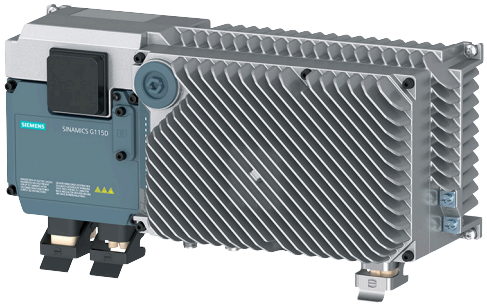
Safety



Edition 07/2025

FUNCTION MANUAL

SINAMICS

G115D, G120, G120C, G120D

Safety functions integrated in the drive - Safety Integrated

SIEMENS

SIEMENS

SINAMICS

SINAMICS G115D, G120, G120P, G120C, G120D Safety Integrated - SINAMICS G115D, G120, G120C and G120D

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Edition 07/2025, Firmware V4.7 SP14

07/2025, FW V4.7 SP14
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Legal information

Warning notice system

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

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

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

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

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

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

Qualified Personnel

The product/system described in this documentation may be operated only by **personnel qualified** for the specific task in accordance with the relevant documentation, in particular its warning notices and safety instructions. Qualified persons are those who, because of their training and experience, are familiar with the installation, assembly, commissioning, operation, decommissioning and disassembly of the product and can recognize risks and avoid possible hazards.

Proper use of Siemens products

Note the following:

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

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

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Changes in the current edition

Significant changes with respect to Function Manual, Edition 03/2020

Corrections

Error correction and editorial revision

Product cancellation

Due to announced product cancellation the SINAMICS G110M was removed from the function manual.

New function

SINAMICS G115D converter now supports the Extended Function 'Safely-Limited Speed (SLS)' with the firmware version V4.7 SP14.

About this manual (Page 13)

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Fundamental safety instructions

1

1.1 General safety instructions

⚠ WARNING

Danger to life if the safety instructions and residual risks are not observed

If the safety instructions and residual risks in the associated hardware documentation are not observed, accidents involving severe injuries or death can occur.

- Observe the safety instructions given in the hardware documentation.
- Consider the residual risks for the risk evaluation.

⚠ WARNING

Malfunctions of the machine as a result of incorrect or changed parameter settings

As a result of incorrect or changed parameterization, machines can malfunction, which in turn can lead to injuries or death.

- Protect the parameterization against unauthorized access.
- Handle possible malfunctions by taking suitable measures, e.g. EMERGENCY STOP or EMERGENCY OFF.

1.2 Warranty and liability for application examples

Application examples are not binding and do not claim to be complete regarding configuration, equipment, or any eventuality which may arise. Application examples do not represent customer-specific solutions, but merely serve to provide assistance with typical tasks.

As the user you yourself are responsible for ensuring that the products described are operated correctly. Application examples do not relieve you of your responsibility for safe handling when using, installing, operating and maintaining the equipment.

1.3 Cybersecurity information

Siemens provides products and solutions with industrial cybersecurity functions that support the secure operation of plants, systems, machines and networks.

In order to protect plants, systems, machines and networks against cyber threats, it is necessary to implement – and continuously maintain – a holistic, state-of-the-art industrial cybersecurity concept. Siemens' products and solutions constitute one element of such a concept.

Customers are responsible for preventing unauthorized access to their plants, systems, machines and networks. Such systems, machines and components should only be connected to an enterprise network or the internet if and to the extent such a connection is necessary and only when appropriate security measures (e.g. firewalls and/or network segmentation) are in place.

For additional information on industrial cybersecurity measures that may be implemented, please visit
https://www.siemens.com/cybersecurity-industry.

Siemens' products and solutions undergo continuous development to make them more secure. Siemens strongly recommends that product updates are applied as soon as they are available and that the latest product versions are used. Use of product versions that are no longer supported, and failure to apply the latest updates may increase customer's exposure to cyber threats.

To stay informed about product updates, subscribe to the Siemens Industrial Cybersecurity RSS Feed under
https://new.siemens.com/cert.

Further information is provided on the Internet:

Configuration Manual Industrial Cybersecurity (https://support.industry.siemens.com/cs/ww/en/view/109975311)

⚠ WARNING

Unsafe operating states resulting from software manipulation

Software manipulations, e.g. viruses, Trojans, or worms, can cause unsafe operating states in your system that may lead to death, serious injury, and property damage.

- Keep the software up to date.
- Incorporate the automation and drive components into a state-of-the-art, integrated industrial cybersecurity concept for the installation or machine.
- Make sure that you include all installed products in the integrated industrial cybersecurity concept.
- Protect files stored on exchangeable storage media from malicious software with suitable protection measures, e.g. virus scanners.
- Carefully check all cybersecurity-related settings once commissioning has been completed.

Introduction

2

2.1 About this manual

Who requires the "Safety Integrated" function manual?

The "Safety Integrated" Function Manual describes safety functions integrated in the drive converter for variable-speed applications.

The "Safety Integrated" Function Manual primarily addresses machine manufacturers (OEMs), plant construction companies, commissioning engineers and service personnel.

What does "safety function integrated in the drive" mean?

Compared to a "standard" drive function, a safety function is significantly less subject to error. Performance level (PL) and safety integrity level (SIL) of the corresponding standards are a measure of the error rate.

A safety function is therefore suitable for use in machines or systems with a particularly high risk potential. The system or machine builder carries out a risk analysis to assess the risk potential of his/her machine or system.

"Integrated in the drive" means that the safety function is integrated in the converter and requires no additional external components.

What converters are described?

	Applications with fixed speed			Applications with variable speed										
	SIMATIC							SINAMICS						
	ET 200S Motor starter	ET 200pro Motor starter	ET 200pro FC-2	G120C	G115D	G120D	G120	G110D	G130	G150	S110	S120	S150	S210
Integrated safety functions according to IEC 61800-5-2														
STO Safe Torque Off	Yes		Yes	Yes				Yes	Yes		Yes			Yes
SS1 Safe Stop 1	-	-	-	-	-	Yes		-	Yes		Yes			Yes
SBC Safe Brake Control	-	-	-	-	-	-	Yes [2]	-	Yes [3]		Yes [4]	Yes [3]		Yes
SLS Safely-Limited Speed	-	-	-	-	Yes	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		-
SCA Safe Cam	-	-	-	-	-	-	-	-	Yes		-	Yes		-
SLA Safely-Limited Acceleration	-	-	-	-	-	-	-	-	Yes		-	Yes		-
Safety functions.														
SP Safe Position	-	-	-	-	-	-	-	-	-		-	Yes		-
Diagnostic functions														
SBT Safe Brake Test	-	-	-	-	-	-	-	-	Yes		-	Yes		-
Fail-safe interfaces														
PROFIsafe via PROFINET/PROFIBUS	Yes	Yes [5]	Yes [5]	Yes				-	Yes		Yes			Yes
Fail-safe digital inputs	Yes [5]		Yes [5]	Yes				- Yes [5]	Yes		Yes, external components required in certain cases			Yes
Fail-safe digital outputs	-	-	-	-		Yes	Yes [8]	-	Yes, with TM54F		Yes	Yes, with TM54F		-
Certifications														
EN ISO 13849-1:2006	Cat. 4 / PL e		Cat. 3 / PL d	Cat. 3 / PL d			Cat. 3 / PL d/e [7]	-	Cat. 3 / PL d [6]		Cat. 3 / PL d [6]			
EN 61508: 2010	SIL 3		SIL 2	SIL 2			SIL 2/3 [7]	-	SIL 2 [6]		SIL 2 [6]			
NFPA 79	Yes		-	-		-	-	-	-		Yes		-	-
NRTL listed	Yes		-	-		-	-	-	-		-	Yes [1]	-	-
				Content of the "Safety Integrated" Function 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 the terminals of the PM240-2 and PM240P-2 Power Modules: 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?

The "Safety Integrated" Function Manual provides information, procedures and operator actions for the following situations:

- Introductory and simplified description of the converter safety functions
- Controlling safety functions via failsafe digital inputs or PROFIsafe
- Commissioning and acceptance test of the safety functions
- Response of the converter with active safety functions
- Replacing a converter 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?

The "Safety Integrated" Function Manual is not sufficient when installing or commissioning "Standard" converter functions. An overview of the documentation available and the associated applications.

Overview of the manuals (Page 318)

What is the meaning of the symbols in the manual?

Reference to further information in the manual

Download from the Internet

DVD that can be ordered

End of a handling instruction.
❒

2.2 Navigator through the "Safety Integrated" Function Manual

Chapter	You can find answers to the following questions in the chapter:
Description (Page 19)	• What are basic functions and what are extended functions? • Which safety functions does the converter have? • Which interfaces does the converter have to select the safety functions? • What preconditions, restrictions and recommendations apply when using the safety functions? • How do the safety functions basically work?
Installing (Page 41)	• Which sequence is recommended when installing the converter? • What options are available to connect the converter to the higher-level control system via PROFIsafe? • How are the PROFIsafe control words and status words assigned? • How do you wire the failsafe digital inputs and outputs of the converter? • What differences are there when wiring inside and outside the control cabinet? • How do you connect a monitored motor holding brake?
Commissioning (Page 107)	• Which sequence is recommended when commissioning the converter? • Which tool do you require for commissioning? • How do you restore the factory setting of the safety functions? • In SINAMICS G120, is it permissible to use the safety functions according to SIL 2 and SIL 3 together? • How do you commission the safety functions? • How do you configure communication via PROFIsafe in the converter? • How do you transfer safety function parameters to other converters? • Why is it necessary to "Accept safety functions"? • What does accepting the safety functions involve?
Operation (Page 177)	• How do you maintain the guaranteed probability of failure of the safety functions over the mission time? • How does the drive respond when selecting or deselecting a safety function? • How do you switch on a motor with a safety function active? • How does the drive respond to a discrepancy signal at a failsafe digital input? • How does the drive respond to limit value violations or if internal monitoring functions respond? • How do you acknowledge safety function faults? • How do the safety functions mutually influence one another? • What do the alarm and fault messages of the safety functions mean?
Corrective maintenance (Page 289)	• How do you maintain the operational safety of the plant or machine? • How do you replace defective components in the converter or the converter itself? • How do you ensure that after a replacement the safety functions still function?

Chapter	You can find answers to the following questions in the chapter:
System properties (Page 293)	• How long can the converter be operated? • At which time intervals must you initiate the converter self-test? • What is the probability of failure of the converter safety functions? • In which time does the drive respond when selecting a safety function? • When a safety function is active, in which time does the drive respond to a motor malfunction? • According to which standards are the converter safety function certified? • Where can you find certifications for the converter? • What is the technical data of the Safe Brake Relay?
Appendix (Page 303)	• As machine builder or company operating a machine, which standards and regulations must you comply with? • Where can you find additional information about the converter?

Description

3

3.1 About this chapter

What can you find in this Chapter?

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

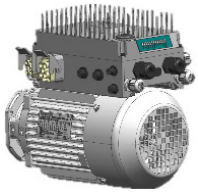
- What are basic functions and what are extended functions?
- What safety functions does my converter have?
- Which interfaces to select the safety functions does my converter have?
- What preconditions, restrictions and recommendations apply when using the safety functions?
- How do the safety functions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

Safety functions integrated in the drive	
Basic functions	**Extended functions**
The basic functions prevent hazardous motion using one or several of the following measures: • The energy feed to the motor is safely switched off • The energy feed to the motor holding brake is safely switched off The following basic functions are available: • Safe Torque Off (STO) • Safe Brake Control (SBC) • Safe Stop 1 (SS1) without speed monitoring Each of the converters described in this manual has one or several of the basic functions.	Extended functions include several basic functions and additional functions to safely monitor the motor speed: • STO and SBC basic functions • Safe Stop 1 (SS1) with speed monitoring • Safely Limited Speed (SLS) • Safe Direction (SDI) • Safe Speed Monitor (SSM) Whether a converter has extended functions generally depends on the Control Unit hardware. The corresponding converters 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.

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

Converter	Basic functions		Extended functions			
	STO	**SS1, SBC**	**SS1, SDI**	**SLS**	**SLS with switchable SLS levels**	**SSM**
 SINAMICS G115D	Available with all product versions	---	---	Available with all product versions	Available with the PROFINET variant	---
SINAMICS G120C	Available with all product versions	---	---			
SINAMICS G120	Available with all CU240E-2, CU250S-2 and CU230P-2 [3] 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 [2] CU250S-2 DP [2] CU250S-2 PN [2] CU250S-2 CAN [2]		Available with the following Control Units: CU240E-2 DP-F CU240E-2 PN-F CU250S-2 [2] CU250S-2 DP [2] CU250S-2 PN [2] CU250S-2 CAN [2]	
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			

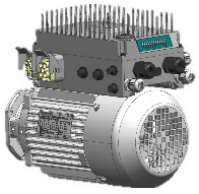
[1] ---: Not available

[2] Requires a license for the safety functions

[3] With Power Modules PM240-2 FSD ... FSG, PM240P-2 FSD ... FSF or Power Module PM330

3.3 Interfaces to select the safety functions

Depending on the converter, the safety function interfaces are failsafe digital inputs and outputs (F-DI, F-DO), PROFIsafe secure fieldbus communication, and a failsafe digital output to control a brake.

Converter		F-DI	F-DO	PROFIsafe	Safe brake control
	SINAMICS G115D	1	---	Telegram 30 [2], telegram 900 [3]	---
	SINAMICS G120C USS SINAMICS G120C CAN	1	---	---	---
	SINAMICS G120C DP SINAMICS G120C PN	1	---	Telegram 30 [2], telegram 900 [3]	---
	SINAMICS G120 with Control Unit ...				
	CU240E-2	1 + 1 [4]	---	---	---
	CU240E-2 DP CU240E-2 PN	1 + 1 [4]	---	Telegram 30 [2], telegram 900 [3]	---
	CU240E-2 F	3 + 1 [4]	---	---	---
	CU240E-2 DP-F CU240E-2 PN-F	3 + 1 [4]	---	Telegram 30 [2], telegram 900 [3]	---
	CU250S-2 CU250S-2 CAN	3 + 1 [4]	1	---	With Safe Brake Relay
	CU250S-2 DP CU250S-2 PN	3 + 1 [4]	1	Telegram 30 [2], telegram 900 [3]	With Safe Brake Relay
	SINAMICS G120D with Control Unit ...				
	CU240D-2 DP CU240D-2 PN	1	---	Telegram 30 [2], telegram 900 [3]	---
	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 [2], telegram 900 [3]	---

[1] --- Not available

[2] Telegram 30 for control and status feedback signals from the safety functions

[3] Telegram 900: Function as for telegram 30 and additional feedback signal of the F-DI status

[4] In addition to the failsafe digital inputs of the Control Unit, an additional failsafe digital input is available for the STO function on the PM240-2 FSD ... FSF and PM240P-2 FSD ... FSF 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.
  Certifications (Page 294)

EMC-compliant installation

Install the drive according to the EMC installation guidelines and observe the requirements for shielding from the EMC installation guidelines.

EMC installation guideline (http://support.automation.siemens.com/WW/view/en/60612658)

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
- Permanent-magnet synchronous motors, induction motors and synchronous reluctance motors
- For group drives, involving the simultaneous operation of several motors connected to one converter

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

- With induction motors for all control modes
- With SIEMOSYN synchronous motors only with U/f control
- Synchronous reluctance motors may only be operated with vector control
- For group drives, involving the simultaneous operation of several motors connected to one converter

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 converter has an encoder connection, the converter evaluates the encoder signal for closed-loop control of 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

Unexpected load acceleration as a result of incorrect closed-loop motor control

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

Unexpectedly high speeds as a result of incorrect motor data

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 converter, then you can use the following critical applications without any restrictions.

If a safety function is enabled in the converter, then some applications can result in faults in the safe actual value acquisition. 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 a converter with closed loop 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 → n_{set} → -n_{set} → 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 converter 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.

Critical application	Remedy
Operating a converter at the current limit	Select and dimension the drive so that the converter current limit does not respond. After commissioning, check that the converter 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 the two braking functions, in the risk assessment you must check where it is permissible that you deactivate the safety function while braking. If yes, then deactivate the safety function until braking has been completed. If you use the SSM function, then it is not permissible to use the two braking functions. It is not possible to deactivate SSM using a control signal.

Restriction with SINAMICS G120 Power Modules

You cannot use all of the integrated safety functions when using the following Power Modules:

Power Module	Article No.	Restriction
Power Module PM230 with IP55 degree of protection	6SL3223-0DE . . - . . A .	Integrated safety functions cannot be used.
	6SL3223-0DE . . - . . G .	The STO basic function can be used.
PM230 Power Module in degree of protection IP20 and push through format	6SL321 . -1NE . . - . . L .	Integrated safety functions cannot be used.
	6SL321 . -1NE . . - . . G .	The STO basic function can be used.

3.6 Recommendations for stable operation

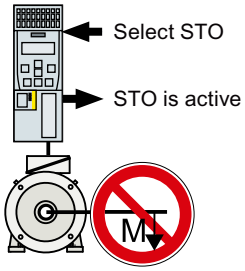
The following preconditions must be satisfied to ensure disturbance-free converter operation with the extended functions enabled:

- Motor and converter are adequately dimensioned for this application:
  - The converter is operated below its current limit.
  - The rated currents of the motor and converter must not differ by more than a factor of 5: Converter rated current/motor rated current < 5 (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 An overview of the principle of operation of the safety functions

3.7.1 Safe Torque Off (STO)

Overview



An active STO function prevents energy from being fed to the motor. The motor can no longer generate torque on the motor shaft.

Consequently, the STO function prevents the starting of an electrically-driven machine component.

Requirement

The machine manufacturer has already performed a risk assessment, e.g. in compliance with EN ISO 1050, "Safety of machinery - Principles of risk assessment". The risk assessment must confirm that it is permissible to use the STO safety function.

Function description

Table 3-2 Principle of operation of STO

	Safe Torque Off (STO)	Standard converter functions linked with STO
1.	The converter identifies when STO is selected via a failsafe digital input or via PROFIsafe.	---
2.	The converter interrupts the energy supply to the motor.	If you use a motor holding brake, the converter closes the motor holding brake. If you use a line contactor, the converter opens the line contactor.
3.	The converter signals "STO is active" via a failsafe digital output or via PROFIsafe.	---

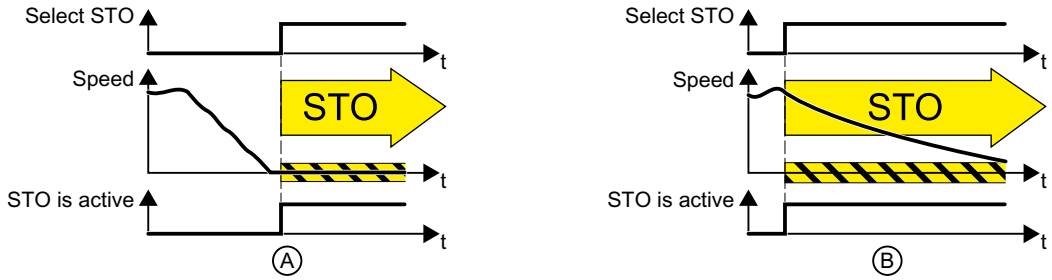


Figure 3-1 STO when the motor is at standstill (A), and rotating (B)

(A): When selecting STO, if the motor is already stationary (zero speed), then STO prevents the motor from starting.

(B): If the motor is still rotating (B) when STO is selected, it coasts down to standstill.

The STO safety function is standardized

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

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

⇒ The STO converter function conforms to IEC/EN 61800-5-2.

Example

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 time of machine components.

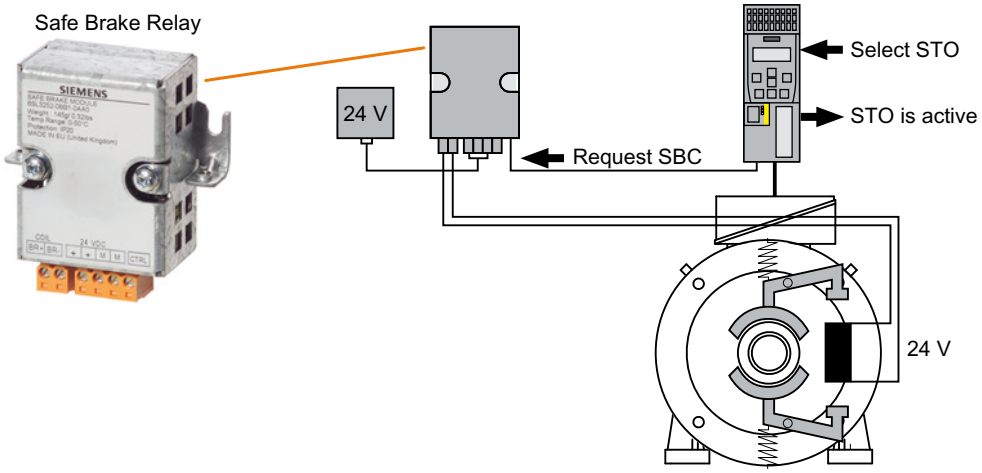
Application	Possible solution
When the EMERGENCY STOP button is pressed, it is not permissible for a stationary motor to inadvertently accelerate.	• Connect the EMERGENCY STOP pushbutton with a failsafe converter digital input. • Select STO via the failsafe digital input.
A central EMERGENCY STOP button must prevent the unintentional acceleration of several motors that are at a standstill.	• Evaluate the EMERGENCY STOP button in a central control. • Select STO via PROFIsafe.

3.7.2 Safe Brake Control (SBC)

Overview

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

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



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

Function description

Table 3-3 The principle of operation of SBC

	Safe Brake Control (SBC)	Standard brake function
1.	When the STO function is active, the converter 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.	The brake closes.
2.	The converter signals "STO is active" via a failsafe digital output or via PROFIsafe.	---

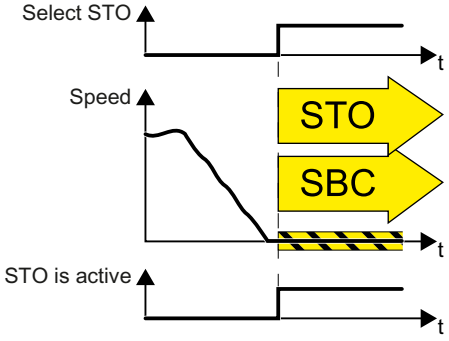


Figure 3-2 The principle of operation of SBC

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."

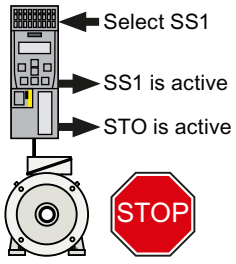
⇒ The SBC converter function is in conformance with IEC/EN 61800-5-2.

Example

Example	Possible solution
After hoisting gear stops, the converter must close the brake in order to minimize the risk of the load falling.	• Connect the motor holding brake to the converter via Safe Brake Relay. • Select STO when the drive stops.

3.7.3 Safe Stop 1 (SS1)

Overview



The converter with active SS1 function initially brakes the motor and then prevents energy being supplied to the motor.

As a consequence, the SS1 function reduces the kinetic energy of electrically driven 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.

Requirement

The machine manufacturer has already performed a risk assessment, e.g. in compliance with EN ISO 1050, "Safety of machinery - Principles of risk assessment". The risk assessment must confirm that it is permissible to use the SS1 safety function.

Function description

SS1 of the Basic Functions

Table 3-4 An overview of the principle of operation of SS1, selected when the motor is rotating

	Safe Stop 1 (SS1)	**Standard converter functions linked with SS1**
1.	The converter identifies when SS1 is selected via a failsafe digital input or via PROFIsafe.	---
2.	SS1 starts a safety timer T. The converter signals "SS1 is active".	The converter brakes the motor along the OFF3 ramp.
3.	After the timer expires, the converter safely switches off the motor torque with the STO function. The converter signals "STO is active" via a failsafe digital output or via PROFIsafe.	---

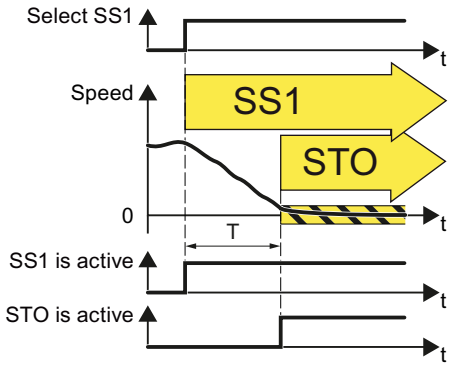


Figure 3-3 Principle of operation of SS1 of the Basic Functions

SS1 of the Extended Functions

Table 3-5 An overview of the principle of operation of SS1, selected when the motor is rotating

	Safe Stop 1 (SS1)	**Standard converter functions linked with SS1**
1.	The converter identifies when SS1 is selected via a failsafe digital input or via PROFIsafe.	---
2.	The converter monitors whether the motor speed decreases. The converter signals "SS1 is active".	The converter brakes the motor along the OFF3 ramp.
3.	If the motor speed is low enough, the converter safely switches off the motor torque using STO. The converter signals "STO is active" via a failsafe digital output or via PROFIsafe.	---

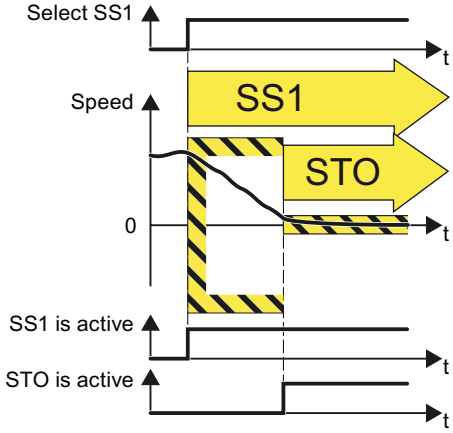


Figure 3-4 Principle of operation of SS1 of the Extended Functions

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."

⇒ Converter function SS1 of the Extended Functions is in conformance with definition [1] of IEC/EN 61800-5-2.

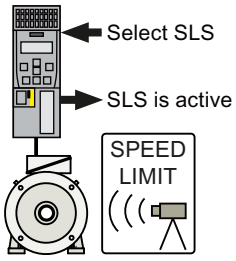
⇒ Converter function SS1 of the Basic Functions is in conformance with definition [2] of IEC/EN 61800-5-2.

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 re-starts.	• Select SS1 in the converter via a failsafe digital input or via PROFIsafe.

3.7.4 Safely Limited Speed (SLS)

Overview



The converter with active SLS function monitors the motor speed. When the monitoring limit is exceeded, the converter stops the motor as quickly as possible.

As a consequence, the SLS function allows an electrically driven machine component to be operated with a temporarily reduced speed or velocity that is not hazardous.

Requirement

The machine manufacturer has already performed a risk assessment, e.g. in compliance with EN ISO 1050, "Safety of machinery - Principles of risk assessment". The risk assessment must confirm that it is permissible to use the SLS safety function.

Function description

Table 3-6 An overview of the principle of operation of SLS, selected when the motor is rotating

	Safely Limited Speed (SLS)	**Standard converter functions linked with SLS**
1.	The converter identifies when SLS is selected via a failsafe digital input or via secure PROFIsafe 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 converter limits the speed setpoint to values below the SLS monitoring. If the motor rotates faster than the SLS monitoring value, then the converter brakes the motor along the OFF3 ramp.
3.	The converter monitors the absolute actual speed against the set SLS monitoring. The converter signals "SLS is active" via a failsafe digital output or via PROFIsafe. If the motor speed exceeds the SLS monitoring, the converter responds with a "safe stop" and brakes the motor as quickly as possible.	The converter limits the speed setpoint to values below the SLS monitoring.

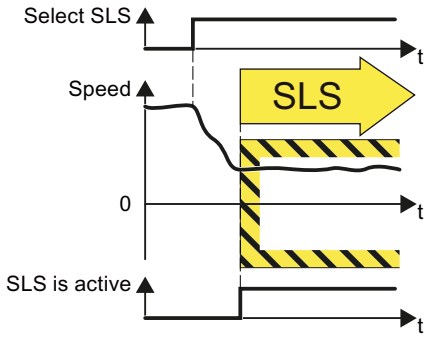


Figure 3-5 Principle of operation of SLS

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 converter function is in conformance with IEC/EN 61800-5-2.

Example

Examples	Possible solution
Setup mode: The machine operator must enter the dangerous area of a machine and manually introduce material into a machine part.	• Select SLS in the converter via a failsafe digital input or via PROFIsafe. • The converter limits and monitors the speed of the machine part.
A turning machine must not exceed a specific maximum torque in order to protect the drill chuck from damage.	

Further information

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 converter requires additional safety-related signals to select an SLS level and to signal back which SLS level is active.

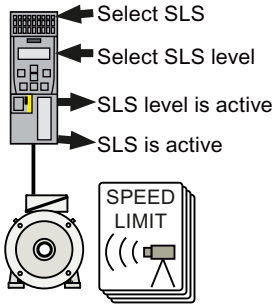


Figure 3-6 SLS level sign

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 below.

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

	Safely Limited Speed (SLS)	Standard converter functions linked with SLS
1.	The converter signals "SLS level 2 is active" via the safety-related PROFIsafe communication.	The converter limits the speed setpoint to values below SLS level 2.
2.	The converter recognizes the selection of SLS level 1 via secure 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 converter limits the speed setpoint to values below SLS level 1. If the motor rotates faster than the SLS monitoring value, then the converter brakes the motor along the OFF3 ramp.
4.	The converter monitors the absolute actual speed against SLS level 1. The converter signals "SLS level 1 is active" via secure PROFIsafe communication.	The converter limits the speed setpoint to values below SLS level 1.

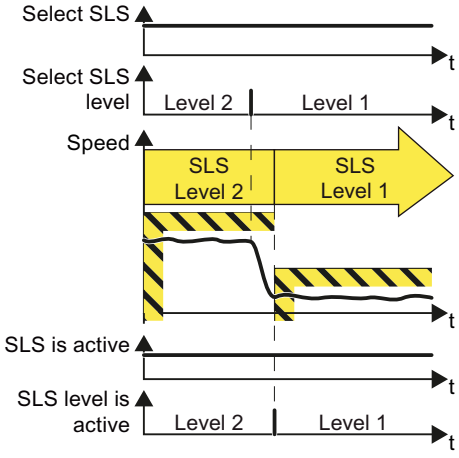


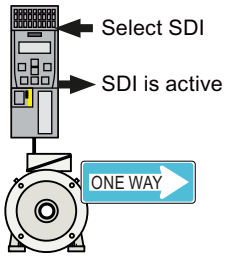
Figure 3-7 Switching over from SLS level 2 to SLS level 1

Table 3-8 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.	• Select SLS and the corresponding SLS level in the converter via PROFIsafe.

3.7.5 Safe Direction (SDI)

Overview



The converter with active SDI function monitors the motor direction of rotation. If the motor rotates in the inhibited direction, the converter stops the motor as quickly as possible.

The SDI function therefore prevents that an electrically driven machine component moves in the inhibited direction.

Requirement

The machine manufacturer has already performed a risk assessment, e.g. in compliance with EN ISO 1050, "Safety of machinery - Principles of risk assessment". The risk assessment must confirm that it is permissible to use the SDI safety function.

Function description

Table 3-9 An overview of the principle of operation of SDI, selected when the motor is rotating

	Safe Direction (SDI)	Standard converter functions linked with SDI
1.	The converter identifies when SDI is selected via a failsafe digital input or via secure PROFIsafe communication.	---
2.	SDI allows a motor to stop moving in the inhibited direction of rotation within a defined time – or along a defined braking ramp.	The converter limits the speed setpoint to values in the selected direction of rotation. If the motor rotates in the inhibited direction, then the converter brakes the motor along the OFF3 ramp.
3.	The converter monitors the direction of the actual speed. The converter signals "SDI is active" via a failsafe digital output or via PROFIsafe. If the motor rotates in the inhibited direction, the converter responds with a "safe stop" and brakes the motor as quickly as possible.	The converter limits the speed setpoint to values in the selected direction of rotation.

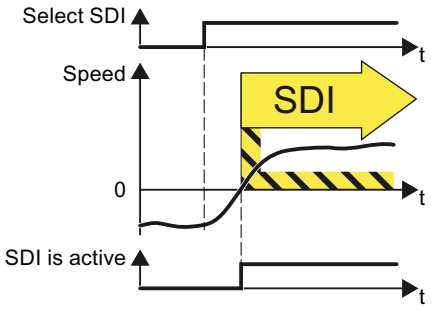


Figure 3-8 Principle of operation of SDI

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."

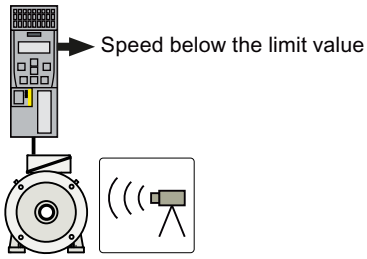
⇒ The SDI converter function is in conformance with IEC/EN 61800-5-2.

Example

Example	Possible solution
When replacing the pressure cylinders of the plates, it is only permissible that the drive moves in the safe direction.	• Select SDI in the converter via a failsafe digital input or via PROFIsafe. • In the converter, inhibit the direction of rotation that is not permitted.
After a protective device to detect a jammed door responds, a rolling shutter gate may only 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.	

3.7.6 Safe Speed Monitoring (SSM)

Overview



The converter with active SSM function monitors the motor speed. The converter signals whether the speed is above or below a limit value.

Requirement

The machine manufacturer has already performed a risk assessment, e.g. in compliance with EN ISO 1050, "Safety of machinery - Principles of risk assessment". The risk assessment must confirm that it is permissible to use the SSM safety function.

Function description

Table 3-10 The principle of operation of SSM

	Safe Speed Monitoring (SSM)	**Standard converter 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 converter compares the motor speed with an adjustable limit value.	
3.	If the speed is less than the limit value, then the converter signals "Speed below limit value" via a failsafe digital output or via PROFIsafe.	

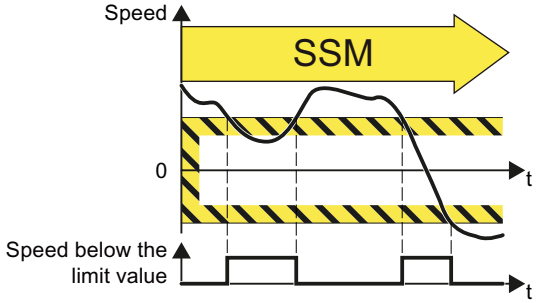


Figure 3-9 The principle of operation of SSM

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 converter function is in conformance with IEC/EN 61800-5-2.

Example

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

3.7.7 EMERGENCY SWITCHING OFF and EMERGENCY STOP

Overview

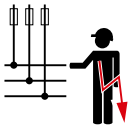
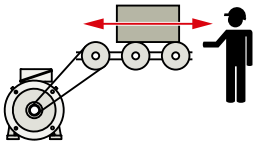
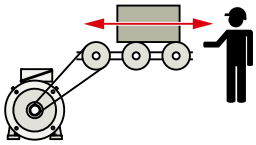
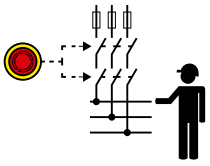
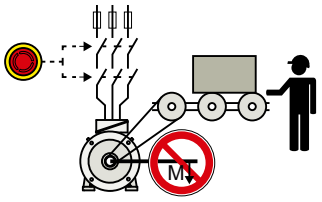
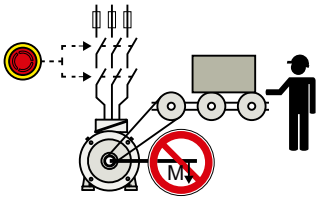
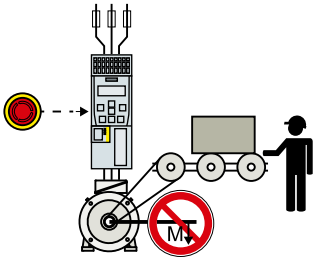
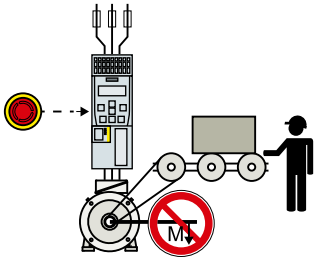
In plants, systems and machines a distinction must be made between "EMERGENCY OFF" and "EMERGENCY STOP". The STO and SS1 safety functions are only suitable for implementing an "EMERGENCY STOP".

Function description

EN 60204-1 defines "EMERGENCY OFF" and "EMERGENCY STOP":

- "EMERGENCY OFF" and "EMERGENCY STOP" are functions that are used in an emergency.
- "EMERGENCY OFF" and "EMERGENCY STOP" minimize different risks in the system or machine:
  - "EMERGENCY OFF" minimizes the risk of electric shock.
  - "EMERGENCY STOP" minimizes the risk of unexpected motion.
  -
- Stop Categories 0, 1 and 2 are available for EMERGENCY STOP.

Table 3-11 The distinction between "EMERGENCY OFF" and "EMERGENCY STOP"

Action:	**EMERGENCY OFF**	**EMERGENCY STOP** **Stop Category 0 according to EN 60204-1**	**EMERGENCY STOP** **Stop Category 1 according to EN 60204-1**
Risk:	 Electric shock	 Unexpected movement	 Movement
Measure to minimize risk:	**Switch off the power supply** Either completely or partially switch off hazardous voltages	**Prevent movement** Prevent any hazardous movement	**Stop movement** Stop hazardous movement and prevent any restart.
Classic solution:	Switch off the power supply: 	Switch-off the drive power supply: 	 Brake the motor and switch off the drive power supply
Solution with the STO or SS1 safety function integrated in the drive:	STO and SS1 are not suitable for switching off an electrical voltage.	Select STO: 	Select SS1 
		It is permissible that you also switch off the converter supply voltage. However, switching off the voltage is not required as a risk reduction measure.	

4 Installing

4.1 About this chapter

What can you find in this Chapter?

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

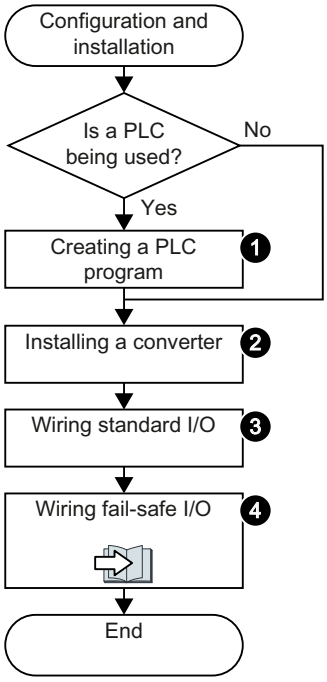
- Which sequence is recommended when installing the converter?
- What options are available to connect the converter to the higher-level control system via PROFIsafe?
- How are the PROFIsafe control words and status words assigned?
- How do I wire the failsafe digital inputs and digital outputs of my converter?
- 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 converter?

4.2 Sequence when installing a converter with safety functions

The following overview shows the procedure for installing integrated safety functions in a converter. For information on some of the steps you will need to consult descriptions in other manuals.

Procedure

To install the converter, proceed as follows:



1. If you are using a higher-level control system (PLC), then create the control program first.
2. Install the converter.
   ⇒ converter operating instructions
3. Connect the converter to the line supply, and wire the standard inputs and outputs of the converter.
   ⇒ converter operating instructions
4. How do you wire the failsafe digital inputs and outputs?
   Controlling via a failsafe digital input (Page 50)
   Evaluating via a failsafe digital output (Page 100)

You have installed the converter.
❒

4.3 Connection via PROFIsafe

4.3.1 Overview of PROFIsafe connections

Communication via PROFIsafe

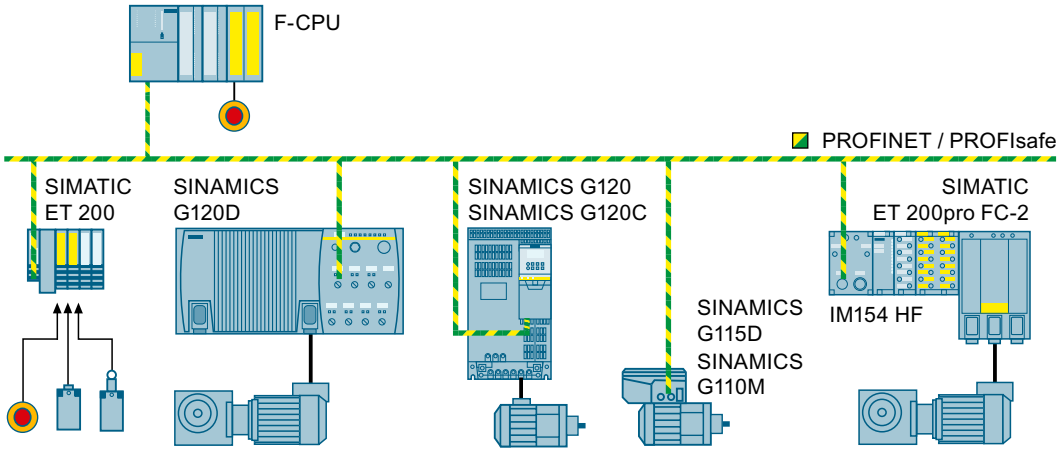


Figure 4-1 PROFIsafe communication between an F-CPU and a converter, e.g. via PROFINET

For communication via PROFIsafe, you must connect the converter to a central failsafe controller (F-CPU) via either PROFIBUS or PROFINET.

Shared Device

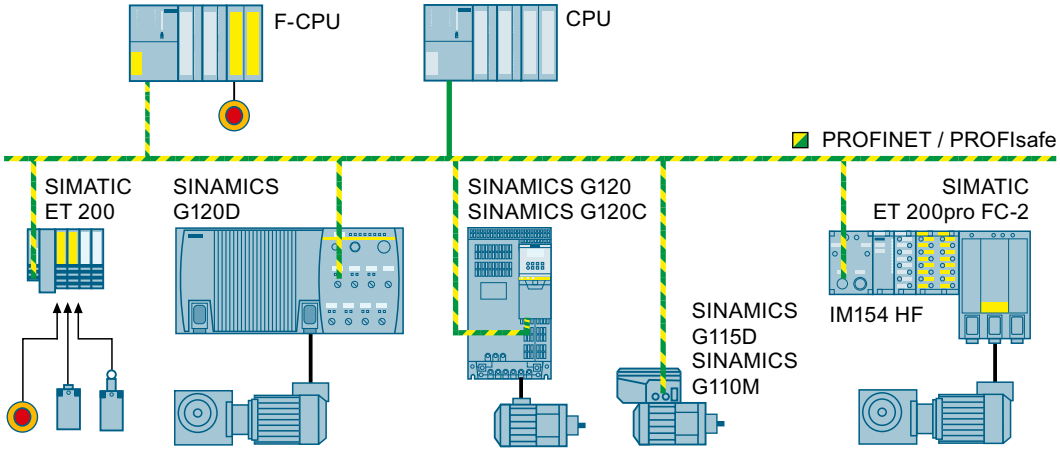


Figure 4-2 Shared device is possible with every converter

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 a converter. Typical applications for

"Shared Device" are systems, in which a standard CPU and a failsafe CPU are used as separate controllers:

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

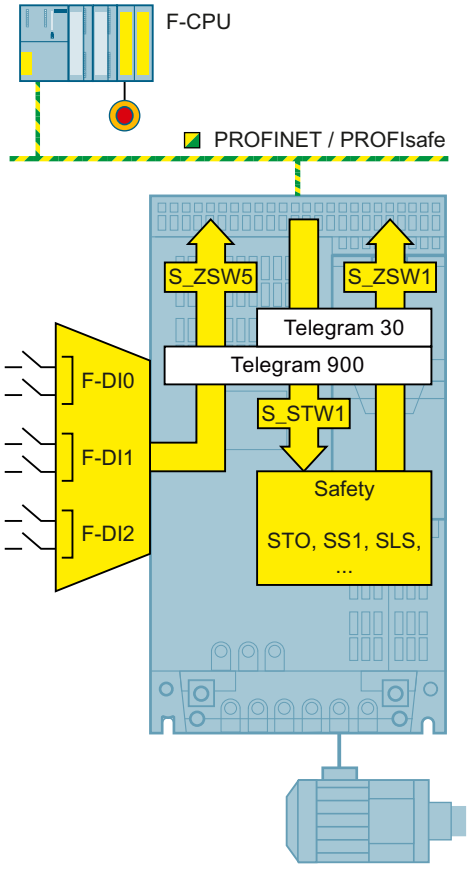
Further information is provided on the Internet:

Which controls support the Shared Device function (http://support.automation.siemens.com/WW/view/en/44383955).

4.3.2 PROFIsafe telegrams

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

Table 4-1 PROFIsafe telegrams

Overview using PROFINET / PROFIsafe as example	Telegram	Process data (PZD)	
		PZD1	PZD2
	**Telegram 30** PZD 1/1	S_STW1	---
		S_ZSW1	---
	Telegram 900 PZD 2/2	S_STW1	S_STW5
		S_ZSW1	S_ZSW5
	The higher-level control selects the safety functions in the converter via the control word S_STW1. The converter uses the status word S_ZSW1 to report the status of the safety functions to the controller. Telegram 900 of the PROFIsafe profile also includes control and status word 5. The converter transfers the status of the following failsafe digital inputs to the control system in status word S_ZSW5: • Basic functions: F-DI 0 • Extended functions: F-DI 0 ... F-DI 2		

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	*Not relevant*		
	7	Internal Event ack	0	Do not acknowledge faults
			1 → 0	Acknowledge "Internal event" for a 1 → 0 signal change
1	*8 ... 15*	*Not relevant*		

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	*Not relevant*		
	7	Internal Event	0	Fault-free operation
			1	The converter signals an "internal event"
1	*8 ... 15*	*Not relevant*		

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
	2	SLS level bit 1			Level 1 Level 2 Level 3 Level 4	0 0 1 1	0 1 0 1
	3	*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	*Not relevant*		
	4	SLS active	0	SLS is not active
			1	SLS is active
	5, 6	*Not relevant*		
	7	Internal Event	0	Fault-free operation
			1	The converter signals an "internal event"

Byte	Bit	Function	Comment			
1	*0*	*Not relevant*				
	1	SLS level bit 0	SLS level is active		Bit 2	Bit 1
	2	SLS level bit 1		Level 1 Level 2 Level 3 Level 4	0 0 1 1	0 1 0 1
	3	*Not relevant*				
	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	*Not relevant*				
	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 (basic functions)

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

Byte	Bit	Function	Comment
0 ... 1	0 ... 7	*Reserved*	Assign the value 0 to all bits.

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

Byte	Bit	Function	Comment		SINAMICS		
					G120	G120D	G115D
0	0 ... 7	*Reserved*	-				
1	0	State of the failsafe digital input F-DI 0	0	LOW signal (0 V)	At terminals 16 and 17	At pins X9.2 and X9.4	At pins X8.2 and X8.4
			1	HIGH signal (24 V)			
	1 ... 7	*Reserved*	-				

Overview of the failsafe digital inputs:

Overview (Page 50)

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

- The failsafe digital input is not used to select a safety function.
- The converter has deactivated the corresponding failsafe digital input due to discrepant input signals.

4.3.6 Control word 5 and status word 5 (extended functions)

Table 4-8 Control word 5 (bit 0 ... 15)

Byte	Bit	Function	Comment
0 ... 1	0 ... 7	*Reserved*	Assign the value 0 to all bits.

Table 4-9 Status word 5 (bit 0 ... 15)

Byte	Bit	Function	Comment		SINAMICS G120	SINAMICS G120D
0	0 ... 7	*Reserved*	-			
1	0	State of the failsafe digital input F-DI 0	0	LOW signal (0 V)	At terminals 5 and 6	At pins X7.2 and X7.4
			1	HIGH signal (24 V)		
	1	State of the failsafe digital input F-DI 1	0	LOW signal (0 V)	At terminals 7 and 8	At pins X8.2 and X8.4
			1	HIGH signal (24 V)		
	2	State of the failsafe digital input F-DI 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	*Reserved*	-			

Overview of the failsafe digital inputs:

Overview (Page 50)

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

- The corresponding failsafe digital input is not used to select a safety function.
- The converter has deactivated the corresponding failsafe digital input due to discrepant input signals.

4.3.7 Application examples

Assigning the converter to the input and output addresses of the control system

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

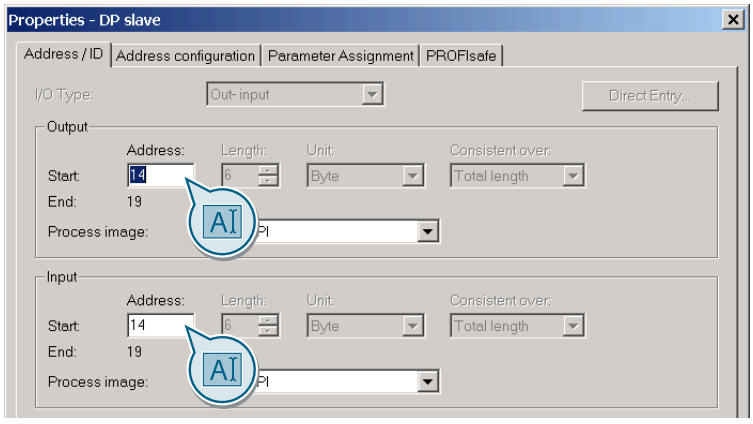


Figure 4-3 Example: in the control, assign the initial address 14 for the converter

Control the converter using the control program

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

Table 4-10 Control word 1

I/O address	Significance	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 4-11 Status word 1

I/O address	Significance	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 converter has detected an internal fault and responded accordingly, e.g. with a STOP A.
E15.1	Active SLS level, bit 0	-	Active SLS level
E15.2	Active SLS level, bit 1	-	
E15.4	SDI positive active	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

SIMATIC library to control the safety functions

The library contains failsafe SIMATIC S7 blocks for PROFIsafe communication between failsafe SIMATIC S7-CPUs and SINAMICS.

LDrvSafe (https://support.industry.siemens.com/cs/ww/en/view/109485794)

Additional application examples

An additional application example is provided on the Internet:

Controlling SINAMICS G120 via PROFIsafe using a SIMATIC S7-1200 F-CPU (https://support.industry.siemens.com/cs/ww/en/view/109746271)

4.4 Controlling via a failsafe digital input

4.4.1 Overview

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

Assignment of the failsafe digital inputs

Table 4-12 SINAMICS G120C

	Terminal strip	Digital input	Failsafe digital input
	16	DI 4	F-DI 0
	17	DI 5	

Table 4-13 SINAMICS G120 with CU240E-2, CU240E-2 DP or CU240E-2 PN Control Unit

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

Table 4-14 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	Failsafe digital inputs	
			Basic functions	Extended functions
	5	DI 0	---	F-DI 0
	6	DI 1		
	7	DI 2		F-DI 1
	8	DI 3		
	16	DI 4	F-DI 0	F-DI 2
	17	DI 5		

Table 4-15 SINAMICS G120 with PM240-2 and PM240P-2 Power Modules

	Terminals of the failsafe digital input on PM240-2 FSD ... FSF and PM240P-2 FSD ... FSF Power Modules
	STO_A STO_B

Table 4-16 SINAMICS G120D with Control Units CU240D-2 DP and CU240D-2 PN

	Connector.pin	**Digital input**	**Failsafe digital input**
	X09.4	DI 4	F-DI 0
	X09.2	DI 5	

Table 4-17 SINAMICS G115D

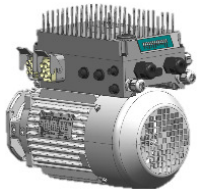
	Connector.pin	**Digital input**	**Failsafe digital input**
	X08.4	DI 2	F-DI 0
	X08.2	DI 3	

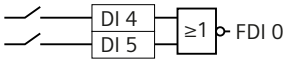
Table 4-18 SINAMICS G120D with Control Units
CU240D-2 DP-F, CU240D-2 PN-F, CU240D-2 PN-F PP and CU240D-2 PN-F FO,
CU250D-2 DP-F, CU250D-2 PN-F, CU250D-2 PN-F PP and CU250D-2 PN-F FO

	Connector.pin	**Digital input**	**Failsafe digital inputs**	
			Basic functions	**Extended functions**
	X07.4	DI 0	-	F-DI 0
	X07.2	DI 1		
	X08.4	DI 2		F-DI 1
	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 to a failsafe digital input through two channels. The converter evaluates the signal on two separate signal paths.

4.4.2 Failsafe digital input

To enable a safety function via the terminal strip of the converter, you need a failsafe digital input.



For specific default settings of the terminal strip, e.g. default setting 2, the converter combines two digital inputs to form one failsafe digital input FDI 0.

Which devices are you allowed to connect?

The failsafe digital 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. failsafe control systems and safety relays.

Signal state

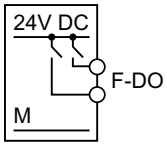
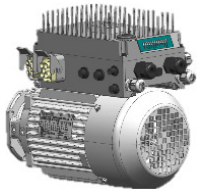
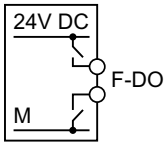
The converter expects signals with the same state at its failsafe digital input:

- High signal: The safety function is deselected.
  The safety function does not affect the converter operation.
- Low signal: The safety function is selected.
  The safety function affects the converter operation.

PM-switching and PP-switching failsafe digital outputs

Depending on the converter, you may connect the following failsafe digital outputs to a failsafe digital input.

Table 4-19 PP-switching or PM-switching failsafe digital outputs

Output	It is permissible to connect the output to the following converters:		
 PP switching output	 SINAMICS G120	 SINAMICS G120C	 SINAMICS G120D  SINAMICS G115D
 PM switching output	 SINAMICS G120	 SINAMICS G120C	

Fault detection

The converter compares the two signals of the failsafe digital input. The converter thus detects, for example the following faults:

- Cable break
- Defective sensor

The converter cannot detect the following faults:

- Cross-circuit of the two cables
- Short-circuit between signal cable and 24 V power supply

Special measures to prevent cross-circuits and short-circuits

The routing of cables over longer distances, e.g. between remote control cabinets, increases the risk of damaging cables. Damaged cables raise the risk of an undetected cross-circuit with power-conducting cables laid in parallel. A cross-circuit can cause interruption to the transfer of safety-related signals.

To avoid cross circuit faults and short-circuits, you must protect the cables between a sensor and the converter; this can be done by routing the cables separately or in a steel pipe/duct

On and off test

The converter filters signal changes using on and off tests at the failsafe digital input using an adjustable software filter.

4.4.3 Wiring examples according to SIL 2 and PL d

Examples for wiring the failsafe digital inputs corresponding to PL d according to EN 13849-1 and SIL 2 according to IEC 61508 are provided on the following pages.

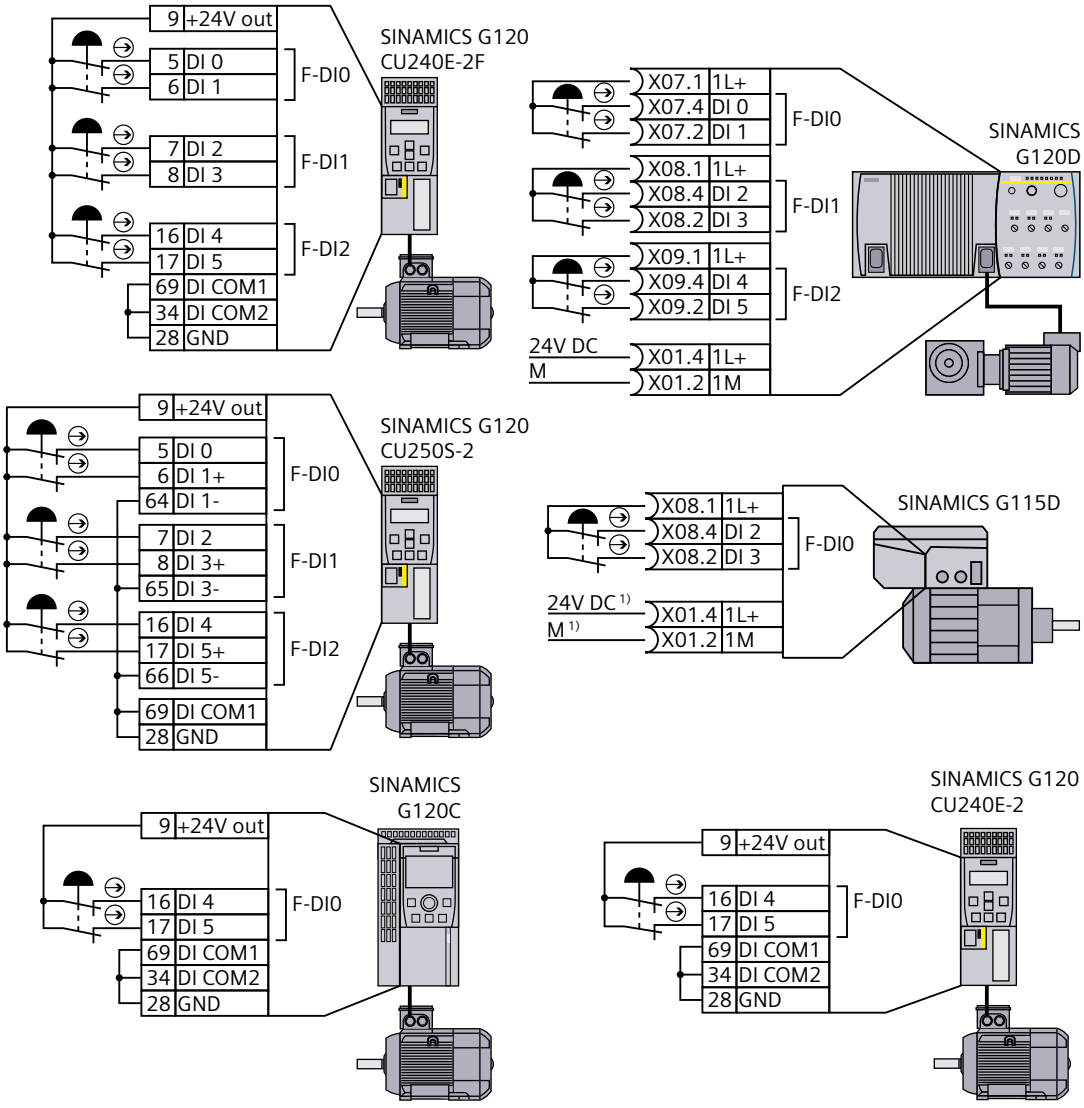
In order to reduce the scope of the examples, not all of the SINAMICS converter types are listed in each wiring example.

If, in an example, two or more terminals of the converter are connected together, then you must connect jumpers that are as short as possible directly at the terminals.

4.4.3.1 Electromechanical sensor

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

The converter supplies the power supply voltage



1) Connection only required for SINAMICS G115D without integrated 24 V power supply unit

Figure 4-4 Connecting an electromechanical sensor to the converter power supply

External power supply

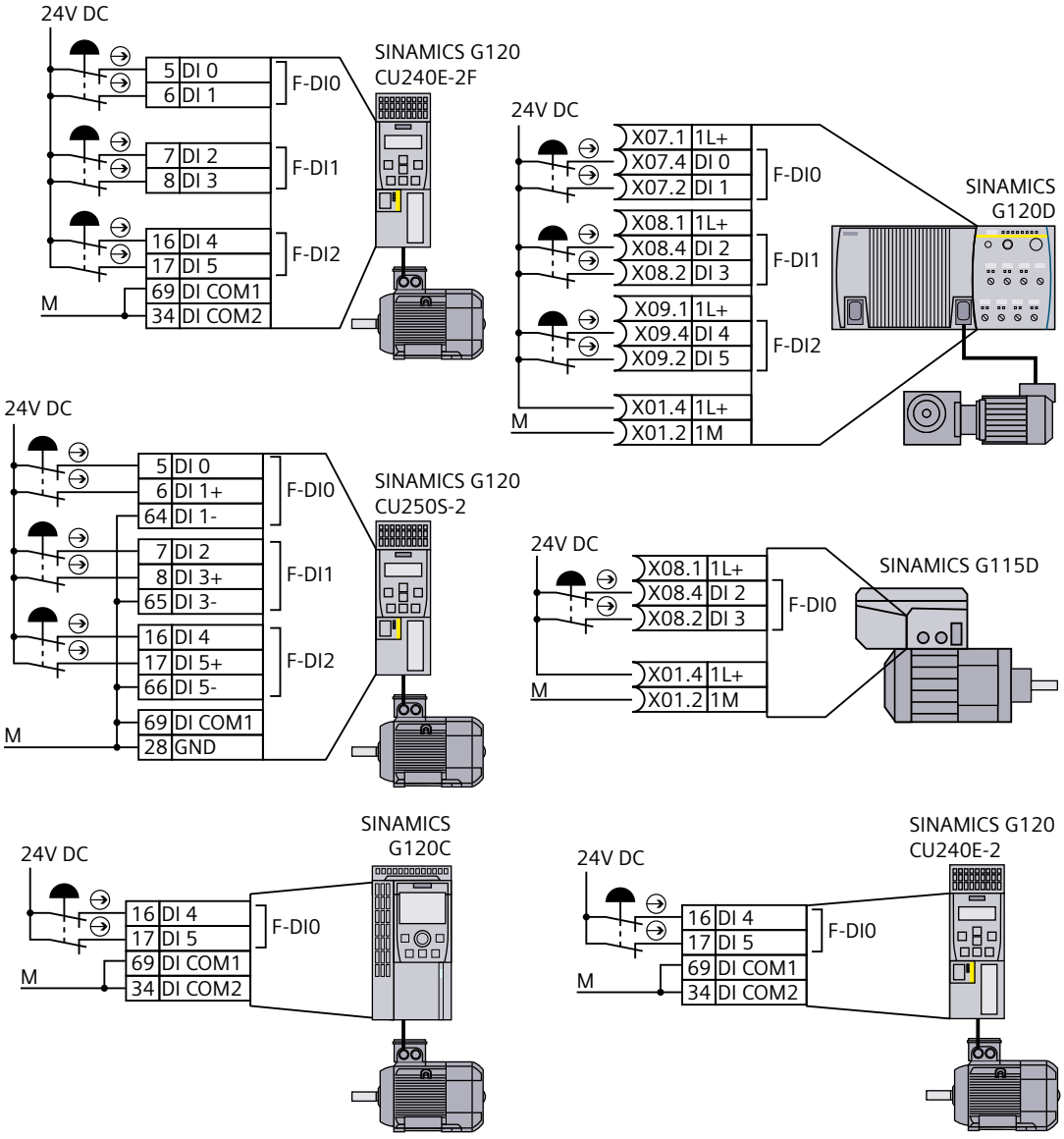


Figure 4-5 Connecting an electromechanical sensor to an external power supply

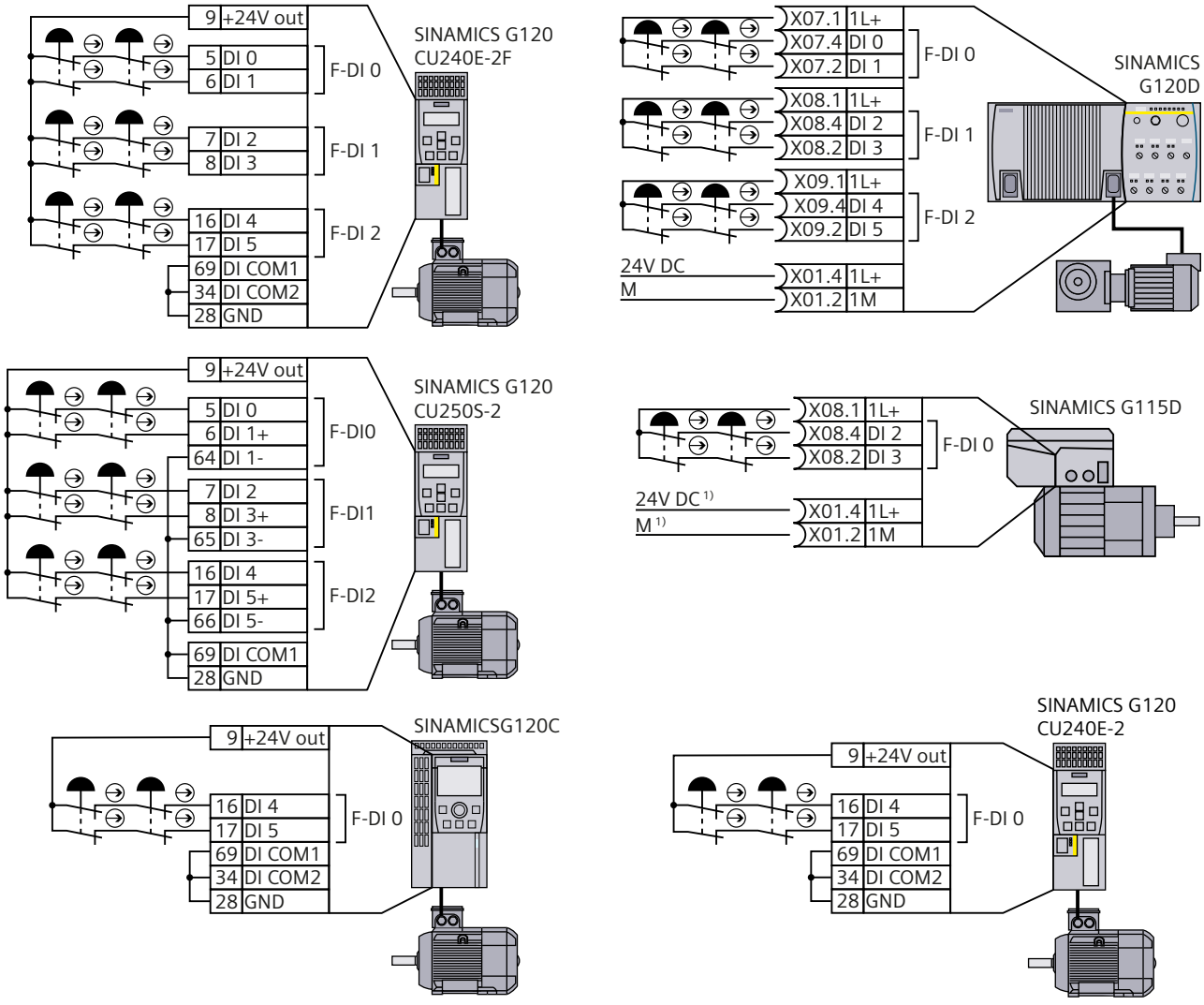
4.4.3.2 Series-connected electromechanical sensors

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.

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 supplies the power supply voltage



1) Connection only required for SINAMICS G115D without integrated 24 V power supply unit

Figure 4-6 Connecting electromechanical sensors to the converter power supply in series

External power supply

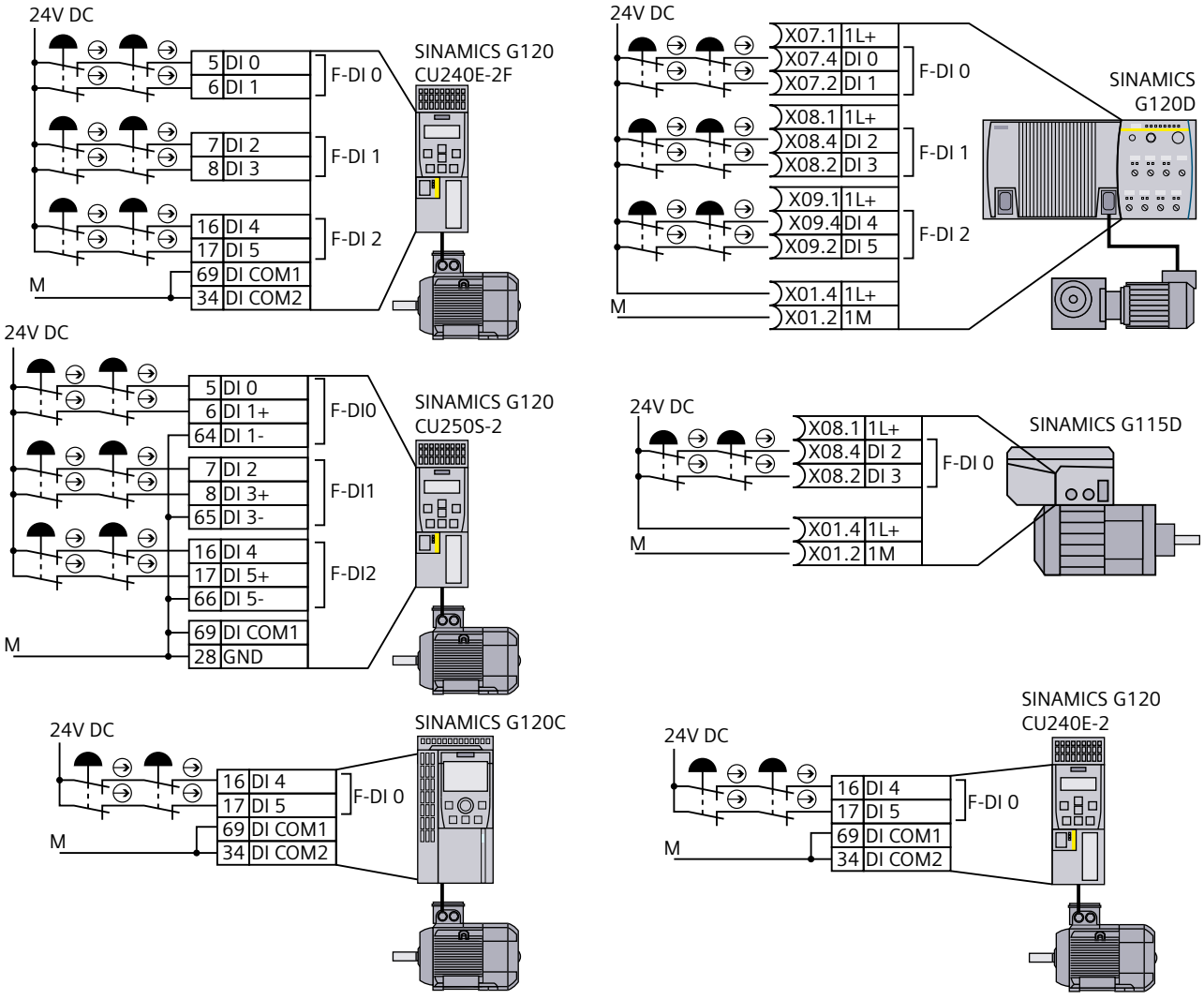


Figure 4-7 Connecting electromechanical sensors to an external power supply in series

Further information

Further information about connecting electromechanical sensors in series is provided in the Internet:

- Several Emergency Stop command devices connected in series (https://support.industry.siemens.com/cs/ww/en/view/35444028)
- SIRIUS Safety Integrated application manual (https://support.industry.siemens.com/cs/de/en/view/81366718)

4.4.3.3 Controlling several converters in parallel using electromechanical sensors

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 supplies the power supply voltage

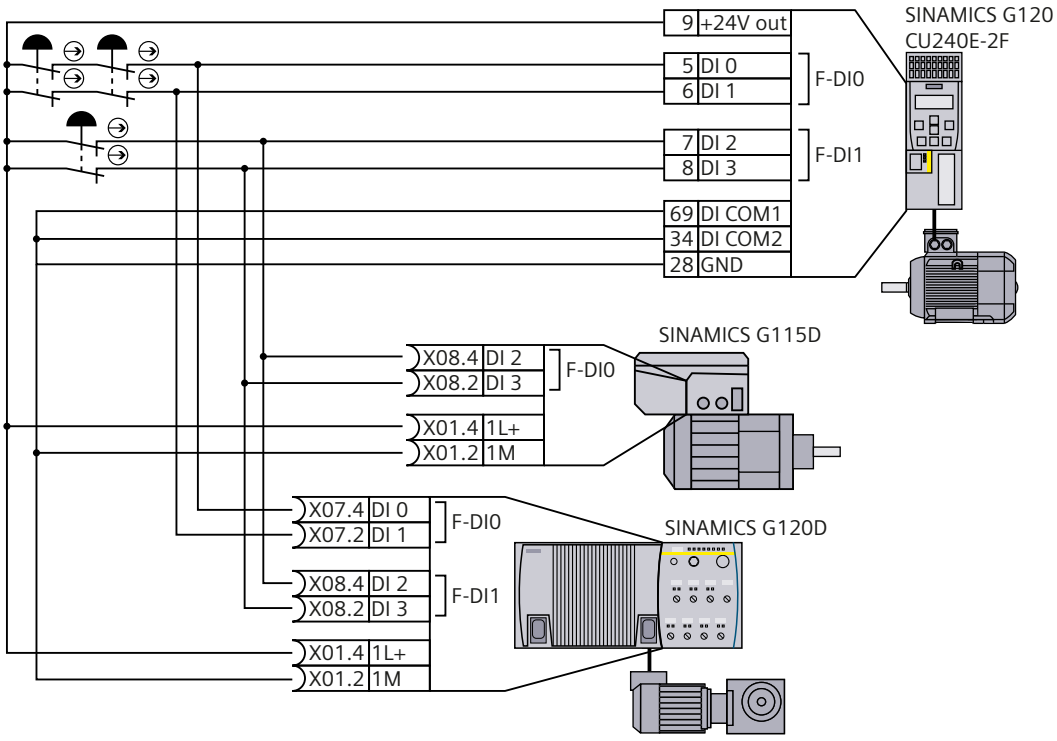


Figure 4-8 Example for controlling several converters in parallel with the power supply from the converter

External power supply

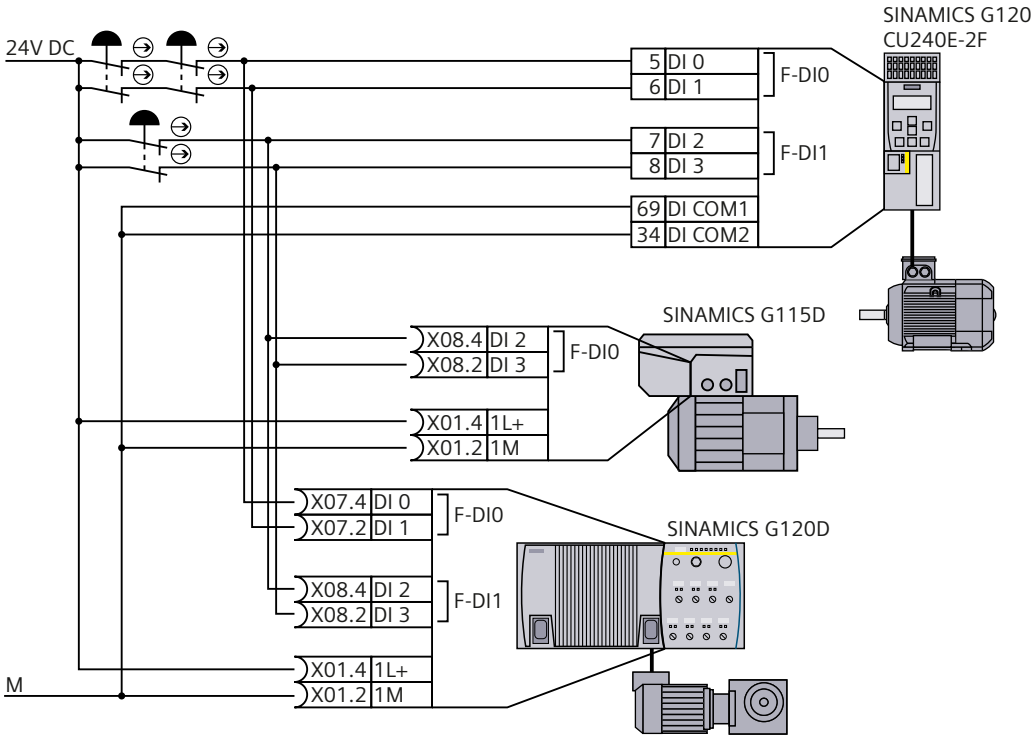


Figure 4-9 Example for controlling several converters in parallel with an external power supply

4.4.3.4 SIRIUS 3SK1 safety relay

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

The diagrams only show the interconnection between the safety relay and a SINAMICS G120 converter as example.

Additional information on wiring a safety relay is provided in the product documentation in the Internet:

SIRIUS 3SK1 safety relays (https://support.industry.siemens.com/cs/ww/en/ps/16381/man).

Components in the same control cabinet

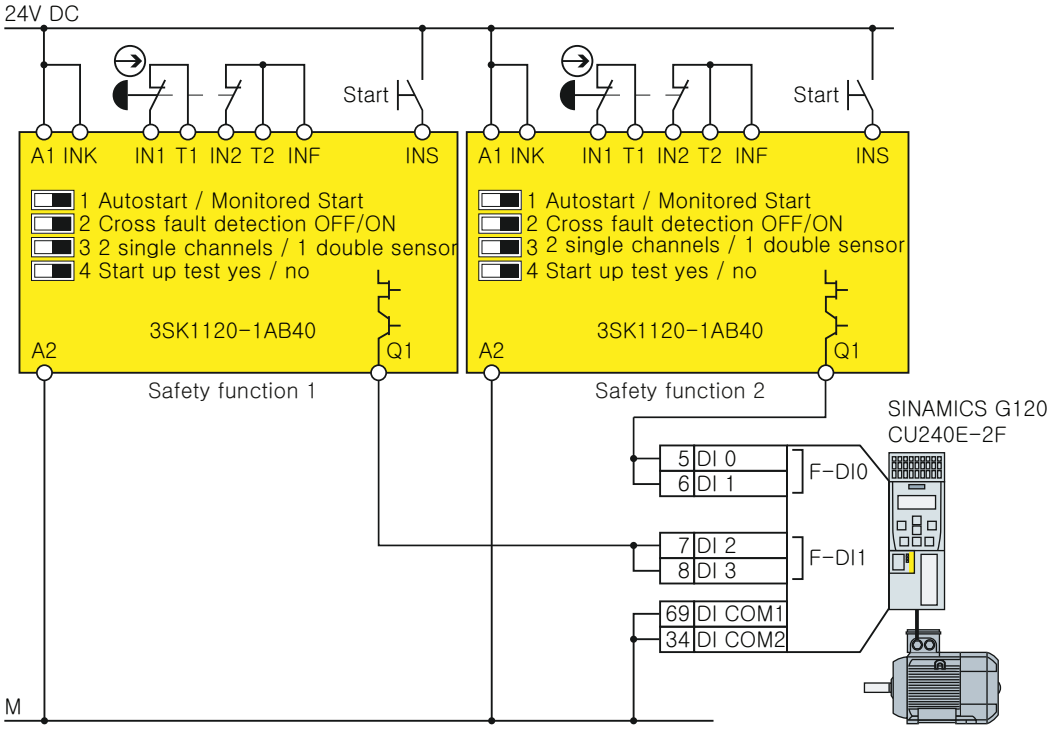


Figure 4-10 Wiring converter and safety relay in an electrical cabinet using SINAMICS G120 with CU240E-2 as example

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 converter through a single-channel cable connection. At the converter, you must connect both terminals of the failsafe digital input with one another.

Components in separate control cabinets

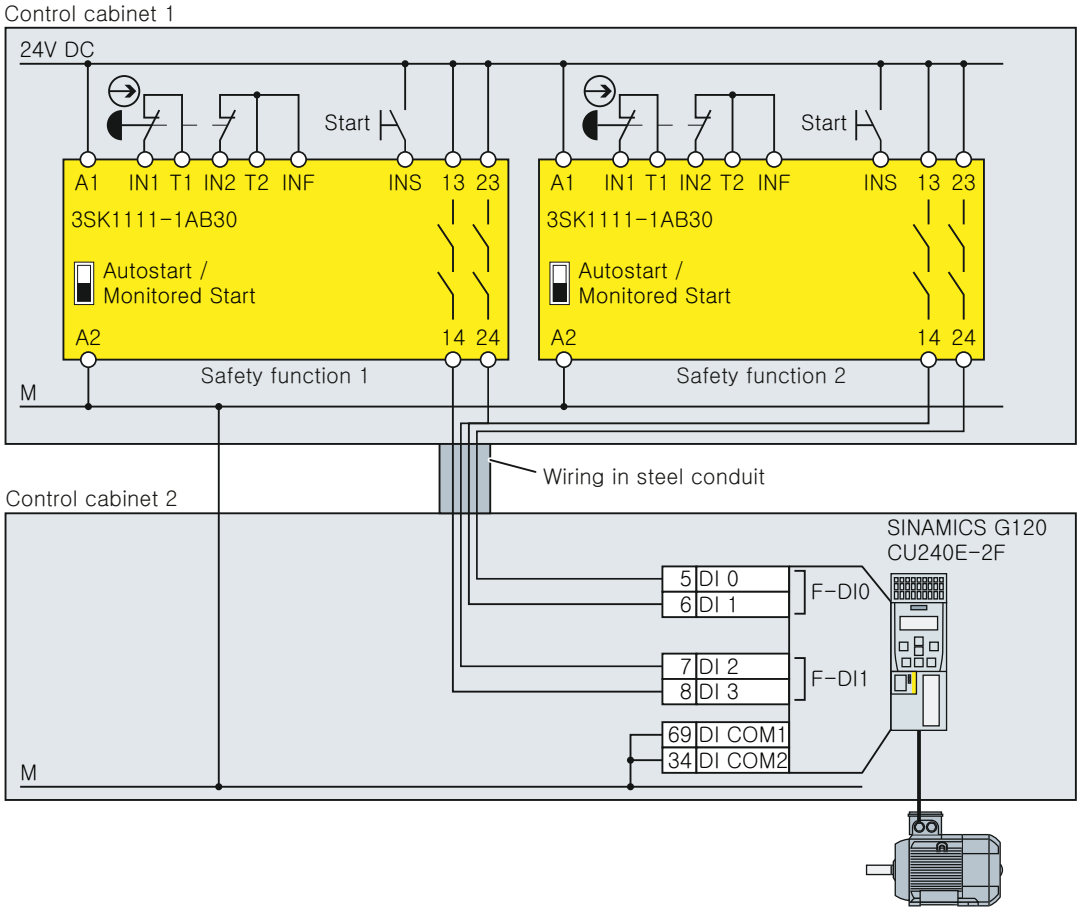


Figure 4-11 Wiring converter and safety relay in separate electrical cabinets using SINAMICS G120 with CU240E-2 as example

For configurations in separate control cabinets, the cables between the safety relay and the failsafe digital inputs of the converter must be protected against cross circuits and short-circuits.

4.4.3.5 3RK3 Modular Safety System

You can use the following outputs to control the failsafe digital inputs in the converter:

- The failsafe digital outputs in the central units of the 3RK3 modular safety system
- The failsafe digital outputs in the EM 2/4F-DI 2F-DO expansion module.
- The failsafe digital outputs in the EM 4F-DO expansion module.
- The failsafe relay outputs in the EM 4/8F-RO expansion module
- Two individual relay contacts of the EM 2/4F-DI 1/2F-RO expansion module.

The diagrams only show the wiring between the 3RK3 modular safety system and as example, a SINAMICS G120 converter.

Additional information on wiring the 3RK3 modular safety system is provided in the Internet:

SIRIUS 3RK3 modular safety system manual (https://support.industry.siemens.com/cs/ww/en/view/26493228)

Components in the same control cabinet

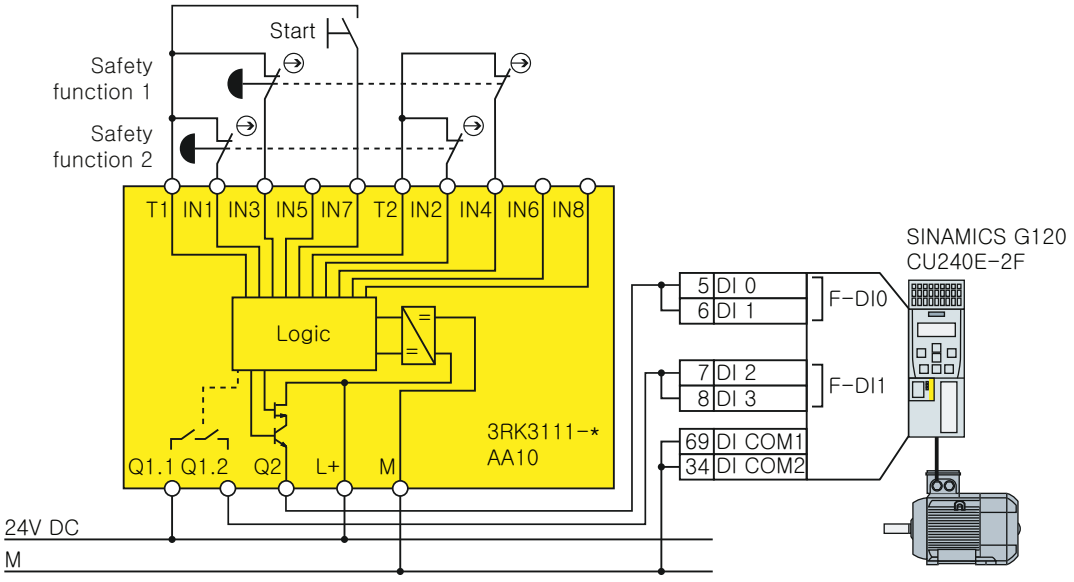


Figure 4-12 Connecting the modular safety system in a control cabinet using a SINAMICS G120 with CU240E-2 as example

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 converter via a single-channel cable connection. At the converter, you must connect both terminals of the failsafe digital input with one another.

Components in separate control cabinets

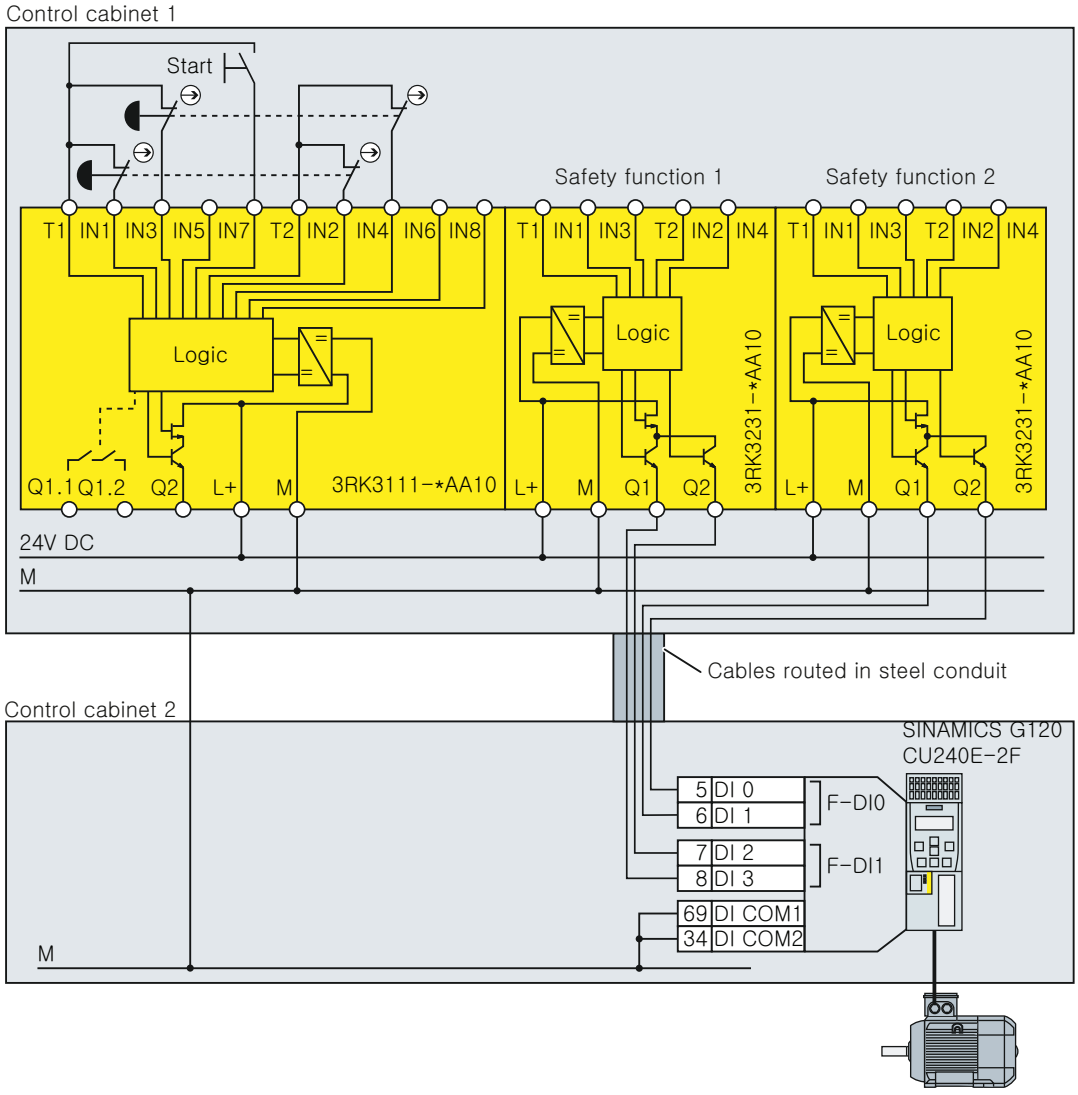


Figure 4-13 Connecting the modular safety system in separate electrical cabinets using SINAMICS G120 with CU240E-2 as example

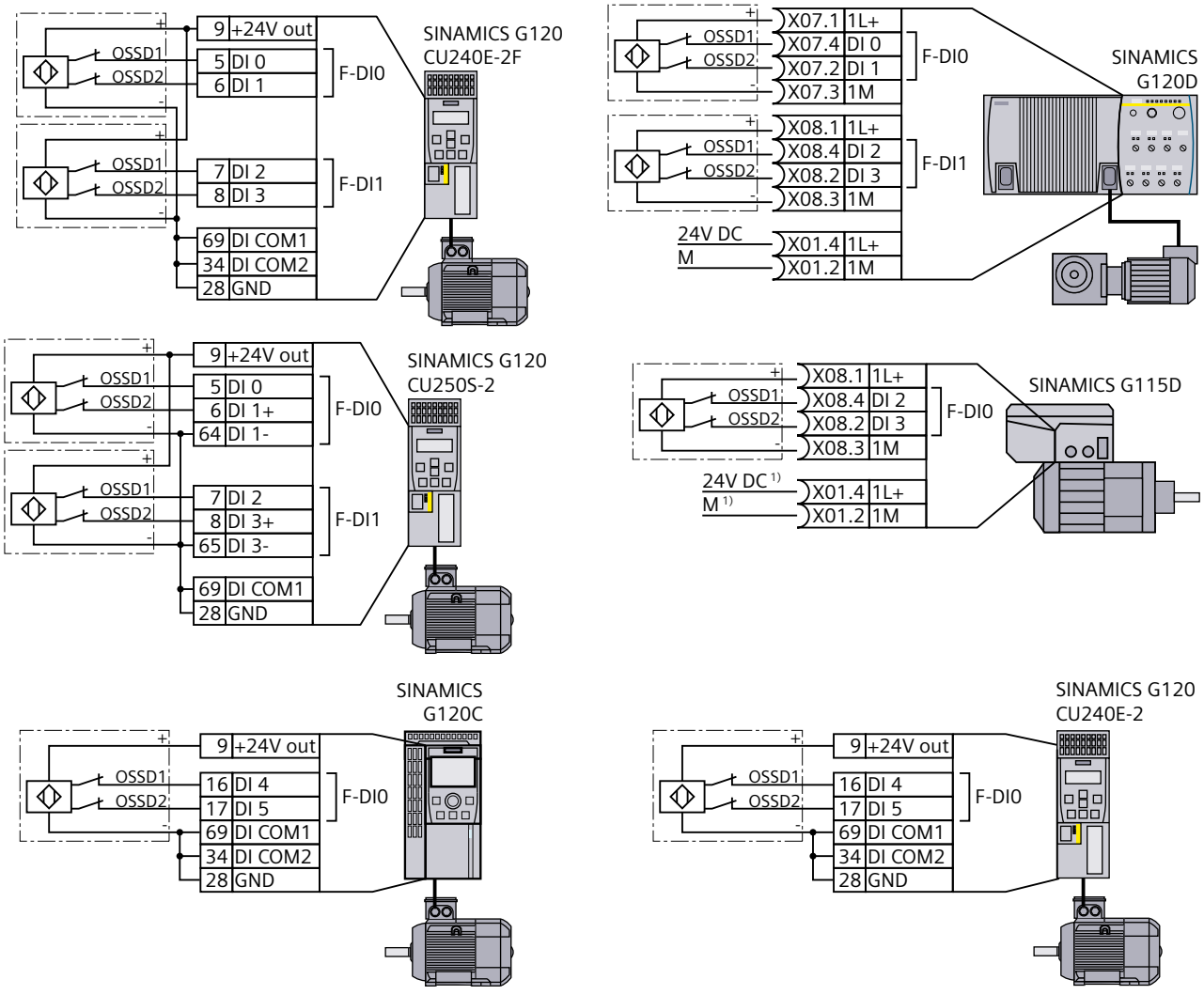
For configurations and designs in separate control cabinets, route cables between the modular safety system and the converter so that they are protected against cross circuits and short circuits.

If you wish to use the failsafe digital outputs of the 3RK3 central unit for a two-channel signal transfer, then you must adapt the discrepancy monitoring of the converter to the different switching times of electronic output and relay contact.

4.4.3.6 Sensors with OSSD outputs

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 supplies the power supply voltage



1) Connection only required for SINAMICS G115D without integrated 24 V power supply unit

Figure 4-14 Connecting a sensor with OSSD outputs, power supply from the converter

External power supply

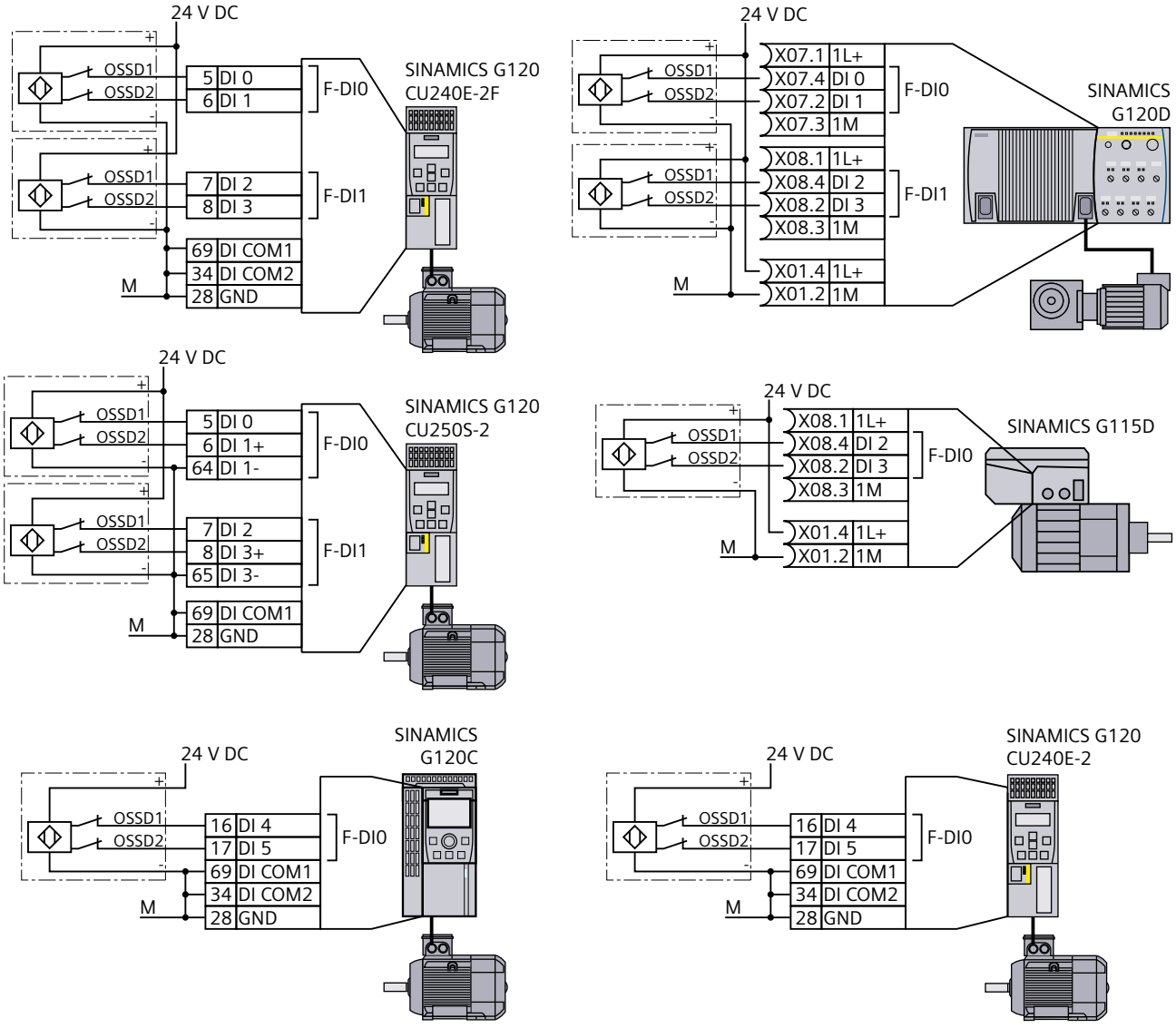


Figure 4-15 Connecting a sensor with OSSD outputs, external power supply

4.4.3.7 SIMATIC I/O modules

The diagrams only show the interconnection between the SIMATIC I/O modules and a converter shown as example. You can find additional information about the I/O modules in the Internet

- S7-300 (https://support.industry.siemens.com/cs/ww/en/view/19026151)
- S7-1500 (https://support.industry.siemens.com/cs/ww/en/view/86140384)
- ET 200S (https://support.industry.siemens.com/cs/ww/en/view/12490437)
- ET 200SP (https://support.industry.siemens.com/cs/ww/en/view/84133942)
- ET 200pro (https://support.industry.siemens.com/cs/ww/en/view/22098524)

Components in the same control cabinet, PP-switching outputs

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

As a consequence, for PP-switching failsafe digital outputs, in an electrical cabinet you may connect the converter to the I/O module through a single channel cable connection. At the converter, you must connect both terminals of the failsafe digital input with one another.

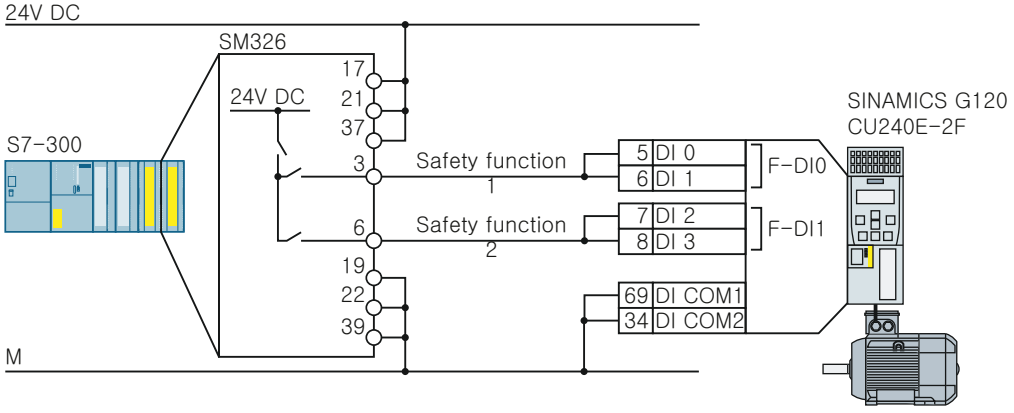


Figure 4-16 Connecting an SM326 module using a SINAMICS G120 with CU240E-2 as example

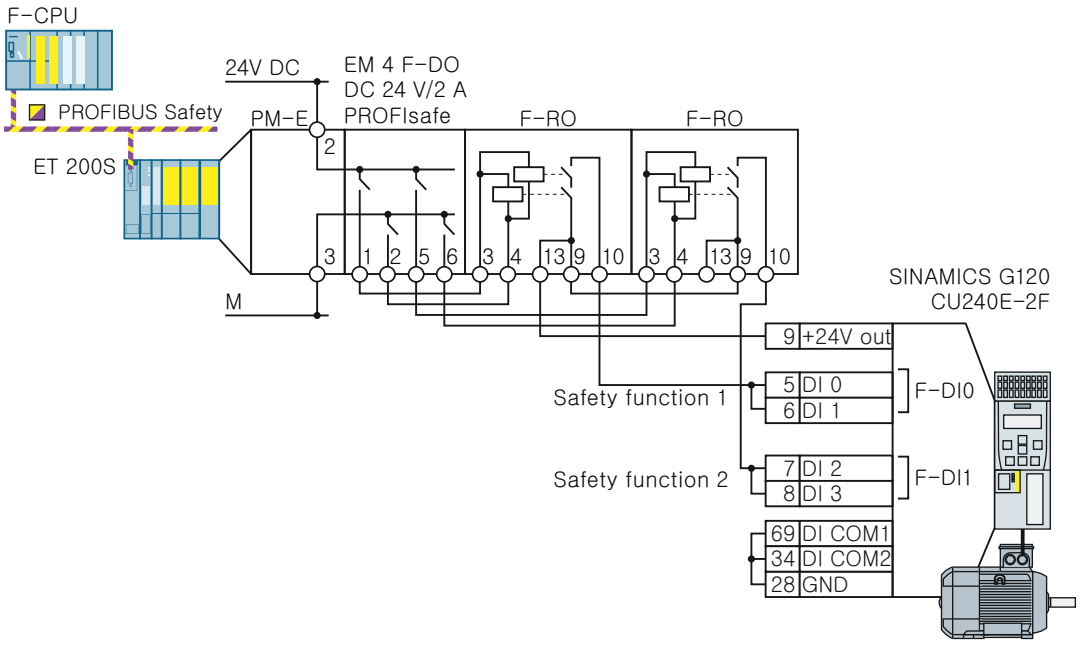


Figure 4-17 Connecting an ET 200S module using a SINAMICS G120 with CU240E-2 as example

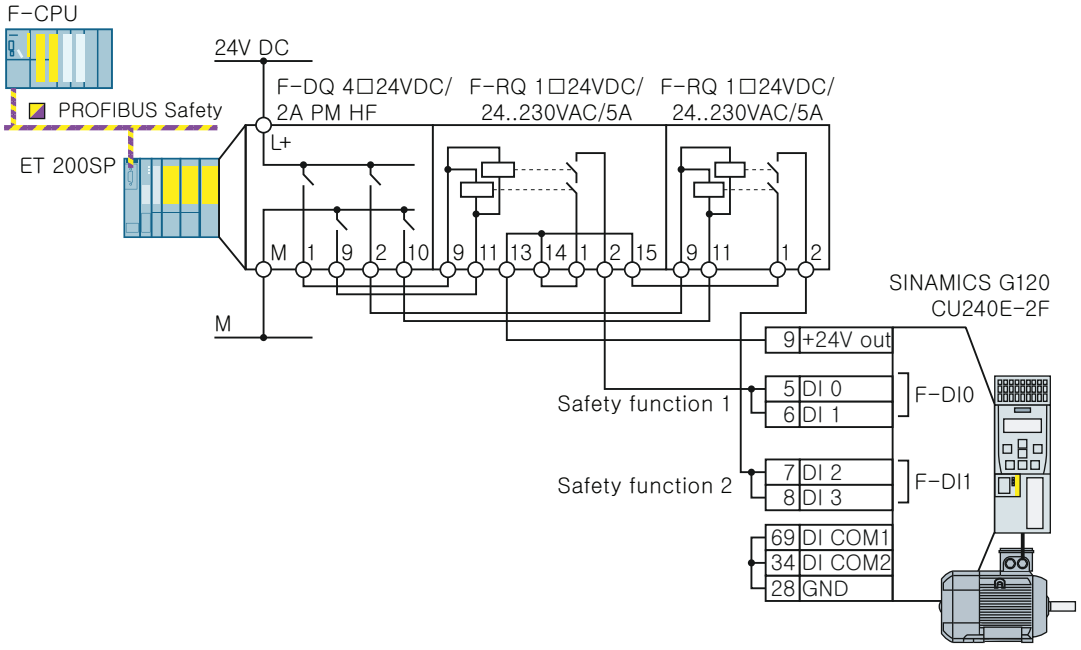
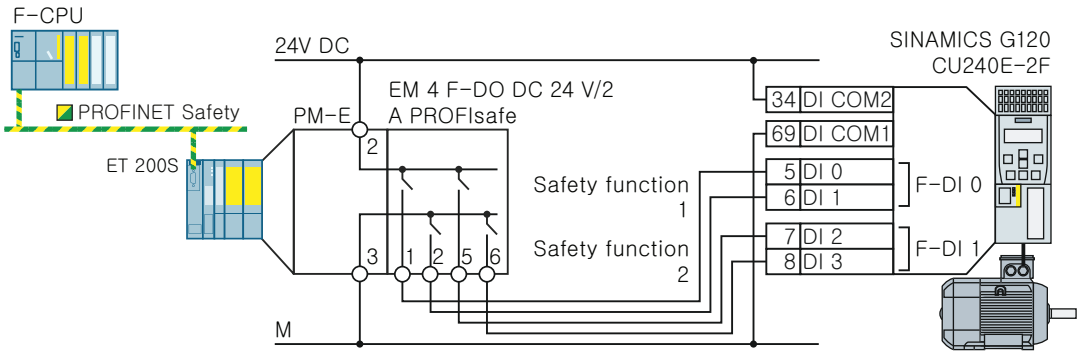


Figure 4-18 Connecting an ET 200SP module using a SINAMICS G120 with CU240E-2 as example

Components in the same control cabinet, PM-switching outputs

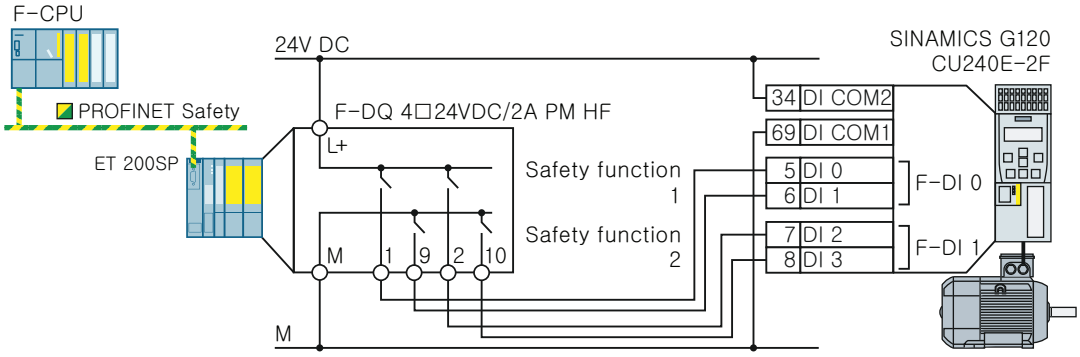
You must use a two-channel cable connection when connecting PM-switching failsafe digital outputs to a failsafe digital input.



DI COM1 Reference potential for digital inputs DI 0 and DI 2

DI COM2 Reference potential for digital inputs DI 1 and DI 3

Figure 4-19 Connecting PM-switching ET 200S outputs using a SINAMICS G120 with CU240E-2 as example

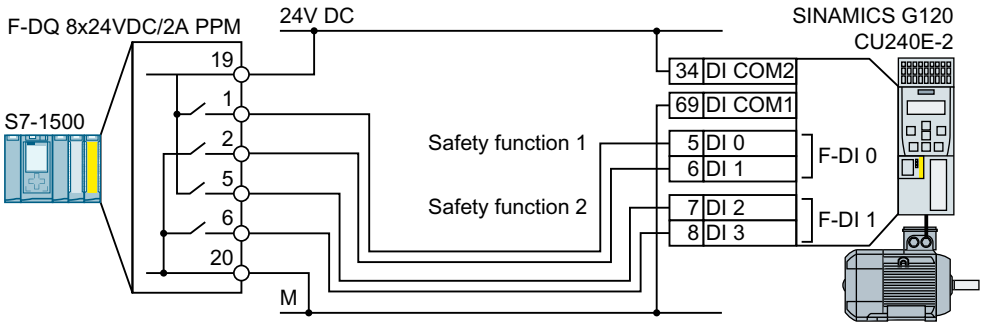


[1] The wiring of the ET 200SP shows as example, the supply of a new potential group when using a bright base unit.

DI COM1 Reference potential for digital inputs DI 0 and DI 2

DI COM2 Reference potential for digital inputs DI 1 and DI 3

Figure 4-20 Connecting PM-switching ET 200SP outputs using a SINAMICS G120 with CU240E-2 as example



DI COM1 Reference potential for digital inputs DI 0 and DI 2

DI COM2 Reference potential for digital inputs DI 1 and DI 3

Figure 4-21 Connecting PM-switching S7-1500 outputs using a SINAMICS G120 with CU240E-2 as example

Components in separate control cabinets

A two-channel cable connection is required when installed in separate electrical cabinets. You must protect the cables between the I/O modules and the converter against cross and short-circuits - or ensure that a cross or short-circuit results in a discrepancy error.

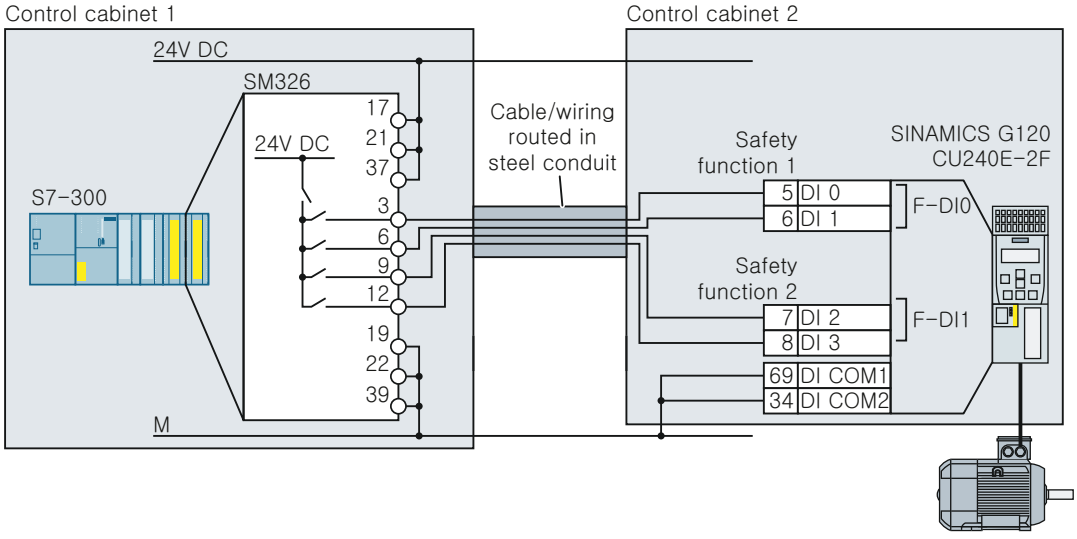
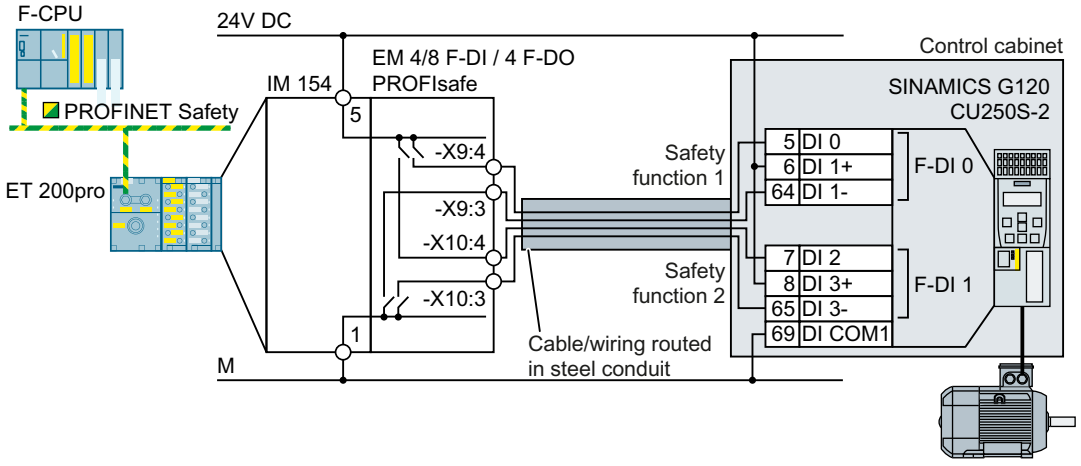


Figure 4-22 Connecting the PP switching module SM326 using a SINAMICS G120 with CU240E-2 as example

Components not in a control cabinet

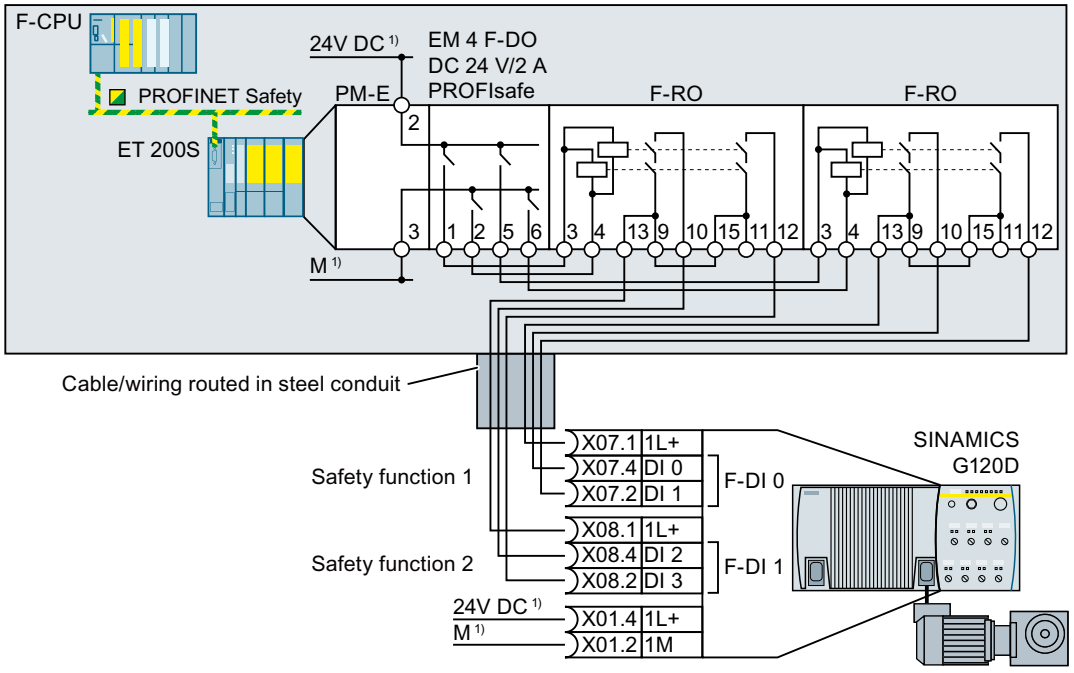
A two-channel cable connection is required when connecting components not installed in a control cabinet to a control cabinet. You must protect the cables between the I/O modules and the converter against cross and short-circuits - or ensure that a cross or short-circuit results in a discrepancy error.



SINAMICS G120D requires a PP-switching failsafe output.

DI COM1 Reference potential for digital inputs DI 0 and DI 2

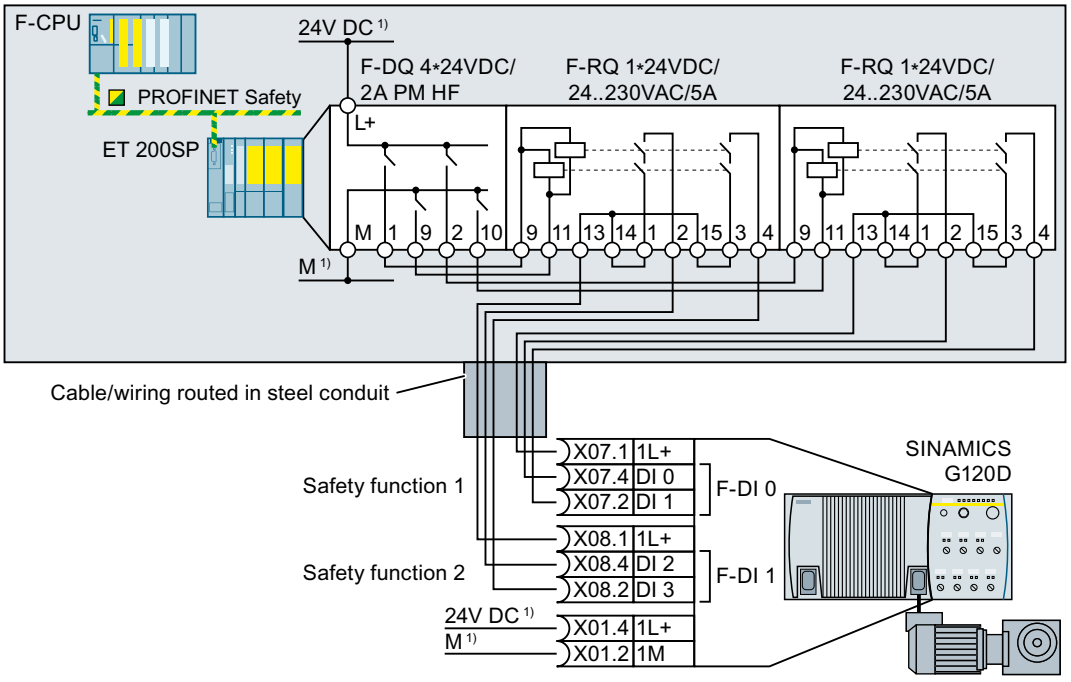
Figure 4-23 Connecting PM-switching ET 200pro outputs using a SINAMICS G120 with CU250S-2 as example



SINAMICS G120D requires a PP-switching failsafe output.

1) You may operate the converter and the ET 200S with different 24-V supplies - as well as with the same 24-V supply.

Figure 4-24 Connecting ET 200S modules using a SINAMICS G120D as example

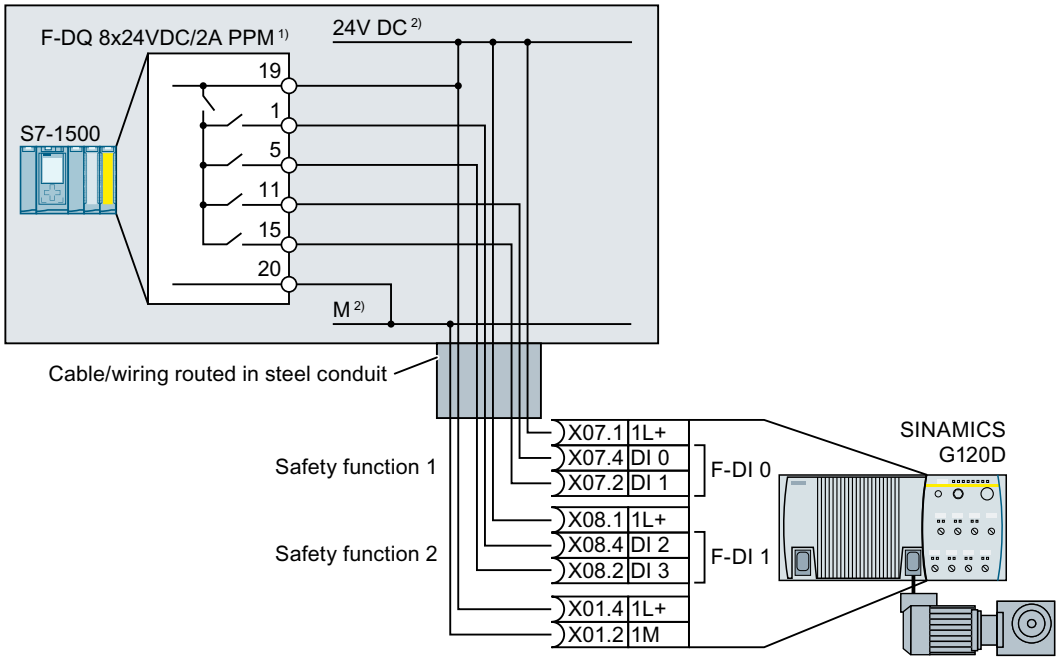


SINAMICS G120D requires a PP-switching failsafe output.

1) The wiring of the ET 200SP shows as example, the supply of a new potential group when using a bright base unit.

You may operate the converter and the ET 200SP with different 24-V supplies - as well as with the same 24-V supply.

Figure 4-25 Connecting ET 200SP modules using a SINAMICS G120D as example



SINAMICS G120D requires a PP-switching failsafe output.

1) The F-DQ module must be configured to be PP-switching.

2) You may operate the converter and the S7-1500 with different 24-V supplies - as well as with the same 24-V supply.

Figure 4-26 Connecting the S7-1500 using a SINAMICS G120D as example

4.4.3.8 SINAMICS G120 converters with CU230P-2 Control Unit

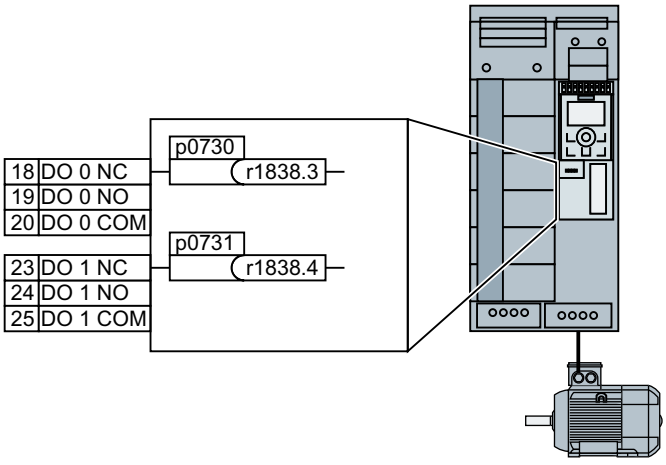
Overview

A higher-level control system is required to select the STO safety function.

Requirement

The following requirements apply:

- The converter signals that the STO safety function is being controlled to the higher-level control system using two digital outputs:
  - For converters with PM240-2 and PM240P-2 Power Modules, you must interconnect feedback signals "STO is active" with two digital outputs.



  - For converters with PM330 Power Modules, you can use terminal strip -X41.
- The higher-level control system monitors the selection of the STO safety function and the feedback from the converter.
- Forced checking procedure (test stop):
  The higher-level control system regularly selects the STO safety function and evaluates the converter feedback signal.
  We recommend that you implement a time monitoring function in the higher-level control system, which issues an alarm if a test stop is overdue.
- Suitable higher-level controllers
  - SIRIUS 3SK1: Single-channel static feedback circuit
  - SIRIUS 3SK2: Two-channel dynamic feedback circuit
  - MSS 3RK3: Two-channel dynamic feedback circuit
  - SIMATIC: Feedback circuit monitoring in the safety program
- Forced checking procedure (test stop) once per year

Function description

SIRIUS 3SK1 safety relay

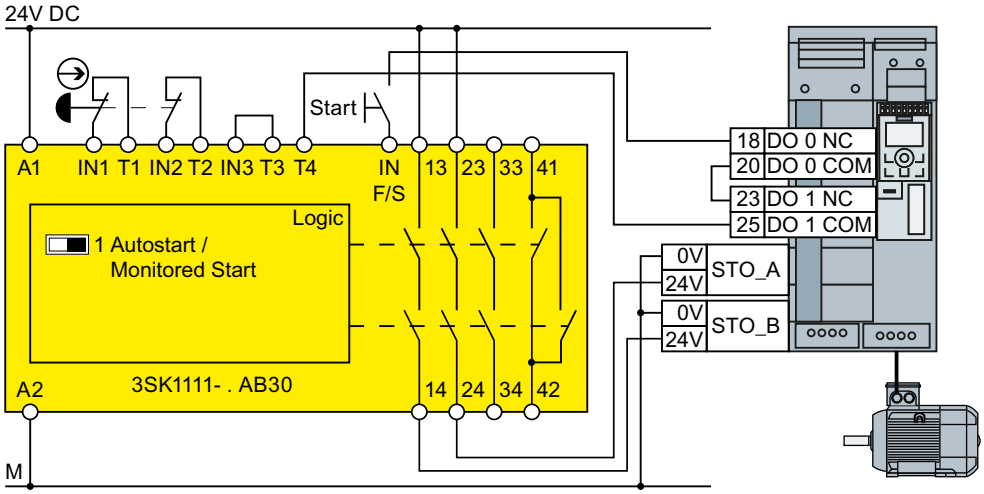


Figure 4-27 Connection of 3SK1 inside a control cabinet for FSD ... FSG

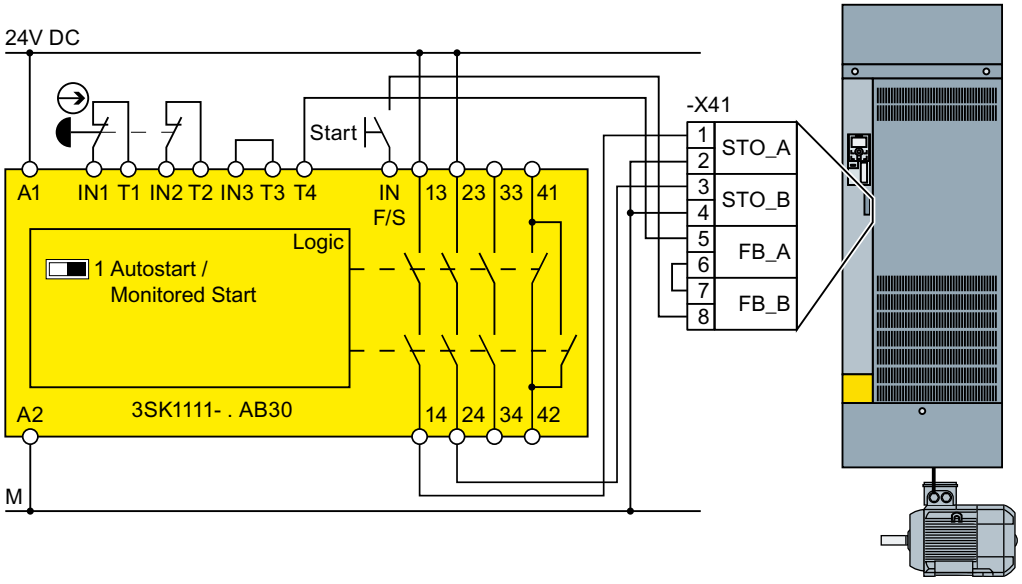


Figure 4-28 Connection of 3SK1 inside a control cabinet for FSGX, FSHX and FSJX

SIRIUS 3SK2 safety relay

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

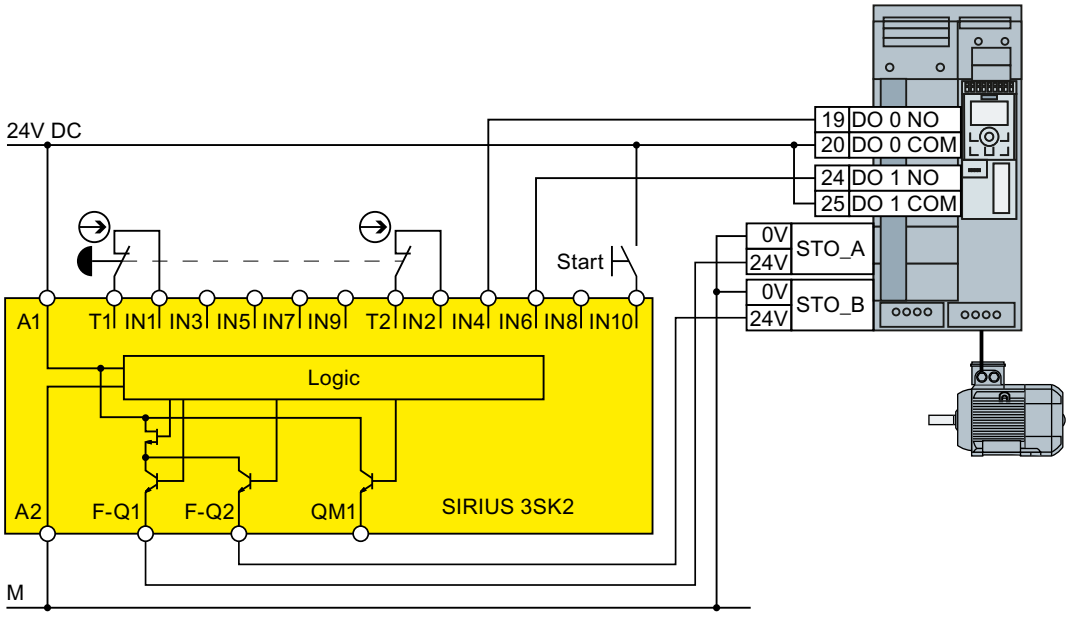
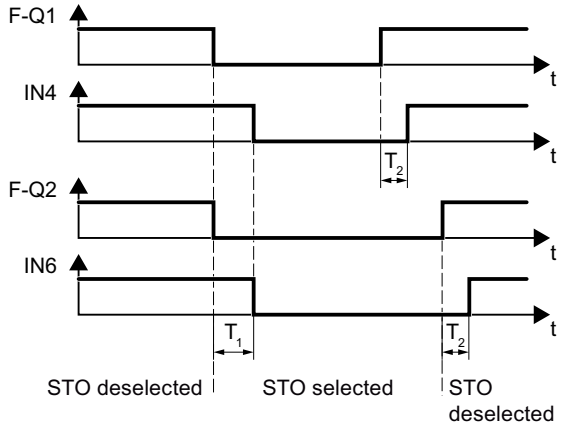


Figure 4-29 Connection of 3SK2 inside a control cabinet for FSD ... FSG



$T_1 \geq 30$ ms

$T_2 \geq 20$ ms

In case of deviating feedback, the safety relay must select the STO function and indicate an error.

Figure 4-30 Dynamic monitoring of STO feedback signal for FSD ... FSG

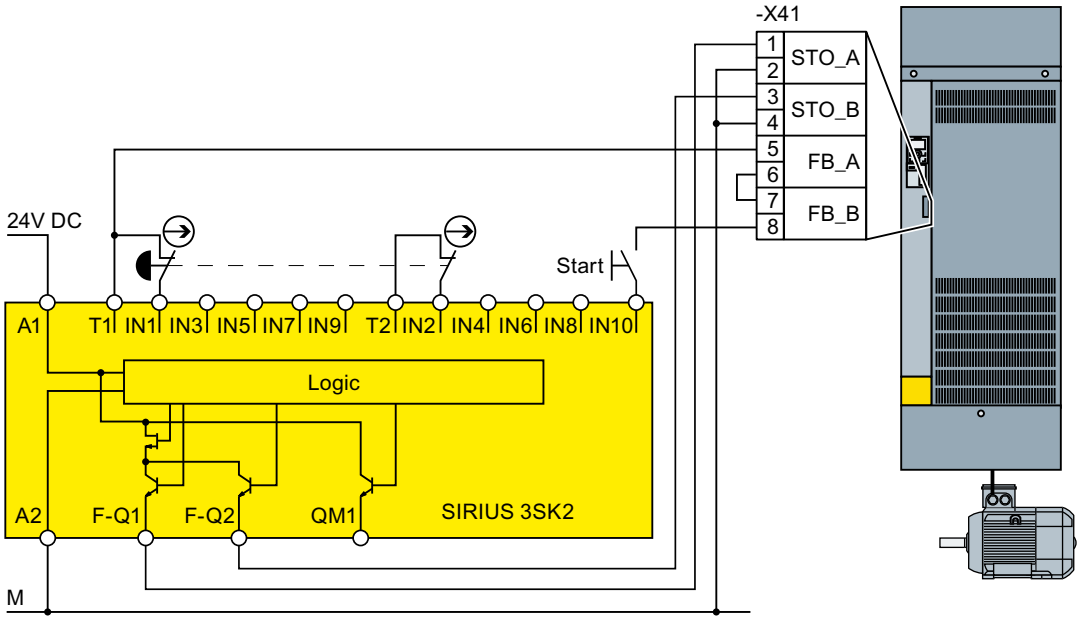


Figure 4-31 Connection of 3SK2 inside a control cabinet for FSGX, FSHX and FSJX

When starting, static monitoring of the STO feedback signal is sufficient for converters FSGX, FSHX and FSJX.

3RK3 Modular Safety System

You can use the following outputs to control the failsafe digital inputs in the converter:

- The failsafe digital outputs in the central units of the 3RK3 modular safety system
- The failsafe digital outputs in the EM 2/4F-DI 2F-DO expansion module
- The failsafe digital outputs in the EM 4F-DO expansion module.
- The failsafe relay outputs in the EM 4/8F-RO expansion module
- 2 individual relay contacts of the EM 2/4F-DI 1/2F-RO expansion module

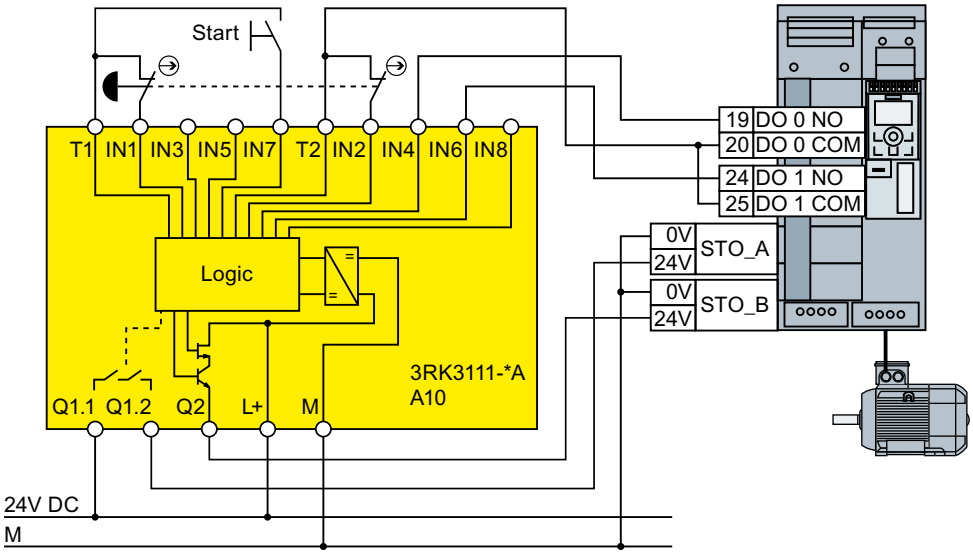
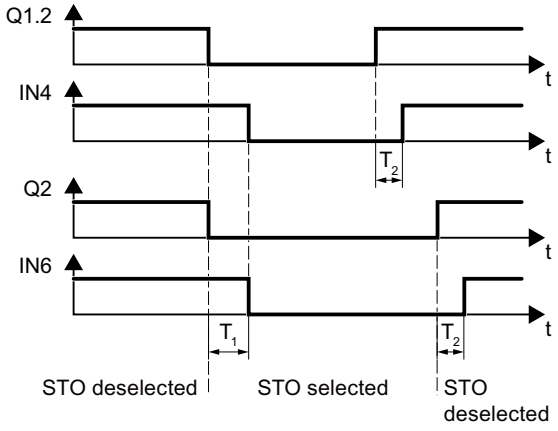


Figure 4-32 Connection of 3RK3 inside a control cabinet for FSD ... FSG



$T_1 \geq 30$ ms

$T_2 \geq 20$ ms

In case of deviating feedback, the Modular Safety System must select the STO function and indicate an error.

Figure 4-33 Dynamic monitoring of STO feedback signal for FSD ... FSG

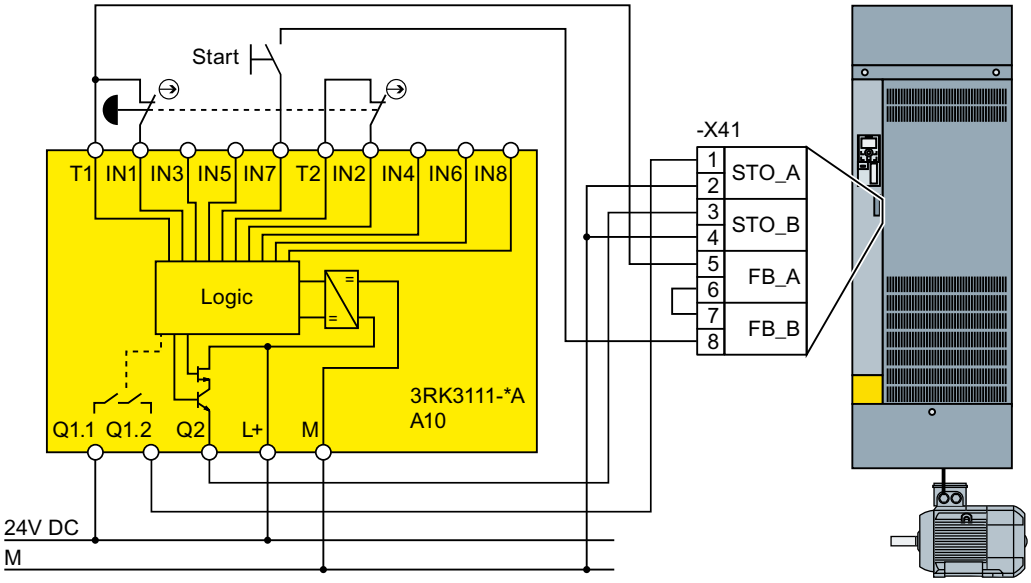


Figure 4-34 Connection of 3RK3 inside a control cabinet for FSGX, FSHX and FSJX

When starting, static monitoring of the STO feedback signal is sufficient for converters FSGX, FSHX and FSJX.

SIMATIC I/O modules

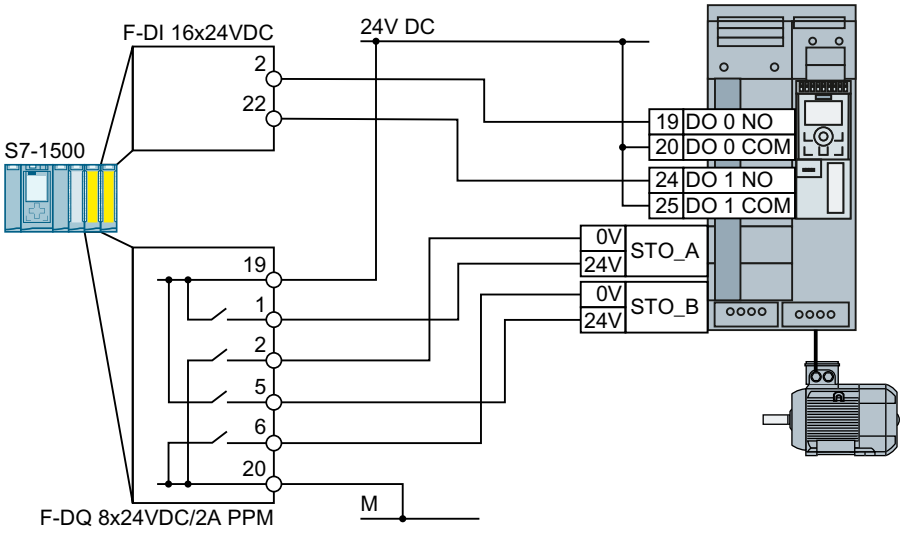
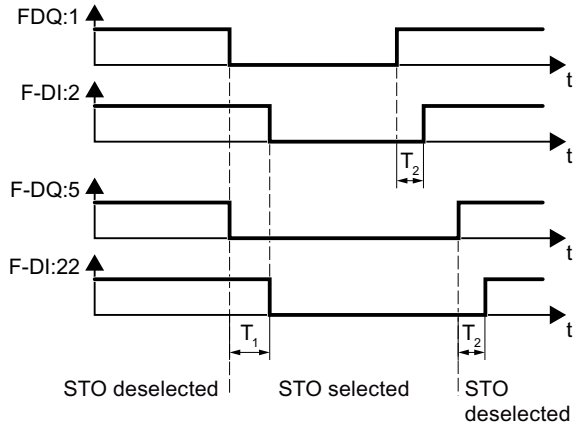


Figure 4-35 Connecting the SIMATIC S7-1500 in a control cabinet for FSD ... FSG



$T_1 \geq 30$ ms
$T_2 \geq 20$ ms

In case of deviating feedback, the SIMATIC must select the STO function and indicate an error.

Figure 4-36 Dynamic monitoring of STO feedback signal for FSD ... FSG

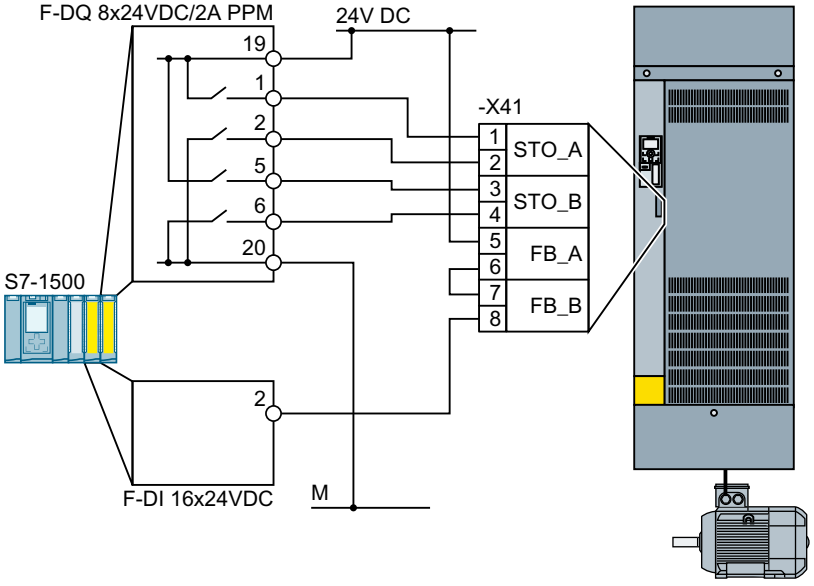


Figure 4-37 Connecting the SIMATIC S7-1500 in a control cabinet for FSGX, FSHX and FSJX

Static monitoring of the STO feedback signal when STO is selected is sufficient for converters FSGX, FSHX and FSJX.

Further information

Further information is provided on the Internet:

SIRIUS 3SK1 safety relays (https://support.industry.siemens.com/cs/ww/en/ps/16381/man)

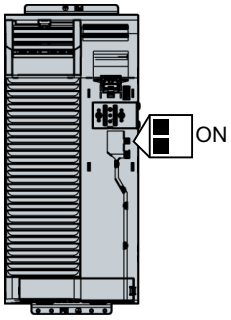
SIRIUS 3SK2 Safety Relays (https://support.industry.siemens.com/cs/ww/en/view/109444336)

SIRIUS 3RK3 modular safety system manual (https://support.industry.siemens.com/cs/ww/en/view/26493228)

- S7-1500 (https://support.industry.siemens.com/cs/ww/en/view/86140384)
- ET 200SP (https://support.industry.siemens.com/cs/ww/en/view/84133942)
- ET 200pro (https://support.industry.siemens.com/cs/ww/en/view/22098524)
- ET 200S (https://support.industry.siemens.com/cs/ww/en/view/12490437)
- S7-300 (https://support.industry.siemens.com/cs/ww/en/view/19026151)

4.4.4 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.



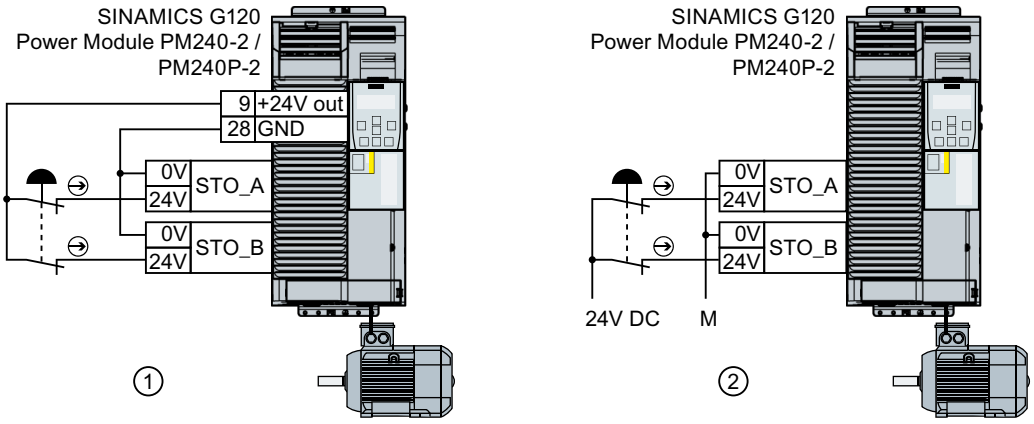
Preconditions when using the STO safety function according to SIL 3:

- You are using a PM240-2 or PM240P-2, FSD ... FSF Power Module
- You control the STO safety function using the terminals of the PM240-2 or PM240P-2 Power Module.
- Both switches on the Power Module are in the “ON” position.

If, in an example, two or more terminals of the converter are connected together, then you must connect jumpers that are as short as possible directly at the terminals.

4.4.4.1 Electromechanical sensor

Connecting an electromechanical sensor

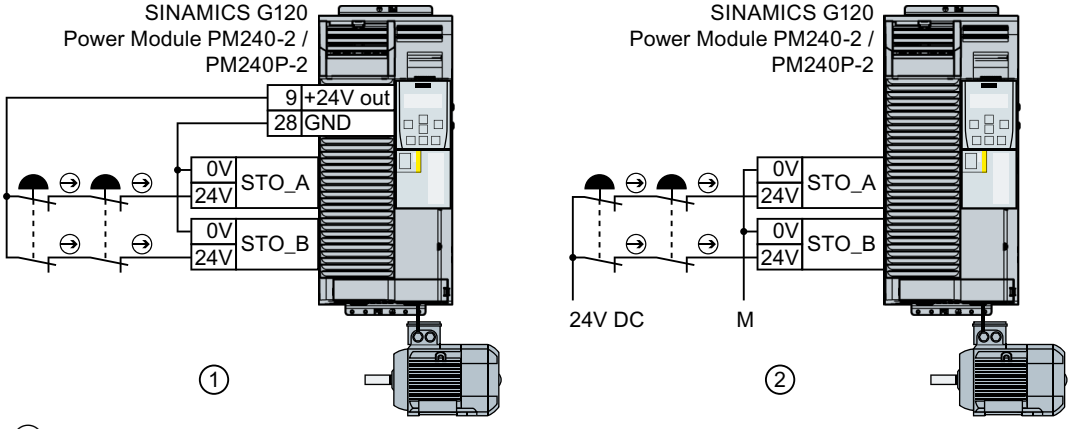


① Power supply voltage from terminal 9 of the Control Unit
② External power supply

Figure 4-38 Connecting an electromechanical sensor

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

Connecting several electromechanical sensors in series



① The converter provides the supply voltage
② External power supply

Figure 4-39 Connecting several electromechanical sensors in series

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 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 converter must be protected, for example, by routing them in a steel tube.

Controlling several converters simultaneously

You may control the safety functions of several converters 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 converter must be protected, for example, by routing them in a steel tube.

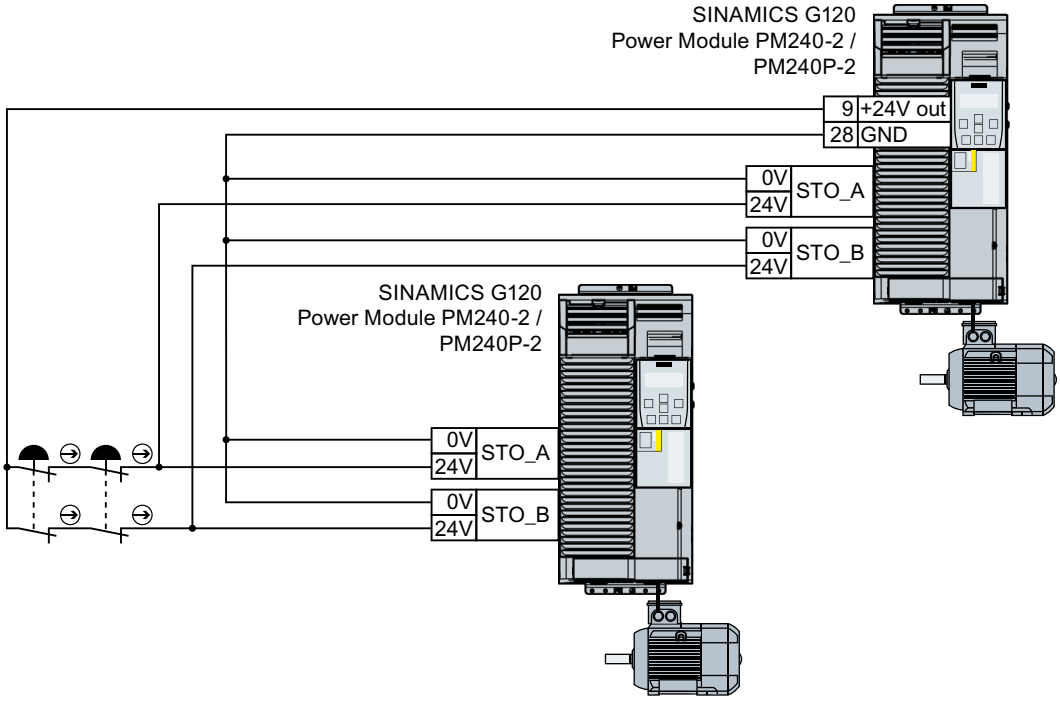


Figure 4-40 Controlling several converters in parallel with the power supply from the converter

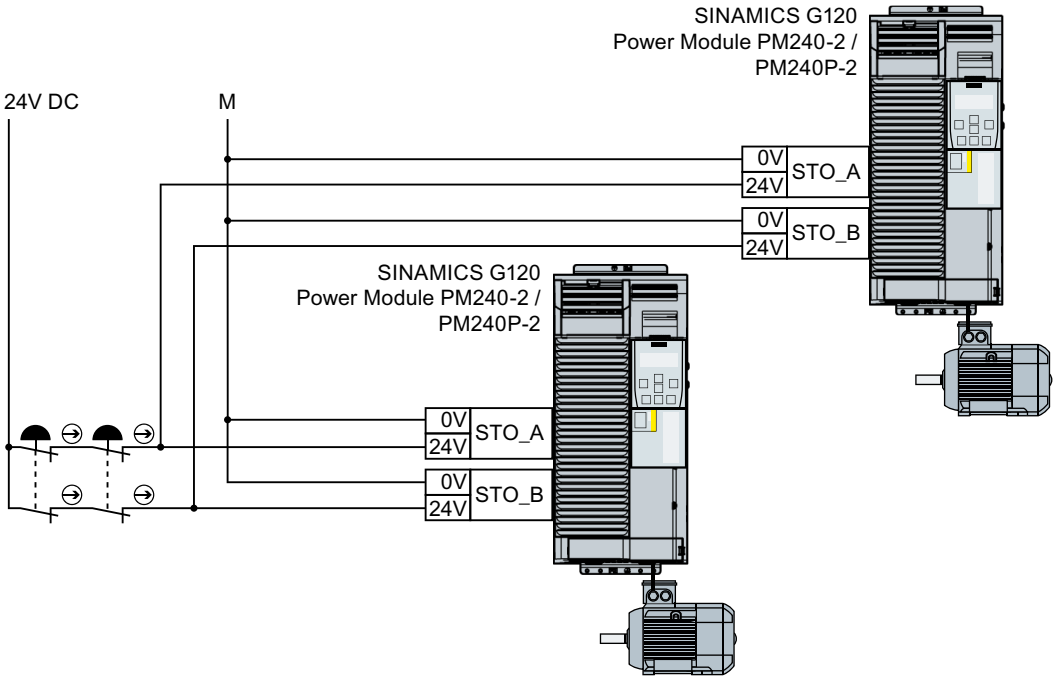


Figure 4-41 Controlling several converters in parallel with an external power supply

4.4.4.2 SIRIUS 3SK1 safety relay

The wiring examples listed below are implemented using 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 converter are interconnected.

You will find additional information about the safety related on the Internet:

SIRIUS 3SK1 safety relays (https://support.industry.siemens.com/cs/ww/en/ps/16381/man)

Components in the same control cabinet

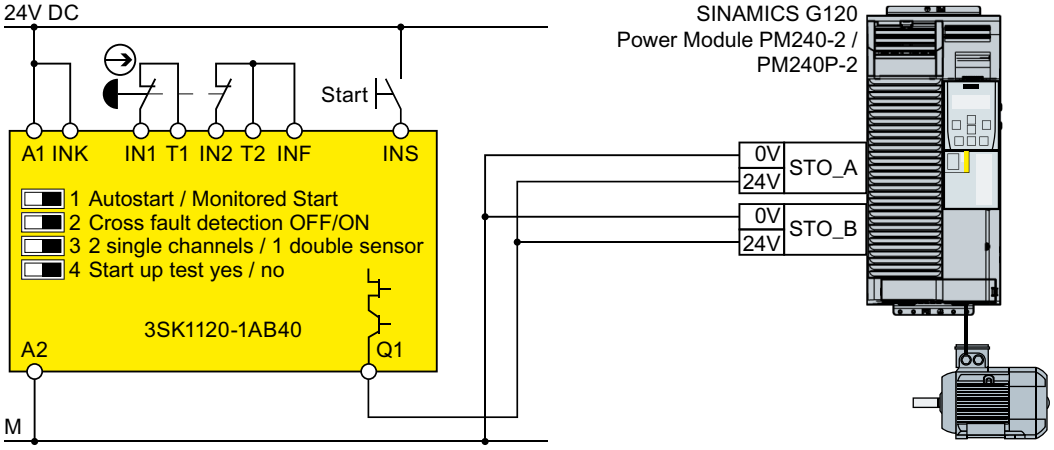


Figure 4-42 Wiring the converter and safety relay within a control cabinet

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 converter through a single-channel cable connection. At the converter, you must connect both terminals of the failsafe digital input with one another.

Components in separate control cabinets

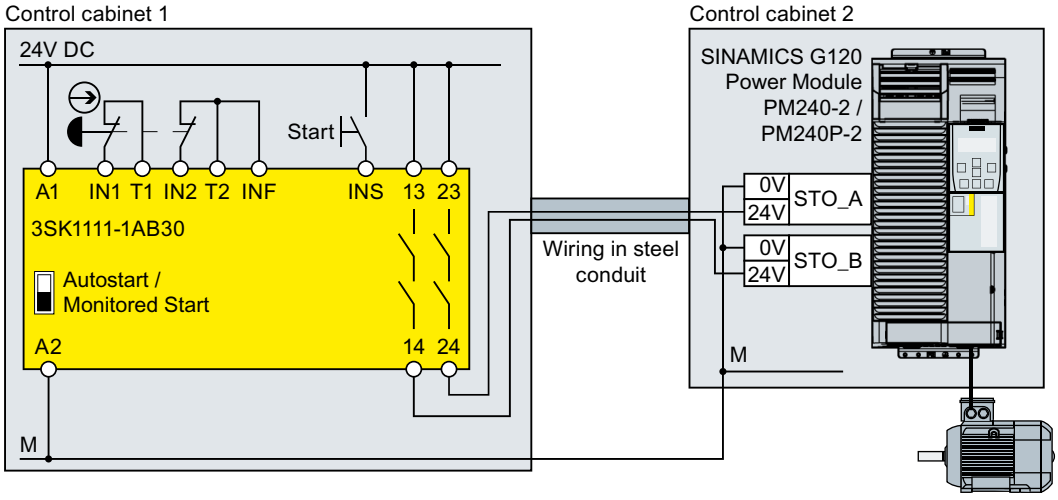


Figure 4-43 Wiring converters and safety relays in separate control cabinets

For configurations in separate control cabinets, the cables between the safety relay and the failsafe digital inputs of the converter must be protected against cross circuits and short-circuits.

4.4.4.3 3RK3 Modular Safety System

You can use the following outputs to control the failsafe digital inputs in the converter:

- The failsafe digital outputs in the central units of the 3RK3 modular safety system
- The failsafe digital outputs in the EM 2/4F-DI 2F-DO expansion module.
- The failsafe digital outputs in the EM 4F-DO expansion module.
- The failsafe relay outputs in the EM 4/8F-RO expansion module
- Two individual relay contacts of the EM 2/4F-DI 1/2F-RO expansion module.

The diagrams only show the wiring between the 3RK3 modular safety system and the converter.

You can find additional information on the 3RK3 modular safety system on the Internet:

SIRIUS 3RK3 modular safety system manual (https://support.industry.siemens.com/cs/ww/en/view/26493228)

Components in the same control cabinet

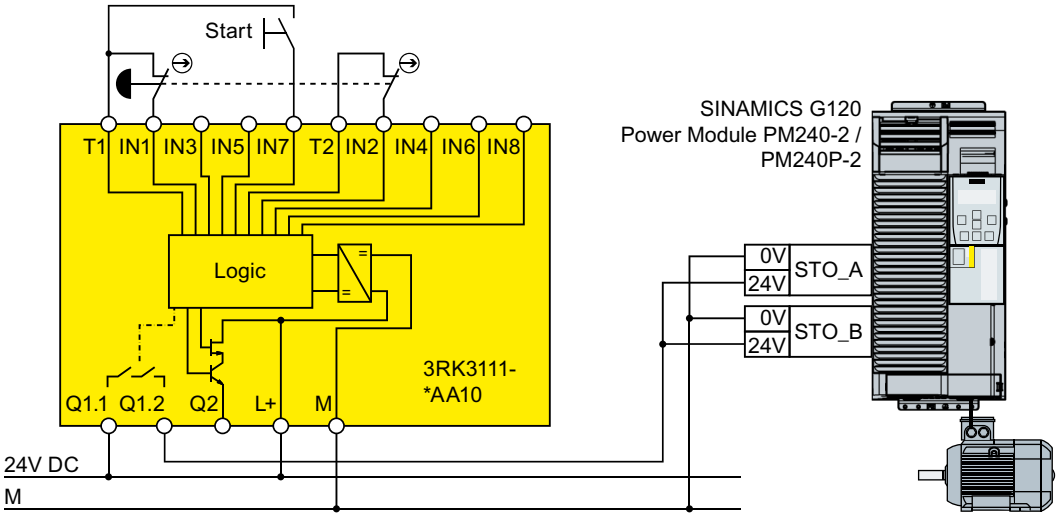


Figure 4-44 Wiring converters and modular safety system within one control cabinet

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 converter via a single-channel cable connection. At the converter, you must connect both terminals of the failsafe digital input with one another.

Components in separate control cabinets

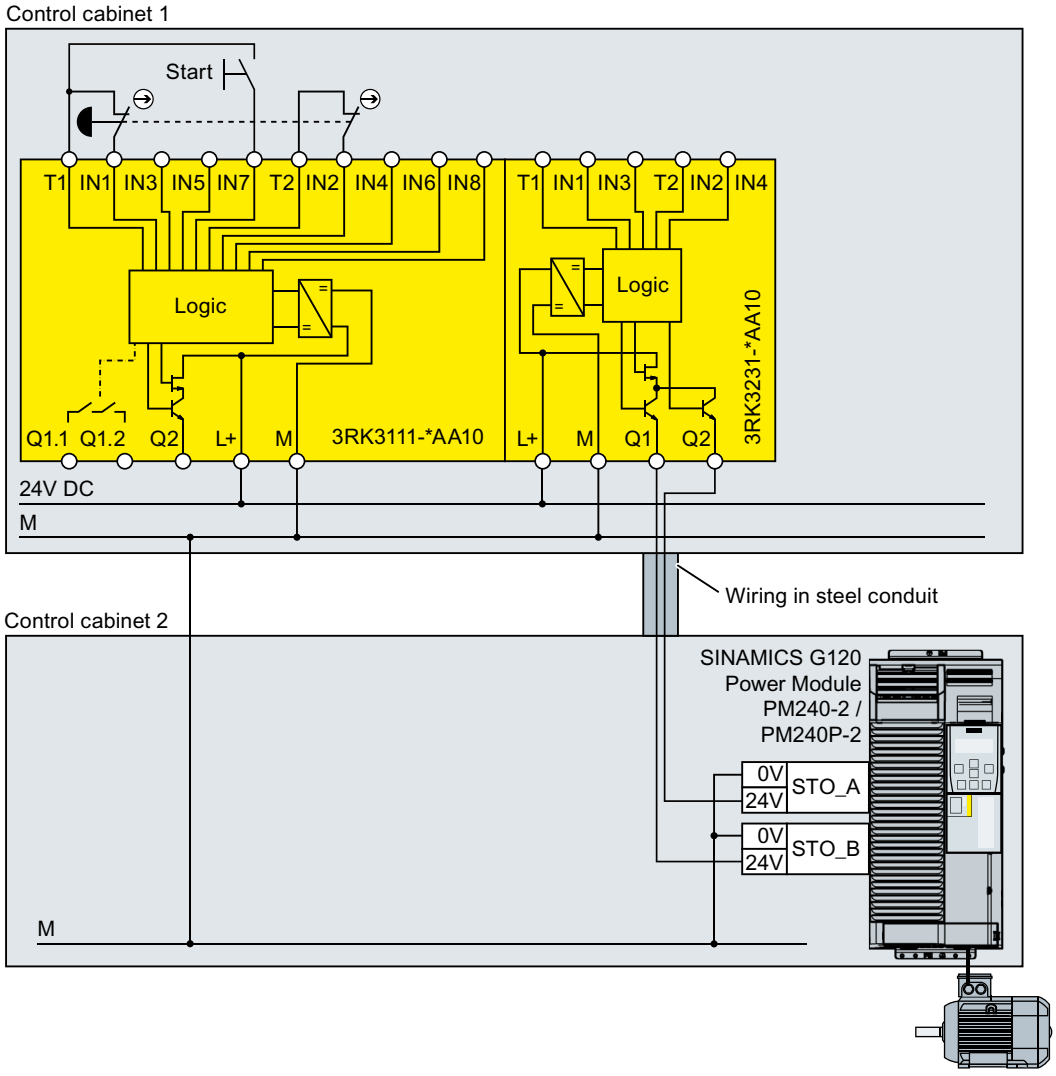


Figure 4-45 Wiring converters and modular safety systems in separate control cabinets

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

If you wish to use the failsafe digital outputs of the 3RK3 central unit for a two-channel signal transfer, then you must adapt the discrepancy monitoring of the converter to the different switching times of electronic output and relay contact.

4.4.4.4 SIMATIC I/O modules

The diagrams only show the interconnection between the SIMATIC I/O modules and a converter shown as example. You can find additional information about the I/O modules in the Internet

- S7-300 (https://support.industry.siemens.com/cs/ww/en/view/19026151)
- S7-1500 (https://support.industry.siemens.com/cs/ww/en/view/86140384)
- ET 200S (https://support.industry.siemens.com/cs/ww/en/view/12490437)
- ET 200SP (https://support.industry.siemens.com/cs/ww/en/view/84133942)
- ET 200pro (https://support.industry.siemens.com/cs/ww/en/view/22098524)

Components in the same control cabinet

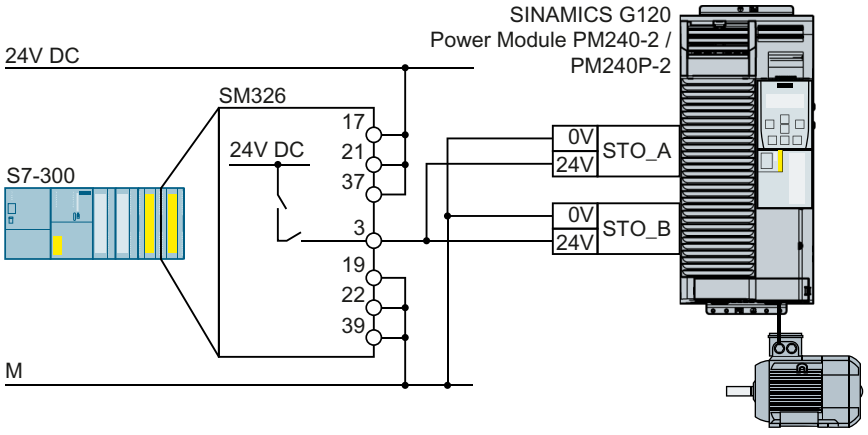


Figure 4-46 Connecting the PP switching module SM326

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

As a consequence, for PP-switching failsafe digital outputs, in an electrical cabinet you may connect the converter to the I/O module through a single channel cable connection. At the converter, you must connect both terminals of the failsafe digital input with one another.

You must use a two-channel cable connection when connecting PM-switching failsafe digital outputs to a failsafe digital input.

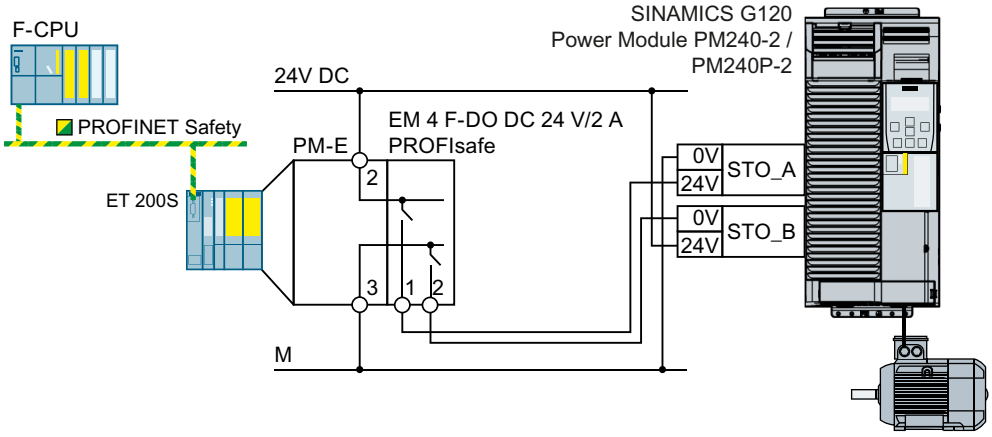


Figure 4-47 Connecting a PM-switching ET 200S module

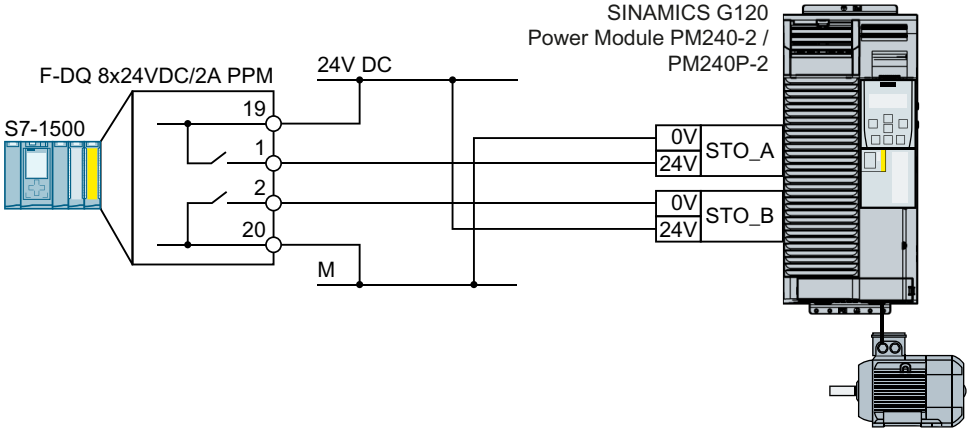


Figure 4-48 Connecting a PM-switching S7-1500 module

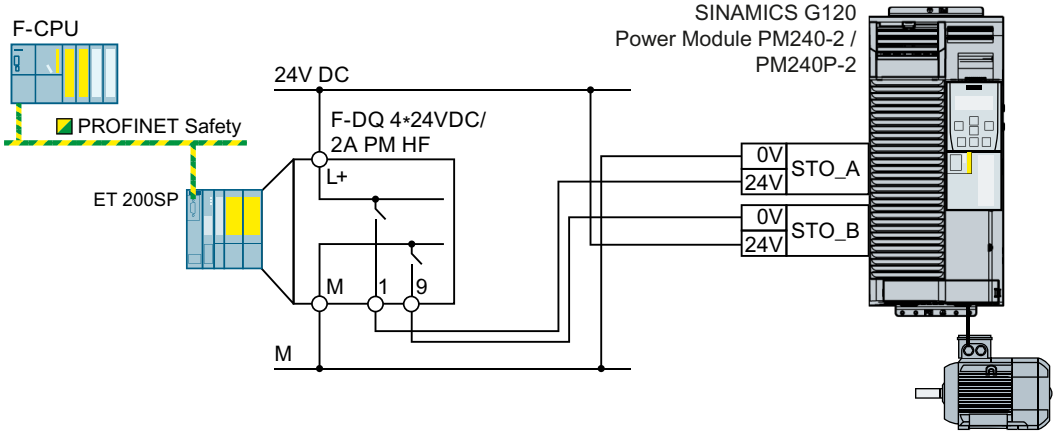


Figure 4-49 Connecting a PM-switching ET 200SP module

Components in separate electrical cabinets or components not installed in an electrical cabinet

A two-channel cable connection is required when installed in separate electrical cabinets - or when connecting components not installed in an electrical cabinet to an electrical cabinet. You must protect the cables between the I/O modules and the converter against cross and short-circuits - or ensure that a cross or short-circuit results in a discrepancy error.

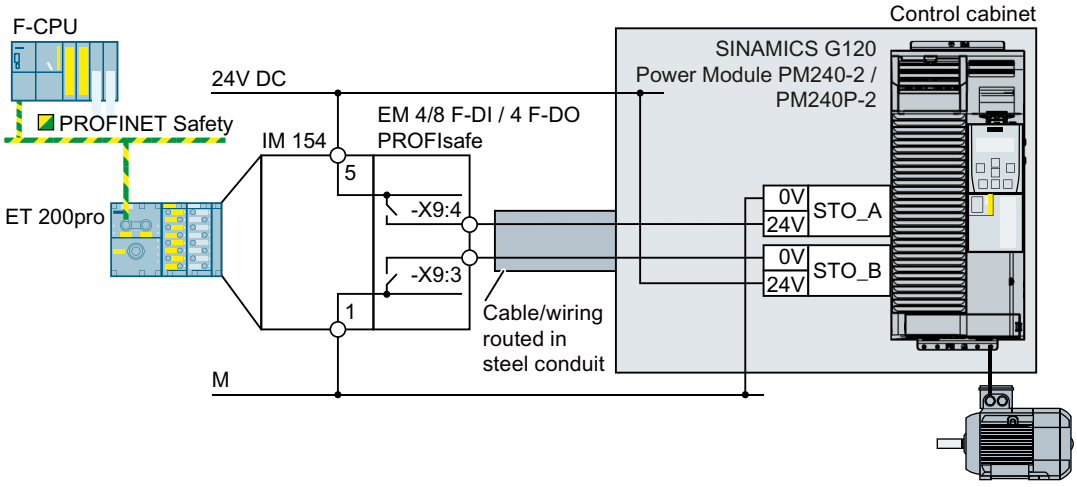


Figure 4-50 Connecting a PM-switching ET 200pro module

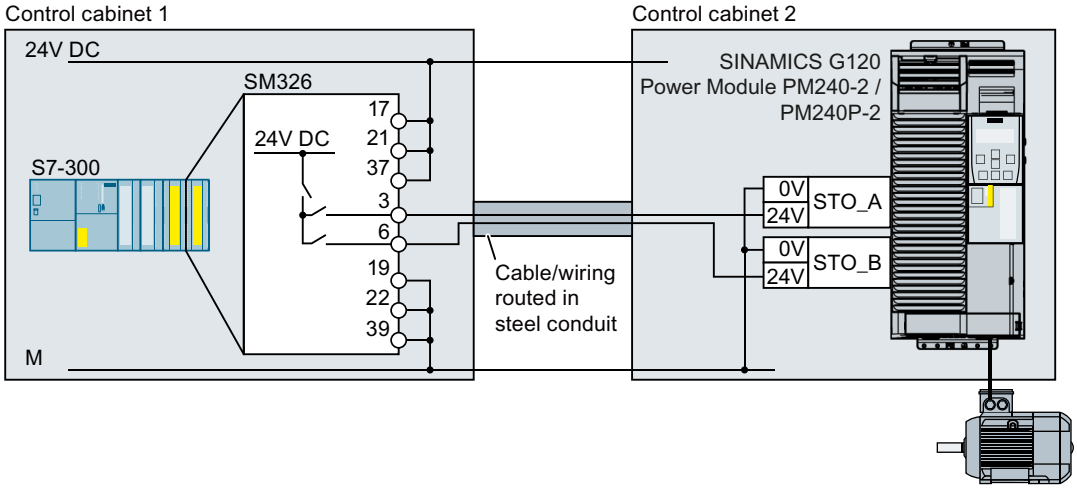


Figure 4-51 Connecting the PP switching module SM326

4.4.4.5 SINAMICS G120 converters with CU230P-2 Control Unit

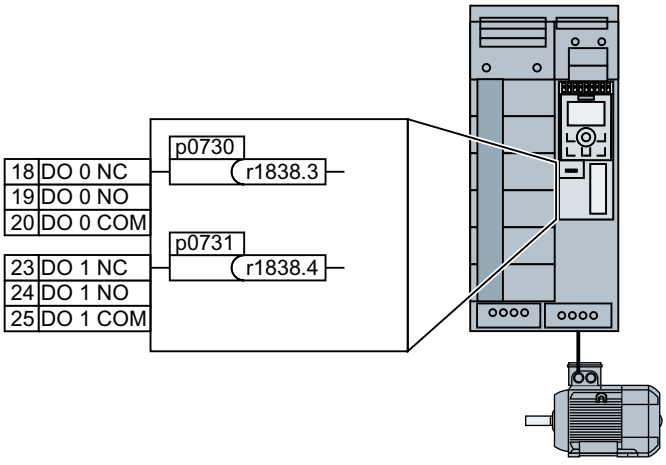
Overview

A higher-level control system is required to select the STO safety function.

Requirement

The following requirements apply:

- The converter signals that the STO safety function is being controlled to the higher-level control system using two digital outputs.
  - For converters with PM240-2 and PM240P-2 Power Modules, you must interconnect feedback signals "STO is active" with two digital outputs.



  - For converters with PM330 Power Modules, you can use terminal strip -X41.
- The higher-level control system monitors the selection of the STO safety function and the feedback from the converter.
- Forced checking procedure (test stop):
  The higher-level control system regularly selects the STO safety function and evaluates the converter feedback signal.
  We recommend that you implement a time monitoring function in the higher-level control system, which issues an alarm if a test stop is overdue.
- Suitable higher-level controllers
  - SIRIUS 3SK1: Single-channel static feedback circuit
    Permissible for converters FSH and FSJ, not permissible for FSA ... FSG
  - SIRIUS 3SK2: Two-channel dynamic feedback circuit
  - MSS 3RK3: Two-channel dynamic feedback circuit
  - SIMATIC: Feedback circuit monitoring in the safety program
- Forced checking procedure (test stop) every 3 months

Function description

SIRIUS 3SK1 safety relay

With a SIRIUS 3SK1 safety relay and FSA ... FSG converters, as a maximum, you can achieve SIL 2/PL d.

Using a SIRIUS 3SK1 safety relay, you can only achieve SIL 3/PL e using an FSGX, FSHX or FSJX converter.

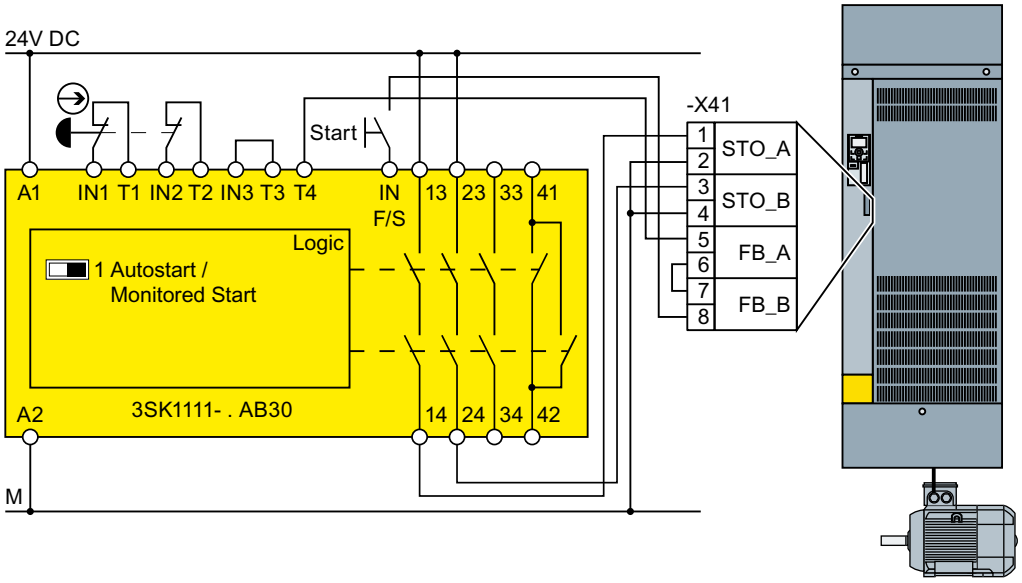


Figure 4-52 Connection 3SK1 inside a control cabinet for FSGX, FSHX and FSJX

SIRIUS 3SK2 safety relay

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

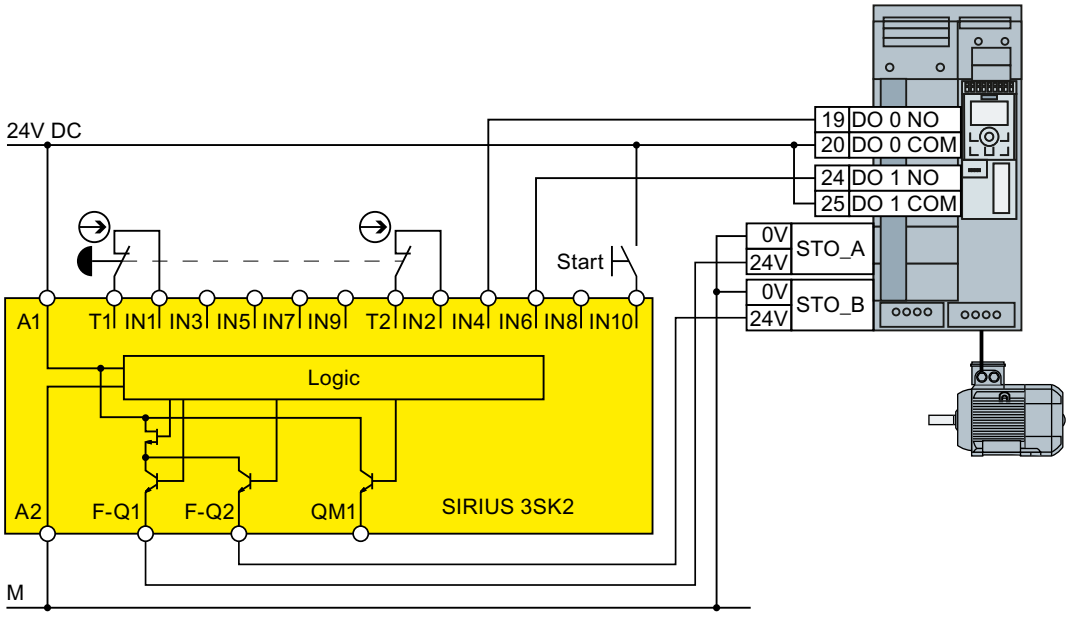
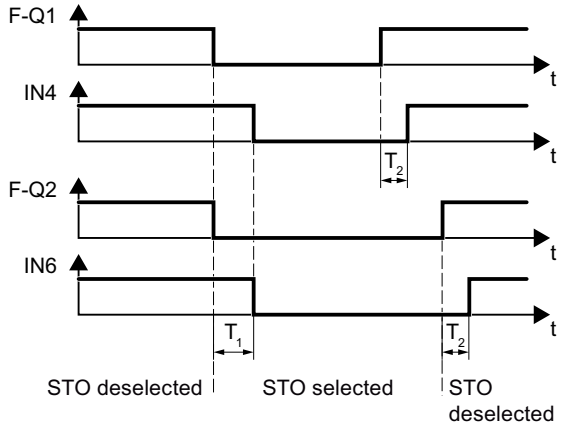


Figure 4-53 Connection 3SK2 inside a control cabinet for FSD ... FSG



$T_1 \geq 30$ ms

$T_2 \geq 20$ ms

In case of deviating feedback, the safety relay must select the STO function and indicate an error.

Figure 4-54 Dynamic monitoring of STO feedback signal for FSD ... FSG

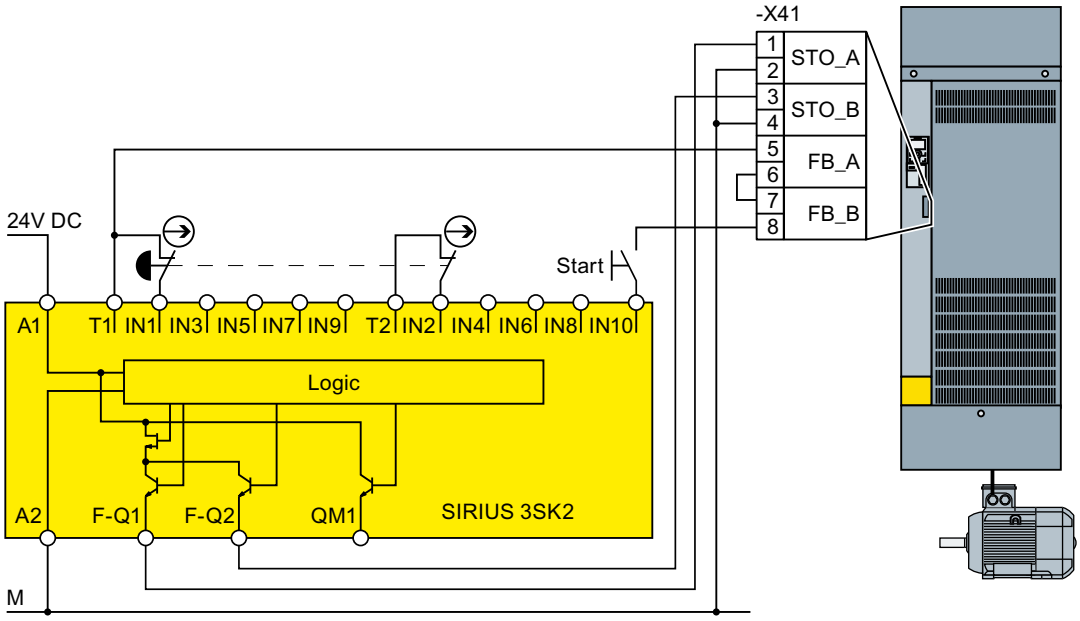


Figure 4-55 Connection 3SK2 inside a control cabinet for FSGX, FSHX and FSJX

When starting, static monitoring of the STO feedback signal is sufficient for converters FSGX, FSHX and FSJX.

3RK3 Modular Safety System

You can use the following outputs to control the failsafe digital inputs in the converter:

- The failsafe digital outputs in the central units of the 3RK3 modular safety system
- The failsafe digital outputs in the EM 2/4F-DI 2F-DO expansion module
- The failsafe digital outputs in the EM 4F-DO expansion module.
- The failsafe relay outputs in the EM 4/8F-RO expansion module
- 2 individual relay contacts of the EM 2/4F-DI 1/2F-RO expansion module

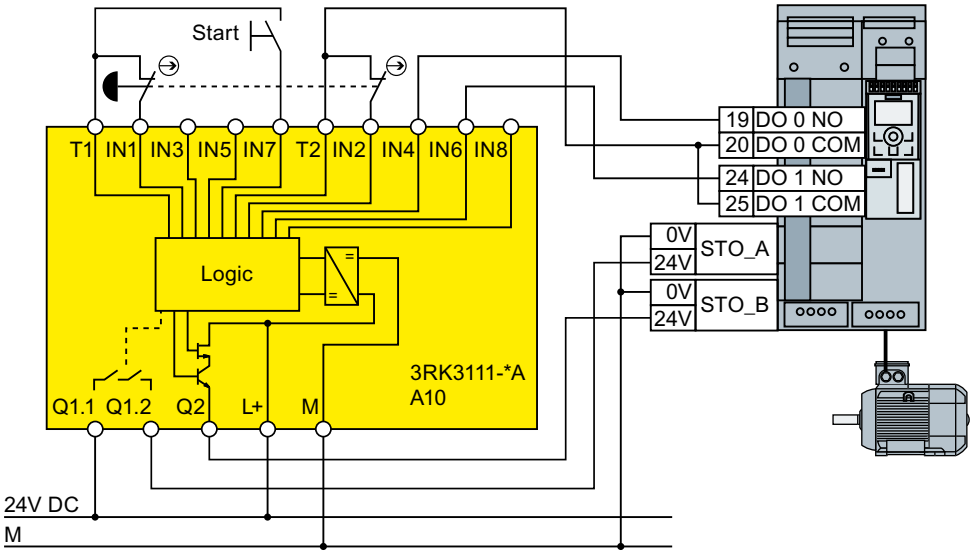
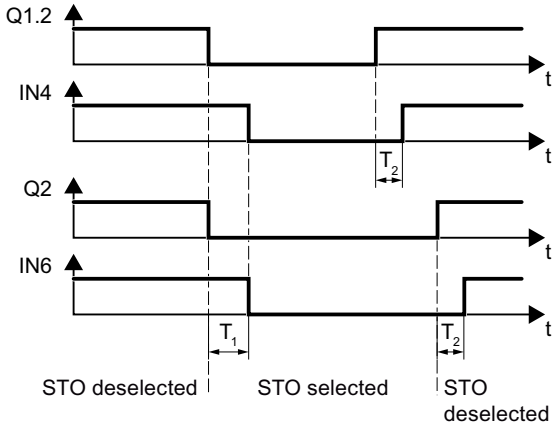


Figure 4-56 Connection 3RK3 inside a control cabinet for FSD ... FSG



$T_1 \geq 30$ ms

$T_2 \geq 20$ ms

In case of deviating feedback, the Modular Safety System must select the STO function and indicate an error.

Figure 4-57 Dynamic monitoring of STO feedback signal for FSD ... FSG

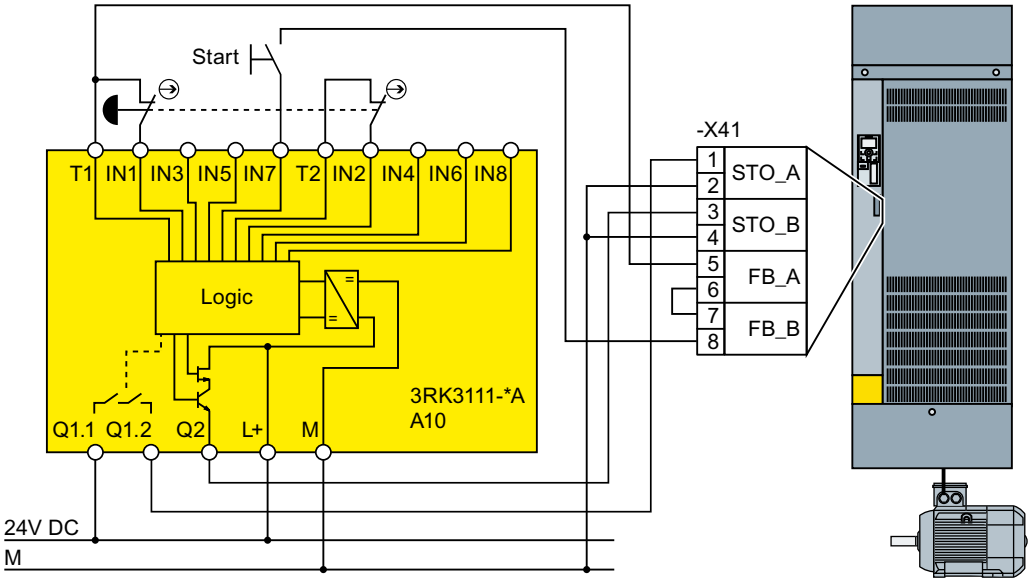


Figure 4-58 Connection 3RK3 inside a control cabinet for FSGX, FSHX and FSJX

When starting, static monitoring of the STO feedback signal is sufficient for converters FSGX, FSHX and FSJX.

SIMATIC I/O modules

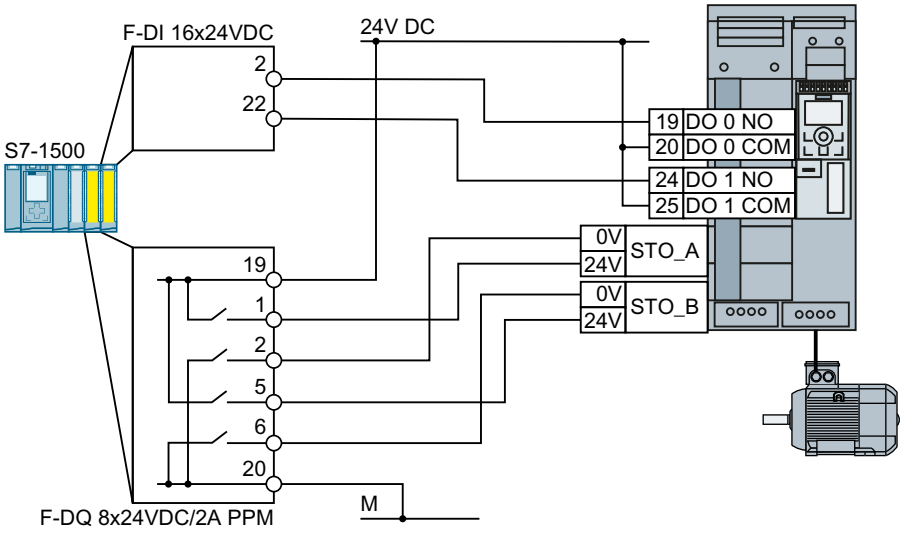
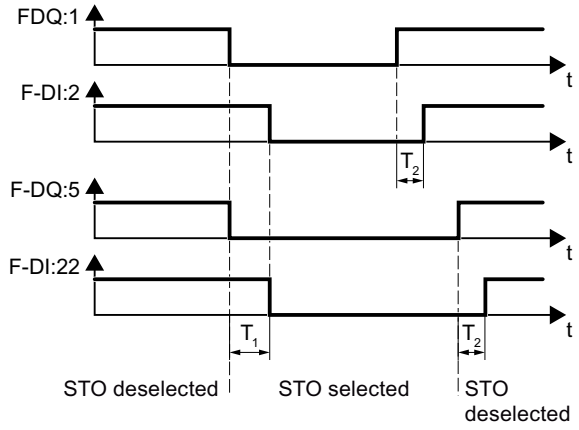


Figure 4-59 Connecting the SIMATIC S7-1500 in a control cabinet for FSD ... FSG



$T_1 \geq 30$ ms

$T_2 \geq 20$ ms

In case of deviating feedback, the SIMATIC must select the STO function and indicate an error.

Figure 4-60 Dynamic monitoring of STO feedback signal for FSD ... FSG

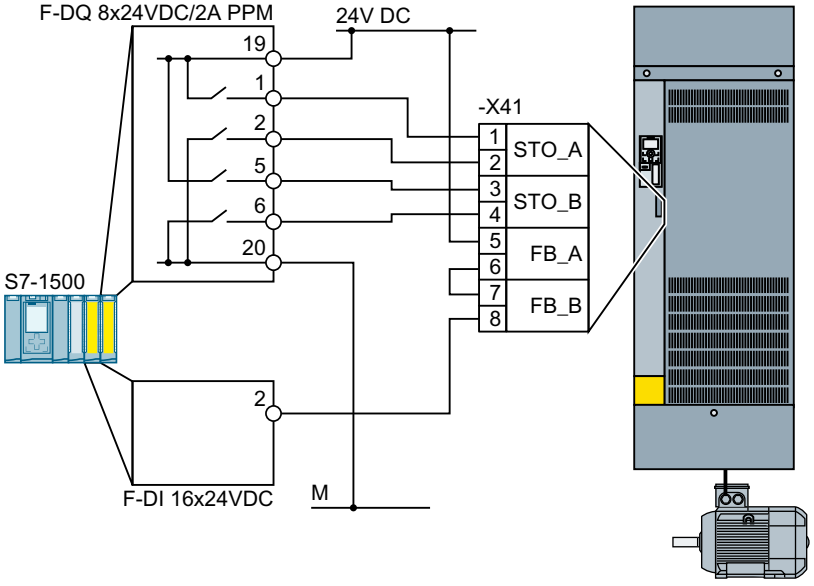


Figure 4-61 Connecting the SIMATIC S7-1500 in a control cabinet for FSGX, FSHX and FSJX

Static monitoring of the STO feedback signal when STO is selected is sufficient for converters FSGX, FSHX and FSJX.

Further information

Further information is provided on the Internet:

SIRIUS 3SK1 safety relays (https://support.industry.siemens.com/cs/ww/en/ps/16381/man)

SIRIUS 3SK2 Safety Relays (https://support.industry.siemens.com/cs/ww/en/view/109444336)

SIRIUS 3RK3 modular safety system manual (https://support.industry.siemens.com/cs/ww/en/view/26493228)

- S7-1500 (https://support.industry.siemens.com/cs/ww/en/view/86140384)
- ET 200SP (https://support.industry.siemens.com/cs/ww/en/view/84133942)
- ET 200pro (https://support.industry.siemens.com/cs/ww/en/view/22098524)
- ET 200S (https://support.industry.siemens.com/cs/ww/en/view/12490437)
- S7-300 (https://support.industry.siemens.com/cs/ww/en/view/19026151)

4.5 Evaluating via a failsafe digital output

4.5.1 Overview

In the factory setting of the converter, the failsafe digital 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 failsafe digital output.

Table 4-20 Converters for cabinet-free installation (IP65)

SINAMICS G120D with Control Unit		Connector. Pin	Digital output	Failsafe digital 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 4-21 Converter for installation in a control cabinet (IP20)

SINAMICS G120 with Control Unit		Terminal strip	Digital output	Failsafe digital output	Read back input	
	CU250S-2 CU250S-2 DP CU250S-2 PN	18: NC 19: NO 20: COM	DO 0	F-DO 0	67	DI 6
	CU250S-2 CAN	23: NC 24: NO 25: COM	DO 2			
Most applications require NO contacts for the failsafe digital output. If your application requires it, instead of NO contacts, you can also use the two NC contacts of the converter. The safe state of the failsafe digital output is always the quiescent state of the two relays.						

What devices can be connected?

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

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

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

- High signal or NO contact closed: The fail-safe digital output is active.
- Low signal or NO contact open: The fail-safe digital output is not active.

4.5.2 Connecting the fail-safe digital output for a SINAMICS G120

Connecting a relay

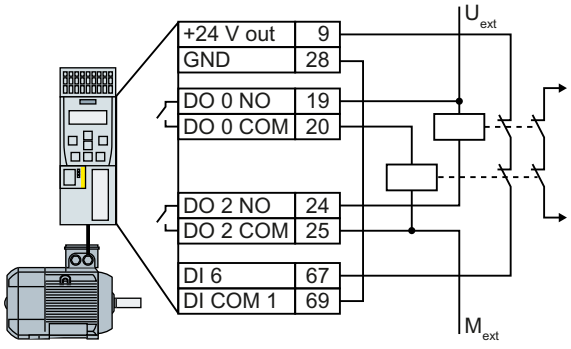


Figure 4-62 Connecting a relay at the F-DO

Connecting an actuator with feedback signal

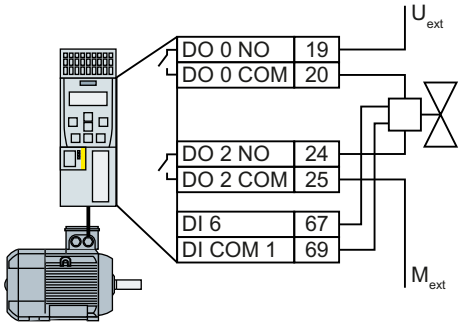


Figure 4-63 Connecting an F-DO to an actuator

Connecting a passive actuator

At the F-DO, a passive actuator behaves just like an inductive or ohmic load.

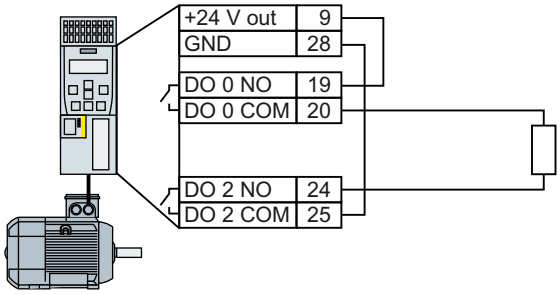


Figure 4-64 Connecting F-DO to a passive actuator

Connecting with a fail-safe digital input

When DO 0 is switched-on and DO 2 is switched-off, fail-safe digital input F-DI must provide 24 V at connection DO 2.

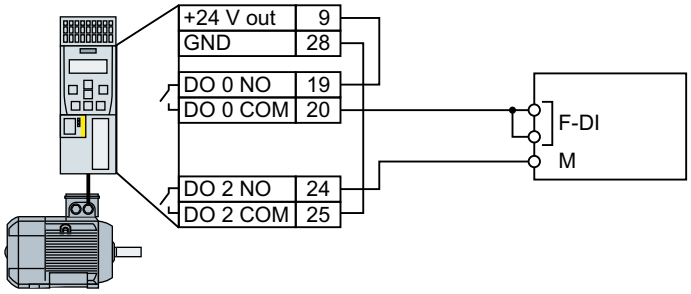


Figure 4-65 Connecting an F-DO with an F-DI

4.5.3 Connecting the fail-safe digital output for a SINAMICS G120D

Connecting a relay

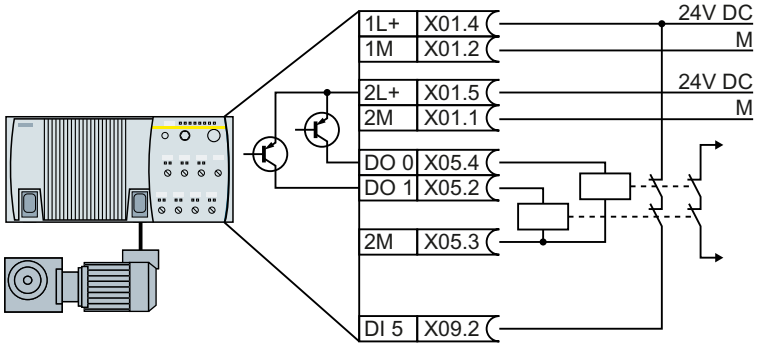


Figure 4-66 Connecting a relay at the F-DO

Connecting an actuator with feedback signal

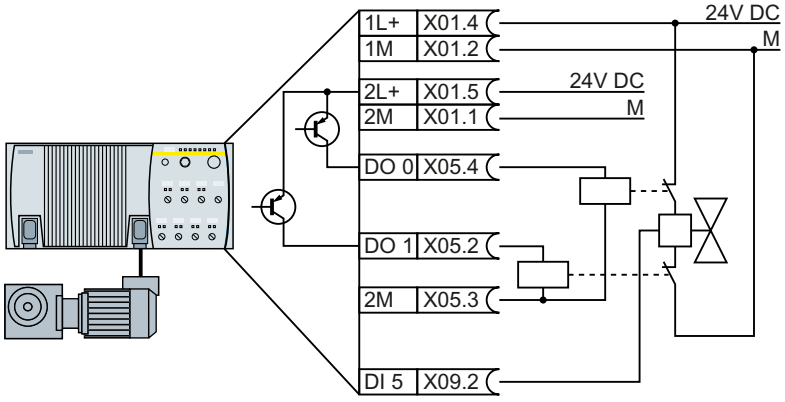


Figure 4-67 Connecting an F-DO to an actuator

Connecting with a fail-safe digital input

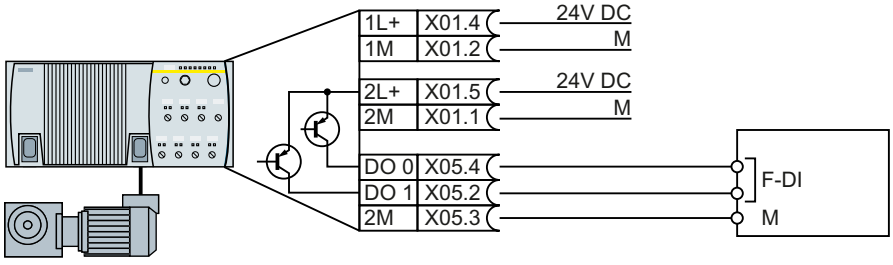
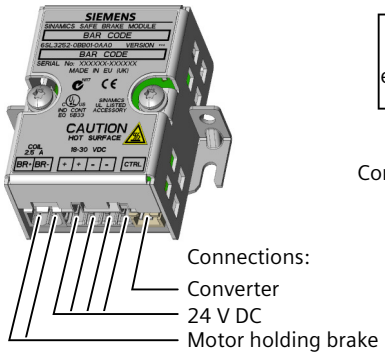


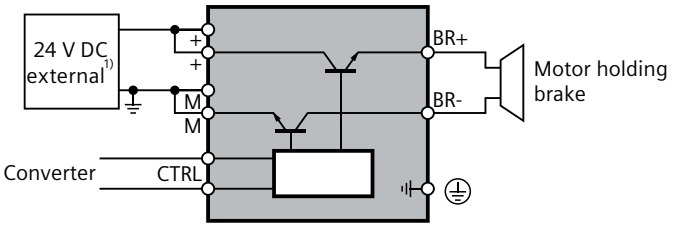
Figure 4-68 Connecting an F-DO with an F-DI

4.6 Connecting a motor holding brake via Safe Brake Relay

The Brake Relay must be connected to the protective conductor if the motor holding brake is supplied from a PELV circuit.

Safe Brake Relay



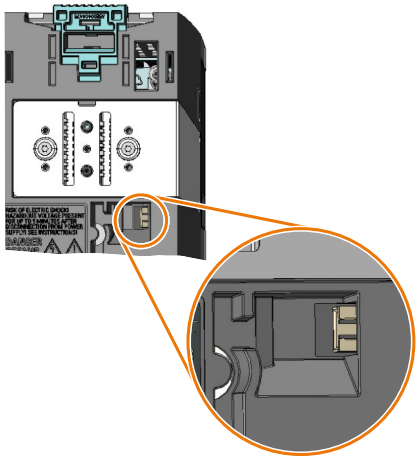


[1] The cable connected to the external 24 V DC power supply must be as short as possible. The maximum cable length is 30 m.

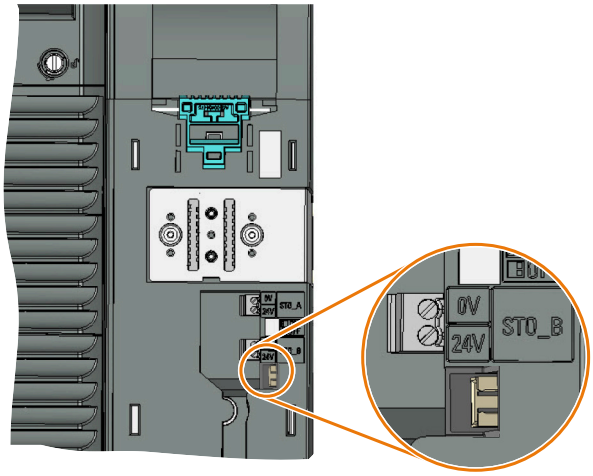
4.6.1 Connecting a Brake Relay at the PM240-2 and at the PM240P-2 Power Modules

Connecting the Brake Relay to the converter

The connector for the Brake Relay is located at the front of the Power Module. Lay the cable harness for the Brake Relay in the cable routing.



Brake relay connector for FSA ... FSC Power Modules without STO terminals



Brake relay connector for FSD ... FSF Power Modules with STO terminals

4.6.2 Connecting a Brake Relay at a PM250 Power Module

Connecting the Brake Relay to the converter

The connector for the brake relay is located at the front of the Power Module for the FSC frame size. These Power Modules have a cable entry for the connecting cable to the Brake Relay.

The connector for the Brake Relay is located at the bottom of the Power Module for the FSD ... FSF frame sizes.

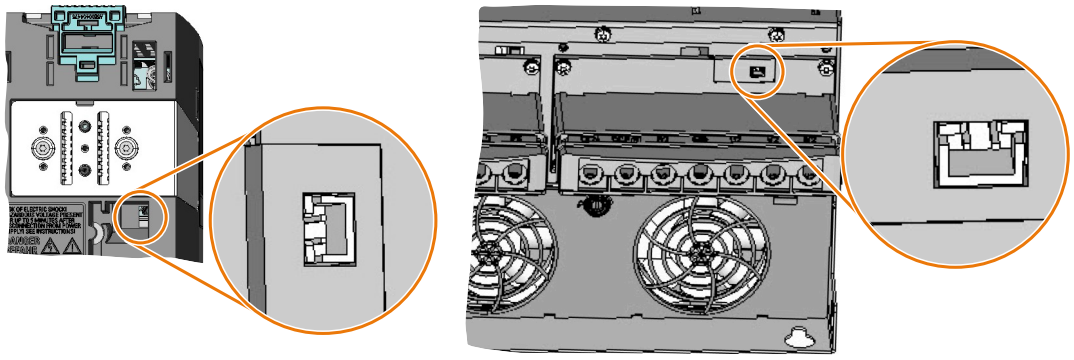


Figure 4-69 Connector position for the Brake Relay

Commissioning

5

5.1 About this chapter

What can you find in this Chapter?

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

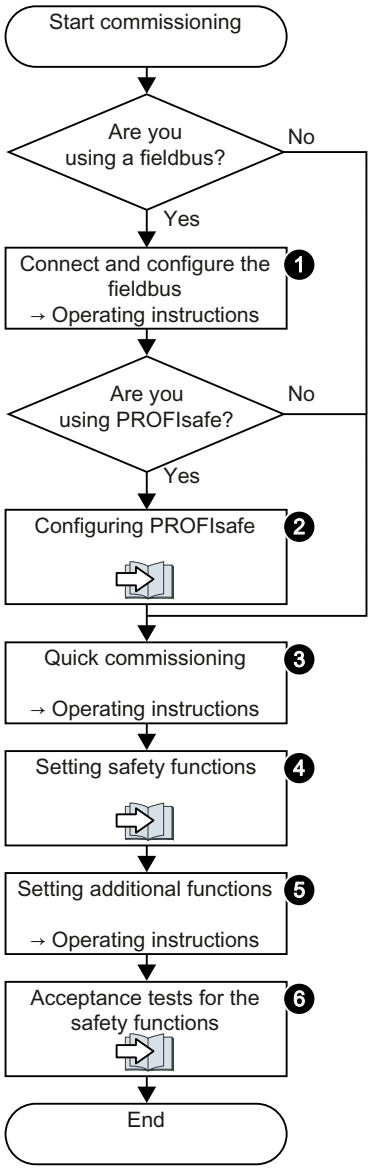
- Which sequence is recommended when commissioning the converter?
- What tool do I need for commissioning?
- How do I restore the factory settings of the safety functions?
- In SINAMICS G120, is it permissible to jointly use the safety functions according to SIL 2 and SIL 3?
- How do I commission the safety functions?
- How do I configure communication via PROFIsafe in the converter?
- How do I transfer the parameters of the safety functions to other converters?
- 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 a converter with integrated safety functions.

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

Procedure



1. Connect the fieldbus to the converter, and configure the communication in the higher-level control.
   → manual of your control system
   → operating instructions of your converter
2. Configure the PROFIsafe communication in the higher-level control system.
   Configure PROFIsafe in the higher-level control system (Page 109).
3. Carry out the basic commissioning of the drive.
   → operating instructions of your converter
4. Set the converter safety functions.
   The following pages in the Function Manual
5. Commission all of the other converter functions required, e.g. motor control or the protective functions.
   → operating instructions of your converter
6. Perform an acceptance test for the safety functions.
   Acceptance tests for the safety functions (Page 173)

You have commissioned the converter with integrated safety functions.
❒

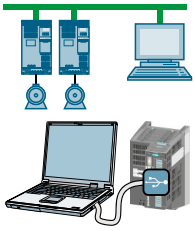
5.3 Configure PROFIsafe in the higher-level control system

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

- Configuring a PROFIsafe telegram with Drive ES Basic (http://support.automation.siemens.com/WW/view/en/64326460)
- Controlling SINAMICS G120 via PROFIsafe, displaying converter 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 Tools to commission the converter

PC tools



STARTER and **Startdrive** are PC tools that are used to commission, troubleshoot and control the converter, as well as to back up and transfer the converter settings. You can connect the PC with the converter via USB or via the PROFIBUS / PROFINET fieldbus.

Connecting cable (3 m) between PC and converter: Article number 6SL3255-0AA00-2CA0

Startdrive DVD: Article number 6SL3072-4CA02-1XG0

Startdrive, system requirements and download (https://support.industry.siemens.com/cs/ww/en/view/109760844)

Startdrive tutorial (http://support.automation.siemens.com/WW/view/en/73598459)

STARTER, system requirements and download (http://support.automation.siemens.com/WW/view/en/26233208)

Offline commissioning or online commissioning

With STARTER and Startdrive, you can work offline as well as online.

- Offline commissioning: without connection to the converter
  Commissioning with Startdrive offline (Page 172)
- Online commissioning: with connection to the converter
  Online commissioning using Startdrive is described in this manual.

5.5 Password

Overview

The password protects the settings of the safety functions from being changed by unauthorized persons.

Function description

Do you have to assign a password?

The probabilities of failure (PFH) and certification of the safety functions also apply without password.

The machine manufacturer decides whether or not a password is required.

Further information

What do I do if I lose the password?

You have forgotten the password, however, you would nevertheless like to change the setting of the safety functions.

Procedure

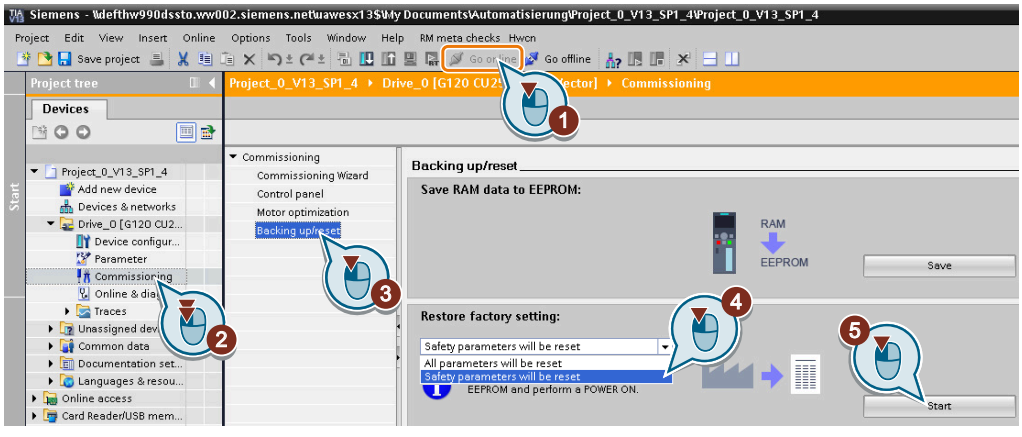
1. Create a new project for the converter using Startdrive.
   Leave all the settings in the project on those set in the factory.
2. Load the project in the converter.
   After loading, the converter has the factory settings.
3. If a memory card inserted in the converter, remove it.
4. Recommission the converter.

You can obtain additional information or learn about alternative procedures from Product Support.

Product Support (Page 321)

5.6 Resetting the safety functions to the factory setting

Procedure



1. Go online.
2. Select "Commissioning".

3. Select "Backing up/reset".
4. Select "Safety parameters are reset".
5. Press 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 converter power supply.
10. Wait until all LEDs on the converter are dark.
11. Switch on the converter power supply again.

You have restored the safety functions in the converter to the factory settings.
❒

Exception: The password for the safety functions is not reset.

Resetting the password for the safety functions (Page 111)

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

5.7 Resetting the password for the safety functions

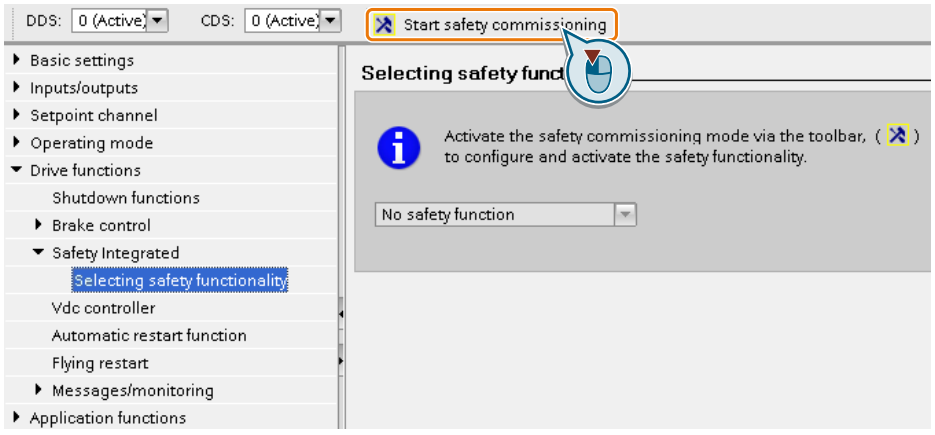
Requirement

You know the actual password for the safety functions.

Procedure

1. Go online.
2. Open the screen form of the safety functions.

3. Press the "Start safety commissioning" button.



4. Enter the current password for the safety functions.
5. Set the new password = 0.

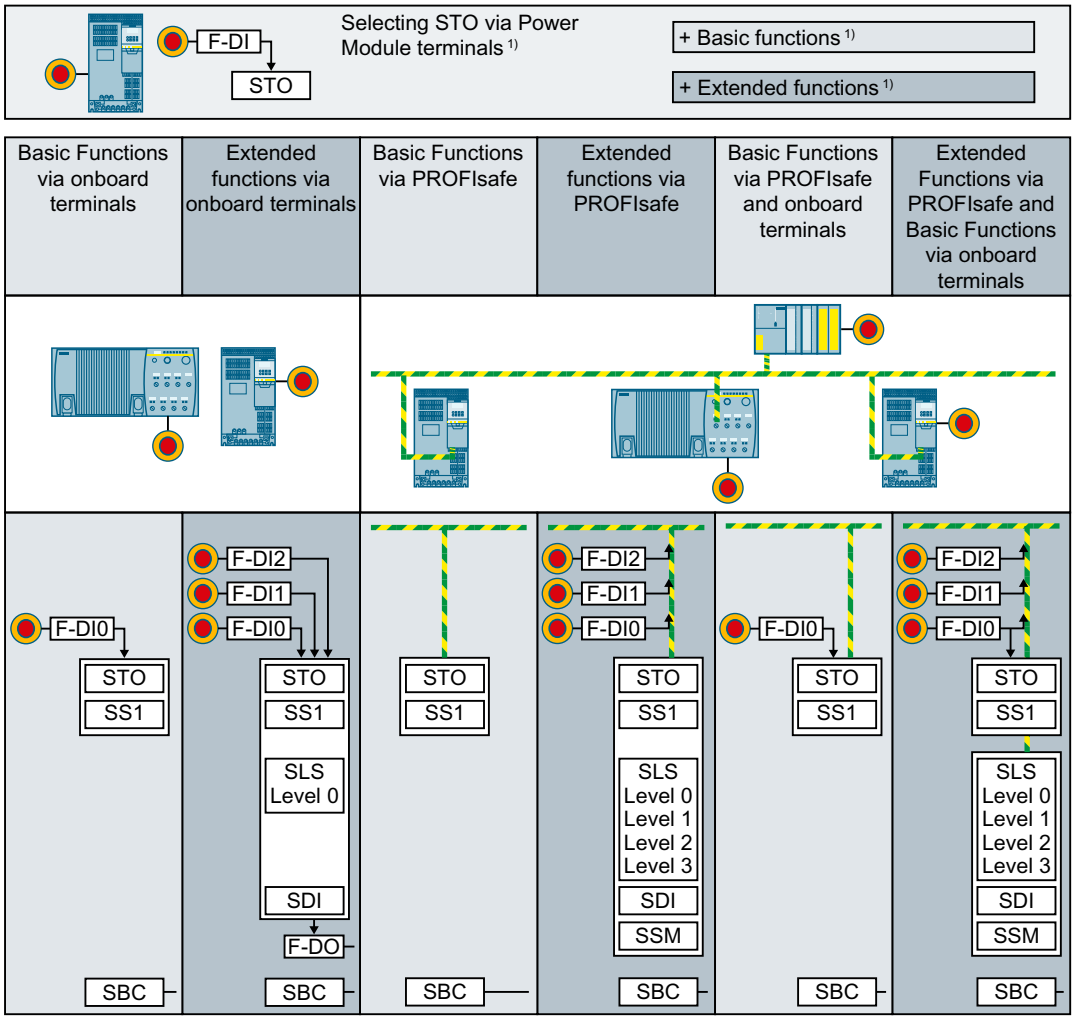
You have reset the password for the safety functions.
❒

Parameter	Description
p0010 = 95	**Drive commissioning parameter filter** Safety Integrated commissioning
p9761	**Enter a password** (factory setting: 0000 hex) Permissible passwords lie in the range 1 ... FFFF FFFF.
p9762	**New password**
p9763	**Confirm password**
p9701 = DC hex	**Confirm data change** (factory setting: 0) Confirm the SI basic parameter change.
p0010 = 0	**Drive commissioning parameter filter** 0: Ready
p0971 = 1	**Save parameter** 1: Save the drive object (copy from RAM to ROM) After the converter has saved the parameters in a non-volatile fashion, then p0971 = 0.

5.8 Selecting configuration of the 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) The "STO via Power Module terminals" function is only possible with the PM240-2 and PM240P-2, FSD ... FSE Power Modules. There are three options when configuring the function:

- You use the "STO via Power Module terminals " function together with the Basic Functions.
- You use the "STO via Power Module terminals " function together with the Extended Functions.
- You use the "STO via Power Module terminals " function as the only safety function.

Figure 5-1 Overview of the possible configurations

Selected configuration	Scope and interfaces of the safety functions
Selecting STO via Power Module terminals	Select STO via the Power Module terminals
Basic Functions via onboard terminals	• Select STO via the failsafe digital input. Additionally, with CU250S-2: • Select SS1 via the failsafe digital input. • Control the motor holding brake via SBC.
Extended Functions via onboard terminals	• Select safety functions via the failsafe digital input. • Only one monitoring limit of SLS can be used (SLS level 0). In addition, for converters with safety-related output: • Evaluating the status of the safety functions via the failsafe digital output.
Basic Functions via PROFIsafe	• Select STO via PROFIsafe. Additionally, with CU250S-2: • Select SS1 via PROFIsafe. • Control the motor holding brake via SBC.
Extended Functions via PROFIsafe	• Select safety functions via PROFIsafe. • All four monitoring limits of SLS can be used (SLS levels 0 ... 3) • Evaluating the status of the failsafe digital inputs via PROFIsafe
Basic Functions via PROFIsafe and onboard terminals	• Select STO via failsafe digital input as well as also via PROFIsafe. Additionally, with CU250S-2: • Select SS1 via the failsafe digital input or PROFIsafe. • Control the motor holding brake via SBC.
Extended Functions via PROFIsafe and Basic Functions via onboard terminals	• Select safety functions via PROFIsafe. • Additionally select STO via the failsafe digital input. • All four monitoring limits of SLS can be used (SLS levels 0 ... 3) • Evaluating the status of the failsafe digital inputs via PROFIsafe Additionally, with CU250S-2: • Select Basic Function SS1 via the failsafe digital input. • Control the motor holding brake via SBC.

5.9 Configuring the safety functions and PROFIsafe

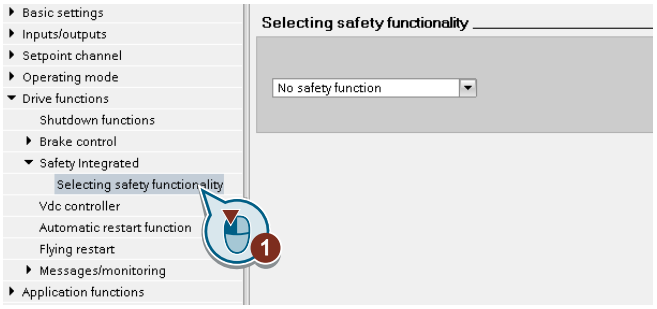
5.9.1 Configuring safety functions

Requirement

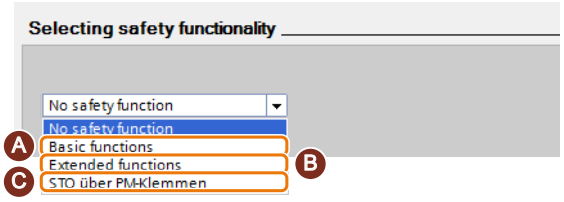
You are offline with Startdrive.

Procedure

1. Select "Select safety functionality".

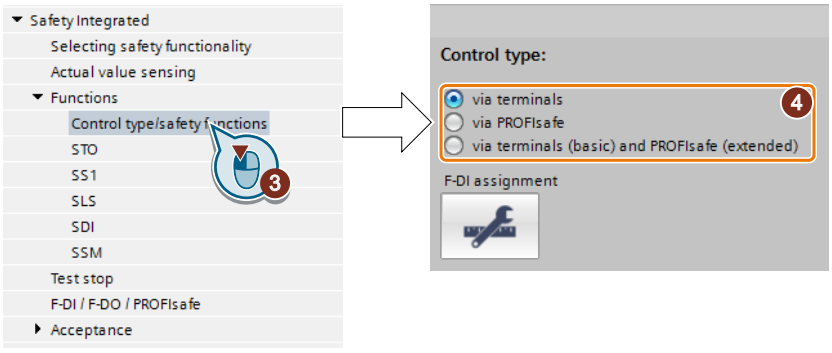


2. Define the configuration of the safety functions:



   - **(A)** You want to exclusively use the Basic converter functions.
   - **(B)** You want to use the Extended safety functions.
   - **(C)** This option is only available with a PM240-2 or PM240P-2 FSD ... FSF Power Module. Select this option if you only use the "STO via Power Module terminals" function.

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.

You have configured the safety functions.
❒

If you selected the onboard terminals as interface, you can now start to commission the safety functions.

For control via PROFIsafe, you must configure the PROFIsafe interface before you start to commission the safety functions.

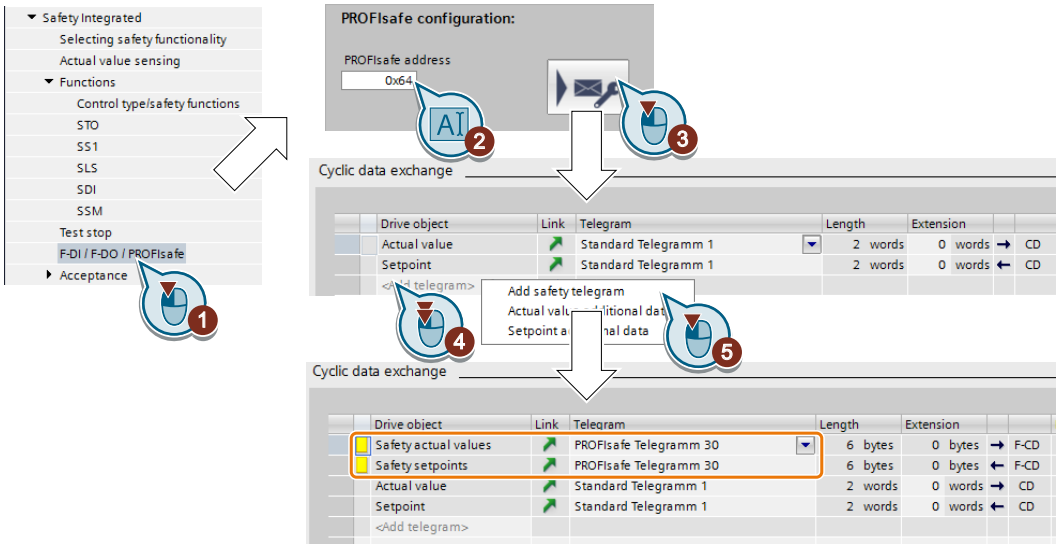
Parameter	Description			
p0010 = 95	**Drive commissioning parameter filter** Safety Integrated commissioning			
p9601	**Enable functions integrated in the drive** (factory setting: 0000 bin)			
		Functions that have been enabled:		Functions that have been enabled:
	0 hex	None	80 hex	STO via Power Module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

5.9.2 Configuring PROFIsafe

Requirement

You are offline with Startdrive.

Procedure



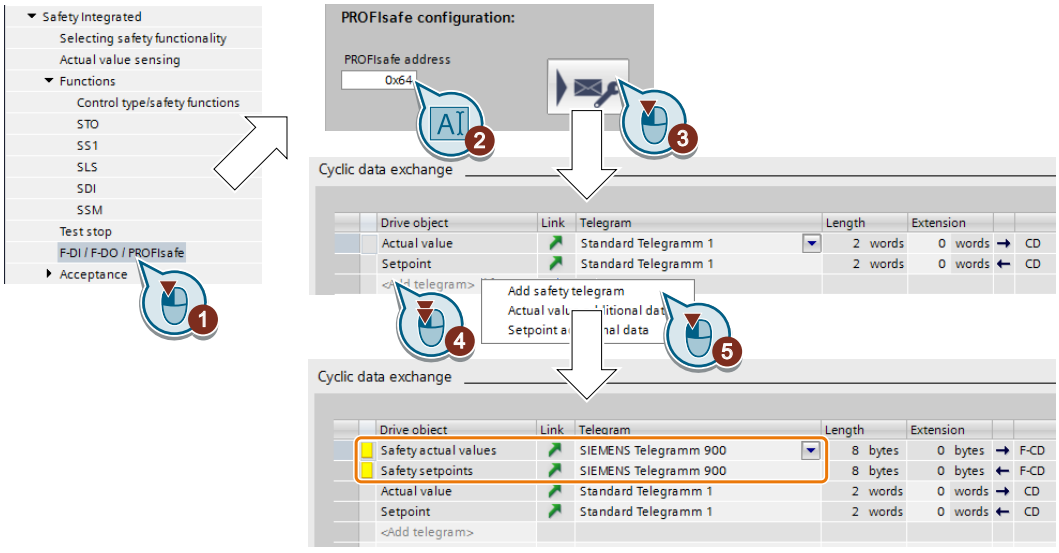
1. Select "F-DI / F-DO / PROFIsafe".
2. Enter the same address as hexadecimal value that you defined in the hardware configuration for the higher-level control system.
3. Press the "Telegram configuration" button.
   Startdrive opens the "Properties" of the cyclic data exchange.
4. Select "Add telegram".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

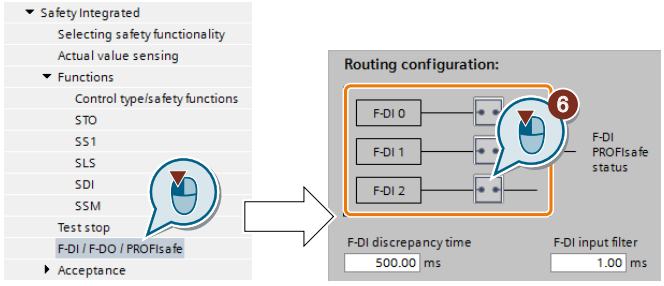
You have established communication between the converter and higher-level control (F-CPU) via PROFIsafe telegram 30.
❒

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

Configuring telegram 900

Procedure





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. Only with extended functions:
   Set which F-DI status of the converter is transferred via PROFIsafe status word 5.

You have configured PROFIsafe telegram 900.
❒

Control word 5 and status word 5 (basic functions) (Page 47).
Control word 5 and status word 5 (extended functions) (Page 48).

If you configured the basic functions with control via PROFIsafe, no further parameter assignment is necessary for transfer of the F-DI 0 status.

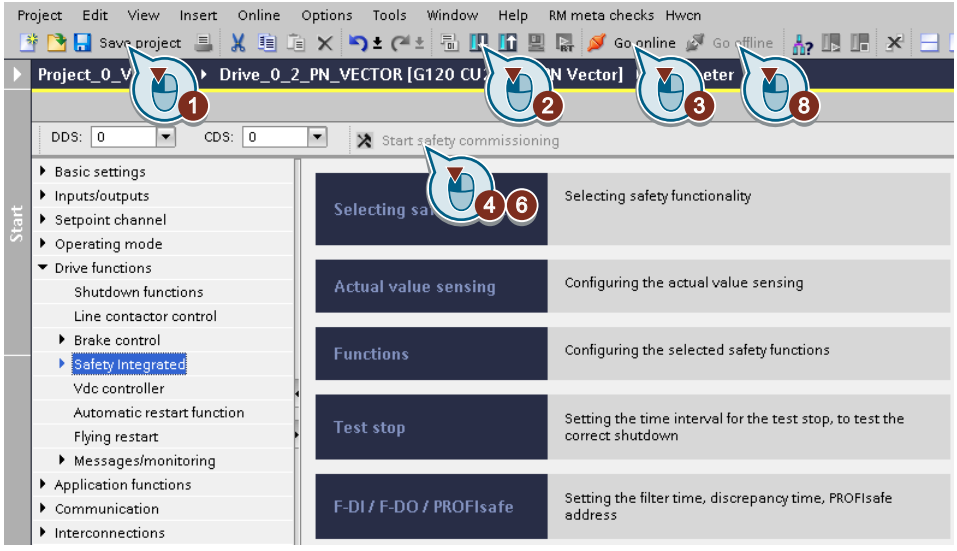
Table 5-1 Parameters for the extended functions

Parameter	Description	
p9501.30	**Enable F-DI in PROFIsafe telegram**(Factory setting: 0 bin) 0 signal: F-DI is inhibited in the PROFIsafe telegram 1 signal: F-DI is enabled in PROFIsafe telegram	
p10050	**Transfer PROFIsafe F-DI** (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
Settings for the discrepancy time and the signal filter of the failsafe digital inputs: Setting the filter for fail-safe digital inputs (Page 141)		

5.9.3 Activate settings

Loading the settings into the drive

Procedure



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. Press the "End safety commissioning" button.
7. Confirm the prompt for saving your settings (copy RAM to ROM).
8. Disconnect the online connection.
9. Switch off the converter power supply.
10. Wait until all LEDs on the converter go dark (no voltage condition).
11. Switch the converter power supply on again.

Your settings are now active.
❒

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

5.10 Setting basic functions

5.10.1 Interconnecting the "STO active" signal

Overview

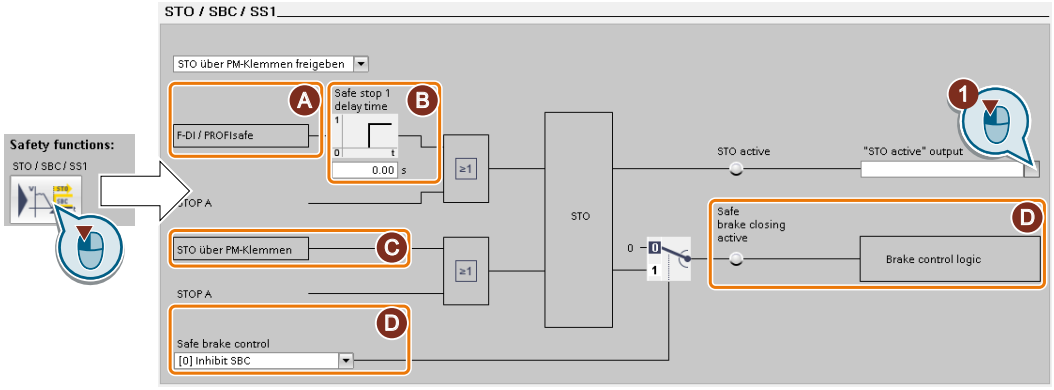
If you require the feedback signal "STO active" of the converter in your higher-level control system, then you must appropriately interconnect the signal.

Requirement

You are online with Startdrive.

Function description

Procedure



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

(A) Control type

(B) Delay time for SS1 and enable SBC for a converter with CU250S-2 Control Unit

(C) STO via the Power Module terminals for a PM240-2 or PM240P-2, FSD ... FSF Power Module

(D) Enable SBC for a converter with CU250S-2 Control Unit

1. Select the button for the feedback signal.
2. Select the signal that matches your particular application.

You have interconnected the "STO active" checkback signal.
❒

After STO has been selected, the converter signals "STO active" to the higher-level control.

Parameter

Parameter	Description		Factory setting
r9773[0...31]	CO/BO: SI status (processor 1 + processor 2)		-
	.01	1 signal: STO is active in the drive	

5.10.2 Setting the filter for failsafe digital inputs

You must set the input filter and the simultaneity monitoring of the failsafe digital input for all SINAMICS converters, where the failsafe digital input F-DI evaluates two redundant signals.

Overview

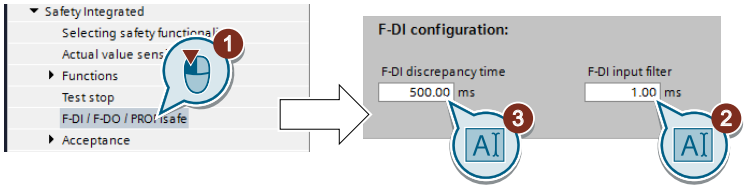
If required, you must set the signal filter for selecting the STO safety function.

Requirement

You are online with Startdrive.

Function description

Procedure



1. Navigate to the filter settings.
2. Set the debounce time for the F-DI input filter.
3. Set the discrepancy time for the simultaneity monitoring.

You have set the signal filter of the failsafe digital input.
❒

Parameter

Parameter	Description	Factory setting
p9650	SI F-DI switchover discrepancy time (CPU 1)	500 ms
p9651	SI STO debounce time (processor 1)	1 ms

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

Debounce times for standard and safety functions

The debounce time p0724 for "standard" digital inputs has no influence on the failsafe digital input signals. Conversely, the same applies: The debounce time of the failsafe digital inputs 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.

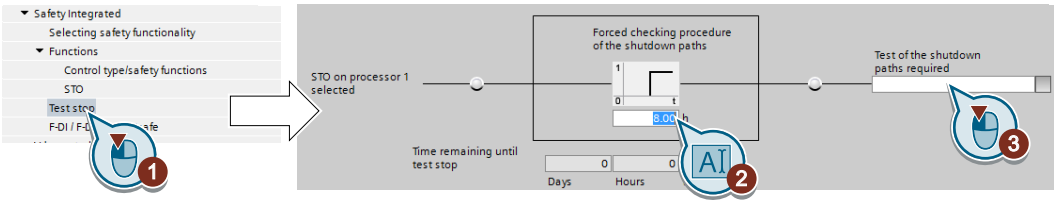
If you use an input as a failsafe digital input, set the debounce time as described above.

5.10.3 Setting the forced checking procedure (test stop)

Requirement

You are online with Startdrive.

Procedure



1. Select the screen form for setting the forced checking procedure.
2. Set the monitoring time to a value to match your application.
3. Using this signal, the converter signals that a forced checking procedure (test stop) is required.
   Interconnect this signal with a converter signal of your choice.

You have set the forced checking procedure (test stop) for the Basic Functions.
❒

Overview

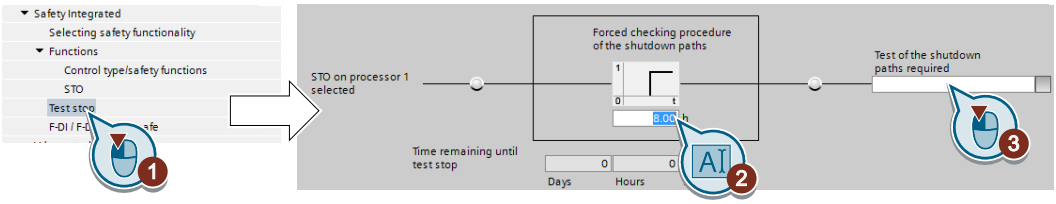
You must set the time interval in which, as a minimum, you must start the forced checking procedure at least once.

Requirement

You are online with Startdrive.

Function description

Procedure



1. Select the screen form for setting the forced checking procedure.
2. Set the monitoring time to a value to match your application.
3. Using this signal, the converter signals that a forced checking procedure (test stop) is required.
   Interconnect this signal with a converter signal of your choice.

You have set the forced checking procedure (test stop) for the Basic Functions.
❒

Parameter

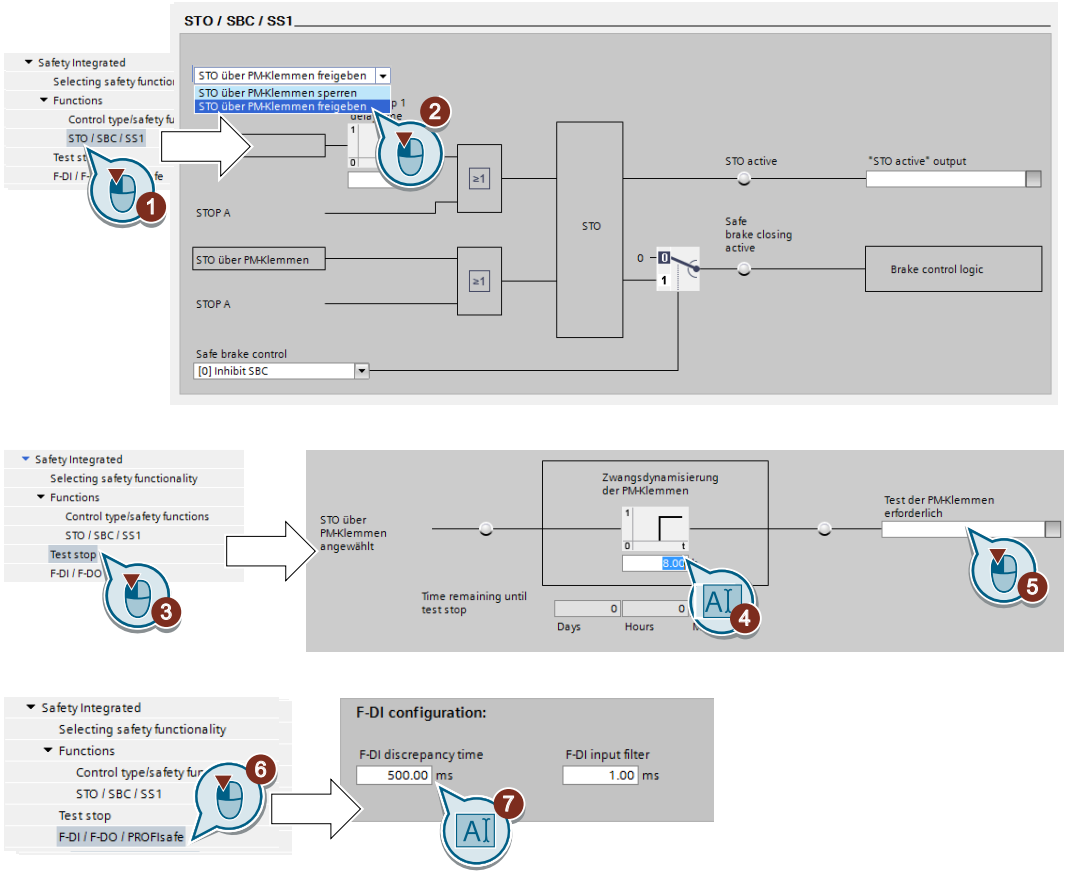
Parameter	Description	Factory setting
p9659	SI forced checking procedure timer	8 h
r9660	SI forced checking procedure remaining time	- h
r9773.0...31	CO/BO: SI status (processor 1 + processor 2)	-

5.10.4 Setting STO via Power Module terminals

Requirement

You are online with Startdrive.

Procedure



1. Select "STO / SBC / SS1".
2. Select "Enable STO via PM terminals".
3. Select "Test stop".
4. Set the monitoring time to a value to match your application.
5. Using this signal, the converter signals that a forced checking procedure (test stop) is required for the "STO via Power Module terminals" function.
6. Select "F-DI / F-DO / PROFIsafe".
7. 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 failsafe digital input on the Control Unit for selecting STO.
   Setting the filter for failsafe digital inputs (Page 122)
   The "F-DI input filter" has no significance for the terminals on the Power Module.

You have set the "STO via Power Module terminals" function.
❒

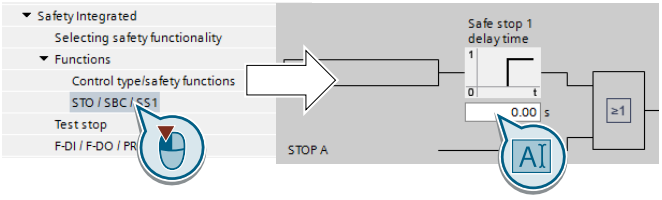
Parameter	Description
p9601.7	**Enable functions integrated in the drive** (factory setting: 0) 1 signal: STO via the Power Module terminals has been enabled
p9650	**F-DI switchover discrepancy time** (Factory setting: 500 ms)
p9661	**Forced checking procedure STO via PM terminals time** (Factory setting: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

5.10.5 Enabling control of SS1 by setting the delay time

Requirement

You are online with Startdrive.

Procedure



Set a delay time > OFF3 ramp down time.
❒

Parameter	Description	
p9652	**Safe Stop 1 delay time**	
	p9652 > 0	Sets the delay time of the pulse suppression for the "Safe Stop 1" (SS1) function to brake with the OFF3 ramp-down time.
	p9652 = 0	SS1 is not enabled.
p1135	**OFF3 ramp-down time**	

Description: the SS1 function without monitoring the speed

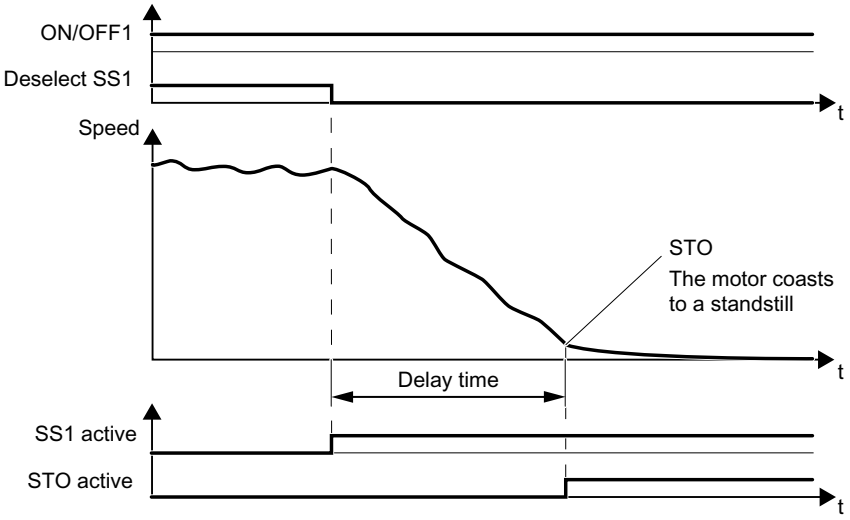


Figure 5-2 SS1 without monitoring the speed

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

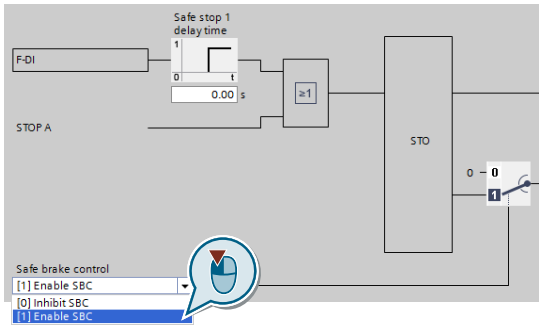
After the delay time, independent of the actual speed, the converter switches off the motor torque using the STO function.

5.10.6 Enabling SBC

Requirement

You are online with Startdrive.

Procedure



Set "[1] enable SBC".
❒

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

5.10.7 Complete commissioning

Overview

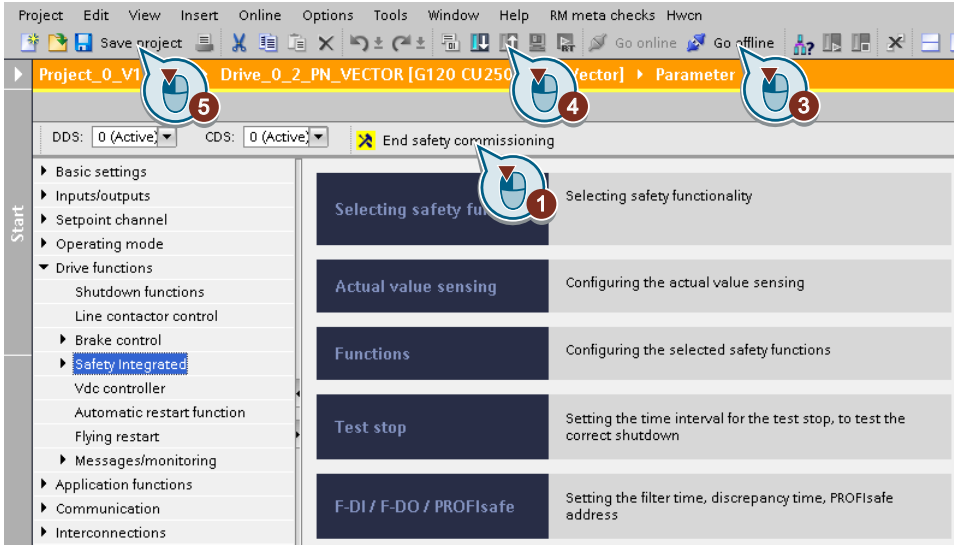
You must exit commissioning the safety functions and save the settings.

Requirement

You are online with Startdrive.

Function description

Procedure



1. Press 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 converter power supply.
7. Wait until all LEDs on the converter go dark (no voltage condition).
8. Switch on the converter power supply again.

Your settings are now active.
❒

Parameter

Parameter	Description	Factory setting
p0010	Drive commissioning parameter filter	1
p0971	Save parameters	0
p9700	SI copy function	0000 hex
p9701	Acknowledge SI data change	0000 hex

Parameters

Parameter	Description	Factory setting
p0010	Drive commissioning parameter filter	1
p0971	Save parameters	0
p9700	SI copy function	0000 hex
p9701	Acknowledge SI data change	0000 hex

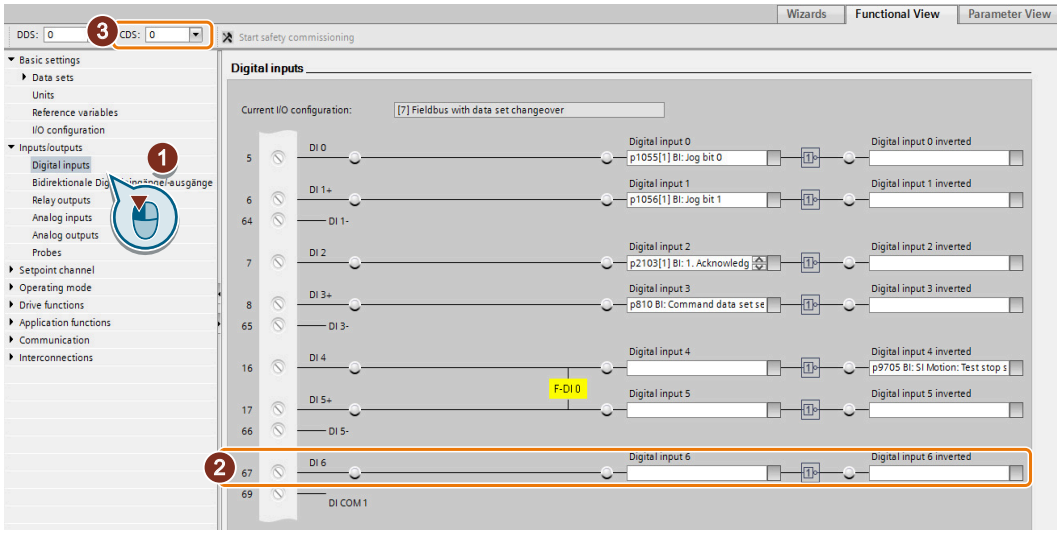
Overview

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 converter via failsafe digital inputs, then you must check as to whether the failsafe digital inputs are in some instances interconnected with a "standard" function.

Function description

Procedure



1. Select the screen for the digital inputs.
2. Remove all interconnections of the digital inputs that you use as failsafe digital 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 failsafe digital inputs only control the safety functions in the converter.
❒

Checking the interconnection of the feedback signal input for the failsafe digital output

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

Requirements

- You are using the failsafe digital output of the converter.
- You use one of the test modes 2 or 3, where the converter evaluates the status of the connected actuator via a digital input.

You must check whether this digital input is assigned a "Standard" function.

Procedure

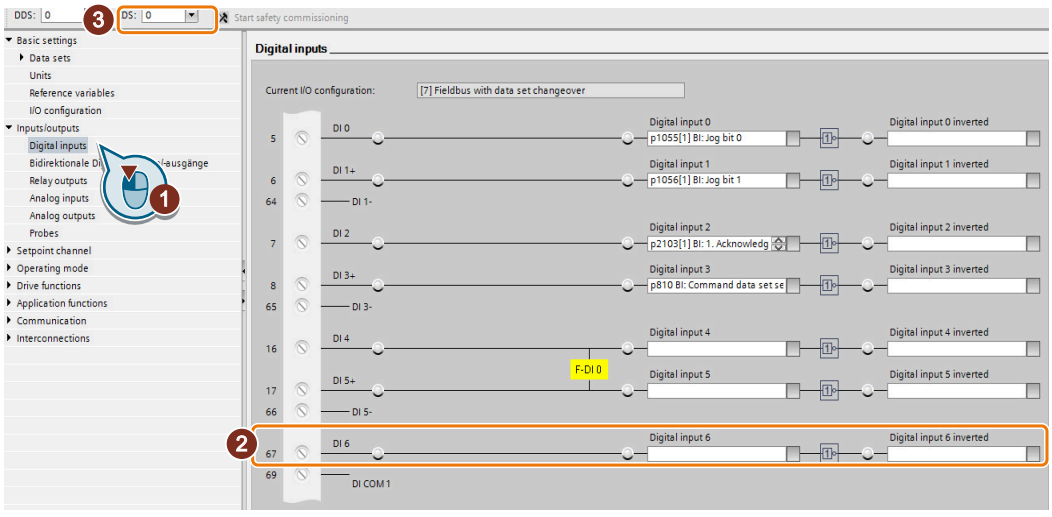


Figure 5-3 Removing the interconnection of the feedback signal input DI 6 for the CU250S-2

1. Select the digital inputs.
2. Remove the interconnection of the digital input that you use as feedback signal input for the failsafe digital 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.

You have now prevented the feedback signal input of the failsafe digital output controlling "Standard" functions in the converter.
❒

5.11 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.
   Basic settings (Page 133).
2. If necessary, interconnect the failsafe inputs and outputs.
   - Setting failsafe digital inputs (Page 139)
   - Setting a failsafe digital output (Page 144)
3. Adapt the safety functions that you are using to suit your application.
   - Setting SS1 (Page 150)
   - Setting SLS (Page 156)
   - Setting SSM (Page 160)
   - Setting SDI (Page 163)
4. Complete commissioning.
   Final steps when commissioning online (Page 167)

5.11.1 Basic settings

5.11.1.1 Enabling the safety functions

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

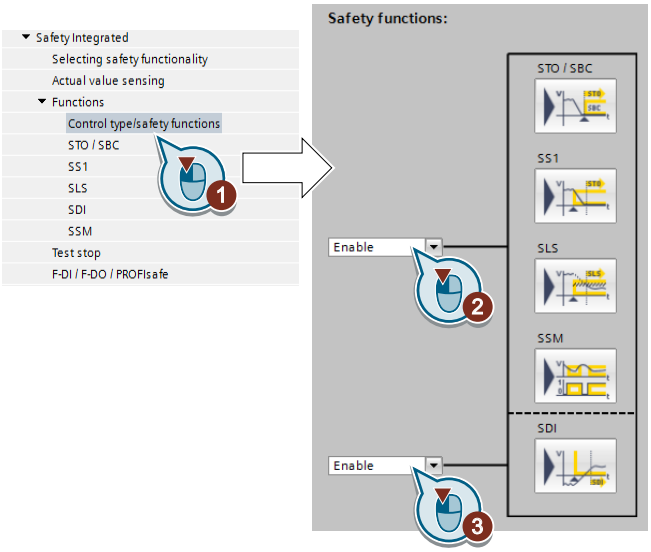
If you are not using one of the safety functions that has been enabled, then you must permanently set the signal to select this function to a 1-signal:

- When controlling via PROFIsafe:
  In the higher-level control, set the corresponding bit in control word 1 to a 1 signal.
  PROFIsafe telegrams (Page 44).
- When controlling via failsafe digital inputs:
  In the converter, set the corresponding signal to "Statically deselected".
  Interconnecting a safety function with fail-safe digital input (Page 139)

Requirement

You are online with Startdrive.

Procedure



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 converter.
❒

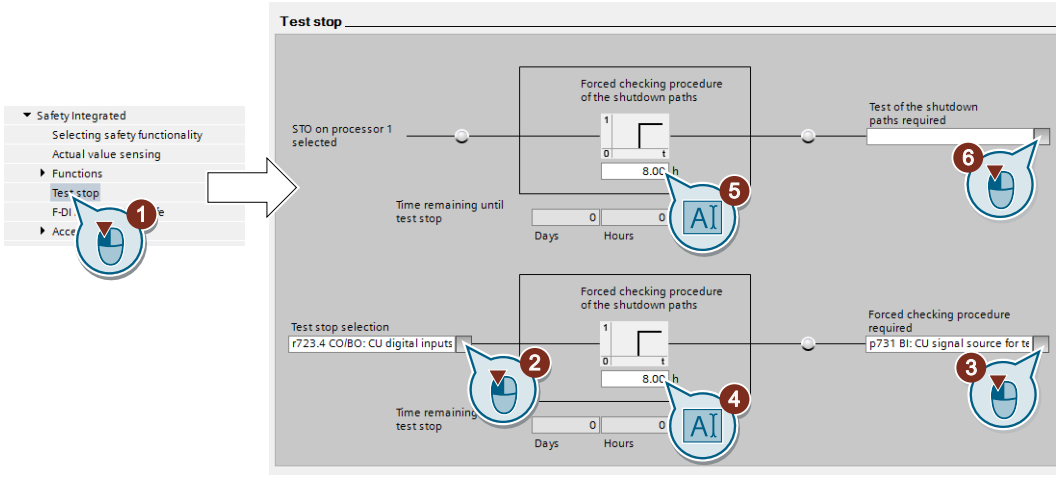
Parameter	Description	
p9501	**Enable safety functions**	
	.00	1 signal: Enable the Extended Functions (without SDI)
	.17	1 signal: Enable SDI

5.11.1.2 Setting the forced checking procedure (test stop)

Requirement

You are online with Startdrive.

Procedure



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 checking procedure (test stop) of the Extended Functions.
❒

Description

The forced checking procedure (test stop) of the extended functions is a converter self test. The converter checks its circuits to monitor the speed and to switch off the torque.

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

You must start the forced checking procedure with a signal of your choice.

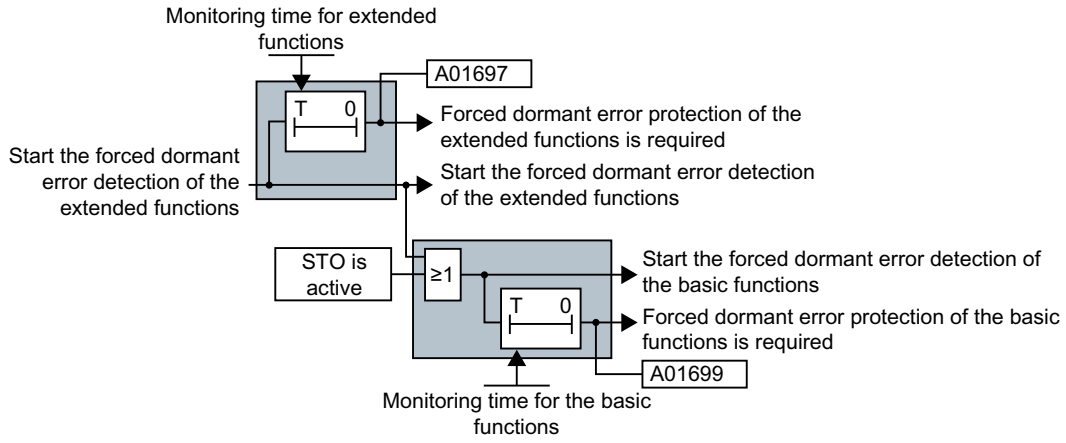


Figure 5-4 Starting and monitoring the forced checking procedure (test stop)

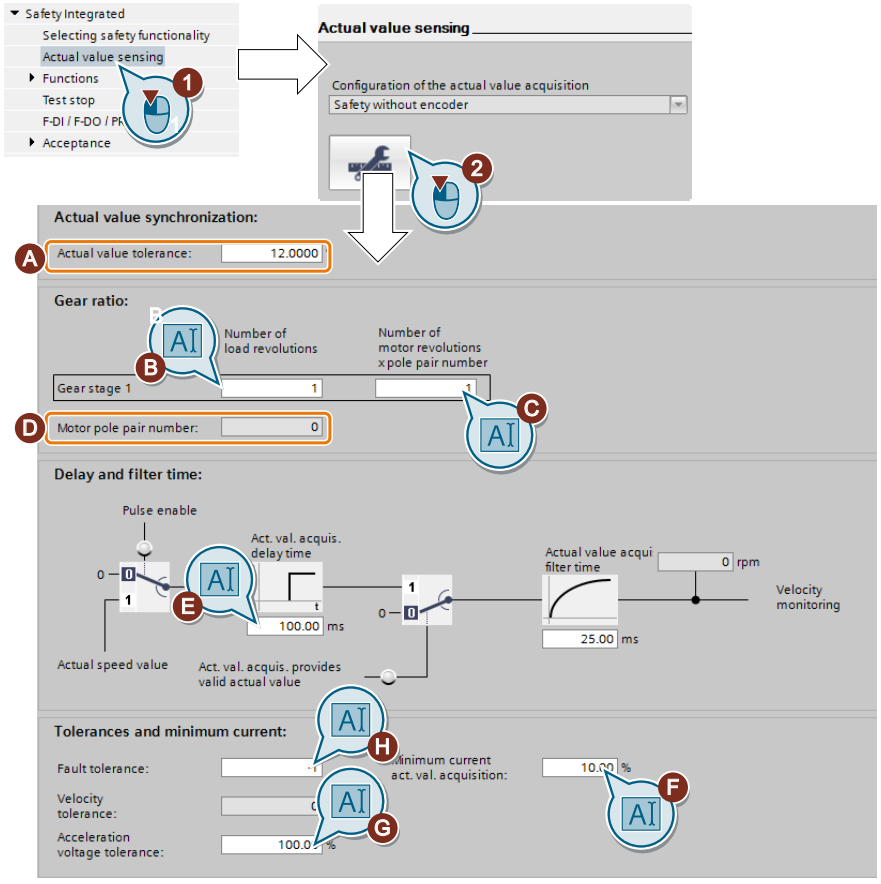
Parameter	Description
p9559	**Forced checking procedure timer** (Factory setting: 8 h) Monitoring time for the forced checking procedure of the extended functions.
p9659	**Forced checking procedure timer** (Factory setting: 8 h) Monitoring time for the forced checking procedure of the basic functions.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

5.11.1.3 Setting encoderless actual value sensing

Requirement

You are online with Startdrive.

Procedure



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 converter issues message C01711 or C30711 (fault value 3 or 44 ... 57), increase this value step-by-step until the message to longer occurs.
     Note: If you increase this value, the speed monitoring of the converter becomes less sensitive to limit violations.
   - **(B), (C), (D) 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 converter 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 converter 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 converter 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 converter tolerates its internal plausibility monitoring per second.
3. Close the screen form.

You have set encoderless actual value sensing.
❒

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

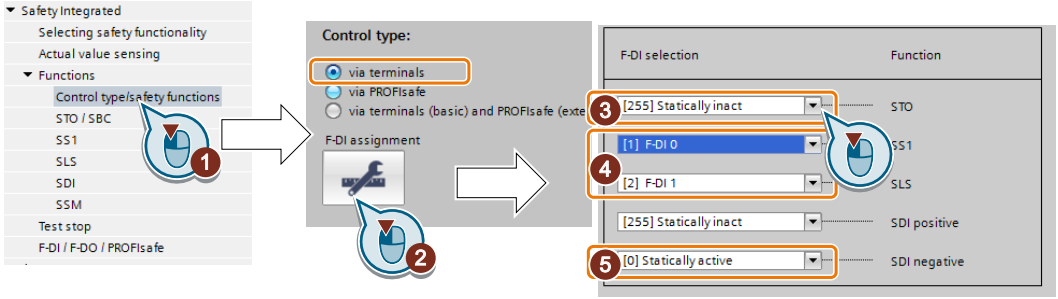
5.11.2 Setting failsafe digital inputs

5.11.2.1 Interconnecting a safety function with fail-safe digital input

Requirements

- You are online with Startdrive.
- You have selected the Extended Functions via onboard terminals.

Procedure



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 failsafe digital 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.

You have assigned specific safety functions to the failsafe digital inputs.
❒

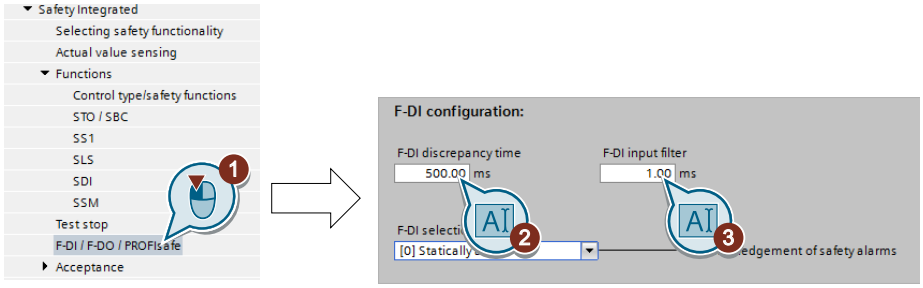
Parameter	Description	
p10022	**STO input terminal** (Factory setting: 0)	0: Statically selected 1: F-DI 0 2: F-DI 1 3: F-DI 2 255: Statically deselected
p10023	**SS1 input terminal** (Factory setting: 0)	
p10026	**SLS input terminal** (Factory setting: 0)	
p10030	**SDI positive input terminal** (Factory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

5.11.2.2 Setting the filter for fail-safe digital inputs

Requirements

- 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



1. Select "F-DI / F-DO / PROFIsafe".
2. The discrepancy time (simultaneity monitoring) tolerates signal changes at the failsafe digital input that do not occur simultaneously.
3. The input filter suppresses brief signal changes.

You have set the filter for the failsafe digital inputs.
❒

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

Debounce times for standard and safety functions

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

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

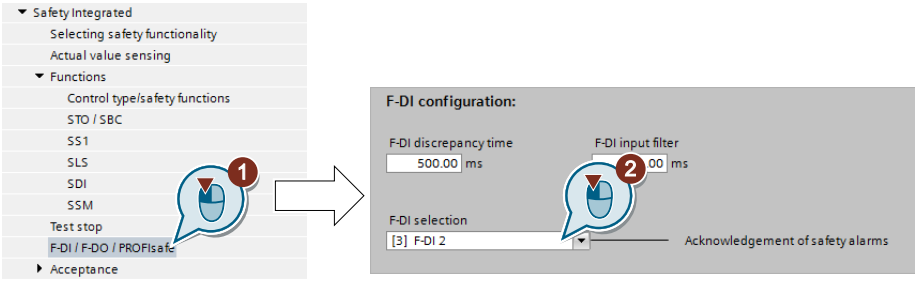
If you use an input as a fail-safe digital input, set the debounce time as described above.

5.11.2.3 Interconnecting the signal for failsafe acknowledgment

Requirements

- You are online with Startdrive.
- You have selected the Extended Functions via onboard terminals.

Procedure



1. Select "F-DI / F-DO / PROFIsafe".
2. Select a free failsafe digital input for the failsafe acknowledgment signal.
   If there are no free failsafe digital inputs available, you have to acknowledge the safety function faults using a different method.
   Acknowledging using a failsafe signal (Page 258)

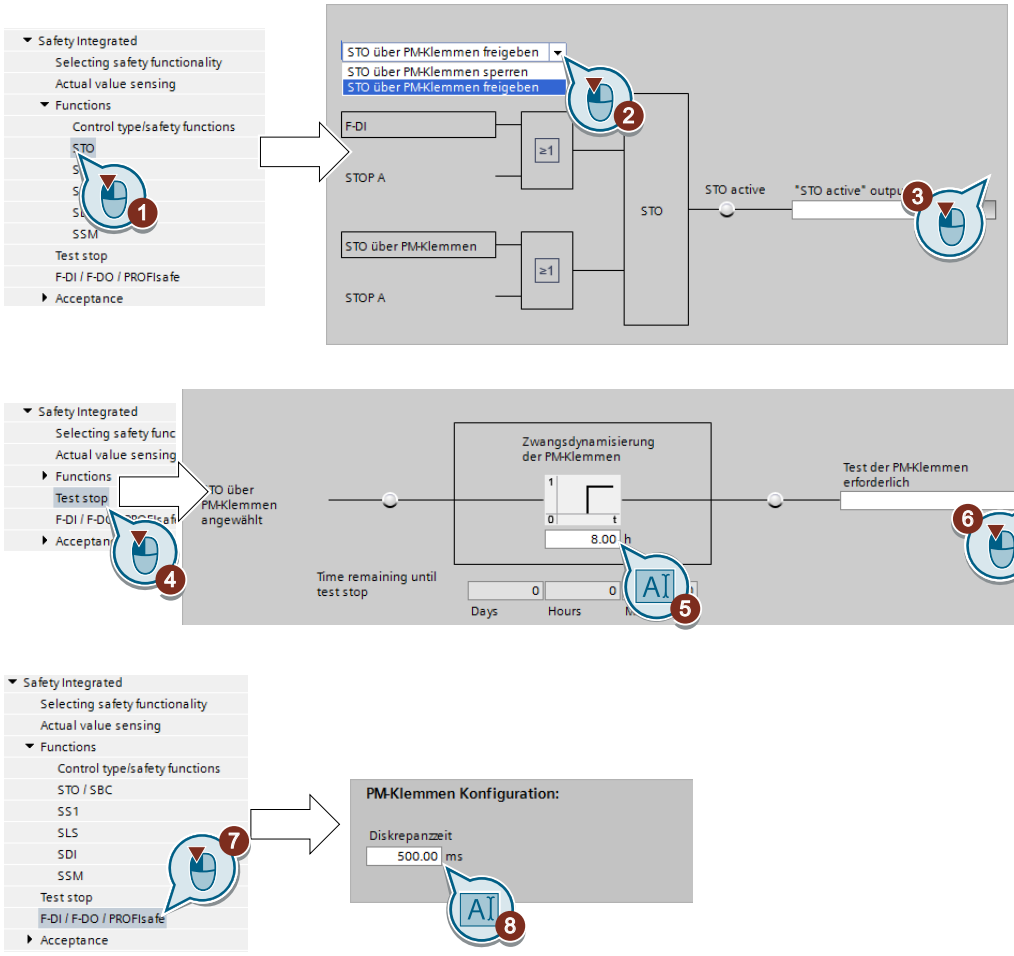
You have interconnected the failsafe acknowledge signal with a failsafe digital input.
❒

5.11.3 Setting STO via Power Module terminals

Requirement

You are online with Startdrive.

Procedure



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 converter signals that a forced checking procedure (test stop) is required for the "STO via Power Module terminals" function.

7. Select "F-DI / F-DO / PROFIsafe".
8. Set the discrepancy time (simultaneity monitoring) of the terminals on the Power Module. The setting not only applies for the Power Module terminals, but also for selecting the STO Basic Function via F-DI.
   Setting the filter for fail-safe digital inputs (Page 141).

You have set the "STO via Power Module terminals" function.
❒

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

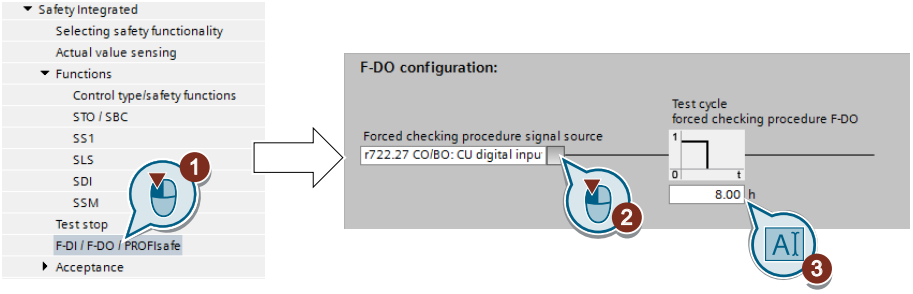
5.11.4 Setting a failsafe digital output

5.11.4.1 Setting the forced checking procedure (test stop)

Requirements

- You are online with Startdrive.
- You have selected the Extended Functions via onboard terminals.

Procedure



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 failsafe digital output - and resets the remaining time of the monitoring to the value ③.
   We recommend that the failsafe digital output is tested together with the forced checking procedure of the safety functions. To do this, interconnect the signal source with the same signal as the forced checking procedure of the safety functions.
   Setting the forced checking procedure (test stop) (Page 135)
3. Set the monitoring time for the forced checking procedure.
   The time must be longer than or equal to the time for monitoring the forced checking procedure of the Extended Functions.
   Setting the forced checking procedure (test stop) (Page 135)

You have defined which signal the converter uses to start the forced checking procedure (test stop) of its failsafe digital output.
❒

Description: Forced checking procedure of the failsafe output

The forced checking procedure of the failsafe digital output is the regular self-test of the converter, where the converter checks whether the output can be shut down (deactivated).

The converter monitors the regular forced checking procedure of the failsafe digital output using a time block.

You must start the forced checking procedure with a signal of your choice.

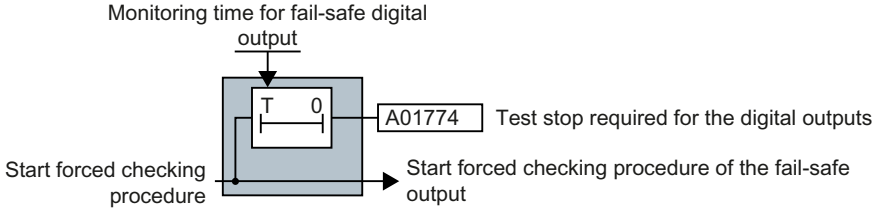


Figure 5-5 Start and monitoring of the forced checking procedure of the failsafe digital output

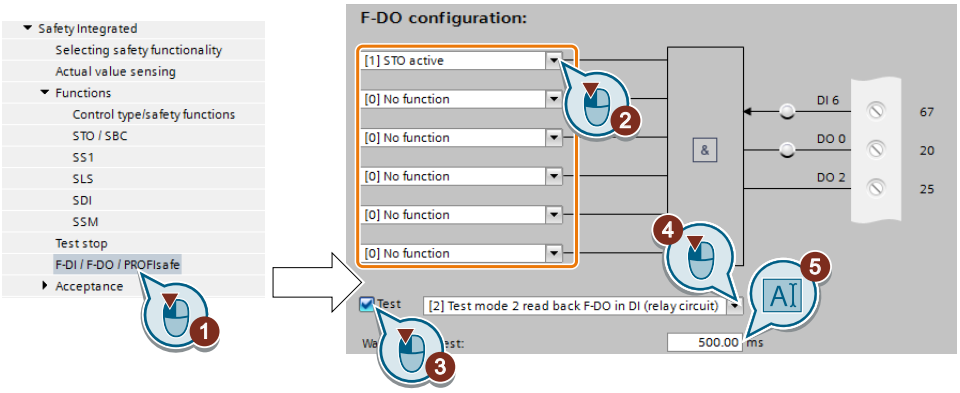
Parameter	Description
p10003	**Forced checking procedure timer** (Factory setting: 8 h) Setting the time to perform the forced checking procedure.
p10007	**Forced checking procedure F-DO signal source** (Factory setting: 0) Select an input terminal to start the forced checking procedure.

5.11.4.2 Output signal and setting the test mode

Requirements

- You are online with Startdrive.
- You have selected the Extended Functions via onboard terminals.

Procedure



1. Select "F-DI / F-DO / PROFIsafe".
2. Interconnect the status signals of your choice with the failsafe digital output. The "Safestate"signal is described below.
   The converter logically combines the status signals according to the following rules:
   - The converter ignored inputs without interconnection.
   - If none of the inputs is interconnected, then the output signal = 0.
3. Activate the test for the failsafe digital 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).
     Setting the filter for fail-safe digital inputs (Page 141)

You have defined which signal the converter transfers via its failsafe digital output, and how the converter tests its failsafe digital output.
❒

Signal "Safestate"

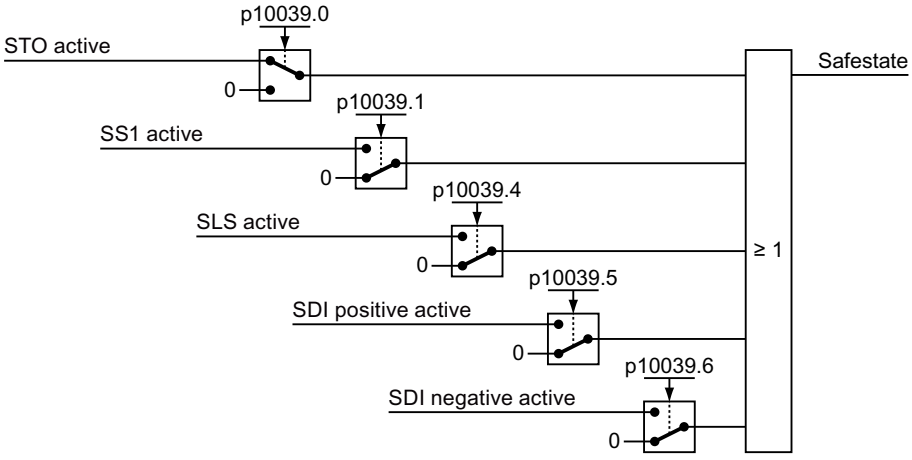


Figure 5-6 The Safetstate signal in the factory setting

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

The test mode of the failsafe output

Using its adjustable test mode, the converter checks as to whether the failsafe digital output can be shut down.

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

Connecting the fail-safe digital output for a SINAMICS G120D (Page 103)

Connecting the fail-safe digital output for a SINAMICS G120 (Page 101)

Test mode 1

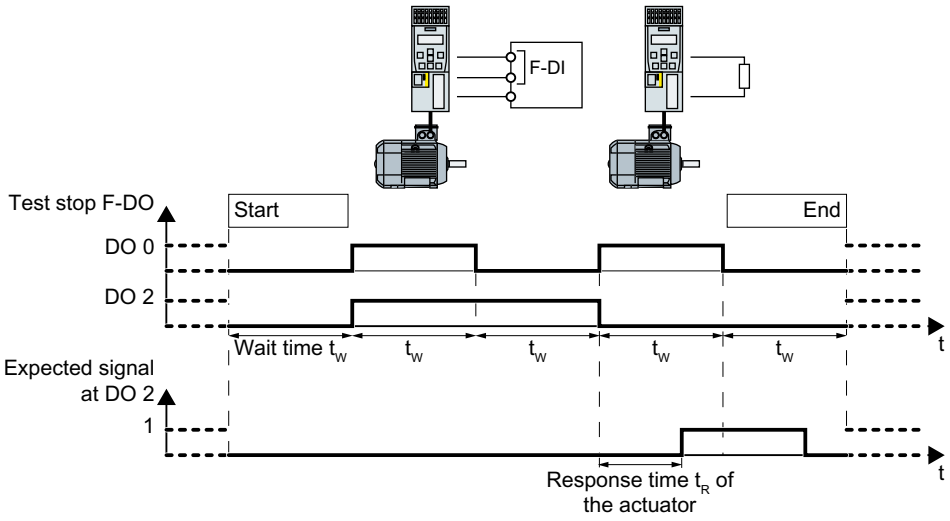


Figure 5-7 Expected response at digital output DO 2 for test mode 1

When testing the failsafe digital output, the converter switches the two digital outputs on and off alternating - and evaluates the voltage signal at output DO 2.

Test mode 2

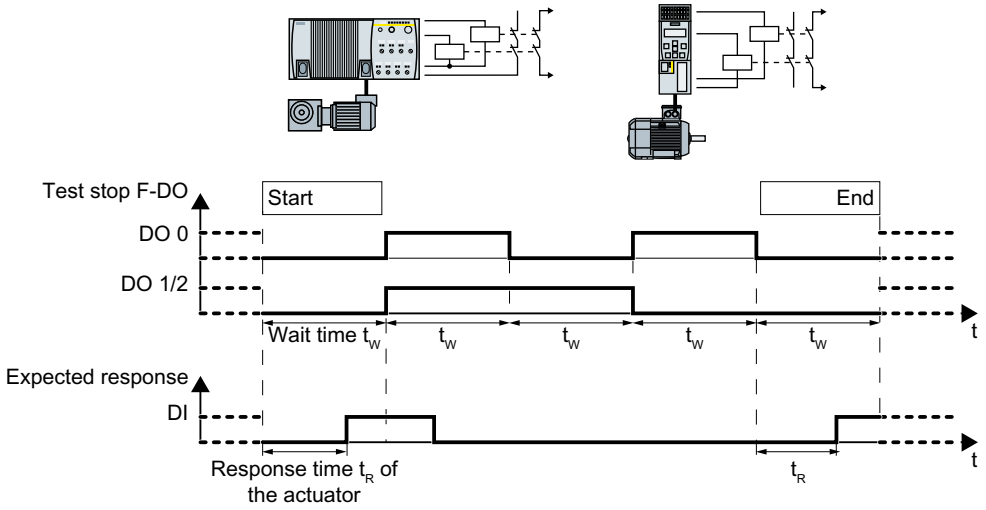


Figure 5-8 Expected response at the digital input for test mode 2

When testing the failsafe digital output, the converter switches the two digital outputs on and off alternating, and evaluates the feedback via a digital input.

Test mode 3

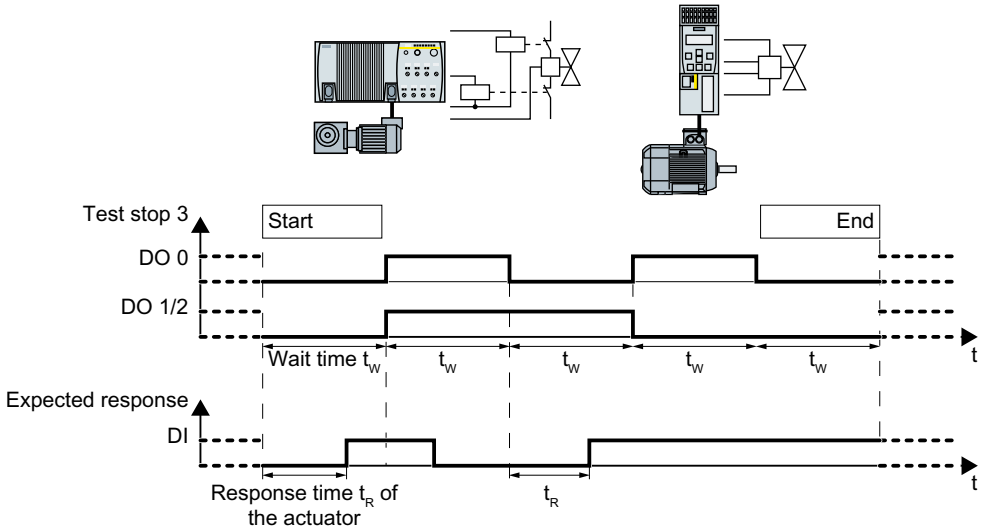


Figure 5-9 Expected response at the digital input for test mode 3

When testing the failsafe digital output, the converter switches the two digital outputs on and off alternating, and evaluates the feedback via a digital input.

Test mode 4

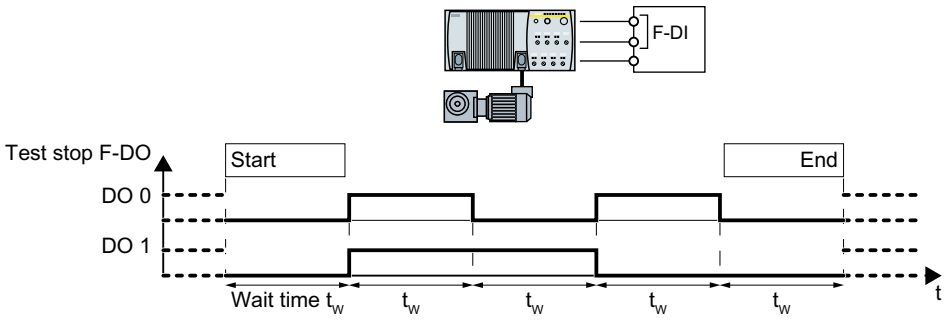


Figure 5-10 Test mode 4

When testing the failsafe digital output, the converter switches the two digital outputs on and off alternating.

SINAMIC G120D converters monitor their transistor outputs using internal signals.

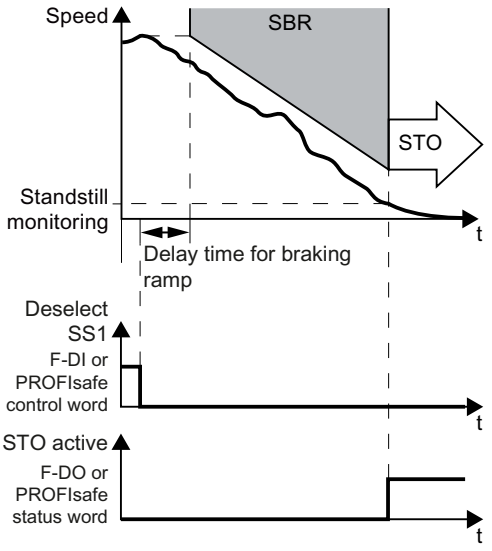
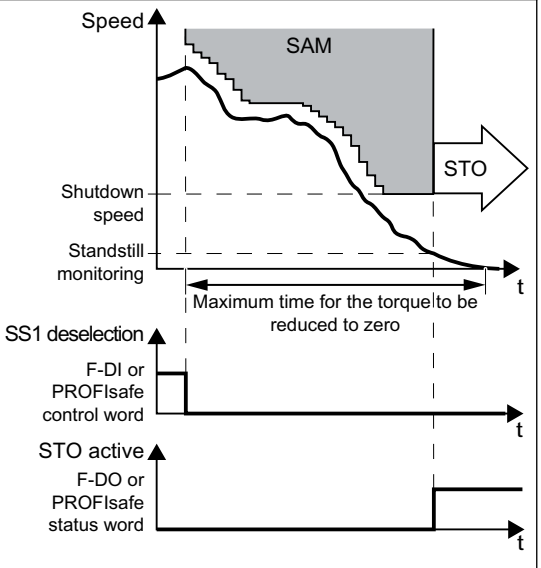
For SINAMICS G120, the connected failsafe digital input F-DI must monitor its input signals for discrepancy.

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

5.11.5 Setting SS1

Monitoring modes

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

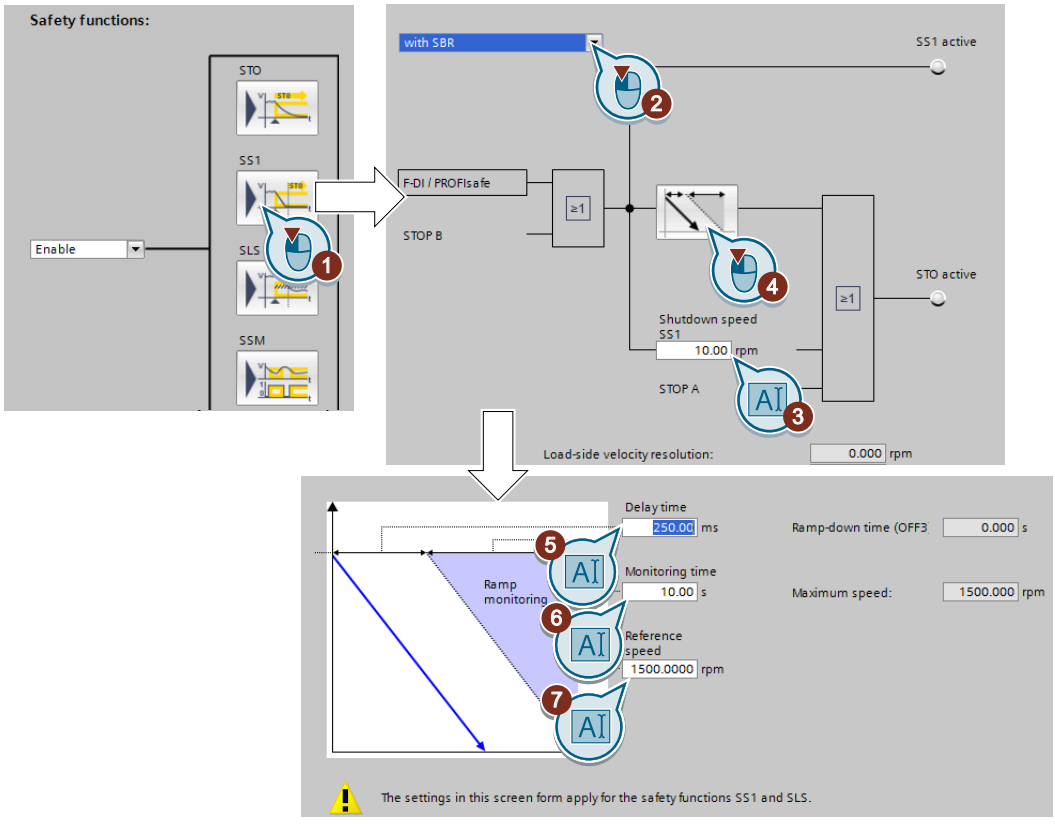
Braking ramp monitoring	Acceleration monitoring
	
• Using the SBR (Safe Brake Ramp) function, the converter monitors whether the motor speed decreases. • The gradient of the SBR function can be adjusted. The SBR function only starts after the "Delay time for braking ramp". The SBR function starts with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

5.11.5.1 Setting SS1 with braking ramp monitoring

Requirement

You are online with Startdrive.

Procedure



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

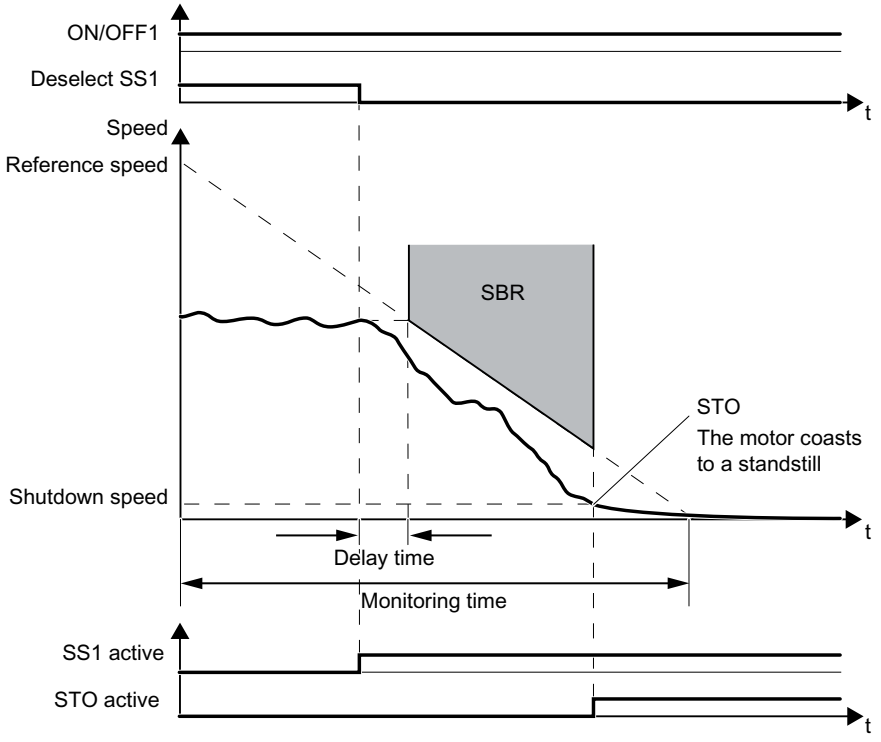


Figure 5-11 SS1 with braking ramp monitoring

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 converter monitors the speed setpoint that applied when SS1 was selected.

Braking

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

Shutdown speed

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

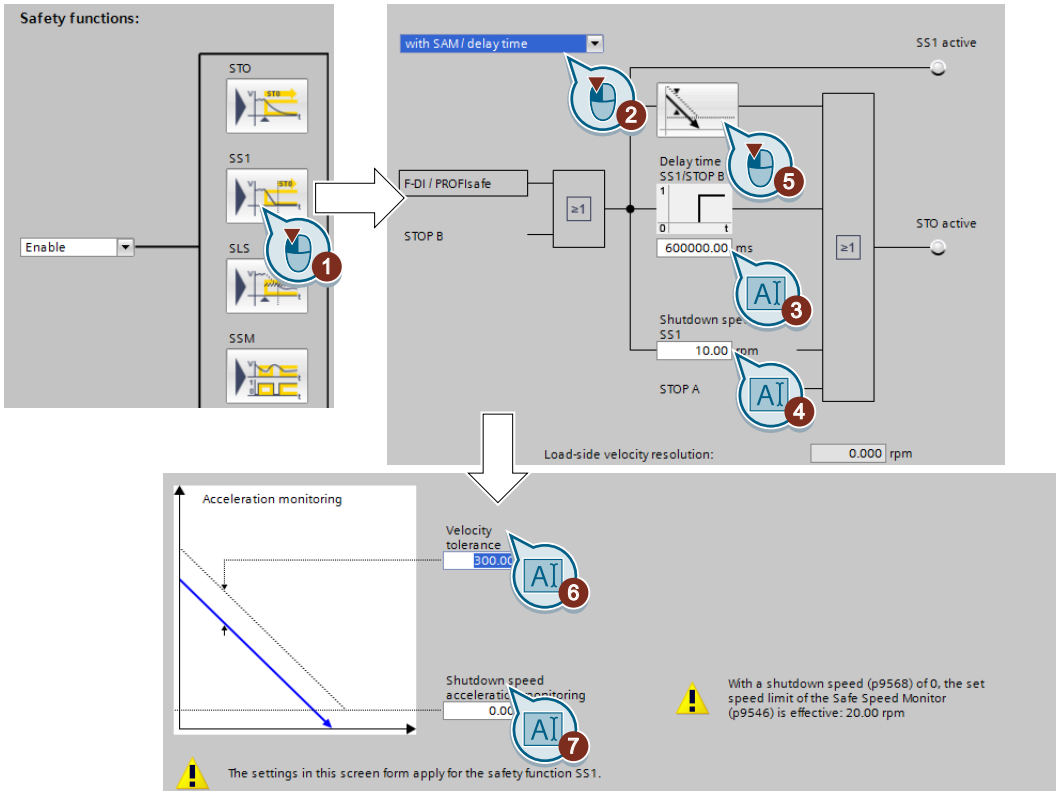
Parameter	Description		
p9501.00	**Enable safety functions** **1 signal:** Enable extended functions. **0 signal:** Disable extended functions.		
p9506	**Function specification:** (Factory setting: 1)		
	1:	With braking ramp monitoring	
	3:	With acceleration monitoring	
p9546	**SSM speed limit** (factory setting: 20 rpm) Only relevant to the SS1 function if p9560 = 0.		
p9560	**Pulse cancellation shutdown speed** (factory setting: 10 rpm) Shutdown speed		
p9581	**Brake ramp reference value** (factory setting: 1500 rpm) Reference speed for SBR		
p9582	**Brake ramp delay time** (factory setting: 250 ms)		
p9583	**Brake ramp monitoring time** (factory setting: 10 s)		
r9722.1	**Status signals** **1 signal**: SS1 active		
r9714	**Speed diagnostics** [rpm]		
	[0]	**Load-side speed actual value** Electrical speed of the motor. For induction motors, the mechanical speed is obtained from the electrical speed and slip.	
	[1]	**Actual SAM/SBR speed limit**	
r9723.16	**1 signal**: SAM/SBR active		
p1135	**OFF3 ramp-down time**		
p1226	**Standstill detection, speed threshold** (Factory setting: 20 rpm)		The converter switches off the motor torque if the speed either fulfills the condition for standstill detection or the shutdown speed p9569 has been reached.
p1227	**Standstill detection monitoring time** (Value depends on the power unit)		

5.11.5.2 Setting SS1 with acceleration monitoring

Requirement

You are online with Startdrive.

Procedure



1. Press the button for the SS1 function.
2. Select "with SAM/delay time".
3. After the "delay time", the converter 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

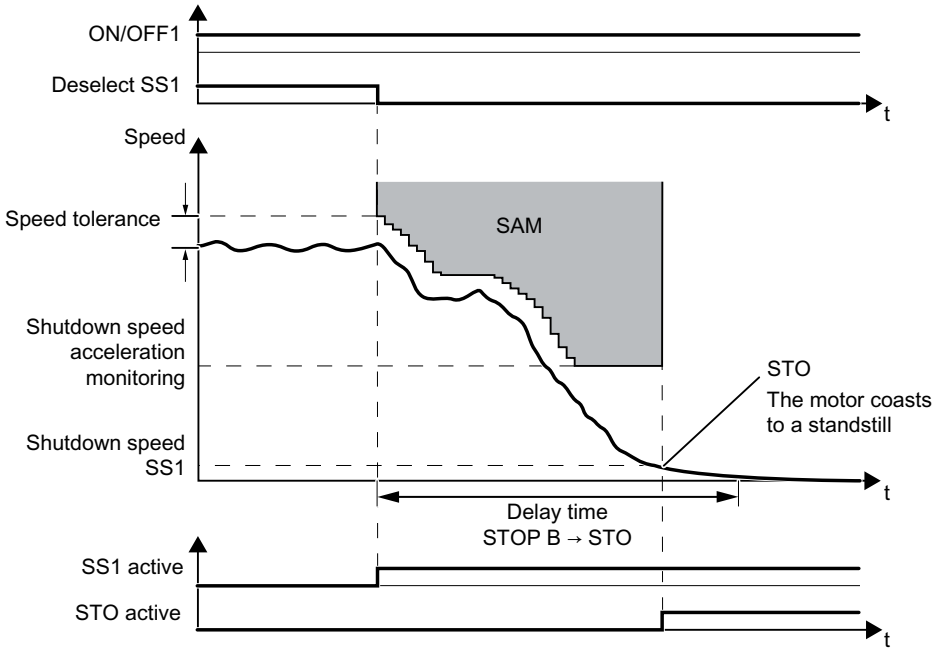


Figure 5-12 SS1 with acceleration monitoring

Speed tolerance

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

Shutdown speed acceleration monitoring

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

Shutdown speed SS1 and delay time

The converter safely switches off the motor torque with the 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	**1 signal:** Enable extended functions. **0 signal:** Disable extended functions.
p9506	**Function specification:** (Factory setting: 1)
	3: With acceleration monitoring
p9548	**Speed tolerance** (Factory setting: 300 rpm)
p9556	**Delay time STOP B → STO** (Factory setting: 600000 ms)
p9560	**Shutdown speed SS1** (Factory setting: 10 rpm)
p9568	**Shutdown speed acceleration monitoring** (Factory setting: 0 rpm)

Parameter	Description		
r9714	**Speed diagnostics** [rpm]		
	[0]	**Load-side speed actual value** Electrical speed of the motor. For induction motors, the mechanical speed is obtained from the electrical speed and slip.	
	[1]	**Actual SAM/SBR speed limit**	
r9722.1	**1 signal**: SS1 active		
r9723.16	**1 signal**: SAM/SBR active		
p1226	**Standstill detection, speed threshold** (Factory setting: 20 rpm)		The converter switches off the motor torque if the speed either fulfills the condition for standstill detection or the shutdown speed p9569 has been reached.
p1227	**Standstill detection monitoring time** (Value depends on the power unit)		

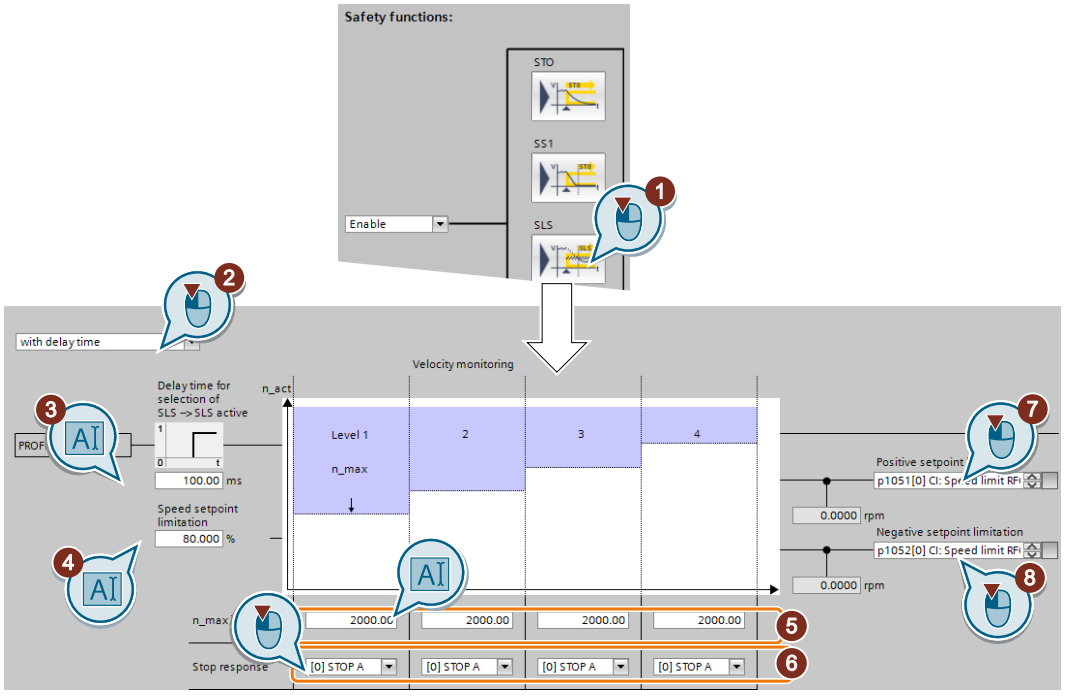
5.11.6 Setting SLS

5.11.6.1 Setting the monitoring functions

Requirement

You are online with Startdrive.

Procedure



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).
   Setting SS1 with braking ramp monitoring (Page 151)
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 monitoring responds.
   Stop responses (Page 254)
7. If you leave this signal interconnection at the factory setting, when SLS is selected, the converter limits the speed setpoint in the positive direction.
8. If you leave this signal interconnection at the factory setting, when SLS is selected, the converter limits the speed setpoint in the negative direction.
9. Close the screen form.

You have set the SLS function.
❒

Description of the SLS function

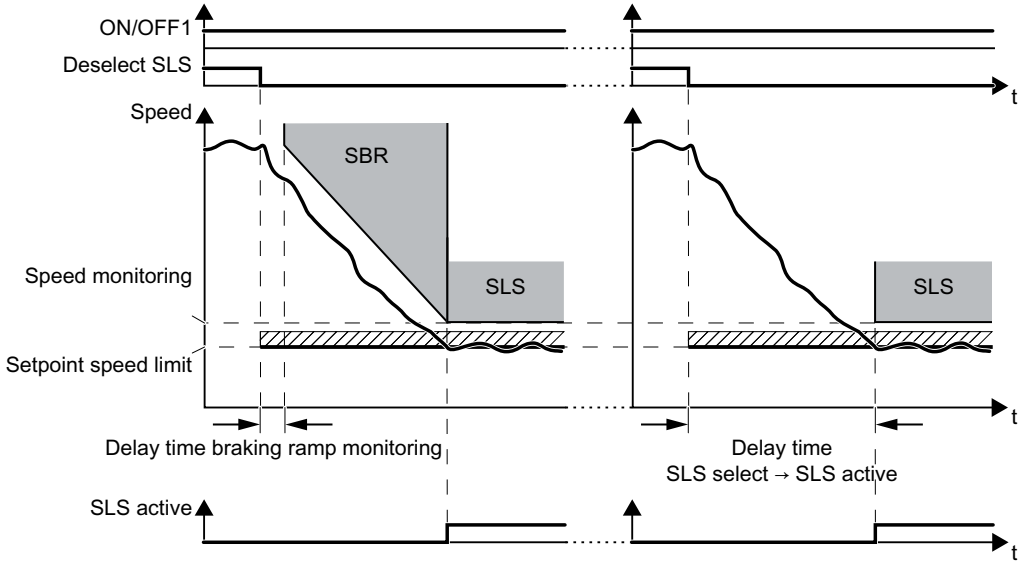


Figure 5-13 Behavior after selecting SLS. Left: with braking ramp monitoring; right: without braking ramp monitoring

After selecting SLS, the converter brakes the motor according to the OFF3 ramp-down time.

Setting SS1 with braking ramp monitoring (Page 151)

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

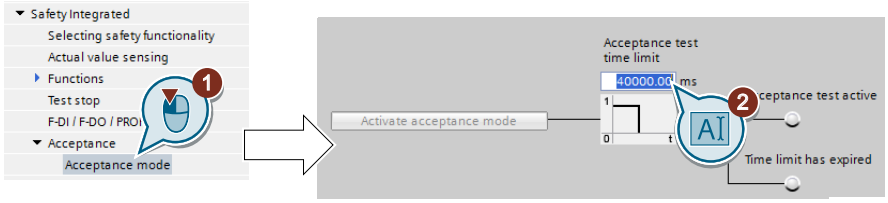
5.11.6.2 Settings for acceptance test

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 converter.

Requirement

You are online with Startdrive.

Procedure



1. Open the screen form for the "Acceptance mode".
2. Set the time in which the converter deactivates its internal speed limiting. During the acceptance test, you must reach the monitored limit value within this time.
   After this time expires, the converter exits the acceptance mode and reactivates its internal speed limiting.

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

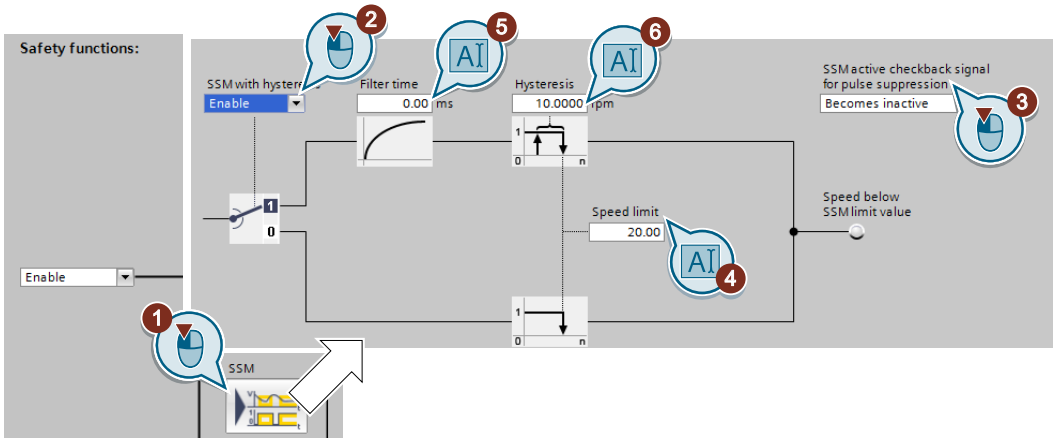
Parameter	
p9558	**Acceptance test mode time limit** (factory setting 40000 ms) Maximum time limit: 100 seconds.

5.11.7 Setting SSM

Requirement

You are online with Startdrive.

Procedure



1. Open the screen form for the SSM safety function.
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.
   Switching on the motor when SSM is active (Page 239)
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 converter compares the load speed with the speed limit.

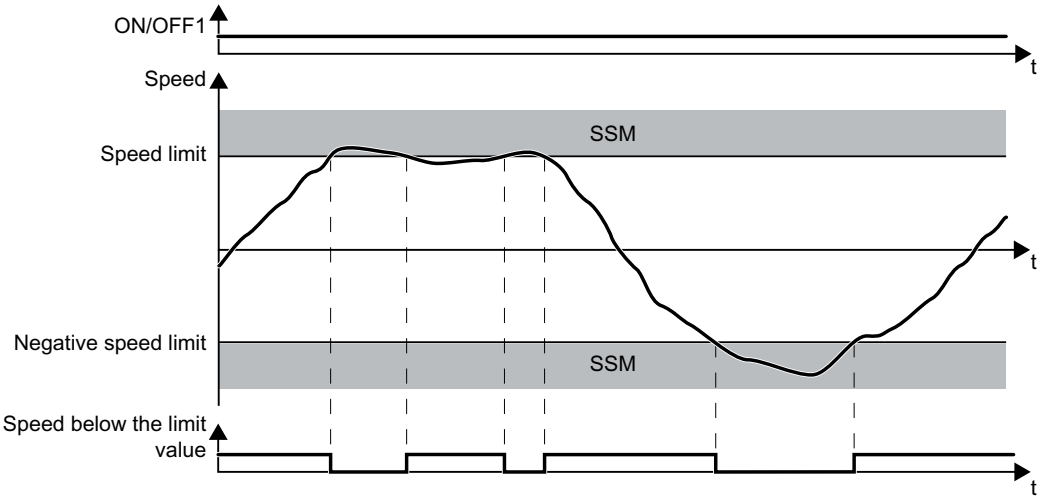


Figure 5-14 Time response of the SSM safety function without hysteresis

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

SSM with hysteresis

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

Speed monitoring

- When the motor is switched on, the converter compares the load speed with the speed limit, taking the hysteresis into account.

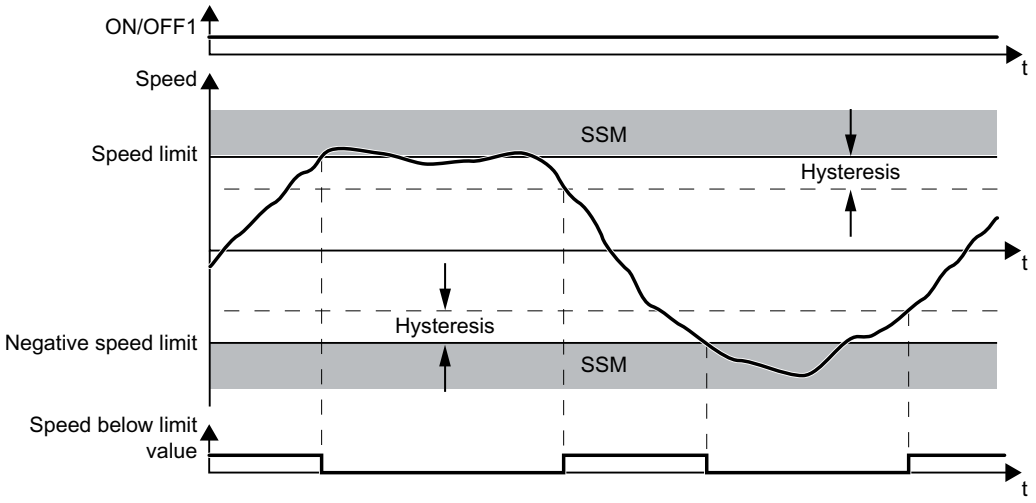


Figure 5-15 Time response of the SSM safety function with hysteresis

Filter

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

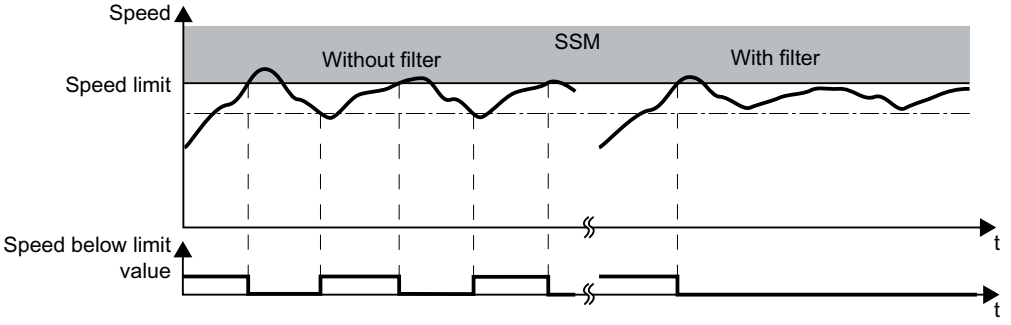


Figure 5-16 Mode of operation of the filter of the SSM function

Parameter	Description
p9501.00	**1 signal:** Enable extended functions. **0 signal:** Disable extended functions.
p9501.16	**1 signal:** Enable hysteresis and filtering **0 signal:** Disable hysteresis and filtering
p9545	**Filter time** (Factory setting: 0 ms)
p9546	**Speed limit** (Factory setting: 20 rpm)
p9547	**Hysteresis** (Factory setting: 10 rpm)
r9714[0]	**Load-side speed actual value** [rpm] Electrical speed of the motor. For induction motors, the mechanical speed is obtained from the electrical speed and slip.
r9722.15	**1 signal**: 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 converter freezes the "Speed below limit value" signal.
- When the motor is switched off, STO is active.

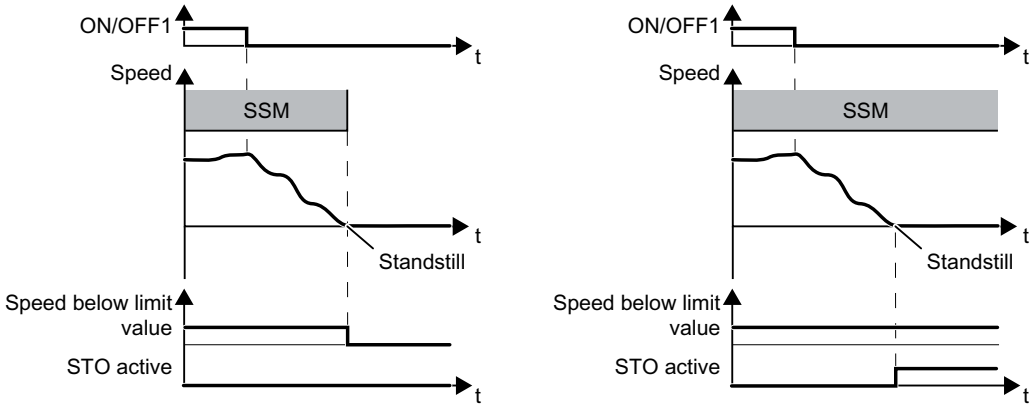


Figure 5-17 Feedback signal SSM when the motor is switched offLeft: SSM becomes inactive. Right: SSM remains active

Switching off the motor when SSM is active (Page 235)

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

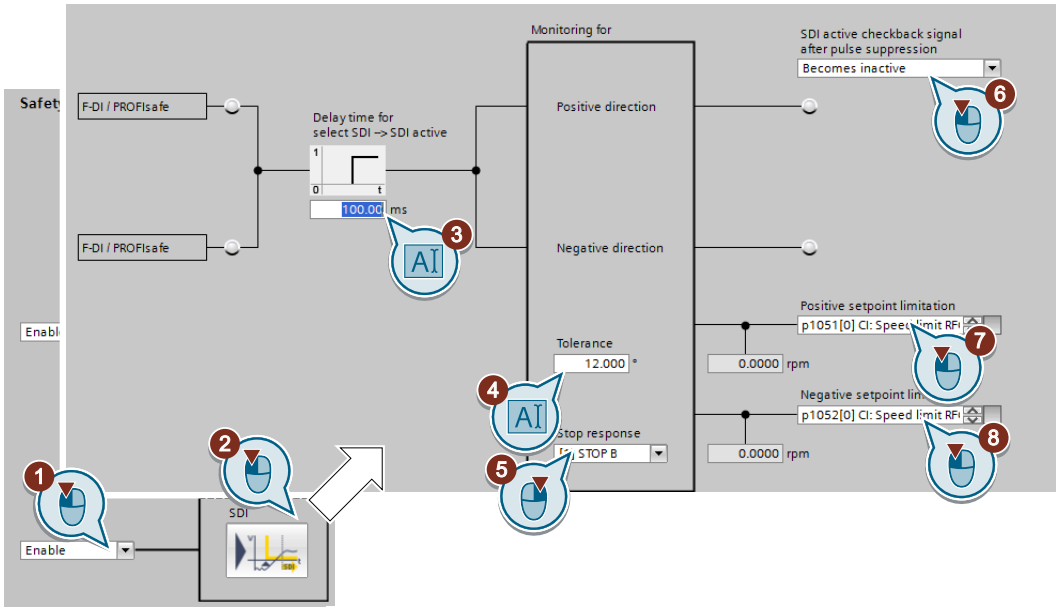
5.11.8 Setting SDI

5.11.8.1 Setting the monitoring functions

Requirement

You are online with Startdrive.

Procedure



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.
   Stop responses (Page 254)
6. Behavior when the motor is switched off.
   Switching off the motor when SDI is active (Page 243)
7. If you leave this signal interconnection at the factory setting, when SDI- is selected, the converter limits the speed setpoint.
8. If you leave this signal interconnection at the factory setting, when SDI+ is selected, the converter 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 converter limits the speed or velocity setpoint to a value of zero in the inhibited direction of rotation.

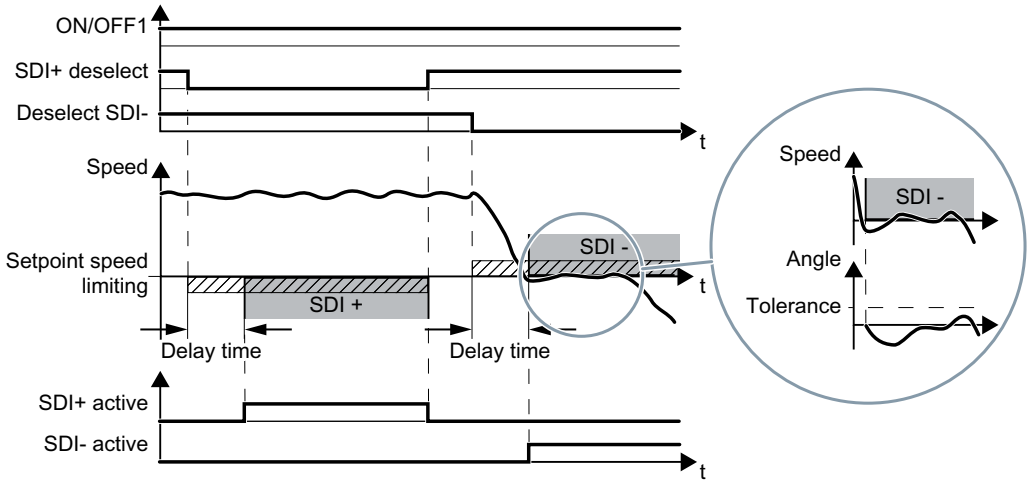


Figure 5-18 Delay time and tolerance

Delay time

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

Tolerance

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

Feedback signal SDI when the motor is switched off

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

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

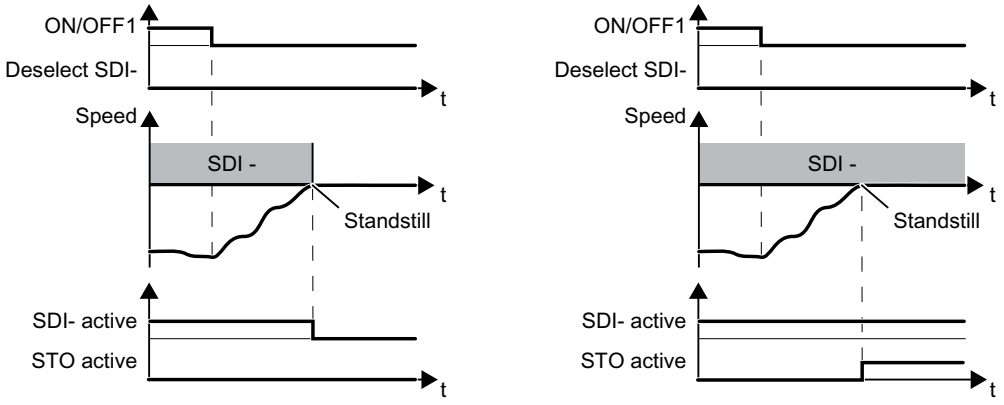


Figure 5-19 Feedback signal SDI when the motor is switched offLeft: SDI becomes inactive. Right: SDI remains active

Switching off the motor when SDI is active (Page 243)

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

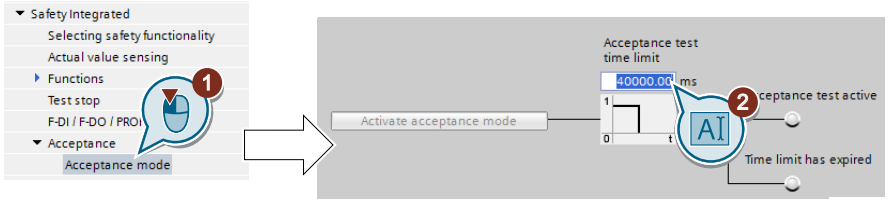
5.11.8.2 Settings for acceptance test

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 converter.

Requirement

You are online with Startdrive.

Procedure



1. Open the screen form for the "Acceptance mode".
2. Set the time in which the converter deactivates its internal speed limiting. During the acceptance test, you must reach the monitored limit value within this time.
   After this time expires, the converter exits the acceptance mode and reactivates its internal speed limiting.

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

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

5.11.9 Final steps when commissioning online

Overview

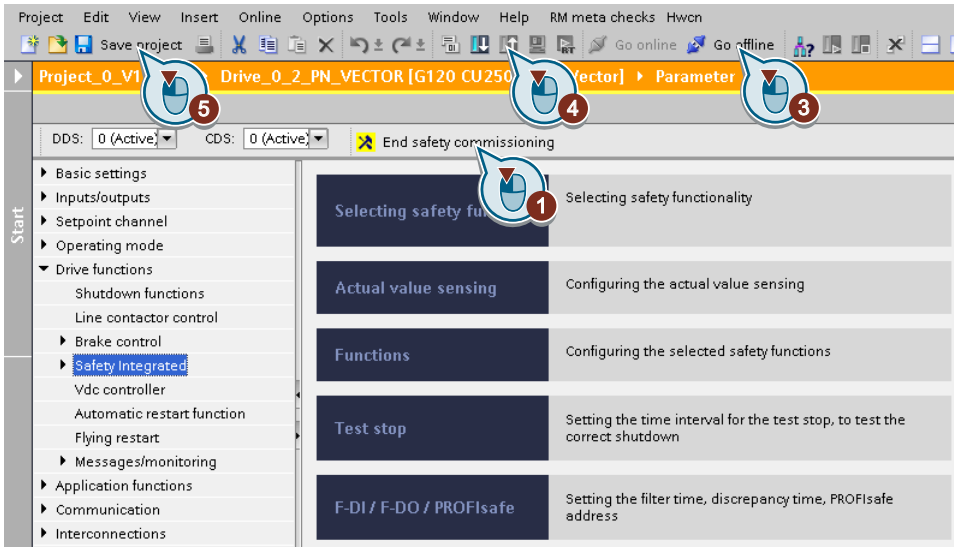
You must exit commissioning the safety functions and save the settings.

Requirement

You are online with Startdrive.

Function description

Procedure



1. Press 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 converter power supply.
7. Wait until all LEDs on the converter go dark (no voltage condition).
8. Switch on the converter power supply again.

Your settings are now active.
❒

Parameter

Parameter	Description	Factory setting
p0010	Drive commissioning parameter filter	1
p0971	Save parameters	0
p9700	SI copy function	0000 hex
p9701	Acknowledge SI data change	0000 hex

Parameter	Description
p9700 = 57 hex	**SI copy function** (factory setting: 0) Start the SI parameter copy function.
p9701 = AC hex	**Confirm data change** (factory setting: 0) Confirm total data change.

Parameter	Description
p0010 = 0	**Drive commissioning parameter filter** 0: Ready
p0971 = 1	**Save parameter** 1: Save the drive object (copy from RAM to ROM) After the converter has saved the parameters in a non-volatile fashion, then p0971 = 0.

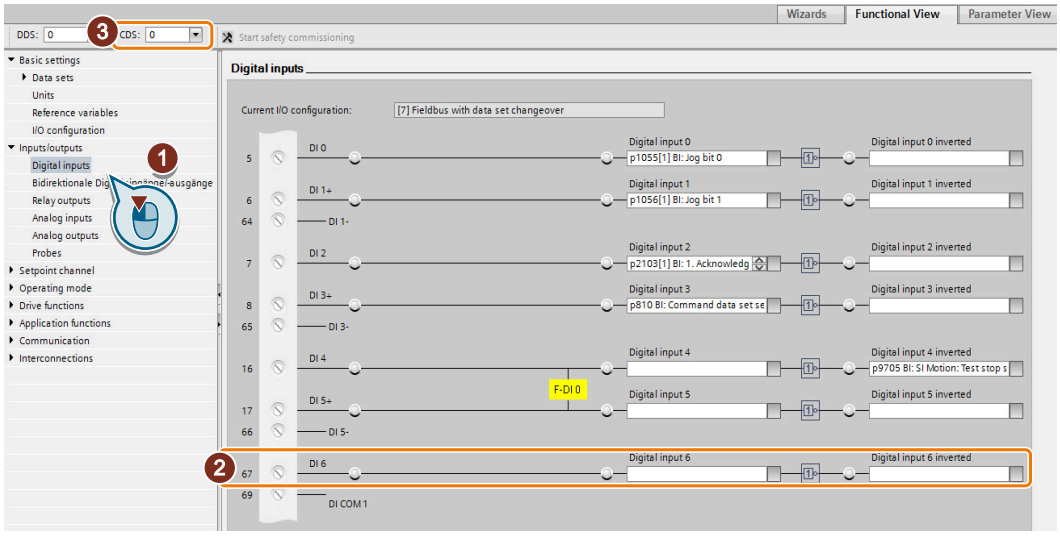
Overview

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 converter via failsafe digital inputs, then you must check as to whether the failsafe digital inputs are in some instances interconnected with a "standard" function.

Function description

Procedure



1. Select the screen for the digital inputs.
2. Remove all interconnections of the digital inputs that you use as failsafe digital 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 failsafe digital inputs only control the safety functions in the converter.
❒

Checking the interconnection of the feedback signal input for the failsafe digital output

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

Requirements

- You are using the failsafe digital output of the converter.
- You use one of the test modes 2 or 3, where the converter evaluates the status of the connected actuator via a digital input.

You must check whether this digital input is assigned a "Standard" function.

Procedure

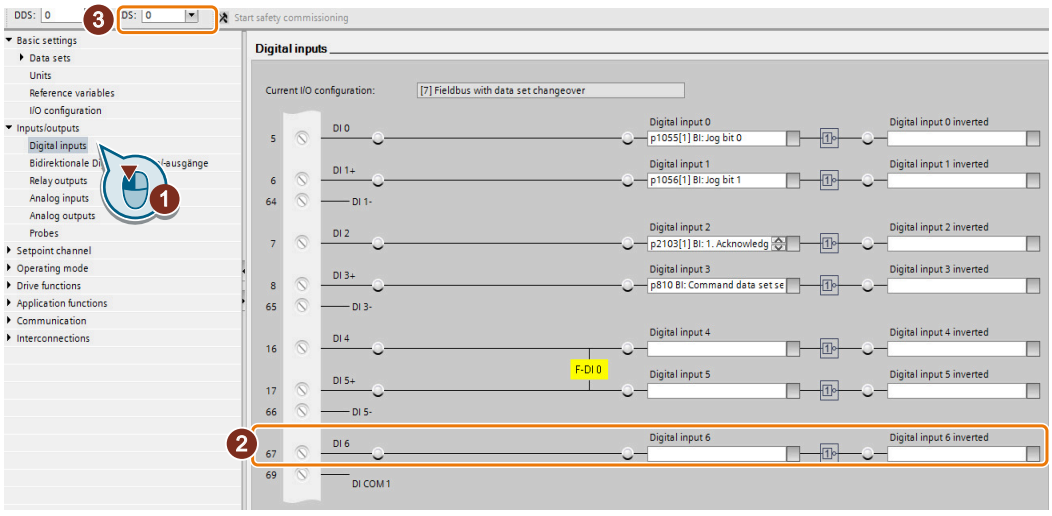


Figure 5-20 Removing the interconnection of the feedback signal input DI 6 for the CU250S-2

1. Select the digital inputs.
2. Remove the interconnection of the digital input that you use as feedback signal input for the failsafe digital 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.

You have now prevented the feedback signal input of the failsafe digital output controlling "Standard" functions in the converter.
❒

5.12 Activating Shared Device

Enabling Shared Device

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

Requirement

You are online with Startdrive.

Procedure

1. In Startdrive, switch to the parameter view.
2. Set p8929 = 2.

You have configured the communication via "Shared Device" in the converter.
❒

5.13 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.

5.14 Commissioning with Startdrive offline

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

Setting the safety functions offline

Procedure

1. Select the safety functions in Startdrive.
2. Set the safety function parameters offline.
   When doing this, orient yourself to the descriptions provided in the online commissioning.
   Configuring the safety functions and PROFIsafe (Page 114)
3. Back up your project.

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

In the next step, you must load the settings from your PC or PG to the converter.

Loading the settings into a converter and activating the safety functions

Procedure

1. In Startdrive, open the project that matches the drive.
2. Select "Load to device".
3. Connect Startdrive online with the drive.
   The converter signals faults after the download. Ignore these faults, as they will be automatically acknowledged by the following steps.
4. Press the "Start safety commissioning" button.
5. Enter the password for the safety functions.
6. Press the "End safety commissioning" button.
7. Confirm the prompt for saving your settings (copy RAM to ROM).
8. Switch off the converter power supply.
9. Wait until all LEDs on the converter are dark.
10. Switch the converter power supply on again.
11. Perform an acceptance test.
    Reduced acceptance test after expanding the function (Page 176)

You have loaded the settings of the safety functions from the Startdrive project to the converter, and have activated the safety functions.
❒

5.15 Standard commissioning

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

Procedure

1. Save your project to your PC or PG.
2. Loading your backed up settings to a second converter:
   Commissioning with Startdrive offline (Page 172)
3. If you control your converter via PROFIsafe, you have to modify the PROFIsafe address.
   Selecting configuration of the safety functions (Page 113)
4. Accept the safety functions.
   Reduced acceptance test after expanding the function (Page 176)

You have transferred the settings of the first converter to a second converter.
❒

5.16 Acceptance tests for the safety functions

5.16.1 Acceptance test

Overview

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 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.

Function description

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 converter?
- Do the converter settings match the configured safety-relevant function in the machine?

Acceptance test of the converter

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

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

Documentation of the converter

The following must be documented for the converter:

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

The documentation must be signed.

Who may perform the acceptance test of the converter?

The following are authorized to perform a converter acceptance test: Only 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 and appropriate manner.

Wizard for the acceptance test

The "Startdrive Advanced" commissioning tool (requires an appropriate license) includes a wizard for the acceptance test of the safety functions integrated in the drive.

"Startdrive Advanced" guides you through the acceptance test, generates the appropriate traces to analyze the machine response – and generates an acceptance report as Excel file.

Further information is provided on the Internet:

Startdrive, system requirements and download (https://support.industry.siemens.com/cs/ww/en/view/109760844)

Reduced acceptance test after function expansions

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

Measure	Acceptance test	
	Acceptance test	**Documentation**
Functional expansion of the machine (additional drive).	Yes. Only check the safety functions of the new drive.	• Supplement machine overview • Supplement converter data • Add function table • Log the new checksums • Countersignature
Transfer of converter settings to other identical machines by means of series commissioning.	No. Only check the control of all of the safety functions.	• Add machine description • Check checksums • Checking the firmware versions

5.16.2 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.	• Supplement function table • Log modified settings • Document the changed checksum and time stamp [1)] • Countersignature
Functional expansion of the machine (additional drive).	Check the safety functions of the new drive.	• Supplement machine overview • Supplement article number and firmware version of the drive • Supplement function table • Log the settings of the new drive • Document the changed checksum and time stamp [1)] • Countersignature
Functional expansion of a drive (e.g. additional SLS level or new safety function following a firmware update).	Check the additional functions.	• Supplement function table • Log modified settings • Document the changed checksum and time stamp [1)] • Countersignature
Transfer of converter settings to other identical machines by means of series commissioning.	Check the control and feedback signal of all safety functions.	• Supplement machine description • Log modified settings • Check the changed checksum and time stamp [1)] • Check the firmware versions

[1)] The converter changes the following parameters after changing the settings of the safety functions:

- checksum r9781

- time stamp r9782

Reduced acceptance after a component has been replaced and a firmware change (Page 290)

Operation

6

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 mission 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 discrepancy signal at a fail-safe digital 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

6.2.1 Overview

Safety functions according to SIL 2 to IEC 61508 and to Pl 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 converter must test its failsafe digital input if you are using a failsafe digital input.
  Testing failsafe digital inputs (Page 179)
- The converter must test its safety functions:
  Testing the basic functions (Page 180)
  Testing the extended functions (Page 182)
- The converter must test its failsafe digital output if you are using a failsafe digital output.
  Testing a failsafe digital output (Page 184)

Safety functions according to SIL 3 to IEC 61508 and to Pl 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 via Power Module terminals" function:

- The converter must test the failsafe digital input on the Power Module.
  Testing failsafe digital inputs (Page 179)
- The converter must test the "STO via Power Module terminals" function.
  Testing the basic functions (Page 180)

6.2.2 Testing failsafe digital inputs

Testing sensors and failsafe digital inputs

The converter tests its failsafe digital inputs and the connected sensors with a signal change at the inputs. We recommend that you test the failsafe digital inputs together with the forced checking procedure (test stop).

Procedure

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

You have tested the failsafe digital inputs.
❒

Converter 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 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	✓	---	✓

6.2.3 Testing the basic functions

Time

The converter monitors as to whether the self test (= forced checking procedure, test stop) is regularly started.

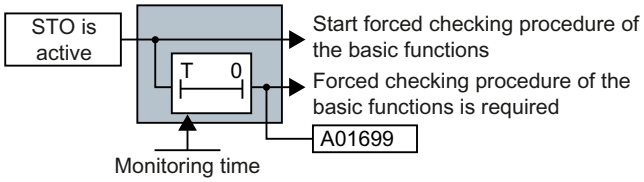


Figure 6-1 Starting and monitoring the forced checking procedure (test stop)

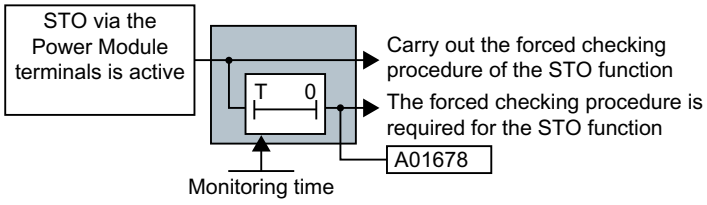


Figure 6-2 Start and monitoring of the forced checking procedure (test stop) for STO via Power Module terminals

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.

Converter signal	Parameter	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
STO active (Basic Functions)	r9773.1	✓	---	✓
Deselect STO (Basic Functions)	r9773.0	✓	✓	---
STO cause – selection via Power Module terminals	r9772.25	---	---	---
Forced checking procedure (test stop) for the "STO via Power Module terminals" function	r9773.30	---	---	---
Forced checking procedure (test stop) required for the Basic Functions	r9773.31	---	---	---

Carry out a forced checking procedure of the Basic Functions

Requirements

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

Procedure

1. Select the STO function.
2. The converter 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 checking procedure.
❒

Carry out the forced checking procedure of the "STO via Power Module terminals" function

Requirements

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

Procedure

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

You have performed the forced checking procedure.
❒

6.2.4 Testing the extended functions

Time

The converter monitors as to whether the self test (= forced checking procedure, test stop) is regularly started.

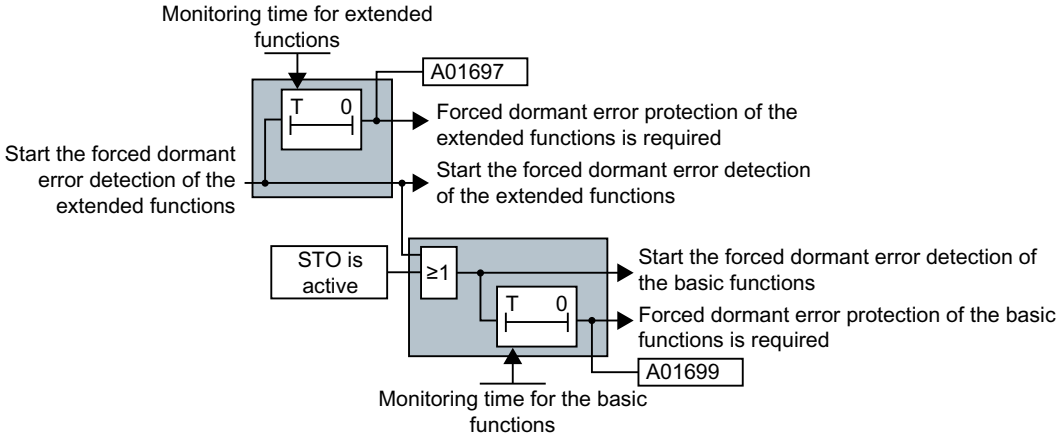


Figure 6-3 Starting and monitoring the forced checking procedure (test stop)

If the converter outputs alarm A01699 or A01697, you must initiate a forced checking procedure at the next opportunity, e.g.:

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

Converter signal	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 checking procedure (Extended Functions)	p9705	---	---	---

Performing a forced checking procedure (test stop)

When testing the Extended Functions, the converter switches the motor into a no-torque condition.

Requirements

- STO is not active.
  If you start the forced checking procedure with STO active, then the converter responds with a fault.
- The motor is switched on (ON/OFF1 = 1), and is at a standstill (speed setpoint = 0).

Procedure

1. Start the forced checking procedure using a signal of your choice, for example a digital input.
2. The converter checks its safety-related circuits. During the check, the converter outputs alarms C01798 and C30798. This check takes several milliseconds.
3. Set the signal to start the forced checking procedure to zero.
4. Check that neither alarm A01699 nor alarm A01697 is active.
5. Check the failsafe digital outputs of the converter.
   Testing failsafe digital inputs (Page 179)
6. Check the failsafe digital output of the converter.
   Testing a failsafe digital output (Page 184)

You have performed the forced checking procedure of the Extended Functions.
❒

6.2.5 Testing a failsafe digital output

Time of the test

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

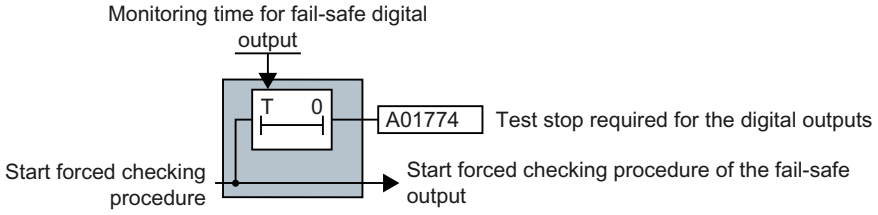


Figure 6-4 Start and monitoring of the forced checking procedure (test stop) of the failsafe digital output

If the converter 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.

Converter signal	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 failsafe digital output	p10007	---	---	---

Testing the failsafe digital output and the connected actuator

The converter tests its failsafe digital output and the connected actuator for a signal change at the failsafe digital output.

Procedure

1. Switch on the motor (ON/OFF1 command = 1).
   If you wish to carry out the forced checking procedure 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 converter briefly switches off the failsafe digital output. This test takes several milliseconds.
4. Set the signal to start the forced checking procedure to zero.
5. Check that alarm A01774 is no longer present.

You have tested the failsafe digital output.
❒

The response of the failsafe digital output depends on the test stop mode that has been selected.

Output signal and setting the test mode (Page 146)

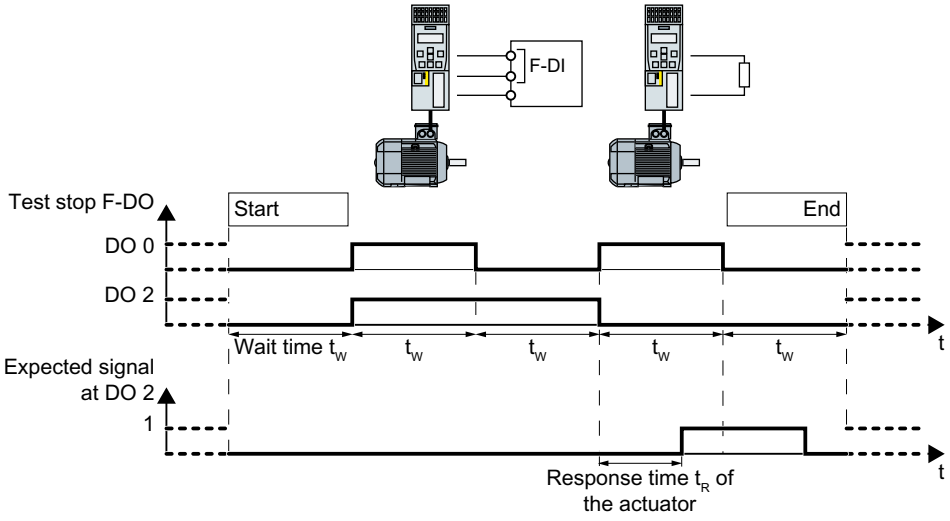


Figure 6-5 Test stop mode 1

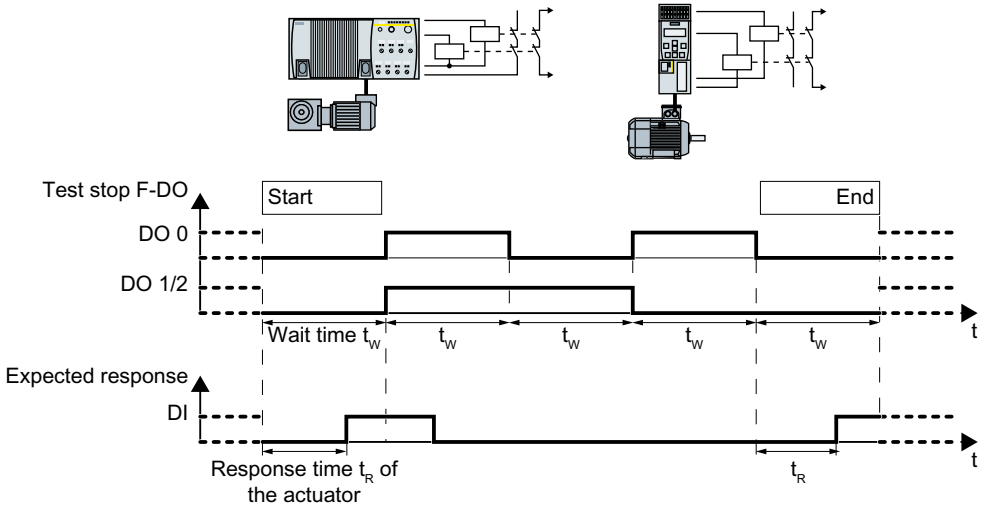


Figure 6-6 Test stop mode 2

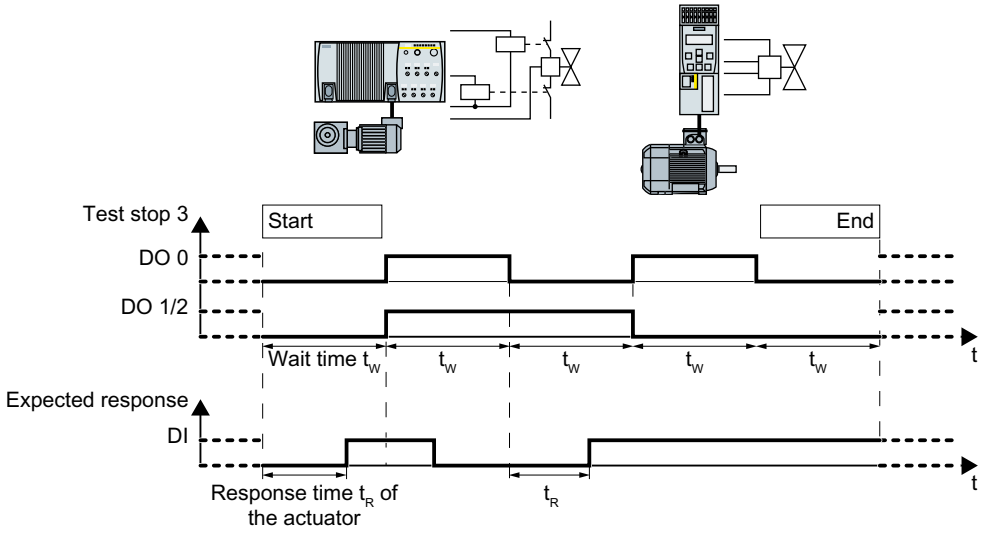


Figure 6-7 Test stop mode 3

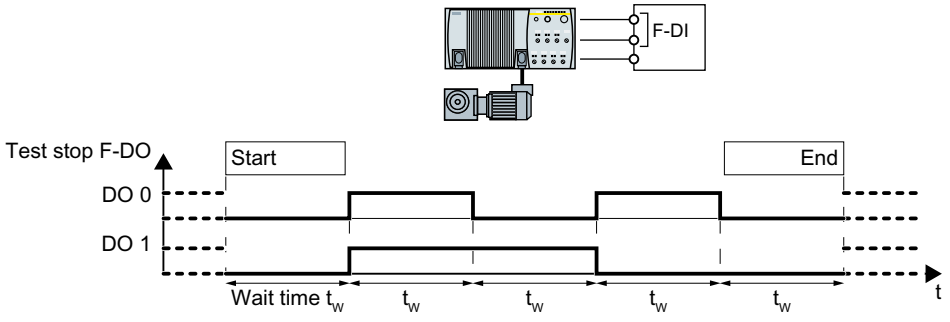


Figure 6-8 Test stop mode 4

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 de-selecting STO	Selecting and deselecting STO when the motor is switched on (Page 188)
Discrepancy in the input signal	The failsafe digital input to select STO identifies an error. Response to a discrepancy when STO is active (Page 190)

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 failsafe digital input or via PROFIsafe.
2. The converter then safely switches off the motor torque.

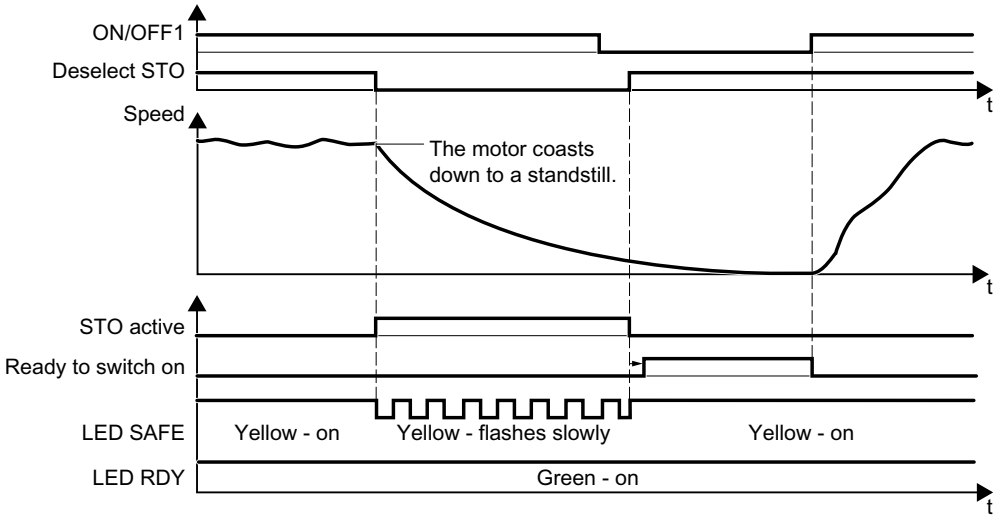


Figure 6-9 Time response of the STO safety function (Safe Torque Off)

Converter signal	Parameter	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
STO active (Basic Functions)	r9773.1	✓	---	✓
Deselect STO (Basic Functions)	r9773.0	✓	✓	---
STO active (Extended Functions)	r9722.0	✓	---	✓
Deselect STO (Extended Functions)	r9720.0	✓	✓	---
Ready for switching on	r0052.0	---	---	---
ON/OFF1	r0054.0	---	---	---

Switching on the motor once STO is active

Procedure

1. Deselect STO.
2. After deselecting STO, wait until the converter 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 re-activated the motor following an active STO.
❒

6.3.3 Response to a discrepancy when STO is active

The converter responds with the active safety function STO to a discrepancy at the failsafe digital input.

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

- 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 via Power Module terminals" function → 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

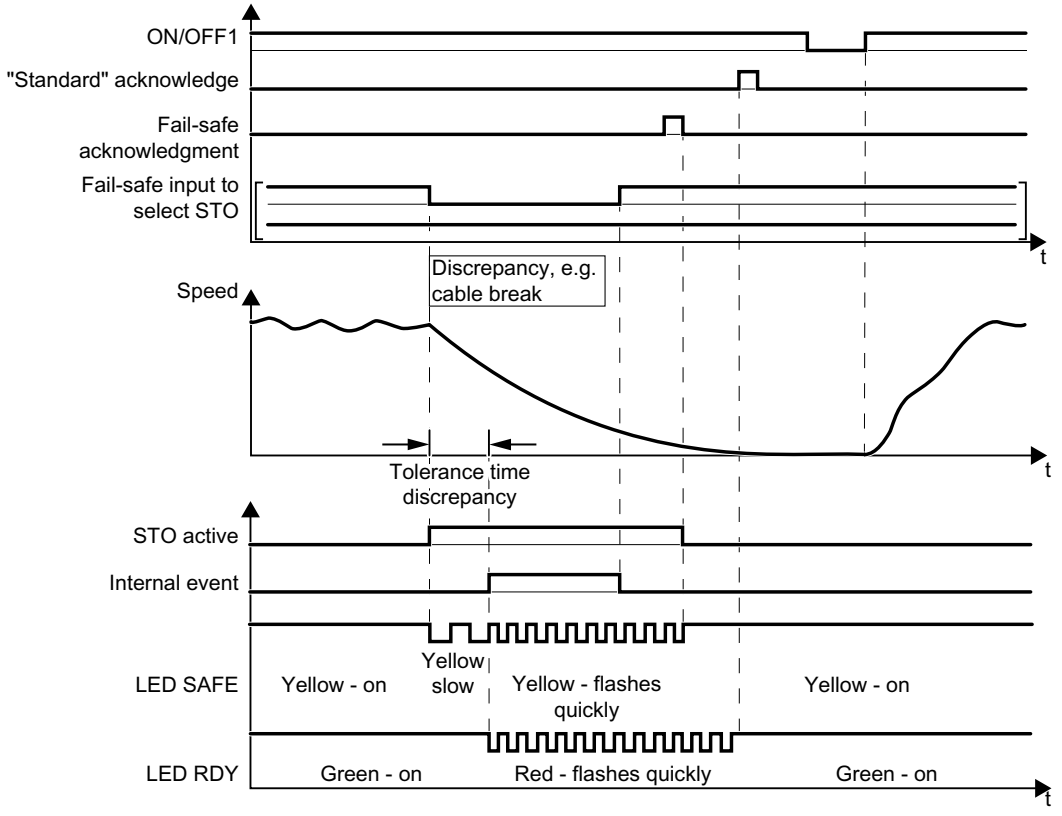


Figure 6-10 Converter response for discrepancy of the input signal for STO (example: cable break in the channel of processor P1)

Converter messages after the tolerance time has expired:

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

Independent of the voltage levels available, the converter sets the evaluation of the discrepant failsafe digital input into the safe state (= zero) until you acknowledge the converter using a failsafe signal or you switch off the power supply voltage and switch it on again.

Converter 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	✓	---	✓
Deselect STO (Basic Functions)	r9773.0	✓	✓	---
"Standard" acknowledgment	p2103	---	---	---
Failsafe acknowledgment	r9720.7	✓	✓	---
ON/OFF1	r0054.0	---	---	---

Case 1: Switching on the motor after a discrepancy

Procedure

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 Failsafe 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 Failsafe acknowledgment (PROFIsafe control word 1, bit 7 = 0 → 1 → 0)	Switch off the power supply voltage and switch on again

3. Acknowledge the converter 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.

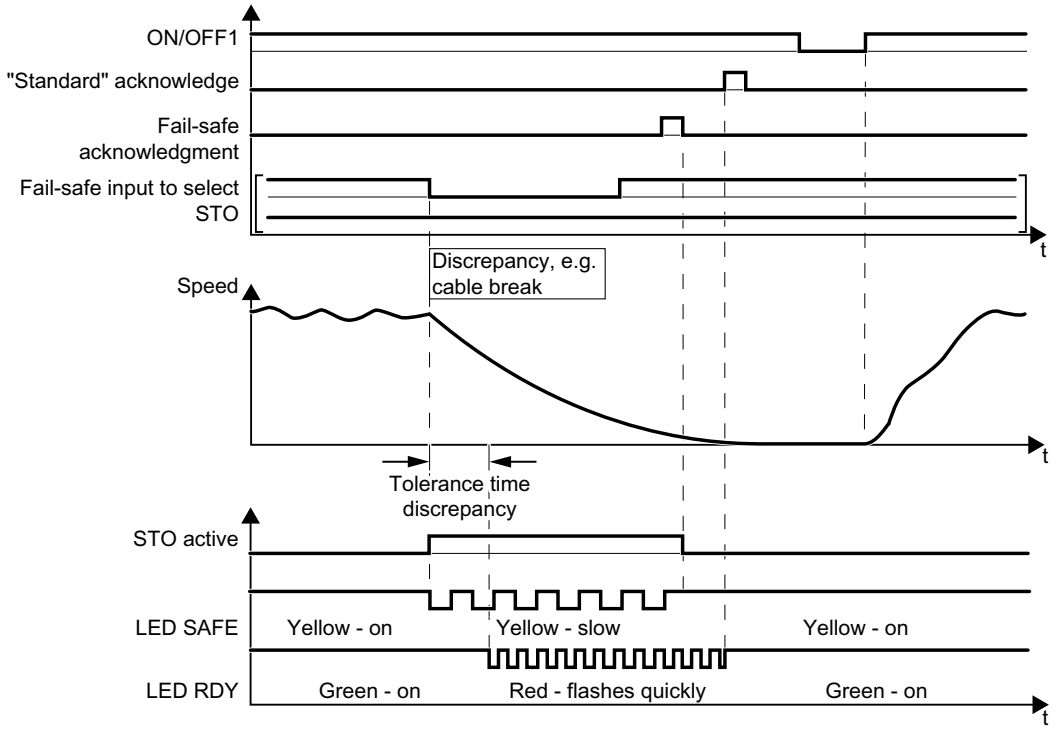


Figure 6-11 Response of safety function STO in the event of a discrepancy

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

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

Converter 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	---	---	---
Failsafe acknowledgment	r9720.7	✓	✓	---
ON/OFF1	r0054.0	---	---	---

Case 2: Switching on the motor after a discrepancy

Procedure

1. Remove the discrepancy.
2. Acknowledge the discrepancy message with a failsafe acknowledge signal via a failsafe digital input: F-DI = 0 → 1 → 0.
   Alternatively: Switch off the power supply voltage and switch on again.
3. Acknowledge the converter 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.
❒

Example 3: Drive response for the "STO via Power Module terminals" function

You have selected the "STO via Power Module terminals" function for the PM240-2 or PM240P-2 Power Module.

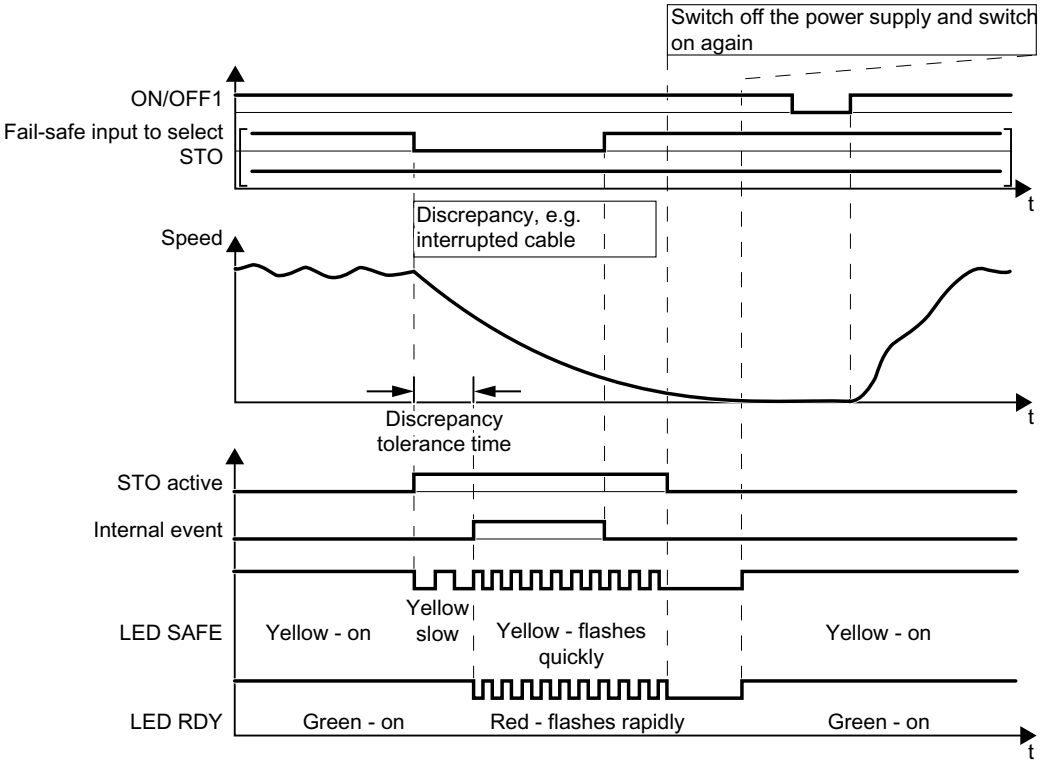


Figure 6-12 Response of safety function STO in the event of a discrepancy at the input of the PM240-2 or PM240P-2 Power Module

Converter messages after the tolerance time has expired:

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

Converter 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	✓	---	✓
Deselect STO (Basic Functions)	r9773.0	✓	✓	---
STO cause – selection via Power Module terminals	r9772.25	---	---	---
"Standard" acknowledgment	p2103	---	---	---
Failsafe acknowledgment	r9720.7	✓	✓	---
ON/OFF1	r0054.0	---	---	---

Example 3: Switching on the motor after a discrepancy

Procedure

1. Remove the discrepancy.
2. Acknowledge the discrepancy message.

Selected setting	How can the internal event be acknowledged?		
	F-DI [1]	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 or 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 Failsafe acknowledgment (PROFIsafe control word 1, bit 7 = 0 → 1 → 0)	Switch off the power supply voltage and switch on again

[1] The message cannot be acknowledged using the Power Module terminals.

3. Acknowledge the converter with the "standard" acknowledge signal.
4. Issue an OFF1 command (ON/OFF1 = 0).
5. Enter a speed setpoint = 0 (motor is stationary) – and switch on the motor (ON/OFF1 = 1).
6. Select the "STO via Power Module terminals" function.
   The converter carries out a forced checking procedure (test stop).
7. Deselect the "STO via Power Module terminals" function.
8. Check that neither fault F01600 nor F30600 with fault value r0949 = 1030 is active.

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 converter 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 converter.
2. You have enabled the SBC function.
3. The STO function is active in the converter.

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.

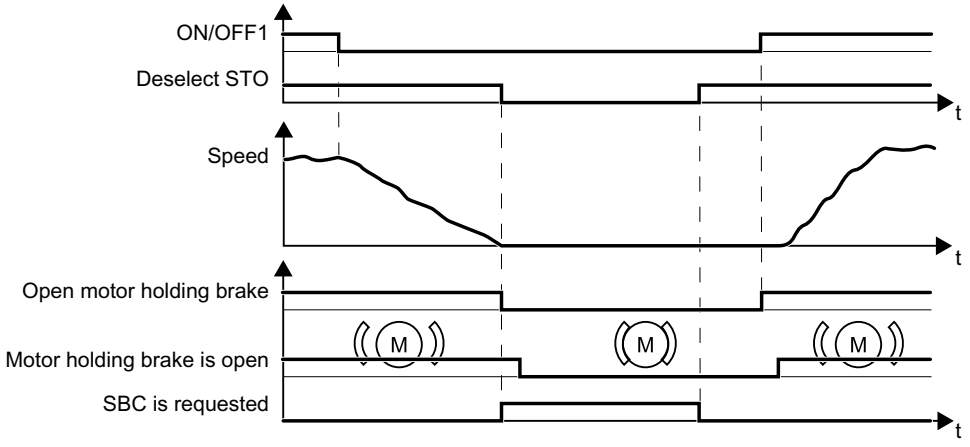


Figure 6-13 Wait until standstill is reached and activate SBC with STO

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

Converter signal	Parameter	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
Deselect STO (Basic Functions)	r9773.0	✓	✓	---
Deselect STO (Extended Functions)	r9720.0	✓	✓	---
SBC requested (basic functions)	r9773.4	---	---	---
ON/OFF1	r0054.0	---	---	---

Converter signal	Parameter	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
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 converter brakes the motor with the OFF3 ramp-down time.
3. The converter 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 converter activates the STO function and controls the brake with the SBC function.

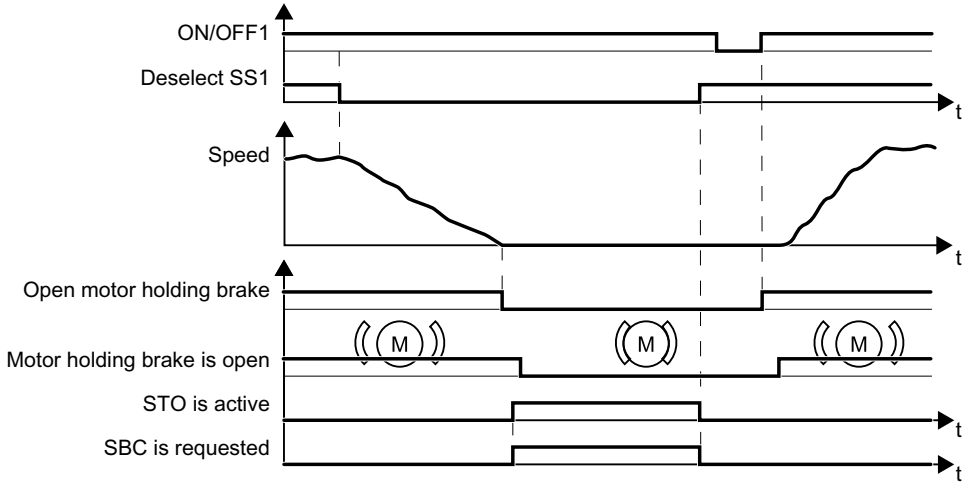


Figure 6-14 When selecting SS1, the motor holding brake closes at standstill

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

Converter 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 converter closes the brake without taking the current speed into consideration.

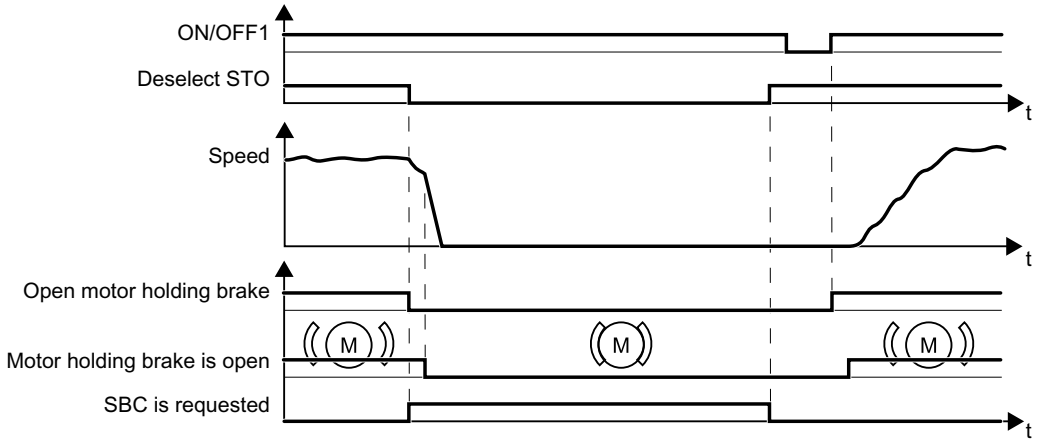


Figure 6-15 The motor holding brake closes after selecting STO

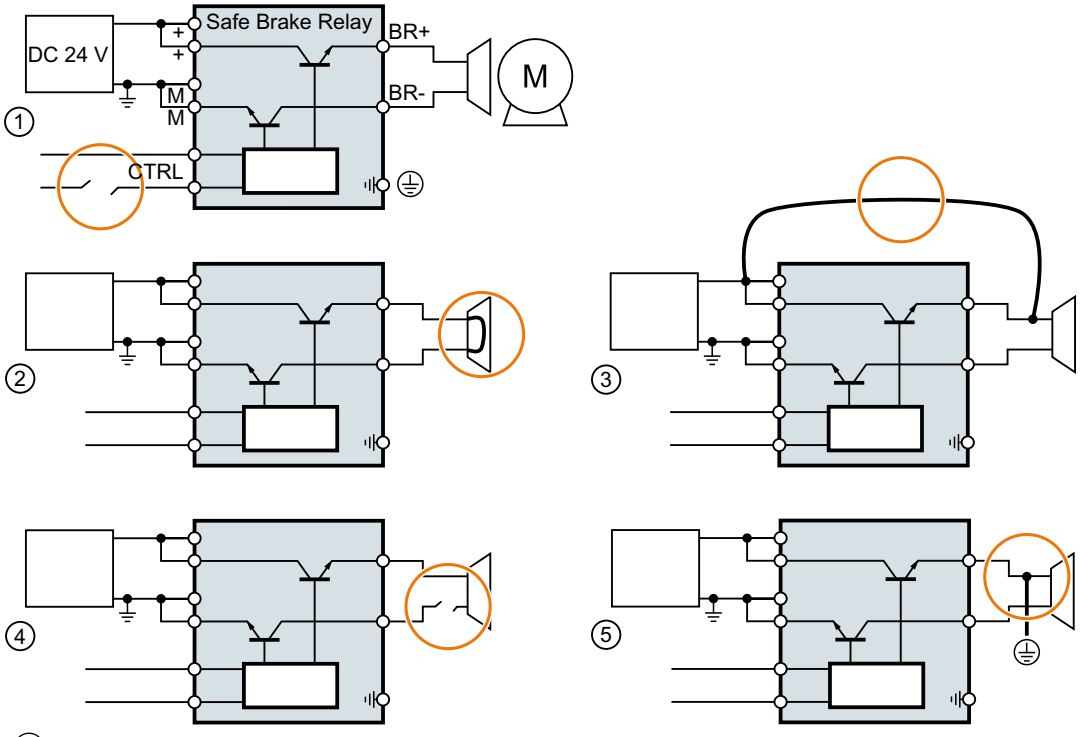
Before you can switch on the motor again, you must deselect the STO function.

Converter signal	Parameter	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
Deselect STO (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 converter identifies faults in the brake cable and in the brake winding.



① Control cable from the converter 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 6-16 Examples of faults in the brake control

Drive response

If the converter 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 201)
Discrepancy in the input signal	The failsafe digital input to select SS1 identifies an error. Response to a discrepancy when SS1 is active (Page 209)
Limit value violation	The speed of the motor violates the SS1 monitoring that has been set. Limit value violation when SS1 is active (Page 213) 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 207)

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 failsafe digital input or via PROFIsafe safe communication.
2. If the motor is switched on when SS1 is selected, the converter brakes the motor with the OFF3 ramp-down time.
3. After the delay time, the converter safely switches off the motor torque with the STO safety function.

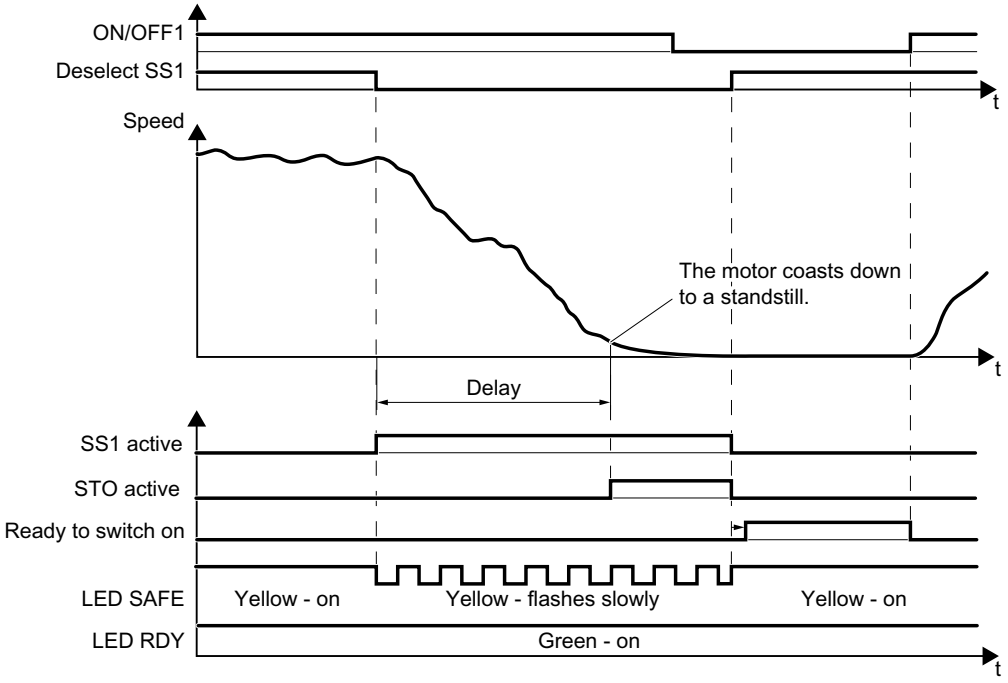


Figure 6-17 Braking behavior and diagnostics of the safety function SS1 (Safe Stop 1)

Converter 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 for switching on	r0052.0	---	---	---
ON/OFF1	r0054.0	---	---	---

Switching on the motor once SS1 is active

Procedure

1. Deselect SS1.
2. After deselecting SS1, wait until the converter 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 activated the motor following an active SS1.
❒

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 failsafe digital input or via PROFIsafe safe communication.
2. If the motor has already been switched off when selecting SS1, then the converter safely switches off the motor torque with the safety function STO.
   If the motor is switched on when SS1 is selected, the converter brakes the motor with the OFF3 ramp-down time. The converter monitors whether the load speed decreases using the SBR function.
3. The converter safely switches off the motor torque using the STO safety function if the load speed reaches the "standstill monitoring".

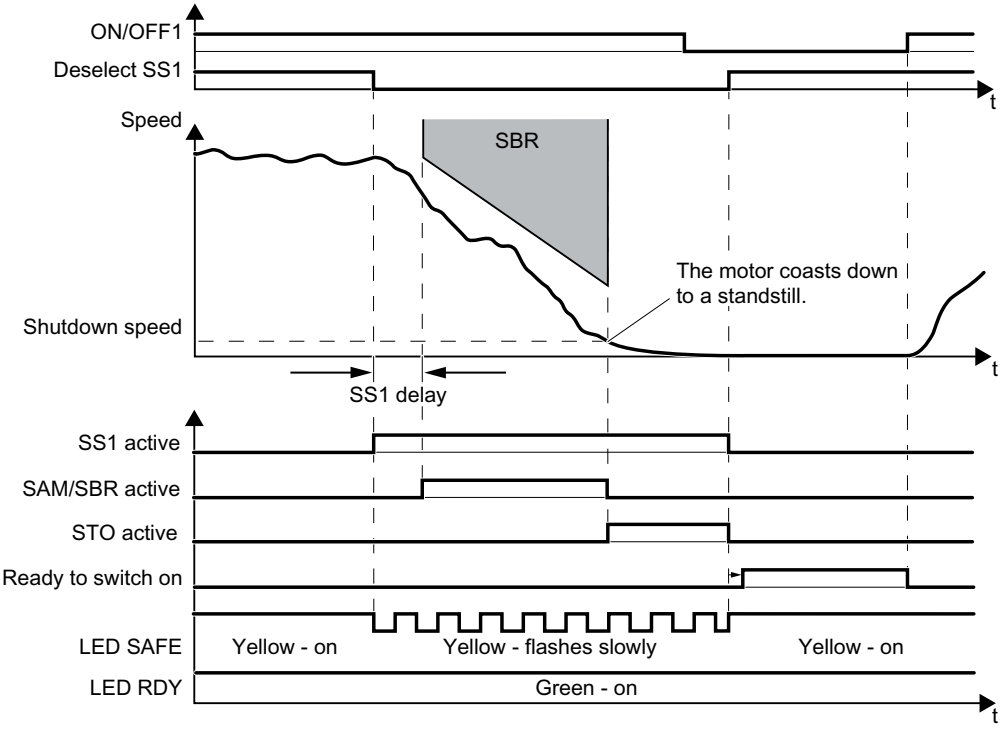


Figure 6-18 Braking behavior and diagnostics of the safety function SS1 (Safe Stop 1)

Converter 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	---	---	---

Converter signal	Parameter	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
Ready for switching on	r0052.0	---	---	---
ON/OFF1	r0054.0	---	---	---

Switching on the motor once SS1 is active

Procedure

1. Deselect SS1.
2. After deselecting SS1, wait until the converter 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 activated the motor following an active SS1.
❒

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 failsafe digital input or via PROFIsafe safe communication.
2. If the motor has already been switched off when selecting SS1, then the converter safely switches off the motor torque with the safety function STO.
   If the motor is switched on when SS1 is selected, the converter brakes the motor with the OFF3 ramp-down time. The converter monitors braking using the SAM function (Safe Acceleration Monitor).
3. The converter 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.

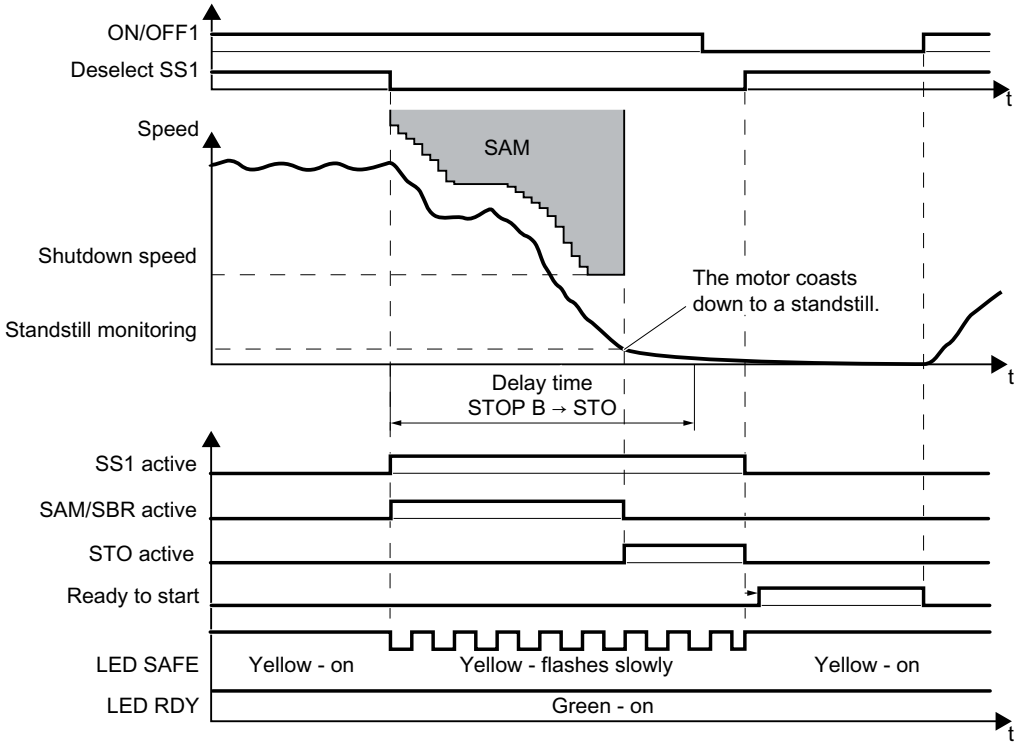


Figure 6-19 Braking behavior and diagnostics of the safety function SS1 (Safe Stop 1)

Converter 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	✓	---	✓

Converter signal	Parameter	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
Deselect SS1 (Extended Functions)	r9720.1	✓	✓	---
SAM/SBR active	r9723.16	---	---	---
Ready for switching on	r0052.0	---	---	---
ON/OFF1	r0054.0	---	---	---

Switching on the motor once SS1 is active

Procedure

1. Deselect SS1.
2. After deselecting SS1, wait until the converter 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 activated the motor following an active SS1.
❒

6.5.3 Switching off the motor when SS1 is active

Description

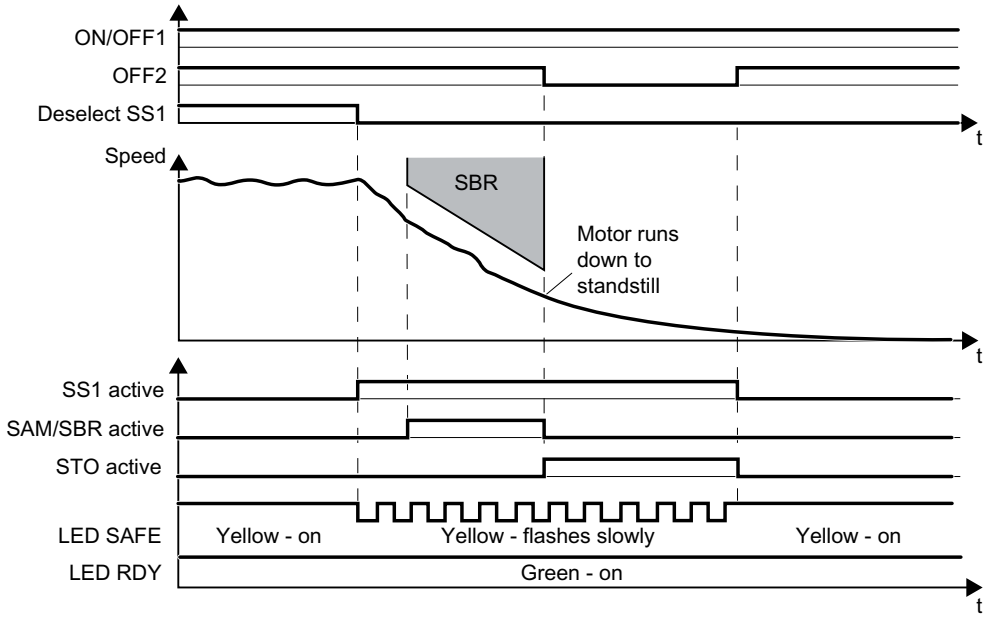


Figure 6-20 OFF2 command when the SS1 safety function is active (example: SS1 with braking ramp monitoring)

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 converter 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 converter switches off the motor torque. The motor then coasts to a standstill. After the delay time, STO is active.
- SS1 with speed monitoring:
  The converter switches off the motor torque with the STO safety function. The motor then coasts to a standstill.

Converter 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	---	---	---

Converter signal	Parameters	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
ON/OFF1	r0054.0	---	---	---
OFF2	r0054.1	---	---	---

6.5.4 Response to a discrepancy when SS1 is active

The converter responds with the active safety function SS1 to a discrepancy at the failsafe digital input.

The behavior of the drive depends on the setting of the converter.

1st case: Response of the drive for SS1 of the Basic Functions

You have selected one of the following settings:

- Basic Functions via onboard terminals
- Basic Functions via PROFIsafe and onboard terminals
- Extended Functions via PROFIsafe and Basic Functions via onboard terminals

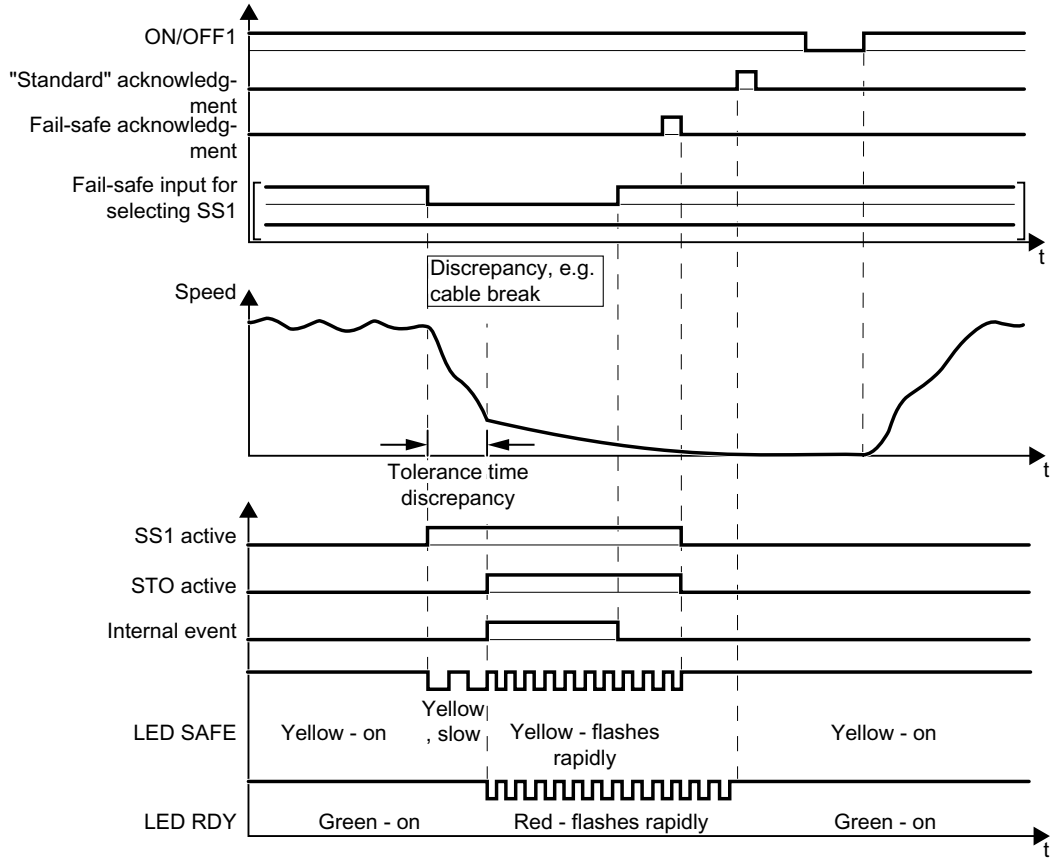


Figure 6-21 Converter response for discrepancy of the input signal for SS1 (example: cable break in the channel of processor P1)

Converter messages after the tolerance time has expired:

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

Independent of the voltage levels available, the converter sets the evaluation of the discrepant failsafe digital input into the safe state (= zero) until you acknowledge the

converter using a failsafe signal or you switch off the power supply voltage and switch it on again.

Converter 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	✓	---	✓
SS1 active (Basic Functions)	r9773.6	✓	---	✓
Deselect SS1 (Basic Functions)	r9773.5	✓	✓	---
"Standard" acknowledgment	p2103	---	---	---
Failsafe acknowledgment	r9720.7	✓	✓	---
ON/OFF1	r0054.0	---	---	---

Switching on the motor after a discrepancy

Procedure

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 Failsafe 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 Failsafe acknowledgment (PROFIsafe control word 1, bit 7 = 0 → 1 → 0)	Switch off the power supply voltage and switch on again

3. Acknowledge the converter with the "standard" acknowledge signal.
4. Issue an OFF1 command (ON/OFF1 = 0).
5. Switch on the motor (ON/OFF1 = 1).

You have acknowledged the discrepancy message, and switched on the motor again.
❒

2nd case: Response of the drive for SS1 of the Extended Functions

You have selected the Extended Functions via onboard terminals.

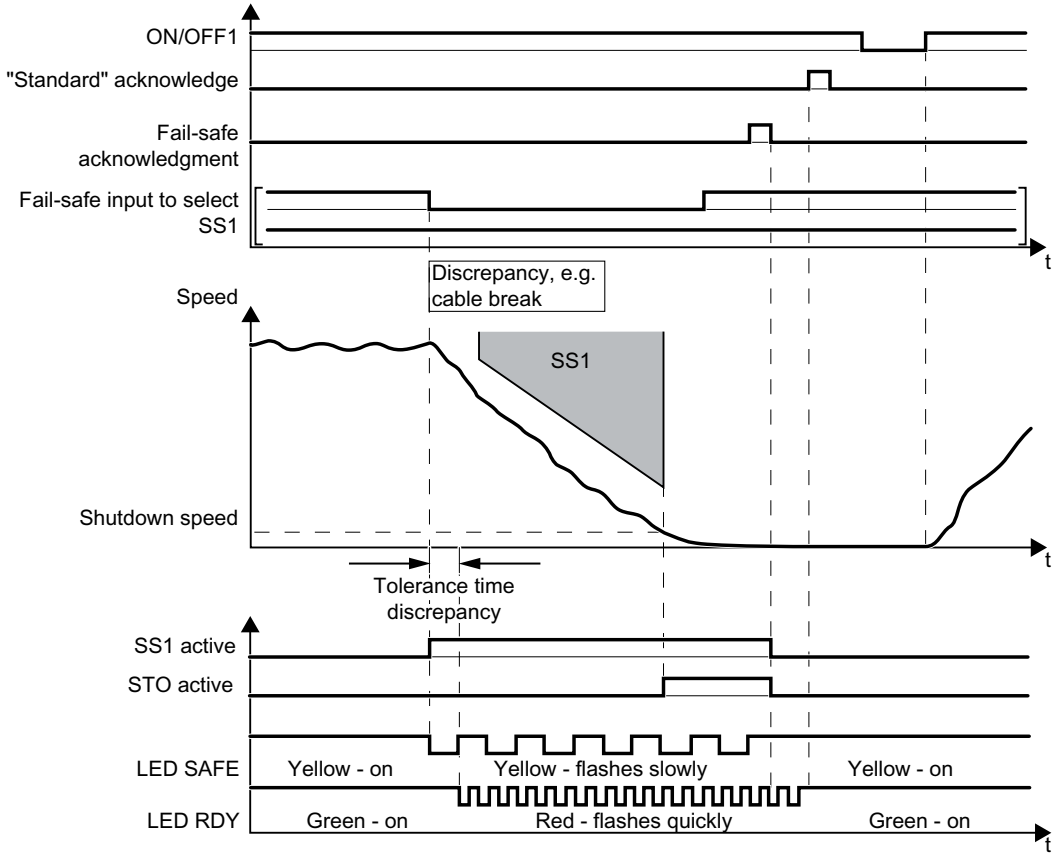


Figure 6-22 Converter response for discrepancy of the input signal for SS1 (as example: SS1 with braking ramp monitoring)

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

After the tolerance time has expired, the converter signals the discrepancy (message C01770 or C30770) but does not interrupt the braking operation for the motor.

Converter 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	✓	---	✓

Converter signal	Parameter	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
Deselect SS1 (Extended Functions)	r9720.1	✓	✓	---
SAM/SBR active	r9723.16	---	---	---
"Standard" acknowledgment	p2103	---	---	---
Failsafe acknowledgment	r9720.7	✓	✓	---
ON/OFF1	r0054.0	---	---	---

Switching on the motor after a discrepancy

Procedure

1. Remove the discrepancy.
2. Acknowledge the discrepancy message with the failsafe acknowledge signal via a failsafe digital input: F-DI = 0 → 1 → 0.
   Alternatively: Switch off the power supply voltage and switch on again.
3. Acknowledge the converter 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 converter safely switches off the motor torque (STOP A).

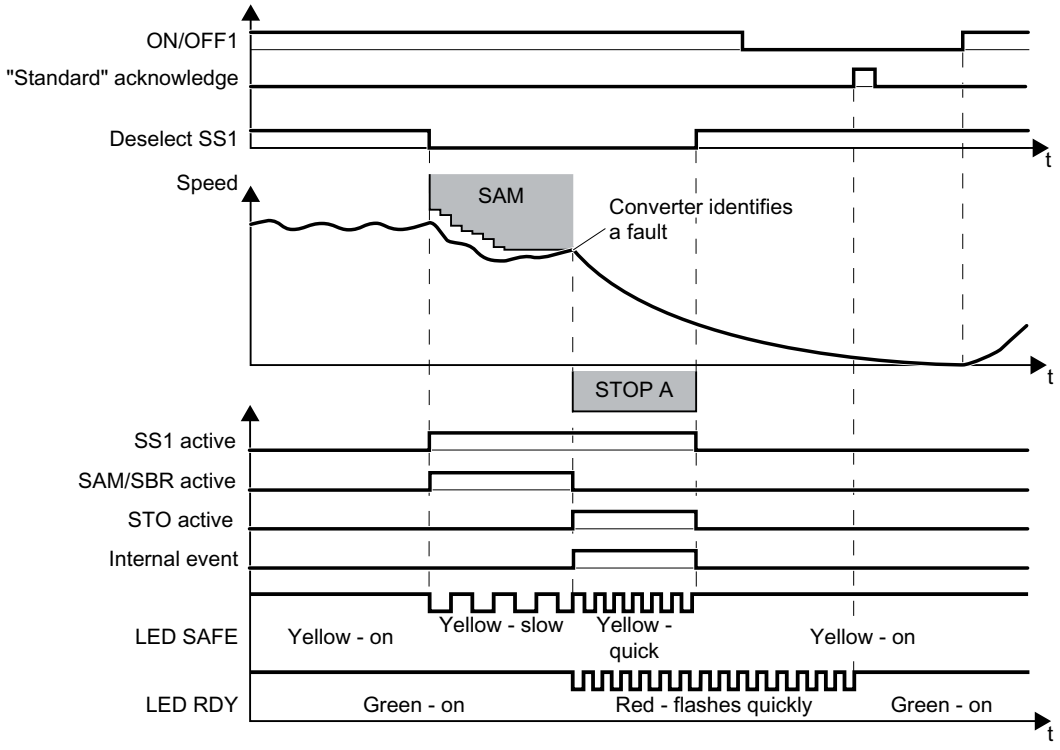


Figure 6-23 General fault response of safety function SS1 (as an example: SS1 with acceleration monitoring)

Converter 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. Deselect function SS1.
2. Issue an OFF1 command (ON/OFF1 = 0).
3. Acknowledge the converter 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 215)
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 221)
Discrepancy in the input signal	The failsafe digital input to select SLS identifies an error. Response to a discrepancy when SLS is active (Page 229)
Limit value violation	The speed of the motor exceeds the set SLS limit value. Limit value violation when SLS is active (Page 231)

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

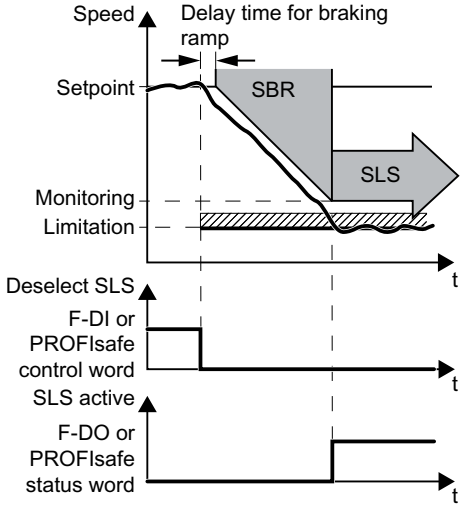
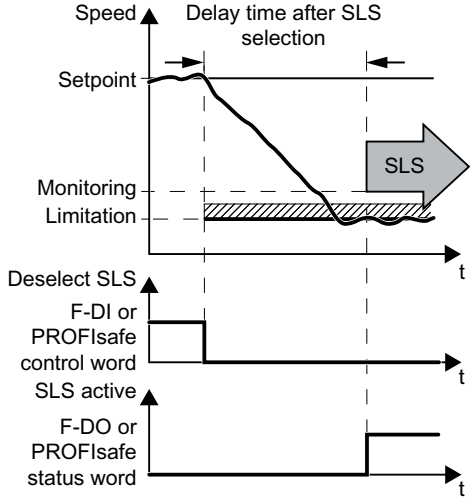
	Switching on the motor (ON/OFF1 = 0 → 1)	**Switching off the motor (ON/OFF1, OFF2 or OFF3 = 1 → 0)**
SLS is not active	If SLS is not active, then there are no restrictions for switching on and switching off the motor.	
SLS is active	If your application requires that SLS always remains active, then you must take into account several special issues when switching on the motor. Switching on the motor when SLS is active (Page 227)	The drive response depends on the signal that you use to switch off the motor. Switching off the motor when SLS is active (Page 225)

6.6.2 Selecting and deselecting SLS when the motor is switched on

Selecting SLS when the motor is switched on

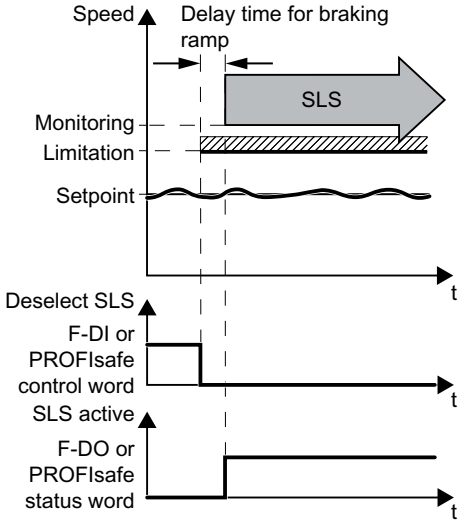
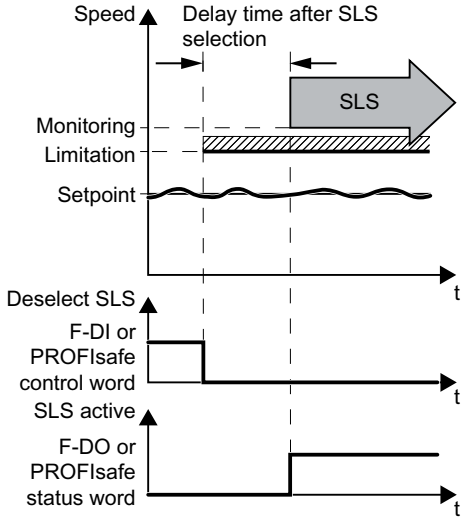
As soon as the converter detects the selection of SLS via a failsafe digital input or via the PROFIsafe safe communication, the following happens:

- The converter limits the speed to a value below the SLS monitoring and brakes the motor with the OFF3 ramp-down time.
- You can select whether the converter monitors motor braking using the SBR (Safe Brake Ramp) function.

With braking ramp monitoring	Without braking ramp monitoring
	
After the adjustable "Delay time for braking ramp" has elapsed, the converter uses the SBR (Safe Brake Ramp) function to determine whether the speed has decreased. The converter switches from SBR to SLS as soon as one of the following two conditions is fulfilled: • The SBR monitoring ramp has reached the value of the speed monitoring. This case is shown in the diagram above. • The actual load speed reaches the value of the speed monitoring and the "delay time for braking ramp" has expired. Advantage: • Already during braking, the converter detects as to whether the load speed decreases too slowly.	The converter monitors the load speed after an adjustable delay time has expired. Advantage: • Instead of the SBR subfunction, you must only set the delay time.

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:

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

Deselect SLS

If the higher-level controller deselects SLS, then the converter deactivates limiting and monitoring.

6.6.2.1 SLS with braking ramp monitoring

If the machine control selects the SLS safety function via a failsafe digital input or via PROFIsafe 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 converter monitors the speed after the delay time has expired.

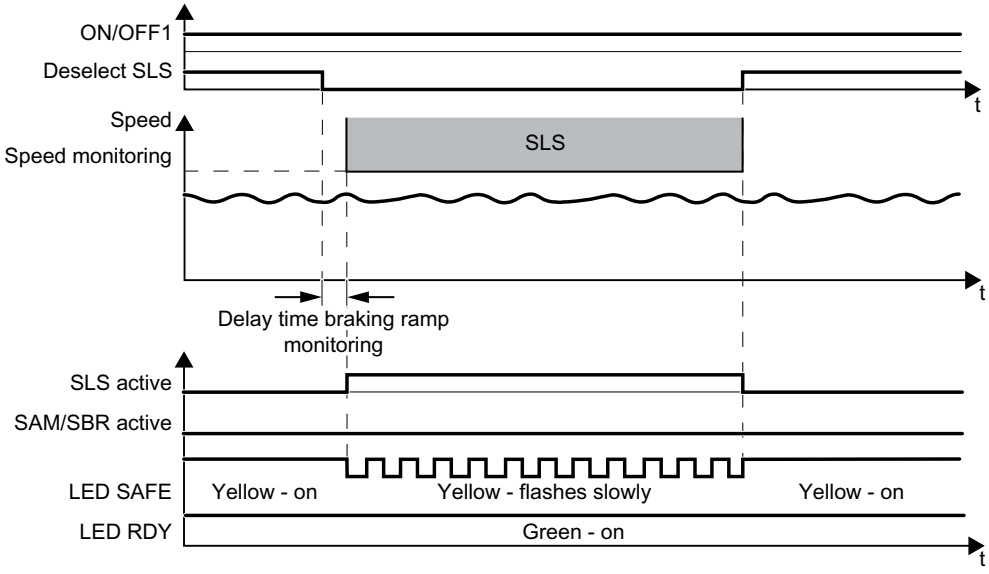


Figure 6-24 Selecting and deselecting the SLS safety function at low speeds

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

Function

1. The converter brakes the motor.
2. The converter monitors the speed after the delay time has expired.
3. If you deselect SLS, then the motor accelerates again up to the speed setpoint.

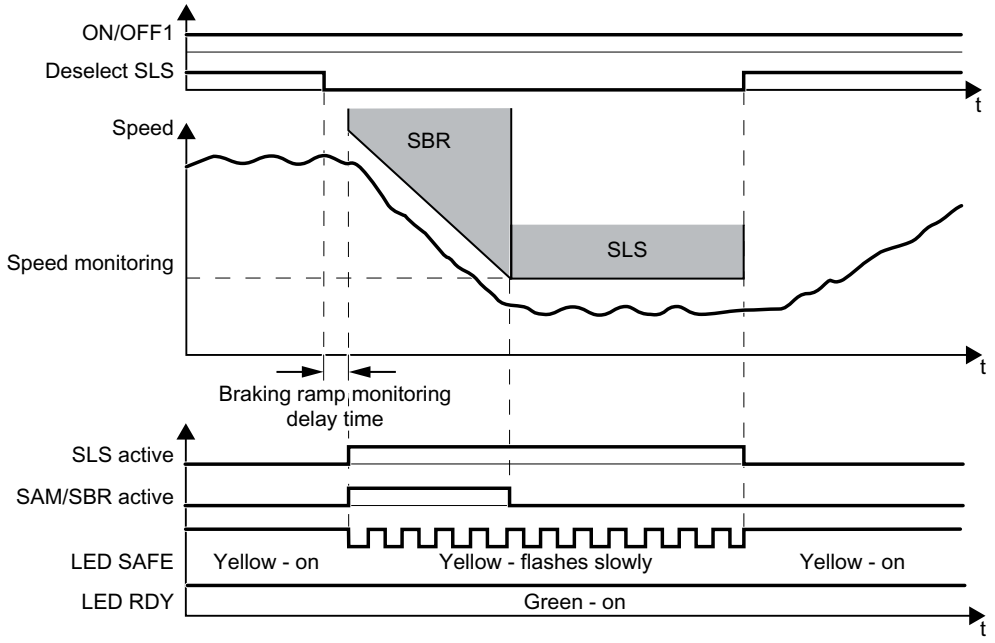


Figure 6-25 Selecting and deselecting the SLS safety function at high speeds

Converter 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

If the machine control selects the SLS safety function via a failsafe digital input or via PROFIsafe 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 converter monitors the speed after the delay time has expired.

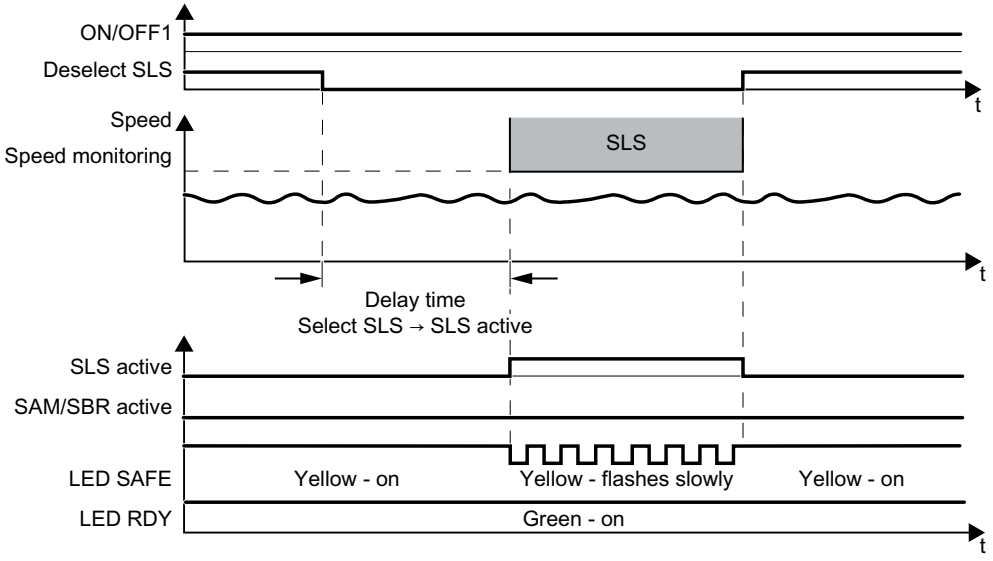


Figure 6-26 Selecting and deselecting the SLS safety function at low speeds

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

Function

1. The converter brakes the motor.
2. The converter monitors the speed after the delay time has expired.
3. If you deselect SLS, then the motor accelerates again up to the speed setpoint.

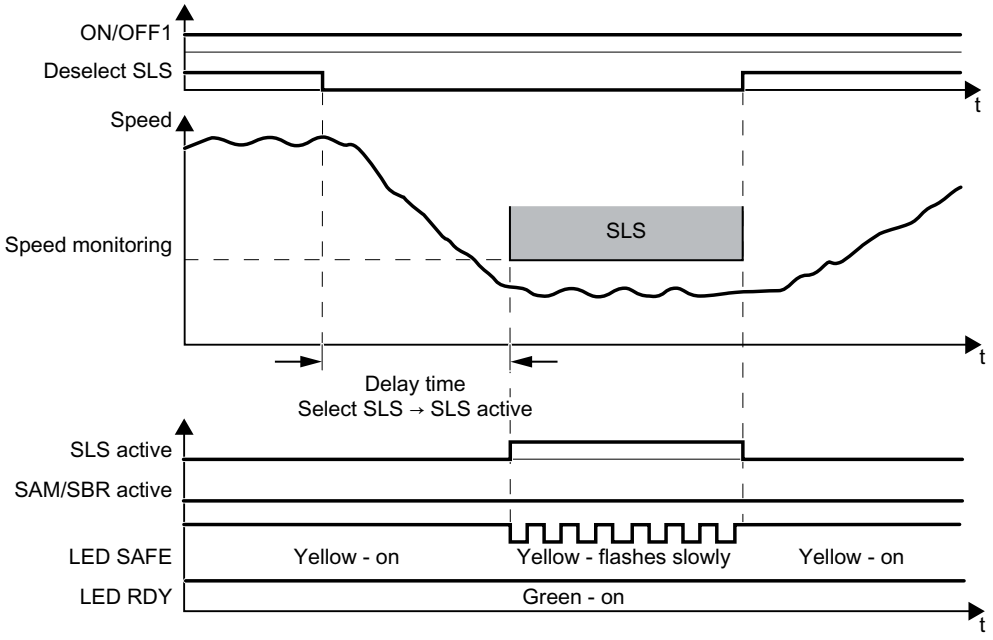


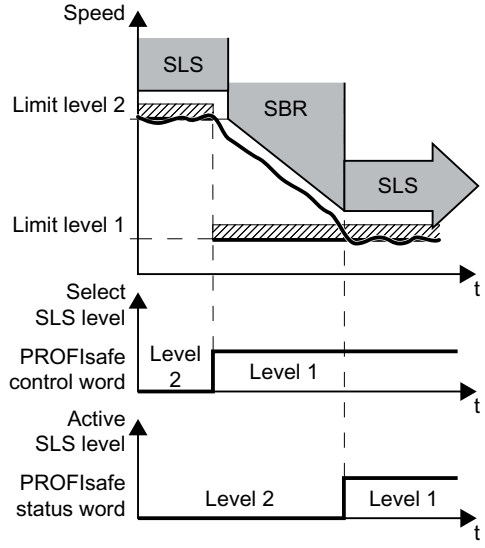
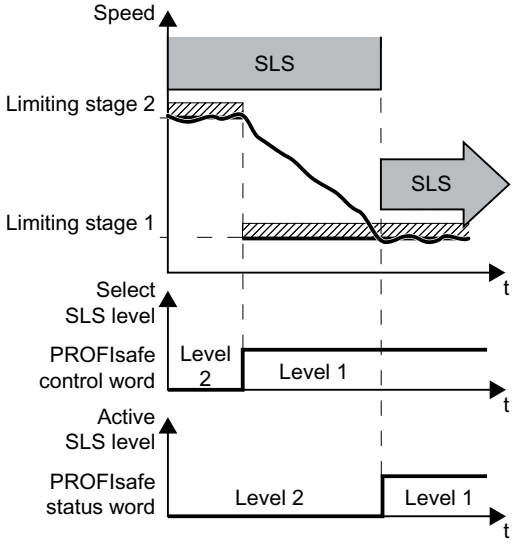
Figure 6-27 Selecting and deselecting the SLS safety function at high speeds

Converter 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.

With braking ramp monitoring	Without braking ramp monitoring
	
The converter monitors the motor as it brakes using the SBR (Safe Brake Ramp) function.	After an adjustable time, the converter switches the SLS monitoring from the higher SLS level to the lower SLS level.

Switching over SLS levels is only possible via PROFIsafe with control word 1.

The converter signals the active SLS level via PROFIsafe to the higher-level control.

Control word 1 and status word 1 (extended functions) (Page 46)

6.6.3.1 SLS with braking ramp monitoring

Function

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

1. The converter brakes the motor.
2. Once the delay time has expired, the converter monitors the motor speed using the SBR (Safe Brake Ramp) function.
3. The converter 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 converter immediately monitors the speed with the higher SLS level.

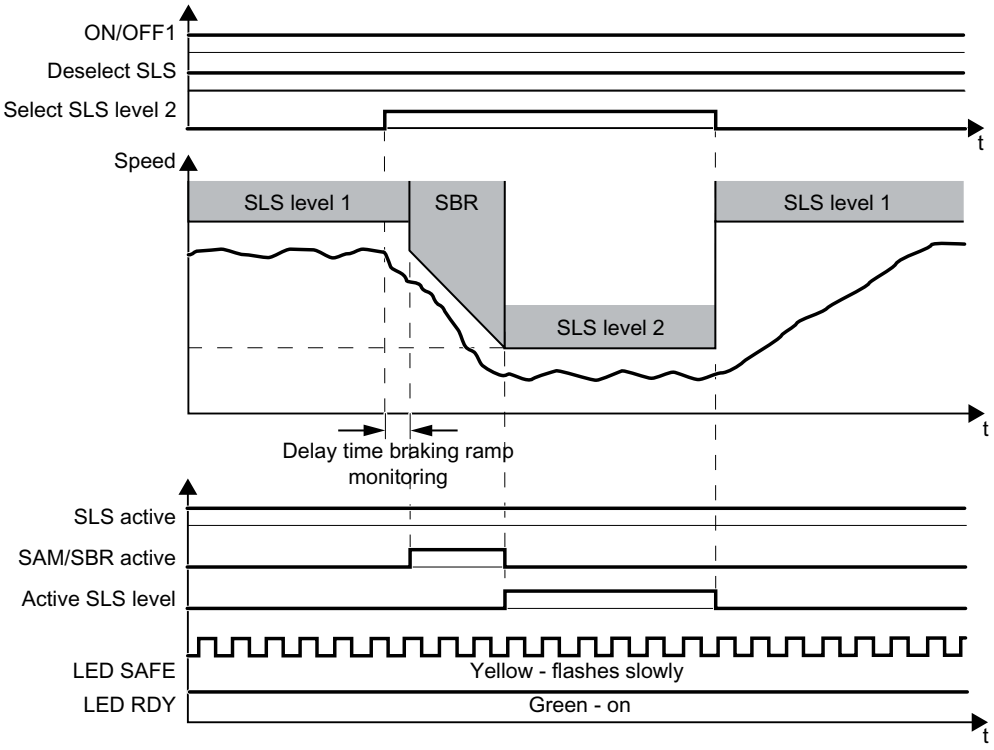


Figure 6-28 Switching between different monitoring thresholds

Converter signal	Parameter	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
SLS active	r9722.4	✓	---	✓
Deselect SLS	r9720.4	✓	✓	---

Converter signal	Parameter	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
SLS level active	r9722.9, r9722.10	✓	---	✓
Select SLS level	r9720.9, r9720.10	✓	✓	---
SAM/SBR active	r9723.16	---	---	---
ON/OFF1	r0054.0	---	---	---

6.6.3.2 SLS without braking ramp monitoring

Function

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

1. The converter brakes the motor.
2. Once the delay time has expired, the converter 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 converter immediately monitors the speed with the higher SLS level.

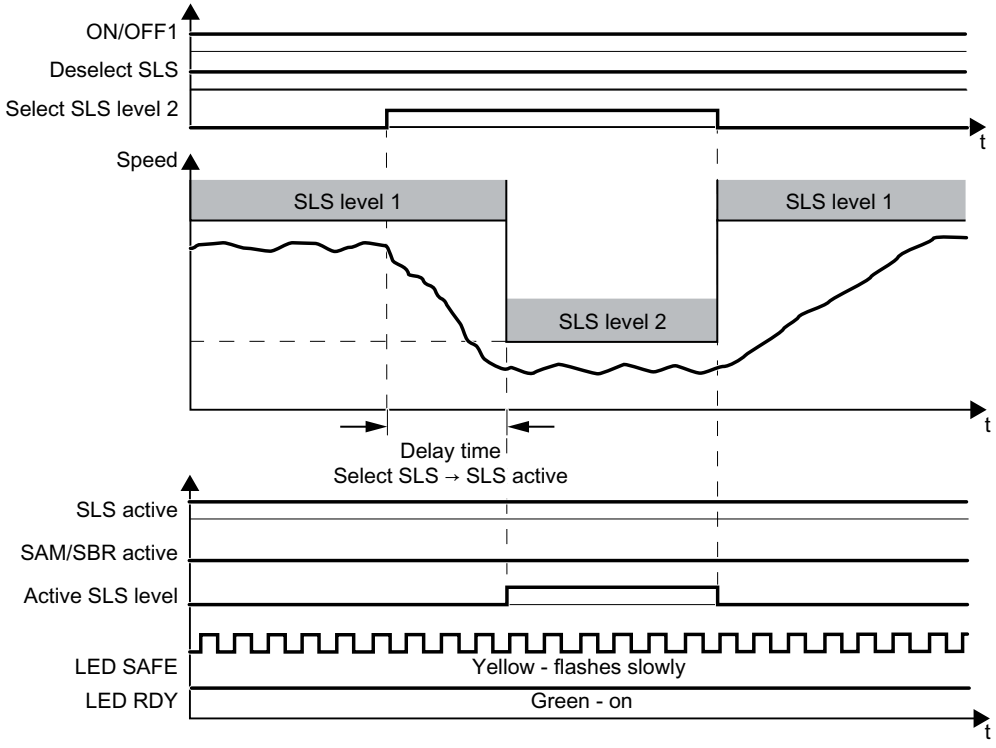


Figure 6-29 Switching between different monitoring thresholds

Converter 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	---	---	---

6.6.4 Switching off the motor when SLS is active

Description

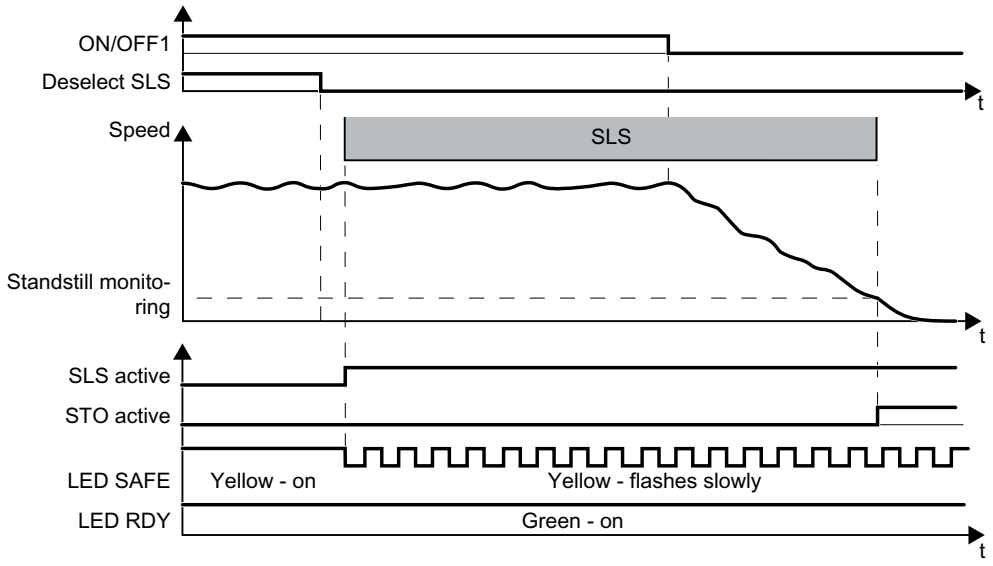


Figure 6-30 OFF1 command when the SLS safety function is active

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

1. The converter brakes the motor with the OFF1 or OFF3 ramp-down time.
2. Also while braking, the converter monitors the motor speed.
3. When reaching the standstill monitoring, the converter safely switches off the motor torque with the STO safety function.
4. The motor coasts down to a standstill.

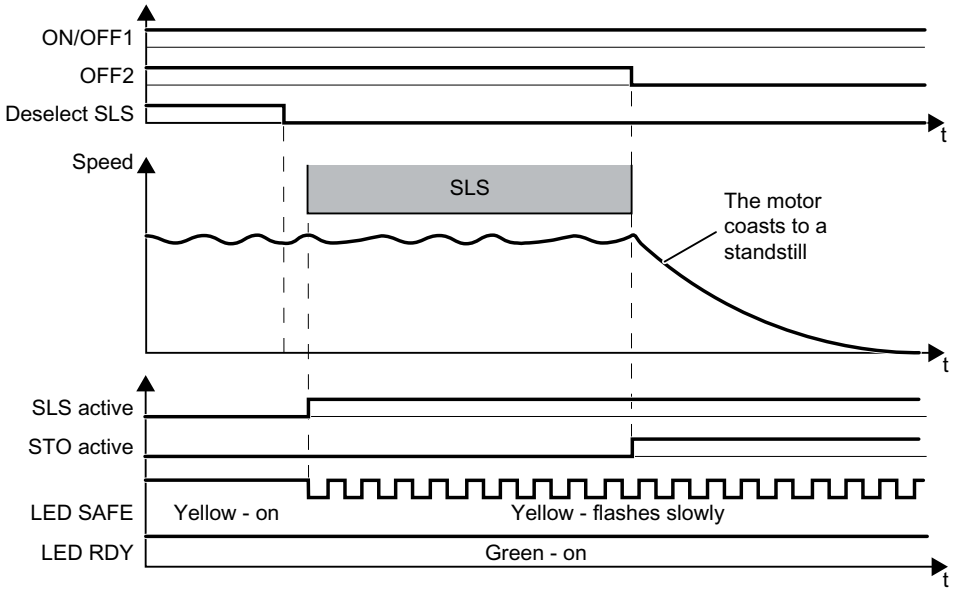


Figure 6-31 OFF2 command when the SLS safety function is active

If you switch off the motor using the OFF2 command, then the converter immediately safely switches off the motor torque using the STO safety function.

Converter 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

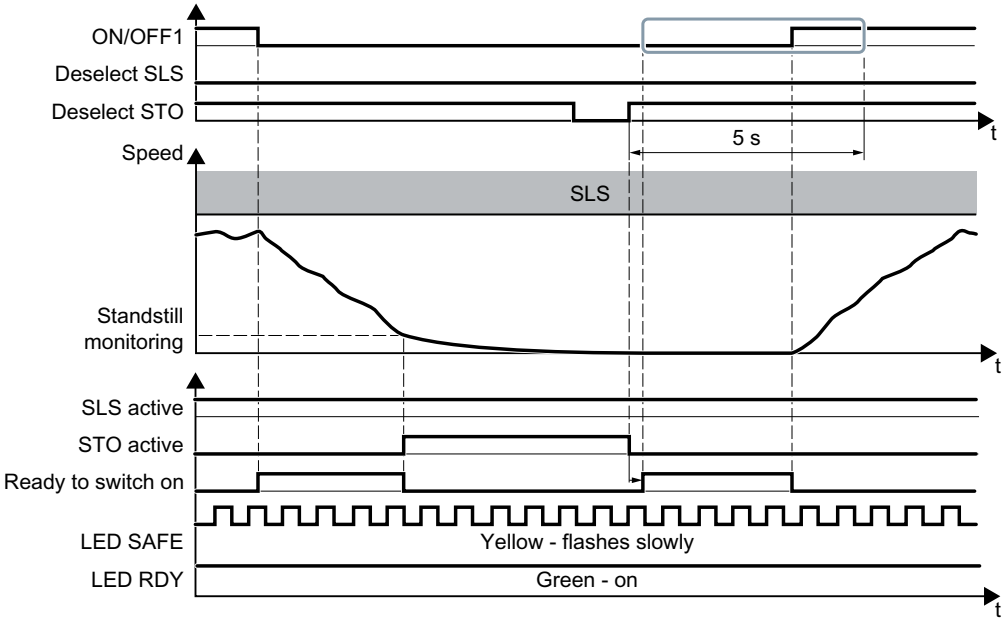


Figure 6-32 Switching the motor off and on (ON/OFF1) when SLS is active

Procedure

1. Select STO (or SS1).
2. Deselect STO (or SS1).
3. After deselecting STO, wait until the converter 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).

You have activated the motor with active SLS.
❒

Converter 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 for switching 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 converter goes back into the STO state.
- The converter no longer responds to the ON command.

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 converter responds with the active SLS safety function to a discrepancy at the failsafe digital input.

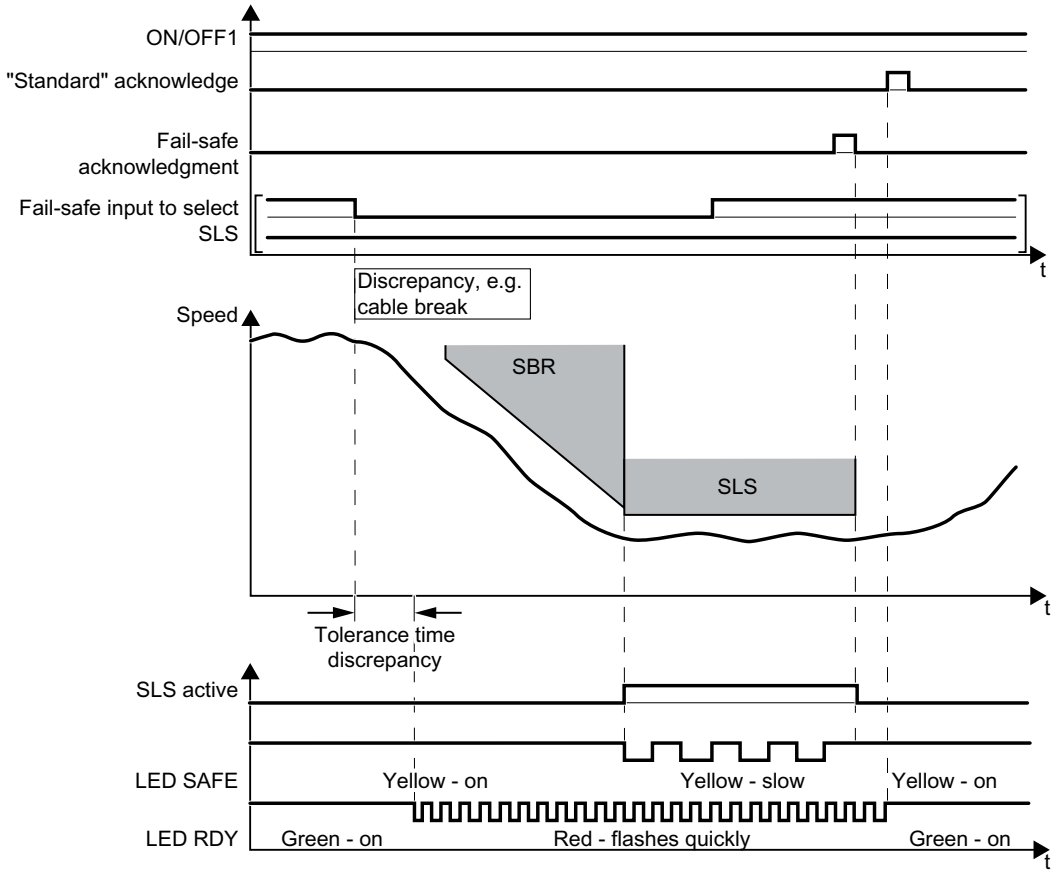


Figure 6-33 Behavior of the converter for discrepancy of the input signal for SLS

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

After the tolerance time has expired, the converter 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 converter sets the evaluation of the discrepant F-DI into the safe state (= zero) until you acknowledge the converter using a failsafe signal or you switch off the power supply voltage and switch it on again.

Converter signal	Parameter	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
SLS active	r9722.4	✓	---	✓
Deselect SLS	r9720.4	✓	✓	---
"Standard" acknowledgment	p2103	---	---	---

Converter signal	Parameter	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
Failsafe acknowledgment	r9720.7	✓	✓	---
ON/OFF1	r0054.0	---	---	---

Deselecting SLS after a discrepancy

Procedure

1. Remove the discrepancy.
2. Acknowledge the discrepancy message with the failsafe acknowledge signal via a failsafe digital 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 converter power supply and switch it on again.
3. Acknowledge the converter 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 converter responds by triggering a STOP A or STOP B. The converter response is parameterized during commissioning.

Stop responses (Page 254)

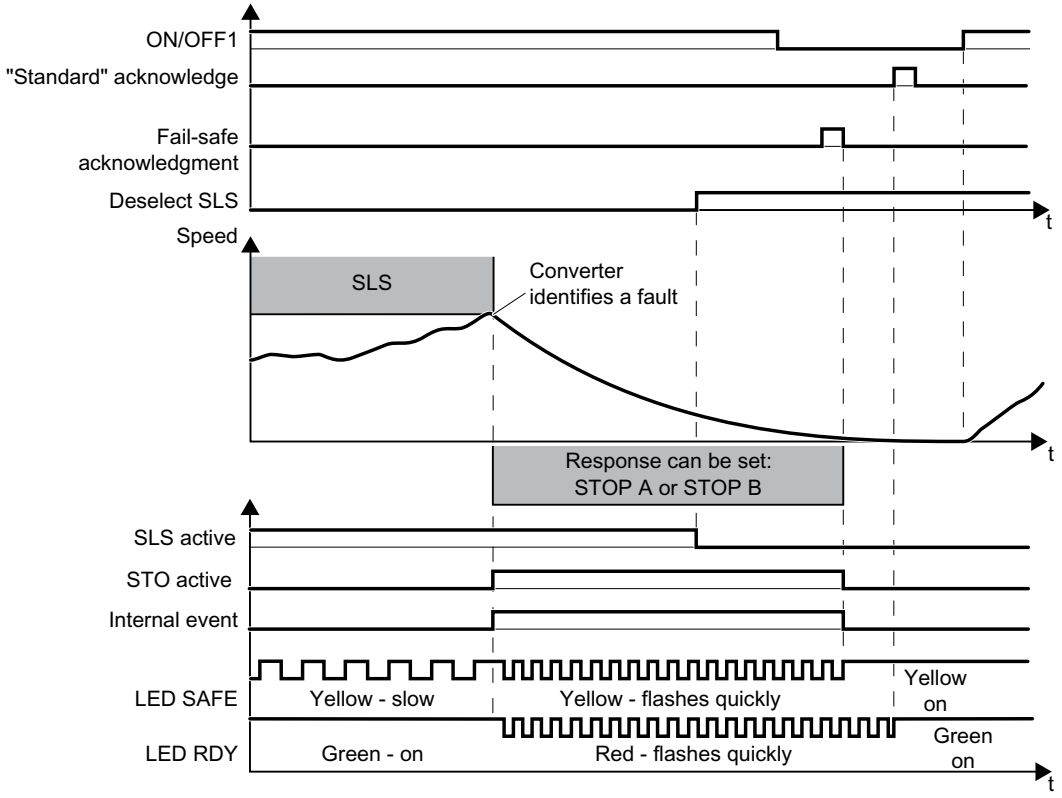


Figure 6-34 Limit value violation of safety function SLS. Example with STOP A as fault response

Converter 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	---	---	---
Failsafe acknowledgment	r9720.7	✓	✓	---
ON/OFF1	r0054.0	---	---	---

Switching the motor on after an internal event

Procedure

1. Deselect the SLS function.
2. Issue an OFF1 command (ON/OFF1 = 0).
3. Acknowledge the internal event in one of the following ways:
   - Failsafe acknowledgment using PROFIsafe control word 0, bit 7 = 0 → 1 → 0.
   - Failsafe acknowledge signal via a failsafe digital 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 converter power supply and switch it on again.
4. Acknowledge the converter 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 234)

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 239).	The drive response depends on the signal that you use to switch off the motor. Switching off the motor when SSM is active (Page 235)

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 converter always sets the feedback signal "Speed below limit value" of the SSM function to 0.

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

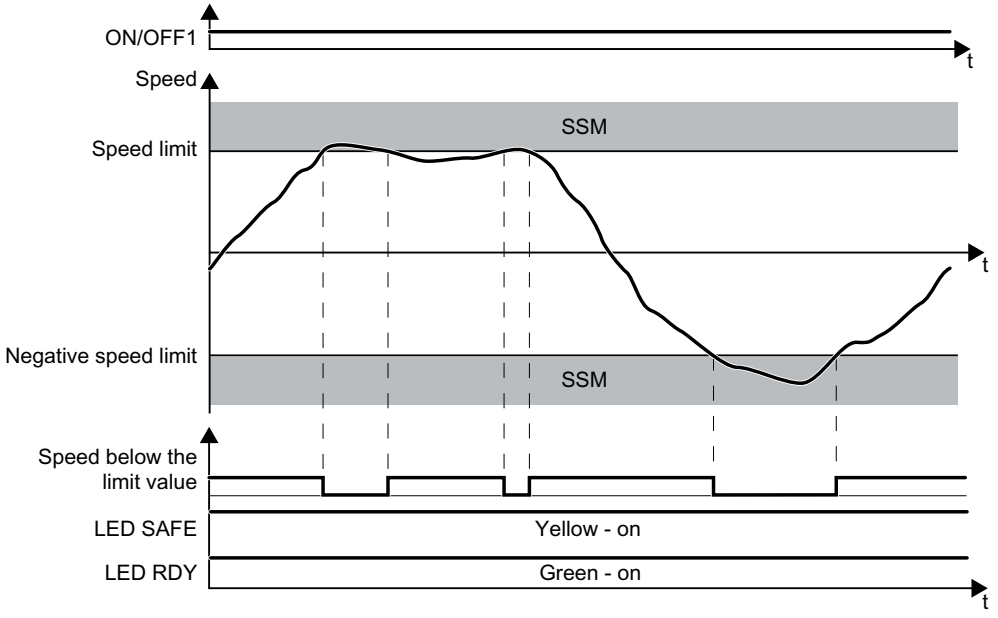


Figure 6-35 Time response of the safety function SSM (Safe Speed Monitor)

Converter 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

The drive response depends on the following conditions:

- Motor speed at the instant when it is switched off
- Off command: OFF1, OFF2 or OFF3
- Setting the SSM function:
  - Feedback signal "SSM active" for pulse inhibit *remains active:*
    When the motor is switched off, the converter prevents the motor from accelerating by issuing an STO. When the motor is switched off, "Status SSM" = 1.
  - Feedback signal "SSM active" for pulse inhibit *becomes inactive:*
    When the motor is switched off, the converter sets "Status SSM" = 0.

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

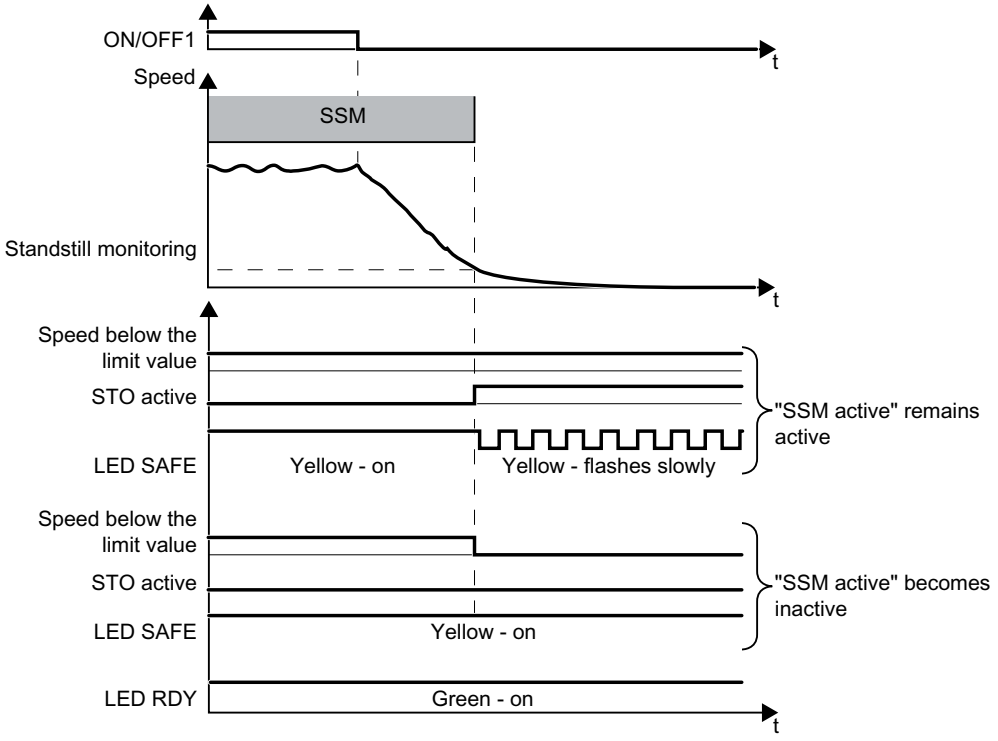


Figure 6-36 OFF1 command when the SSM safety function is active

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 converter brakes the motor down to standstill and then switches it off.
2. Also while braking, the converter monitors the motor speed.

If the "SSM active" feedback signal should remain active when the pulses are inhibited, then the converter safely switches off the motor torque using the safety function STO.

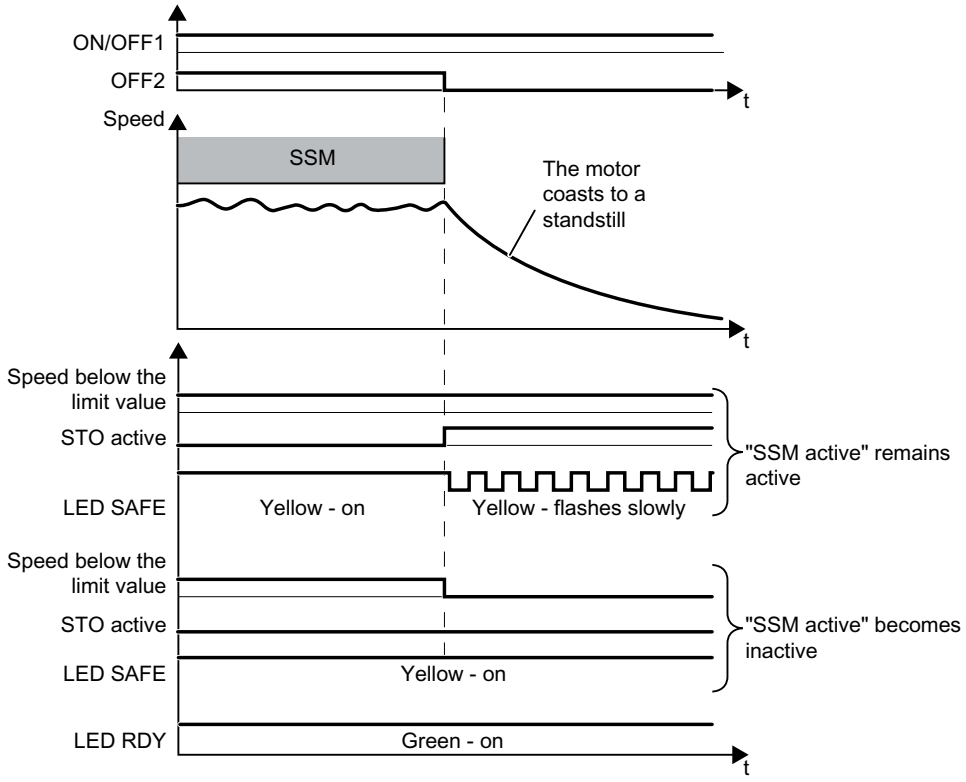


Figure 6-37 OFF2 command when the SSM safety function is active

The converter 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 converter safely switches off the motor torque using the safety function STO.

Converter 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

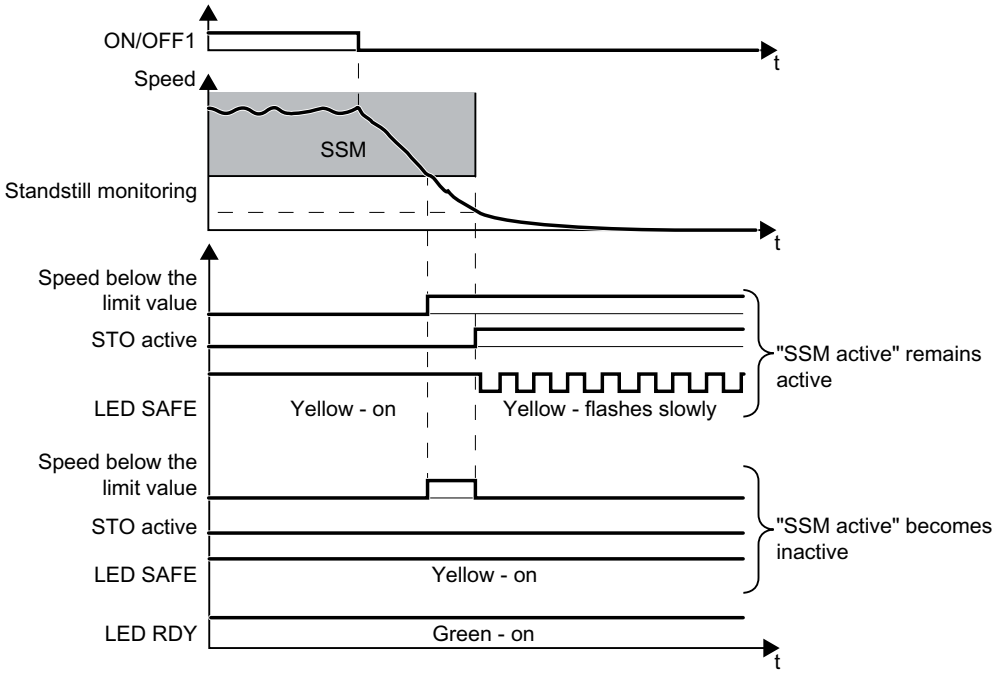


Figure 6-38 OFF1 command when the SSM safety function is active

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 converter brakes the motor down to standstill and then switches it off.
2. Also while braking, the converter monitors the motor speed.

If the "SSM active" feedback signal should remain active when the pulses are inhibited, then the converter safely switches off the motor torque using the safety function STO.

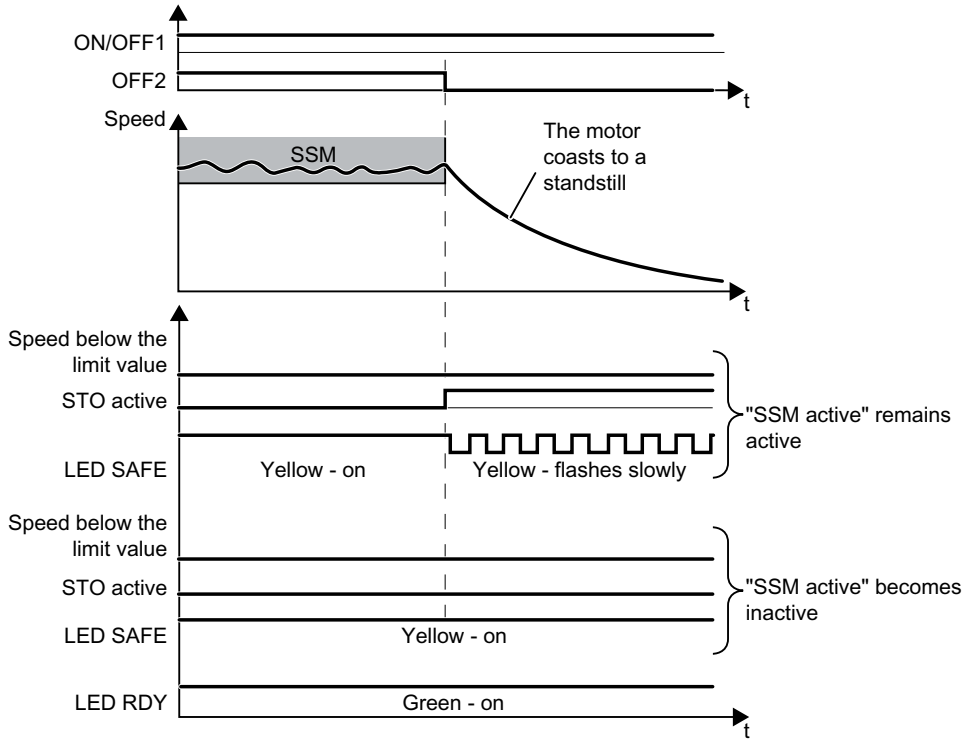


Figure 6-39 OFF2 command when the SSM safety function is active

The converter 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 converter safely switches off the motor torque using the safety function STO.

The feedback signal "SSM active" remains = 0.

Converter 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

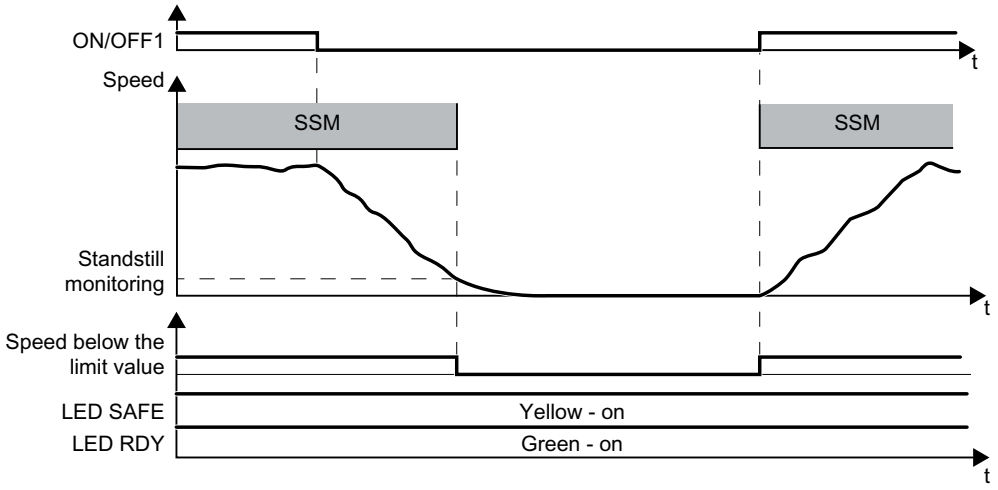


Figure 6-40 Switching on the motor when the SSM function is active, interrupting SSM

With this setting, the SSM function does not influence switching on the motor. SSM is active when you switch on the motor.

Converter 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

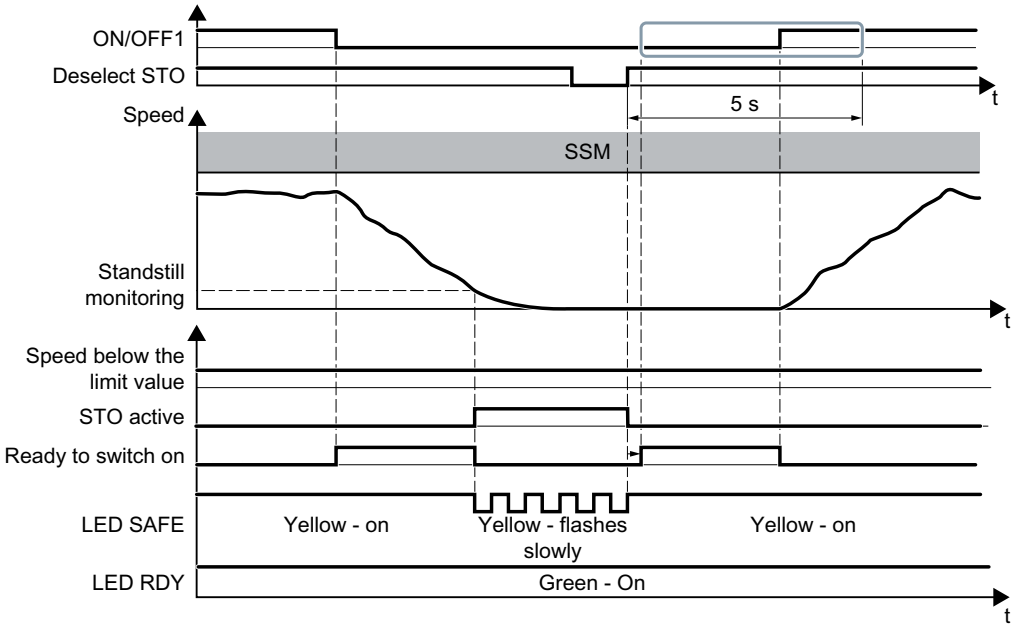


Figure 6-41 Switching on the motor when SSM is active

With this setting, you must maintain a certain sequence before switching on the motor.

Procedure

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 converter 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).

You have switched on the motor.
❒

Converter 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 for switching 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 converter goes back into the STO state.
- The converter no longer responds to the ON command.

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 242)
Discrepancy in the input signal	The failsafe digital input to select SDI identifies an error. Response to a discrepancy when Safe Direction is active (SDI) (Page 248)
Limit value violation	The motor rotates in the monitored direction. Limit value violation when Safe Direction (SDI) is active (Page 250)

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 245)	The drive response depends on the signal that you use to switch off the motor. Switching off the motor when SDI is active (Page 243)

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 failsafe digital input or via PROFIsafe safe communication.
2. The converter limits the speed to the permitted direction of rotation. When SDI is selected, if the motor rotates in the impermissible direction, then the converter brakes the motor down to standstill.
3. After the delay time has expired, the converter monitors the selected direction of rotation of the motor.
   The converter tolerates brief motion in the monitored direction of rotation up to an adjustable angle of rotation of the motor shaft.

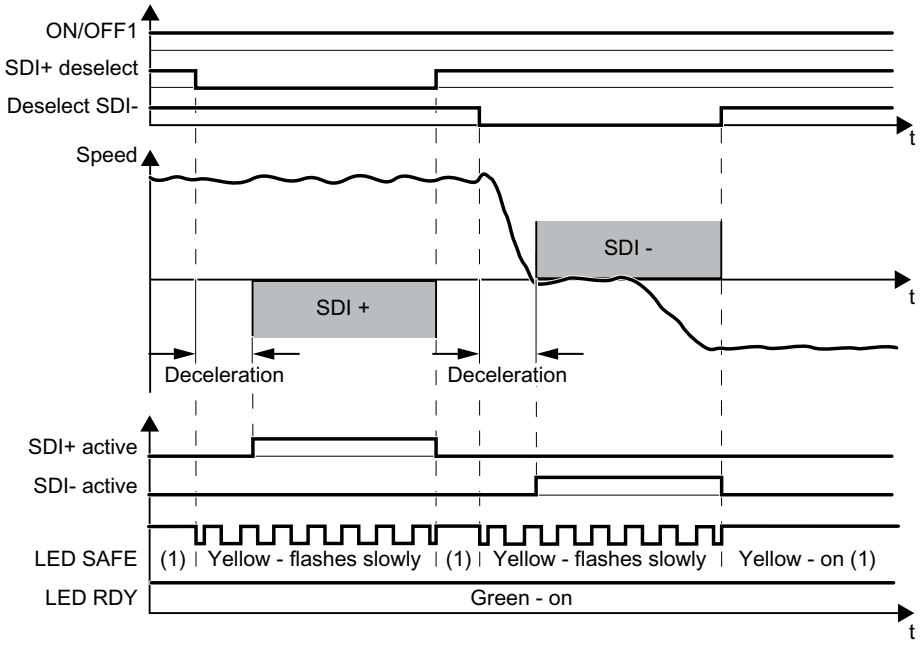


Figure 6-42 Time response of the safety function SDI (Safe direction)

Converter 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

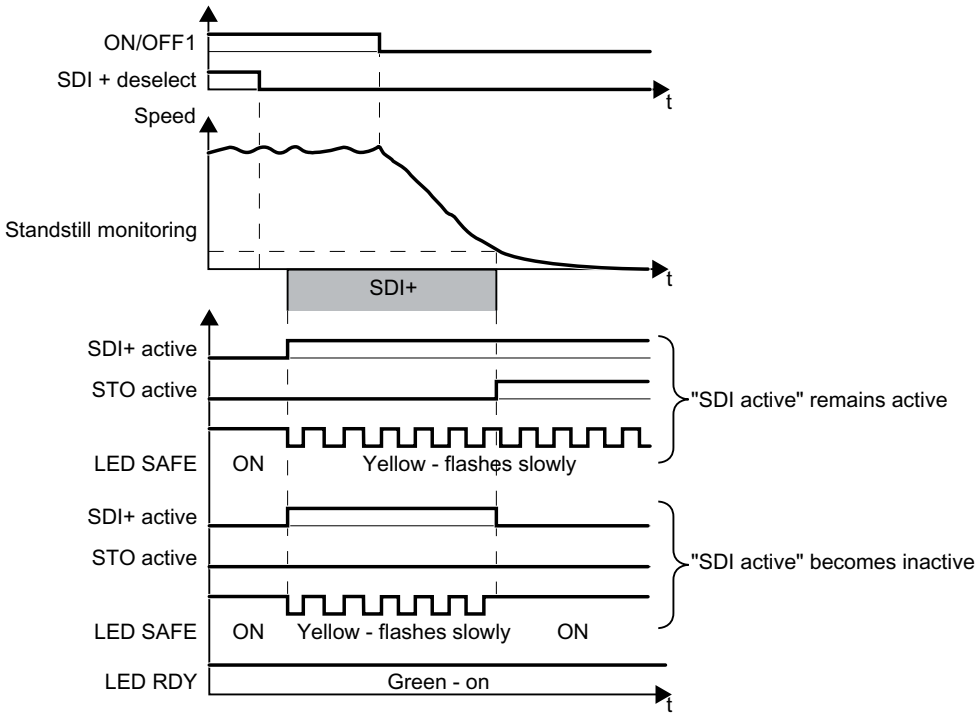


Figure 6-43 OFF1 command when the SDI safety function is active

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

1. The converter brakes the motor with the OFF1 or OFF3 ramp-down time until the speed reaches the standstill monitoring threshold.
2. Also while braking, the converter monitors the direction of rotation.

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

1. Feedback signal "SDI active" for pulse inhibit *remains active*
   With this setting, the converter safely switches off the motor torque when reaching the standstill monitoring using the STO safety function. The converter ensures that the motor does not actively accelerate. The "SDI active" signal also remains at 1 for a motor that has been switched off.
2. Feedback signal "SDI active" for pulse inhibit *becomes inactive*
   With this setting the converter converter off the motor torque, but not safely. The system does not safely prevent that the motor actively accelerates. Therefore, the converter sets the "SDI active" signal to 0 when the motor is switched off.

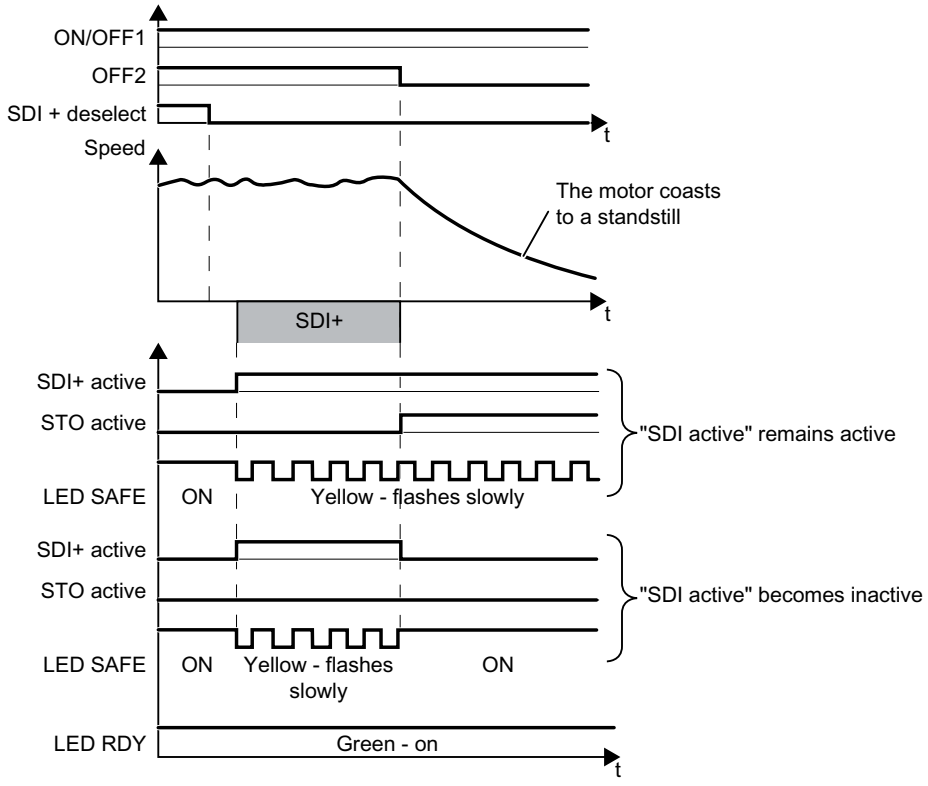


Figure 6-44 OFF2 command when the SDI safety function is active

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

Converter 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

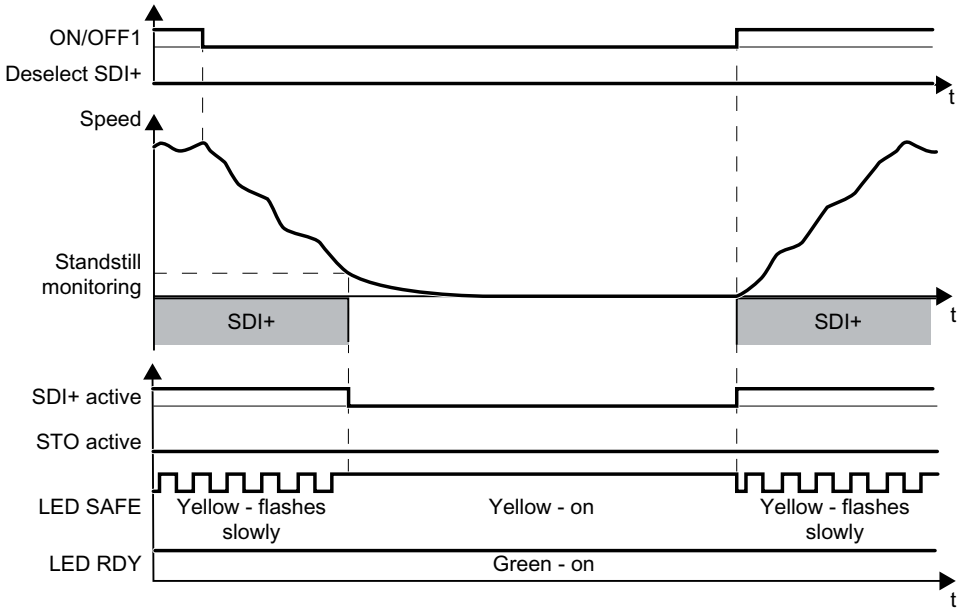


Figure 6-45 Switching the motor off and on when SDI is active, interrupts the feedback signal from SDI

With this setting, the SDI function does not influence switching on the motor. SDI is active when you switch on the motor.

Converter signal	Parameter	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

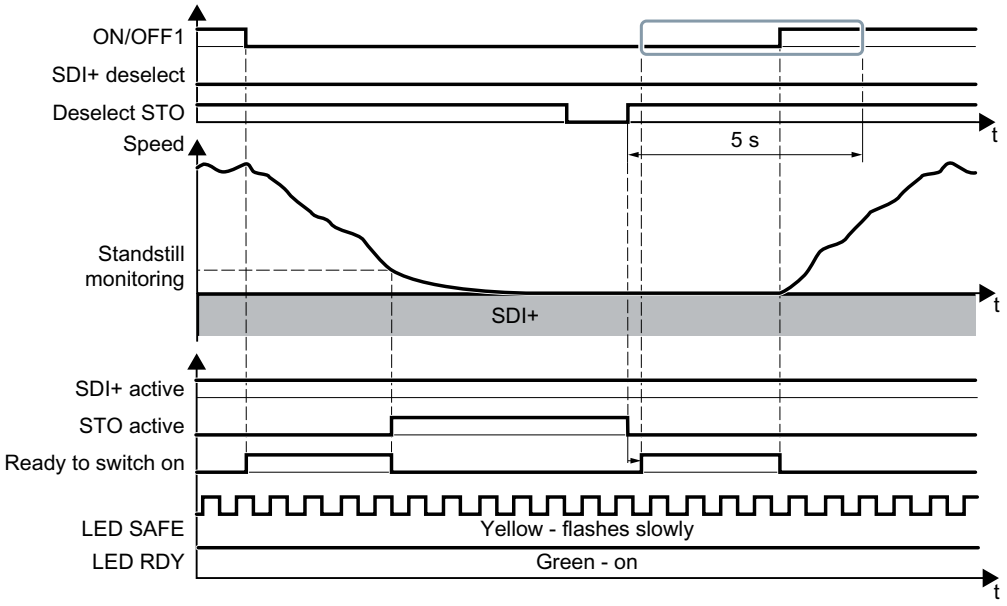


Figure 6-46 Switching the motor off and on when SDI is active

Procedure

1. Select STO (or SS1).
2. Deselect STO (or SS1) again.
3. After deselecting STO, wait until the converter 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).

You have switched on the motor again.
❒

Converter 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	✓	✓	---
SDI+ active	r9722.12	✓	---	✓
SDI+ deselect	r9720.12	✓	✓	---
SDI- active	r9722.13	✓	---	✓
Deselect SDI	r9720.13	✓	✓	---
ON/OFF1	r0054.0	---	---	---
Ready for switching 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 converter goes back into the STO state.
- The converter no longer responds to the ON command.

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 converter responds with the active SDI safety function to a discrepancy at the failsafe digital input.

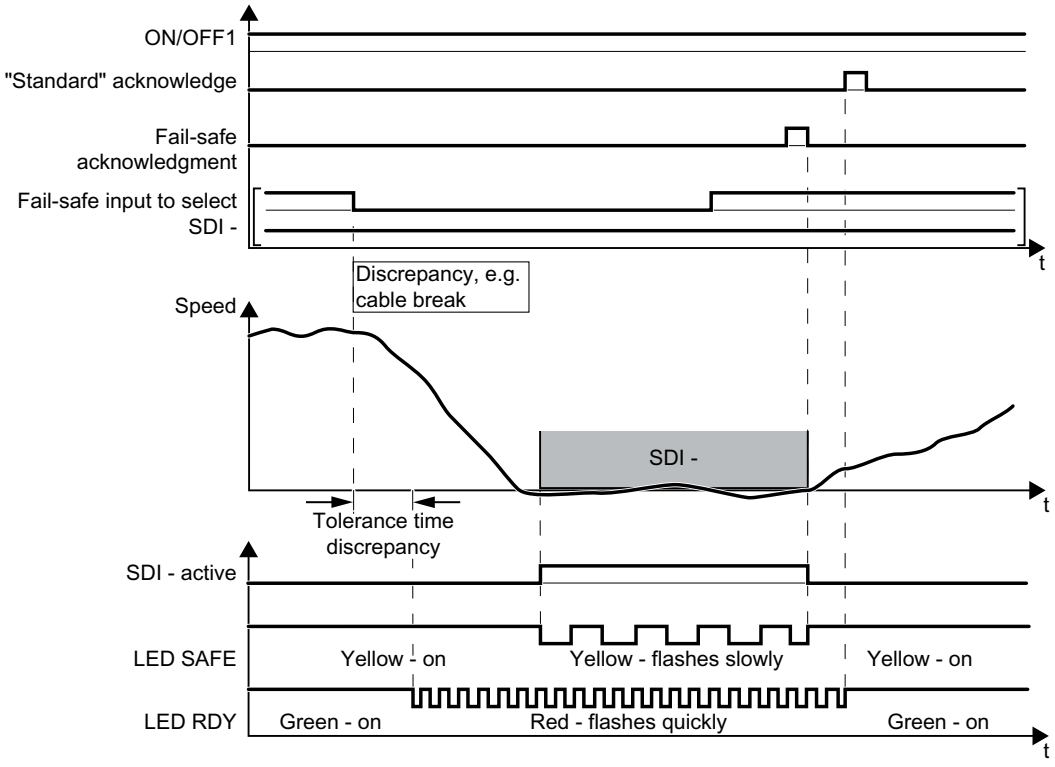


Figure 6-47 Response of the converter for discrepancy of the input signal for SDI (SDI- as example)

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

After the tolerance time has expired, the converter 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 converter sets the evaluation of the discrepant failsafe digital input into the safe state (= zero) until you acknowledge the converter using a failsafe signal or you switch off the power supply voltage and switch it on again.

Converter signal	Parameter	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	✓	✓	---

Converter signal	Parameter	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
"Standard" acknowledgment	p2103	---	---	---
Failsafe acknowledgment	r9720.7	✓	✓	---
ON/OFF1	r0054.0	---	---	---

Deselecting SDI after a discrepancy

Procedure

1. Remove the discrepancy.
2. Acknowledge the discrepancy message with the failsafe acknowledge signal via a failsafe digital 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 converter power supply and switch it on again.
3. Acknowledge the converter 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 converter responds by triggering a STOP A or STOP B. The converter response is parameterized during commissioning.

Stop responses (Page 254)

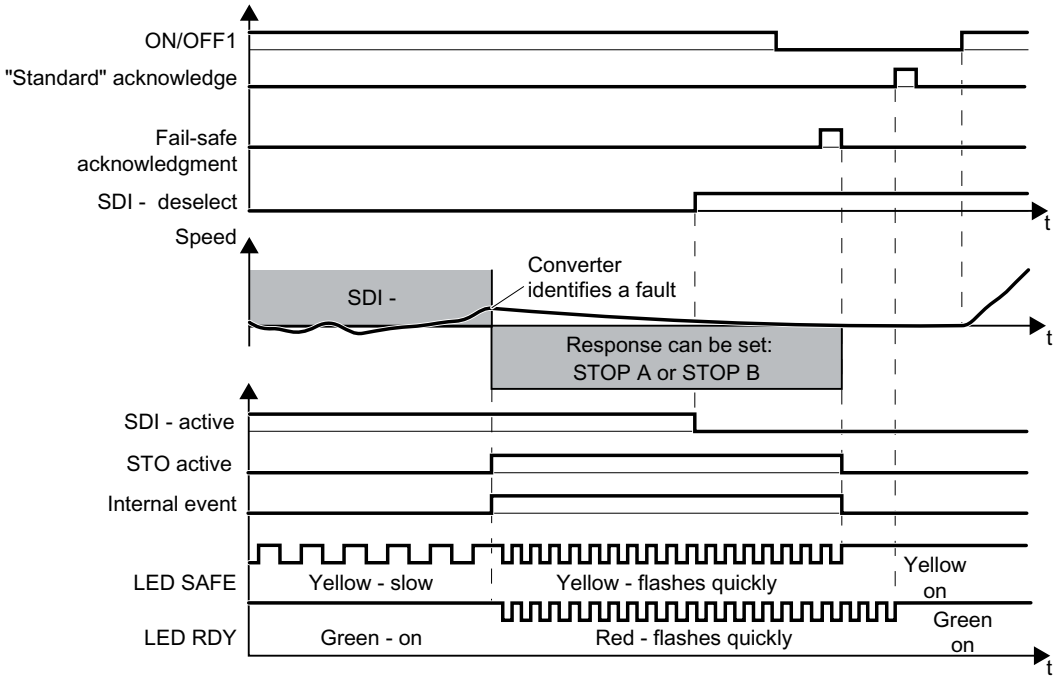


Figure 6-48 Limit value violation of safety function SDI. Example with STOP A as fault response

Converter 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	✓	---	✓
SDI+ active	r9722.12	✓	---	✓
SDI+ deselect	r9720.12	✓	✓	---
SDI- active	r9722.13	✓	---	✓
Deselect SDI	r9720.13	✓	✓	---
"Standard" acknowledgment	p2103	---	---	---
Failsafe acknowledgment	r9720.7	✓	✓	---
ON/OFF1	r0054.0	---	---	---

Switching the motor on after an internal event

Procedure

1. Deselect the SDI function.
2. Issue an OFF1 command (ON/OFF1 = 0).
3. Acknowledge the internal event in one of the following ways:
   - Failsafe acknowledgment using PROFIsafe control word 0, bit 7 = 0 → 1 → 0.
   - Failsafe acknowledge signal via a failsafe digital 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 converter power supply and switch it on again.
4. Acknowledge the converter 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.
❒

6.9 Response to a discrepancy in the signals transferred via PROFIsafe

6.9.1 Response with the basic functions

Function description

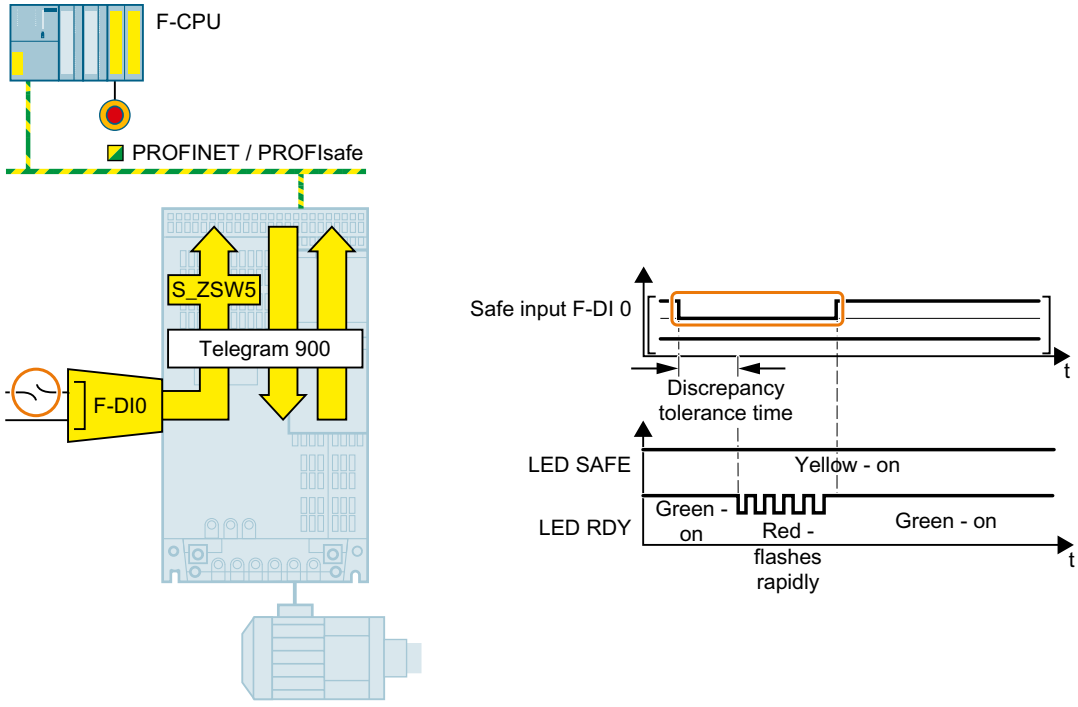


Figure 6-49 Behavior of the converter in the event of a discrepancy in the failsafe digital input in PROFIsafe telegram 900

After the tolerance time has expired, the converter signals the discrepancy (fault F01611 or F30611).

Independent of the voltage levels available, the converter sets the evaluation of the discrepant failsafe digital input into the safe state (= zero) until you acknowledge the discrepancy.

Further information

In the event of a discrepancy of the failsafe digital input, the converter also activates the safety function STO.

To disable the safety function STO again, you need to acknowledge the converter fail-safe.

Response to a discrepancy when STO is active (Page 190)

6.9.2 Response with the extended functions

Function description

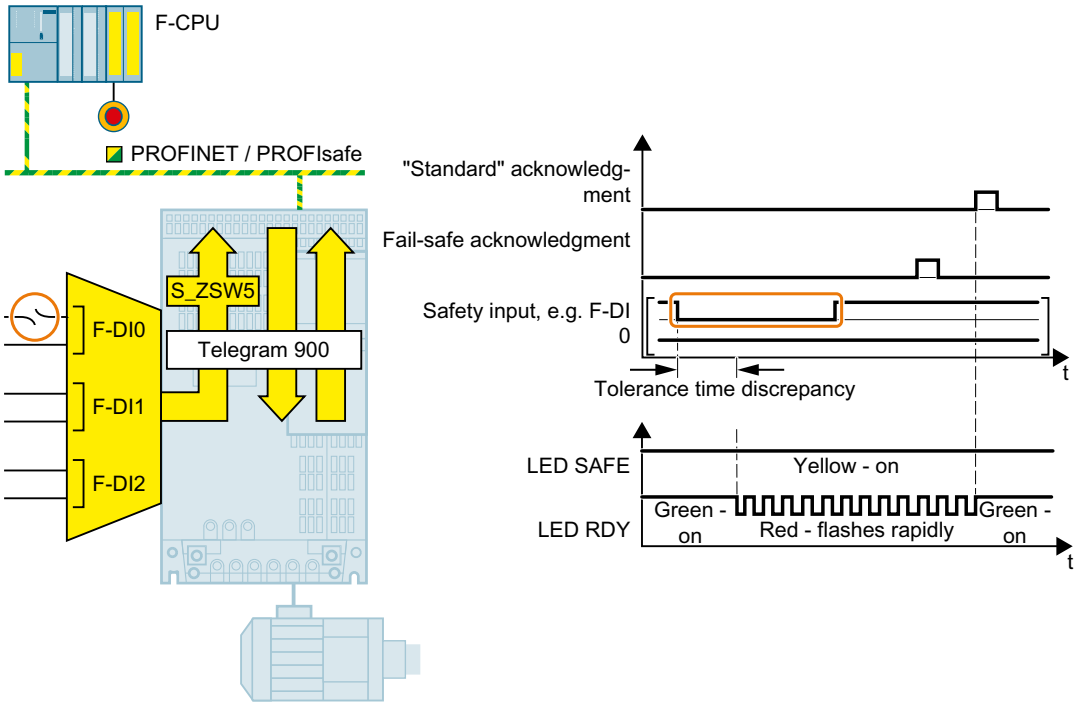


Figure 6-50 Behavior of the converter in the event of a discrepancy in a failsafe digital input in PROFIsafe telegram 900

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

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

Independent of the voltage levels available, the converter sets the evaluation of the discrepant failsafe digital input into the safe state (= zero) until you acknowledge the converter using a failsafe signal or you switch off the power supply voltage and switch it on again.

Converter signal	Parameter	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
Internal event	r9722.7	✓	---	✓
"Standard" acknowledgment	p2103	---	---	---
Failsafe acknowledgment	r9720.7	✓	✓	---

Acknowledging a discrepancy message

Procedure

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 Failsafe 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 Failsafe acknowledgment (PROFIsafe control word 1, bit 7 = 0 → 1 → 0)	Switch off the power supply voltage and switch on again

3. Acknowledge the converter 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 converter to bring the motor to a standstill as quickly as possible by triggering a STOP reaction. For example, an "internal event" can be caused by one of the following:

- The converter detects an internal fault in its hardware or its firmware on the basis of a data cross-check (F01611).
- The converter identifies when a limit value is violated as a result of an inadmissible motor speed (C01714).

An "internal event" can only be acknowledged using a failsafe signal.

Failsafe acknowledgment (Page 258)

STOP A

For a STOP A, the converter safely switches off the torque of the connected motor immediately.

STOP B

For a STOP B, the converter brakes the motor with the OFF3 ramp-down time until standstill is detected. This is then followed by a STOP A.

If you operate the motor with torque control, then the converter switches over the control mode to speed control.

The converter monitors the braking of the motor. The type of monitoring corresponds to the monitoring mode of SS1.

Setting SS1 (Page 150)

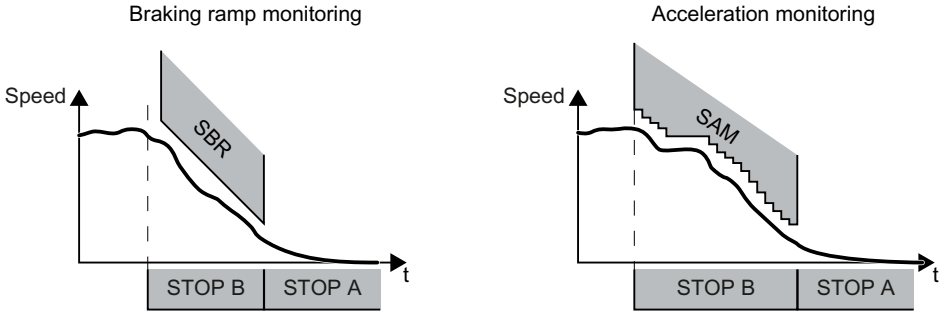


Figure 6-51 Speed monitoring for a STOP B

If the motor does not follow the defined braking ramp, the converter interrupts the braking of the motor and responds with a STOP A.

STOP F

If a safety function is active [1], a STOP F initiates a STOP A or STOP B:

- Fault F01611 immediately initiates a STOP A.
- For message C01711, the converter response depends on the active safety function:
  - When STO is active, then the converter initiates a STOP A.
  - In all other cases, the converter initiates a STOP B.

If none of the safety functions are active, then the converter 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 converter responds with a stop as described above.

[1] 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

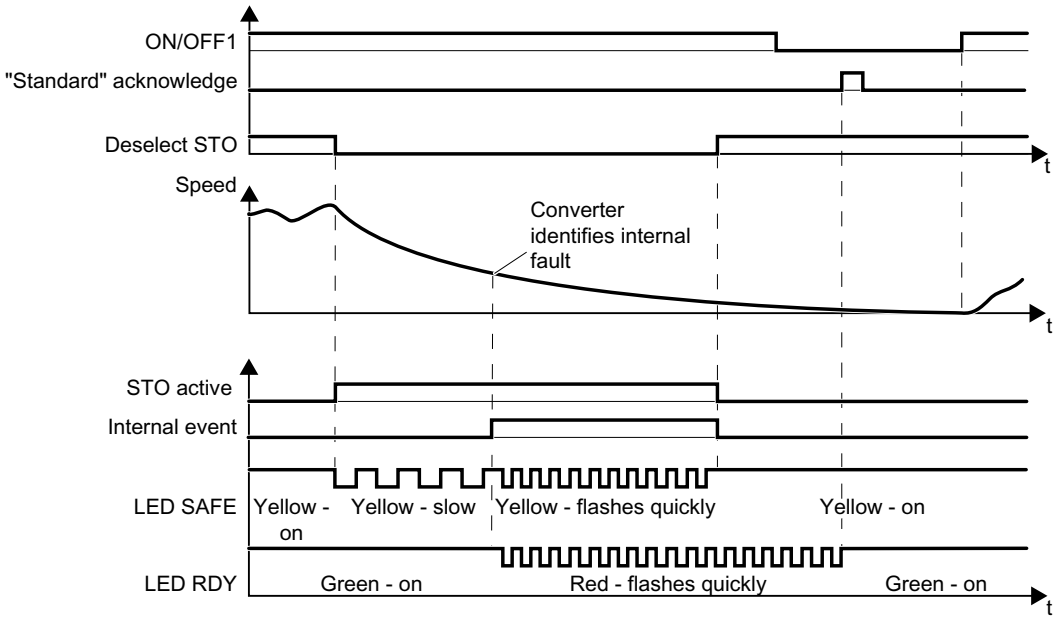


Figure 6-52 Internal event when the STO safety function is active

The converter signals an internal event.

Converter 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	---	---	---
ON/OFF1	r0054.0	---	---	---

Switching the motor on after an internal event

Procedure

1. Deselect the STO function.
2. Issue an OFF1 command (ON/OFF1 = 0).
3. Acknowledge the converter 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 converter responds with a STOP F.

A STOP F does not unconditionally stop the motor.

Stop responses (Page 254)

The drive response

The motor behavior is explained using the SSM function and a STOP B with acceleration monitoring as an example:

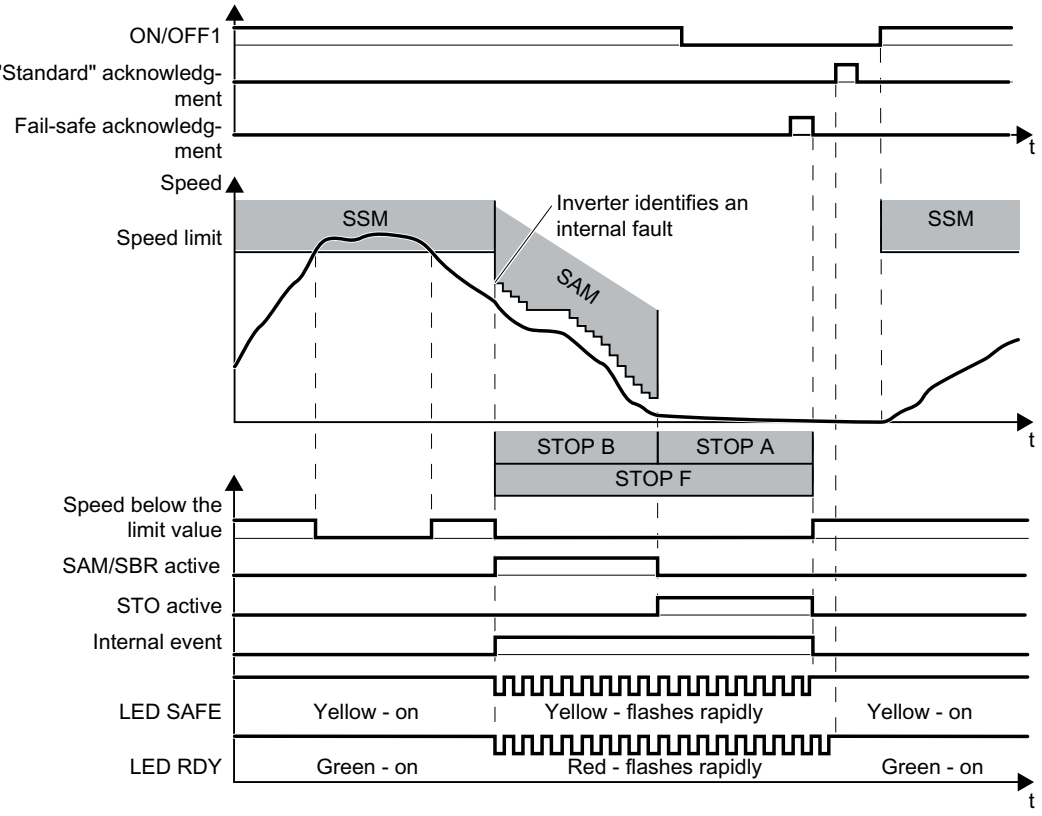


Figure 6-53 Response of the SSM safety function to an internal event

Converter 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	✓	---	✓
SSM feedback signal active (speed below limit value)	r9722.15	✓	---	✓

Converter signal	Parameter	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
SAM/SBR active	r9723.16	---	---	---
"Standard" acknowledgment	p2103	---	---	---
Failsafe acknowledgment	r9720.7	✓	✓	---
ON/OFF1	r0054.0	---	---	---

Switching the motor on after an internal event

Procedure

1. Issue an OFF1 command (ON/OFF1 = 0).
2. Acknowledge the internal event in one of the following ways:
   - Failsafe acknowledgment using PROFIsafe control word 0, bit 7 = 0 → 1 → 0.
   - Failsafe acknowledge signal via a failsafe digital 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 converter power supply and switch it on again.
3. Acknowledge the converter with the "standard" acknowledge signal.
4. Switch on the motor (ON/OFF1 = 1).
   Switching on the motor when SSM is active (Page 239)

You have acknowledged the internal event and switched on the motor again.
❒

6.11 Failsafe acknowledgment

6.11.1 Acknowledging using a failsafe signal

You must acknowledge the majority of safety function faults using a failsafe signal. The following options are available.

- Acknowledging via a failsafe digital input
- Acknowledging via PROFIsafe
- Acknowledging by selecting and deselecting STO
- Acknowledging by switching the power supply voltage on and off

Acknowledging via a failsafe digital input

Procedure

1. Acknowledge the fault with F-DI = 0 → 1 → 0.
2. Then, acknowledge the converter with the "standard" acknowledgement signal.

You have acknowledged the converter in a failsafe fashion.
❒

Acknowledging via PROFIsafe

Procedure

1. Acknowledge the fault with bit 7 of the control word 0: Bit 7 = 0 → 1 → 0.
2. Then, acknowledge the converter with the "standard" acknowledgement signal.

You have acknowledged the converter in a failsafe fashion.
❒

Acknowledging by selecting and deselecting STO

Procedure

1. Select the safety function STO or SS1 and then deselect again:
   - F-DI = 1 → 0 → 1
     or
   - PROFIsafe control word 1, bit 0 or 1 = 1 → 0 → 1
2. Then, acknowledge the converter with the "standard" acknowledgement signal.

You have acknowledged the converter in a failsafe fashion.
❒

Acknowledging by switching the power supply on and off

You can acknowledge faults by temporarily shutting off the power supply voltage of the converter and then switching it on again.

6.11.2 Response to a discrepancy of the failsafe acknowledge signal

Drive response

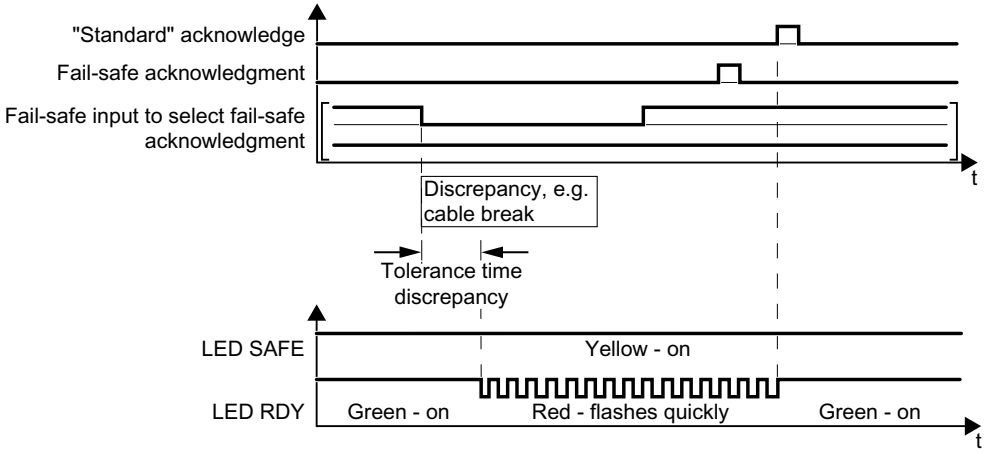


Figure 6-54 Behavior of the converter for discrepancy of the input signal for failsafe acknowledgment

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

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

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

Converter signal	Parameter	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
"Standard" acknowledgment	p2103	---	---	---
Failsafe acknowledgment	r9720.7	✓	✓	---

Acknowledging a discrepancy message

Procedure

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 converter power supply and switch it on again.
3. Acknowledge the converter 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 converter function you also select.

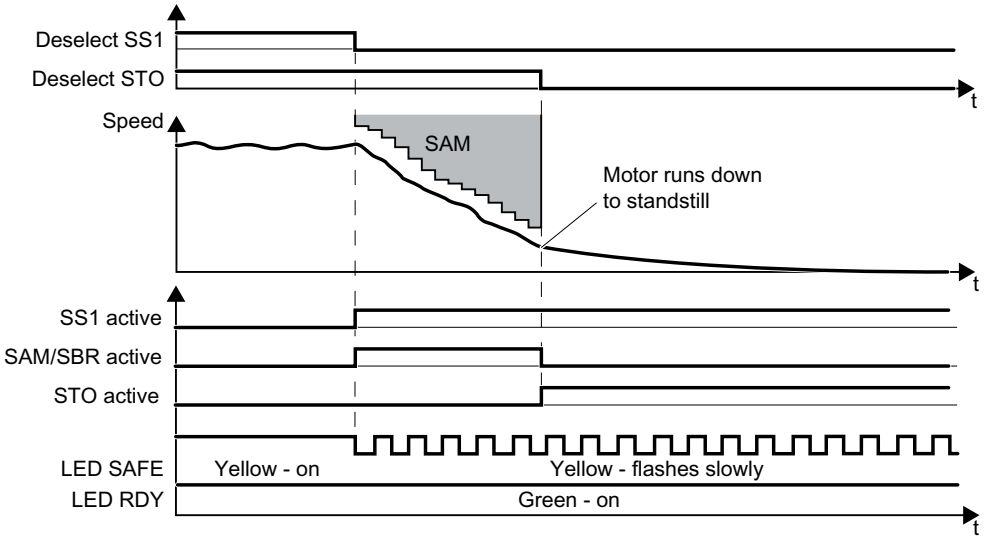
Table 6-11 Interaction between two safety functions

	Select STO	Select SS1	Select SLS	Select SDI
STO is active	---	No effect	No effect	No effect
SS1 is active	(Page 262)	---	No effect [1]	No effect [1]
SLS is active	(Page 263)	(Page 267)	---	(Page 273)
SDI is active	(Page 264)	(Page 268)	(Page 271)	---
SSM is active	(Page 265)	(Page 269)	(Page 272)	(Page 274)

[1] Exception: When SS1 is active and the following conditions are simultaneously satisfied, the converter initiates a STOP A:

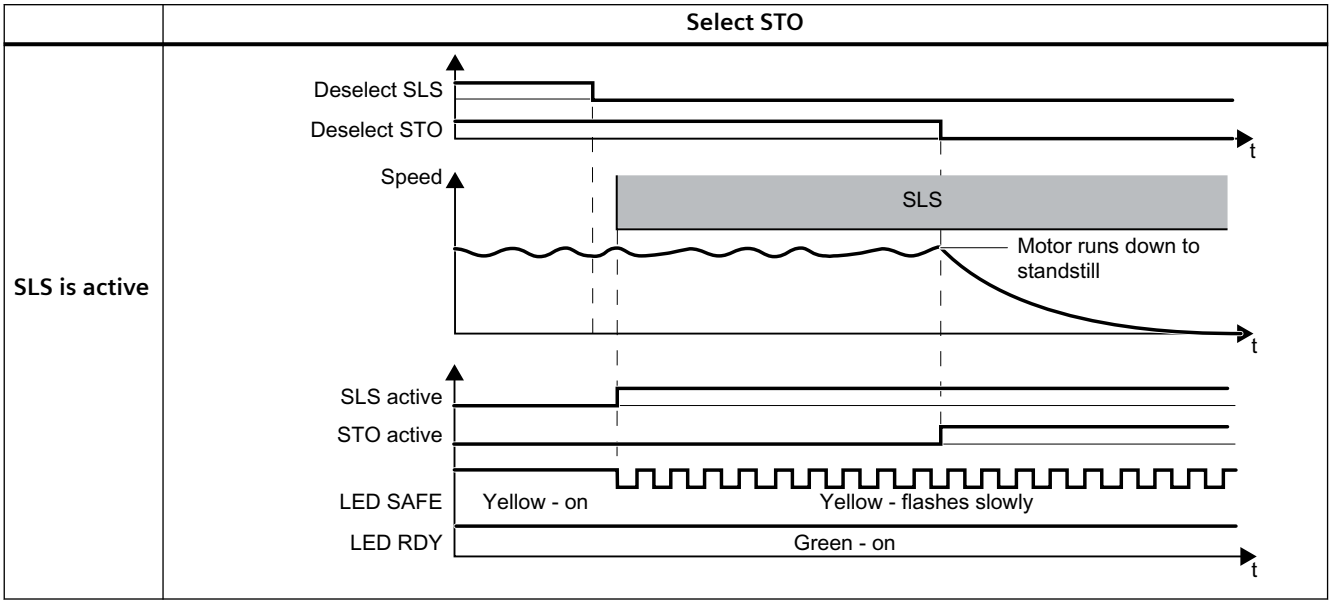
- The motor speed exceeds the SLS limit or exits the SDI tolerance window
- STOP A is set as fault response for SLS or SDI

6.12.1 Selecting STO when SS1 is active

	Select STO
SS1 is active	 Example: SS1 with acceleration monitoring

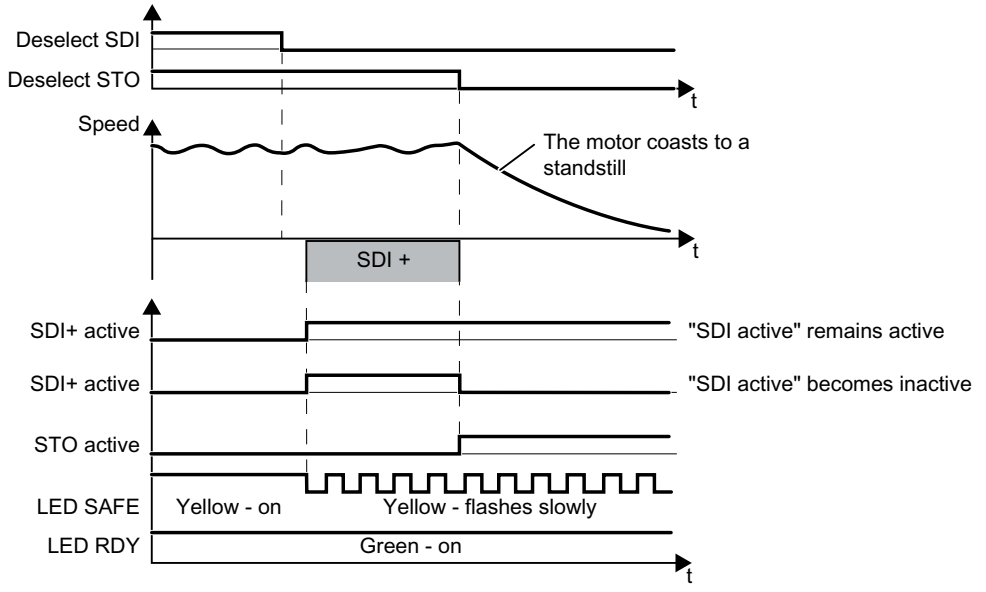
Converter signals	Parameters	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
STO active (Basic Functions)	r9773.1	✓	---	✓
Deselect STO (Basic Functions)	r9773.0	✓	✓	---
STO cause, selection via terminal on the Power Module	r9772.25	---	---	---
STO active (Extended Functions)	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	---	---	---

6.12.2 Selecting STO when SLS is active



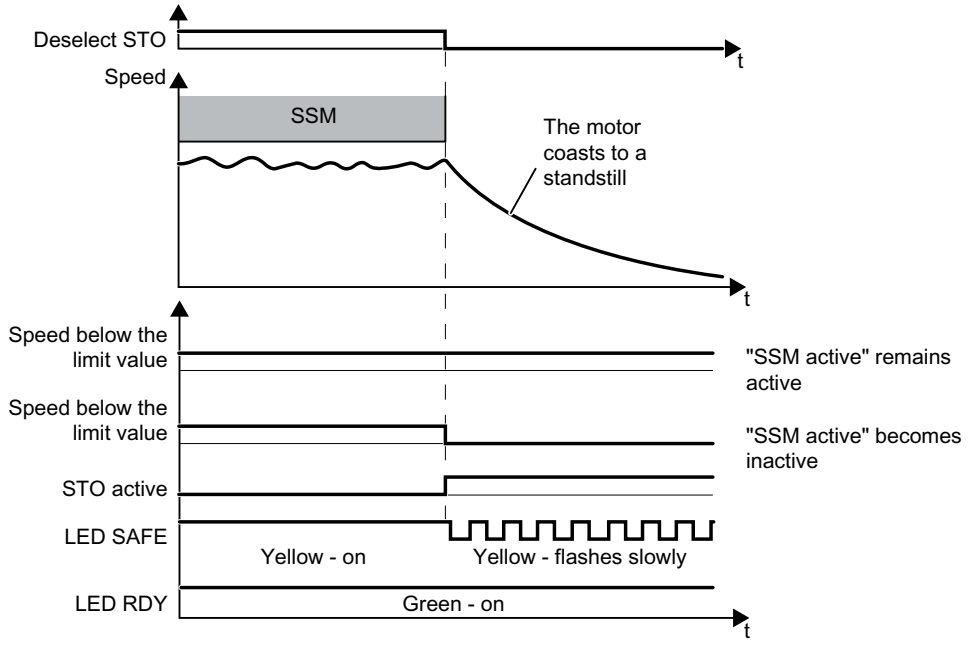
Converter signals	Parameters	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
STO active (Basic Functions)	r9773.1	✓	---	✓
Deselect STO (Basic Functions)	r9773.0	✓	✓	---
STO cause, selection via terminal on the Power Module	r9772.25	---	---	---
STO active (Extended Functions)	r9722.0	✓	---	✓
Deselect STO (Extended Functions)	r9720.0	✓	✓	---
SLS active	r9722.4	✓	---	✓
Deselect SLS	r9720.4	✓	✓	---

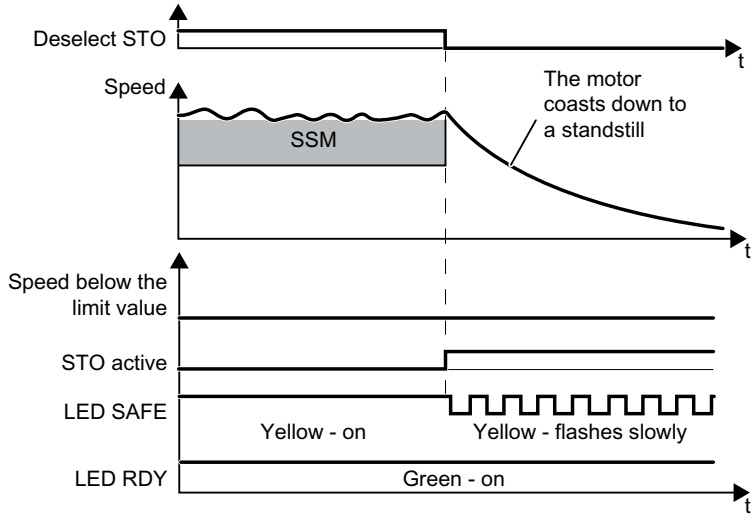
6.12.3 Selecting STO when SDI is active

	Select STO
SDI is active	

Converter signals	Parameter	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
STO active (Basic Functions)	r9773.1	✓	---	✓
Deselect STO (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	✓	✓	---

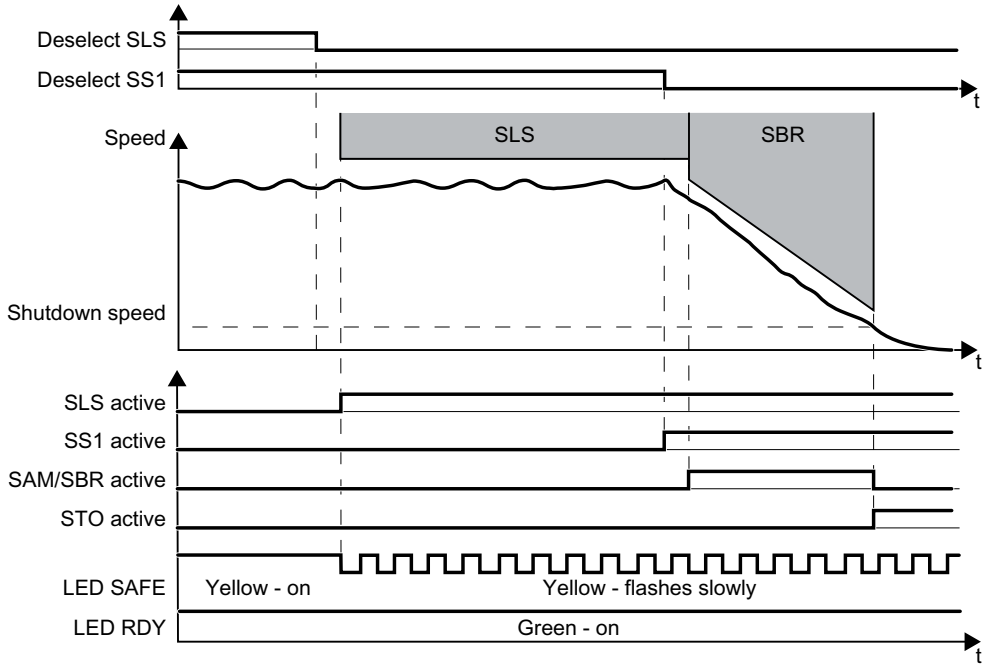
6.12.4 Selecting STO when SSM is active

	Select STO
SSM is active	 Example for speed < SSM monitoring speed

	Select STO
SSM is active	 Example for speed > SSM monitoring speed

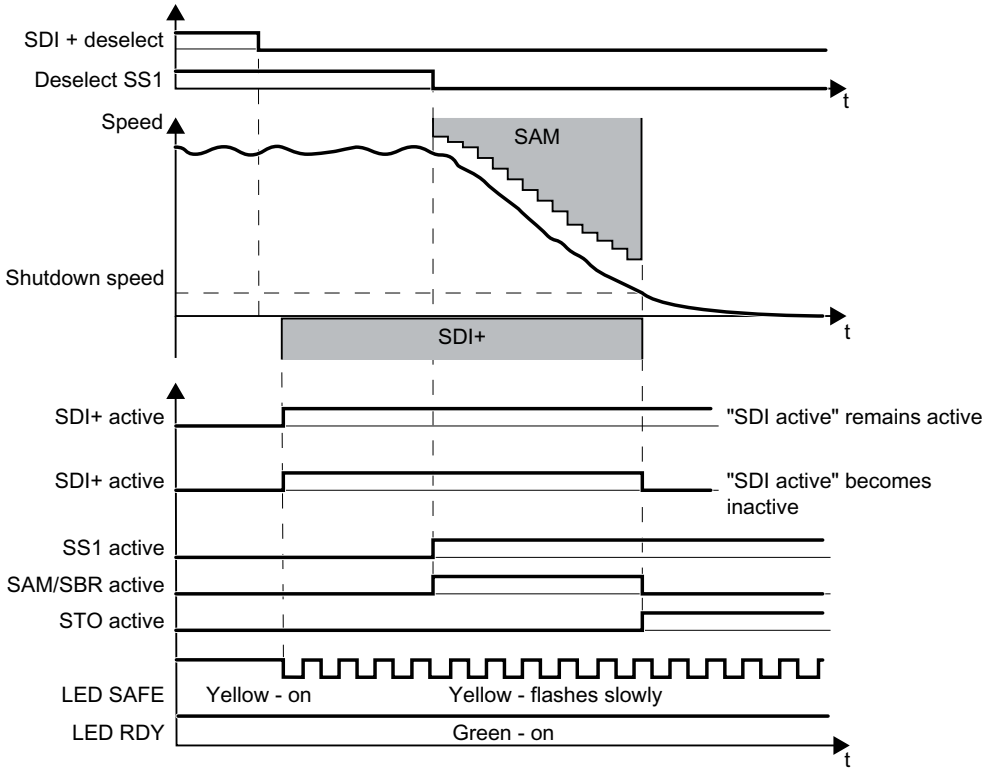
Converter signals	Parameter	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
STO active (Basic Functions)	r9773.1	✓	---	✓
Deselect STO (Basic Functions)	r9773.0	✓	✓	---
STO cause, selection via terminal on the Power Module	r9772.25	---	---	---
STO active (Extended Functions)	r9722.0	✓	---	✓
Deselect STO (Extended Functions)	r9720.0	✓	✓	---
SSM feedback signal active (speed below limit value)	r9722.15	✓	---	✓

6.12.5 Selecting SS1 when SLS is active

	Select SS1
SLS is active	 Example: SS1 with braking ramp monitoring

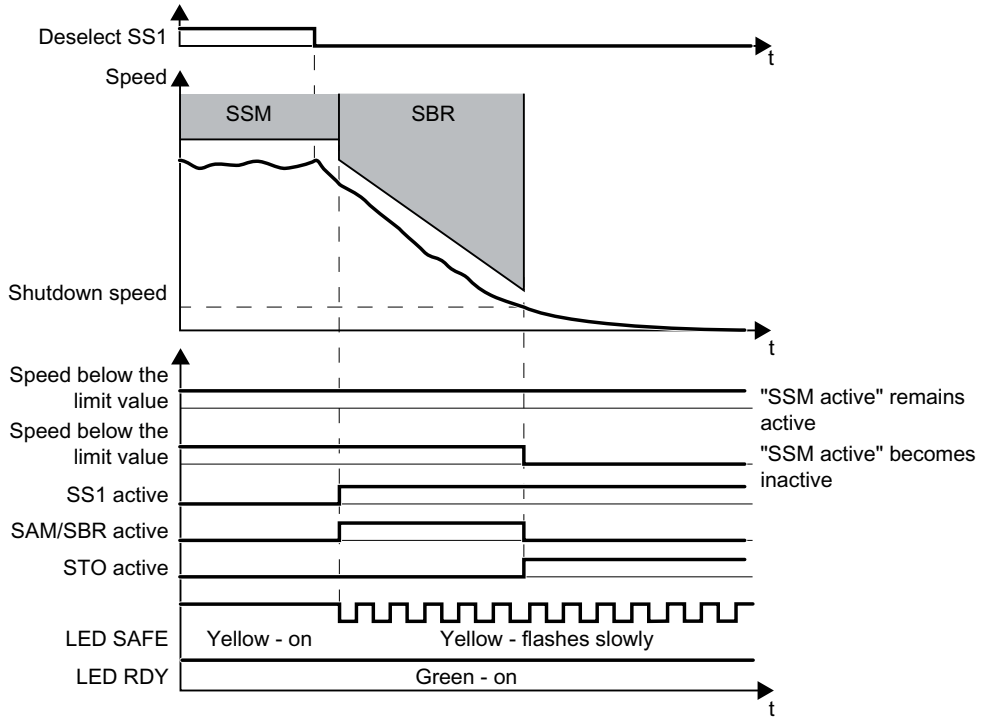
Converter signals	Parameter	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
STO active (Extended Functions)	r9722.0	✓	---	✓
SS1 active (Basic Functions)	r9773.6	✓	---	✓
Deselect SS1 (Basic Functions)	r9773.5	✓	✓	---
SS1 active (Extended Functions)	r9722.1	✓	---	✓
Deselect SS1 (Extended Functions)	r9720.1	✓	✓	---
SLS active	r9722.4	✓	---	✓
Deselect SLS	r9720.4	✓	✓	---
SAM/SBR active	r9723.16	---	---	---

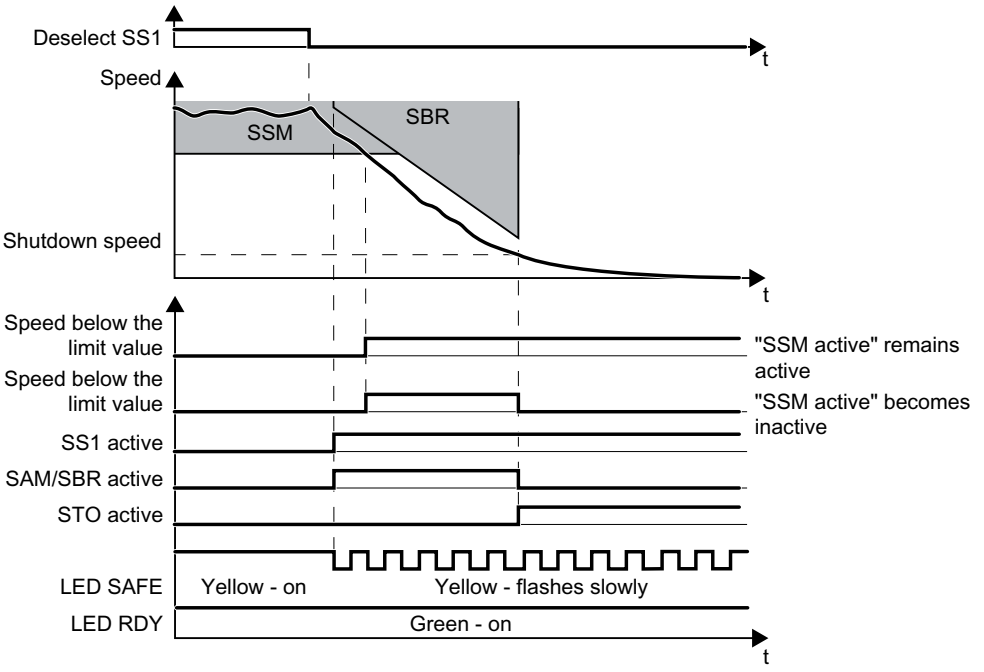
6.12.6 Selecting SS1 when SDI is active

	Select SS1
SDI is active	 Example: SS1 with acceleration monitoring SAM

Converter 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	---	---	---

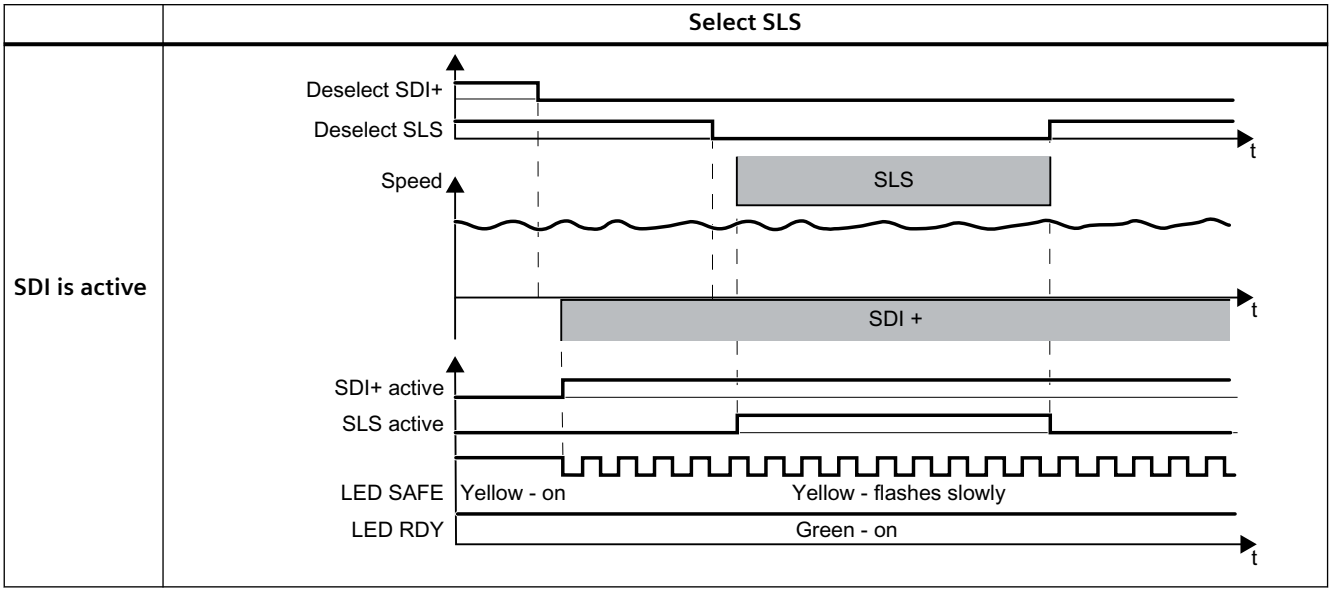
6.12.7 Selecting SS1 when SSM is active

	Select SS1
SSM is active	 Example: SS1 with brake ramp monitoring < SSM monitoring speed

	Select SS1
SSM is active	 Example: SS1 with brake ramp monitoring, speed < SSM monitoring speed

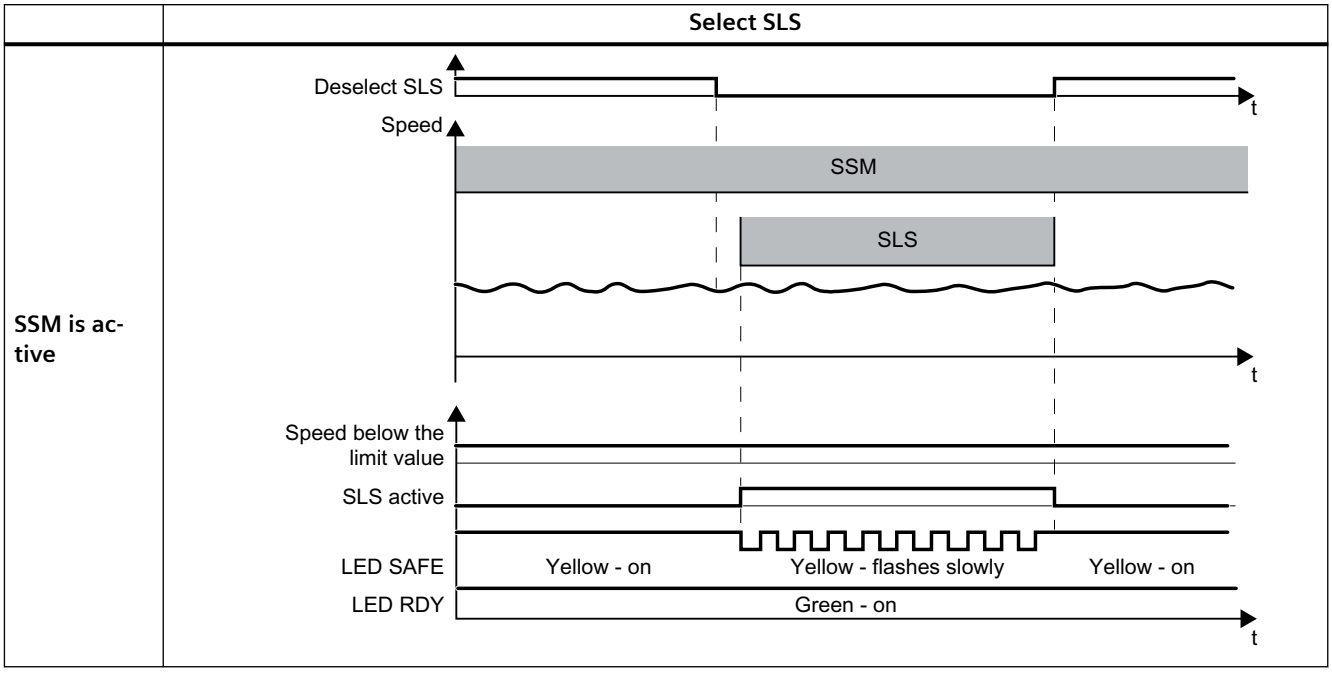
Converter signals	**Parameter**	**Included in the PROFIsafe telegram**	**Can be interconnected with**	
			F-DI	**F-DO**
STO active (Extended Functions)	r9722.0	✓	---	✓
SS1 active (Basic Functions)	r9773.6	✓	---	✓
Deselect SS1 (Basic Functions)	r9773.5	✓	✓	---
SS1 active (Extended Functions)	r9722.1	✓	---	✓
Deselect SS1 (Extended Functions)	r9720.1	✓	✓	---
SSM feedback signal active (speed below limit value)	r9722.15	✓	---	✓
SAM/SBR active	r9723.16	---	---	---

6.12.8 Selecting SLS when SDI is active



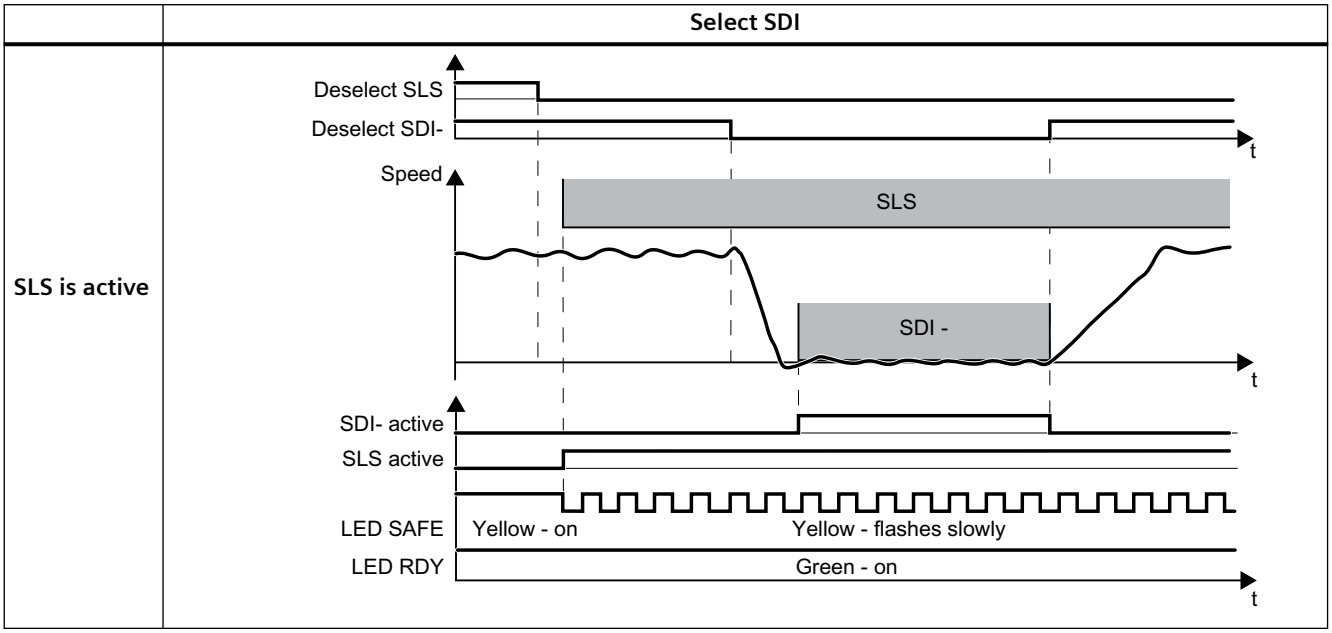
Converter signals	Parameter	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
SLS active	r9722.4	✓	---	✓
Deselect SLS	r9720.4	✓	✓	---
SSM feedback signal active (speed below limit value)	r9722.15	✓	---	✓
SDI+ active	r9722.12	✓	---	✓
SDI+ deselect	r9720.12	✓	✓	---
SDI- active	r9722.13	✓	---	✓
Deselect SDI-	r9720.13	✓	✓	---

6.12.9 Selecting SLS when SSM is active



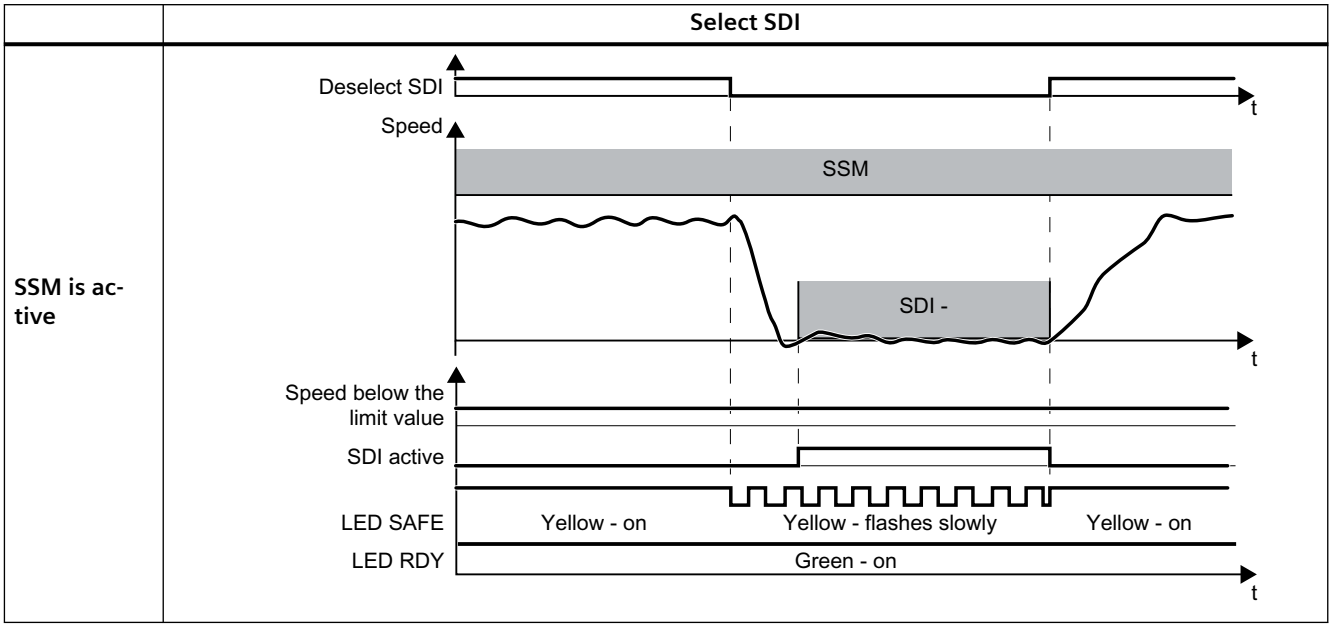
Converter signals	Parameter	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
SLS active	r9722.4	✓	---	✓
Deselect SLS	r9720.4	✓	✓	---
SSM feedback signal active (speed below limit value)	r9722.15	✓	---	✓

6.12.10 Selecting SDI when SLS is active



Converter 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	✓	✓	---

6.12.11 Selecting SDI when SSM is active



Converter 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 converter 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 failsafe input or output.

Converter 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	✓	---	✓
Deselect STO (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	✓	✓	---

Converter signals	Parameter	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
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 or PM240P-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	---	---	---
Start forced checking procedure (test stop) of the failsafe digital output	p10007	---	---	---
"Standard" acknowledgment	p2103	---	---	---
Failsafe acknowledgment	r9720.7	✓	✓	---
Ready for switching 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

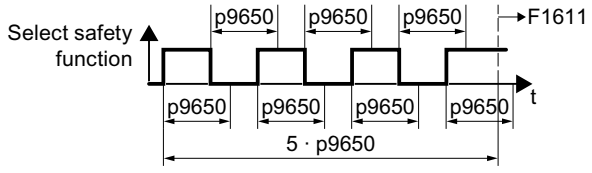
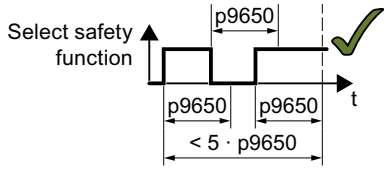
Syntax for faults and alarms

F12345	Fault 12345
A67890	Alarm 67890
C01700	Message 1700 for safety functions
	Messages C ... are either alarms or faults. See the following table.

List of alarms and faults

The following table only contains the alarms and faults of the safety functions. The complete list of all alarms and faults of the converter, detailed causes and remedial measures can be found in the List Manual.

Signal	Cause	Remedy
	Complete information on the messages is available in the List Manual.	
F01600	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 converter and switch on again. 3. Replace the Power Module if it cannot be acknowledged. Cause 2: The "STO via Power Module terminals" function is selected, however the function is not enabled in the Control Unit (p9601.7 = p9801.7 = 0). Remedy: 1. Set both switches on the Power Module to the "OFF" setting, or enable the function in the Control Unit. 2. Acknowledge the converter 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 converter 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 or PM240P-2 Power Module. Remedy: 1. Remove the discrepancy at the terminals. 2. Acknowledge the converter fail-safe. 3. Replace the Power Module if it cannot be acknowledged. 9999: Subsequent response to fault F01611.

Signal	Cause	Remedy
	Complete information on the messages is available in the List Manual.	
F01611	Defect in a monitoring channel. 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. 1 ... 999: Fault in data cross-check between processor 1 and processor 2. Details and remedy: Please refer to the List Manual. 1000: Check (watchdog) timer has expired. When selecting a safety function, the signal changed too frequently. The converter monitors the signal to select a safety function after a signal change. If the signal state continues to change in shorter intervals than entered in p9650, after the time 5 × p9650 the converter outputs fault F1611:  Remedy: • Check the F-DI wiring (contact problems). • Resolve the contact problems or faults at the PROFIBUS master/ PROFINET controller. The converter terminates the monitoring and does not signal any faults if the signal state remains stable before the time 5 × p9650 expires, longer than p9650:  1001, 1002: Initialization error, change timer/check timer. • Remedy: Switch off the power supply voltage of the converter and switch on again. 2000: Status of the STO selection for the two monitoring channels is different. Response to a discrepancy when STO is active (Page 190) 2001: Checkback signal of the safe pulse suppression for the two monitoring channels is different.

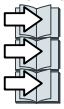
Signal	Cause	Remedy
	Complete information on the messages is available in the List Manual.	
		2002: Status of the delay timer SS1 in the two monitoring channels is different. Response to a discrepancy when STO is active (Page 190) Response to a discrepancy when SS1 is active (Page 209) 2003: Status of the STO terminal at processor 1 and processor 2 is different. Remedy for 2000, 2001, and 2003: • Check the F-DI changeover tolerance time. Increase the value (p9650). • Check the F-DI wiring (contact problems). • Check the causes of the STO selection in r9772. 6000: Internal software fault • Switch off the power supply voltage of the converter and switch on again. • Upgrade firmware to later version • Replace Control Unit 6064: Target address and PROFIsafe address differ (F_Dest_Add). • Check the value of the F_Dest_Add F-parameter in the converter • Check the PROFIsafe address at processor 1 (p9610) and processor 2 (p9810). 6065: Target address invalid (F_Dest_Add). • The target address must not be 0 or FFFF. 6066: Source address invalid (F_Source_Add). • The source address must not be 0 or FFFF. 6067: Watchdog time value invalid (F_WD_Time). • The watchdog time value must not be 0. 6165: Fault in reception of the PROFIsafe telegram. This fault can also occur if the converter 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. • Check the configuration and communication in the converter. • Check the value of the F_WD_Time F-parameter in the converter. Increase the value. 6166: Time monitoring fault in reception of the PROFIsafe telegram. • Check the configuration of the communication in the converter. • Check the setting of the F_WD_Time value in the converter. Increase the value. • Evaluate the diagnostic information in the F host. • Check the PROFIsafe connection.
A01620, F01620	Safe torque off active	Not necessary.
A01621, F01621	Safe Stop 1 active	Not necessary.

Signal	Cause	Remedy
	Complete information on the messages is available in the List Manual.	
F01625	Sign-of-life error in the Safety data	Check that the control cabinet design and cable routing are both in compliance with EMC regulations. Check as to whether an inadmissible voltage, e.g. 230 V, is connected at the Control Unit digital output. Fault acknowledgment 1. Select STO, and then deselect again. 2. If it cannot be acknowledged, replace the Control Unit.
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: • p1215 = 0 and p9602 = 1. • p1215 = 3 and p9602 = 1.
F01640, F01641	It has been identified that a component has been replaced, acknowledgment/data save is necessary	Corrective maintenance (Page 289)
F01649	Internal software error	1. Switch off the Control Unit power supply and then on again. 2. If it cannot be acknowledged, replace the Control Unit.
F01650	Acceptance test required	Acceptance tests for the safety functions (Page 173)
F01651	Synchronization, safety time slices unsuccessful.	1. Switch off the Control Unit power supply and then on again. 2. If it cannot be acknowledged, replace the Control Unit.
F01653	PROFIBUS/PROFINET configuration error	Check the PROFIBUS or PROFINET configuration of the safety slot on the master side and on the Control Unit.
A01654	PROFIsafe configuration differs	Check the PROFIsafe configuring in the higher-level control. • Alarm value r2124 = 1: In the higher-level F control, remove the PROFIsafe configuring, or enable PROFIsafe in the drive. • Alarm value r2124 = 2: In the higher-level F control, configure the appropriate PROFIsafe telegram.
F01655	Aligning the monitoring functions	1. Check that the control cabinet design and cable routing are in compliance with EMC regulations. 2. Switch off the Control Unit power supply and then on again.
F01656	Parameter processor 2 incorrect	1. Recommission the safety functions. 2. If this is not successful, then replace the Control Unit.

Signal	Cause	Remedy
	Complete information on the messages is available in the List Manual.	
F01658	PROFIsafe telegram number unsuitable	The PROFIsafe telegram number in p60022 is not suitable for the enabled safety functions. Check the following: • If PROFIsafe is not enabled (p9601.3 = 0), PROFIsafe telegrams must not be selected in p60022. • If PROFIsafe is enabled (p9601.3 = 1), you must select a PROFIsafe telegram in p60022. • If transfer of the F-DI via PROFIsafe is selected (p9501.30 = 1), you must select telegram 900 in p60022.
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. Restrictions when using safety functions (Page 23)
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 converter has identified a defect: 1. Switch off the Control Unit power supply and then on again. 2. Contact Technical Support if it cannot be acknowledged. You have not configured the "STO via Power Module terminals" function, but you have activated the terminals on the PM240-2 or PM240P-2 Power Module: 1. Set the switch for the failsafe digital input of the Power Module (STO_A and STO_B) into the "OFF" position.
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.
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 Power Module terminals" function has been exceeded. Deselect the "STO via Power Module terminals" function and then select again.

Signal	Cause	Remedy
	Complete information on the messages is available in the List Manual.	
F01680	Checksum error safe monitoring functions	1. Check the safety-related parameters. 2. Switch off the power supply voltage of the converter and switch on again.
F01681	Incorrect parameter value	Correct the parameter value: Fault value (r0949) yyyyxxxx decimal, yyyy = supplementary information, xxxx = 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 converter 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) of the extended functions is selected when powering up – and this is not permissible. Deselect the forced checking procedure 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 extended 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 basic functions 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) [1)]	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
	Complete information on the messages is available in the List Manual.	
C01711 (alarm) [1]	Defect in a monitoring channel Fault value r2124 provides more detailed information.	The complete list of the r2124 fault values is provided in the List Manual. 0 ... 2: Fault in data cross-check between processor 1 and processor 2. Remedy: Please refer to the List Manual. 3: Difference of the position actual value (r9713) between the two monitoring channels is greater than the tolerance in p9542. Setting encoderless actual value sensing (Page 137) 4 ... 43: Fault in data cross-check between processor 1 and processor 2. Remedy: Please refer to the List Manual. 44 ... 57: The tolerance value for the monitoring function differs between the two monitoring channels. Setting encoderless actual value sensing (Page 137) 58 ... 999: Fault in data cross-check between processor 1 and processor 2. Remedy: Please refer to the List Manual. 1000: Check (watchdog) timer has expired. • Too many signal changes at the F-DI Remedy: • Check the F-DI wiring (contact problems). 1001: Initialization error of the check timer. • Remedy: Switch off the power supply voltage of the converter and switch on again. • Upgrade converter firmware 1005: Pulses already canceled for test stop selection. 1011: Acceptance test status between the monitoring channels differ. • Diagnostics in the List Manual under r9571. 1020: Cyclic communication failure between the monitoring channels. • Remedy: Switch off the power supply voltage of the converter and switch on again. • Replace the Control Unit or the converter. 1041: Current value too low for encoderless actual value acquisition. • Reduce the minimum current (p9588).

Signal	Cause	Remedy
	Complete information on the messages is available in the List Manual.	
		1042: Current or voltage plausibility error. • Increase the ramp-up and ramp-down time (p1120/p1121). • Check whether the current and speed control settings are correct (torque-forming, field-forming current andactual speed value must not fluctuate). • Reduce the dynamic response of the setpoint. • Increase the minimum current (p9588). • Maintain an adequate wait time before switching on the motor.  Switching on the motor when SLS is active (Page 227) Switching on the motor when SSM is active (Page 239) Switching on the motor when SDI is active (Page 245) 1043: Too many acceleration processes. • Increase the value for "Actual value sensing encoderless acceleration limit" (p9589). • Increase the ramp-up and ramp-down time (p1120/p1121). • Check whether the current and speed control settings are correct (torque-generating, field-generating current and speed actual value must not fluctuate). • Reduce the dynamic response of the setpoint. 1044: Actual current value plausibility error. 6000 ... 6166: The significance of the message values is described in the safety fault F01611 with the fault value r0949.
C01712 (alarm) [1)]	Defect when processing F-IO	1. Check the F-DI wiring. 2. Check the setting of the safety functions. 3. Perform an acceptance test.
C01714 (alarm) [1)]	Safely limited speed exceeded	1. Check the speed setpoint received from the higher-level control. 2. Check the SLS limits.
C01716 (fault)	Tolerance for safe direction of motion exceeded	Check the tolerance setting for the SDI function.
C01770 (fault)	Discrepancy error of the failsafe digital inputs.	Check the F-DI wiring.
A01772	Test stop for failsafe digital output running	The alarm automatically disappears after successfully ending or canceling (error) the forced checking procedure (test stop).
F01773	Test stop for failsafe digital output error	1. Check the wiring of the failsafe digital output. 2. Start the forced checking procedure.
A01774	Test stop for failsafe digital output required	The time to carry out the forced checking procedure (test stop) has expired (p10003). Start the forced checking procedure of the failsafe output.
A01788	Automatic test stop waits for STO to be deselected via the motion monitoring functions	The converter was not able to carry out the automatic test stop (forced checking procedure) after switching on the power supply voltage. Possible causes: • STO for the extended functions is selected. • A safety message is active, which resulted in STO.

Signal	Cause	Remedy
	Complete information on the messages is available in the List Manual.	
A01790	Powering up stopped due to "STO via Power Module terminals"	After the power supply voltage has been switched on, the converter was not able to complete its automatic self test. Possible cause: The "STO via Power Module terminals" function is active.
A01796	Waiting for communication	• Check the operating state of the F host. • Check the communication connection to the F host.
C01798 (alarm)	Test stop for motion monitoring is running	The converter is presently carry out the forced checking procedure (test stop) for the extended functions. The converter withdraws the message after the end of the test stop.
C01799 (alarm)	Acceptance test mode active	Not necessary. The converter withdraws the message after the end of the acceptance test mode.
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 converter and switch on again. 3. Replace the Power Module if it cannot be acknowledged. Cause 2: The "STO via Power Module terminals" function is selected, however the function is not enabled in the Control Unit (p9601.7 = p9801.7 = 0). Remedy: 1. Set both switches on the PM240-2 or PM240P-2 Power Module to the "OFF" setting, or enable the function in the Control Unit. 2. Acknowledge the converter 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 converter 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 or PM240P-2 Power Module. Remedy: 1. Remove the discrepancy at the terminals. 2. Acknowledge the converter 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.

Signal	Cause	Remedy
	Complete information on the messages is available in the List Manual.	
F30625	Sign-of-life error in the Safety data	1. Select STO. 2. Deselect STO. 3. If it cannot be acknowledged, replace the Control Unit.
F30630	Brake control defective	1. Check the following: – p1278 = 0. – Motor holding brake connection – Motor holding brake function – EMC-compliant control cabinet design and cable routing 2. Select STO, and then deselect again.
F30649	Internal software error	1. Switch off the Control Unit power supply and then on again. 2. Contact Technical Support if it cannot be acknowledged.
F30650	Acceptance test required	Acceptance tests for the safety functions (Page 173)
F30651	Synchronization with Control Unit unsuccessful.	1. Switch off the Control Unit power supply and then on again. 2. Contact Technical Support if it cannot be acknowledged.
F30655	Aligning the monitoring functions	1. Check that the control cabinet design and cable routing are in compliance with EMC regulations. 2. Switch off the Control Unit power supply and then on again.
F30656	Parameter processor 2 incorrect	1. Recommission the safety functions. 2. If this is not successful, then replace the Control Unit.
F30659	Write task for parameter rejected	Check the following: • Password • Only restore factory settings with the safety functions inhibited
F30662	Error, internal communications	1. Switch off the Control Unit power supply and then on again. 2. Contact Technical Support if it cannot be acknowledged.
F30664	Fault during power-up	Switch off the power supply voltage of the converter and switch on again. Contact Technical Support if it cannot be acknowledged.
F30665	System is defective	1. Switch off the Control Unit power supply and then on again. 2. If it cannot be acknowledged, replace the Control Unit.
A30666, F30666	Static 1 signal at the F-DI for safe acknowledgement	Set the F-DI input to a 0 signal for acknowledging the safety functions.
F30680	Checksum error safe monitoring functions	1. Check the setting of the safety functions. 2. Switch off the Control Unit power supply and then on again.
F30681	Incorrect parameter value	Correct the parameter value: Fault value (r0949) yyyyxxxx decimal, yyyy = supplementary information, xxxx = parameter
F30682	Monitoring function not supported	Deselect the monitoring function involved (p9501, p9601, p9801).
F30683	SLS enable missing	1. Enable the SLS function (p9501.0). 2. Save the setting (copy RAM to ROM). 3. Switch off the Control Unit power supply and then on again.
F30692	Parameter value not permitted for encoderless	Correct the parameter value.

Signal	Cause	Remedy
	Complete information on the messages is available in the List Manual.	
A30693, F30693	Safety parameterization changed, POWER ON required	1. Save the settings so that they are protected against power failure (RAM → ROM). 2. Switch off the Control Unit power supply and then on again.
C30700 (fault)	STOP A initiated	Generally, this fault is a consequence of C30701, C30706, C30714 or C30716.
C30701 (fault)	STOP B initiated	Generally, this fault is a consequence of C30706, C30714 or C30716.
C30706 (alarm or fault) [1]	SAM/SBR limit exceeded	1. Check the motor braking response. 2. Adapt the tolerance for the parameterization of the "safe braking ramp".
C30711 (alarm) [1]	Defect in a monitoring channel. Fault value r2124 provides more detailed information.	Diagnostics for the fault values and remedies are described under message C01711.
C30712 (alarm) [1]	Defect when processing F-IO	1. Check the F-DI wiring. 2. Check the setting of the safety functions. 3. Perform an acceptance test.
C30714 (alarm) [1]	Safely limited speed exceeded	1. Check the speed setpoint received from the higher-level control. 2. Check the SLS limits.
C30716 (fault)	Tolerance for safe direction of motion exceeded	Check the tolerance for the "SDI" function.
C30770 (fault)	Discrepancy error of the failsafe digital inputs or the failsafe digital outputs.	Check the F-DI wiring.
A30772	Test stop for failsafe digital output running	The alarm automatically disappears after successfully ending or canceling (error) the forced checking procedure (test stop).
F30773	Test stop for failsafe digital output error	1. Check the wiring of the failsafe digital output. 2. Start the forced checking procedure.
A30788	Automatic test stop: Wait for STO to be deselected via SMM	• Deselect STO of the extended functions. • Remove the cause for active safety messages and acknowledge the messages
C30798 (alarm)	Test stop for motion monitoring is running	Not necessary. The converter withdraws the message after the end of the test stop.
C30799 (alarm)	Acceptance test mode active	Not necessary. The converter withdraws the message after the end of the acceptance test mode.

[1] If the safety functions of the converter have been enabled, then this alarm initiates a STOP response and a converter fault.

Corrective maintenance

7

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 ensure that the safety functions are still working correctly after replacing defective components?

Further information

You can find information on replacing defective components or replacing the converter in the operating instructions of the converter.

Overview of the manuals (Page 318)

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.

⚠ WARNING

Incorrect/faulty components in safety-related systems and machines

Disregarding current product developments and properties can mean that product faults are possibly not resolved. Incorrect/faulty components in safety-related systems and machines can result in an increase risk of accidents.

- Register to receive the appropriate newsletters on these topics.
- If necessary, modify your plant or machine so that the requirements of the safety functions are always complied with.

Registering to receive the newsletter

Procedure

1. On the Internet, open the following page:
   Siemens automation technology (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 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 converter with an identical type	An acceptance test for the safety functions is not required. Only check the direction of rotation of the motor.	• Supplement converter data • Document the modified checksum and time stamp [1)] • Countersignature
Replacing a Power Module with an identical type		Supplement the hardware version in the converter data.
Replacing the motor with an identical pole pair number		No change
Replace the gearbox with an identical ratio		
Replacing the Safe Brake Relay	Check the SBC function.	Supplement the hardware version in the converter data.

Measure	Acceptance test	Documentation
Replacing safety-related I/O devices (e.g. Emergency Stop switch).	Check the control of the safety functions affected by the components that have been replaced.	No change
Converter firmware update	An acceptance test for the safety functions is not required. Check as to whether the firmware update was successful and the converter functions as expected.	• Supplement firmware version in the converter data • Document the modified checksum and time stamp [1)] • Countersignature

[1)] The converter changes the following parameters after replacing converter components and after a firmware update:

- checksum r9781
- time stamp r9782

System properties

8

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 converter?
- In what time intervals must I initiate a converter self test?
- What are the probabilities of failure of the safety functions of my converter?
- 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 converter certified?
- Where can I find the converter certificate?
- What is the technical data of the Safe Brake Relay?

8.2 System properties of the Safety Integrated functions

Mission time

The safety parameters of the Safety Integrated Functions are valid for a service life of twenty years,

Test interval

You must test the safety-related circuits of the converter at least once every year. This process is called "forced checking procedure" or "test stop".

Regularly testing the safety functions (Page 177)

Probability of failure

The specified probability of failure values apply under the following preconditions:

- The mission time of the converter has not expired.
- The test interval has not expired.

The probability of failure for Safety Integrated Functions must be specified in the form of a PFH value (probability of failure per hour) according to IEC 61800-5-2, IEC 62061 and EN ISO 13849-1. The PFH value of a Safety Integrated Function depends on the safety concept

of the converter and its hardware configuration, as well as on the PFH values of other components used for this Safety Integrated Function.

More information

The PFH values can be found under:

PFH-Werte (https://support.industry.siemens.com/cs/ww/en/view/76254308)

You can map the PFH values of all Safety Integrated components from Siemens using the "Safety evaluation" function in the TIA selection tool:

Safety Evaluation (http://www.siemens.com/safety-evaluation-tool)

8.3 Certifications

Certifications

The safety functions fulfill the following requirements:

"STO via Power Module terminals" **Control via terminals STO_A and STO_B in the SINAMICS G120 PM240-2 or PM240P-2 Power Module, FSD ... FSF**	**All other safety functions of the SINAMICS G115D, G120, G120C and G120D converters**
• Category 3 and Performance Level (PL) e according to EN ISO 13849-1: 2015 • Safety integrity level 3 (SIL 3) to IEC 61508: 2010 • EC Declaration of Conformity	• Category 3 and Performance Level (PL) d according to EN ISO 13849-1: 2015 • Safety integrity level 2 (SIL 2) to IEC 61508: 2010 • EC Declaration of Conformity

EC type-examination certificate and manufacturer declaration

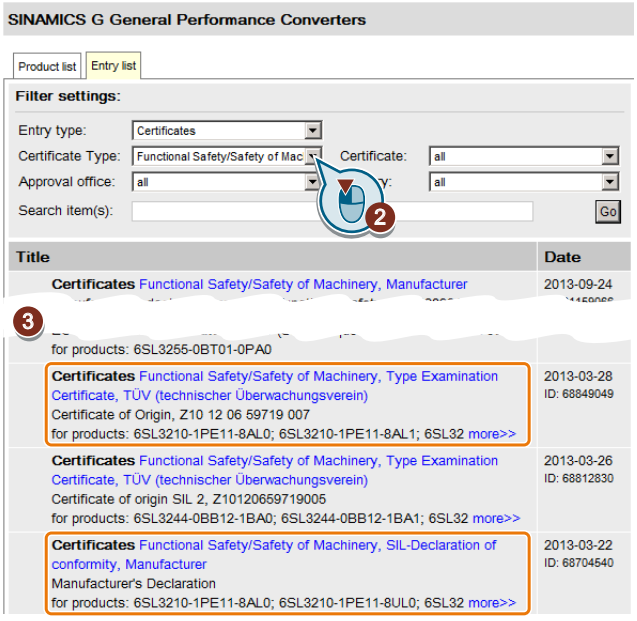
The safety functions integrated in the drive are certified by a test institute for each of the firmware versions that have been released. With the EC type-examination certificate, the test institute confirms that the safety functions comply with the requirements as laid down in EN ISO 13849-1 and IEC 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. Open the following page in the Internet:
   Certificates (https://support.industry.siemens.com/cs/ww/en/ps/cert?ct=442)
2. Filter according to Certificate type "Functional safety/machine safety".
3. Select the certificate according to the converter article number.
   - There is an EC type-examination certificate and a manufacturer declaration for each converter family.
   - Each certificate includes lists with the associated firmware and hardware.



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 converter are 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	2.5 A
Conductor cross section, max.	2.5 mm^2
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
- Selection via the failsafe digital input or PROFIsafe.

The "worst case values" in the following tables mean the following:

Worst case for a fault-free converter:	The response time is less than or equal to the specified value.
Worst case for a converter fault:	The response time is less than or equal to the specified value. The response time is applicable for fault causes within the converter 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

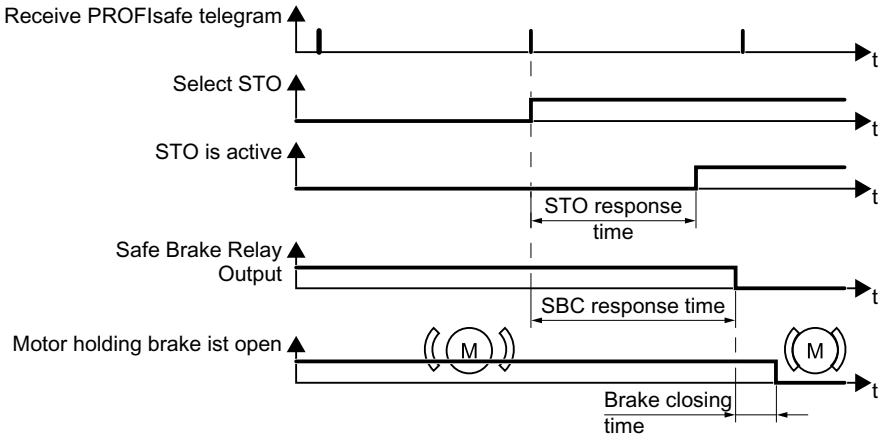


Figure 8-1 Response times when selected via PROFIsafe

Table 8-1 Response times when using the basic functions

Function	Selection via	Response	Response time	
			Worst case for a fault-free converter	Worst case for a converter fault
STO	PROFIBUS	STO is active	14 ms	14 ms
	PROFINET		14 ms + bus cycle time [1]	14 ms + bus cycle time [1]
SBC	PROFIBUS	Signal change at the output of the Safe Brake Relay	16 ms	30 ms
	PROFINET		16 ms + bus cycle time [1]	30 ms + bus cycle time [1]

[1] Bus cycle time: Time for cyclic data exchange via PROFINET

Table 8-2 Response times when using the extended functions

Function	Selection via	Response	Response time	
			Worst case for a fault-free converter	Worst case for a converter fault
STO	PROFIBUS	STO is active	54 ms	56 ms
	PROFINET		54 ms + bus cycle time [1]	56 ms + bus cycle time [1]
SBC	PROFIBUS	Signal change at the output of the Safe Brake Relay	56 ms	62 ms
	PROFINET		56 ms + bus cycle time [1]	62 ms + bus cycle time [1]

[1] Bus cycle time: Time for cyclic data exchange via PROFINET

Response times when selected via a failsafe digital input

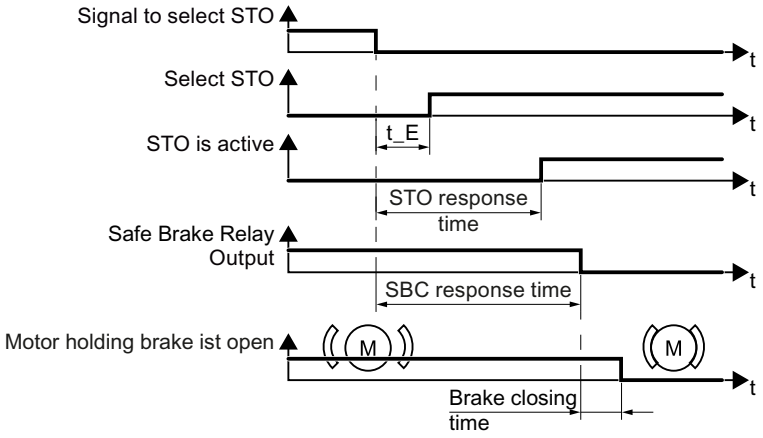


Figure 8-2 Response times when selected via a failsafe digital input

Table 8-3 Response times when using the basic functions

Function	Selection via	Response	Response time	
			Worst case for a fault-free converter	Worst case for a converter fault
STO	F-DI	STO is active	4 ms + t_E [1]	6 ms + t_E [1]
	Terminals STO_A, STO_B on the PM240-2 or PM240P-2 Power Module (HW STO)		20 ms	---
	Output time of the HW STO feedback signals via a digital output		24 ms	---
SBC	F-DI	Signal change at the output of the Safe Brake Relay	8 ms + t_E [1]	22 ms + t_E [1]
	Terminals STO_A, STO_B on the PM240-2 or PM240P-2 Power Module.		24 ms	---

[1] When p9651 > 0: t_E = p9651 + 3 ms; p9651: Debounce time
When p9651 = 0: t_E = 4 ms

Table 8-4 Response times when using the extended functions

Function	Selection via	Response	Response time	
			Worst case for a fault-free converter	Worst case for a converter fault
STO	F-DI	STO is active	50 ms + t_E [1]	52 ms + t_E [1]
SBC		Signal change at the output of the Safe Brake Relay	52 ms + t_E [1]	60 ms + t_E [1]

[1] When p10017 > 0: t_E = p10017 + 3 ms; p10017: Debounce time
When p10017 = 0: t_E = 4 ms

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

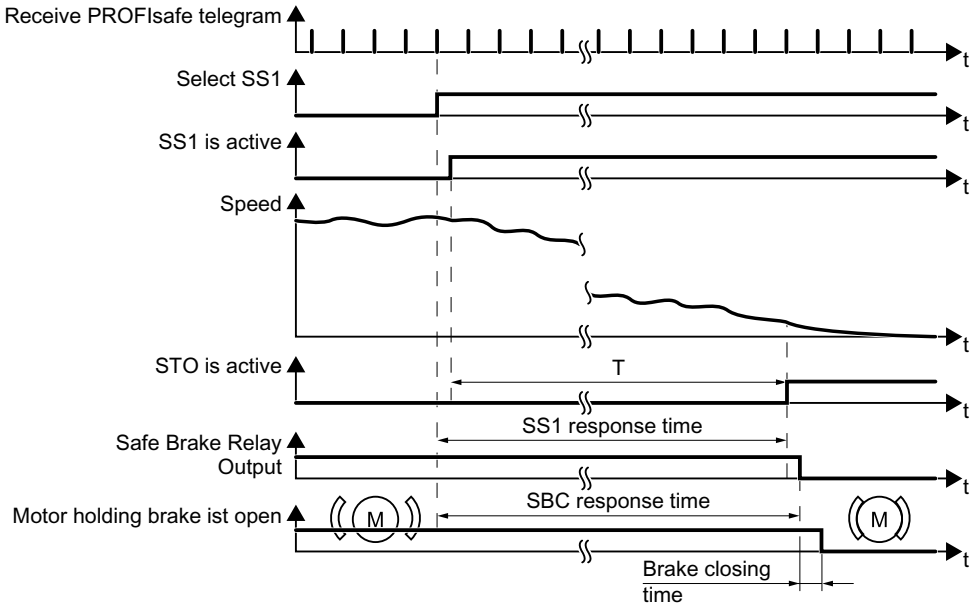


Figure 8-3 Response times when selected via PROFIsafe

Table 8-5 Response times when using the basic functions

Function	Selection via	Response	Response time	
			Worst case for a fault-free converter	Worst case for a converter fault
SS1	PROFIBUS	STO is active	14 ms + T [2]	14 ms + T [2]
	PROFINET		14 ms + T [2] + bus cycle time[1]	14 ms + T [2] + bus cycle time[1]
SBC	PROFIBUS	Signal change at the output of the Safe Brake Relay	16 ms + T [2]	30 ms + T [2]
	PROFINET		16 ms + T [2] + bus cycle time[1]	30 ms + T [2] + bus cycle time[1]

[1] Bus cycle time: Time for cyclic data exchange via PROFINET

[2] T = p9652

Table 8-6 Response times when using the extended functions

Function	Selection via	Response	Response time	
			Worst case for a fault-free converter	Worst case for a converter fault
SS1	PROFIBUS	STO is active	54 ms + T [2]	56 ms + T [2]
	PROFINET		54 ms + T [2] + bus cycle time [1]	56 ms + T [2] + bus cycle time [1]
SBC	PROFIBUS	Signal change at the output of the Safe Brake Relay	56 ms + T [2]	62 ms + T [2]
	PROFINET		56 ms + T [2] + bus cycle time [1]	62 ms + T [2] + bus cycle time [1]

[1] Bus cycle time: Time for cyclic data exchange via PROFINET

[2] T depends on how safety function SS1 is set:

- SS1 with braking ramp monitoring: T = p9582 + time to brake down to standstill detection
- SS1 with acceleration monitoring: T = the lower of the two times:
  - p9556
  - Time to brake down to standstill detection

Response times when selected via a failsafe digital input of the Control Unit

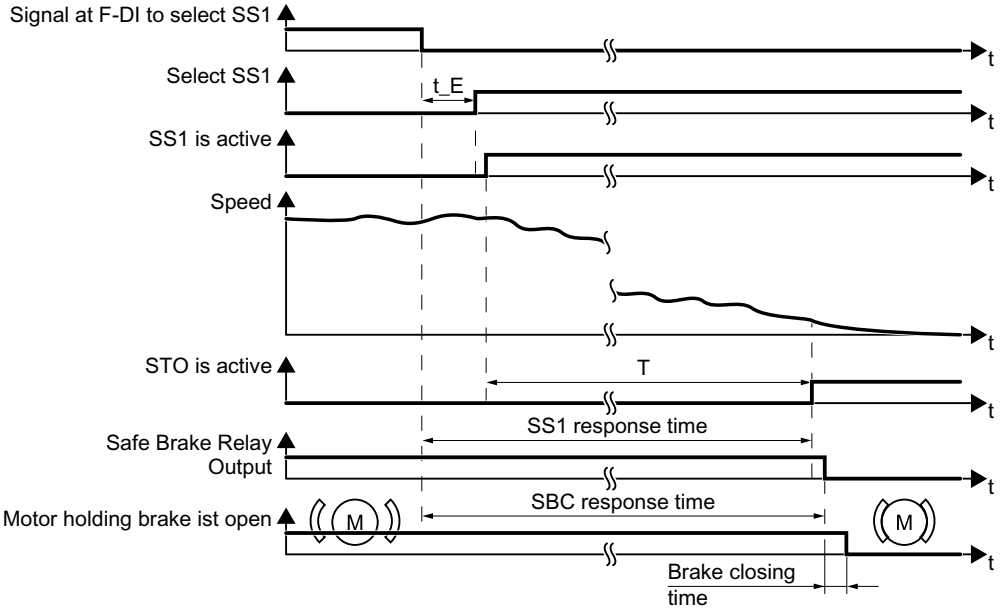


Figure 8-4 Response times when selected via a failsafe digital input F-DI

Table 8-7 Response times when using the basic functions

Function	Selection via	Response	Response time	
			Worst case for a fault-free converter	Worst case for a converter fault
SS1	F-DI	STO is active	4 ms + T [2] + t_E [1]	6 ms + T [2] + t_E [1]
SBC		Signal change at the output of the Safe Brake Relay	8 ms + T [2] + t_E [1]	22 ms + T [2] + t_E [1]

1) T = p9652

2) When p9651 > 0: t_E = p9651 + 3 ms; p9651: Debounce time
When p9651 = 0: t_E = 4 ms

Table 8-8 Response times when using the extended functions

Function	Selection via	Response	Response time	
			Worst case for a fault-free converter	Worst case for a converter fault
SS1	F-DI	STO is active	50 ms + T [2] + t_E [1]	52 ms + T [2] + t_E [1]
SBC		Signal change at the output of the Safe Brake Relay	52 ms + T [2] + t_E [1]	60 ms + T [2] + t_E [1]

1) When p10017 > 0: t_E = p10017 + 3 ms; p10017: Debounce time
When p10017 = 0: t_E = 4 ms

2) T depends on how safety function SS1 is set:

- SS1 with braking ramp monitoring: T = p9582 + time to brake down to standstill detection
- SS1 with acceleration monitoring: T = the lower of the two times:
  - p9556
  - Time to brake down to standstill detection

8.6 Response times when a monitoring function responds

Response times when limit values are violated

Table 8-9 Response times

Function	Response	Response times	
		Worst case for a fault-free drive system	Worst case when a fault exists
SS1	STOP A	67 ms [1]	101 ms [1]
SLS	STOP A or STOP B	67 ms [1]	113 ms [1]
SDI	STOP A or STOP B	61 ms [1]	107 ms [1]

Function	Response	Response times	
		Worst case for a fault-free drive system	Worst case when a fault exists
SSM	Signal change in PROFIsafe bit S_STW1.7	101 ms [1]	135 ms [1]
	Forced checking procedure of the failsafe output F_DO:	77 ms [1]	113 ms [1]

[1] 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 converter receives the PROFIsafe monitoring time from the higher-level-level, failsafe control (F-CPU).

If the PROFIsafe telegram is not received before the end of the PROFIsafe monitoring time, the converter activates the STO function.

Depending when the interruption takes place, the converter can signal the following faults:

- Basic functions have been enabled: Fault F01611
- Extended functions have been enabled: Message C01711

Appendix

A

A.1 About this chapter

What can you find in this Chapter?

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

- As machine manufacturer or company operating a machine, what standards and regulations must I observe?
- Where can I find further information on my converter?

A.2 Standards and specifications

A.2.1 General

A.2.1.1 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.2.1.2 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.2.2 Machine safety 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.2.2.1 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.

IEC 61800-5-2 Adjustable-speed electrical power drive systems Part 5-2 is relevant for the Machinery Directive: Safety requirements - Functional safety

Within the context of IEC 61508, IEC 61800-5-2 considers adjustable speed electric power drive systems (PDS), which are suitable for use in safety-related applications (PDS(SR)).

IEC 61800-5-2 places demands on PDS(SR) as subsystems of a safety-related system. This therefore permits the implementation of the electrical/electronic/programmable electronic elements of a PDS(SR) taking into account the safety-relevant performance of the safety function(s) of a PDS.

Manufacturers and suppliers of PDS(SR) can prove to users (e.g. integrators of control systems, developers of machines and plants etc.) the safety-relevant performance of their equipment by implementing the specifications stipulated in standard IEC 61800-5-2.

A.2.2.2 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:

Standards (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.2.2.3 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. The EN ISO 13849-1 and IEC61508 standards define principles for implementing safety-related machine controllers which, when properly applied, ensure that all the safety requirements of the EC Machinery Directive are fulfilled. These standards ensure that the relevant safety requirements of the Machinery Directive are fulfilled.

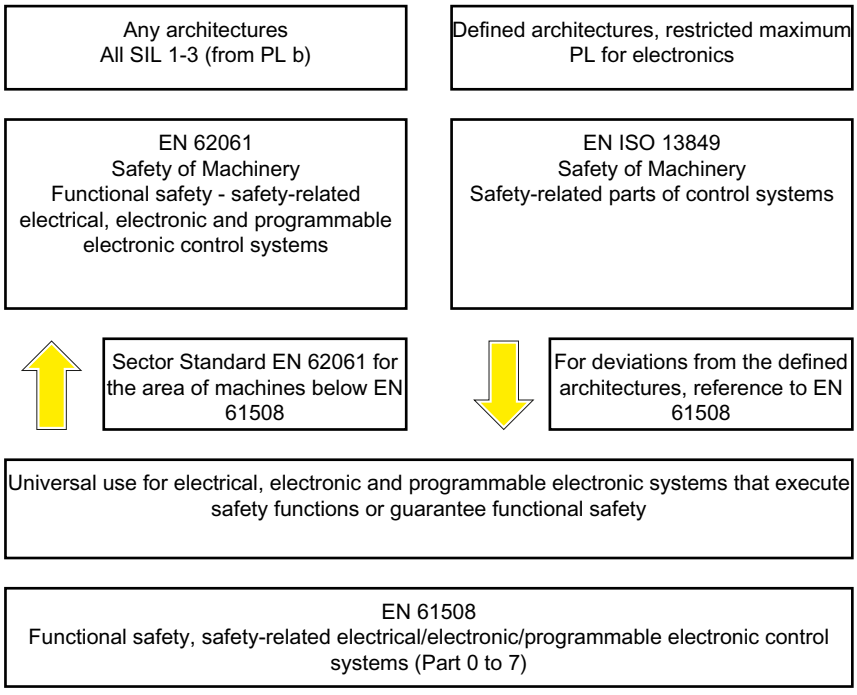


Figure A-1 Standards for implementing safety-related controllers

The application areas of EN ISO 13849-1, EN 62061, and EN 61508 are very similar. To help users make an appropriate decision, the IEC and ISO associations have specified the application areas of both standards in a joint table in the introduction to the standards. EN ISO 13849-1 or EN 62061 should be applied depending on the technology (mechanics, hydraulics, pneumatics, electrics, electronics, programmable electronics), risk classification and architecture.

Further, Standard IEC 61800-5-2 is applicable for variable-speed electric drives with integrated safety functions. IEC 61800-5-2 defines requirements and gives recommendations for designing and developing, integrating and validating safety-related applications regarding their functional safety. IEC 61800-5-2 is applicable for adjustable speed electric power drive systems, which are handled in other parts of IEC 61800 standards.

	Systems for executing safety-related control functions	EN ISO 13849-1	EN 62061
A	Non-electrical (e.g. hydraulic, pneumatic)	X	Not covered
B	Electromechanical (e.g. relay and/or basic electronics)	Restricted to the designated architectures (see comment 1) and max. up to PL = e	All architectures and max. up to SIL 3

C	Complex electronics (e.g. programmable electronics)	Restricted to the designated architectures (see comment 1) and max. up to PL = d	All architectures and max. up to SIL 3
D	A standards combined with B standards	Restricted to the designated architectures (see comment 1) and max. up to PL = e	X See comment 3
E	C standards combined with B standards	Restricted to the designated architectures (see comment 1) and max. up to PL = d	All architectures and max. up to SIL 3
F	C standards combined with A standards or C standards combined with A standards and B standards	X See comment 2	X See comment 3
"X" indicates that the point is covered by this standard. Comment 1: Designated architectures are described in Annex B of EN ISO 13849-1 and provide a simplified basis for the quantification. Comment 2: For complex electronics: Using designated architectures in compliance with EN ISO 13849-1 up to PL = d or every architecture in compliance with EN 62061. Comment 3: For non-electrical systems: Use components that comply with EN ISO 13849-1 as sub-systems.			

A.2.2.4 DIN EN ISO 13849-1

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 considers complete safety functions and all the devices required to execute these. With DIN EN ISO 13849-1, safety functions are considered from both a qualitative as well as a quantitative perspective. Performance levels (PL), which are based on specific 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.

Note

DIN EN ISO 13849-1 and machinery directive

Since May 2007, DIN EN ISO 13849-1 has been harmonized as part of the Machinery Directive.

A.2.2.5 EN 62061

EN 62061 (this is identical to IEC 62061) is a sector-specific standard below IEC/EN 61508. It describes the implementation of safety-related electrical control systems of machines and takes into account the complete lifecycle - from the conceptual phase to de-commissioning. 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_D:
  Probability of dangerous failures per hour
- T1:
  Lifetime

Simple sub-systems (e.g. sensors and actuators) in electromechanical components can, in turn, comprise sub-system elements (devices) interconnected in different ways with the characteristic quantities required for determining the relevant PFH_D value of the sub-system.

Safety-related characteristic quantities for subsystem elements (devices):

- λ:
  Failure rate
- B10 value: For elements that are subject to wear
- T1:
  Lifetime

For electromechanical devices, a manufacturer specifies a failure rate λ with reference to the number of operating cycles. The failure rate per unit time and the lifetime must be determined using the switching frequency for the particular application.

Parameters for the sub-system, which comprises sub-system elements, that must be defined during the design phase:

- T2:
  Diagnostic test interval
- β:
  Susceptibility to common cause failure
- DC:
  Diagnostic coverage

The PFH_D value of the safety-related controller is determined by adding the individual PFH_D values for subsystems.

The user has the following options when setting up a safety-related controller:

- Use devices and sub-systems that already comply with EN ISO 13849-1, IEC/EN 61508, or IEC/EN 62061. The standard provides information specifying how qualified devices can be integrated when safety functions are implemented.
- Develop own subsystems:
  - Programmable, electronic systems and complex systems: Application of 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.

Note

Function examples

Details of simple sub-systems that have been implemented and integrated are now available as "functional examples".

Note

EN 62061 and machinery directive

IEC 62061 has been ratified as EN 62061 in Europe and harmonized as part of the Machinery Directive.

A.2.2.6 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 (**e**lectrical, **e**lectronic, and **p**rogrammable **e**lectronic **s**ystem) are used in order to execute safety functions and/or to ensure the appropriate level of functional safety. Other hazards (e.g. electric shock) are 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.2.2.7 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 "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.

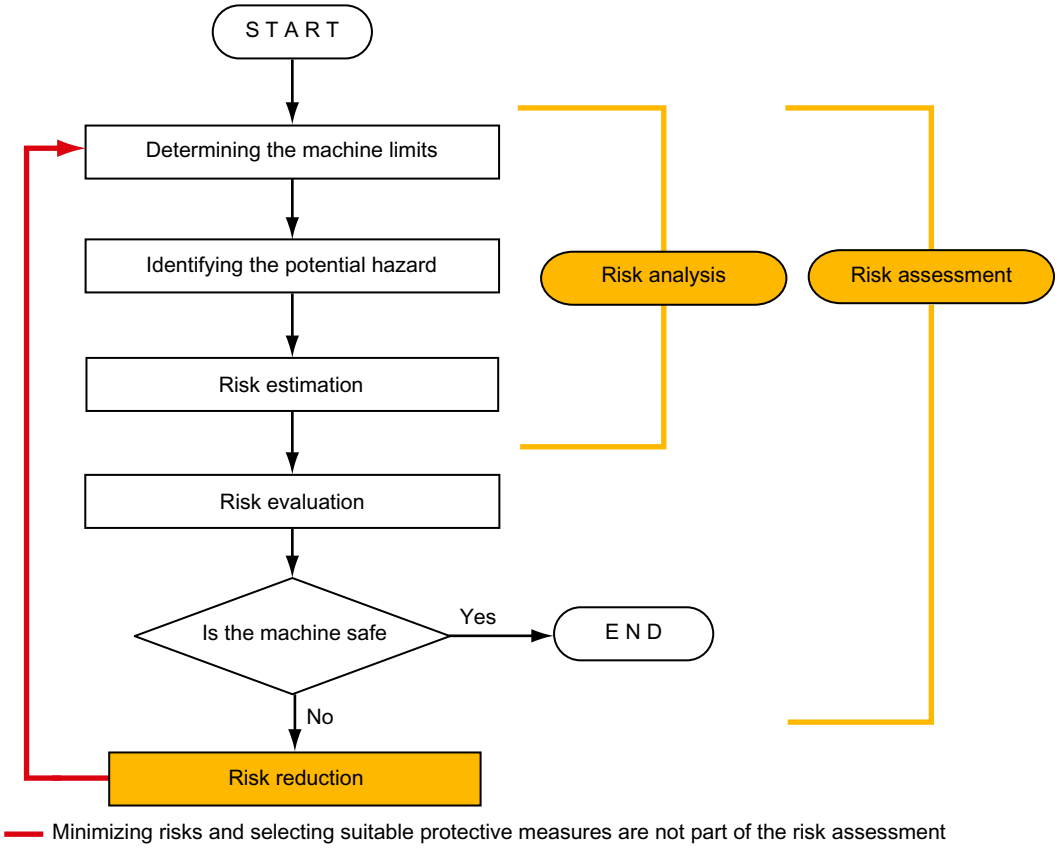


Figure A-2 Iterative process for achieving safety

Risks must be reduced by designing and implementing the machine accordingly (e.g. by means of controllers or protective measures suitable for the safety-related functions).

If the protective measures involve the use of interlocking or control functions, these must be designed according to EN ISO 13849-1. For electrical and electronic 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.2.2.8 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.2.2.9 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.2.2.10 EC declaration of conformity

The EC Declaration of Conformity for the product can be obtained from your local Siemens office or in the Internet at:

EC declaration of conformity (https://support.industry.siemens.com/cs/ww/en/view/67385845)

A.2.3 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.

You can find further information in the following sections:

- Minimum requirements of the OSHA (Page 314)
- NRTL listing (Page 314)

- NFPA 79 (Page 314)
- ANSI B11 (Page 315)

A.2.3.1 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.)

OSHA (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.2.3.2 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.2.3.3 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 in accordance with 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:

NRGF (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.2.3.4 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 results of a risk analysis can be used to select a suitable safety system based on the safety class of the application in question.

A.2.4 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:

Table A-1 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.2.5 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.2.6 Other safety-related issues

A.2.6.1 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.

Note

These publications are in German. In some instances, they are also available in English and French.

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 Internet address (http://www.bghm.de/) (website is in German, although some of the sheets are available in English):

1. First select the area "Arbeitsschützer", followed by the menu item "Praxishilfen" and finally "DGUV-Informationen".

A.2.6.2 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.3 Manuals and technical support

A.3.1 Overview of the manuals

You can find manuals here with additional information that can be downloaded

- **Operating instructions**
  Installing, commissioning and maintaining the converter. Advanced commissioning

  - CU250S-2 operating instructions (https://support.industry.siemens.com/cs/ww/en/view/109782994)
  - CU240B/E-2 operating instructions (https://support.industry.siemens.com/cs/ww/en/view/109782865)
  - SINAMICS G120C operating instructions. (https://support.industry.siemens.com/cs/ww/en/view/109818116)
  - Operating instructions SINAMICS G120D with CU240D-2 (https://support.industry.siemens.com/cs/ww/en/view/109477366)
  - Operating instructions SINAMICS G120D with CU250D-2 (https://support.industry.siemens.com/cs/ww/en/view/109477365)
  - SINAMICS G115D operating instructions (https://support.industry.siemens.com/cs/ww/en/view/109974598)
- **Function Manuals**

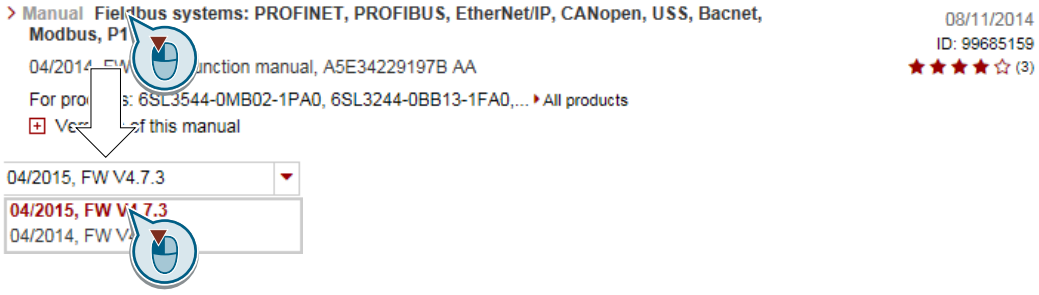
  - "Safety Integrated" function manual (https://support.industry.siemens.com/cs/ww/en/view/109818119)
    Configuring PROFIsafe.
    Installing, commissioning and operating failsafe functions of the converter (this manual).
  - "Fieldbus" function manual (https://support.industry.siemens.com/cs/ww/en/view/109818118)
    Configuring fieldbuses
  - "Basic positioner" function manual (https://support.industry.siemens.com/cs/ww/en/view/109477922)
    Commissioning the basic positioner
- **List Manuals**

  - CU240B/E-2 List Manual (https://support.industry.siemens.com/cs/ww/en/view/109782301)
  - CU250S-2 List Manual (https://support.industry.siemens.com/cs/ww/en/view/109782287)
  - SINAMICS G120C List Manual (https://support.industry.siemens.com/cs/ww/en/view/109817922)
  - List manual SINAMICS G120D (https://support.industry.siemens.com/cs/ww/en/view/109477255)

– SINAMICS G115D List Manual (https://support.industry.siemens.com/cs/ww/en/view/109817912)

Finding the most recent edition of a manual

If there a multiple editions of a manual, select the latest edition:

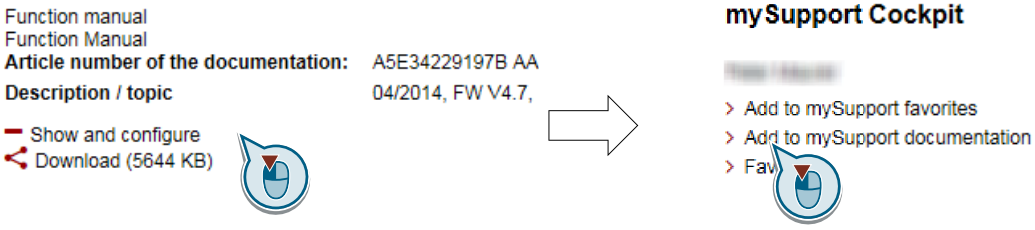


Configuring a manual

Further information about the configurability of manuals is available in the Internet:

MyDocumentationManager (https://www.industry.siemens.com/topics/global/en/planning-efficiency/documentation/Pages/default.aspx).

Select "Display and configure" and add the manual to your "mySupport-documentation":



Not all manuals can be configured.

The configured manual can be exported in RTF, PDF or XML format.

A.3.2 Configuring support

Catalog

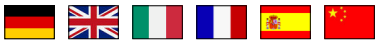
Ordering data and technical information for the converters SINAMICS G.

Catalogs for download or online catalog (Industry Mall):

Everything about SINAMICS G120 (www.siemens.en/sinamics-g120)

TIA Selection Tool

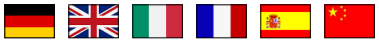
The configuration tool for SINAMICS drives, as well as SINUMERIK, SIMOTION controllers and SIMATIC technology



TIA Selection Tool (https://www.siemens.com/global/en/products/automation/topic-areas/tia/tia-selection-tool.html)

EMC Guidelines configuration manual

EMC-compliant control cabinet design, potential equalization and cable routing



EMC installation guideline (http://support.automation.siemens.com/WW/view/en/60612658)

Safety Evaluation Tool

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:

PFH-Werte (https://support.industry.siemens.com/cs/ww/en/view/76254308)

A.3.3 Product Support

Overview

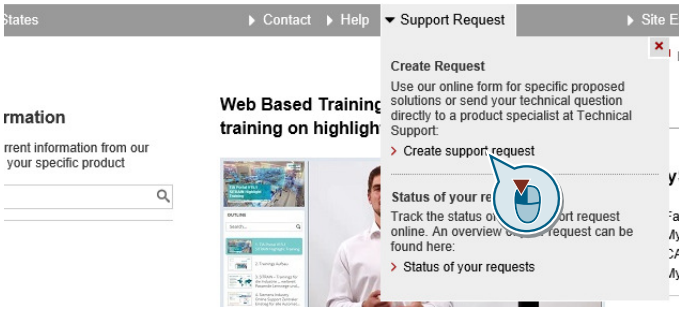
You can find additional information about the product on the Internet:

Product support (https://support.industry.siemens.com/cs/ww/en/)

This URL provides the following:

- Up-to-date product information (product announcements)
- FAQs
- Downloads
- The Newsletter contains the latest information on the products you use.
- The Knowledge Manager (Intelligent Search) helps you find the documents you need.
- Users and specialists from around the world share their experience and knowledge in the Forum.
- You can find your local representative for Automation & Drives via our contact database under "Contact & Partner".
- Information about local service, repair, spare parts and much more can be found under "Services".

If you have any technical questions, use the online form in the "Support Request" menu:



Get more information

SINAMICS:
www.siemens.com/sinamics

Industry Mall:
www.siemens.com/industrymall

Industry Online Support:
www.siemens.com/online-support