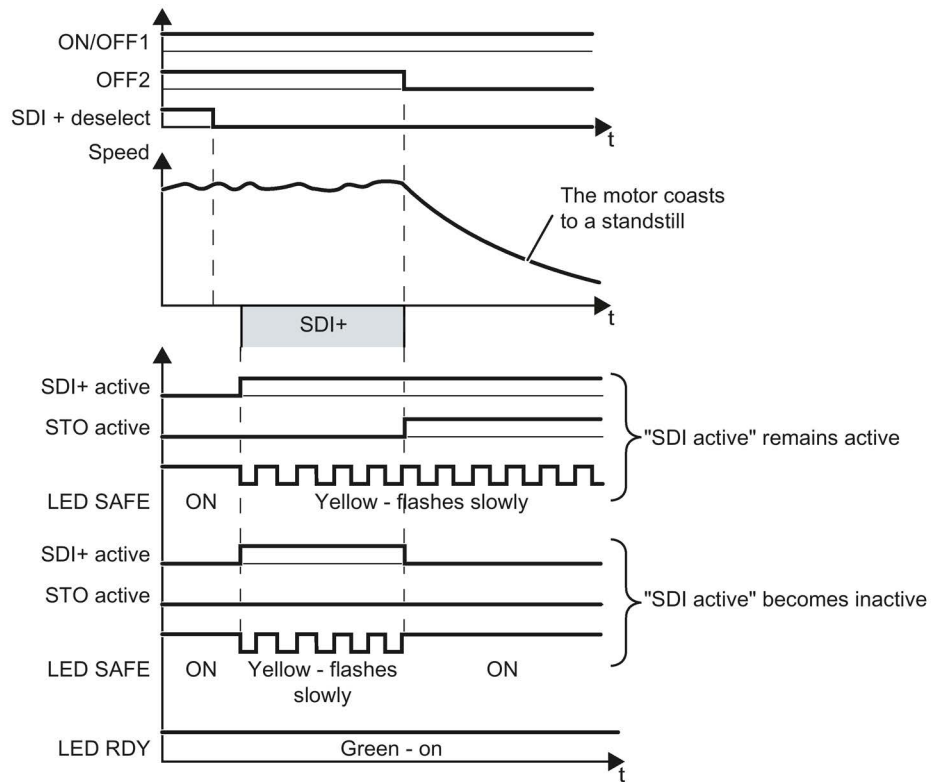


Figure 6-43 OFF2 command when the SDI safety function is active

Inverter signal	Parameters	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
STO active (extended functions)	r9722.0	✓	---	✓
SDI+ active	r9722.12	✓	---	✓
SDI+ deselect	r9720.12	✓	✓	---
SDI- active	r9722.13	✓	---	✓
Deselect SDI-	r9720.13	✓	✓	---
ON/OFF1	r0054.0	---	---	---
OFF2	r0054.1	---	---	---

### 6.8.4 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

With this setting, the SDI function does not influence switching on the motor. SDI is active when you switch on the motor.

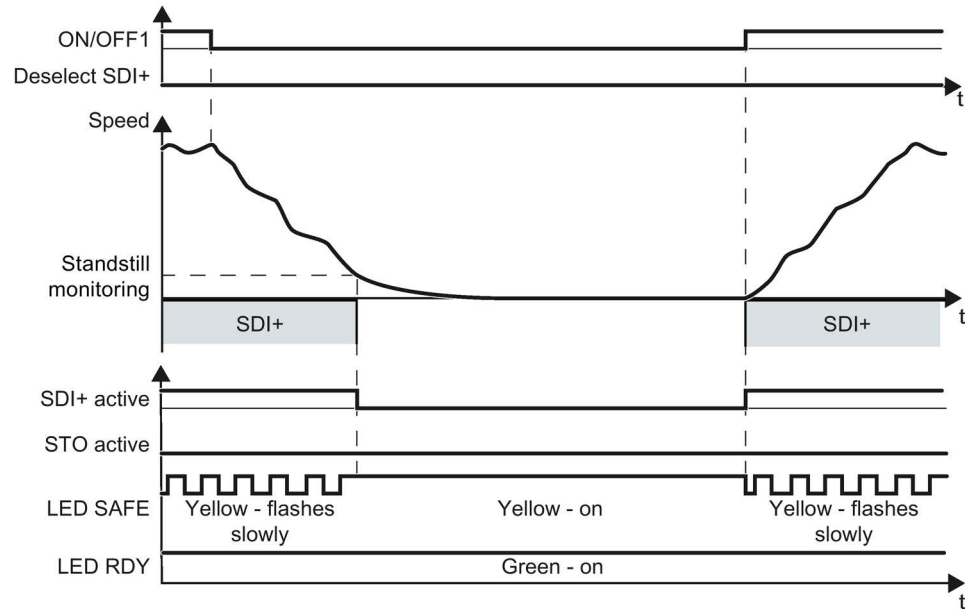


Figure 6-44 Switching the motor off and on when SDI is active, interrupts the feedback signal from SDI

Inverter signals	Parameters	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
STO active (extended functions)	r9722.0	✓	---	✓
SDI+ active	r9722.12	✓	---	✓
SDI+ deselect	r9720.12	✓	✓	---
SDI- active	r9722.13	✓	---	✓
Deselect SDI-	r9720.13	✓	✓	---
ON/OFF1	r0054.0	---	---	---

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

Procedure



1 To switch the motor on, proceed as follows:

1. Select STO (or SS1).
2. Deselect STO (or SS1) again.
3. After deselecting STO, wait until the inverter is "ready to switch on".

Alternatively: After deselecting STO, wait a certain time before switching on. We recommend a wait time of 200 ms.

4. Switch on motor within 5 s after deselecting STO (ON command).

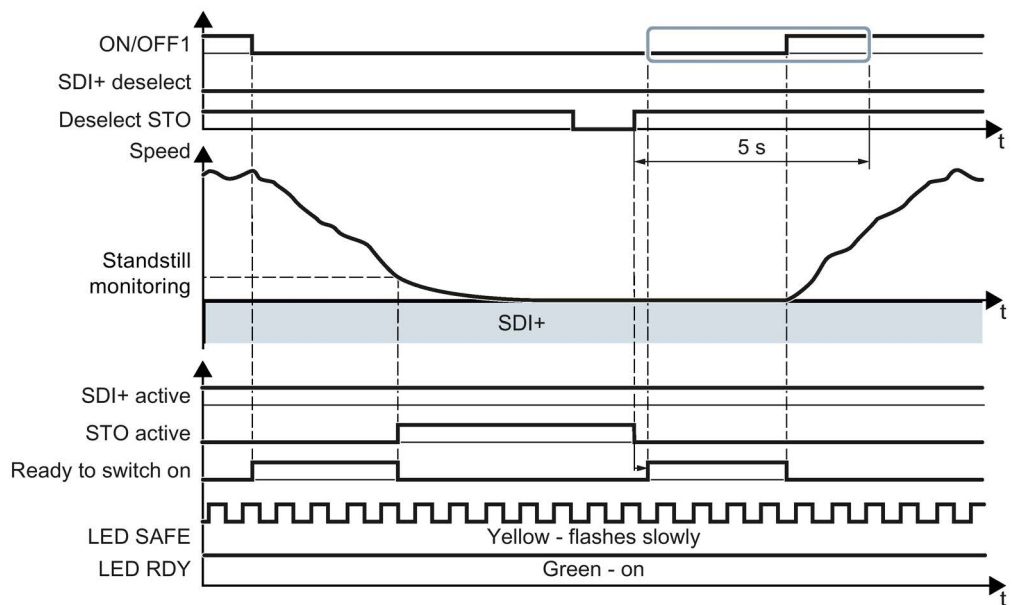


Figure 6-45 Switching the motor off and on when SDI is active

■ You have switched on the motor again.

Inverter signals	Parameters	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
STO active (extended functions)	r9722.0	✓	---	✓
Deselect STO (extended functions)	r9720.0	✓	✓	---
SDI+ active	r9722.12	✓	---	✓
SDI+ deselect	r9720.12	✓	✓	---
SDI- active	r9722.13	✓	---	✓
Deselect SDI-	r9720.13	✓	✓	---
ON/OFF1	r0054.0	---	---	---
Ready to switch on	r0052.0	---	---	---



**You have not switched on the motor within 5 seconds**

If you do not switch on the motor within 5 seconds after deselecting STO, the following happens:

- The inverter goes back into the STO state.
- The inverter no longer responds to the ON command.
- The inverter outputs Alarm A01795.

To switch on the motor you must repeat the procedure described above.

### 6.8.5 Response to a discrepancy when Safe Direction is active (SDI)

#### Drive response

The inverter responds with the active SDI safety function to a discrepancy at the safety-related input.

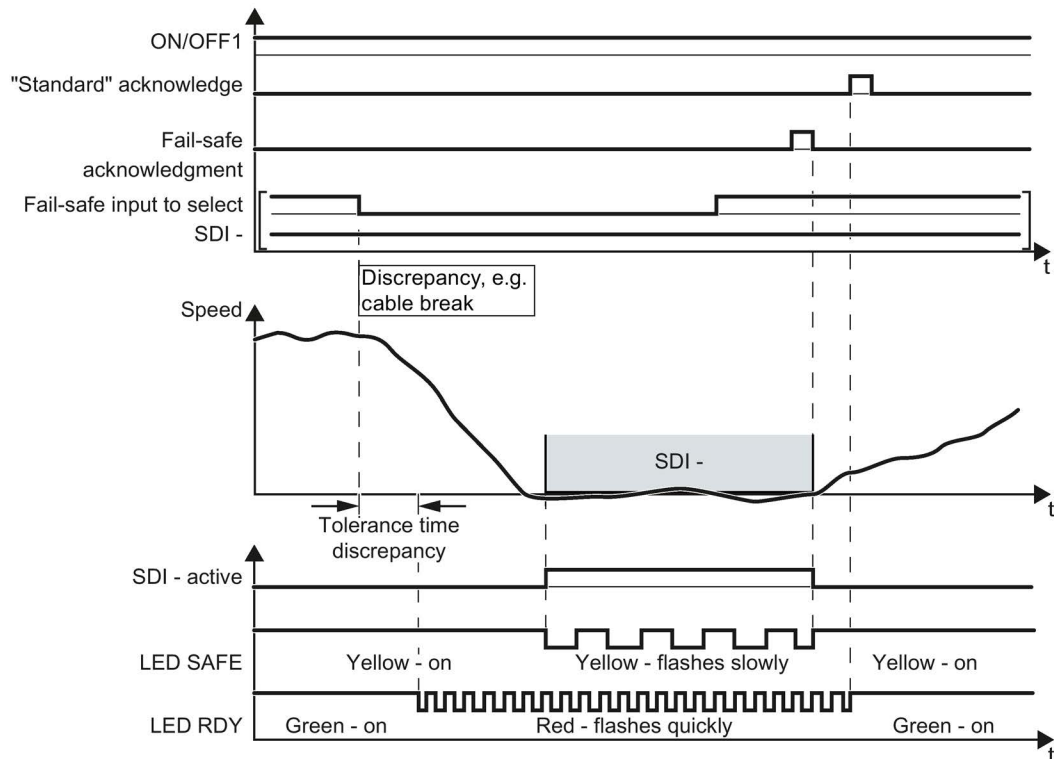


Figure 6-46 Response of the inverter for discrepancy of the input signal for SDI (SDI- as example)

The inverter does not set the error bit of the safety functions (= internal event).

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.

Independent of the voltage levels available, the inverter sets the evaluation of the discrepant F-DI into the safe state (= zero) until you acknowledge the inverter using a fail-safe signal or you switch off the power supply voltage and switch it on again.

Inverter signals	Parameters	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
STO active (extended functions)	r9722.0	✓	---	✓
SDI+ active	r9722.12	✓	---	✓
SDI+ deselect	r9720.12	✓	✓	---
SDI- active	r9722.13	✓	---	✓
Deselect SDI-	r9720.13	✓	✓	---
"Standard" acknowledgment	p2103	---	---	---
Fail-safe acknowledgment	r9720.7	✓	✓	---
ON/OFF1	r0054.0	---	---	---

## 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 safety-related 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 power supply voltage of the inverter and switch on again.

3. Acknowledge the inverter with the "standard" acknowledge signal.



You have acknowledged the discrepancy message and deselected SDI.

### 6.8.6 Limit value violation when Safe Direction (SDI) is active

#### Drive response

When motion monitoring detects a fault when SDI is active, the inverter responds by triggering a STOP A or STOP B. The inverter response is parameterized during commissioning. The various STOP variants are described in the section Stop responses (Page 280).

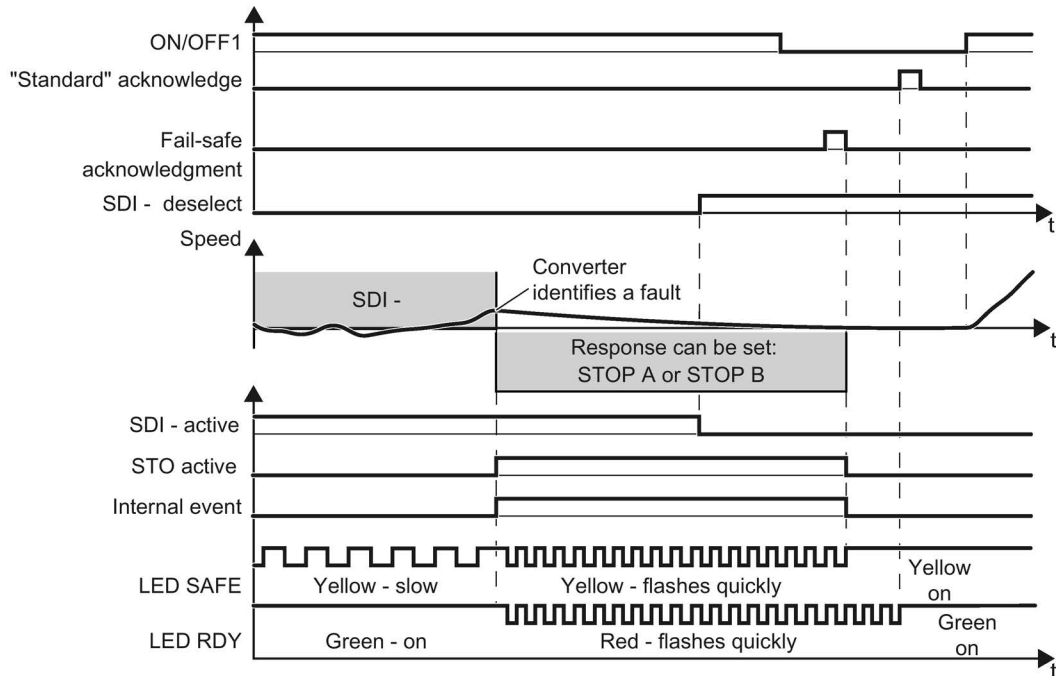


Figure 6-47 Limit value violation of safety function SDI. Example with STOP A as fault response

Inverter signals	Parameters	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
Internal event	r9722.7	✓	---	✓
STO active (extended functions)	r9722.0	✓	---	✓
SDI+ active	r9722.12	✓	---	✓
SDI+ deselect	r9720.12	✓	✓	---
SDI- active	r9722.13	✓	---	✓
Deselect SDI-	r9720.13	✓	✓	---
"Standard" acknowledgment	p2103	---	---	---
Fail-safe acknowledgment	r9720.7	✓	✓	---
ON/OFF1	r0054.0	---	---	---

## Switching the motor on after an internal event

### Procedure



1 To switch the motor on after an internal event while SDI is active, proceed as follows:

- 2 1. Deselect the SDI function.
- 2 2. Issue an OFF1 command (ON/OFF1 = 0).
- 2 3. Acknowledge the internal event in one of the following ways:
  - Fail-safe acknowledgment using PROFIsafe control word 0, bit 7 = 0 → 1 → 0
  - Fail-safe acknowledge signal via a safety-related 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 power supply voltage of the inverter and switch on again.
- 2 4. Acknowledge the inverter with the "standard" acknowledge signal.
- 2 5. Switch on the motor (ON/OFF1 = 1).
- You have acknowledged the internal event and switched on the motor again.

## 6.9 Response to a discrepancy in the signals transferred via PROFIsafe

### Drive response

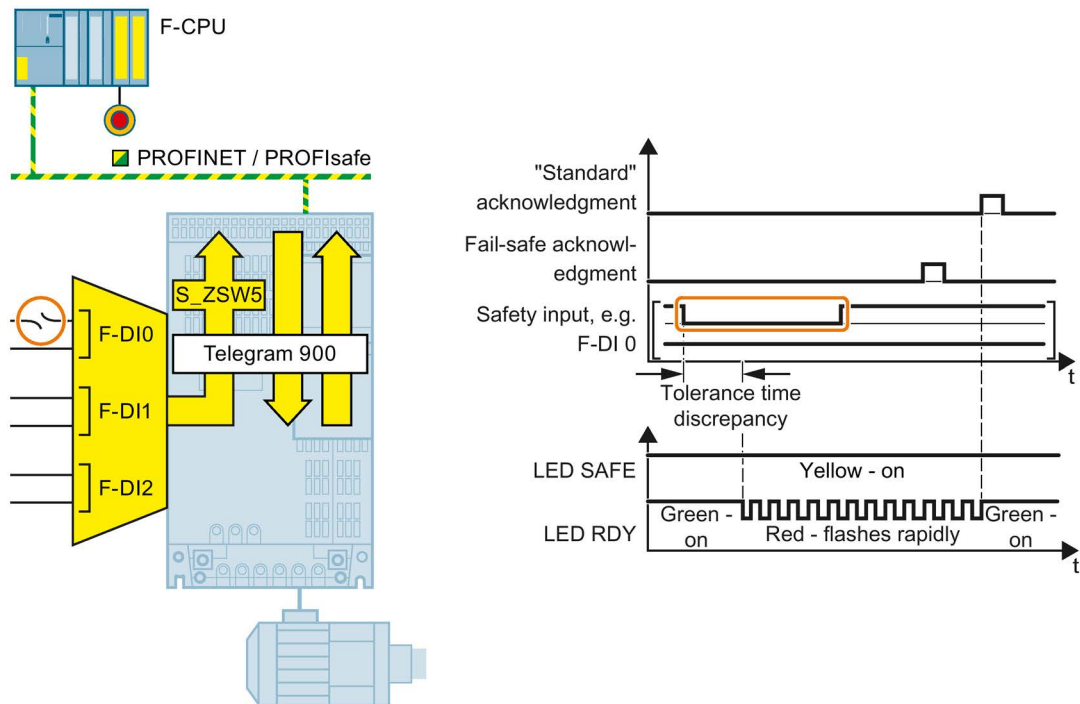


Figure 6-48 Behavior of the inverter in the event of a discrepancy in a safety-related input in PROFIsafe telegram 900

The inverter does not set the error bit of the safety functions (= internal event).

After the tolerance time has expired, the inverter signals the discrepancy (fault C01770 or C30770).

Independent of the voltage levels available, the inverter sets the evaluation of the discrepant F-DI into the safe state (= zero) until you acknowledge the inverter using a fail-safe signal or you switch off the power supply voltage and switch it on again.

Inverter signals	Parameter	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
Internal event	r9722.7	✓	---	✓
"Standard" acknowledgment	p2103	---	---	---
Fail-safe acknowledgment	r9720.7	✓	✓	---

### Acknowledging a discrepancy message

#### Procedure



- 1 To acknowledge the discrepancy message, proceed as follows:
- 2
  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)	Switch off the power supply voltage and switch on again.
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)	Switch off the power supply voltage and switch on again.

3. Acknowledge the inverter with the "standard" acknowledge signal.



You have acknowledged the discrepancy message

## 6.10 Stop responses

### Internal event

An "internal event" is a major fault that causes the inverter 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 inverter detects an internal fault in its hardware or its firmware on the basis of a data cross-check (F01611).
- The inverter identifies when a limit value is violated as a result of an inadmissible motor speed (C01714).

An "internal event" can only be acknowledged using a fail-safe signal. See also: Fail-safe acknowledgment (Page 286).

### STOP A

For a STOP A, the inverter safely switches off the torque of the connected motor immediately.

### STOP B

For a STOP B, the inverter 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 inverter switches over the control mode to speed control.

The inverter monitors the braking of the motor. The type of monitoring corresponds to the monitoring mode of SS1, also see section Setting SS1 (Page 161).

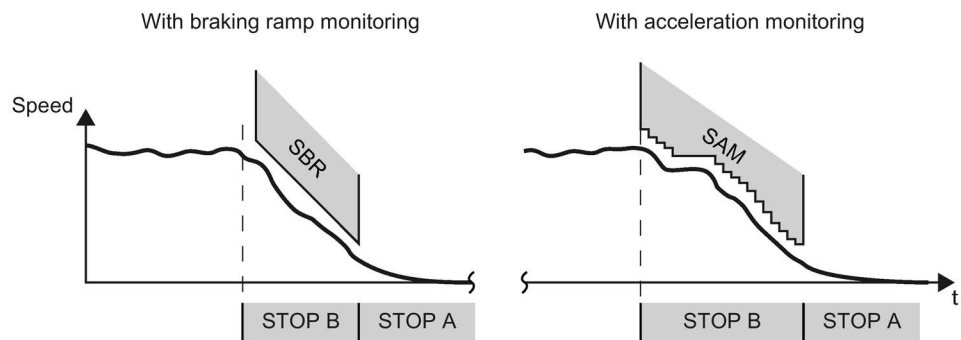


Figure 6-49 Speed monitoring for a STOP B

If the motor does not follow the defined braking ramp, the inverter interrupts the braking of the motor and responds with a STOP A.



## STOP F

If a safety function is active <sup>1)</sup>, a STOP F initiates a STOP A or STOP B:

- Fault F01611 immediately initiates a STOP A.
- For message C01711, the inverter response depends on the active safety function:
  - When STO is active, then the inverter initiates a STOP A.
  - In all other cases, the inverter initiates a STOP B.

If none of the safety functions are active, then the inverter responds as follows:

- Fault F01611 immediately initiates a STOP A.
- There is no immediate stop response for message C01711. However, the message is kept. When selecting a safety function, the inverter responds with a stop as described above.

<sup>1)</sup> The SSM function is considered as active safety function if the SSM filter and the SSM hysteresis have been enabled.

### 6.10.1 Example 1: Internal event with STO active

#### Drive response

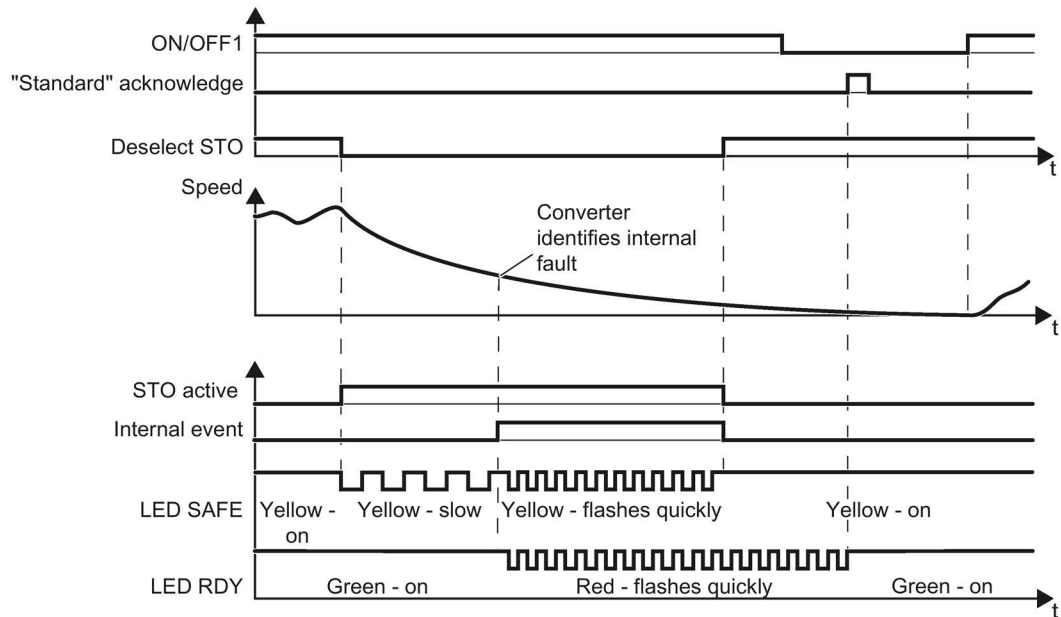


Figure 6-50 Internal event when the STO safety function is active

The inverter signals an internal event.

Inverter signals	Parameter	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
Internal event	r9722.7	✓	---	✓
STO active (extended functions)	r9722.0	✓	---	✓
Deselect STO (extended functions)	r9720.0	✓	✓	---
"Standard" acknowledgment	p2103	---	---	---
ON/OFF1	r0054.0	---	---	---

## Switching the motor on after an internal event

### Procedure



1 To switch the motor on after an internal event, proceed as follows:

- 2 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.

### 6.10.2 Example 2: Internal event with SSM 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.

A STOP F does not unconditionally stop the motor. See also: Stop responses (Page 280).

#### The drive response

The motor behavior is explained using the SSM function and a STOP B with acceleration monitoring as an example:

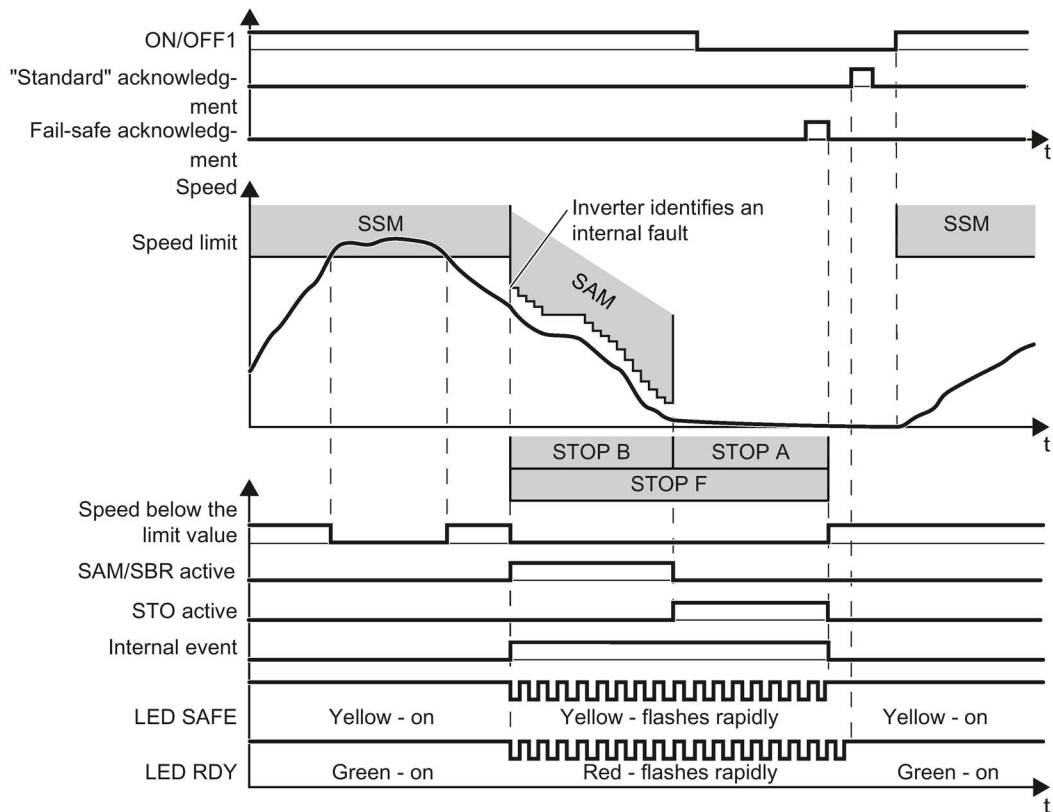


Figure 6-51 Response of the SSM safety function to an internal event

Inverter signals	Parameter	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
Internal event	r9722.7	✓	---	✓
STO active (extended functions)	r9722.0	✓	---	✓
SSM feedback signal active (speed below limit value)	r9722.15	✓	---	✓
SAM/SBR active	r9723.16	---	---	---
"Standard" acknowledgment	p2103	---	---	---
Fail-safe acknowledgment	r9720.7	✓	✓	---
ON/OFF1	r0054.0	---	---	---

## Switching the motor on after an internal event

### Procedure



- 1 To switch the motor in the example above on again, proceed as follows:
  - 2
    1. Issue an OFF1 command (ON/OFF1 = 0).
    2. Acknowledge the internal event in one of the following ways:
      - Fail-safe acknowledgment using PROFIsafe control word 0, bit 7 = 0 → 1 → 0
      - Fail-safe acknowledge signal via a safety-related 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 power supply voltage of the inverter and switch on again.
    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 264).
- You have acknowledged the internal event and switched on the motor again.

## 6.11 Fail-safe acknowledgment

### 6.11.1 Acknowledging using a fail-safe signal

You must acknowledge the majority of safety function faults using a fail-safe signal. The following options are available.

- Acknowledging using a safety-related input F-DI
- Acknowledging via PROFIsafe
- Acknowledging by selecting and deselecting STO
- Acknowledging by switching the power supply voltage on and off

#### Acknowledging using a safety-related input F-DI

##### Procedure



To acknowledge the inverter using a safety-related input F-DI, proceed as follows:

1. Acknowledge the fault with  $F-DI = 0 \rightarrow 1 \rightarrow 0$ .
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:  $\text{Bit } 7 = 0 \rightarrow 1 \rightarrow 0$ .
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 safety function STO or SS1 and then deselect again.
  - $F-DI = 1 \rightarrow 0 \rightarrow 1$
  - or
  - PROFIsafe control word 1, bit 0 or 1 =  $1 \rightarrow 0 \rightarrow 1$
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 shutting off the power supply voltage of the inverter and then switching it on again.

### 6.11.2 Response to a discrepancy of the fail-safe acknowledge signal

#### Drive response

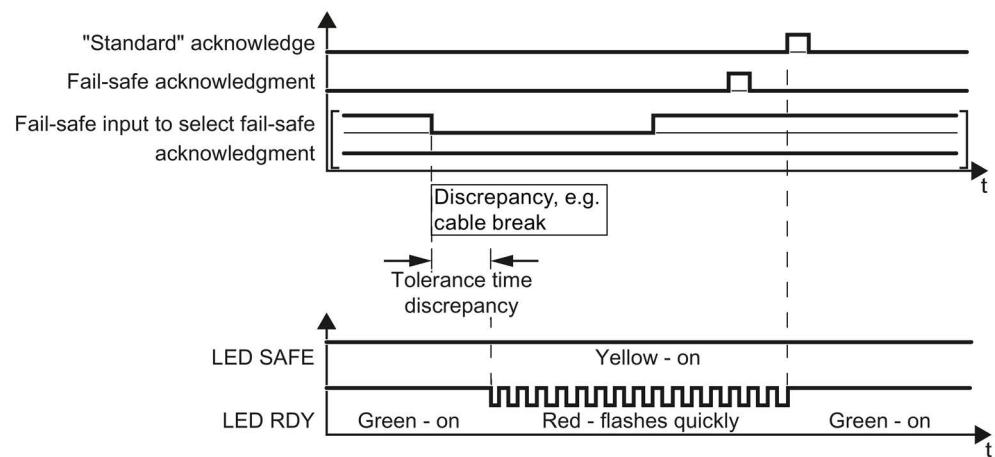


Figure 6-52 Behavior of the inverter for discrepancy of the input signal for fail-safe acknowledgment

The inverter does not set the error bit of the safety functions (= internal event).

After the tolerance time has expired, the inverter signals the discrepancy (fault C01770 or C30770).

Independent of the voltage levels available, the inverter sets the evaluation of the discrepant F-DI into the safe state (= zero) until you acknowledge the inverter using a fail-safe signal or you switch off the power supply voltage and switch it on again.

Inverter signals	Parameter	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
"Standard" acknowledgment	p2103	---	---	---
Fail-safe acknowledgment	r9720.7	✓	✓	---

## Acknowledging a discrepancy message

### Procedure



1 To acknowledge the discrepancy message, proceed as follows:

1. Remove the discrepancy.
2. Acknowledge the discrepancy message in one of the following ways:
  - 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 power supply voltage of the inverter and switch on again.
3. Acknowledge the inverter with the "standard" acknowledge signal.



You have acknowledged the discrepancy message



## 6.12 Selecting safety function when a safety function is active

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 inverter function you also select.

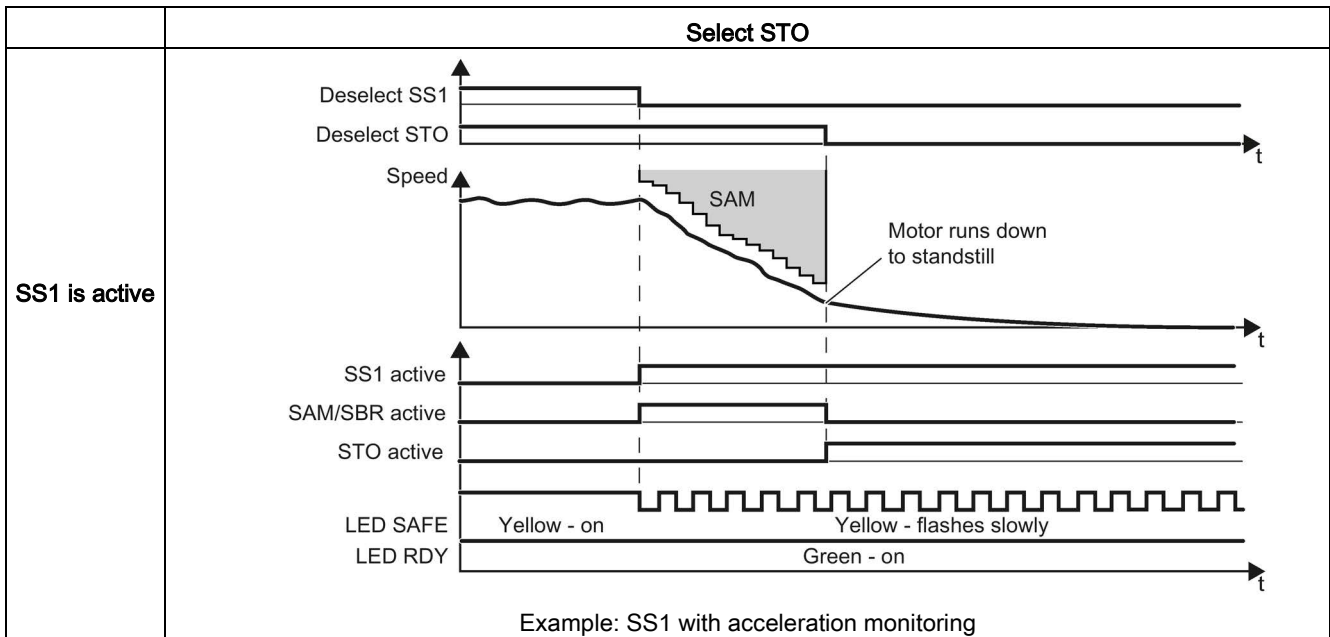
Table 6- 11 Interaction between two safety functions

	Select STO	Select SS1	Select SLS	Select SDI
<b>STO is active</b>	---	No effect	No effect	No effect
<b>SS1 is active</b>	See below	---	No effect <sup>1)</sup>	No effect <sup>1)</sup>
<b>SLS is active</b>	See below	See below	---	See below
<b>SDI is active</b>	See below	See below	See below	---
<b>SSM is active</b>	See below	See below	See below	See below

<sup>1)</sup> When SS1 is active and the following conditions are simultaneously satisfied, the inverter initiates a STOP A:

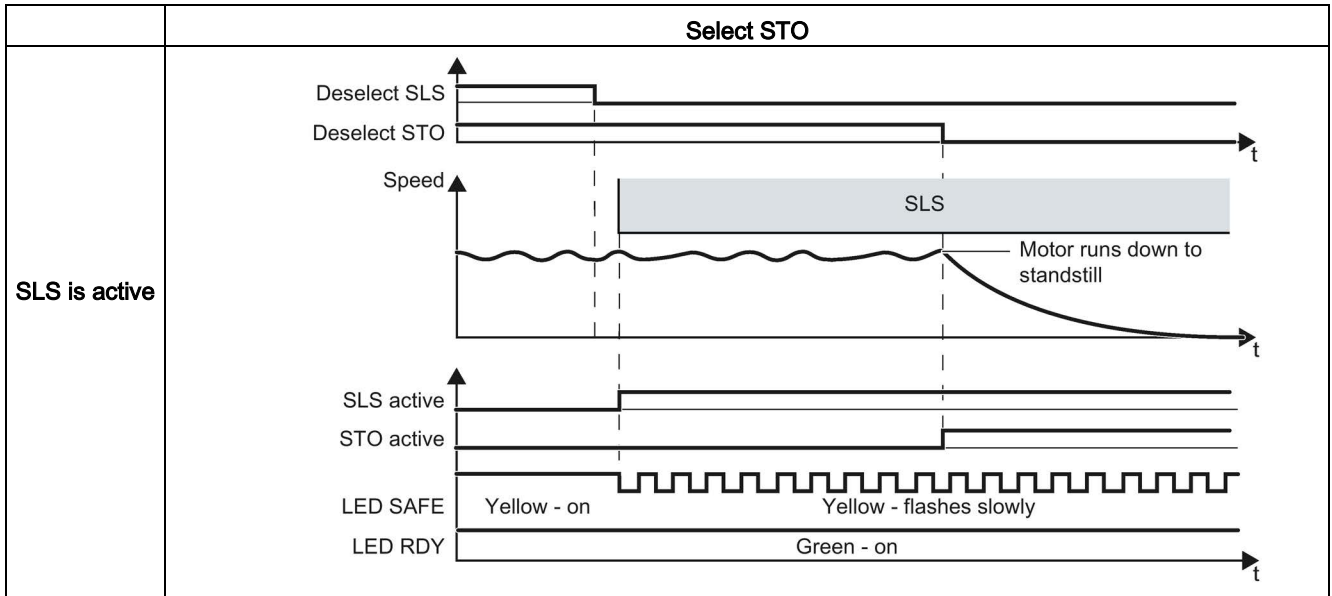
- The motor speed exceeds the SLS limit or exits the SDI tolerance window
- STOP A is set as fault response for SLS or SDI

6.12 Selecting safety function when a safety function is active



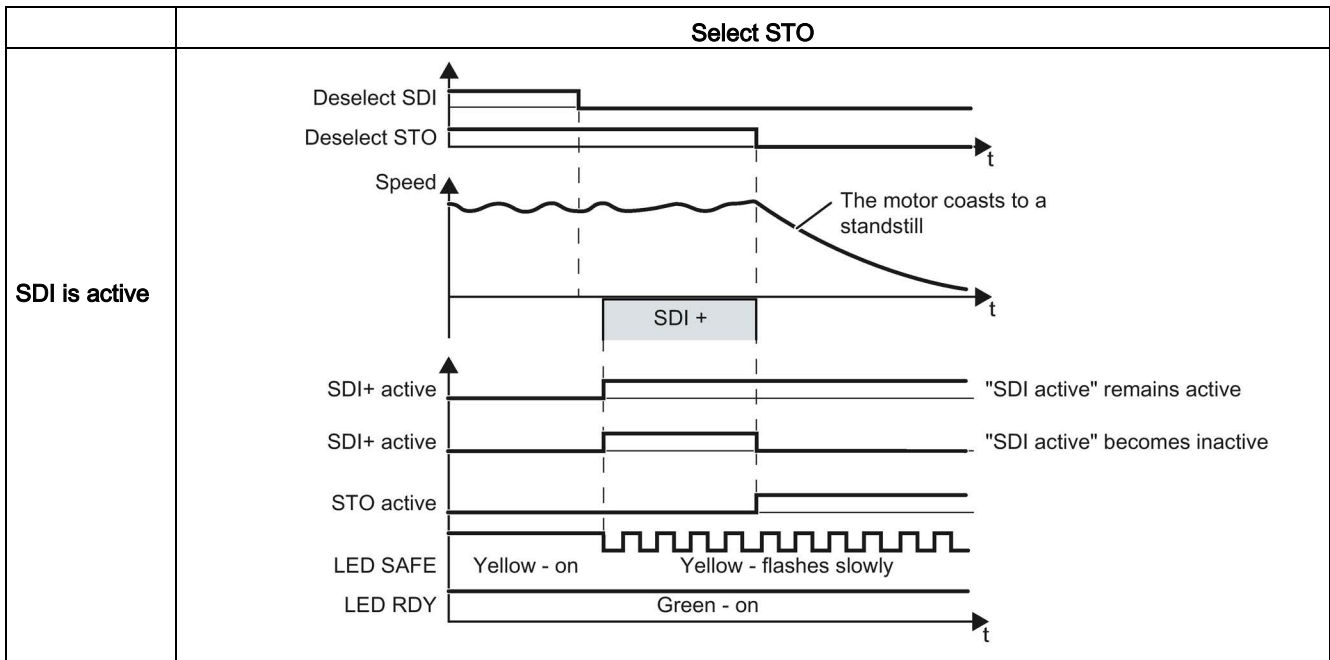
Inverter signals	Parameters	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
STO active (basic functions)	r9773.1	✓	---	✓
STO deselection (basic functions)	r9773.0	✓	✓	---
STO cause, selection via terminal on the Power Module	r9772.25	---	---	---
STO active (extended functions)	r9722.0	✓	---	✓
Deselect STO (extended functions)	r9720.0	✓	✓	---
SS1 active (extended functions)	r9722.1	✓	---	✓
Deselect SS1 (extended functions)	r9720.1	✓	✓	---
SAM/SBR active	r9723.16	---	---	---
ON/OFF1	r0054.0	---	---	---

6.12 Selecting safety function when a safety function is active



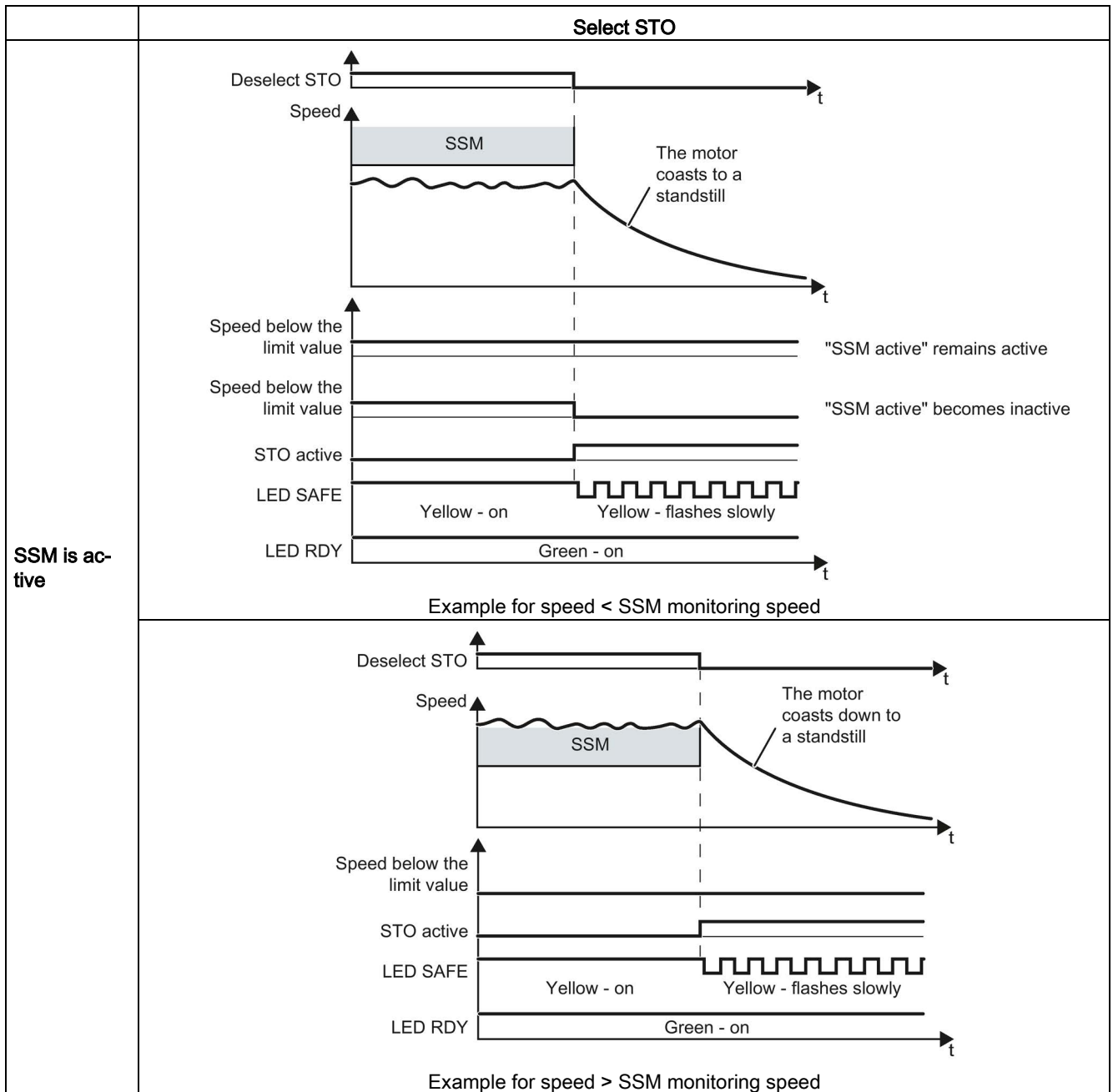
Inverter signals	Parameters	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
STO active (basic functions)	r9773.1	✓	---	✓
STO deselection (basic functions)	r9773.0	✓	✓	---
STO cause, selection via terminal on the Power Module	r9772.25	---	---	---
STO active (extended functions)	r9722.0	✓	---	✓
Deselect STO (extended functions)	r9720.0	✓	✓	---
SLS active	r9722.4	✓	---	✓
Deselect SLS	r9720.4	✓	✓	---

6.12 Selecting safety function when a safety function is active



Inverter signals	Parameter	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
STO active (basic functions)	r9773.1	✓	---	✓
STO deselection (basic functions)	r9773.0	✓	✓	---
STO cause, selection via terminal on the Power Module	r9772.25	---	---	---
STO active (extended functions)	r9722.0	✓	---	✓
Deselect STO (extended functions)	r9720.0	✓	✓	---
SDI+ active	r9722.12	✓	---	✓
SDI+ deselect	r9720.12	✓	✓	---
SDI- active	r9722.13	✓	---	✓
Deselect SDI-	r9720.13	✓	✓	---

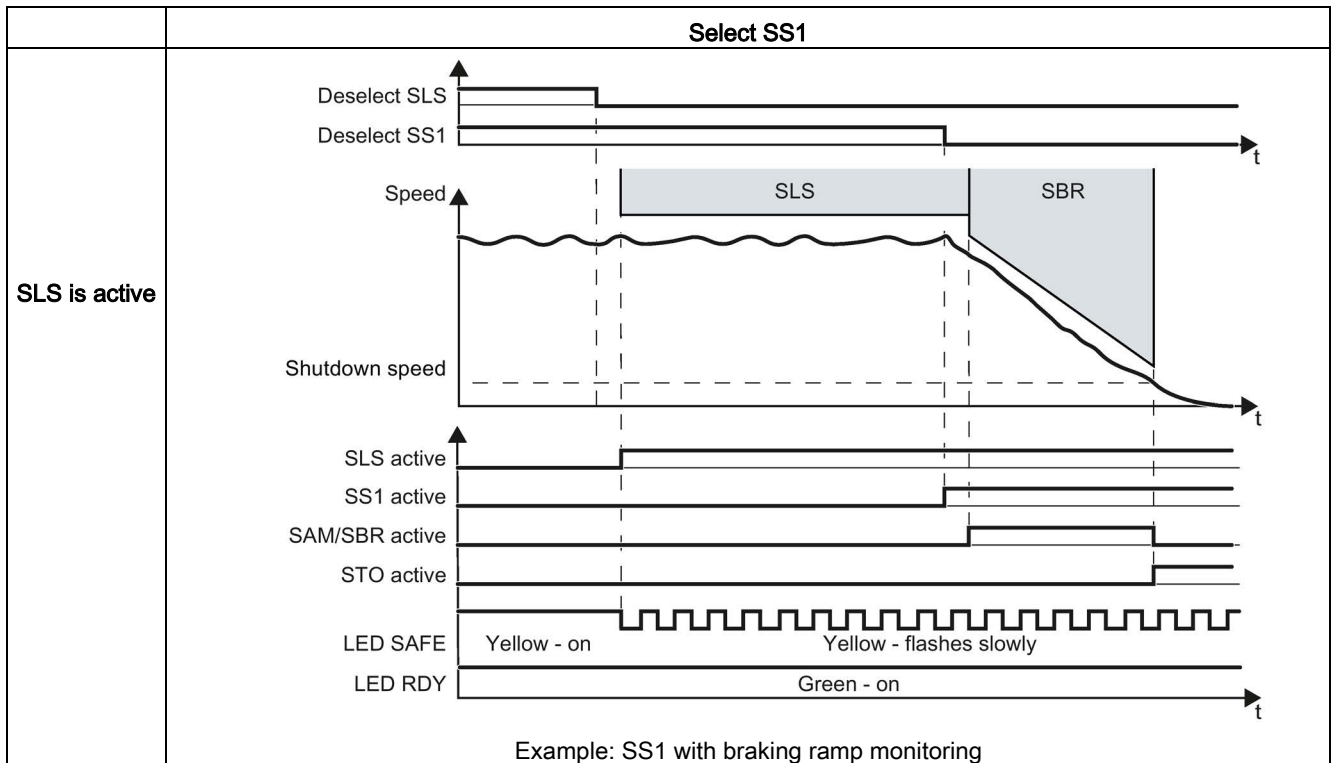
6.12 Selecting safety function when a safety function is active



6.12 Selecting safety function when a safety function is active

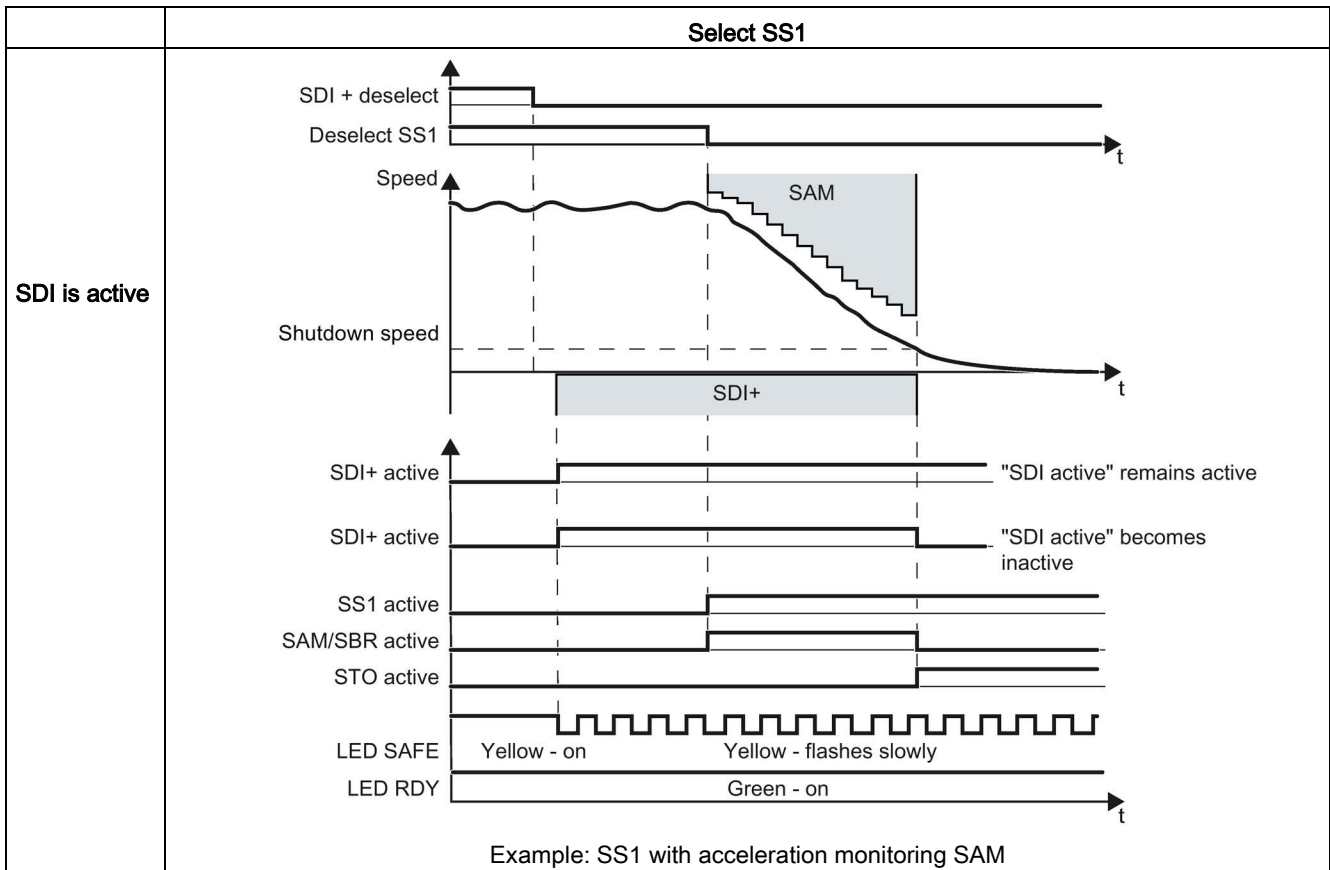
Inverter signals	Parameter	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
STO active (basic functions)	r9773.1	✓	---	✓
STO deselection (basic functions)	r9773.0	✓	✓	---
STO cause, selection via terminal on the Power Module	r9772.25	---	---	---
STO active (extended functions)	r9722.0	✓	---	✓
Deselect STO (extended functions)	r9720.0	✓	✓	---
SSM feedback signal active (speed below limit value)	r9722.15	✓	---	✓

6.12 Selecting safety function when a safety function is active



Inverter signals	Parameter	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
STO active (extended functions)	r9722.0	✓	---	✓
SS1 active (basic functions)	r9773.6	✓	---	✓
Deselect SS1 (basic functions)	r9773.5	✓	✓	---
SS1 active (extended functions)	r9722.1	✓	---	✓
Deselect SS1 (extended functions)	r9720.1	✓	✓	---
SLS active	r9722.4	✓	---	✓
Deselect SLS	r9720.4	✓	✓	---
SAM/SBR active	r9723.16	---	---	---

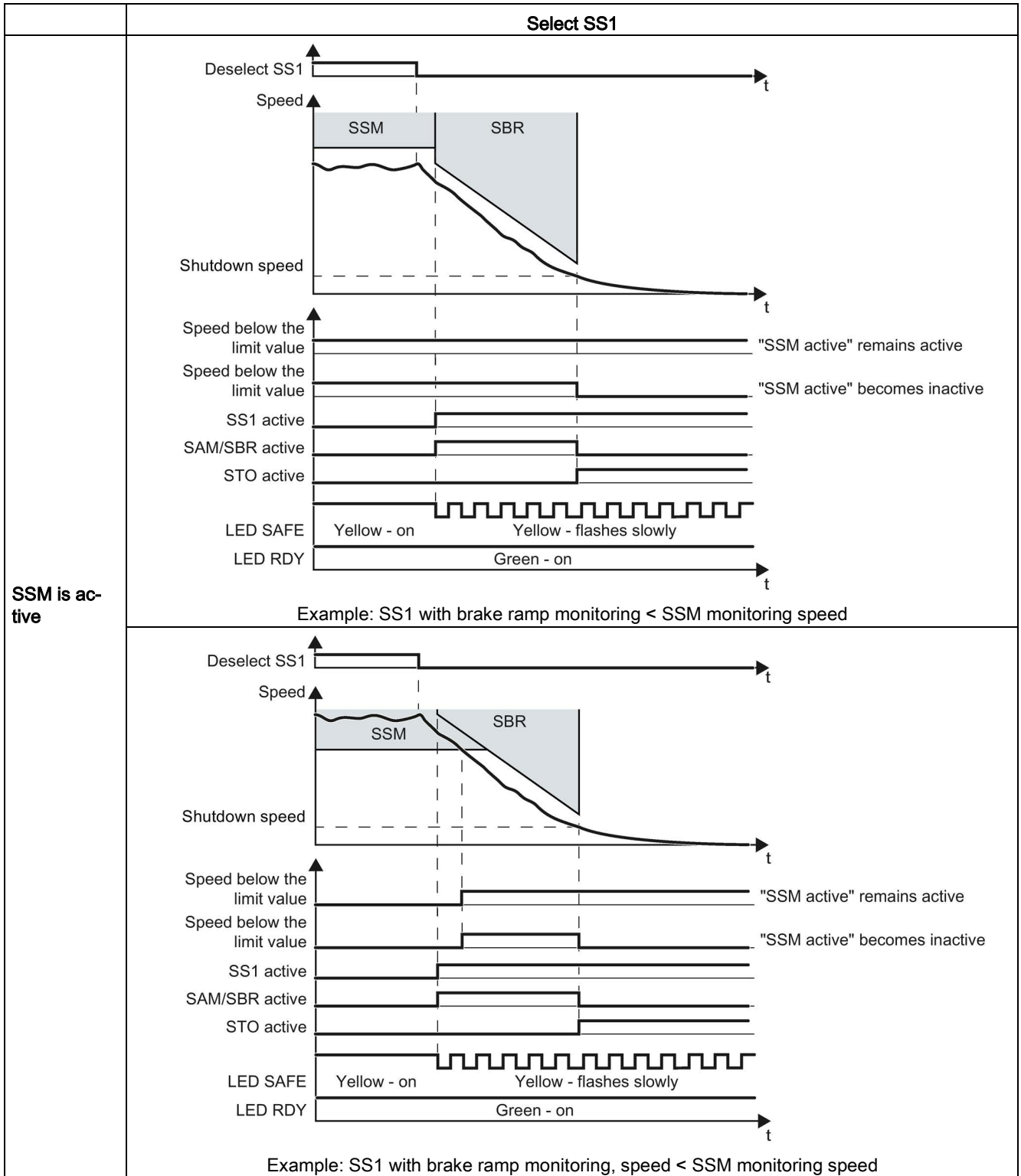
6.12 Selecting safety function when a safety function is active



Inverter signals	Parameter	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
STO active (extended functions)	r9722.0	✓	---	✓
SS1 active (basic functions)	r9773.6	✓	---	✓
Deselect SS1 (basic functions)	r9773.5	✓	✓	---
SS1 active (extended functions)	r9722.1	✓	---	✓
Deselect SS1 (extended functions)	r9720.1	✓	✓	---
SDI+ active	r9722.12	✓	---	✓
SDI+ deselect	r9720.12	✓	✓	---
SDI- active	r9722.13	✓	---	✓
Deselect SDI-	r9720.13	✓	✓	---
SAM/SBR active	r9723.16	---	---	---



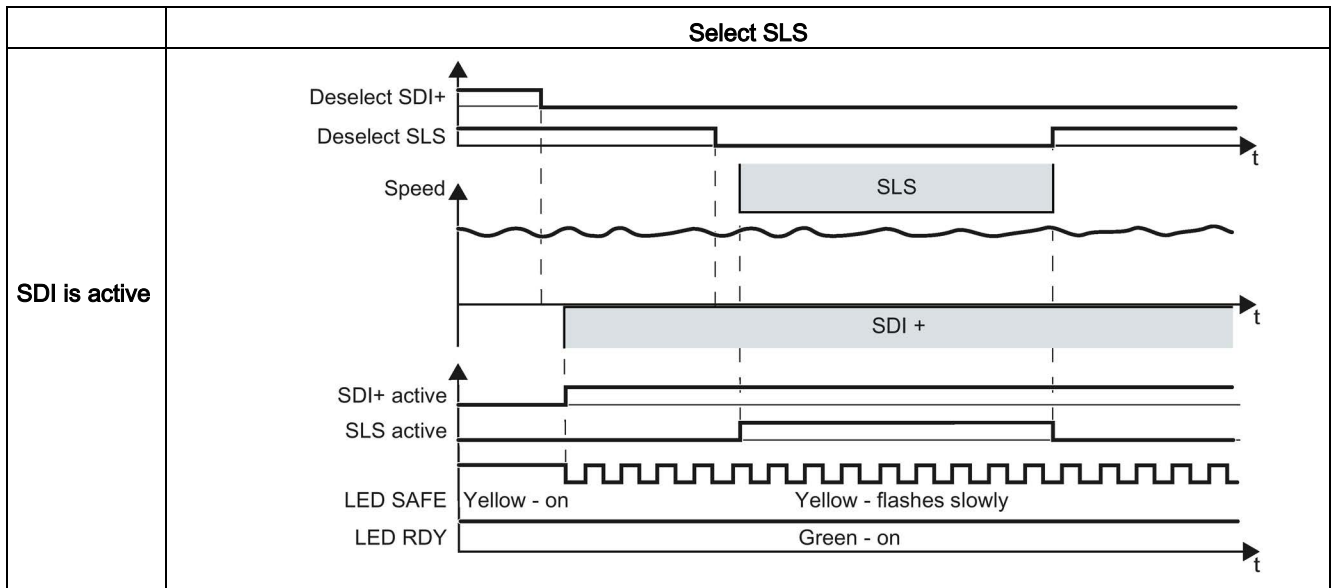
6.12 Selecting safety function when a safety function is active



6.12 Selecting safety function when a safety function is active

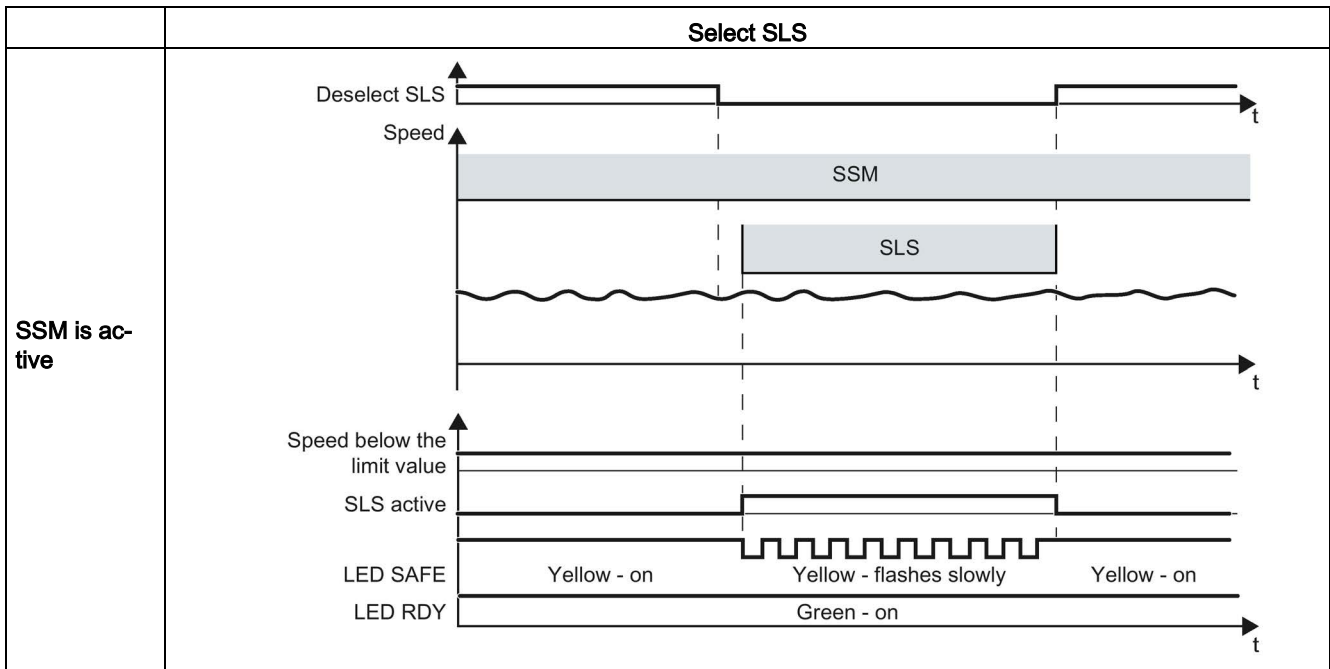
Inverter signals	Parameter	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
STO active (extended functions)	r9722.0	✓	---	✓
SS1 active (basic functions)	r9773.6	✓	---	✓
Deselect SS1 (basic functions)	r9773.5	✓	✓	---
SS1 active (extended functions)	r9722.1	✓	---	✓
Deselect SS1 (extended functions)	r9720.1	✓	✓	---
SSM feedback signal active (speed below limit value)	r9722.15	✓	---	✓
SAM/SBR active	r9723.16	---	---	---

6.12 Selecting safety function when a safety function is active



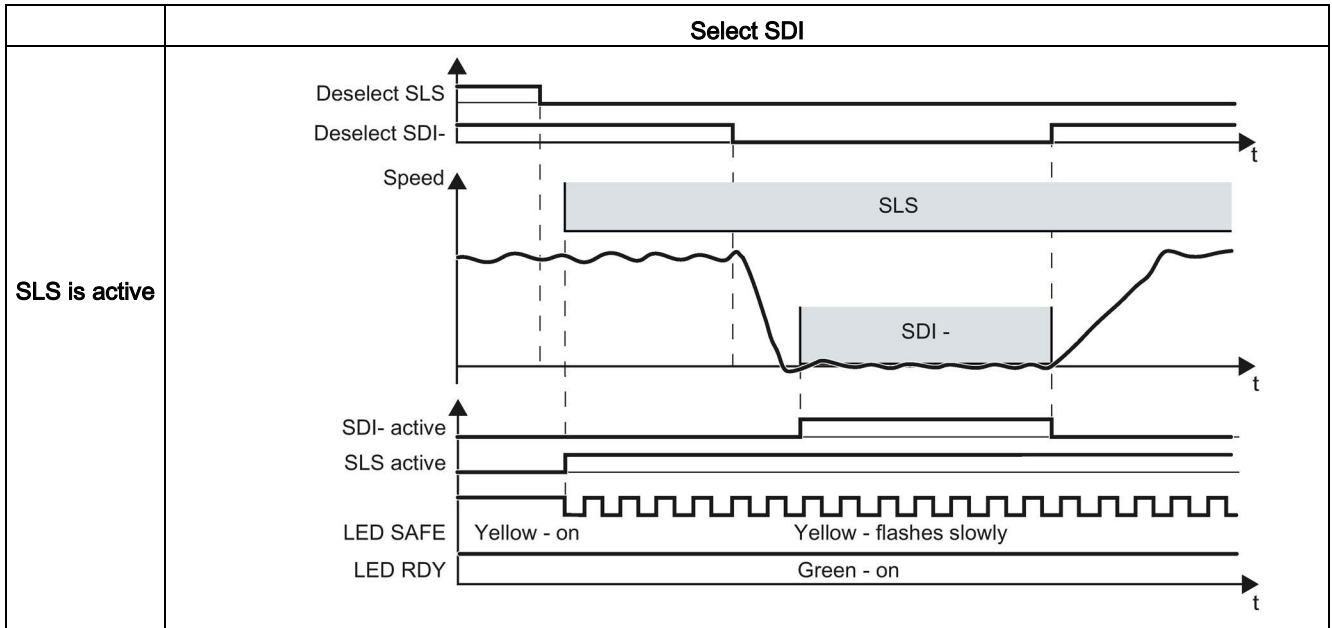
Inverter signals	Parameter	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
SLS active	r9722.4	✓	---	✓
Deselect SLS	r9720.4	✓	✓	---
SSM feedback signal active (speed below limit value)	r9722.15	✓	---	✓
SDI+ active	r9722.12	✓	---	✓
SDI+ deselect	r9720.12	✓	✓	---
SDI- active	r9722.13	✓	---	✓
Deselect SDI-	r9720.13	✓	✓	---

6.12 Selecting safety function when a safety function is active



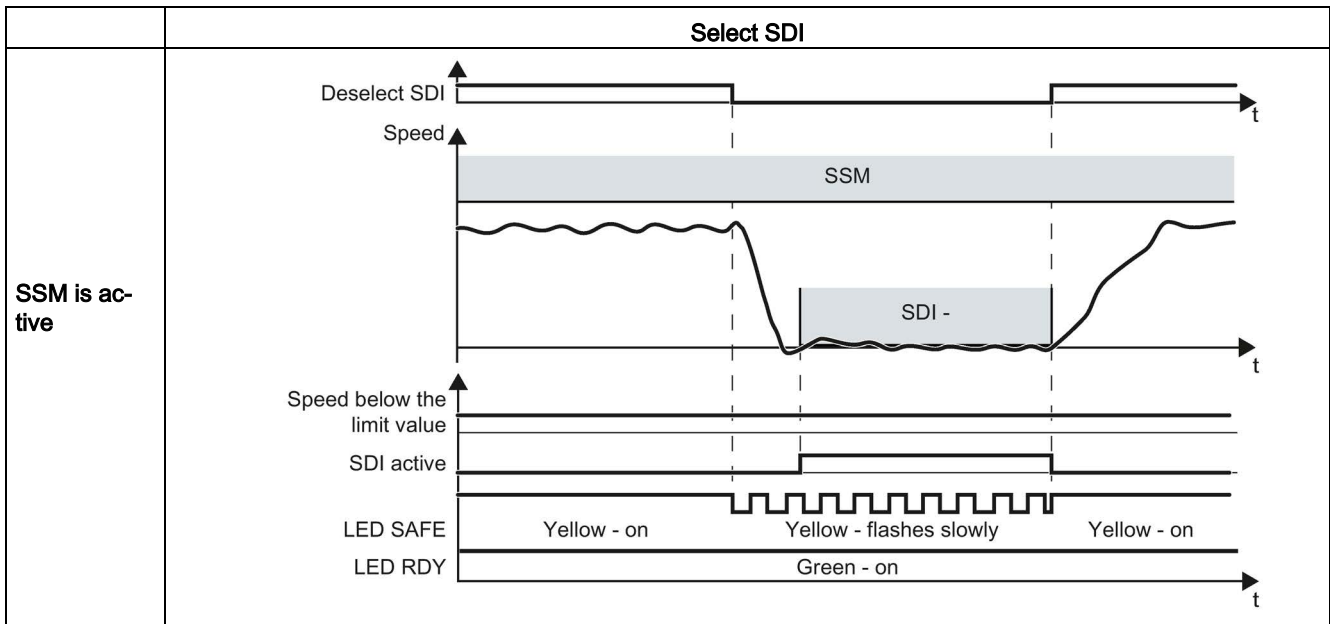
Inverter signals	Parameter	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
SLS active	r9722.4	✓	---	✓
Deselect SLS	r9720.4	✓	✓	---
SSM feedback signal active (speed below limit value)	r9722.15	✓	---	✓

6.12 Selecting safety function when a safety function is active



Inverter signals	Parameter	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
SLS active	r9722.4	✓	---	✓
Deselect SLS	r9720.4	✓	✓	---
SDI+ active	r9722.12	✓	---	✓
SDI+ deselect	r9720.12	✓	✓	---
SDI- active	r9722.13	✓	---	✓
Deselect SDI-	r9720.13	✓	✓	---

6.12 Selecting safety function when a safety function is active



Inverter signals	Parameter	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
SSM feedback signal active (speed below limit value)	r9722.15	✓	---	✓
SDI+ active	r9722.12	✓	---	✓
SDI+ deselect	r9720.12	✓	✓	---
SDI- active	r9722.13	✓	---	✓
Deselect SDI-	r9720.13	✓	✓	---

## 6.13 Overview of the inverter signals relevant for operation

The following table lists the signals relevant for using the safety functions: Most of the signals are included in the PROFIsafe telegram, or can be interconnected using a safety-related input or output.

Inverter signals	Parameter	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
Internal event	r9722.7	✓	---	✓
STO active (basic functions)	r9773.1	✓	---	✓
STO deselection (basic functions)	r9773.0	✓	✓	---
STO cause, selection via terminal on the Power Module	r9772.25	---	---	---
STO active (extended functions)	r9722.0	✓	---	✓
Deselect STO (extended functions)	r9720.0	✓	✓	---
SBC requested (basic functions)	r9773.4	---	---	---
SS1 active (basic functions)	r9773.6	✓	---	✓
Deselect SS1 (basic functions)	r9773.5	✓	✓	---
SS1 active (extended functions)	r9722.1	✓	---	✓
Deselect SS1 (extended functions)	r9720.1	✓	✓	---
SLS active	r9722.4	✓	---	✓
Deselect SLS	r9720.4	✓	✓	---
SLS level active	r9722.9, r9722.10	✓	---	✓
Select SLS level	r9720.9, r9720.10	✓	✓	---
SSM feedback signal active (speed below limit value)	r9722.15	✓	---	✓
SDI+ active	r9722.12	✓	---	✓
SDI+ deselect	r9720.12	✓	✓	---
SDI- active	r9722.13	✓	---	✓
Deselect SDI-	r9720.13	✓	✓	---
SAM/SBR active	r9723.16	---	---	---
Forced checking procedure (test stop) of the STO terminals on the PM240-2 Power Module required	r9773.30	---	---	---
Forced checking procedure (test stop) required for the basic functions	r9773.31	---	---	---
Forced checking procedure (test stop) required for the extended functions	r9723.0	---	---	---
Forced checking procedure (test stop) required for the extended functions	p9705	---	---	---

6.13 Overview of the inverter signals relevant for operation

Inverter signals	Parameter	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
Start the forced checking procedure (test stop) of the safety-related output	p10007	---	---	---
"Standard" acknowledgment	p2103	---	---	---
Fail-safe acknowledgment	r9720.7	✓	✓	---
Ready to switch on	r0052.0	---	---	---
ON/OFF1	r0054.0	---	---	---
OFF2	r0054.1	---	---	---
OFF3	r0054.2	---	---	---
Release motor holding brake	r0899.12	---	---	---
Close motor holding brake	r0899.13	---	---	---



## 6.14 List of alarms and faults

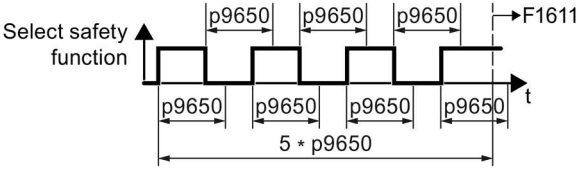
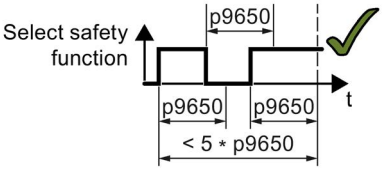
### Syntax for faults and alarms

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
<b>Complete information on the messages is available in the List Manual.</b>		
F01600	STOP A initiated. Fault value r0949 provides more detailed information.	<p>The remedy depends on the fault value. The complete list of the fault values is provided in the List Manual.</p> <p>0: Stop request from processor 2.</p> <p>1005: Pulses are canceled, although neither is STO selected nor an internal STOP A active.</p> <p>Cause 1: Defective hardware. Remedy:</p> <ol style="list-style-type: none"> <li>1. Select STO and then deselect again.</li> <li>2. Switch off the power supply voltage of the inverter and switch on again.</li> <li>3. Replace the Power Module if it cannot be acknowledged.</li> </ol> <p>Cause 2: STO via terminals of the Power Module is selected, however the function is not enabled in the Control Unit (p9601.7 = p9801.7 = 0). Remedy:</p> <ol style="list-style-type: none"> <li>1. Set the switch on the Power Module to the "OFF" setting, or enable the function in the Control Unit.</li> <li>2. Acknowledge the inverter fail-safe.</li> <li>3. Replace the Power Module if it cannot be acknowledged.</li> </ol> <p>1010 ... 1011: For details, please refer to the List Manual. Remedy:</p> <ol style="list-style-type: none"> <li>1. Select STO and then deselect again.</li> <li>2. Switch off the power supply voltage of the inverter and switch on again.</li> <li>3. Replace the Power Module if it cannot be acknowledged.</li> </ol> <p>1030: Discrepancy at terminals STO_A and STO_B on the PM240-2 Power Module. Remedy:</p> <ol style="list-style-type: none"> <li>1. Remove the discrepancy at the terminals.</li> <li>2. Acknowledge the inverter fail-safe.</li> <li>3. Replace the Power Module if it cannot be acknowledged.</li> </ol> <p>9999: Subsequent response to fault F01611.</p>

Signal	Cause	Remedy
<b>Complete information on the messages is available in the List Manual.</b>		
F01611	Defect in a monitoring channel. Fault value r0949 provides more detailed information.	<p>The remedy depends on the fault value. The complete list of the fault values is provided in the List Manual.</p> <p>0: Stop request from processor 2.</p> <p>1 ... 999: Fault in data cross-check between processor 1 and processor 2.</p> <p>Details and remedy: Please refer to the List Manual.</p> <p>1000: Check (watchdog) timer has expired.</p> <p>When selecting a safety function, the signal changed too frequently.</p> <p>The inverter monitors the signal to select a safety function after a signal change.</p> <p>If the signal state continues to change in shorter intervals than entered in p9650, after the time <math>5 \times p9650</math> the inverter outputs fault F1611:</p>  <p>Remedy:</p> <ul style="list-style-type: none"> <li>• Check the F-DI wiring (contact problems).</li> <li>• Resolve the contact problems or faults at the PROFIBUS master/PROFINET controller.</li> </ul> <p>The inverter terminates the monitoring and does not signal any faults if the signal state remains stable before the time <math>5 \times p9650</math> expires, longer than p9650:</p>  <p>1001, 1002: Initialization error, change timer/check timer.</p> <ul style="list-style-type: none"> <li>• Remedy: Switch off the power supply voltage of the inverter and switch on again.</li> </ul> <p>2000: Status of the STO selection in the two monitoring channels is different.</p> <p>See also: Response to a discrepancy when STO is active (Page 210).</p> <p>2001: Checkback signal of the safe pulse suppression for the two monitoring channels is different.</p>

Signal	Cause	Remedy
<b>Complete information on the messages is available in the List Manual.</b>		
		<p>2002: Status of the delay timer SS1 in the two monitoring channels is different. See also: Response to a discrepancy when STO is active (Page 210). See also: Response to a discrepancy when SS1 is active (Page 230).</p> <p>2003: Status of the STO terminal at processor 1 and processor 2 is different. Remedy for 2000, 2001, and 2003:</p> <ul style="list-style-type: none"> <li>• Check the F-DI changeover tolerance time. Increase the value (p9650).</li> <li>• Check the F-DI wiring (contact problems).</li> <li>• Check the causes of the STO selection in r9772.</li> </ul> <p>6000: Internal software fault</p> <ul style="list-style-type: none"> <li>• Switch off the power supply voltage of the inverter and switch on again.</li> <li>• Upgrade firmware to later version</li> <li>• Replace Control Unit</li> </ul> <p>6064: Target address and PROFIsafe address differ (F_Dest_Add).</p> <ul style="list-style-type: none"> <li>• Check the value of the F_Dest_Add F-parameter in the inverter</li> <li>• Check the PROFIsafe address at processor 1 (p9610) and processor 2 (p9810).</li> </ul> <p>6065: Target address invalid (F_Dest_Add).</p> <ul style="list-style-type: none"> <li>• The target address must not be 0 or FFFF.</li> </ul> <p>6066: Source address invalid (F_Source_Add).</p> <ul style="list-style-type: none"> <li>• The source address must not be 0 or FFFF.</li> </ul> <p>6067: Watchdog time value invalid (F_WD_Time).</p> <ul style="list-style-type: none"> <li>• The watchdog time value must not be 0.</li> </ul> <p>6165: Fault in reception of the PROFIsafe telegram. This fault can also occur if the inverter has received an inconsistent or out-of-date PROFIsafe telegram after the power supply voltage is switched off and switched on again or after the PROFIBUS/PROFINET line has been inserted.</p> <ul style="list-style-type: none"> <li>• Check the configuration and communication in the inverter.</li> <li>• Check the value of the F_WD_Time F-parameter in the inverter. Increase the value.</li> </ul> <p>6166: Time monitoring fault in reception of the PROFIsafe telegram.</p> <ul style="list-style-type: none"> <li>• Check the configuration of the communication in the inverter.</li> <li>• Check the setting of the F_WD_Time value in the inverter. Increase the value.</li> <li>• Evaluate the diagnostic information in the F host.</li> <li>• Check the PROFIsafe connection.</li> </ul>
A01620, F01620	Safe torque off active	Not necessary.

6.14 List of alarms and faults

Signal	Cause	Remedy
	<b>Complete information on the messages is available in the List Manual.</b>	
A01621, F01621	Safe Stop 1 active	Not necessary.
F01625	Sign-of-life error in the Safety data	<ol style="list-style-type: none"> <li>1. Select STO, and then deselect again.</li> <li>2. If it cannot be acknowledged, replace the Control Unit.</li> </ol>
F01630	Brake control defective Fault value r0949 provides more detailed information.	Depending on the fault value, check the following: 10, 11: p1278 ≠ 0, brake not connected, cable interrupted or ground fault 20: Short-circuit in the brake winding 30, 31, 40: Brake not connected or a short-circuit in the brake winding 50: Fault in the Safe Brake Relay, in the Control Unit or in the Power Module.
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: <ul style="list-style-type: none"> <li>• p1215 = 0 and p9602 = 1.</li> <li>• p1215 = 3 and p9602 = 1.</li> </ul>
F01640, F01641	It has been identified that a component has been replaced, acknowledgment/data save is necessary	See Section Corrective maintenance (Page 317).
F01649	Internal software error	<ol style="list-style-type: none"> <li>1. Switch off the Control Unit power supply and then on again.</li> <li>2. If it cannot be acknowledged, replace the Control Unit.</li> </ol>
F01650	Acceptance test required	See Section Acceptance tests for the safety functions (Page 195).
F01651	Synchronization, safety time slices unsuccessful.	<ol style="list-style-type: none"> <li>1. Switch off the Control Unit power supply and then on again.</li> <li>2. If it cannot be acknowledged, replace the Control Unit.</li> </ol>
F01653	PROFIBUS/PROFINET configuration error	Check the PROFIBUS or PROFINET 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. <ul style="list-style-type: none"> <li>• Alarm value r2124 = 1: In the higher-level F control, remove the PROFIsafe configuring, or enable PROFIsafe in the drive.</li> <li>• Alarm value r2124 = 2: In the higher-level F control, configure the appropriate PROFIsafe telegram.</li> </ul>
F01655	Aligning the monitoring functions	<ol style="list-style-type: none"> <li>1. Check that the control cabinet design and cable routing are in compliance with EMC regulations.</li> <li>2. Switch off the Control Unit power supply and then on again.</li> </ol>
F01656	Parameter processor 2 incorrect	<ol style="list-style-type: none"> <li>1. Recommission the safety functions.</li> <li>2. If this is not successful, then replace the Control Unit.</li> </ol>

Signal	Cause	Remedy
<b>Complete information on the messages is available in the List Manual.</b>		
F01658	PROFIsafe telegram number unsuitable	The PROFIsafe telegram number in p60022 is not suitable for the enabled safety functions. Check the following: <ul style="list-style-type: none"> <li>• If PROFIsafe is not enabled (p9601.3 = 0), PROFIsafe telegrams must not be selected in p60022.</li> <li>• If PROFIsafe is enabled (p9601.3 = 1), you must select a PROFIsafe telegram in p60022.</li> <li>• If transfer of the F-DI via PROFIsafe is selected (p9501.30 = 1), you must select telegram 900 in p60022.</li> </ul>
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.
F01660	Safety functions not supported	Use a Power Module that supports the safety functions. See also: Restrictions when using safety functions (Page 26).
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.
F01665	System is defective	The inverter has identified a defect: <ol style="list-style-type: none"> <li>1. Switch off the Control Unit power supply and then on again.</li> <li>2. Contact Technical Support if it cannot be acknowledged.</li> </ol> You have not configured the "STO via the terminals of the PM240-2 Power Module" function, but you have activated the terminals on the Power Module. <ol style="list-style-type: none"> <li>1. Set the switch for the safety-related input of the Power Module (STO_A and STO_B) into the "OFF" position.</li> </ol>
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.
A01669	Unsuitable combination of motor and power unit.	The ratio between the rated power unit current (r0207[0]) and rated motor current (p0305) should be greater than 5. In operation, message C01711 or C30711 can be sporadically output with values 1041 ... 1044. Use a suitable power unit with a lower power rating or a motor with a higher power rating.

6.14 List of alarms and faults

Signal	Cause	Remedy
	<b>Complete information on the messages is available in the List Manual.</b>	
A01678	Test stop for STO via terminals at the PM required	The set time (p9661) to monitor the forced checking procedure (test stop) for the "STO via the terminals at the Power Module" function has been exceeded. Deselect STO via the terminals of the PM240-2 Power Module and select again.
F01680	Checksum error safe monitoring functions	1. Check the safety-related parameters. 2. Switch off the power supply voltage of the inverter and switch on again.
F01681	Incorrect parameter value	Correct the parameter value: Fault value (r0949) yyyyxxx decimal, yyyy = supplementary information, xxx = parameter
F01682	Monitoring function not supported	Deselect 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. Switch off the power supply voltage of the inverter and switch on again.
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 parameterization changed, 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	Test stop for motion monitoring is selected when powering up	The forced checking procedure (test stop) for the safe motion monitoring functions was already selected (which is not permissible) when powering up. Deselect the forced dormant error detection of the extended functions and then select again.
A01697, F01697	Test stop for motion monitoring is required	The time set in p9559 for the forced checking procedure (test stop) for the safe motion monitoring functions has been exceeded. Start the forced checking procedure. p9705 defines the signal source to select the forced checking procedure.
A01698	Commissioning mode active	Not necessary.
A01699	Test stop for STO is required	The time set in p9659 for the forced checking procedure (test stop) for the "STO" function has been exceeded. Select STO, and then deselect again.
C01700 (fault)	STOP A initiated	Generally, this fault is a consequence of C01701, C01706, C01714 or C01716.
C01701 (fault)	STOP B initiated	Generally, this fault is a consequence of C01706, C01714 or C01716.
C01706 (alarm or fault) <sup>1)</sup>	SAM/SBR limit exceeded	1. Check the motor braking response. 2. Adapt the tolerance for the parameterization of the "safe braking ramp".

Signal	Cause	Remedy
<b>Complete information on the messages is available in the List Manual.</b>		
C01711 (alarm) <sup>1)</sup>	Defect in a monitoring channel Fault value r2124 provides more detailed information.	<p>The complete list of the r2124 fault values is provided in the List Manual.</p> <p>0 ... 2: Fault in data cross-check between processor 1 and processor 2. Remedy: Please refer to the List Manual.</p> <p>3: Difference of the position actual value (r9713) between the two monitoring channels is greater than the tolerance in p9542. See also Section: Setting encoderless actual value sensing (Page 136).</p> <p>4 ... 43: Fault in data cross-check between processor 1 and processor 2. Remedy: Please refer to the List Manual.</p> <p>44 ... 57: The tolerance value for the monitoring function differs between the two monitoring channels. See also Section: Setting encoderless actual value sensing (Page 136).</p> <p>58 ... 999: Fault in data cross-check between processor 1 and processor 2. Remedy: Please refer to the List Manual.</p> <p>1000: Check (watchdog) timer has expired.</p> <ul style="list-style-type: none"> <li>• Too many signal changes at the F-DI</li> </ul> <p>Remedy:</p> <ul style="list-style-type: none"> <li>• Check the F-DI wiring (contact problems).</li> </ul> <p>1001: Initialization error of the check timer.</p> <ul style="list-style-type: none"> <li>• Remedy: Switch off the power supply voltage of the inverter and switch on again.</li> <li>• Upgrade inverter firmware</li> </ul> <p>1005: Pulses already canceled for test stop selection.</p> <p>1011: Acceptance test status between the monitoring channels differ.</p> <ul style="list-style-type: none"> <li>• Diagnostics in the List Manual under r9571.</li> </ul> <p>1020: Cyclic communication failure between the monitoring channels.</p> <ul style="list-style-type: none"> <li>• Remedy: Switch off the power supply voltage of the inverter and switch on again.</li> <li>• Replace the Control Unit or the inverter.</li> </ul> <p>1041: Current value too low for encoderless actual value acquisition.</p> <ul style="list-style-type: none"> <li>• Reduce the minimum current (p9588).</li> </ul> <p>1042: Current or voltage plausibility error.</p> <ul style="list-style-type: none"> <li>• Increase the ramp-up and ramp-down time (p1120/p1121).</li> <li>• Check whether the current and speed control settings are correct (torque-forming, field-forming current and actual speed value must not fluctuate).</li> <li>• Reduce the dynamic response of the setpoint.</li> <li>• Increase the minimum current (p9588).</li> <li>• Maintain an adequate wait time before switching on the motor, also see: <ul style="list-style-type: none"> <li>– Switching on the motor when SLS is active (Page 251)</li> <li>– Switching on the motor when SSM is active (Page 264)</li> <li>– Switching on the motor when SDI is active (Page 271)</li> </ul> </li> </ul> <p>1043: Too many acceleration processes.</p> <ul style="list-style-type: none"> <li>• Increase the voltage tolerance (p9589).</li> <li>• Increase the ramp-up and ramp-down time (p1120/p1121).</li> <li>• Check whether the current and speed control settings are correct (torque-forming, field-forming current and speed actual value).</li> </ul>

6.14 List of alarms and faults

Signal	Cause	Remedy
	<b>Complete information on the messages is available in the List Manual.</b>	
C01712 (alarm) <sup>1)</sup>	Defect when processing F-IO	<ol style="list-style-type: none"> <li>1. Check the F-DI wiring.</li> <li>2. Check the setting of the safety functions.</li> <li>3. Perform an acceptance test.</li> </ol>
C01714 (alarm) <sup>1)</sup>	Safely limited speed exceeded	<ol style="list-style-type: none"> <li>1. Check the speed setpoint received from the higher-level control.</li> <li>2. Check the SLS limits.</li> </ol>
C01716 (fault)	Tolerance for safe direction of motion exceeded	Check the tolerance setting for the SDI function.
C01770 (fault)	Discrepancy error of the safety-related inputs or outputs.	Check the F-DI wiring.
A01772	Test stop for safety-relevant outputs is running	The alarm automatically disappears after successfully ending or canceling (error) the forced checking procedure (test stop).
F01773	Test stop safety-relevant output incorrect	<ol style="list-style-type: none"> <li>1. Check the wiring of the safety-related output.</li> <li>2. Start the forced dormant error detection.</li> </ol>
A01774	Test stop for safety-relevant outputs is required	<p>The time to carry out the forced checking procedure (test stop) has expired (p10003).</p> <p>Start the forced dormant error detection of the safety-related output.</p>
A01788	Automatic test stop waits for STO to be deselected via the motion monitoring functions	<p>The inverter was not able to carry out the automatic test stop (forced checking procedure) after switching on the power supply voltage.</p> <p>Possible causes:</p> <ul style="list-style-type: none"> <li>• The STO function is selected via the safe motion monitoring functions.</li> <li>• A safety message is active, which resulted in STO.</li> </ul>
A01790	Power-up stopped due to STO via terminals	After the power supply voltage has been switched on, the inverter was not able to complete its automatic self test. Possible cause: "STO via terminals at the Power Module" is active.
A01796	Waiting for communication	<ul style="list-style-type: none"> <li>• Check the operating state of the F host.</li> <li>• Check the communication connection to the F host.</li> </ul>
C01798 (alarm)	Test stop for motion monitoring is running	The inverter is presently carry out the forced checking procedure (test stop) for the safe motion monitoring functions. The inverter withdraws the message after the end of the test stop.
C01799 (alarm)	Acceptance test mode active	Not necessary. The inverter withdraws the message after the end of the acceptance test mode.



Signal	Cause	Remedy
<b>Complete information on the messages is available in the List Manual.</b>		
F30600	STOP A initiated. Fault value r0949 provides more detailed information.	The remedy depends on the fault value. The complete list of the fault values is provided in the List Manual. 0: Stop request from processor 2. 1005: Pulses are canceled, although neither is STO selected nor an internal STOP A active. Cause 1: Defective hardware. Remedy: 1. Select STO and then deselect again. 2. Switch off the power supply voltage of the inverter and switch on again. 3. Replace the Power Module if it cannot be acknowledged. Cause 2: STO via terminals of the Power Module is selected, however the function is not enabled in the Control Unit (p9601.7 = p9801.7 = 0). Remedy: 1. Set the switch on the Power Module to the "OFF" setting, or enable the function in the Control Unit. 2. Acknowledge the inverter fail-safe. 3. Replace the Power Module if it cannot be acknowledged. 1010 ... 1011: For details, please refer to the List Manual. Remedy: 1. Select STO and then deselect again. 2. Switch off the power supply voltage of the inverter and switch on again. 3. Replace the Power Module if it cannot be acknowledged. 1030: Discrepancy at terminals STO_A and STO_B on the PM240-2 Power Module. Remedy: 1. Remove the discrepancy at the terminals. 2. Acknowledge the inverter fail-safe. 3. Replace the Power Module if it cannot be acknowledged. 9999: Subsequent response to fault F01611.
F30611	Defect in a monitoring channel. Fault value r0949 provides more detailed information.	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.
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.

6.14 List of alarms and faults

Signal	Cause	Remedy
	<b>Complete information on the messages is available in the List Manual.</b>	
F30649	Internal software error	<ol style="list-style-type: none"> <li>1. Switch off the Control Unit power supply and then on again.</li> <li>2. Contact Technical Support if it cannot be acknowledged.</li> </ol>
F30650	Acceptance test required	See Section Acceptance tests for the safety functions (Page 195).
F30651	Synchronization with Control Unit unsuccessful.	<ol style="list-style-type: none"> <li>1. Switch off the Control Unit power supply and then on again.</li> <li>2. Contact Technical Support if it cannot be acknowledged.</li> </ol>
F30655	Aligning the monitoring functions	<ol style="list-style-type: none"> <li>1. Check that the control cabinet design and cable routing are in compliance with EMC regulations.</li> <li>2. Switch off the Control Unit power supply and then on again.</li> </ol>
F30656	Parameter processor 2 incorrect	<ol style="list-style-type: none"> <li>1. Recommission the safety functions.</li> <li>2. If this is not successful, then replace the Control Unit.</li> </ol>
F30659	Write task for parameter rejected	Check the following: <ul style="list-style-type: none"> <li>• Password</li> <li>• Only restore factory settings with the safety functions inhibited</li> </ul>
F30662	Error, internal communications	<ol style="list-style-type: none"> <li>1. Switch off the Control Unit power supply and then on again.</li> <li>2. Contact Technical Support if it cannot be acknowledged.</li> </ol>
F30664	Fault during power-up	Switch off the power supply voltage of the inverter and switch on again. Contact Technical Support if it cannot be acknowledged.
F30665	System is defective	<ol style="list-style-type: none"> <li>1. Switch off the Control Unit power supply and then on again.</li> <li>2. If it cannot be acknowledged, replace the Control Unit.</li> </ol>
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.
F30680	Checksum error safe monitoring functions	<ol style="list-style-type: none"> <li>1. Check the setting of the safety functions.</li> <li>2. Switch off the Control Unit power supply and then on again.</li> </ol>
F30681	Incorrect parameter value	Correct the parameter value: Fault value (r0949) yyyyxxx decimal, yyyy = supplementary information, xxxx = parameter
F30682	Monitoring function not supported	Deselect the monitoring function involved (p9501, p9601, p9801).
F30683	SLS enable missing	<ol style="list-style-type: none"> <li>1. Enable the SLS function (p9501.0).</li> <li>2. Save the setting (copy RAM to ROM).</li> <li>3. Switch off the Control Unit power supply and then on again.</li> </ol>
F30692	Parameter value not permitted for encoderless	Correct the parameter value.
A30693, F30693	Safety parameterization changed, POWER ON required	<ol style="list-style-type: none"> <li>1. Save the settings so that they are protected against power failure (RAM → ROM).</li> <li>2. Switch off the Control Unit power supply and then on again.</li> </ol>
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.

Signal	Cause	Remedy
<b>Complete information on the messages is available in the List Manual.</b>		
C30706 (alarm or fault) <sup>1)</sup>	SAM/SBR limit exceeded	<ol style="list-style-type: none"> <li>1. Check the motor braking response.</li> <li>2. Adapt the tolerance for the parameterization of the "safe braking ramp".</li> </ol>
C30711 (alarm) <sup>1)</sup>	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) <sup>1)</sup>	Defect when processing F-IO	<ol style="list-style-type: none"> <li>1. Check the F-DI wiring.</li> <li>2. Check the setting of the safety functions.</li> <li>3. Perform an acceptance test.</li> </ol>
C30714 (alarm) <sup>1)</sup>	Safely limited speed exceeded	<ol style="list-style-type: none"> <li>1. Check the speed setpoint received from the higher-level control.</li> <li>2. Check the SLS limits.</li> </ol>
C30716 (fault)	Tolerance for safe direction of motion exceeded	Check the tolerance for the "SDI" function.
C30770 (fault)	Discrepancy error of the safety inputs or outputs.	Check the F-DI wiring.
A30772	Test stop for safety-relevant outputs is running	The alarm automatically disappears after successfully ending or canceling (error) the forced checking procedure (test stop).
F30773	Test stop safety-relevant output incorrect	<ol style="list-style-type: none"> <li>1. Check the wiring of the safety-related output.</li> <li>2. Start the forced dormant error detection.</li> </ol>
A30788	Automatic test stop: Wait for STO to be deselected via SMM	<ul style="list-style-type: none"> <li>• Deselect STO of the extended functions.</li> <li>• Remove the cause for active safety messages and acknowledge the messages</li> </ul>
C30798 (alarm)	Test stop for motion monitoring is running	Not necessary. The inverter withdraws the message after the end of the test stop.
C30799 (alarm)	Acceptance test mode active	Not necessary. The inverter withdraws the message after the end of the acceptance test mode.
<sup>1)</sup> If the safety functions of the inverter have been enabled, then this alarm initiates a STOP response and an inverter fault.		



# Corrective maintenance

## 7.1 About this chapter

### What can you find in this Chapter?


In this chapter, you will find answers to the following questions:

- Where can I obtain the necessary information to maintain the operational safety and reliability of my system or machine?
- 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?

## 7.2 Maintaining operational safety

### Responsibility for operational safety

As company operating plants or machines or as supplier of plants and machines with safety-related equipment, you are responsible for the operational safety of your plant or machine. As a consequence, you are obliged to continually inform yourself about the products used.

 <b>WARNING</b>
<b>Risk of death by using incorrect components in safety-related plants and systems</b> Disregarding current product developments and features can result in an increased risk of accidents in safety-related plants and machines. <ul style="list-style-type: none"><li>• Register to receive the appropriate newsletters on these topics.</li><li>• If necessary, modify your plant or machine so that the requirements of the safety functions are always complied with.</li></ul>

### Registering to receive the newsletter

#### Procedure




1 Proceed as follows to subscribe to the "Safety Integrated Newsletter":

1. In the Internet, open the following page: Siemens automation technology ([www.automation.siemens.com](http://www.automation.siemens.com)).
2. On this page, open the folder "Presales info".
3. In folder "Presales info", select the "Newsletter" link.
4. Select "Login/registration" and log in with your access data.
5. In the "Newsletter system", select the "All newsletters" tab.
6. Open folder "Products and solutions".
7. Subscribe to the "Safety Integrated Newsletter".

You have subscribed to the "Safety Integrated Newsletter".

## 7.3 Replacing components of the SINAMICS G120 or G120D inverters


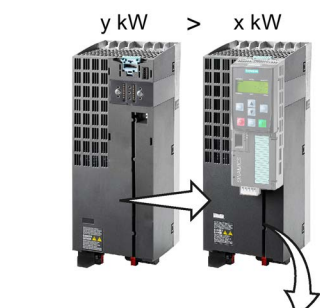
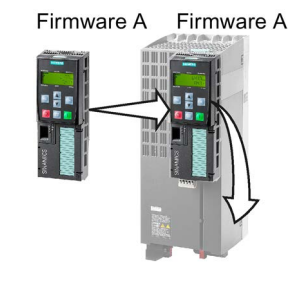
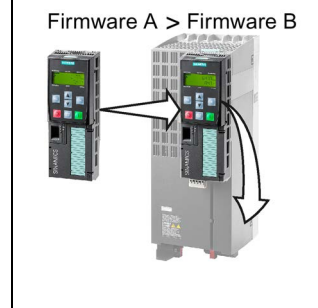
 <b>WARNING</b>
<p>Danger to life as a result of unexpected machine movement when the hardware or firmware is changed</p> <p>The drive can malfunction after replacing drive components or updating the firmware. This can place people at risk or cause material damage.</p> <ul style="list-style-type: none"> <li>• Before switching on the power supply voltage again, ensure that nobody is in the dangerous area around the machine.</li> <li>• Close the protective devices available before you switch on the power supply voltage.</li> <li>• Check the stability of the closed-loop control, for example, by briefly moving the drive in both directions of rotation.</li> <li>• Perform a reduced acceptance test.</li> </ul>

### 7.3.1 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.

In the following cases you will need to replace the inverter:

Replacing the Power Module		Replacing the Control Unit	
<b>Replacement:</b> <ul style="list-style-type: none"> <li>• Same type</li> <li>• Same power rating</li> </ul>	<b>Replacement:</b> <ul style="list-style-type: none"> <li>• Same type</li> <li>• Same frame size</li> <li>• <i>Higher</i> power rating</li> </ul>	<b>Replacement:</b> <ul style="list-style-type: none"> <li>• Same type</li> <li>• Same firmware version</li> </ul>	<b>Replacement:</b> <ul style="list-style-type: none"> <li>• Same type</li> <li>• <i>higher</i> firmware version (e.g. replace FW V4.2 by FW V4.3)</li> </ul>
			
	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**

**Risk of injury due to uncontrolled drive motion**

Replacing inverters of different types can result in uncontrolled motion of the drive.

- In all cases that are not permitted according to the table above, recommission the drive after replacing an inverter.

**Special issue relating to communication via PROFINET: Device replacement without removable data storage medium**

The inverter supports the PROFINET functionality, replacing the device without data storage medium. After replacing the Control Unit, the inverter is automatically assigned its device name from the IO controller.

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>).

Independent of this, after replacing the inverter, you must transfer the settings of the old inverter to the new inverter.



## 7.3.2 Replacing a Control Unit with enabled safety function

### Replacing a Control Unit with data backup on a memory card

If you use a memory card with firmware, after the replacement, you obtain a precise copy (firmware and settings) of the replaced Control Unit.

#### Precondition

You have a memory card with the actual settings of the Control unit to be replaced.

#### 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. Remove the memory card from the old Control Unit and insert it in the new Control Unit.
5. Mount the new Control Unit on the Power Module. The new Control Unit must have the same article number and the same or higher firmware version as the Control Unit that was replaced.
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. Check what the inverter reports after loading.
  - Alarm A01028:  
The loaded settings are not compatible with the inverter.  
Clear the alarm with p0971 = 1 and recommission the drive.
  - Fault F01641:  
Acknowledge the message.  
Perform a **reduced** acceptance test, see section: Reduced acceptance after a component has been replaced and a firmware change (Page 350).

- 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 STARTER


### Precondition

You have backed up the actual settings of the Control Unit to be replaced to a PC using STARTER.

### 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 right project for the drive in the PC.
8. Go online and transfer the settings from the PC to 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. 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 supply voltage.
14. Wait until all LEDs on the inverter go dark.
15. Switch on the inverter supply voltage again.
16. Perform a **reduced** acceptance test, see section: Reduced acceptance after a component has been replaced and a firmware change (Page 350).



You have replaced the Control Unit and transferred the safety function settings from the PC to the new Control Unit.

## Replacing a Control Unit with data backup in Startdrive

### Precondition

You have backed up the actual settings of the Control Unit to be replaced to a PC using Startdrive.

### Procedure



1 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 right project for the drive in the PC.
8. Select "Load to device".
9. Connect Startdrive online with the drive.

The inverter signals faults after the download. Ignore these faults, as they will be automatically acknowledged by the following steps.

10. Press the "Start safety commissioning" button.
11. Enter the password for the safety functions.
12. Confirm the prompt for saving your settings (copy RAM to ROM).
13. Disconnect the online connection.
14. Switch off the inverter supply voltage.
15. Wait until all LEDs on the inverter go dark.
16. Switch on the inverter supply voltage again.
17. Perform a **reduced** acceptance test, see section: Reduced acceptance after a component has been replaced and a firmware change (Page 350).



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

### Precondition

You have backed up the actual settings of the Control Unit to be replaced to an operator panel.

### 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. Plug the Operator Panel into the Control Unit or connect the Operator Panel handheld device with the inverter.
8. Transfer the settings from the Operator Panel to the inverter.
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 supply voltage.
12. Wait until all LEDs on the inverter go dark.
13. Switch on the inverter supply voltage again.

The inverter reports the faults F01641, F01650, F01680 and F30680. Ignore these faults, as they will be automatically acknowledged by the following steps.
14. Set p0010 to 95.
15. Set p9761 to the safety password.
16. Set p9701 to AC hex.
17. Set p0010 to 0.
18. Back up the settings so they are not lost when the power fails:
  - BOP-2 in the menu "EXTRAS" - "RAM-ROM".
  - IOP in the menu "SAVE RAM TO ROM".
19. Switch off the inverter supply voltage.
20. Wait until all LEDs on the inverter go dark.

21. Switch on the inverter supply voltage again.

22. Perform a **reduced** acceptance test, see section: Reduced acceptance after a component has been replaced and a firmware change (Page 350).

- You have replaced the Control Unit and transferred the safety function settings from the operator panel to the new Control Unit.

### 7.3.3 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.

### 7.3.4 Replacing a Power Module with enabled safety function



**! DANGER**

**Danger from touching energized Power Module connections**

After switching off the mains voltage, it will take up to 5 minutes until the capacitors in the Power Module are sufficiently discharged for the residual voltage to be safe. Death or serious injury will result if energized parts are touched.

- Check the safe isolation of the Power Module connections before carrying out installation work.

**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. A motor running backwards may damage the machine or installation.

- 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.

**Procedure**




To replace the Power Module, proceed as follows:

1. Switch off the main voltage of the Power Module.  
You can leave any external 24 V supply to the Control Unit switched on.
2. Remove the connecting cables of the Power Module.
3. Remove the Control Unit from the Power Module.
4. Replace the Power Module.
5. Mount the Control Unit onto the new Power Module.
6. Connect up the new Power Module using the connecting cables.
7. Switch on the line supply and, if necessary, the 24 V supply for the Control Unit.
8. The inverter reports F01641.
9. Carry out a reduced acceptance test, see Section Reduced acceptance after a component has been replaced and a firmware change (Page 350).

- You have successfully replaced the Power Module.

## 7.4 Replacing the SINAMICS G120C converter

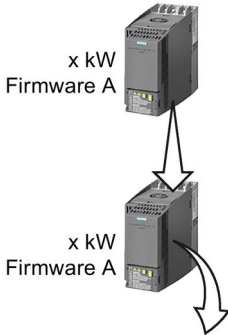
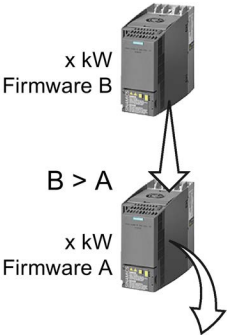
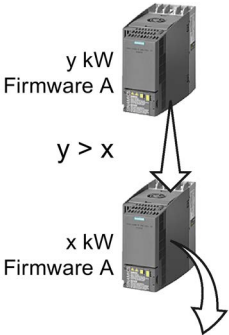
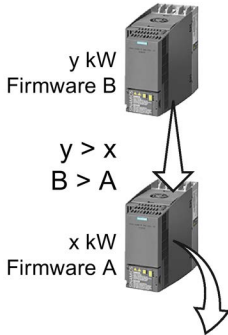
 <b>WARNING</b>
<p>Danger to life as a result of unexpected machine movement when the hardware or firmware is changed</p> <p>The drive can malfunction after replacing drive components or updating the firmware. This can place people at risk or cause material damage.</p> <ul style="list-style-type: none"> <li>• Before switching on the power supply voltage again, ensure that nobody is in the dangerous area around the machine.</li> <li>• Close the protective devices available before you switch on the power supply voltage.</li> <li>• Check the stability of the closed-loop control, for example, by briefly moving the drive in both directions of rotation.</li> <li>• Perform a reduced acceptance test.</li> </ul>

### 7.4.1 Overview of how to replace an inverter

#### Permissible replacement

You must replace the inverter if it continually malfunctions.

In the following cases you will need to replace the inverter:

<p>Replacement:</p> <ul style="list-style-type: none"> <li>• Same power rating</li> <li>• Same firmware version</li> </ul>	<p>Replacement:</p> <ul style="list-style-type: none"> <li>• Same power rating</li> <li>• <i>Higher</i> firmware version (e.g. replace FW V4.2 by FW V4.3)</li> </ul>	<p>Replacement:</p> <ul style="list-style-type: none"> <li>• Same frame size</li> <li>• <i>Higher</i> power rating</li> <li>• Same firmware version</li> </ul>	<p>Replacement:</p> <ul style="list-style-type: none"> <li>• Same frame size</li> <li>• <i>Higher</i> power rating</li> <li>• <i>higher</i> firmware version (e.g. replace FW V4.2 by FW V4.3)</li> </ul>
 <p>x kW Firmware A</p> <p>x kW Firmware A</p>	 <p>x kW Firmware B</p> <p><math>B &gt; A</math></p> <p>x kW Firmware A</p>	 <p>y kW Firmware A</p> <p><math>y &gt; x</math></p> <p>x kW Firmware A</p>	 <p>y kW Firmware B</p> <p><math>y &gt; x</math> <math>B &gt; A</math></p> <p>x kW Firmware A</p>
<p>inverter and motor must be adapted to one another (ratio of the motor and inverter rated power &gt; 1/8)</p>			

After you have carried out the replacement, you must restore the inverter's settings.

 **WARNING**

**Risk of injury due to uncontrolled drive motion**

Replacing inverters of different types can result in uncontrolled motion of the drive.

- In all cases that are not permitted according to the table above, recommission the drive after replacing an inverter.

**Special issue relating to communication via PROFINET: Device replacement without removable data storage medium**

The inverter supports the PROFINET functionality, replacing the device without data storage medium.

**Precondition**

The topology of the PROFINET IO system with the IO device involved is configured in your higher-level control system.

**Replacing the device**

The inverter can be replaced without having to insert a removable data storage medium (e.g. a memory card) with the saved device names in the inverter – or having to reassign the device names with a PG.

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>).



## 7.4.2 Replacing a converter with enabled safety function

**⚠ DANGER****Danger from touching energized Power Module connections**

After the power supply has been switched off, it takes up to 5 min. until the capacitors in the inverter have discharged so that the remaining voltage is at a non-hazardous level. Death or serious injury can result when live parts are touched.

- Check that the inverter connections are in a no-voltage condition before you carry out any installation work.

**NOTICE****Material damage from swapping the motor's connection lines**

The direction in which the motor rotates changes if you interchange the two phases of the motor cable. A motor running backwards may damage the machine or installation.

- Connect the three phases of the motor cables in the correct sequence.
- After replacing the inverter, check the direction in which the motor rotates.

## 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.
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.
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:  
Carry out a **reduced** acceptance test, see Section Reduced acceptance after a component has been replaced and a firmware change (Page 350).



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 STARTER


### Requirement

You have backed up the actual settings of the inverter to be replaced to a PC using STARTER.

### 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. Open the right project for the drive in STARTER.
8. Go online and transfer the settings from the PC to 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 LEDs on the inverter are dark.
15. Switch on the inverter supply voltage again.
16. Carry out a **reduced** acceptance test, see Section Reduced acceptance after a component has been replaced and a firmware change (Page 350).

■ You have replaced the inverter and transferred the safety function settings from the PC to the new inverter.

## Replacing an inverter with data backup in Startdrive

### Requirement

You have backed up the actual settings of the inverter to be replaced to a PC using Startdrive.

### 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. In Startdrive, open the project that matches the drive.
8. Select "Load to device".
9. Connect Startdrive online with the drive.

The inverter signals faults after the download. Ignore these faults, as they will be automatically acknowledged by the following steps.

10. Press the "Start safety commissioning" button.
11. Enter the password for the safety functions.
12. Confirm the prompt for saving your settings (copy RAM to ROM).
13. Disconnect the online connection.
14. Switch off the inverter supply voltage.
15. Wait until all LEDs on the inverter go dark.
16. Switch on the inverter supply voltage again.
17. Carry out a **reduced** acceptance test, see Section Reduced acceptance after a component has been replaced and a firmware change (Page 350).



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



- 1 To replace the inverter, proceed as follows:
- 2
  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. 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.
  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 supply voltage.
  12. Wait until all LEDs on the inverter go dark.
  13. Switch on the inverter supply voltage again.
    - The inverter reports the faults F01641, F01650, F01680 and F30680. Ignore these faults, as they will be automatically acknowledged by the following steps.
  14. Set p0010 to 95.
  15. Set p9761 to the safety password.
  16. Set p9701 to AC hex.
  17. Set p0010 to 0.
  18. Back up the settings so they are not lost when the power fails:
    - For BOP-2, in the menu "EXTRAS" - "RAM-ROM".
    - For IOP, in the menu "SAVE RAM TO ROM".
  19. Switch off the inverter power supply.
  20. Wait until all LEDs on the inverter are dark.

21. Switch on the inverter supply voltage again.

22. Carry out a **reduced** acceptance test, see Section Reduced acceptance after a component has been replaced and a firmware change (Page 350).

- You have replaced the inverter and transferred the safety function settings from the operator panel to the new inverter.

### 7.4.3 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.

## 7.5 Replacing components of the SINAMICS G110M inverters

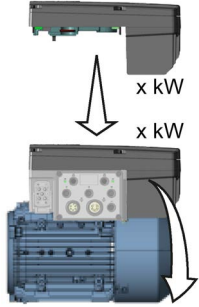
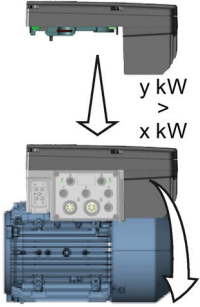
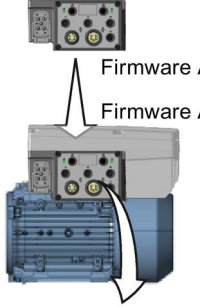
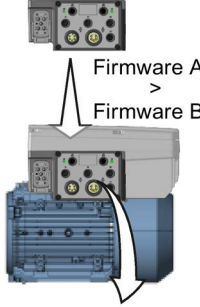
 <b>WARNING</b>
<p>Danger to life as a result of unexpected machine movement when the hardware or firmware is changed</p> <p>The drive can malfunction after replacing drive components or updating the firmware. This can place people at risk or cause material damage.</p> <ul style="list-style-type: none"> <li>• Before switching on the power supply voltage again, ensure that nobody is in the dangerous area around the machine.</li> <li>• Close the protective devices available before you switch on the power supply voltage.</li> <li>• Check the stability of the closed-loop control, for example, by briefly moving the drive in both directions of rotation.</li> <li>• Perform a reduced acceptance test.</li> </ul>


### 7.5.1 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.

In the following cases you will need to replace the inverter:

Replacing the Power Module		Replacing the Control Unit	
<b>Replacement:</b> <ul style="list-style-type: none"> <li>• Same power rating</li> </ul>	<b>Replacement:</b> <ul style="list-style-type: none"> <li>• <i>Higher</i> power rating</li> </ul>	<b>Replacement:</b> <ul style="list-style-type: none"> <li>• Same firmware version</li> </ul>	<b>Replacement:</b> <ul style="list-style-type: none"> <li>• <i>higher</i> firmware version (e.g. replace FW V4.2 by FW V4.3)</li> </ul>
			
	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.	

 <b>WARNING</b>
<b>Risk of injury due to uncontrolled drive motion</b> Replacing inverters with different firmware can result in uncontrolled motion of the drive. <ul style="list-style-type: none"><li>• In all cases that are not permitted according to the table above, recommission the drive after replacing an inverter.</li></ul>

**Special issue relating to communication via PROFINET: Device replacement without removable data storage medium**

The inverter supports the PROFINET functionality, replacing the device without data storage medium.

**Precondition**

The topology of the PROFINET IO system with the IO device involved is configured in your higher-level control system.

**Replacing the device**

The Control Unit can be replaced without having to insert a removable data storage medium (e.g. a memory card) with the saved device names in the inverter – or having to reassign the device names with a PG.

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>).



## 7.5.2 Replacing a Control Unit with enabled safety function



### DANGER

#### Danger from touching energized Power Module connections

After switching off the mains voltage, it will take up to 5 minutes until the capacitors in the Power Module are sufficiently discharged for the residual voltage to be safe. Death or serious injury can result when live parts are touched.

- Check that the Power Module connections are in a no-voltage condition after you have removed the cables from the Power Module.

## Replacing a Control Unit with data backup on a memory card

If you use a memory card with firmware, after the replacement, you obtain a precise copy (firmware and settings) of the replaced Control Unit.

### Precondition

You have a memory card with the actual settings of the Control unit to be replaced.

### Procedure



To replace the Control Unit, proceed as follows:

1. Switch off the inverter power supply voltage.
2. Remove all cables from the inverter.
3. After 5 minutes, check whether the device is in a no-voltage condition.
4. Release the four screws from the Power Module.
5. Remove the Power Module.
6. Withdraw the ribbon cable to the CPI module from the Control Unit.
7. Release the four screws from the Control Unit.
8. Remove the defective Control Unit.
9. Mount the new Control Unit. The new Control Unit must have the same article number and the same or higher firmware version as the Control Unit that was replaced.
10. Insert the ribbon cable to the CPI module back into the Control Unit.
11. Mount the Power Module on the Control Unit.
12. Reconnect all of the cables to the inverter.
13. Switch on the power supply voltages again.

14. The inverter loads its settings from the memory card.

15. Check what the inverter reports after loading.

- Alarm A01028:

The loaded settings are not compatible with the inverter.

Clear the alarm with p0971 = 1 and recommission the drive.

- Fault F01641:

Acknowledge the message.

Carry out a **reduced** acceptance test, see Section Reduced acceptance after a component has been replaced and a firmware change (Page 350).

- 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 STARTER


### Precondition


You have backed up the actual settings of the Control Unit to be replaced to a PC using STARTER.

### Procedure



To replace the Control Unit, proceed as follows:

1. Switch off the inverter power supply voltage.
2. Remove all cables from the inverter.
3. After 5 minutes, check whether the device is in a no-voltage condition.
4. Release the four screws from the Power Module.
5. Remove the Power Module.
6. Withdraw the ribbon cable to the CPI module from the Control Unit.
7. Release the four screws from the Control Unit.
8. Remove the defective Control Unit.
9. Mount the new Control Unit. The new Control Unit must have the same article number and the same or higher firmware version as the Control Unit that was replaced.
10. Insert the ribbon cable to the CPI module back into the Control Unit.
11. Mount the Power Module on the Control Unit.
12. Reconnect all of the cables to the inverter.
13. Switch on the power supply voltages again.
14. Open the right project for the drive in the PC.
15. Select the screen form for the safety functions.
16. Go online and transfer the settings from the PC to 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.
17. Select the "Change settings" button.
18. Select the "Activate settings" button.
19. Save your settings (copy RAM to ROM).
20. Switch off the inverter supply voltage.
21. Wait until all LEDs on the inverter go dark.
22. Switch on the inverter supply voltage again.
23. Carry out a **reduced** acceptance test, see Section Reduced acceptance after a component has been replaced and a firmware change (Page 350).

-  You have replaced the Control Unit and transferred the safety function settings from the PC to the new Control Unit.

## Replacing a Control Unit with data backup in Startdrive

### Precondition

You have backed up the actual settings of the Control Unit to be replaced to a PC using Startdrive.

### Procedure



To replace the Control Unit, proceed as follows:

1. Switch off the inverter power supply voltage.
  2. Remove all cables from the inverter.
  3. After 5 minutes, check whether the device is in a no-voltage condition.
  4. Release the four screws from the Power Module.
  5. Remove the Power Module.
  6. Withdraw the ribbon cable to the CPI module from the Control Unit.
  7. Release the four screws from the Control Unit.
  8. Remove the defective Control Unit.
  9. Mount the new Control Unit. The new Control Unit must have the same article number and the same or higher firmware version as the Control Unit that was replaced.
  10. Insert the ribbon cable to the CPI module back into the Control Unit.
  11. Mount the Power Module on the Control Unit.
  12. Reconnect all of the cables to the inverter.
  13. Switch on the power supply voltages again.
  14. Open the right project for the drive in the PC.
  15. Select "Load to device".
  16. Connect Startdrive online with the drive.

The inverter signals faults after the download. Ignore these faults, as they will be automatically acknowledged by the following steps.
  17. Press the "Start safety commissioning" button.
  18. Enter the password for the safety functions.
  19. Confirm the prompt for saving your settings (copy RAM to ROM).
  20. Disconnect the online connection.
  21. Switch off the inverter supply voltage.
  22. Wait until all LEDs on the inverter go dark.
  23. Switch on the inverter supply voltage again.
  24. Carry out a **reduced** acceptance test, see Section Reduced acceptance after a component has been replaced and a firmware change (Page 350).
- 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

### Precondition

You have backed up the actual settings of the Control Unit to be replaced to an operator panel.

### Procedure



To replace the Control Unit, proceed as follows:

1. Switch off the inverter power supply voltage.
2. Remove all cables from the inverter.
3. After 5 minutes, check whether the device is in a no-voltage condition.
4. Release the four screws from the Power Module.
5. Remove the Power Module.
6. Withdraw the ribbon cable to the CPI module from the Control Unit.
7. Release the four screws from the Control Unit.
8. Remove the defective Control Unit.
9. Mount the new Control Unit. The new Control Unit must have the same article number and the same or higher firmware version as the Control Unit that was replaced.
10. Insert the ribbon cable to the CPI module back into the Control Unit.
11. Mount the Power Module on the Control Unit.
12. Reconnect all of the cables to the inverter.
13. Switch on the power supply voltages again.
14. Connect the handheld operator panel to the inverter.
15. Transfer the settings from the Operator Panel to the inverter.
16. Wait until the transfer is complete.
17. 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.
18. Switch off the inverter supply voltage.
19. Wait until all LEDs on the inverter go dark.
20. Switch on the inverter supply voltage again.

The inverter reports the faults F01641, F01650, F01680 and F30680. Ignore these faults, as they will be automatically acknowledged by the following steps.
21. Set p0010 to 95.
22. Set p9761 to the safety password.

- 23. Set p9701 to AC hex.
- 24. Set p0010 to 0.
- 25. Back up the settings so they are not lost when the power fails: "SAVE RAM TO ROM".
- 26. Switch off the inverter supply voltage.
- 27. Wait until all LEDs on the inverter go dark.
- 28. Switch on the inverter supply voltage again.
- 29. Carry out a **reduced** acceptance test, see Section Reduced acceptance after a component has been replaced and a firmware change (Page 350).

- You have replaced the Control Unit and transferred the safety function settings from the operator panel to the new Control Unit.

### 7.5.3 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. Switch off the inverter power supply voltage.
- 2. Remove all cables from the inverter.
- 3. Wait for 5 minutes until the device is in a no-voltage condition.
- 4. Release the four screws from the Power Module.
- 5. Remove the Power Module.
- 6. Withdraw the ribbon cable to the CPI module from the Control Unit.
- 7. Release the four screws from the Control Unit.
- 8. Remove the defective Control Unit.
- 9. Mount the new Control Unit.
- 10. Insert the ribbon cable to the CPI module back into the Control Unit.
- 11. Mount the Power Module on the Control Unit.
- 12. Reconnect all of the cables to the inverter.
- 13. Switch on the power supply voltages again.
- 14. Recommission the drive.

- The Control Unit replacement has been completed after the drive has been successfully commissioned.

## 7.5.4 Replacing a Power Module with enabled safety function



### DANGER

#### Danger from touching energized Power Module connections

After switching off the mains voltage, it will take up to 5 minutes until the capacitors in the Power Module are sufficiently discharged for the residual voltage to be safe. Death or serious injury will result if energized parts are touched.

- Check that the Power Module connections are in a no-voltage condition after you have removed the cables from the Power Module.

#### Procedure




To replace the Power Module, proceed as follows:

1. Switch off the inverter power supply voltage.
2. Remove all cables from the inverter.
3. After 5 minutes, check whether the device is in a no-voltage condition.
4. Release the four screws from the Power Module.
5. Remove the Power Module.
6. If a memory card is inserted in the Power Module, remove the memory card and insert it into the new Power Module.
7. Mount the new Power Module on the Control Unit.
8. Reconnect all of the cables to the inverter.
9. Switch on the power supply voltages again.
10. The inverter reports F01641.
11. Carry out a reduced acceptance test, see Section Reduced acceptance after a component has been replaced and a firmware change (Page 350).

You have successfully replaced the Power Module.

## 7.6 Replacing the SIMATIC ET 200pro FC-2 inverter

 <b>WARNING</b>
Danger to life as a result of unexpected machine movement when the hardware or firmware is changed
The drive can malfunction after replacing drive components or updating the firmware. This can place people at risk or cause material damage.
<ul style="list-style-type: none"><li>• Before switching on the power supply voltage again, ensure that nobody is in the dangerous area around the machine.</li><li>• Close the protective devices available before you switch on the power supply voltage.</li><li>• Check the stability of the closed-loop control, for example, by briefly moving the drive in both directions of rotation.</li><li>• Perform a reduced acceptance test.</li></ul>

### 7.6.1 Overview of how to replace an inverter

#### Permissible replacement

You must replace the inverter if it continually malfunctions.

If you replace a defective inverter by a new inverter with the same or higher firmware version, the settings of the defective inverter can be loaded to the new inverter.

You must recommission the drive if the defective inverter has a higher firmware version than the new inverter.



## 7.6.2 Replacing a converter with enabled safety function



### DANGER

Risk of fatal injury when touching energized Power Module connections

After the power supply has been switched off, it takes up to 5 min. until the capacitors in the inverter have discharged so that the remaining voltage is at a non-hazardous level. Death or serious injury can result when live parts are touched.

- Check that the inverter connections are in a no-voltage condition before you carry out any installation work.

## 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.
2. Remove the inverter connecting cables.
3. Remove the defective inverter.
4. Remove the memory card from the old inverter, and insert it into the new inverter.
5. Install the new inverter.
6. Install the connecting cables of the inverter.
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:  
Carry out a **reduced** acceptance test, see Section Reduced acceptance after a component has been replaced and a firmware change (Page 350).

- 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 STARTER


### Requirement

You have backed up the actual settings of the inverter to be replaced to a PC using STARTER.

### Procedure



To replace the inverter, proceed as follows:

1. Disconnect the line voltage to the inverter.
2. Remove the inverter connecting cables.
3. Remove the defective inverter.
4. Install the new inverter.
5. Install the connecting cables of the inverter.
6. Connect up the line voltage again.
7. Open the right project for the drive in STARTER.
8. Go online and transfer the settings from the PC to 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 LEDs on the inverter are dark.
15. Switch on the inverter power supply voltage again).
16. Perform a **reduced** acceptance test, see the section Reduced acceptance after a component has been replaced and a firmware change (Page 350).

- You have replaced the inverter and transferred the safety function settings from the PC to the new inverter.

## Replacing an inverter with data backup in Startdrive

### Requirement

You have backed up the actual settings of the inverter to be replaced to a PC using Startdrive.

### Procedure



To replace the inverter, proceed as follows:

1. Disconnect the line voltage to the inverter.
2. Remove the inverter connecting cables.
3. Remove the defective inverter.
4. Install the new inverter.
5. Install the connecting cables of the inverter.
6. Connect up the line voltage again.
7. In Startdrive, open the project that matches the drive.
8. Select "Load to device".
9. Connect Startdrive online with the drive.

The inverter signals faults after the download. Ignore these faults, as they will be automatically acknowledged by the following steps.

10. Press the "Start safety commissioning" button.
11. Enter the password for the safety functions.
12. Confirm the prompt for saving your settings (copy RAM to ROM).
13. Disconnect the online connection.
14. Switch off the inverter supply voltage.
15. Wait until all LEDs on the inverter go dark.
16. Switch on the inverter supply voltage again.
17. Carry out a **reduced** acceptance test, see Section Reduced acceptance after a component has been replaced and a firmware change (Page 350).



You have replaced the inverter and transferred the safety function settings from the PC to the new inverter.

## Replacing an inverter with data backup in the operator panel

### Procedure



- 1 To replace the inverter, proceed as follows:
  - 2
    1. Disconnect the line voltage to the inverter.
    2. Remove the inverter connecting cables.
    3. Remove the defective inverter.
    4. Install the new inverter.
    5. Install the connecting cables of the inverter.
    6. Connect up the line voltage again.
    7. Connect the inverter to the operator panel.
    8. Transfer the settings from the Operator Panel to the inverter.
    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 supply voltage.
    12. Wait until all LEDs on the inverter go dark.
    13. Switch on the inverter supply voltage again.
      - The inverter reports the faults F01641, F01650, F01680 and F30680. Ignore these faults, as they will be automatically acknowledged by the following steps.
    14. Set p0010 to 95.
    15. Set p9761 to the safety password.
    16. Set p9701 to AC hex.
    17. Set p0010 to 0.
    18. Back up the settings so they are not lost when the power fails: Menu "SAVE RAM TO ROM".
    19. Switch off the inverter power supply.
    20. Wait until all LEDs on the inverter are dark.
    21. Switch on the inverter supply voltage again.
    22. Perform a **reduced** acceptance test, see the section Reduced acceptance after a component has been replaced and a firmware change (Page 350).
- You have replaced the inverter and transferred the safety function settings from the operator panel to the new inverter.

### 7.6.3 Replacing a converter without data backup

If the settings have not been backed up, after replacing the inverter, you must recommission the drive.

#### Procedure



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.
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.

## 7.7 Reduced acceptance after a component has been replaced and a firmware change

After a component has been replaced or the firmware updated, a reduced acceptance test of the safety functions must be performed.

Table 7- 1 Reduced acceptance test after component replacement

Measure	Acceptance test	Documentation
Replacing the Control Unit or the inverter with an identical type	An acceptance test for the safety functions is not required. Only check the motor's direction of rotation.	<ul style="list-style-type: none"> <li>• Supplement inverter data</li> <li>• Log the new checksum</li> <li>• Countersignature</li> </ul>
Replacing a Power Module with an identical type		Supplement the hardware version in the inverter data.
Replacing the motor with an identical pole pair number		No change.
Replacing the gearbox with an identical ratio		
Replacing the Safe Brake Relay	Check the SBC function.	Supplement the hardware version in the inverter data.
Replacing the safety-related peripherals (e.g. Emergency Stop switch).	Check the control of the safety functions affected by the components that have been replaced.	No change.
Inverter firmware update	An acceptance test for the safety functions is not required. Check as to whether the firmware update was successful and the inverter functions as expected.	<ul style="list-style-type: none"> <li>• Supplement firmware version in the inverter data</li> <li>• Log the new checksum</li> <li>• Countersignature</li> </ul>

See also Section: Acceptance tests for the safety functions (Page 195).

# System properties

## 8.1 About this chapter

### What can you find in this Chapter?

In this chapter, you will find answers to the following questions:

- How long may I operate my inverter?
- In what time intervals must I initiate an inverter self test?
- What are the probabilities of failure of the safety functions of my inverter?
- 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?
- According to which standards are the safety functions of my inverter certified?
- Where can I find the inverter certificate?
- What are the technical data of the Safe Brake Relay?

## 8.2 Probability of failure of the safety functions (PFH value)

The specified probability of failure values apply under the following preconditions:

- The service life of the inverter has not expired.
- The test interval has not expired.

### Service life

You may not operate inverters with integrated safety functions for longer than 20 years. The 20 years starts when the device is delivered. The service life cannot be extended. This is the case even if a service department checks the inverter – or in the meantime, the inverter was decommissioned.

### Test interval

You must test the safety-related circuits of the inverter at least once every year. This process is called "forced dormant error detection" or "test stop".

Information on the procedure can be found in Section: Safety Evaluation Tool ([www.siemens.com/safety-evaluation-tool](http://www.siemens.com/safety-evaluation-tool)).

### Probability of failure

Table 8- 1 Probability of failure of the safety functions

Safety function	PFH, PFH <sub>D</sub> 1)	PFD 2)
STO, SBC 3), SS1, SLS, SDI, SSM	5×10 <sup>-8</sup> 1/h	5×10 <sup>-3</sup>

1) PFH, PFH<sub>D</sub>: Probability of failures per hour.

PFH according to IEC 61800-5-2, PFH<sub>D</sub> according to IEC 62061.

2) PFD: For a low demand rate of the safety function: Mean probability of dangerous failure when the safety function is demanded according to IEC 61508.

3) Including Safe Brake Relay

The machine manufacturer must specify a probability of failure in the form of a PFH value for every safety function of a machine.

The integrated inverter 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.
- An inverter for safely stopping (SS1) a motor if a protective door is opened.

IEC 62061 explains how to calculate the PFH<sub>D</sub> value for the complete safety function from the PFH<sub>D</sub> values of the components used for the safety function.

We provide a free tool in the Internet to calculate the PFH<sub>D</sub> value of a complete machine: Safety Evaluation Tool ([www.siemens.com/safety-evaluation-tool](http://www.siemens.com/safety-evaluation-tool)).



Application examples for the probability of failure PFH and PFD are available in the Internet:  
Application example (<http://support.automation.siemens.com/WW/view/en/76254308>).

## 8.3 Certification

### Certifications

The safety functions fulfill the following requirements:

STO with control via terminals STO_A and STO_B in the SINAMICS G120 PM240-2 Power Module, FSD and FSE	All other safety functions of the SINAMICS G110M, G120, G120C, G120D and SIMATIC ET 200pro FC-2 inverters
<ul style="list-style-type: none"> <li>• Category 3 and Performance Level (PL) e according to EN ISO 13849-1: 2006</li> <li>• Safety integrity level 3 (SIL 3) to IEC 61508: 2010</li> <li>• EC Declaration of Conformity</li> </ul>	<ul style="list-style-type: none"> <li>• Category 3 and Performance Level (PL) d according to EN ISO 13849-1: 2006</li> <li>• Safety integrity level 2 (SIL 2) to IEC 61508: 2010</li> <li>• EC declaration of conformity</li> </ul>

### EC type-examination certificate and manufacturer declaration

The safety functions integrated in the drive are certified by a test institute for each of the firmware versions that have been released. With the EC type-examination certificate, the test institute confirms that the safety functions comply with the requirements as laid down in EN ISO 13849-1 and IEC 61508.

We provide a manufacturer's declaration for the transition period from releasing a firmware version up to the test institute issuing an EC type-examination certificate. The manufacturer declaration confirms that the safety functions are in conformance with the appropriate standards.

#### Procedure



Proceed as follows, to load the certificates relevant for Safety Integrated from the Internet:

1. In the Internet, open the following page: Certificates (<http://support.automation.siemens.com/WW/view/en/36426537/134200>)
2. Filter according to Certificate type "Functional safety/machine safety".
3. Select the certificate according to the inverter article number.
  - There is an EC type-examination certificate and a manufacturer declaration for each inverter family.
  - Each certificate includes lists with the associated firmware and hardware.

**SINAMICS G General Performance Converters**

Product list | **Entry list**

**Filter settings:**

Entry type: Certificates  
 Certificate Type: Functional Safety/Safety of Mac Certificate: all  
 Approval office: all Y: all  
 Search item(s):  Go

Title	Date
<b>Certificates</b> Functional Safety/Safety of Machinery, Manufacturer	2013-09-24
for products: 6SL3255-0BT01-0PA0	
<b>Certificates</b> Functional Safety/Safety of Machinery, Type Examination Certificate, TÜV (technischer Überwachungsverein) Certificate of Origin, Z10 12 06 59719 007 for products: 6SL3210-1PE11-8AL0; 6SL3210-1PE11-8AL1; 6SL32 more>>	2013-03-28 ID: 68849049
<b>Certificates</b> Functional Safety/Safety of Machinery, Type Examination Certificate, TÜV (technischer Überwachungsverein) Certificate of origin SIL 2, Z10120659719005 for products: 6SL3244-0BB12-1BA0; 6SL3244-0BB12-1BA1; 6SL32 more>>	2013-03-26 ID: 68812830
<b>Certificates</b> Functional Safety/Safety of Machinery, SIL-Declaration of conformity, Manufacturer Manufacturer's Declaration for products: 6SL3210-1PE11-8AL0; 6SL3210-1PE11-8UL0; 6SL32 more>>	2013-03-22 ID: 68704540

- You have loaded certificates relevant for Safety Integrated from the Internet.

## EC Declaration of Conformity

According to Annex IV of the machinery directive, drives equipped with Safety Integrated are defined as "Logic units for safety functions" and therefore as a safety component. The machinery directive specifies that safety components should be handled just like machines. As a consequence, safety components require a CE marking.

As machine builder, you must provide documentation that you create for the CE marking of the machine, together with the EC Declaration of Conformity for the products that have been installed.

The current EC Declarations of Conformity for the inverter are available in the Internet:

EC Declaration of Conformity

(<http://support.automation.siemens.com/WW/view/en/67385845>)

## 8.4 Safe Brake Relay

### Technical data of the Safe Brake Relay

Technical data	Property
Supply voltage	20.4 to 28.8 V DC We recommend that you use a power supply with a minimum rated voltage of 26 V in order to compensate for voltage drops along the brake cable.
Current drawn at 24 V DC	0.05 A + the current drawn by the motor brake
Maximum current	2 A
Conductor cross section, max.	2.5 mm <sup>2</sup>
Dimensions (W x H x D)	69 mm x 63 mm x 33 mm
Weight	approx. 0.17 kg

## 8.5 Response times after selection

### 8.5.1 General information

The response times depend on the following conditions:

- Safety function setting
  - Basic function
  - Extended function
- PROFIBUS or PROFINET
- Selected via safety-related input or PROFIsafe

The "worst case values" in the following tables mean the following:

Worst case for a fault-free inverter:	The response time is less than or equal to the specified value.
Worst case for an inverter fault:	The response time is less than or equal to the specified value. The response time is applicable for fault causes within the inverter itself, e.g. for a defective microprocessor.

### 8.5.2 Safe Torque Off (STO) and Safe Brake Control (SBC)

The response time of the STO function is the time between selecting the function and the function becoming active.

#### Response times when selected via PROFIsafe

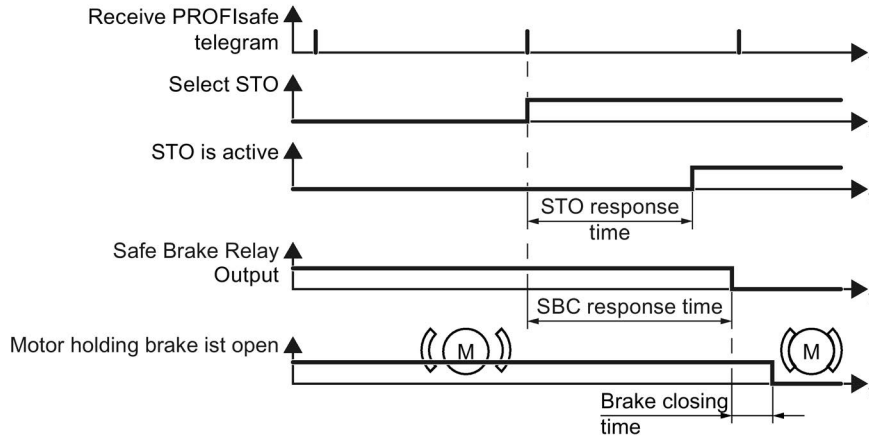


Figure 8-1 Response times when selected via PROFIsafe

Table 8-2 Response times when using the basic functions

Selection via	Worst case for a fault-free inverter		Worst case for an inverter fault	
	STO response time	SBC response time	STO response time	SBC response time
PROFIBUS	14 ms	16 ms	14 ms	30 ms
PROFINET	14 ms + bus cycle time	16 ms + bus cycle time	14 ms + bus cycle time	30 ms + bus cycle time

Table 8-3 Response times when using the extended functions

Selection via	Worst case for a fault-free inverter		Worst case for an inverter fault	
	STO response time	SBC response time	STO response time	SBC response time
PROFIBUS	54 ms	56 ms	56 ms	62 ms
PROFINET	54 ms + bus cycle time	56 ms + bus cycle time	56 ms + bus cycle time	62 ms + bus cycle time

Bus cycle time: Time for a cyclic data exchange via PROFINET.

**Response times when selected via a safety-related input**

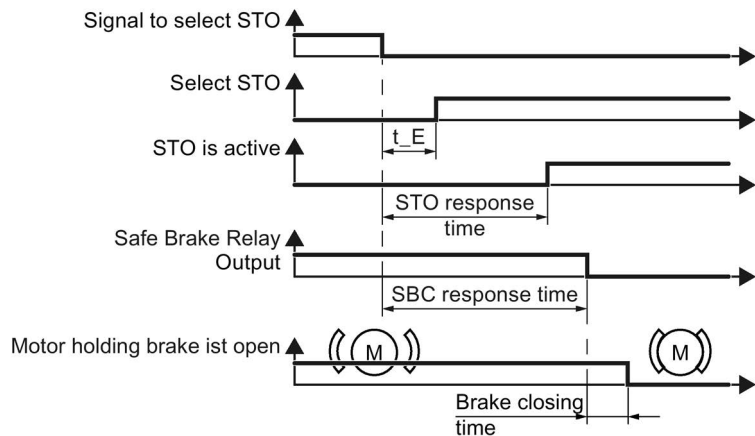


Figure 8-2 Response times when selected via a safety-related input

Table 8- 4 Response times when using the basic functions

Selection via	Worst case for a fault-free inverter		Worst case for an inverter fault	
	STO response time	SBC response time	STO response time	SBC response time
F-DI on the Control Unit	4 ms + t <sub>E</sub> <sup>1)</sup>	8 ms + t <sub>E</sub> <sup>1)</sup>	6 ms + t <sub>E</sub> <sup>1)</sup>	22 ms + t <sub>E</sub> <sup>1)</sup>
Terminals STO_A, STO_B on the PM240-2 Power Module.	20 ms	24 ms	---	---
<sup>1)</sup> If p9651 > 0: t <sub>E</sub> = p9651 + 3 ms If p9651 = 0: t <sub>E</sub> = 4 ms p9651: Delays				

Table 8- 5 Response times when using the extended functions

Selection via	Worst case for a fault-free inverter		Worst case for an inverter fault	
	STO response time	SBC response time	STO response time	SBC response time
F-DI	50 ms + t <sub>E</sub> <sup>1)</sup>	52 ms + t <sub>E</sub> <sup>1)</sup>	52 ms + t <sub>E</sub> <sup>1)</sup>	60 ms + t <sub>E</sub> <sup>1)</sup>
<sup>1)</sup> If p10017 > 0: t <sub>E</sub> = p10017 + 3 ms If p10017 = 0: t <sub>E</sub> = 4 ms p10017: Debounce time				

### 8.5.3 Safe Stop 1 (SS1) and Safe Brake Control (SBC)

The response time of the SS1 function is the time between selecting the SS1 function and the STO function becoming active.

#### Response times when selected via PROFIsafe

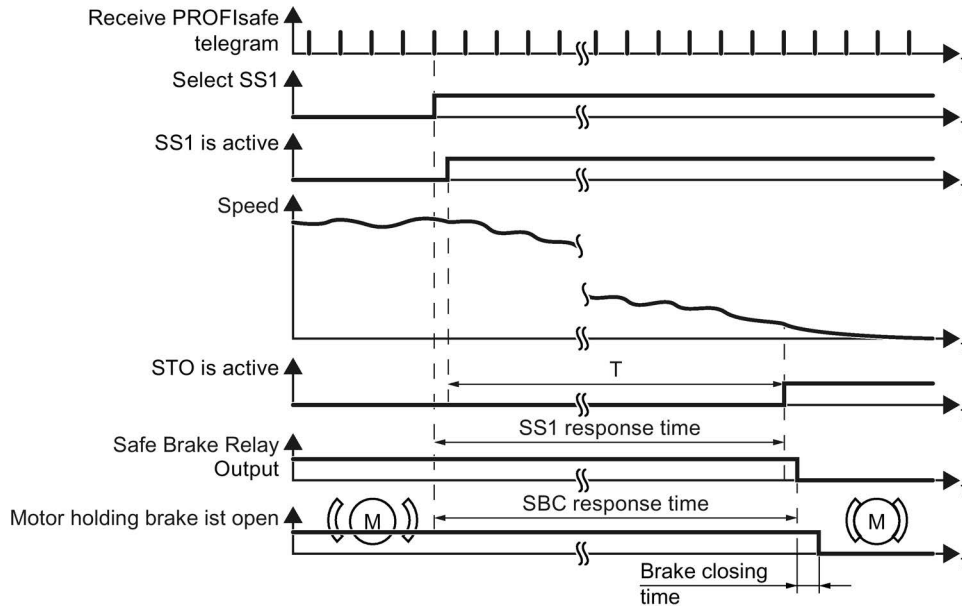


Figure 8-3 Response times when selected via PROFIsafe

Table 8- 6 Response times when using the basic functions

Selection via	Worst case for a fault-free inverter		Worst case for an inverter fault	
	SS1 response time	SBC response time	SS1 response time	SBC response time
PROFIBUS	14 ms + T <sup>1)</sup>	16 ms + T <sup>1)</sup>	14 ms + T <sup>1)</sup>	30 ms + T <sup>1)</sup>
PROFINET	14 ms + T <sup>1)</sup> + bus cycle time	16 ms + T <sup>1)</sup> + bus cycle time	14 ms + T <sup>1)</sup> + bus cycle time	30 ms + T <sup>1)</sup> + bus cycle time
<sup>1)</sup>	T = p9652			



Table 8- 7 Response times when using the extended functions

Selection via	Worst case for a fault-free inverter		Worst case for an inverter fault	
	SS1 response time	SBC response time	SS1 response time	SBC response time
PROFIBUS	54 ms + T <sup>1)</sup>	56 ms + T <sup>1)</sup>	56 ms + T <sup>1)</sup>	62 ms + T <sup>1)</sup>
PROFINET	54 ms + T <sup>1)</sup> + bus cycle time	56 ms + T <sup>1)</sup> + bus cycle time	56 ms + T <sup>1)</sup> + bus cycle time	62 ms + T <sup>1)</sup> + bus cycle time
<sup>1)</sup> T depends on how safety function SS1 is set: <ul style="list-style-type: none"> <li>• SS1 with braking ramp monitoring: T = p9582 + time to brake down to standstill detection</li> <li>• SS1 with acceleration monitoring: T = the lower of the two times: <ul style="list-style-type: none"> <li>– p9556</li> <li>– Time to brake down to standstill detection</li> </ul> </li> </ul>				

Bus cycle time: Time for a cyclic data exchange via PROFINET.

Response times when selected via a safety-related input of the Control Unit

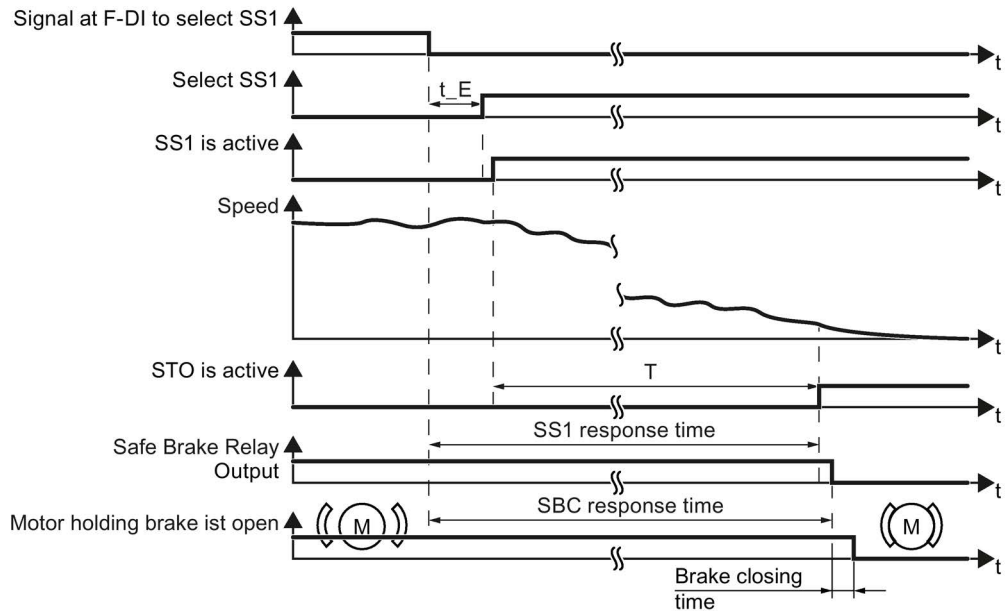


Figure 8-4 Response times when selected via a safety-related input F-DI

Table 8- 8 Response times when using the basic functions

Selection via	Worst case for a fault-free inverter		Worst case for an inverter fault	
	SS1 response time	SBC response time	SS1 response time	SBC response time
F-DI	$4 \text{ ms} + T^{1)} + t_{E}^{2)}$	$8 \text{ ms} + T^{1)} + t_{E}^{2)}$	$6 \text{ ms} + T^{1)} + t_{E}^{2)}$	$22 \text{ ms} + T^{1)} + t_{E}^{2)}$
1)	$T = p9652$			
2)	If $p9651 > 0$ : $t_E = p9651 + 3 \text{ ms}$ If $p9651 = 0$ : $t_E = 4 \text{ ms}$ p9651: Delays			

Table 8- 9 Response times when using the extended functions

Selection via	Worst case for a fault-free inverter		Worst case for an inverter fault	
	SS1 response time	SBC response time	SS1 response time	SBC response time
F-DI	$50 \text{ ms} + T^{1)} + t_{E}^{2)}$	$52 \text{ ms} + T^{1)} + t_{E}^{2)}$	$52 \text{ ms} + T^{1)} + t_{E}^{2)}$	$60 \text{ ms} + T^{1)} + t_{E}^{2)}$
1)	<p>T depends on how safety function SS1 is set:</p> <ul style="list-style-type: none"> <li>• SS1 with braking ramp monitoring: <math>T = p9582 + \text{time to brake down to standstill detection}</math></li> <li>• SS1 with acceleration monitoring: <math>T = \text{the lower of the two times:}</math> <ul style="list-style-type: none"> <li>– p9556</li> <li>– Time to brake down to standstill detection</li> </ul> </li> </ul>			
2)	<p>If <math>p10017 &gt; 0</math>: <math>t_E = p10017 + 3 \text{ ms}</math>  If <math>p10017 = 0</math>: <math>t_E = 4 \text{ ms}</math>  p10017: Debounce time</p>			

## 8.6 Response times when a monitoring function responds

### Response times when limit values are violated

Table 8- 10 Time until the response is initiated

Function	Response	Worst case for a fault-free drive system	Worst case when a fault exists
SS1	STOP A	67 ms <sup>2)</sup>	101 ms <sup>2)</sup>
SLS	STOP A or STOP B	67 ms <sup>2)</sup>	113 ms <sup>2)</sup>
SDI	STOP A or STOP B	61 ms <sup>2)</sup>	107 ms <sup>2)</sup>
<sup>2)</sup>	Immediately after switching-on the motor, the response times are extended by p9586 (Delay time actual value sensing).		

### Signal change into the "Status SSM"

Response	Interface	Worst case for a fault-free drive system	Worst case when a fault exists
Signal change into the "Status SSM"	PROFIsafe	101 ms <sup>3)</sup>	135 ms <sup>3)</sup>
	Safety-related output F-DO	77 ms <sup>3)</sup>	113 ms <sup>3)</sup>
<sup>3)</sup>	Immediately after switching-on the motor, the response times are extended by p9586 (Delay time actual value sensing).		

### Response time after PROFIsafe communication interruption

The inverter receives the monitoring time from the higher-level-level, fail-safe control (F-CPU).

If the PROFIsafe telegram is not received before the end of the PROFIsafe monitoring time, the inverter responds as follows:

- The inverter signals one of the following faults:
  - Basic functions have been enabled: Fault F01611
  - Extended functions have been enabled: Message C01711
- The inverter activates the STO function.

## Appendix

### A.1 About this chapter

#### What can you find in this Chapter?

In this chapter, you will find answers to the following questions:

- What does a typical acceptance for safety functions look like?
- As machine manufacturer or company operating a machine, what standards and regulations must I observe?
- Where can I find more information on my inverter?

## A.2 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 to test the expected maximum braking distances and braking times.
- The trace function in the STARTER and Startdrive PC tools 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 have recorded a trace for an acceptance test, you have to proceed as follows:
  - When you save the trace, enter the storage location in the acceptance report.
  - If you print the trace, append the printout to the acceptance report.
- If you can carry out the acceptance test without the trace function, there is no need to use this tool.
- Alarm A01697:

This alarm is issued following each system startup and is not critical for acceptance.

After the acceptance test of the inverter's safety functions, you must also check whether the safety-related functions in the machine or system are functioning correctly. See also Acceptance test (Page 195).

### Acceptance support by the STARTER application

The "Safety Acceptance Test" application guides you semi-automatically through the acceptance test of the safety functions. The application logs its settings as an Excel file.

Application acceptance test

(<http://support.automation.siemens.com/WW/view/en/73102423>).

### A.2.1 Acceptance test STO (basic functions)

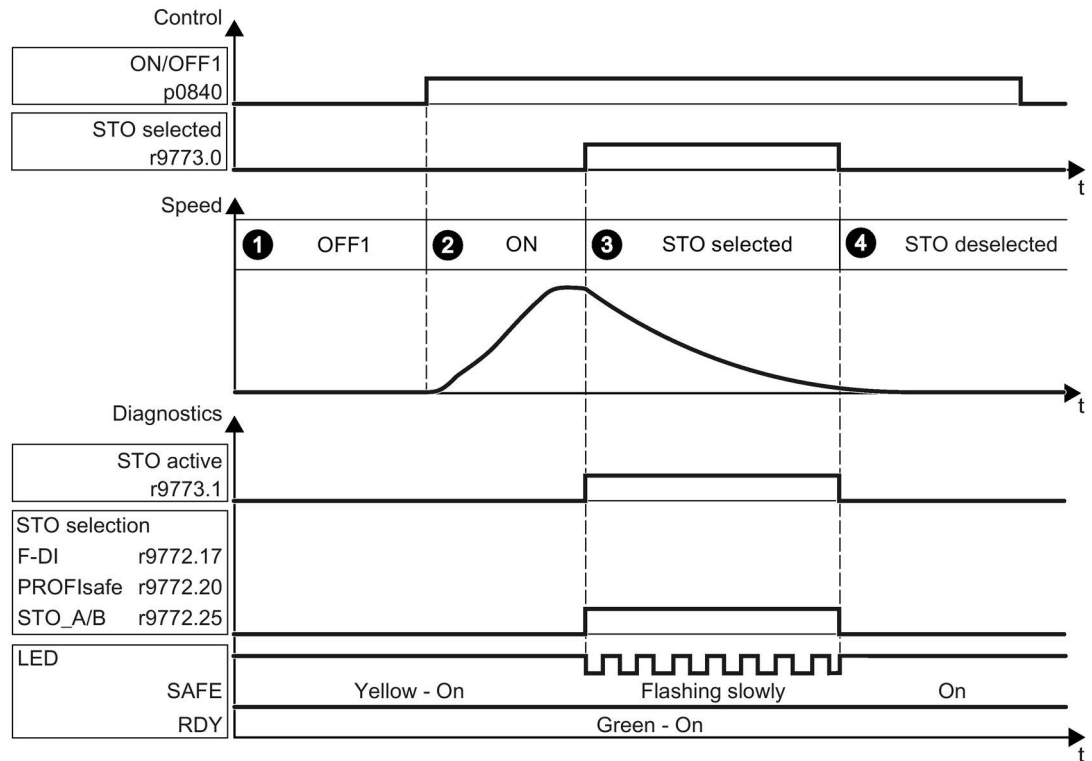


Figure A-1 Acceptance test for STO (basic functions)

#### Procedure



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

		Status
1.	<b>The inverter is ready</b>	
	<ul style="list-style-type: none"> <li>The inverter signals neither faults nor alarms of the safety functions (r0945[0...7], r2122[0...7]).</li> <li>STO is not active (r9773.1 = 0).</li> </ul>	
2.	<b>Switch on motor</b>	
	2.1. Enter a speed setpoint ≠ 0.	
	2.2. Switch on the motor (ON command).	
	2.3. Check that the correct motor is running.	

			Status
3.	<b>Select STO</b>		
3.1.	Select STO while the motor is running. <i>Test each configured activation, e.g. via digital inputs and PROFIsafe.</i>		
3.2.	Check the following:		
	When controlled via PROFIsafe	When controlled via fail-safe digital inputs (F-DI)	When controlled via terminals STO_A and STO_B on Power Module PM240-2
	<ul style="list-style-type: none"> <li>The inverter signals the following: "STO selection via PROFIsafe" (r9772.20 = 1)</li> </ul>	<ul style="list-style-type: none"> <li>The inverter signals the following: "STO Selection via terminal" (r9772.17 = 1)</li> </ul>	<ul style="list-style-type: none"> <li>The inverter signals the following: "STO Selection via terminal on Power Module" (r9772.25 = 1)</li> </ul>
	<ul style="list-style-type: none"> <li>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 standstill.</li> </ul>		
	<ul style="list-style-type: none"> <li>The inverter signals neither faults nor alarms of the safety functions (r0945[0...7], r2122[0...7]).</li> </ul>		
	<ul style="list-style-type: none"> <li>The inverter signals the following: "STO is selected" (r9773.0 = 1). "STO is active" (r9773.1 = 1).</li> </ul>		
4.	<b>Deselect STO</b>		
4.1.	Deselect STO.		
4.2.	Check the following:		
	<ul style="list-style-type: none"> <li>STO is not active (r9773.1 = 0).</li> </ul>		
	<ul style="list-style-type: none"> <li>The inverter signals neither faults nor alarms of the safety functions (r0945[0...7], r2122[0...7]).</li> </ul>		

You have performed the acceptance test of the STO function.



### A.2.2 Acceptance test STO (extended functions)

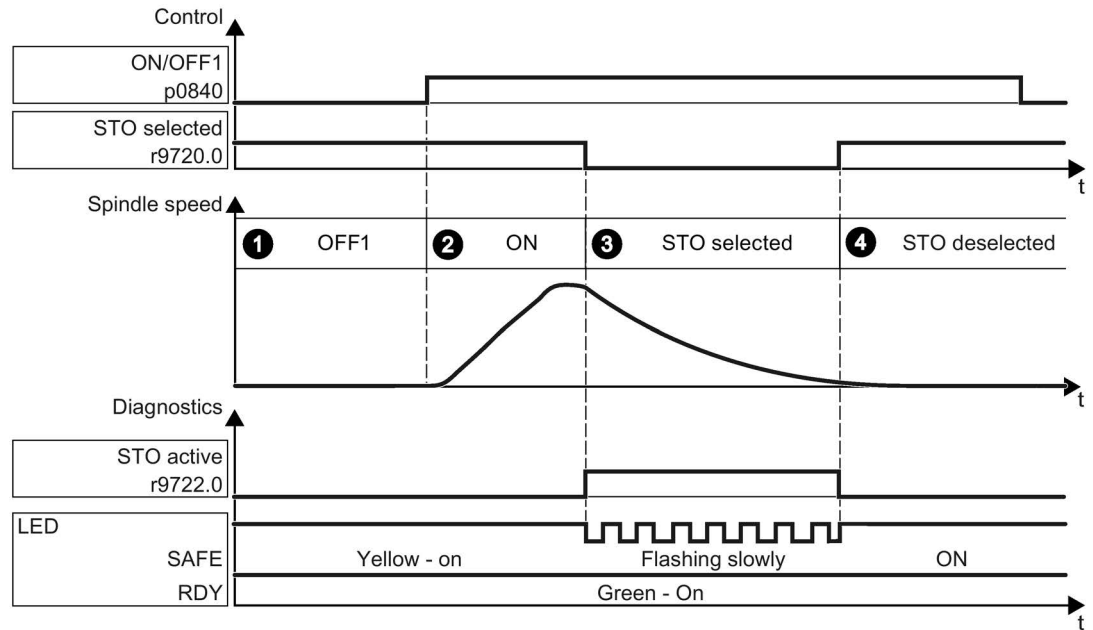


Figure A-2 Acceptance test for STO (Extended functions)

#### Procedure



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

		Status
1.	<b>The inverter is ready</b>	
	<ul style="list-style-type: none"> <li>The inverter signals neither faults nor alarms of the safety functions (r0945[0...7], r2122[0...7]).</li> <li>STO is not active (r9722.0 = 0).</li> </ul>	
2.	<b>Switch on motor</b>	
	2.1. Enter a speed setpoint ≠ 0.	
	2.2. Switch on the motor (ON command).	
3.	<b>Select STO</b>	
	3.1. Select STO while the motor is running.	
	3.2. Check the following:	
	<ul style="list-style-type: none"> <li>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.</li> <li>The inverter signals neither faults nor alarms of the safety functions (r0945[0...7], r2122[0...7]).</li> <li>The inverter signals the following: "STO is active" (r9722.0 = 1).</li> </ul>	

		Status
4.	<b>Deselect STO</b>	
4.1.	Deselect STO.	
4.2.	Check the following:	
	<ul style="list-style-type: none"><li>• STO is not active (r9722.0 = 0).</li></ul>	
	<ul style="list-style-type: none"><li>• The inverter signals neither faults nor alarms of the safety functions (r0945[0...7], r2122[0...7]).</li></ul>	



You have performed the acceptance test of the STO function.

### A.2.3 SS1 acceptance test (basic functions)

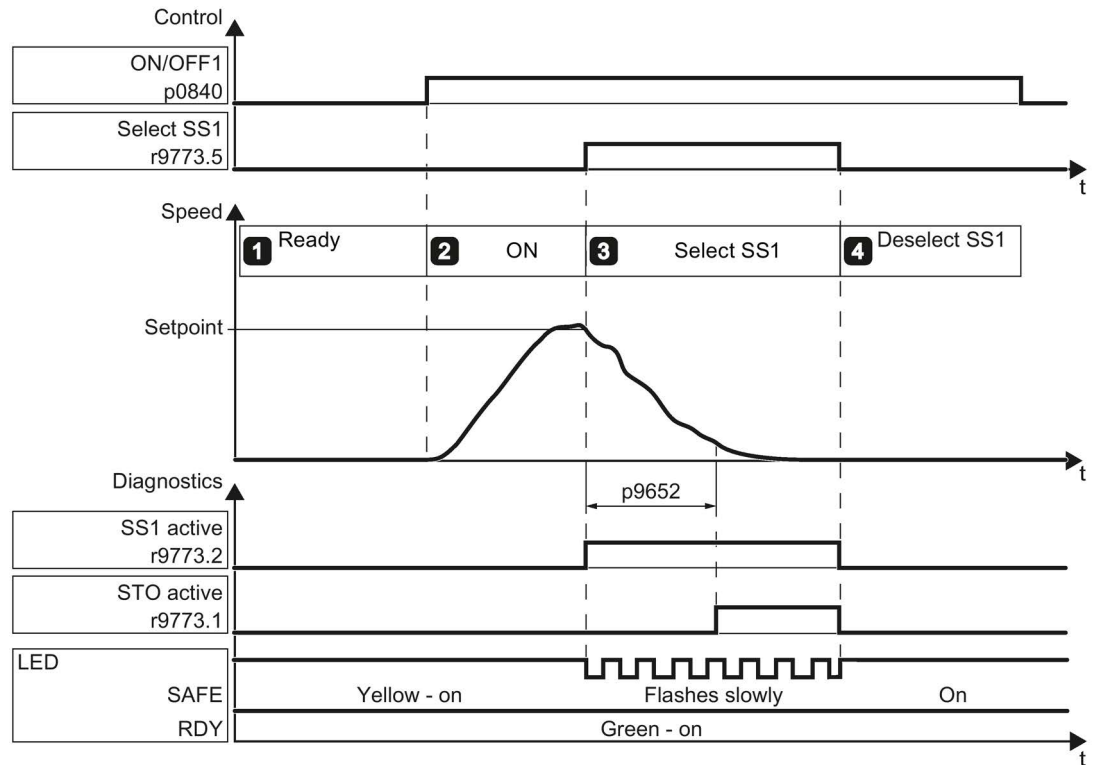


Figure A-3 SS1 acceptance test for basic functions

#### Procedure



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

		Status
1.	<b>The inverter is ready</b>	
	Check the following:	
	<ul style="list-style-type: none"> <li>The inverter signals neither faults nor alarms of the safety functions (r0945[0...7], r2122[0...7]).</li> <li>SS1 is not active (r9773.6 = 0).</li> </ul>	
2.	<b>Switch on motor</b>	
	2.1. Enter a speed setpoint ≠ 0.	
	2.2. Switch on the motor (ON command).	
	2.3. Check that the correct motor is running.	

		Status
3.	<b>Select SS1</b>	
3.1.	Select SS1 while the motor is switched on. <i>Test each configured activation, e.g. via digital inputs and PROFIsafe.</i>	
3.2.	In your machine, check the following:	
	<ul style="list-style-type: none"> <li>The motor brakes on the OFF3 ramp.</li> </ul>	
	<ul style="list-style-type: none"> <li>SS1 is active (r9773.6 = 1).</li> </ul>	
	<ul style="list-style-type: none"> <li>After the p9652 time has expired, the inverter signals: "STO is active" (r9773.1 = 1).</li> </ul>	
4.	<b>Deselect SS1</b>	
4.1.	Deselect SS1.	
4.2.	Check the following:	
	<ul style="list-style-type: none"> <li>SS1 is not active (r9773.6 = 0).</li> </ul>	
	<ul style="list-style-type: none"> <li>The inverter signals neither faults nor alarms of the safety functions (r0945[0...7], r2122[0...7]).</li> </ul>	

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

## A.2.4 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.

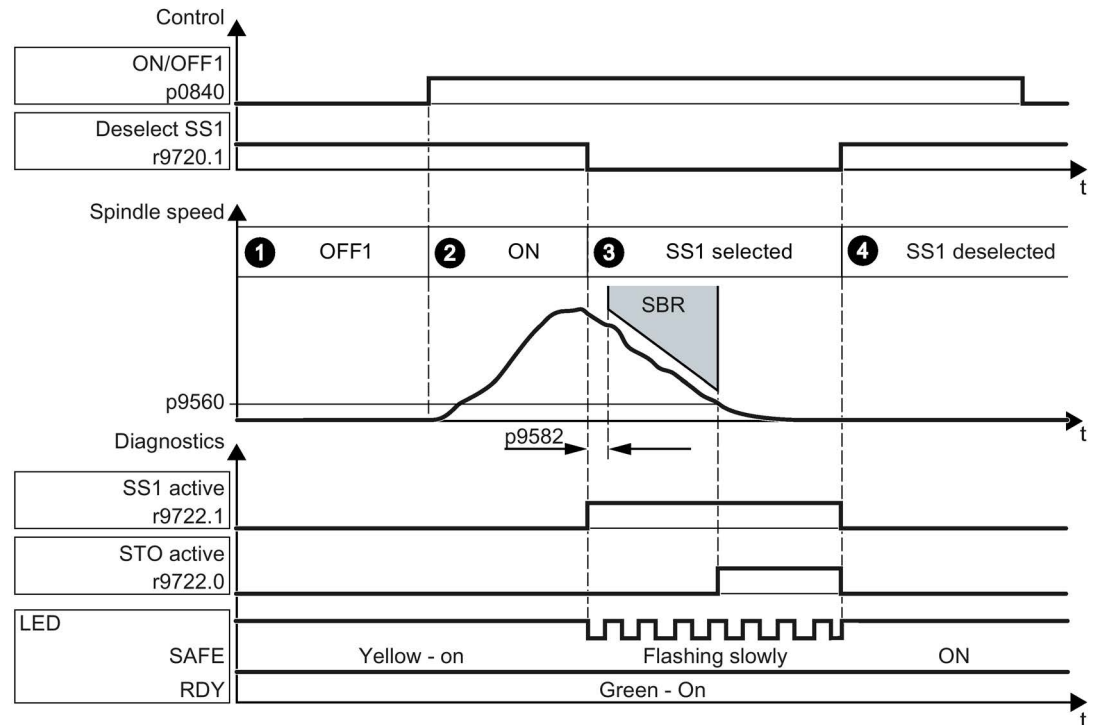


Figure A-4 Diagram 1 - acceptance test SS1 with braking ramp monitoring

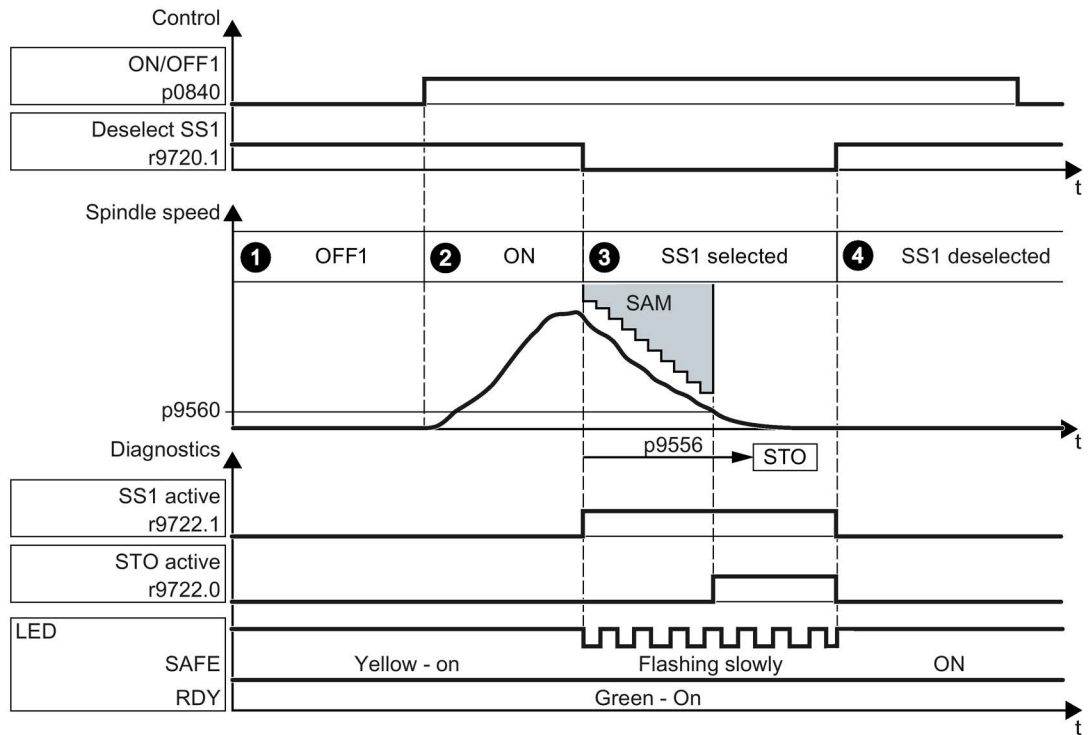


Figure A-5 Diagram 2 - acceptance test for SS1 with acceleration monitoring

**Procedure**



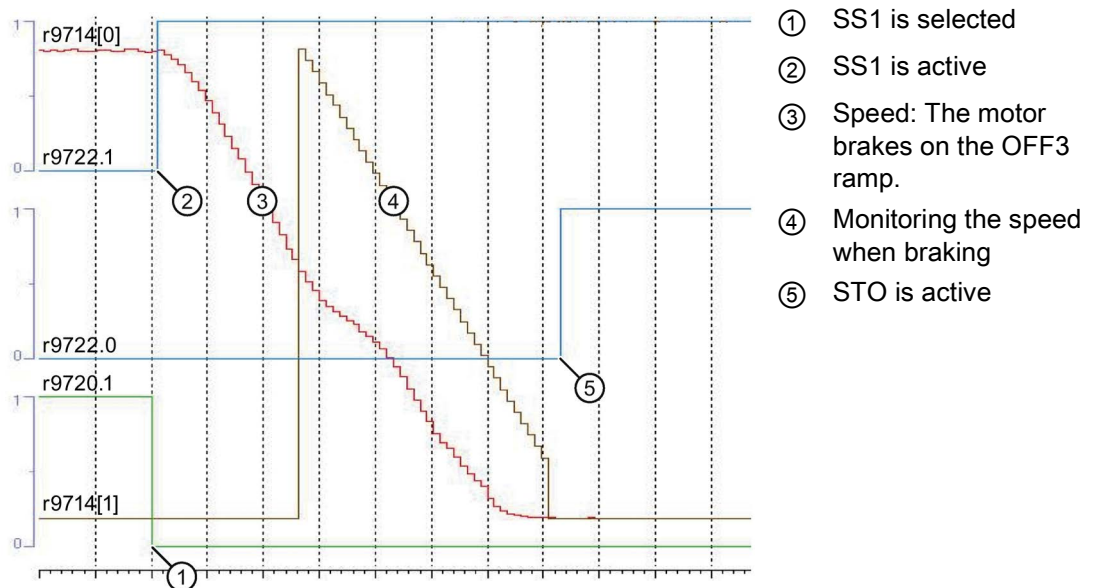
To perform the acceptance test of the SS1 function, proceed as follows:

		Status
1.	<b>The inverter is ready</b>	
	<ul style="list-style-type: none"> <li>The inverter signals neither faults nor alarms of the safety functions (r0945[0...7], r2122[0...7]).</li> <li>SS1 is not active (r9722.1 = 0).</li> </ul>	
	Go online with the STARTER and configure the following trace: <ul style="list-style-type: none"> <li>Trigger on variable - bit pattern (r9720.1 = 0)</li> <li>Record the following values: r9714[0], r9714[1], r9722</li> </ul> Display the bits r9722.0/.1 <ul style="list-style-type: none"> <li>Select the time interval and pretrigger so you can recognize the selection of SS1 and the transition into the subsequent STO state.</li> <li>Start the trace.</li> </ul>	
2.	<b>Switch on motor</b>	
	2.1. Enter a speed setpoint ≠ 0.	
	2.2. Switch on the motor (ON command).	
	2.3. Check that the correct motor is running.	

		Status
3.	<b>Select SS1</b>	
3.1.	Select SS1 while the motor is switched on. <i>Test each configured activation, e.g. via digital inputs and PROFIsafe.</i>	
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.	
	<ul style="list-style-type: none"> <li>SS1 is active after selecting SS1 (r9722.1 = 1).</li> <li>The motor brakes on the OFF3 ramp.</li> <li>STO becomes active if the velocity drops below the shutdown velocity p9560 (r9722.0 = 1).</li> <li>The recorded curves of r9714[0] and r9714[1] are approximately parallel.</li> </ul>	
4.	<b>Deselect SS1</b>	
4.1.	Deselect SS1.	
4.2.	Check the following:	
	<ul style="list-style-type: none"> <li>SS1 is not active (r9722.1 = 0).</li> <li>The inverter signals neither faults nor alarms of the safety functions (r0945[0...7], r2122[0...7]).</li> </ul>	

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

### Example of a trace



### A.2.5 SBC acceptance test

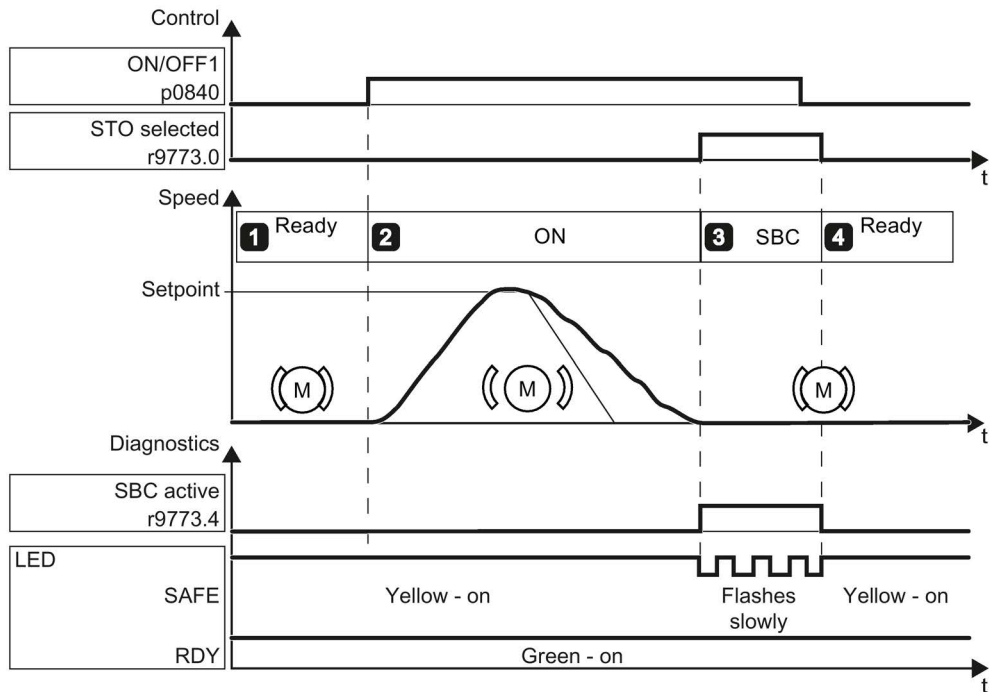


Figure A-6 Acceptance test for SBC

#### Procedure



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

		Status
1.	<b>The inverter is ready</b>	
	<ul style="list-style-type: none"> <li>The inverter signals neither faults nor alarms of the safety functions (r0945[0...7], r2122[0...7]).</li> <li>SBC is not active (r9773.4 = 0).</li> </ul>	
2.	<b>Switch on motor</b>	
	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.	<b>Select SBC</b>	
	3.1. Select the STO function or the SS1 function. 3.2. Check: The inverter signals "SBC is active" (r9773.4 = 1).	



		Status
4.	<b>inverter is ready</b>	
4.1.	Deselect STO.	
4.2.	Check the following:	
	<ul style="list-style-type: none"> <li>The inverter signals "SBC is not active" (r9773.4 = 0).</li> </ul>	
	<ul style="list-style-type: none"> <li>The inverter signals neither faults nor alarms of the safety functions (r0945[0...7], r2122[0...7]).</li> </ul>	

- You have performed the acceptance test of the SBC function.

### A.2.6 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: With a limit value violation, the drive responds with a STOP A.
- Diagram 2: With a limit value violation, the drive responds with a STOP B.

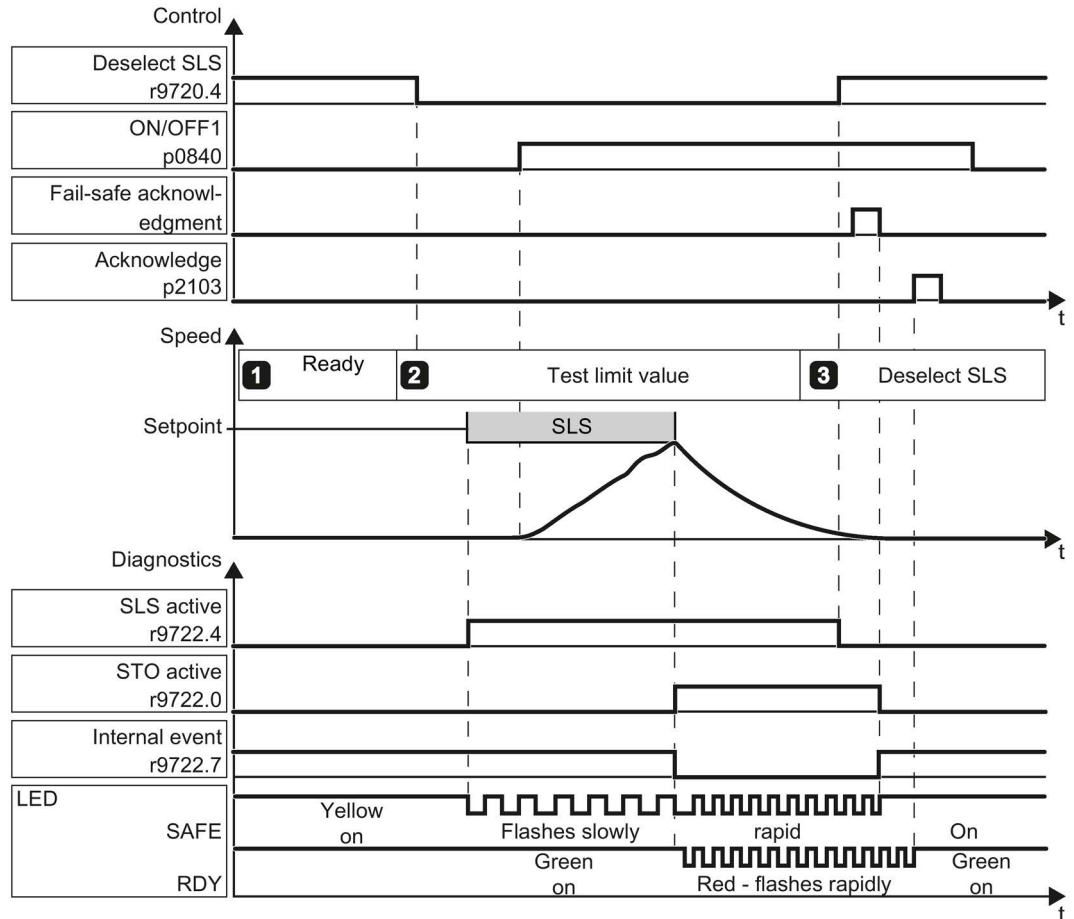


Figure A-7 Diagram 1 - acceptance test for SLS with stop reaction STOP A

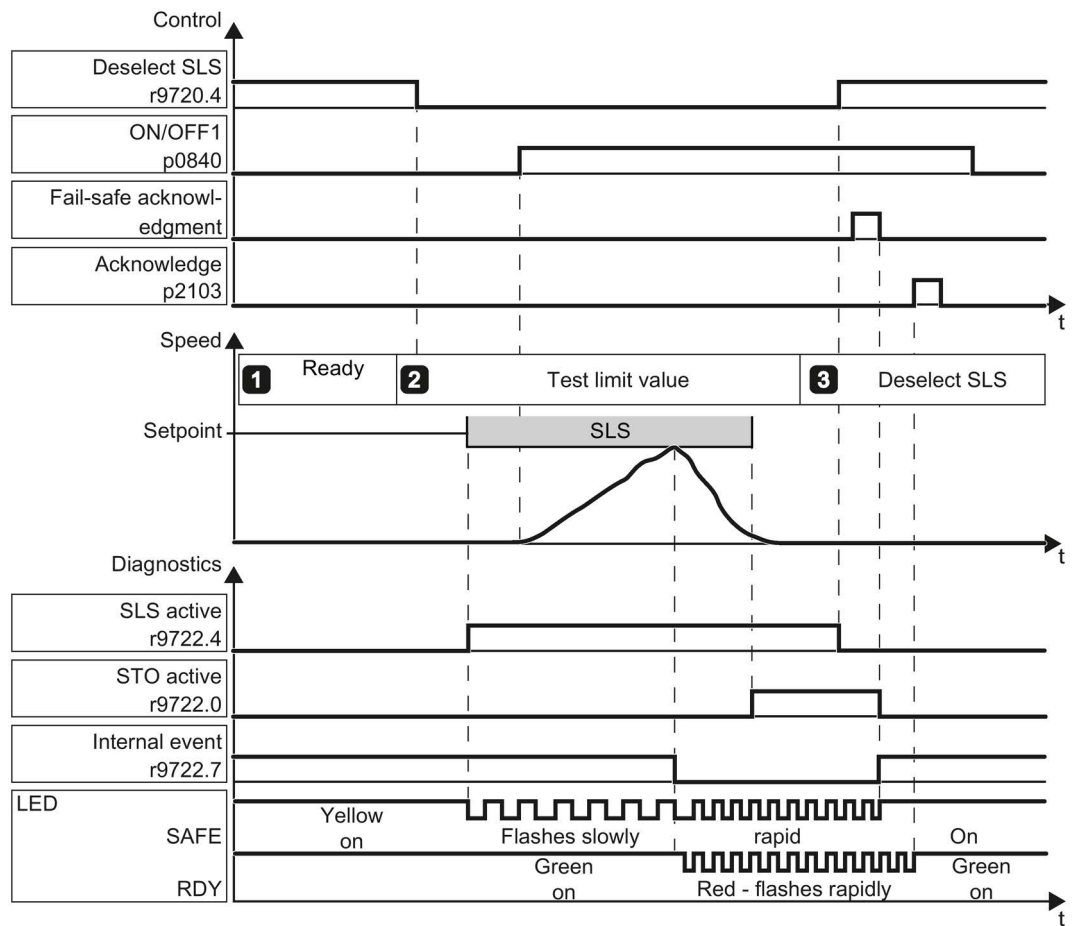
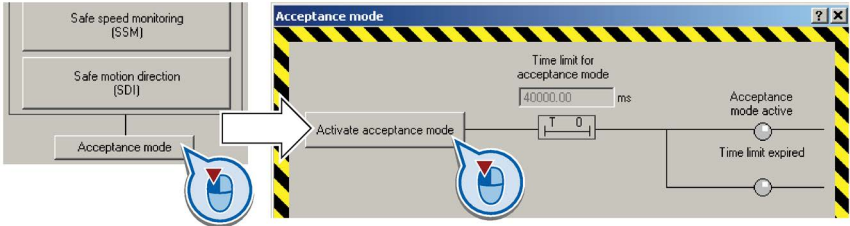
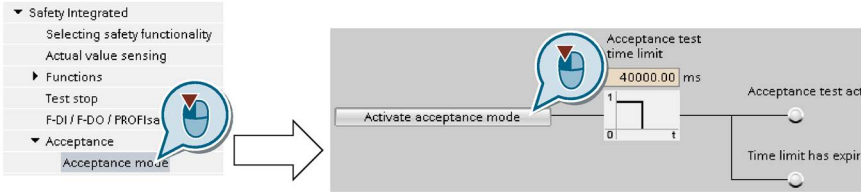


Figure A-8 Diagram 2 - acceptance test SLS with stop reaction STOP B


**Procedure**



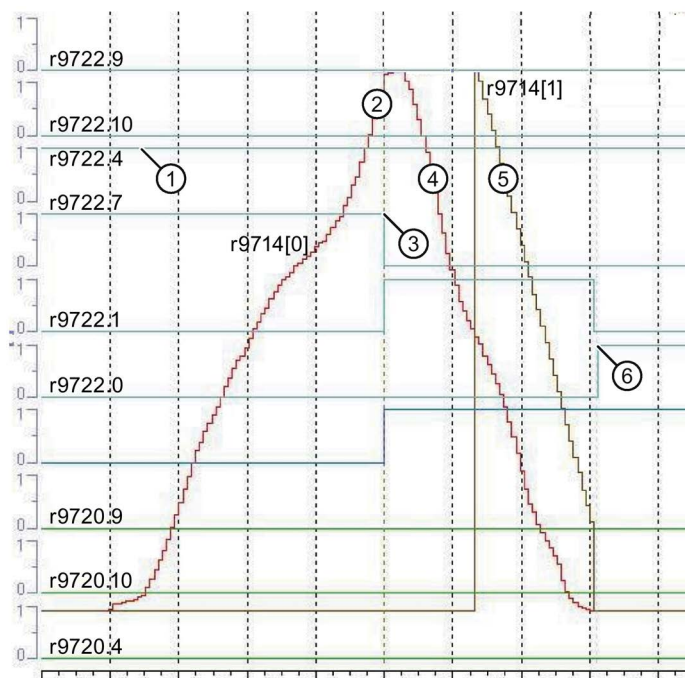
To perform the acceptance test of the SLS function, proceed as follows:

		Status
If you are using multiple SLS levels, repeat the test for each of the SLS levels.		
1.	<p><b>The inverter is ready</b></p> <p>Check the following:</p> <ul style="list-style-type: none"> <li>The inverter signals neither faults nor alarms of the safety functions (r0945[0...7], r2122[0...7]).</li> <li>SLS is not active (r9722.4 = 0).</li> </ul> <p>Go online with the STARTER and configure the following trace:</p> <ul style="list-style-type: none"> <li>Trigger on variable - bit pattern (r9722.7 = 0)</li> <li>Record the following values: r9714[0], r9714[1], r9722</li> </ul> <p>Display the bits r9722.0/.4/.7/.9/.10</p> <ul style="list-style-type: none"> <li>Select the interval and pretrigger so you can recognize when the active SLS limit has been exceeded and the subsequent drive responses.</li> </ul>	
2.	<p><b>Switch on motor</b></p> <p>2.1. Enter a speed setpoint &gt; SLS level.</p> <p>2.2. Select SLS with the SLS level to be tested.</p> <p>2.3. Activate the acceptance mode:</p> <p>In STARTER:</p>  <p>In Startdrive:</p>  <p><b>WARNING</b>  <b>Machine motion hazard</b>                  In the following test, speed limitation of the SLS function is deactivated. The increased motor speed can lead to material damage or physical injury.</p> <ul style="list-style-type: none"> <li>For this test, secure dangerous machine parts using barriers, for example.</li> </ul>	
2.4.	<p>Switch on the motor within 5 seconds after selecting SLS (ON command).</p> <p><i>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.</i></p>	

			Status
2.5.	Check that the correct motor is running.		
	<i>The following tests depend on how you have set the SLS function during commissioning:</i>		
	<i>Diagram 1: The inverter responds with STOP A in the event of a limit violation.</i>	<i>Diagram 2: The inverter responds with STOP B in the event of a limit violation.</i>	
2.6.	The inverter signals the following: <ul style="list-style-type: none"> <li>• C01714 and C30714 (safe velocity limit exceeded)</li> <li>• C01700 and C30700 (STOP A initiated)</li> </ul>	The inverter signals the following: <ul style="list-style-type: none"> <li>• C01714 and C30714 (safe velocity limit exceeded)</li> <li>• C01701 and C30701 (STOP B initiated)</li> <li>• C01700 and C30700 (STOP A initiated)</li> </ul>	
2.7.	Analyze the trace.		
	<ul style="list-style-type: none"> <li>• After SLS is selected, the inverter signals "SLS is active" (r9722.4 = 1).</li> <li>• The inverter signals the selected SLS level (r9722.9 and r9722.10).</li> <li>• If r9714[0] exceeds the active SLS limit, the inverter signals an internal event (r9722.7 = 0).</li> </ul>		
	<i>STOP A in the event of a limit value violation</i>	<i>STOP B in the event of a limit value violation</i>	
	<ul style="list-style-type: none"> <li>• If r9714[0] exceeds the active SLS limit, the motor coasts down to a standstill (r9722.0 = 1).</li> </ul>	<ul style="list-style-type: none"> <li>• If r9714[0] exceeds the active SLS limit, the motor brakes on the OFF3 ramp (r9722.1 = 1).</li> <li>• After braking, STO is active (r9722.0 = 1).</li> </ul>	
3.	<b>Deselect SLS</b>		
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 Speed: The motor accelerates to the active SLS level
- ③ The speed exceeds the active SLS level
- ④ Speed: STOP B is active - the motor brakes on the OFF3 ramp
- ⑤ Monitoring the speed when braking
- ⑥ STO as a consequence of STOP B being active

### A.2.7 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.

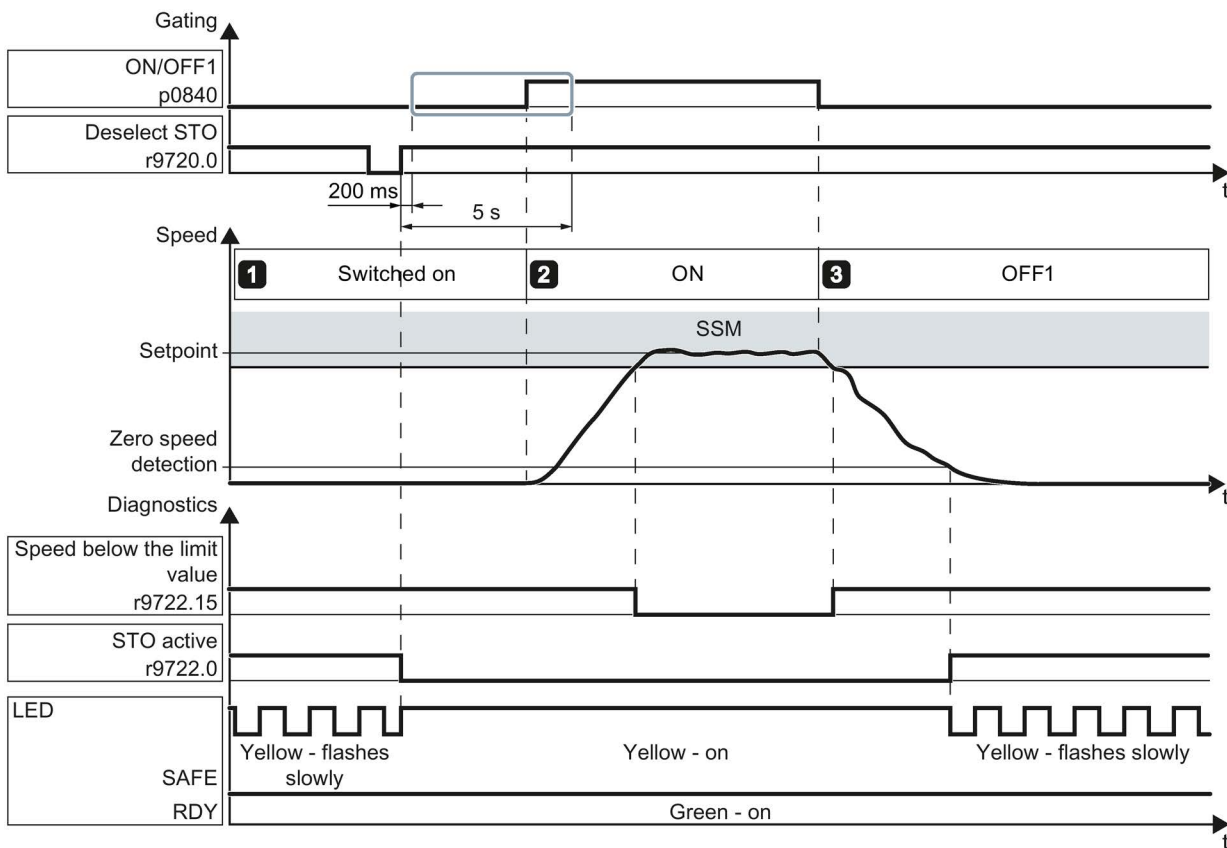


Figure A-9 Diagram 1 - acceptance test SSM with active feedback signal when the motor is switched off

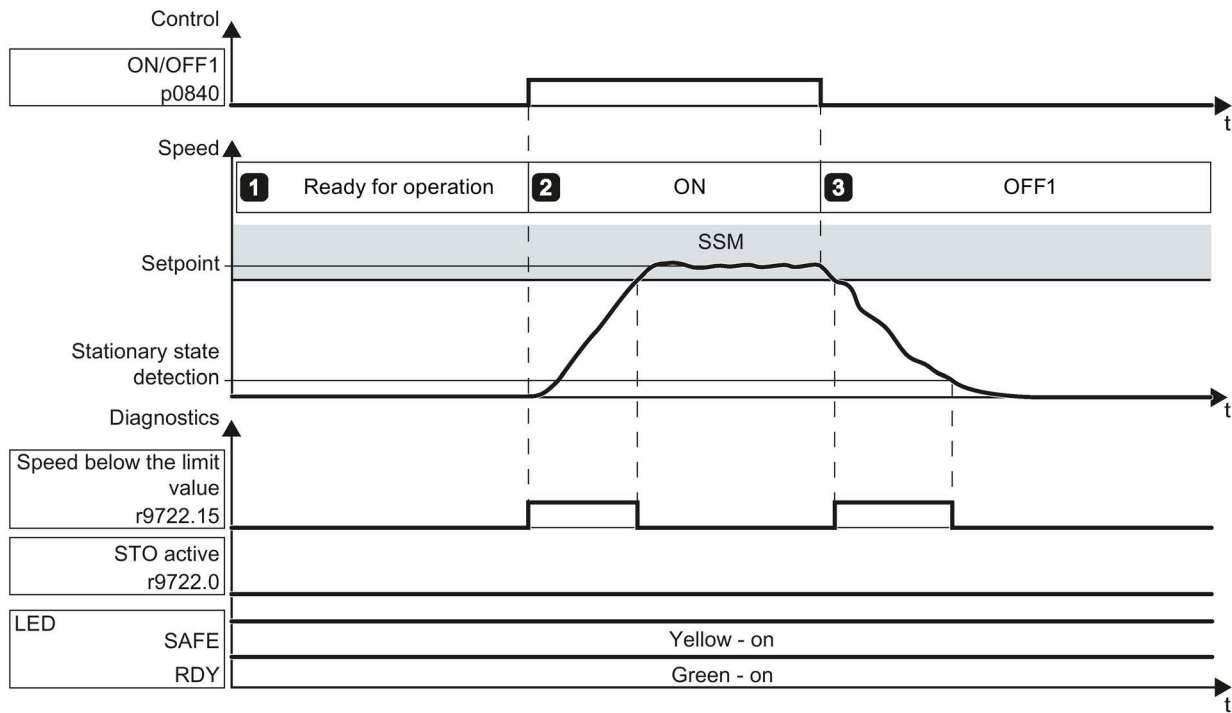


Figure A-10 Diagram 2 - acceptance test SSM with inactive feedback signal when the motor is switched off

**Procedure**



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

		Status
1.	<b>The inverter is ready</b>	
	<ul style="list-style-type: none"> <li>Check: The inverter signals neither faults nor alarms of the safety functions (r0945[0...7], r2122[0...7]).</li> </ul>	
	Go online with the STARTER and configure the following trace: <ul style="list-style-type: none"> <li>Trigger on variable - bit pattern (r9722.15 = 0)</li> <li>Record the following values: r0899, r9714[0], r9722</li> </ul> Display the following bits: <ul style="list-style-type: none"> <li>- r0899.11</li> <li>- r9722.15</li> </ul> <ul style="list-style-type: none"> <li>Select the interval and pretrigger so you can recognize when the level exceeds the SSM limit and subsequently falls below it again.</li> </ul>	



			Status
2.	<b>Switch on motor</b>		
2.1.	Specify a speed setpoint which is above the SSM limit.		
2.2.	<p><i>The following procedure depends on how you have set the SSM function during commissioning:</i></p> <p><i>Diagram 1:</i>  <i>The "speed below limit value" check-back signal remains active when the motor is switched off.</i></p> <p><i>Diagram 2:</i>  <i>The "speed below limit value" check-back signal becomes inactive when the motor is switched off.</i></p>		
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 s of deselecting STO (ON command).		
2.3.	Check that the correct motor is running.		
2.4.	Wait until the motor speed reaches the setpoint.		
3.	<b>Switch off the motor</b>		
3.1.	Switch off the motor (OFF1 command).		
3.2.	Analyze the trace:		
	<ul style="list-style-type: none"> <li>If <math>r9714[0] &gt; \text{velocity limit } p9346</math>, <math>r9722.15 = 0</math> applies.</li> </ul>		
	<p><i>SSM without hysteresis:</i></p> <ul style="list-style-type: none"> <li>If <math>r9714[0] &lt; \text{velocity limit } p9546</math>, <math>r9722.15 = 1</math> applies.</li> </ul>	<p><i>SSM with hysteresis:</i></p> <ul style="list-style-type: none"> <li>If <math>r9714[0] &lt; \text{velocity limit } p9546 - \text{hysteresis } p9547</math>, <math>r9722.15 = 1</math> applies.</li> </ul>	
	<p><i>The "speed below limit value" check-back signal remains active when the motor is switched off:</i></p> <ul style="list-style-type: none"> <li>If the motor is switched off (<math>r0899.11 = 0</math>), then <math>r9722.15 = 1</math> applies.</li> </ul>	<p><i>The "speed below limit value" check-back signal becomes inactive when the motor is switched off:</i></p> <ul style="list-style-type: none"> <li>If the motor is switched off (<math>r0899.11 = 0</math>), then <math>r9722.15 = 0</math> applies.</li> </ul>	



You have completed the acceptance test of the SSM function.

### Example of a trace



- ① Speed: The motor accelerates
- ② Speed above the limit value
- ③ Speed below the limit value

### A.2.8 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. It differs depending on the settings you have made for 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.

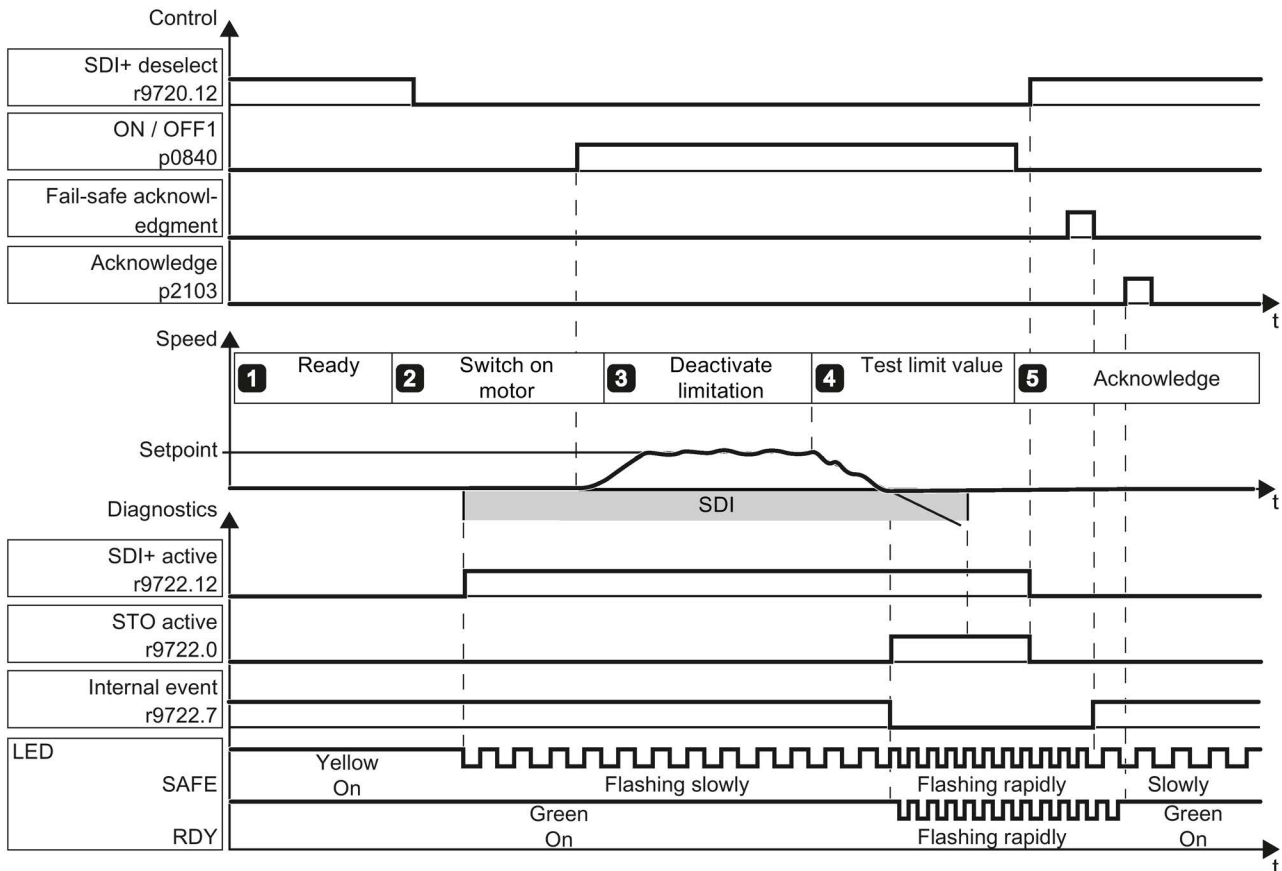


Figure A-11 Diagram 1 - acceptance for SDI+, "SDI active" remains active when the motor is switched off

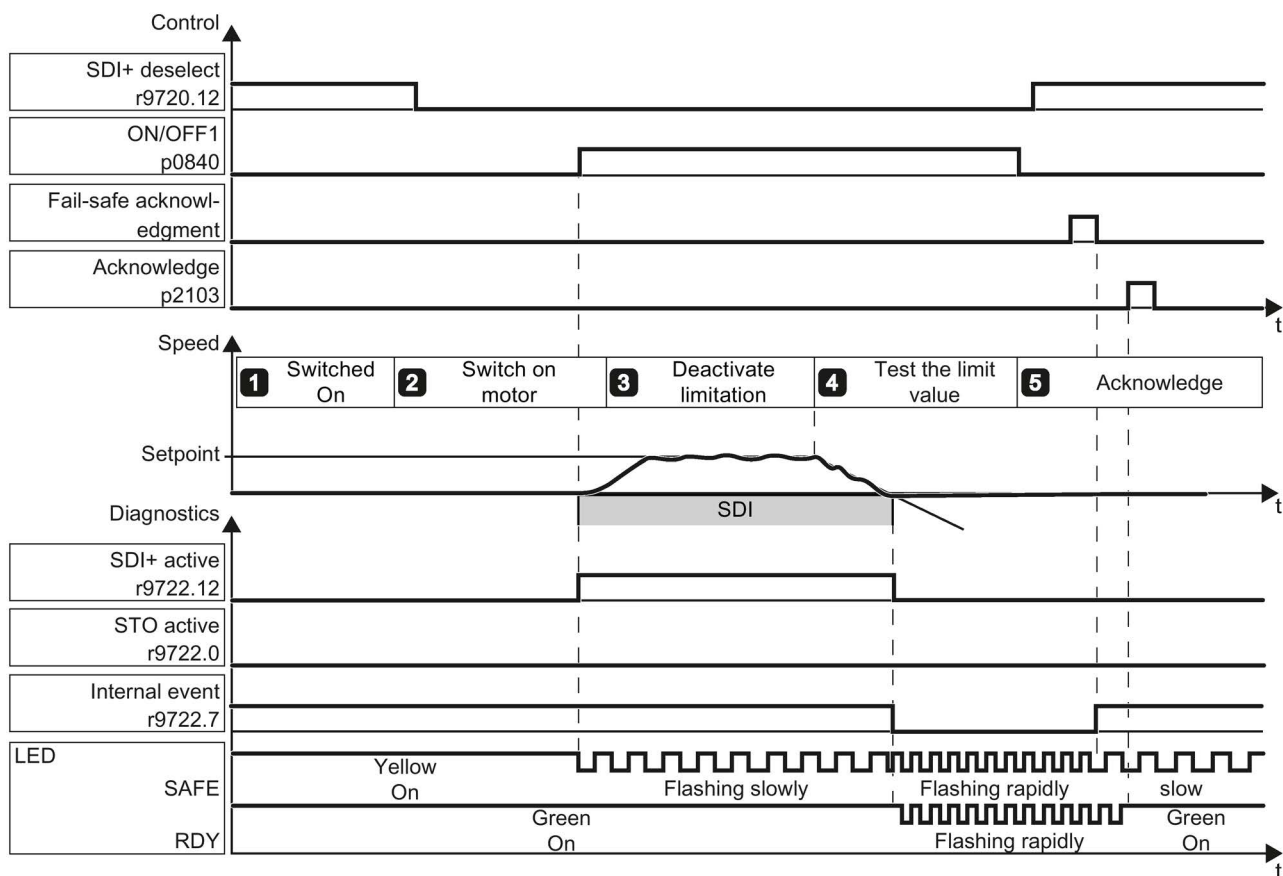
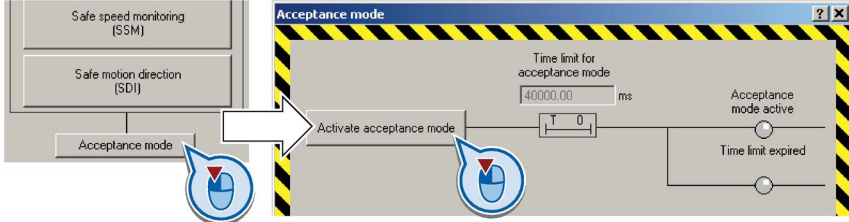



Figure A-12 Diagram 2 - acceptance for SDI+, "SDI active" becomes inactive when the motor is switched off

### Procedure

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

		Status		
1.	<b>The inverter is ready</b>			
	Check the following:			
	<ul style="list-style-type: none"> <li>The inverter signals neither faults nor alarms of the safety functions (r0945[0...7], r2122[0...7]).</li> <li>SDI+ is not active (r9722.12 = 0).</li> </ul>			
	Go online with the STARTER and configure the following trace: <ul style="list-style-type: none"> <li>Trigger on variable - bit pattern (r9722.7 = 0).</li> <li>Record the following values: r9713[0], r9722</li> </ul> Display the bits r9722.0/.1/.7/.12 <ul style="list-style-type: none"> <li>Select the interval and pretrigger so you can recognize when the SDI tolerance has been exceeded and the subsequent drive responses.</li> </ul>			
2.	<b>Switch on motor</b>			
	2.1.		Enter a positive speed setpoint.	
	2.2.		Select SDI+ so that only positive speeds are permitted.	
	2.3.		<i>The next steps depend on how you have set the SDI function during commissioning:</i>	
			<i>Diagram 1:</i> <i>The "SDI active" feedback signal remains active when the motor is switched off.</i>	<i>Diagram 2:</i> <i>The "SDI active" feedback signal becomes inactive when the motor is switched off.</i>
	Switch on motor within 5 seconds after deselecting SDI (ON command). <i>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.</i>	Switch on the motor (ON command).		
2.4.	Check that the correct motor is rotating in the expected direction.			

		Status										
3.	<p><b>Deactivate the setpoint limitation for the acceptance test</b></p> <p>Activate the Acceptance mode: In STARTER:</p>  <p>In Startdrive:</p> 											
4.	<p><b>Test the set limit value</b></p> <p>4.1. Enter a negative speed setpoint.</p> <p>4.2. <i>The following test depends on how you have set the SDI function during commissioning:</i></p> <table border="1"> <thead> <tr> <th><i>STOP A in the event of a limit value violation</i></th> <th><i>STOP B in the event of a limit value violation</i></th> </tr> </thead> <tbody> <tr> <td> <ul style="list-style-type: none"> <li>The inverter signals the following:                             <ul style="list-style-type: none"> <li>C01716 and C30716 (tolerance for safe direction of motion exceeded)</li> <li>C01700 and C30700 (STOP A initiated)</li> </ul> </li> </ul> </td> <td> <ul style="list-style-type: none"> <li>The inverter signals the following:                             <ul style="list-style-type: none"> <li>C01716 and C30716 (tolerance for safe direction of motion exceeded)</li> <li>C01701 and C30701 (STOP B initiated)</li> <li>C01700 and C30700 (STOP A initiated)</li> </ul> </li> </ul> </td> </tr> </tbody> </table> <p>4.3. Analyze the trace:</p> <table border="1"> <tbody> <tr> <td colspan="2"> <ul style="list-style-type: none"> <li>When SDI+ is selected, the inverter signals: SDI+ is active (r9722.12 = 1).</li> <li>If r9713[0] &gt; SDI tolerance, then the inverter signals an internal event (r9722.7 = 0).</li> </ul> </td> </tr> <tr> <th><i>STOP A in the event of a limit value violation</i></th> <th><i>STOP B in the event of a limit value violation</i></th> </tr> <tr> <td> <ul style="list-style-type: none"> <li>The motor coasts down to a standstill (r9722.0 = 1).</li> </ul> </td> <td> <ul style="list-style-type: none"> <li>The inverter brakes the motor on the OFF3 ramp (r9722.1 = 1).</li> <li>After braking, STO is active (r9722.0 = 1).</li> </ul> </td> </tr> </tbody> </table>	<i>STOP A in the event of a limit value violation</i>	<i>STOP B in the event of a limit value violation</i>	<ul style="list-style-type: none"> <li>The inverter signals the following:                             <ul style="list-style-type: none"> <li>C01716 and C30716 (tolerance for safe direction of motion exceeded)</li> <li>C01700 and C30700 (STOP A initiated)</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>The inverter signals the following:                             <ul style="list-style-type: none"> <li>C01716 and C30716 (tolerance for safe direction of motion exceeded)</li> <li>C01701 and C30701 (STOP B initiated)</li> <li>C01700 and C30700 (STOP A initiated)</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>When SDI+ is selected, the inverter signals: SDI+ is active (r9722.12 = 1).</li> <li>If r9713[0] &gt; SDI tolerance, then the inverter signals an internal event (r9722.7 = 0).</li> </ul>		<i>STOP A in the event of a limit value violation</i>	<i>STOP B in the event of a limit value violation</i>	<ul style="list-style-type: none"> <li>The motor coasts down to a standstill (r9722.0 = 1).</li> </ul>	<ul style="list-style-type: none"> <li>The inverter brakes the motor on the OFF3 ramp (r9722.1 = 1).</li> <li>After braking, STO is active (r9722.0 = 1).</li> </ul>	
<i>STOP A in the event of a limit value violation</i>	<i>STOP B in the event of a limit value violation</i>											
<ul style="list-style-type: none"> <li>The inverter signals the following:                             <ul style="list-style-type: none"> <li>C01716 and C30716 (tolerance for safe direction of motion exceeded)</li> <li>C01700 and C30700 (STOP A initiated)</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>The inverter signals the following:                             <ul style="list-style-type: none"> <li>C01716 and C30716 (tolerance for safe direction of motion exceeded)</li> <li>C01701 and C30701 (STOP B initiated)</li> <li>C01700 and C30700 (STOP A initiated)</li> </ul> </li> </ul>											
<ul style="list-style-type: none"> <li>When SDI+ is selected, the inverter signals: SDI+ is active (r9722.12 = 1).</li> <li>If r9713[0] &gt; SDI tolerance, then the inverter signals an internal event (r9722.7 = 0).</li> </ul>												
<i>STOP A in the event of a limit value violation</i>	<i>STOP B in the event of a limit value violation</i>											
<ul style="list-style-type: none"> <li>The motor coasts down to a standstill (r9722.0 = 1).</li> </ul>	<ul style="list-style-type: none"> <li>The inverter brakes the motor on the OFF3 ramp (r9722.1 = 1).</li> <li>After braking, STO is active (r9722.0 = 1).</li> </ul>											

		Status
5.	<b>Acknowledge fault</b>	
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. It differs depending on the settings you have made for 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.

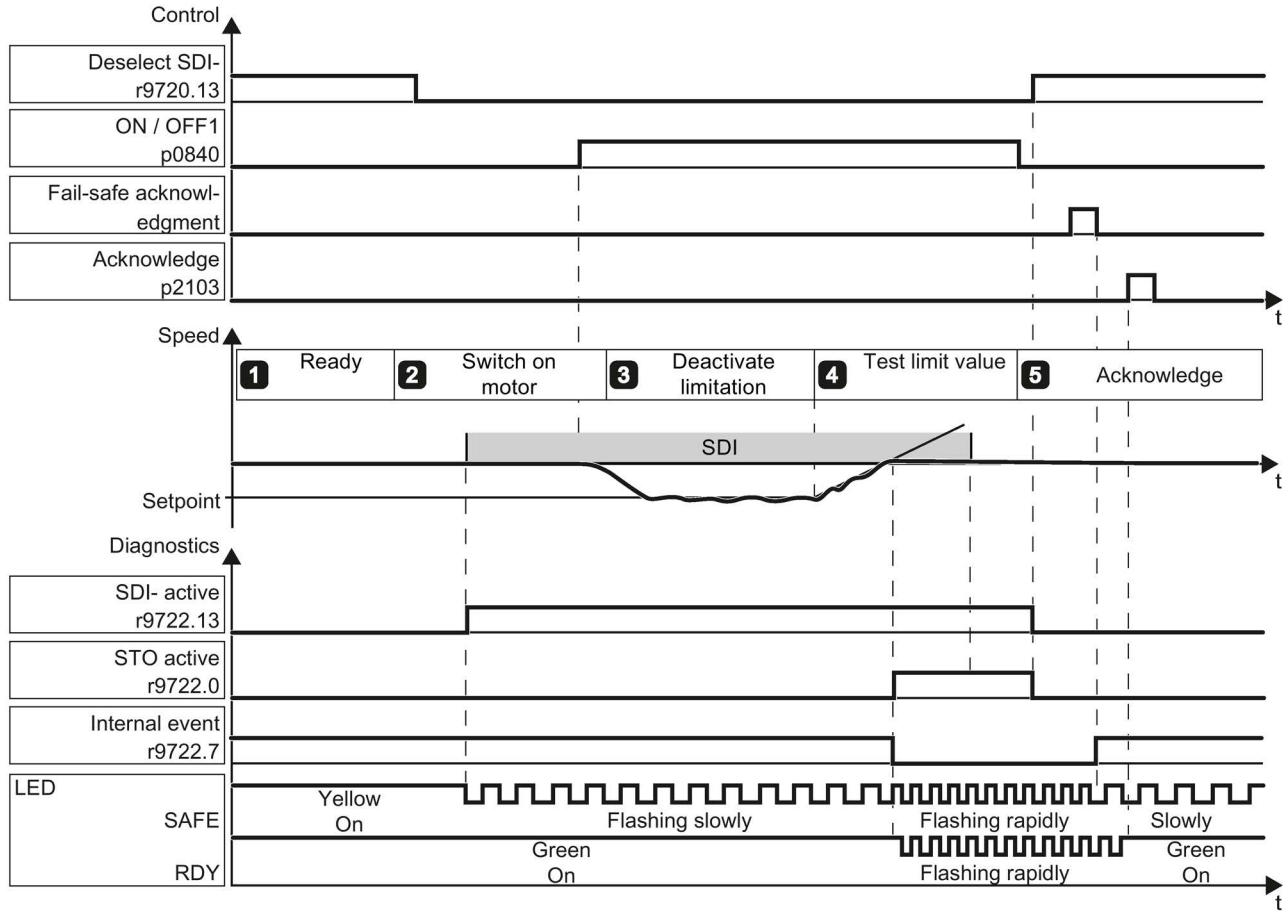


Figure A-13 Diagram 1 - acceptance for SDI-, "SDI active" remains active when the motor is switched off



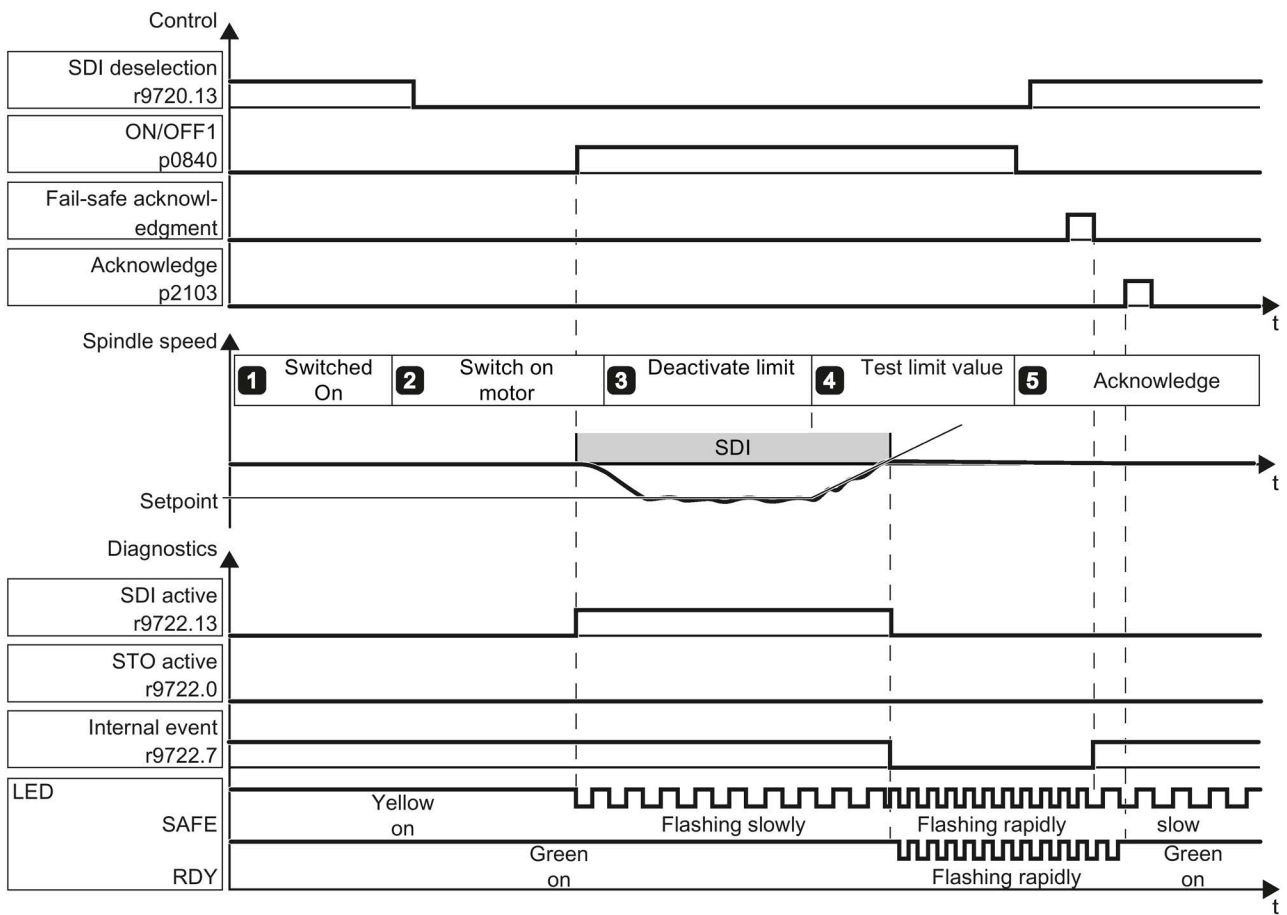


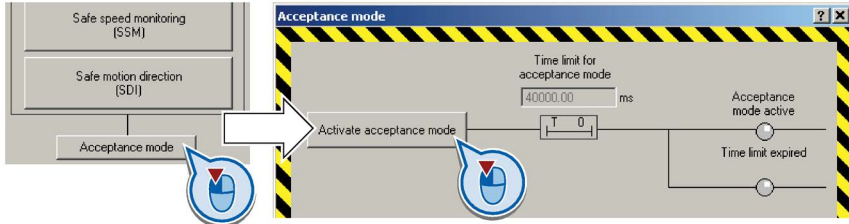

Figure A-14 Diagram 2 - acceptance for SDI-, "SDI active" becomes inactive when the motor is switched off

**Procedure**



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

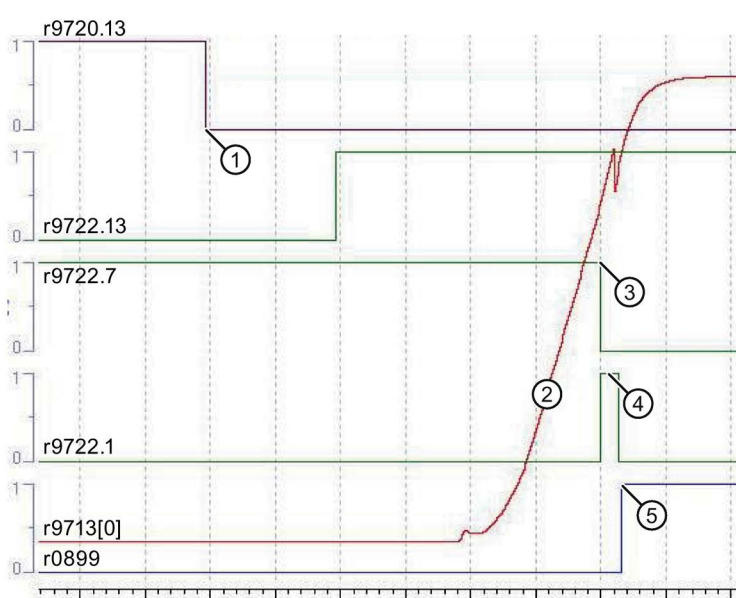
		Status	
1.	<b>The inverter is ready</b>		
	Check the following:		
	<ul style="list-style-type: none"> <li>• SDI- is not active (r9722.13 = 0).</li> </ul>		
	<ul style="list-style-type: none"> <li>• The inverter signals neither faults nor alarms of the safety functions (r0945[0...7], r2122[0...7]).</li> </ul>		
Go online with the STARTER and configure the following trace: <ul style="list-style-type: none"> <li>• Trigger on variable - bit pattern (r9722.7 = 0).</li> <li>• Record the following values: r9713[0], r9722</li> </ul> Display the bits r9722.0/.1/.7/.13 <ul style="list-style-type: none"> <li>• Select the interval and pretrigger so you can recognize when the SDI tolerance has been exceeded and the subsequent drive responses.</li> </ul>			
2.	<b>Switch on motor</b>		
	2.1.	Enter a negative speed setpoint.	
	2.2.	Select SDI- so that only negative speeds are permitted.	
	2.3.	<i>The next steps depend on what settings you made for SDI during commissioning:</i>	
		<i>Diagram 1:</i> The "SDI active" feedback signal remains active when the motor is switched off.	<i>Diagram 2:</i> The "SDI active" feedback signal becomes inactive when the motor is switched off.
		Switch on motor within 5 seconds after deselecting SDI (ON command). <i>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.</i>	Switch on the motor (ON command).
2.4.	Check that the correct motor is rotating in the expected direction.		

		Status																							
3.	<p><b>Deactivate the setpoint limitation for the acceptance test</b></p> <p>Activate the Acceptance mode:</p> <p>In STARTER:</p>  <p>In Startdrive:</p> 																								
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			Status
5.	<b>Acknowledge fault</b>		
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 Position actual value: The motor starts to rotate
- ③ The position actual value of the drive deviates from the permissible tolerance
- ④ STOP B is active - the motor brakes on the OFF3 ramp
- ⑤ STO as a consequence of STOP B being active

### A.2.9 Acceptance test for F-DI status in PROFIsafe telegram 900

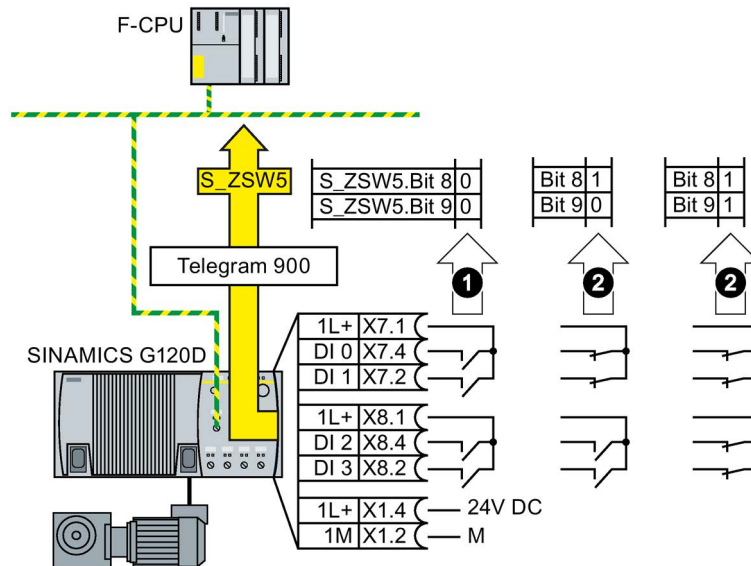


Figure A-15 Acceptance test for the status of the safety-related inputs using the example of a SINAMICS G120D

#### Procedure



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

		Status
-	<b>The inverter is ready</b> <ul style="list-style-type: none"> <li>The inverter signals neither faults nor alarms of the safety functions (r0945[0...7], r2122[0...7]).</li> </ul>	
1.	<b>Check the "Low" status of the safety-related input</b>	
1.1.	Switch the signal of the safety-related input to be tested to low.	
1.2.	In the F-CPU, check whether in status word S_ZSW5 the corresponding bit has the value 0.	
2.	<b>Check the "High" status of the safety-related input</b>	
2.1.	Switch the signal of the safety-related input to be tested to high.	
2.2.	In the F-CPU, check whether in status word S_ZSW5 the corresponding bit has the value 1.	

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

## A.3 Documentation for acceptance

### A.3.1 Creating logs with the settings of the safety functions

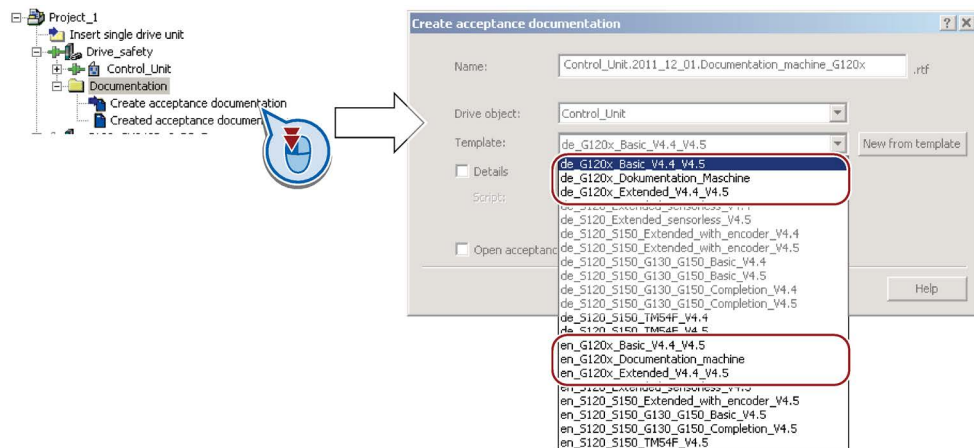
STARTER creates a log of the settings of the safety functions, which you can use for your machine documentation.

#### Procedure



1 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 document

en\_G120x\_Dokumentation\_machine: English document

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

de\_G120x\_Basic\_V4.4...: German report

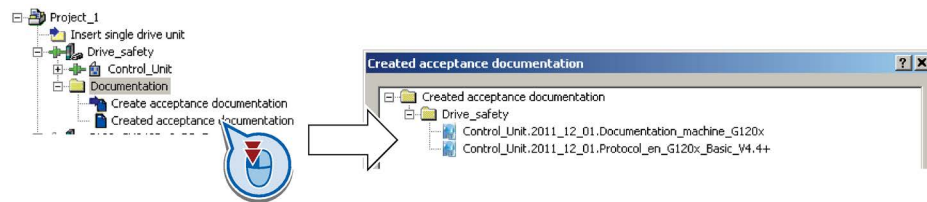
en\_G120x\_Basic\_V4.4...: English report

– 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.

You can find the logs and the machine documentation in the following sections.

### A.3.2 Example of machine documentation

#### Machine or system description

Designation	...
Type	...
Serial number	...
Manufacturer	...
End user	...
<b>Block diagram of the machine and/or plant:</b> ... ... ... ... ... ...	

#### Inverter data

Table A- 1 Hardware version of the safety-related inverter

Labeling the drive	Article number and hardware version of the inverter
...	...
...	...

#### Function table

Table A- 2 Active safety functions depending on the operating mode and safety equipment

Operating mode	Safety equipment	Drive	Selected safety function	Checked
...	...	...	...	
...	...	...	...	
<i>Example:</i>				
<i>Production</i>	<i>Protective door closed</i>	<i>Conveyor belt</i>	---	---
	<i>Protective door open</i>	<i>Conveyor belt</i>	<i>SS1 (braking in 2 seconds)</i>	
	<i>Emergency Stop button pressed</i>	<i>Conveyor belt</i>	<i>STO</i>	
<i>Setting up</i>	<i>Protective door closed</i>	<i>Conveyor belt</i>	---	---
	<i>Protective door open</i>	<i>Conveyor belt</i>	<i>SLS level 1 (300 rpm)</i>	
	<i>Emergency Stop button pressed</i>	<i>Conveyor belt</i>	<i>STO</i>	



**Logging the settings**

<b>File name of the log:</b>	
...	
...	

**Data backup**

Data	Storage medium			Holding area
	Archiving type	Designation	Date	
Log of the settings	...	...	...	...
Acceptance tests	...	...	...	...
STARTER traces	...	...	...	...
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.3.3 Log of the settings for the basic functions, firmware V4.4 ... V4.7 SP2

Drive = <pDO-NAME\_v>

Table A- 3 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- 4 Monitoring cycle

Name	Number	Value
SI monitoring clock cycle (processor 1)	r9780	<r9780_v>

Table A- 5 Checksums

Name	Number	Value
SI module identifier, Control Unit	r9670	<r9670_v>
SI module identifier, Power Module	r9672	<r9672_v>
SI reference checksum SI parameters (processor 1)	p9799	<p9799_v>
SI reference checksum SI parameters (processor 2)	p9899	<p9899_v>

Table A- 6 Settings of the safety functions

Name	Number	Value
SI enable, functions integrated in the drive	p9601	<p9601_v>
<i>Only for the CU250S-2 Control Unit</i>   SI enable safe brake control	p9602	<p9602_v>
SI PROFIsafe address	p9610	<p9610_v>
F-DI switch over discrepancy time	p9650	<p9650_v>
SI STO debounce time	p9651	<p9651_v>
<i>Only for the CU250S-2 Control Unit</i>   SI Safe Stop 1 delay time	p9652	<p9652_v>
SI forced dormant error detection timer	p9659	<p9659_v>
SI forced checking procedure STO via PM terminals time	p9661	<p9661_v>

Table A- 7 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.3.4 Report of the settings for the extended functions, firmware V4.4 ... V4.7 SP2

Drive = <pDO-NAME\_v>

Table A- 8 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- 9 Monitoring cycle

Name	Number	Value
SI monitoring clock cycle	r9780	<r9780_v>

Table A- 10 Checksums

Name	Number	Value
SI Motion reference checksum SI parameters (processor 2)	p9399[0]	<p9399[0]_v>
	p9399[1]	<p9399[1]_v>
SI module identifier, Control Unit	r9670	<r9670_v>
SI module identifier, Power Module	r9672	<r9672_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- 11 Safety functions

Name	Number	Value
SI Motion enable safety 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>

Name		Number	Value
SI Motion SSM filter time		p9545	<p9545_v>
SI Motion SSM speed limit		p9546	<p9546_v>
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 checking procedure 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>
<i>From firmware V4.5</i>	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>
<i>Only for the CU250S-2 Control Unit</i>	Enable safe brake control	p9602	<p9602_v>
SI PROFIsafe address		p9610	<p9610_v>
F-DI switchover discrepancy time		p9650	<p9650_v>
SI STO debounce time		p9651	<p9651_v>
<i>Only for the CU250S-2 Control Unit</i>	Safe Stop 1 delay time	p9652	<p9652_v>
SI forced checking procedure timer		p9659	<p9659_v>
SI forced checking procedure STO via PM terminals time		p9661	<p9661_v>
F-DI switchover discrepancy 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>

Name	Number	Value
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 transfer F-DI	p10050	<p10050_v>

Table A- 12 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 checking procedure timer	p10003	<p10003_v>
SI forced checking procedure 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- 13 Safety logbook

Name	Number	Value
SI change control checksum	r9781[0]	<r9781[0]_v>
SI change control checksum	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.4 Standards and specifications

### A.4.1 General information

#### A.4.1.1 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. For this purpose, companies describe in the various standards the current state of the art covering all aspects relevant to safety. If it can be justifiably assumed that all of the relevant standards are complied with, this ensures that state-of-the-art technology has been utilized and, in turn, a plant builder 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 based on internationally harmonized rules and regulations. This is also intended to avoid competitive advantages or disadvantages 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.4.1.2 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 implement functional safety are based on the following basic goals:

- Avoiding 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 avoiding systematic faults. This is expressed in the standards using specific classification. In IEC/EN 61508, IEC/EN 62061 "Safety Integrity Level" (SIL) and EN ISO 13849-1 "Category" and "Performance Level" (PL).

## A.4.2 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.4.2.1 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.4.2.2 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 (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.4.2.3 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 safety functions failing in a dangerous fashion is sufficiently minimized. EN ISO 13849-1 (formerly EN 954-1) and 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.

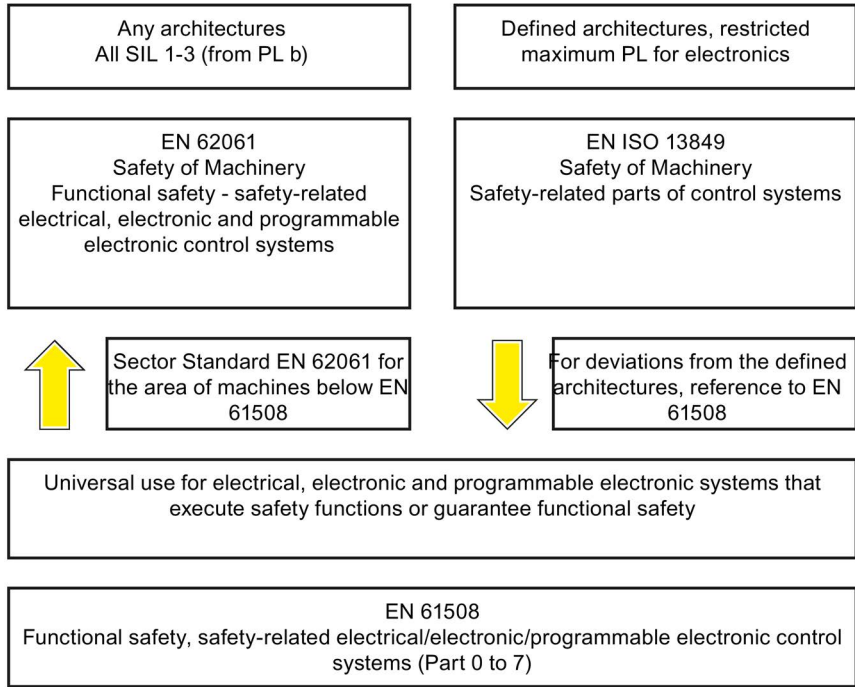


Figure A-16 Standards for implementing safety-related controllers

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
<p>"X" indicates that the point is covered by this standard.</p> <p>Comment 1: Designated architectures are described in Annex B of EN ISO 13849-1 and provide a simplified basis for the quantification.</p> <p>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.</p> <p>Comment 3: For non-electrical systems: Use components that comply with EN ISO 13849-1 as sub-systems.</p>			

#### A.4.2.4 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. For deviations from this, DIN EN ISO 13849-1 refers to IEC 61508.

When combining several safety-related parts to form a complete system, the standard explains how to determine the resulting PL.

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**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.

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#### A.4.2.5 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 IEC 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<sub>D</sub>:  
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<sub>D</sub> value of the sub-system.

Safety-related characteristic quantities for subsystem elements (devices):

- $\lambda$ :  
Failure rate
  
- B10 value: For elements that are subject to wear
  
- T1:  
Lifetime

For electromechanical devices, a manufacturer specifies a failure rate  $\lambda$  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
  
- $\beta$ :  
Susceptibility to common cause failure
  
- DC:  
Diagnostic coverage

The PFH<sub>D</sub> value of the safety-related controller is determined by adding the individual PFH<sub>D</sub> 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 IEC 61508 or IEC 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. DIN EN ISO 13849-1 must be applied for non-electric systems.

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**Note****Function examples**

Details of simple sub-systems that have been implemented and integrated are now available as "functional examples".

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**Note****EN 62061 and machinery directive**

IEC 62061 has been ratified as EN 62061 in Europe and harmonized as part of the Machinery Directive.

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**A.4.2.6 Series of standards IEC 61508 (VDE 0803)**

This series of standards describes the current state of the art.

IEC 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 IEC 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 particular case, the manufacturer may use IEC 61508, although no presumption of conformity exists here.
- A harmonized European standard (e.g. EN 62061, EN ISO 13849, EN 60204-1) references IEC 61508. This ensures that the appropriate requirements of the directives are fulfilled ("standard that is also applicable"). When manufacturers apply IEC 61508 properly and responsibly in accordance with this reference, they can use the presumption of conformity of the referencing standard.

IEC 61508 covers all the aspects that must be taken into account when E/E/PES systems (electrical, electronic, and programmable electronic system) 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 not part of the standard, similar to DIN ISO 13849.

IEC 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 IEC 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.4.2.7 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 "Safety of Machinery - General Design Principles - Risk Assessment and Minimizing Risks"
- EN ISO 13849-1 (successor to EN 954-1) "Safety-related parts of control systems"

EN ISO 12100 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)
  - Identification of hazards (EN ISO 12100)
  - 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.

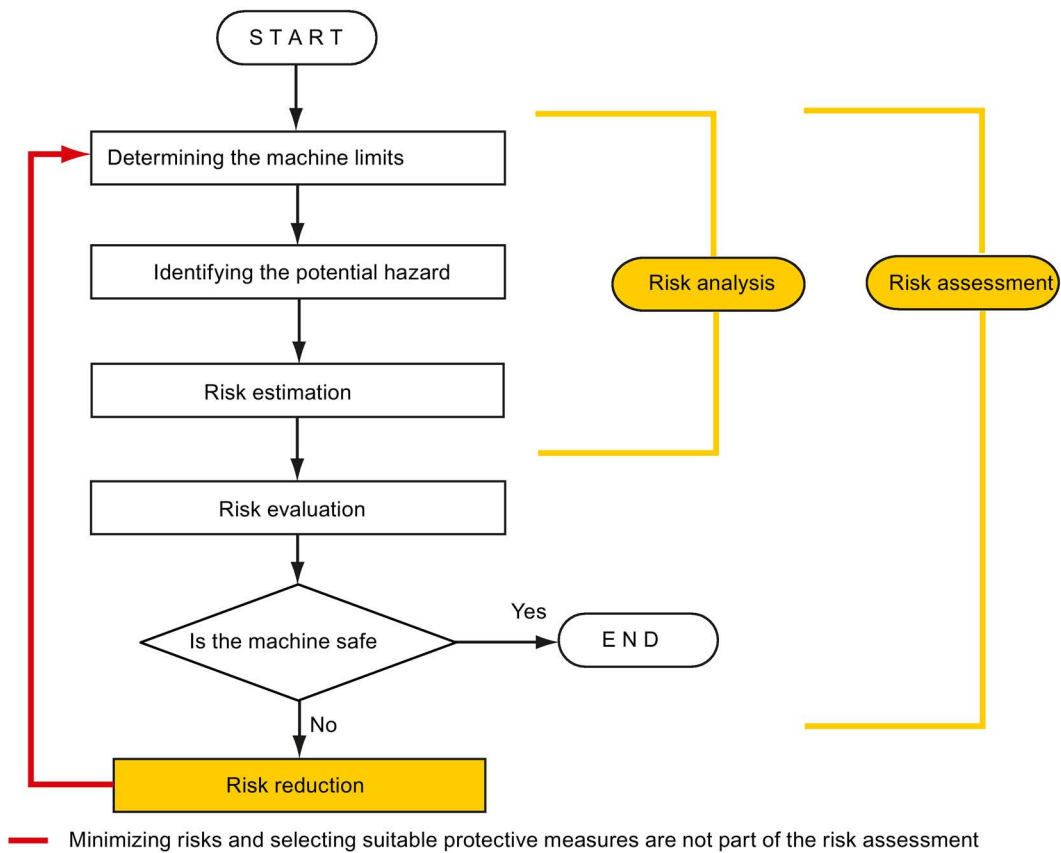


Figure A-17 Iterative process for achieving safety

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 control systems, EN 62061 can be applied instead of EN ISO 13849-1. Electronic controllers and bus systems must also comply with IEC 61508.

### A.4.2.8 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.4.2.9 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).

### A.4.3 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.4.3.1 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.4.3.2 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.4.3.3 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). Just the same as 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) Initiate that the system switches 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> → Online 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.4.3.4 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.4.4 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- 14 Japanese standards

ISO/IEC number	JIS number	Comment
ISO12100 (EN 1050)	JIS B 9700, JIS B 9702	earlier designation TR B 0008 and TR B 0009
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.4.5 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.4.6 Other safety-related issues

### A.4.6.1 Additional references

- Safety Integrated, The Safety Program for Industries of the World (5th Edition and Supplement), Article No. 6ZB5 000-0AA01-0BA1
- Safety Integrated - Terms and Standards - Machine Safety Terminology (Edition 04/2007), Article No. E86060-T1813-A101-A1

### A.4.6.2 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.

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#### Note

These publications are in German. In some instances, they are also available in English and French.

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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):

Employer's Liability Insurance Association ([www.bghm.de](http://www.bghm.de))

First select the area "Arbeitsschützer", followed by the menu item "Praxishilfen" and finally "DGUV-Informationen".

## A.5 Manuals and technical support

### A.5.1 Manuals for your inverter

Table A- 15 Manuals for your inverter

Information depth	Manual	Contents	Available languages	Download or article number
++	<b>Compact operating instructions or Getting Started</b> for the following inverters: <ul style="list-style-type: none"> <li>• SINAMICS G120 with Control Units CU230P-2; CU240B-2; CU240E-2</li> <li>• SINAMICS G120 with CU250S-2 Control Unit</li> <li>• SINAMICS G120C</li> <li>• SINAMICS G120D</li> <li>• SINAMICS G110M</li> </ul>	Install the inverter and rotate the motor.	English, German, Italian, French, Spanish, Chinese	Download manuals ( <a href="http://support.automation.siemens.com/WW/view/en/22339653/133300">http://support.automation.siemens.com/WW/view/en/22339653/133300</a> ) <b>SINAMICS Manual Collection</b> Documentation on DVD, Article number 6SL3097-4CA00-0YG0
+++	<b>Operating instructions</b> for the following inverters: <ul style="list-style-type: none"> <li>• SINAMICS G120 with the Control Units CU240B-2; CU240E-2</li> <li>• SINAMICS G120 with the Control Unit CU250S-2</li> <li>• SINAMICS G120C</li> <li>• SINAMICS G120D with the Control Unit CU240D-2</li> <li>• SINAMICS G120D with the Control Unit CU250D-2</li> <li>• SINAMICS G110M</li> <li>• SIMATIC ET 200pro FC-2</li> </ul>	Installing, commissioning and maintaining the inverter.		
+++	<b>Function Manual for Safety Integrated</b>	(this manual)	English, German, Chinese	
+++	<b>Fieldbus Function Manual</b> for the SINAMICS G120, G120C and G120D inverters	Configuring fieldbuses.		

Information depth	Manual	Contents	Available languages	Download or article number
+++	<b>List Manual</b> for the following inverters: <ul style="list-style-type: none"> <li>• SINAMICS G120 with the Control Units CU240B-2; CU240E-2</li> <li>• SINAMICS G120 with the Control Unit CU250S-2</li> <li>• SINAMICS G120C</li> <li>• SINAMICS G120D with the Control Units CU240D-2, CU250D-2</li> <li>• SINAMICS G110M</li> <li>• SIMATIC ET 200pro FC-2</li> </ul>	Complete list of all parameters, alarms and faults. Graphic function diagrams.		
+	<b>Getting Started Guide</b> for the following SINAMICS G120 Power Modules: <ul style="list-style-type: none"> <li>• PM240, PM250 and PM260</li> <li>• PM240-2</li> </ul>	Installing the Power Module	English	
+	<b>Installation Instructions</b> for reactors, filters and braking resistors	Installing components		
+++	<b>Hardware Installation Manual</b> for the following SINAMICS G120 Power Modules: <ul style="list-style-type: none"> <li>• PM240</li> <li>• PM240-2</li> <li>• PM250</li> <li>• PM260</li> </ul>	Installing power modules, reactors and filters. Maintaining power modules.	English, German	
+++	<b>Operating Instructions</b> for the following Operator Panels: <ul style="list-style-type: none"> <li>• BOP-2</li> <li>• IOP</li> </ul>	Operating operator panels, installing door assembly for IOP		
+++	<b>Operating instructions</b> Distributed ET 200pro I/O system	Installing, commissioning and troubleshooting the distributed ET 200pro I/O system and F-Switch.	English, German, Italian, French, Spanish, Chinese, Russian	Download SIMATIC ( <a href="http://support.automation.siemens.com/WW/view/en/19737445/133300">http://support.automation.siemens.com/WW/view/en/19737445/133300</a> )
+++	<b>Manual</b> SIMATIC ET 200pro motor starter	Installing, commissioning and troubleshooting the ET 200pro motor starter and the F-RSM module.	English, French, German	



## A.5.2 Configuring support

Table A- 16 Support when configuring and selecting the inverter

Manual or tool	Contents	Available languages	Download or article number
Catalog D 31	Ordering data and technical information for SINAMICS G inverters	English, German, Italian, French, Spanish	Everything about SINAMICS G120 ( <a href="http://www.siemens.com/sinamics-g120">www.siemens.com/sinamics-g120</a> )
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 (Article number: 6SL3070-0AA00-0AG0) and in the Internet: Download SIZER ( <a href="http://support.automation.siemens.com/W/view/en/10804987/130000">http://support.automation.siemens.com/W/view/en/10804987/130000</a> )

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](http://www.siemens.com/safety-evaluation-tool)).

## A.5.3 Product Support

You can find additional information on the product and more in the Internet under: Product support (<http://www.siemens.com/automation/service&support>).

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.
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- Information about local service, repair, spare parts and much more can be found under "Services".

## A.6 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:

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91050 Erlangen, Germany

E-mail (<mailto:docu.motioncontrol@siemens.com>)

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## Additional information

SINAMICS inverters:

[www.siemens.com/sinamics](http://www.siemens.com/sinamics)

Safety Integrated:

[www.siemens.com/safety-integrated](http://www.siemens.com/safety-integrated)

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