



# SINAMICS

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

Safety functions integrated in the drive - Safety Integrated

**Function Manual** 



# SIEMENS

# SINAMICS

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

**Function Manual** 

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Edition 01/2016, firmware V4.7 SP6

### 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.

### 

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

### 

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

### 

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

### NOTICE

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

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

### **Qualified Personnel**

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

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#### 

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

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

# Change history

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

#### New functions in firmware V4.7 SP6

PM240-2 FSF Power Modules with integrated basic function "STO via Power Module terminals" (SIL 3 and PL e).

Overview (Page 59)

#### Corrections

"STO via Power Module terminals" function: After a discrepancy signal, when acknowledging the signal, the function must be selected and deselected.

Response to a discrepancy when STO is active (Page 224)

The safety output of the CU250S-2 Control Unit does not have test mode 4, but instead test mode 1.

Connecting the safety output for SINAMICS G120 (Page 92)

Testing a safety output (Page 218)

#### Additional supplements and revised descriptions

· Connecting SIMATIC I/O modules to the safety input of the inverter

SIMATIC I/O modules (Page 76)

SIMATIC I/O modules (Page 88)

Safety functions password

Safety functions password (Page 101)

Resetting the password for the safety functions (Page 104)

Description to download supplementary manuals has been revised.

 $\square$  Overview of the manuals (Page 437)

 Signal cables do not have to be separately routed if signal cables are routed in steel pipes between distributed electrical cabinets.

Wiring examples according to SIL 2 and PL d (Page 64)

Wiring examples according to SIL 3 and PL e (Page 80)

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# Fundamental safety instructions

### 1.1 General safety instructions

### 

#### Risk of death if the safety instructions and remaining risks are not carefully observed

If the safety instructions and residual risks are not observed in the associated hardware documentation, 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.

### 

# Danger to life or malfunctions of the machine as a result of incorrect or changed parameterization

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

- Protect the parameterization (parameter assignments) against unauthorized access.
- Respond to possible malfunctions by applying suitable measures (e.g. EMERGENCY STOP or EMERGENCY OFF).

1.2 Industrial security

# 1.2 Industrial security

### Note

### Industrial security

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

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

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

### 

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

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

- Keep the software up to date. You will find relevant information and newsletters at this address (http://support.automation.siemens.com).
- Incorporate the automation and drive components into a holistic, state-of-the-art industrial security concept for the installation or machine.

You will find further information at this address (http://www.siemens.com/industrialsecurity).

• Make sure that you include all installed products into the holistic industrial security concept.

# Introduction

## 2.1 About this manual

### Who requires this manual and why?

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

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

### What are drive-integrated safety functions?

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

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

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

2.1 About this manual

### What inverters are described?

	Fixed speed applications		Variable speed applicatio						ар	tion con plicatio	ns		
	ET 200S	SIMATIC ET 200S ET 200pro Motor starter		G110M	SI G120C	NAMICS G120D	G120	G110D	SINAMICS G130	G150	S110	SINAMICS S120	S S150
Integrated safety	functions	s accordi	ng to IEC	61800-5	5-2								
STO Safe Torque Off	Y	es			Yes			Yes	Ye	es		Yes	
SS1 Safe Stop 1	-	-	÷	-	-1		Yes	-	Ye	es		Yes	
SBC Safe Brake Control	-	-	ж	÷		-	Yes 2)	-	Ye	s <sup>3)</sup>	Yes <sup>4)</sup>	Ye	S <sup>3)</sup>
SBT Safe Brake Test	-	-	-	-	-	Ŧ		-	Ye	es		Y	es
SLS Safely-Limited Speed	-	-	-	ī	-		Yes	-	Ye	s		Yes	
SSM Safe Speed Monitor		-	36	н	-		Yes	-	Ye	s		Yes	
SDI Safe Direction	-	-	÷	×	-		Yes	-	Ye	IS	Yes		
SOS Safe Operating Stop	-	-	-	-	- 1	-	-	-	Ye	s	Yes		
SS2 Safe Stop 2	-	-	-	-	- "	-	-	-	Ye	es		Yes	
SLP Safely-Limited Position	-	-	-	-	-	-	-	-	Ye	s	-	Yes	Yes
Fail-safe interface	s												
PROFIBUS / PROFIsafe	Yes	Yes 5)	Yes 5)			Yes		-	Ye	es	Yes		
PROFINET / PROFIsafe	Yes	Yes 5)	Yes 5)			Yes		-	Ye	es	Yes		
Safety inputs	Ye	S <sup>5)</sup>	Yes 5)			Yes				, external components uired in certain cases			
Safety outputs	-	-	-	-	-1	Yes	Yes <sup>8)</sup>	-	Yes, with	n TM54F	Yes	Yes, wit	n TM54F
Certifications													
EN ISO 13849-1: 2006		/PLe	Cat. 3 / PLd Cat. 3 / PL d/e 7		Cat. 3 / PL d/e 7)	-	Cat. 3		C	at. 3 / PL o	j 6)		
EN 61508: 2010		L 3		SIL	2		SIL 2/3 7)	-	SIL	2 6)		SIL 2 6)	
NFPA 79		es		H	-	×	<del></del>	-			Y		-
NRTL listed	Y	es	-	-	-	-	-	-			-	Yes 1)	
				Conte	ents of th	ne manu	ual						

Contents of the manual

1) Only for SINAMICS S120 Booksize

<sup>2)</sup> Only for CU250S-2 Control Units with Safe Brake Relay

<sup>3)</sup> For chassis and cabinet modules with Safe Brake Adapter

4) With Safe Brake Relay

<sup>5)</sup> With external components

6) SBT: Cat 2 / PL d, SIL 1

<sup>7)</sup> STO via terminals of the PM240-2 Power Module: Cat 3 / PL e, SIL 3 STO via the Control Unit terminals and all other safety functions: Cat. 3 / PL d, SIL 2

8) Only with CU250S-2 Control Units

Image 2-1 Products with drive-integrated safety functions

### What applications are described?

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

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

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

### What other information do you need?

This manual alone is not sufficient for installing or commissioning the standard inverter functions. An overview of the documentation available and the associated applications.



Cverview of the manuals (Page 437)

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

Reference to further information in the manual



An operating instruction starts here.



This concludes the operating instruction.



Download from the Internet



DVD that can be ordered

2.2 Guide through the manual

# 2.2 Guide through the manual

Chapter	In this chapter, you will find answers to the following questions:
Description	What are basic functions and what are extended functions?
(Page 21)	Which safety functions does the inverter have?
	Which interfaces does the inverter have to select the safety functions?
	• What preconditions, restrictions and recommendations apply when using the safety func- tions?
	How do the safety functions basically work?
Installing (Page 45)	Which sequence is recommended when installing the inverter?
	• What options are available to connect the inverter to the higher-level control system via PROFIsafe?
	How are the PROFIsafe control words and status words assigned?
	How do you wire the safety-related inputs and outputs of the inverter?
	• What differences are there when wiring inside and outside the control cabinet?
	How do you connect a monitored motor holding brake?
	Which sequence is recommended when commissioning the inverter?
(Page 97)	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 communications via PROFIsafe in the inverter?
	How do you transfer safety function parameters to other inverters?
	Why is it necessary to "Accept safety functions"?
	What does accepting safety functions involve?
(Page 211)	• How do you maintain the guaranteed probability of failure of the safety functions over the usage period?
(******	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 discrepant signal at a safety-related 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 mainte-	How do you maintain the operational safety of the plant or machine?
nance (Page 329)	How do you replace defective components in the inverter or the inverter itself?
	How do you ensure that after a replacement the safety functions still function?

Chapter	In this chapter, you will find answers to the following questions:
System properties	How long may you operate the inverter?
(Page 363)	<ul> <li>In which time intervals must you initiate the inverter self test?</li> </ul>
	What is the probability of failure of the inverter safety functions?
	<ul> <li>In which time does the drive respond when selecting a safety function?</li> </ul>
	<ul> <li>When a safety function is active, in which time does the drive respond to a motor mal- function?</li> </ul>
	According to which standards are the inverter safety function certified?
	Where can you find certifications for the inverter?
	What is the technical data of the Safe Brake Relay?
Appendix (Page 377)	What does a typical acceptance for a safety function look like?
	<ul> <li>As machine builder or company operating a machine, which standards and regulations must you comply with?</li> </ul>
	Where can you find additional information about the inverter?

### Introduction

2.2 Guide through the manual

# Description

### 3.1 About this chapter

### What can you find in this Chapter?

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

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

3.2 Basic functions and extended functions

# 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:	Extended functions include several basic func- tions and additional functions to safely monitor				
<ul> <li>The energy feed to the motor is safely switched off</li> </ul>	<ul><li>• STO and SBC basic functions</li></ul>				
The energy feed to the motor holding brake is safely switched off	<ul><li>Safe Stop 1 (SS1) with speed monitoring</li><li>Safely Limited Speed (SLS)</li></ul>				
The following basic functions are available:	Safe Direction (SDI)				
Safe Torque Off (STO)	Safe Speed Monitor (SSM)				
Safe Brake Control (SBC)	Whether an inverter has extended functions gen-				
• Safe Stop 1 (SS1) without speed monitoring Each of the inverters described in this manual has one or several of the basic functions.	erally depends on the Control Unit hardware. The corresponding inverters have an "F" at the end of the product name, e.g. Control Unit CU240E-2 F. For SINAMICS G120 with a CU250S-2 Control Unit, you require a license for the extended functions.				

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

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

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

3.3 Interfaces to select the safety functions

# 3.3 Interfaces to select the safety functions

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

Inverter		F-DI	F-DO	PROFIsafe	Safety output for a brake
50 2	SINAMICS G110M with Control Unit				
	CU240M USS	1	1)		
	CU240M DP CU240M PN	1		Telegram 30 <sup>3)</sup>	
	SINAMICS G120C USS SINAMICS G120C CAN	1			
	SINAMICS G120C DP SINAMICS G120C PN	1		Telegram 30 <sup>3)</sup>	
	SINAMICS G120 with Cor	ntrol Unit		·	
	CU240E-2	1 + 1 <sup>5)</sup>			
	CU240E-2 DP CU240E-2 PN	1 + 1 <sup>5)</sup>		Telegram 30 <sup>3)</sup>	
	CU240E-2 F	3 + 1 <sup>5)</sup>			
	CU240E-2 DP-F CU240E-2 PN-F	3 + 1 <sup>5)</sup>		Telegram 30 <sup>3)</sup> , Telegram 900 <sup>4)</sup>	
	CU250S-2 CU250S-2 CAN	3 + 1 <sup>5)</sup>	1		Available with Safe Brake Relay
	CU250S-2 DP CU250S-2 PN	3 + 1 <sup>5)</sup>	1	Telegram 30 <sup>3)</sup> , Telegram 900 <sup>4)</sup>	Available with Safe Brake Relay
	SINAMICS G120D with Control Unit				
	CU240D-2 DP CU240D-2 PN	1		Telegram 30 <sup>3)</sup>	
	CU240D-2 DP-F CU240D-2 PN-F CU240D-2 PN-F PP CU240D-2 PN-F FO CU250D-2 DP-F CU250D-2 PN-F CU250D-2 PN-F PP CU250D-2 PN-F FO	3	1	Telegram 30 <sup>3)</sup> , Telegram 900 <sup>4)</sup>	
	SIMATIC ET 200pro FC-2	Via ET 200pro system <sup>2)</sup>		Via ET 200pro sys- tem <sup>2)</sup>	

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

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

- <sup>3)</sup> Telegram 30 for control and for the status feedback signal from the safety functions
- <sup>4)</sup> Telegram 900: Function as for telegram 30 and additional feedback signal of the F-DI status
- <sup>5)</sup> An additional safety-relevant input for the STO on the PM240-2 FSD and 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.

Certification (Page 365)

### Motors and control modes

You can use the basic functions without any restrictions:

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

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

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

### Encoderless safety functions

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

"Encoderless" means the following:

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

### Taking into account the slip of induction motors

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

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

3.5 Restrictions when using safety functions

# 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.



### 

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

The encoderless actual value sensing does not identify all faults and errors in the closedloop 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

### 

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

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

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

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

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

### **Critical applications**

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

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

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

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

3.5 Restrictions when using safety functions

### Inadmissible SINAMICS G120 Power Modules

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

Power Module	Restriction	
PM230 in degree of protec-	Article numbers 6SL3223-0DE A . :	
tion IP55	The integrated safety functions are not possible.	
	Article numbers 6SL3223-0DE G . :	
	The basic STO function is possible.	
PM230 in degree of protec-	Article numbers 6SL3211NE L . :	
tion IP20 and Push Through	The integrated safety functions are not possible.	
	Article numbers 6SL3211NE <b>G</b> . :	
	The basic STO function is not possible.	
PM240 FSGX	Article numbers 6SL3224-0XE4 UA0:	
	Only the basic STO, SBC and SS1 functions are permissible.	

# 3.6 Recommendations for stable operation

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

- Motor and inverter are adequately dimensioned for this application:
  - The inverter is operated below its current limit.
  - The rated currents of the motor and inverter must not differ by more than a factor of 5: Inverter rated current/motor rated current < 5 (r0207[0] / p0305 < 5).</li>
- 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)

### What is the effect of the STO safety function?

The inverter with active STO function prevents energy supply 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.



Table 3-2 The STO principle of operation as overview

	Safe Torque Off (STO)	Standard inverter functions linked with STO
1.	The inverter recognizes the selection of STO via a safety-relevant input or via the PROFIsafe safe communication.	
2.	The inverter prevents the energy supply to the motor.	If you use a motor holding brake, the inverter closes the motor holding brake.
		If you use a line contactor, the inverter opens the line contactor.
3.	The inverter signals that "STO is active" via a safety-relevant output or via the PROFIsafe safe communication.	

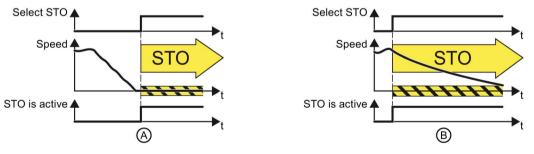


Image 3-1 Functionality of STO when the motor is at standstill (A) and rotating (B)

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

 $\Rightarrow$  The STO inverter function conforms to IEC/EN 61800-5-2.

### The distinction between Emergency Off and Emergency Stop

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

Risk:	Risk of electric shock:	Risk of unexpected motion:
Measure to minimize risk:	Safe switch off Switching off the electric power sup- ply for the installation, either com- pletely or partially.	Safely stop and safely prevent re- starting Stopping or preventing the dangerous movement
Command:	Emergency Off	Emergency Stop
Classic solution:	Switch off the power supply:	Switch off the drive power supply:
Solution with the STO safety function inte- grated in the drive:	STO is not suitable for safely switch- ing off an electric voltage.	Select STO:

The STO function is suitable for achieving an Emergency Stop but not an Emergency Off.

### Application examples for the STO function

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

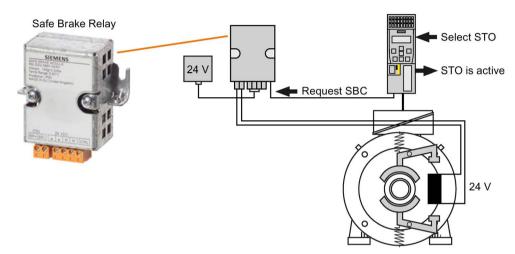
Examples	Possible solution	
When the Emergency Stop button is pressed, a stationary motor should not unintentionally start.	• Wire the Emergency Stop button to a safe- ty-related input of the inverter.	
	Select STO via the safety-related input.	
A central Emergency Stop button must prevent the unintentional acceleration of several motors that are at a standstill.	<ul> <li>Evaluate the Emergency Stop button in a central control.</li> <li>Select STO via PROFIsafe.</li> </ul>	

### 3.7.2 Safe Brake Control (SBC)

### What is the effect of the SBC safety function?

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

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



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

Table 3-3 An overview of the principle of operation of SE	Table 3- 3	e of operation of SBC
---	------------	-----------------------

	Safe Brake Control (SBC)	Standard brake function
1.	When the STO function is active, the inverter requests the SBC function via the connecting cable to the Safe Brake Relay.	The brake closes.
	The Safe Brake Relay safely switches off the supply voltage for the connected brake.	
2.	The inverter signals that "STO is active" via a safety output or via the PROFIsafe safe communication.	

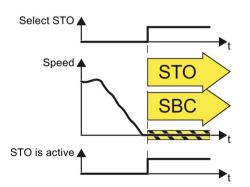


Image 3-2 The principle of operation of SBC

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."

 $\Rightarrow$  The SBC inverter function is in conformance with IEC/EN 61800-5-2.

### Application example for the SBC function

Example	Possible solution
After a hoisting gear stops, the inverter must close the brake in order to minimize the risk of the load falling.	<ul> <li>Connect the motor holding brake to the inverter via Safe Brake Relay.</li> <li>Select STO when the drive stops.</li> </ul>

### 3.7.3 Safe Stop 1 (SS1)

### What is the effect of the SS1 safety function?

The inverter 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.

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

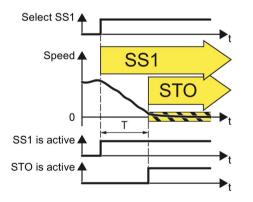


Image 3-3 Principle of operation of SS1 of the basic functions

### SS1 of the extended functions



Table 3-5	An overview of the r	principle of operation of SS1	, selected when the motor is rotating
		principle of operation of 00 i	, selected when the motor is rotating

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

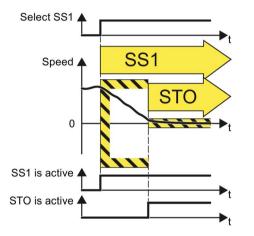


Image 3-4 Principle of operation of SS1 of the extended functions

#### 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."

 $\Rightarrow$  Inverter function SS1 of the extended functions is in conformance with the definition [1] of IEC/EN 61800-5-2.

 $\Rightarrow$  Inverter function SS1 of the basic functions is in conformance with the definition [2] of IEC/EN 61800-5-2.

#### Application example

Example	Possible solution
The drive must brake as quickly as possible after the Emergency Stop button has been pressed. It is not permissible that the stationary motor undesira- bly restarts.	<ul> <li>Select SS1 in the inverter using a safety- related input or via PROFIsafe.</li> </ul>

3.7 An overview of the principle of operation of the safety functions

#### 3.7.4 Safely Limited Speed (SLS)

#### How does SLS function?

The inverter with active SLS function monitors the motor speed. When the monitoring limit is exceeded, the inverter 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.



	A	and a start start start start start	- 1 01 0	and a stand with a set the subscription in the first set
Table 3-6	An overview of the	principle of operation	1 OT SLS,	selected when the motor is rotating

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

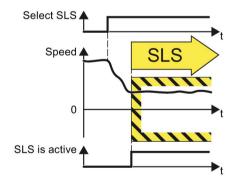


Image 3-5 Principle of operation of SLS

#### 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."

 $\Rightarrow$  The SLS inverter function is in conformance with IEC/EN 61800-5-2.

#### Application examples for the SLS function

Examples	Possible solution
Setup mode: The machine operator must enter the dangerous area of a machine and manually intro- duce material into a machine part.	<ul> <li>Select SSL in the inverter via a safety input or via PROFIsafe.</li> <li>The inverter limits and manitors the speed</li> </ul>
A turning machine must not exceed a specific max- imum torque in order to protect the drill chuck from damage.	<ul> <li>The inverter limits and monitors the speed of the machine part.</li> </ul>

#### Functional expansion: selecting SLS levels

Expansion of the SLS function to include several SLS levels:

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

It is only possible to select SLS levels via PROFIsafe.

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

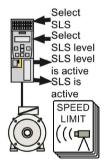


Table 3-7 Switching over from SLS level 2 to SLS level 1

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

#### Description

3.7 An overview of the principle of operation of the safety functions

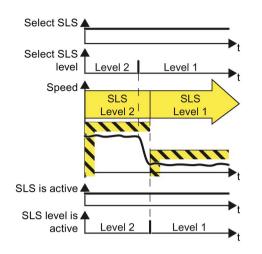


Image 3-6 Switching over from SLS level 2 to SLS level 1

#### Application example for selecting SLS levels

Examples	Possible solution
Depending on the diameter of the saw blade, a circular saw must not exceed a specific maximum speed.	• Select SLS and the corresponding SLS level in the inverter via PROFIsafe.

3.7 An overview of the principle of operation of the safety functions

#### 3.7.5 Safe Direction (SDI)

#### What is the effect of the SDI safety function?

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

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

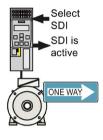


Table 3-8 An overview of the principle of operation of SDI, selected when the motor is rotating

	Safe Direction (SDI)	Standard inverter functions linked with SDI
1.	The inverter recognizes the selection of SDI via a safety input or via the PROFIsafe safe communication.	
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 inverter limits the speed setpoint to values in the selected direction of rotation.
		If the motor rotates in the inhibited direction, then the inverter brakes the motor along the OFF3 ramp.
3.	The inverter monitors the direction of the actual speed.	The inverter limits the speed
	The inverter signals that "SDI is active" via a safety output or via the PROFIsafe safe communication.	setpoint to values in the selected direction of rotation.
	If the motor rotates in the inhibited direction, the inverter responds with a "safe stop" and brakes the motor as quickly as possible.	

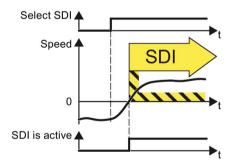


Image 3-7 Principle of operation of SDI

#### 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."

 $\Rightarrow$  The SDI inverter function is in conformance with IEC/EN 61800-5-2.

3.7 An overview of the principle of operation of the safety functions

#### Application examples

Example	Possible solution
When replacing the pressure cylinders of the plates, it is only permissible that the drive moves in the safe direction.	<ul> <li>Select SDI in the inverter via a safety input or via PROFIsafe.</li> <li>In the inverter, inhibit the direction of retained</li> </ul>
After a protective device to detect a jammed door responds, a rolling shutter gate may only move in the opening direction.	<ul> <li>In the inverter, inhibit the direction of rota- tion that is not permitted.</li> </ul>
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)

#### What is the effect of the SSM safety function?

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

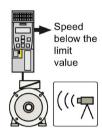


Table 3-9 An overview of the principle of operation of SSM

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

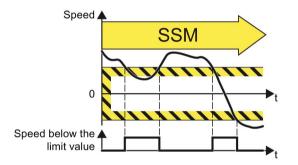


Image 3-8 The principle of operation of SSM

#### 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."

 $\Rightarrow$  The SSM inverter function is in conformance with IEC/EN 61800-5-2.

#### Application example

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

#### Description

3.7 An overview of the principle of operation of the safety functions

## Installing

## 4.1 About this chapter

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

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

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

4.2 Sequence when installing an inverter with safety functions

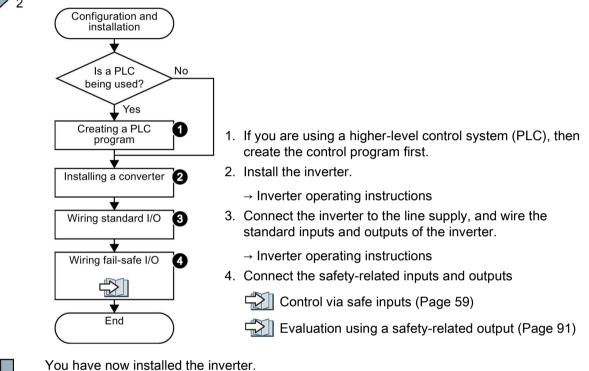
## 4.2 Sequence when installing an inverter with safety functions

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

#### Procedure



To install the inverter, proceed as follows:



## 4.3 Connection via PROFIsafe

#### 4.3.1 Overview of PROFIsafe connections

#### Communication via PROFIsafe

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

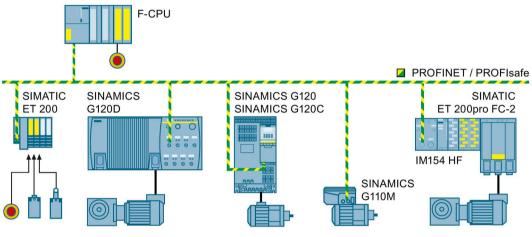


Image 4-1 PROFIsafe communication between an F-CPU and an inverter, e.g. via PROFINET

4.3 Connection via PROFIsafe

#### SIMATIC ET 200pro FC-2

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

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

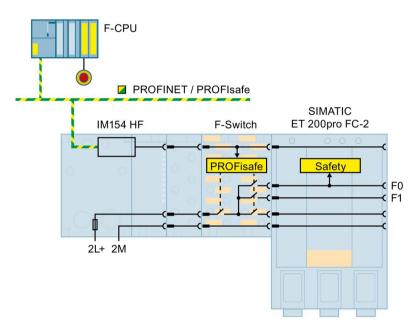


Image 4-2 F-Switch to connect PROFIsafe of the ET 200pro FC-2 converter, e.g. via PROFINET

Additional information on the ET 200pro system and the F-Switch module is available in the "SIMATIC distributed ET 200pro I/O system" Operating instructions.

Overview of the manuals (Page 437).

Additional possibilities of installing the F-Switch module are listed in the Internet:



FAQ (http://support.automation.siemens.com/WW/view/en/26694409).

#### PROFIsafe communication within the SIMATIC ET 200pro

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

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

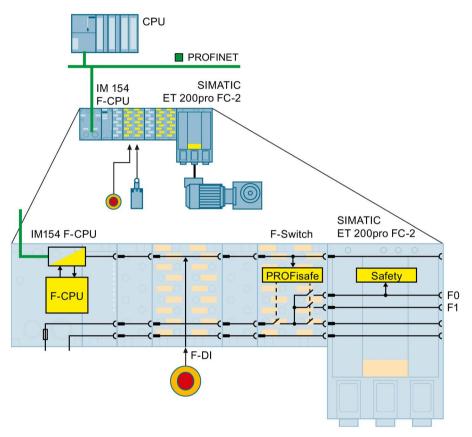


Image 4-3 Safe communications between IM154 F-CPU and inverters within an ET 200pro, e.g. connected to PROFINET

4.3 Connection via PROFIsafe

#### **Shared Device**

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

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

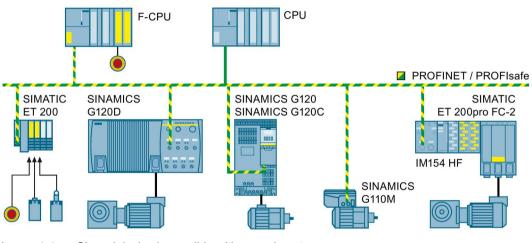


Image 4-4 Shared device is possible with every inverter

Further information is provided in the Internet:



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

#### PROFIsafe communication I-slave ↔ slave

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

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

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

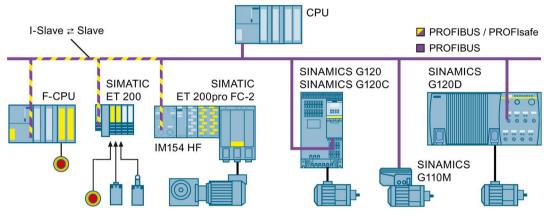


Image 4-5 The I-slave-slave communication is only possible with ET 200pro FC-2

4.3 Connection via PROFIsafe

### 4.3.2 PROFIsafe telegrams

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

Table 4-1 PROFIsafe telegrams

Overview using PROFINET / PROFIsafe as	Telegram	Process data (PZD)	
example		PZD1	PZD2
F-CPU	Telegram 30	S_STW1	
	PZD 1/1	S_ZSW1	
	Telegram 900	S_STW1	S_STW5
PROFINET / PROFIsafe	PZD 2/2	S_ZSW1	S_ZSW5
F-DI0 F-DI0 F-DI1 F-DI1 F-DI2	The higher-level control s the inverter via the control uses the status word S_2 the safety functions to th Telegram 900 of the PRC control and status word S word S_ZSW5 to transfe inputs to the control.	ol word S_STW ZSW1 to report f e controller. DFIsafe profile a 5. The inverter u	1. The inverter the status of also contains uses status

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

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

Byte	Bit	Function	Comme	Comment	
0	0	STO	0	Select STO	
			1	Deselect STO	
	1	SS1	0	Select SS1	
			1	Deselect SS1	
26 Not relevant					
	7 Internal Event		0	Do not acknowledge faults	
ack		<b>1</b> → 0	Acknowledge "Internal event" for a $1 \rightarrow 0$ signal change		
1	8 15	Not relevant			

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

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

Byte	Bit	Function	Comm	nent
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
	26	Not relevant		
	7	Internal Event	0	Fault-free operation
			1	The inverter signals an "internal event"
1	8 15	Not relevant		

4.3 Connection via PROFIsafe

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

Byte	Bit	Function	Comm	Comment						
0	0	STO	0	0 Select STO						
			1	1 Deselect STO						
	1	SS1	0	Select SS1						
			1	Deselect S						
	2, 3	Not relevant								
	4	SLS	0	Select SLS						
			1 Deselect SLS							
	5, 6	Not relevant								
	7	Internal event	0	Do not ack	nowledge f	aults				
		ack	$1 \rightarrow 0$ Acknowledge "Internal event" for a 1 $\rightarrow$				or a 1 $\rightarrow$ 0 signal change			
1	0	Not relevant								
	1	SLS level bit 0	Select	SLS level		Bit 2	Bit 1			
					Level 1	0	0			
	2	SLS level bit 1			Level 2 Level 3	0	1			
					Level 3 Level 4	1	1			
	3	Not relevant								
	4	SDI positive	0	Select SDI	with positiv	e directio	on of rotation			
			1	Deselect SDI with positive direction of rotation						
	5	SDI negative	0	Select SDI with negative direction of rotation						
			1	Deselect S	DI with neg	ative dire	ction of rotation			
	6, 7	Not relevant	-	•						

Byte	Bit	Function	Comm	Comment					
0	0	Power removed	0	STO is not a	ctive				
			1	1 STO is active					
	1	SS1 active	0	0 SS1 is not active					
			1 SS1 is active						
	2, 3	Not relevant							
	4	SLS active	0	SLS is not a	ctive				
			1	SLS is active	9				
	5, 6	Not relevant							
	7	Internal Event	0	Fault-free op	peration				
			1	The inverter	signals ar	n "interna	al event"		
1	0	Not relevant							
	1	SLS level bit 0	SLS le	evel is active		Bit 2	Bit 1		
					Level 1	0	0		
	2	SLS level bit 1			Level 2 Level 3	0	1		
					Level 3	1	0		
	3	Not relevant				1	· · · · · · · · · · · · · · · · · · ·		
	4	SDI positive	0	SDI positive	direction of	of rotatio	n is not active		
		active	1	SDI positive					
	5	SDI negative	0						
		active	1						
	6	Not relevant		-					
	7	Status SSM	0	Absolute val value	ue of the s	speed is	greater than the SSM limit		
			1	Absolute value of the speed is less than the SSM limit value					

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

4.3 Connection via PROFIsafe

#### 4.3.5 Control word 5 and status word 5

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

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

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

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

Overview of the safety-related inputs:

Overview (Page 59)

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

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

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

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

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

ddress / ID Ad	dress con	figuration   Par	ameter A:	ssignment   F	PROFIsate		
/О Туре:		Out- input		-			Direct Entry
-Output							
A	ddress:	Length:	Unit		Consistent over:		
Start:	4	6 🔆	Byte	~	Total length	-	
End: 1	9	7					
Process imag	e:	OB1 PI			·		
-Input	0						
A	ddress:	Length:	Unit		Consistent over:		
Start: 1	4	6 +	Byte	Ψ.	Total length	-	
End: 1	9						
Process imag				- Instein	1		

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

#### Control the inverter using the control program

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

I/O address	Meaning	Co	mment
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 $1 \rightarrow 0$
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

#### Installing

4.3 Connection via PROFIsafe

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

Table 4-9 Status word 1

#### 4.4.1 Overview

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



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

Wiring examples according to SIL 2 and PL d (Page 64).

#### Assignment of safety-related inputs

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

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

# Table 4- 12SINAMICS G120 with Control Units<br/>CU240E-2 F, CU240E-2 DP-F or CU240E-2 PN-F,<br/>CU250S-2, CU250S-2 CAN, CU250S-2 DP or CU250S-2 PN

	Terminal strip on the Control Unit			
	Terminals	Digital input	Safety-related inputs	
			Basic functions	Extended func- tions
	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 4-13 SINAMICS G120 with PM240-2 Power Module

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

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

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

## Table 4- 15SINAMICS G120D with Control Units<br/>CU240D-2 DP-F, CU240D-2 PN-F, CU240D-2 PN-F PP and CU240D-2 PN-F FO,<br/>CU250D-2 DP-F, CU250D-2 PN-F, CU250D-2 PN-F PP and CU250D-2 PN-F FO

Connector.pin	Digital input	Safety-related inputs	
		Basic functions	Extended func- tions
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 using two channels with one safety-related input. The inverter evaluates the signal on two separate signal paths.

#### Which devices are you allowed to connect?

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

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

#### Signal state

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

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

#### Installing

4.4 Control via safe inputs

#### Connecting PP and PM-switching safety-relevant outputs

Depending on the particular inverter, you can connect the following safety -related outputs to a safety-related input.

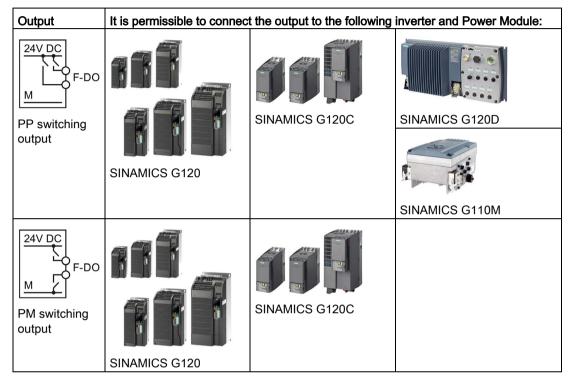


Table 4-16 Connecting PP switching or PM switching outputs

#### Fault detection

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

- Cable break
- Defective sensor

The inverter cannot detect the following faults:

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

#### 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 reduce the risk of cable damage, you need to lay signal lines in steel pipes.

#### Bright and dark test

The inverter filters signal changes using bright and dark tests at its safe input using an adjustable software filter.

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

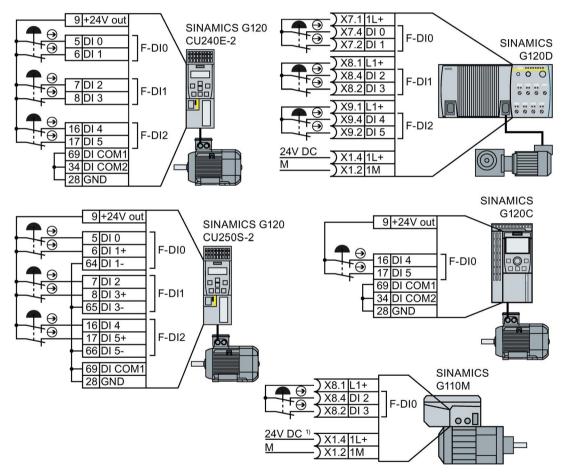
On the following pages you will find examples for wiring safety-related inputs corresponding to PL d according to EN 13849-1 and SIL 2 according to IEC 61508.

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

#### 4.4.2.1 Electromechanical sensor

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

#### The inverter provides the supply voltage



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

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

#### External power supply

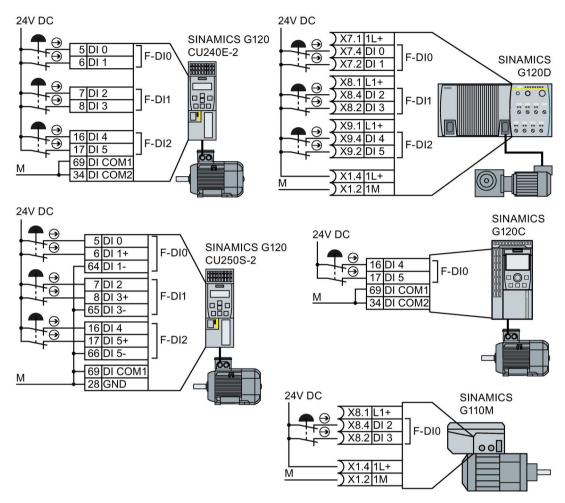


Image 4-8 Connecting an electromechanical sensor to an external power supply

#### SIMATIC ET 200pro

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

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

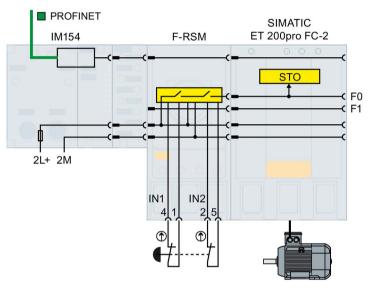


Image 4-9 Directly controlling the safety functions in the ET 200pro FC-2 converter via the F-RSM module

Additional ways of installing F-RSM module are provided in the Internet:



FAQ (http://support.automation.siemens.com/WW/view/en/26694409).

#### 4.4.2.2 Series-connected electromechanical sensors

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

If the sensors are simultaneously opened, then sensor faults can only be identified with some restrictions.



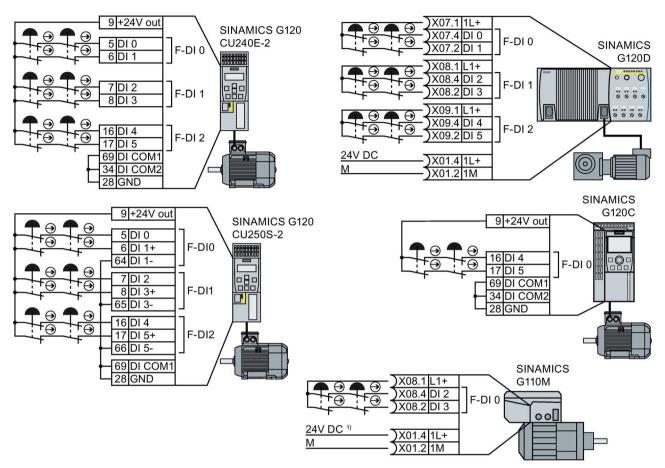
Further information about connecting electromechanical sensors in series is provided in the Internet:

- FAQ "Connecting several Emergency Stop command devices 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)

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

#### The inverter provides the supply voltage

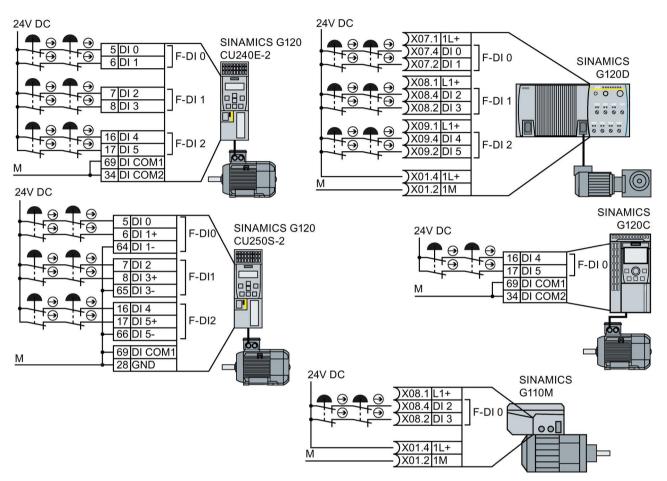
Connect the 24 V supply of the inverter to the sensors and connect the reference potentials of the inputs used to GND.



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

Image 4-10 Connecting electromechanical sensors to the inverter power supply in series

#### External power supply



Connect the external power supply to the sensors and connect the reference potentials of the inputs used to the reference potential of the external power supply.

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

#### 4.4.2.3 Activating several inverters simultaneously

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

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

#### The converter provides the supply voltage

Connect the 24 V supply of a converter to the sensors and interconnect the reference potentials of the inputs used to GND.

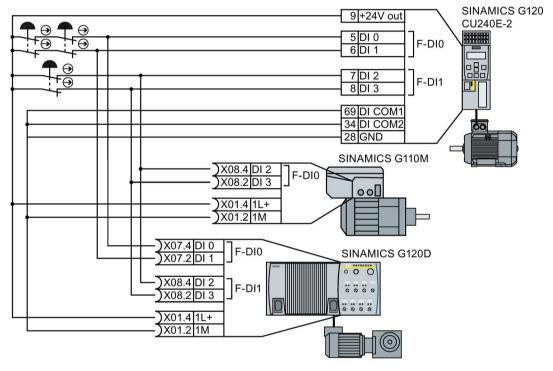


Image 4-12 Example for controlling several inverters in parallel with the power supply from the inverter

#### External power supply

Connect the external power supply to the sensors and connect the reference potentials of the inputs used to the reference potential of the external power supply.

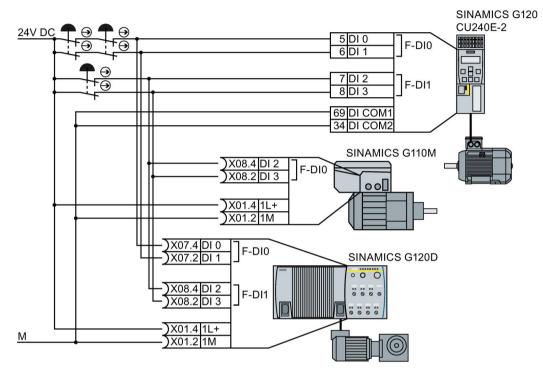


Image 4-13 Example for controlling several inverters in parallel with an external power supply

#### 4.4.2.4 SIRIUS 3SK1 safety relay

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

The diagrams only show the interconnection between the safety relay and a SINAMICS G120 inverter as example. Information on completely wiring the 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

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

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

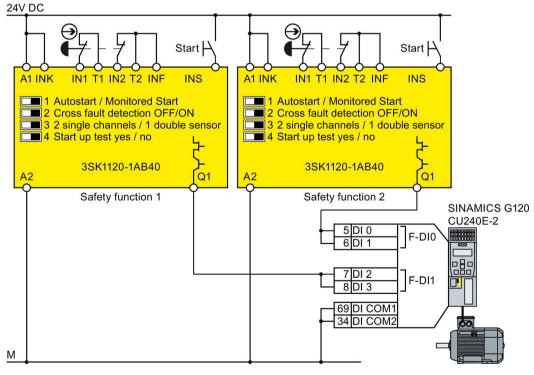


Image 4-14 Wiring inverter and safety relay in an electrical cabinet using SINAMICS G120 with CU240E-2 as example

### Components in separate control cabinets

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

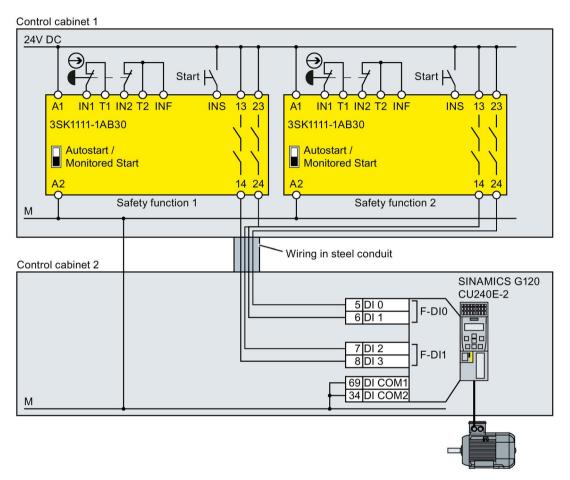


Image 4-15 Wiring inverter and safety relay in separate electrical cabinets using SINAMICS G120 with CU240E-2 as example

#### Installing

4.4 Control via safe inputs

# 4.4.2.5 3RK3 Modular Safety System

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

- The safety-related outputs in the central modules of the modular 3RK3 safety system
- The safety-related outputs in the EM 2/4F-DI 2F-DO expansion module.
- The safety-related outputs in the EM 4F DO expansion module
- The safety-related 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 modular 3RK3 safety system and as example, a SINAMICS G120 inverter.

Additional information on wiring the modular 3RK3 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

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

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

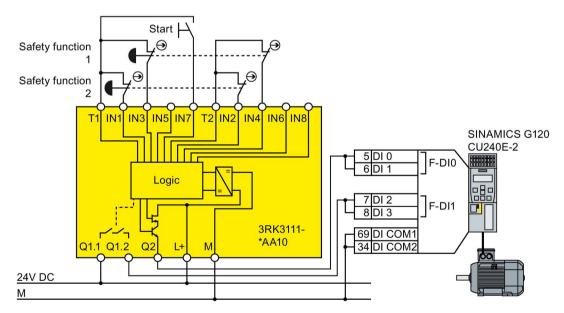


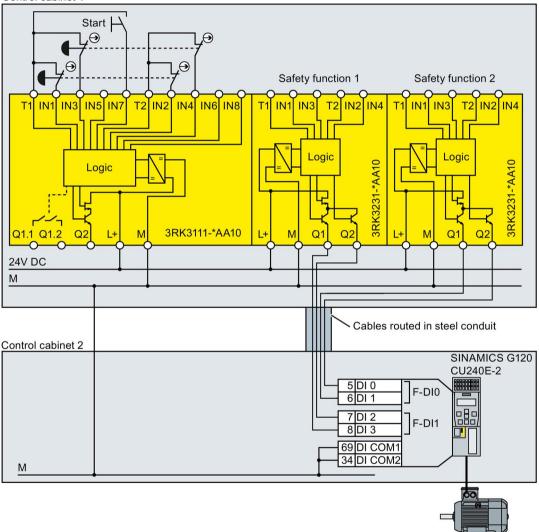
Image 4-16 Connecting the modular safety system in an electrical cabinet using SINAMICS G120 with CU240E-2 as example

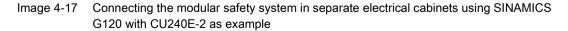
#### Components in separate control cabinets

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

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

Control cabinet 1





## 4.4.2.6 SIMATIC I/O modules

The diagrams only show the interconnection between the SIMATIC I/O modules and an inverter shown as example. Additional information on the I/O modules is provided in the Internet:



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

#### Components in the same control cabinet

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

As a consequence, for PP switching outputs, in an electrical cabinet you may connect the inverter to the I/O module through a single channel cable connection. The two terminals of the safety-related input must be connected to each other at the inverter.

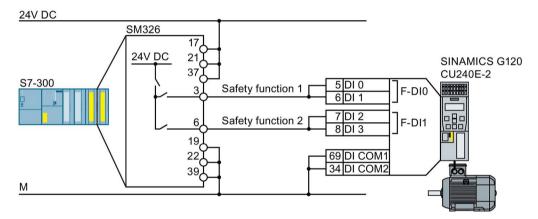


Image 4-18 Connecting the PP switching module SM326 using a SINAMICS G120 with CU240E-2 as example

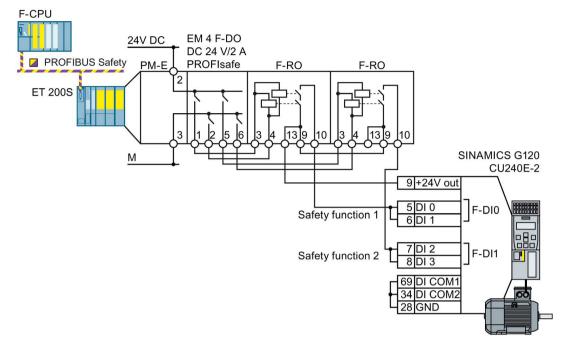


Image 4-19 Connecting PP switching ET 200S outputs using a SINAMICS G120 with CU240E-2 as example

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

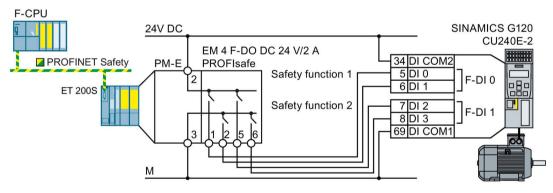
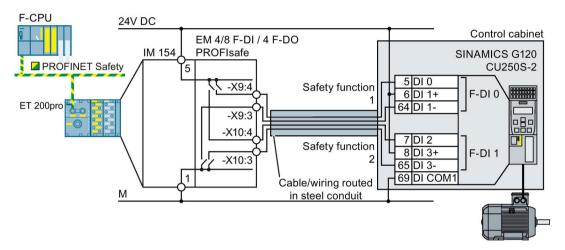


Image 4-20 Connecting PM switching ET 200S outputs using a SINAMICS G120 with CU240E-2 as example

### 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 inverter against cross and short-circuits - or ensure that a cross or short-circuit results in a discrepancy error.



# Image 4-21 Connecting PM switching ET 200pro outputs using a SINAMICS G120 with CU250S-2 as example

SINAMICS G120D requires a PP switching output. In the following example, you may operate the inverter and the ET 200S with different 24-V supplies - as well as with the same 24-V supply.

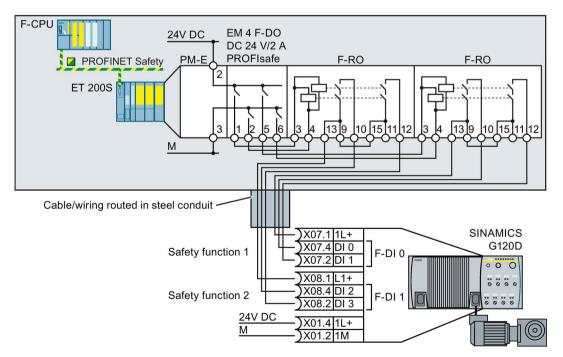


Image 4-22 Connecting PP switching ET 200S outputs using a SINAMICS G120D as example

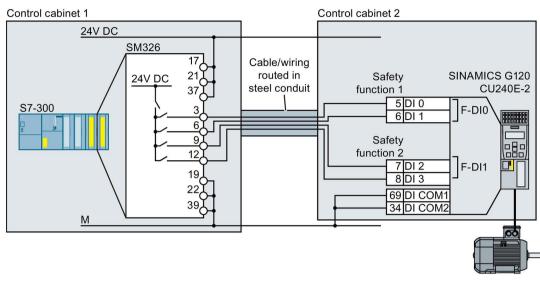


Image 4-23 Connecting the PP switching module SM326 using a SINAMICS G120 with CU240E-2 as example

# 4.4.3 Wiring examples according to SIL 3 and PL e

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

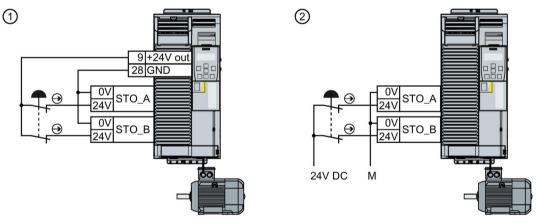
Preconditions when using the STO safety function according to SIL 3:

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

# 4.4.3.1 Electromechanical sensor

#### Connecting an electromechanical sensor

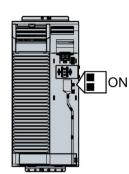
If there is a risk of cross-circuits or short-circuits, the cables between the sensor and the inverter must be protected, for example, by routing them in a steel tube.



① Power supply voltage from terminal 9 of the Control Unit

② External power supply

Image 4-24 Connecting an electromechanical sensor

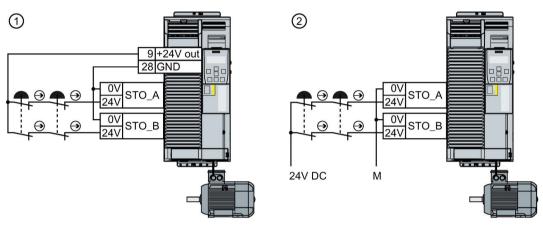


#### Connecting several electromechanical sensors in series

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

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

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



① The inverter provides the supply voltage

② External power supply

Image 4-25 Connecting several electromechanical sensors in series

### Controlling several inverters simultaneously

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

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

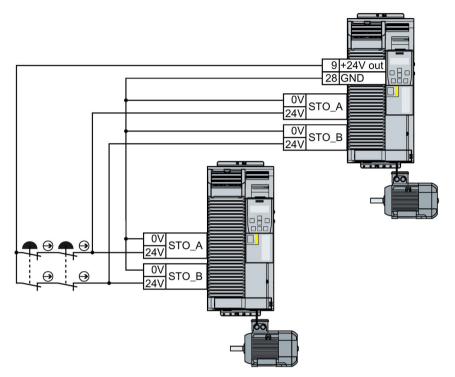


Image 4-26 Controlling several inverters in parallel with the power supply from the inverter

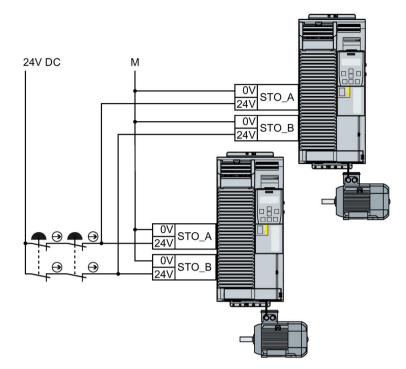


Image 4-27 Controlling several inverters in parallel with an external power supply

## 4.4.3.2 SIRIUS 3SK1 safety relay

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

The diagrams only show how the safety relay and inverter are interconnected.



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

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

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

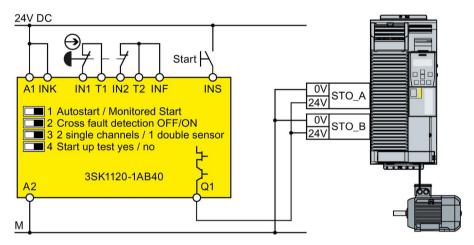


Image 4-28 Wiring the inverter and safety relay within a control cabinet

## Components in separate control cabinets

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

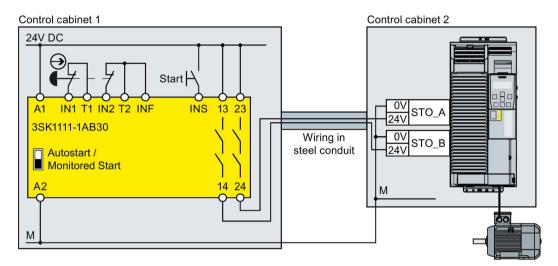


Image 4-29 Wiring inverters and safety relays in separate control cabinets

#### Installing

4.4 Control via safe inputs

# 4.4.3.3 3RK3 Modular Safety System

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

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



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

SIRIUS 3RK3 Modular Safety System (http://support.automation.siemens.com/WW/view/en/26412499/133300)

#### Components in the same control cabinet

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

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

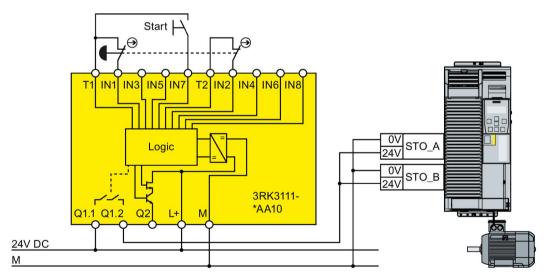
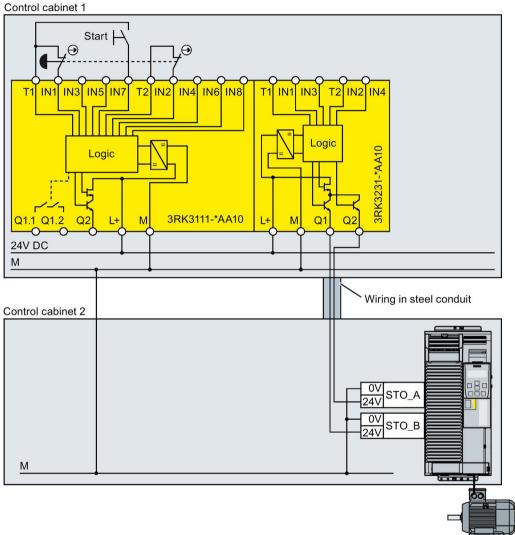


Image 4-30 Wiring inverters and modular safety system within one control cabinet

#### Components in separate control cabinets

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

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



Wiring inverters and modular safety systems in separate control cabinets Image 4-31

## 4.4.3.4 SIMATIC I/O modules

The diagrams only show the interconnection between the SIMATIC I/O modules and an inverter shown as example. Additional information on the I/O modules is provided in the Internet:



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

#### Components in the same control cabinet

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

As a consequence, for PP switching outputs, in an electrical cabinet you may connect the inverter to the I/O module through a single channel cable connection. The two terminals of the safety-related input must be connected to each other at the inverter.

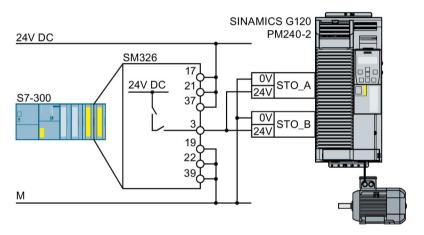


Image 4-32 Connecting the PP switching module SM326

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

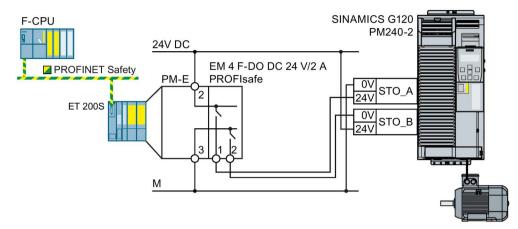


Image 4-33 Connecting PM switching ET 200S outputs

### 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 inverter against cross and short-circuits - or ensure that a cross or short-circuit results in a discrepancy error.

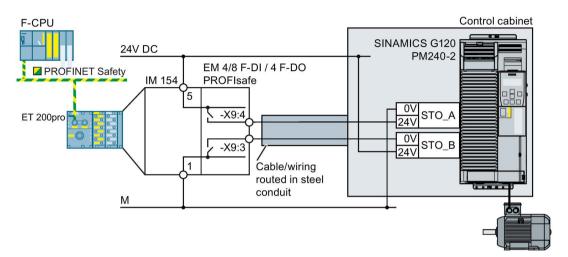


Image 4-34 Connecting PM switching ET 200pro outputs

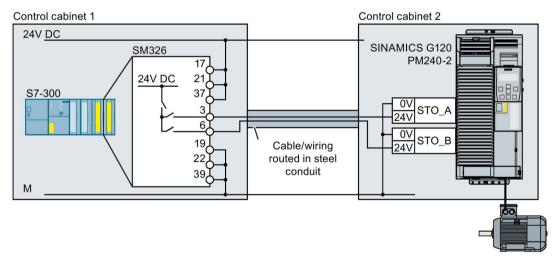


Image 4-35 Connecting the PP switching module SM326

# 4.5.1 Overview

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

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

Table 4- 17 inverters for cabinet-free installation (IP65)

Table 4- 18	Inverter for installation in a control cabinet (IP20)
-------------	---

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

Most applications require NO contacts for a safety output.

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

#### What devices can be connected?

The safety output is designed for the following devices:

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

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

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

# 4.5.2 Connecting the safety output for SINAMICS G120

# Connecting a relay

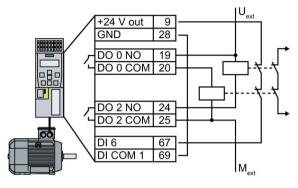


Image 4-36 Connecting a relay at the F-DO

# Connecting an actuator with feedback signal

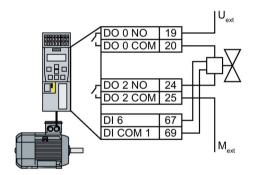


Image 4-37 Connecting an F-DO to an actuator

# Connecting a passive actuator

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

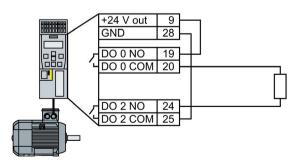


Image 4-38 Connecting F-DO to a passive actuator

# Connecting with a safety-related input

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

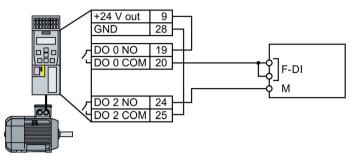


Image 4-39 Connecting an F-DO with an F-DI

# 4.5.3 Connecting the safety output for SINAMICS G120D

# Connecting a relay

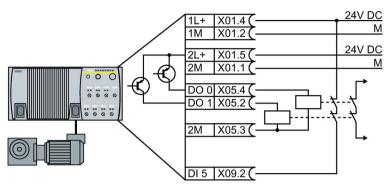


Image 4-40 Connecting a relay at the F-DO

## Connecting an actuator with feedback signal

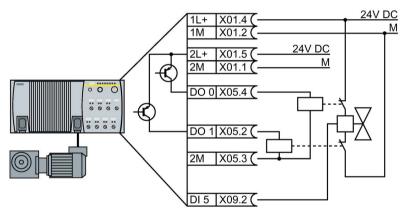


Image 4-41 Connecting an F-DO to an actuator

# Connecting with a safety-related input

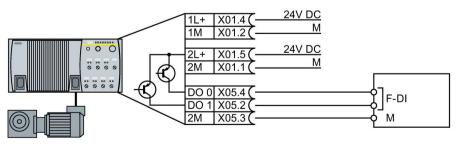
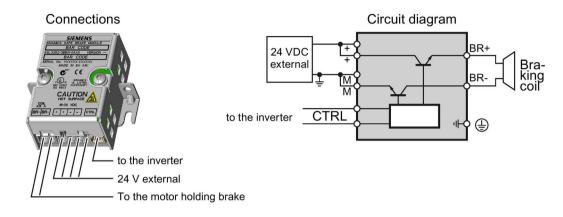


Image 4-42 Connecting an F-DO with an F-DI

# 4.6 Connecting a motor holding brake via Safe Brake Relay

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

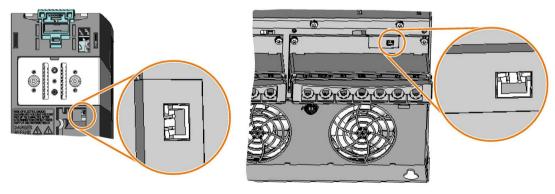


# 4.6.1 Connecting a Brake Relay to a PM240 Power Module

# Connecting the Brake Relay to the inverter

The connector for the Brake relay is located at the front of the Power Module for the FSA ... FSC frame sizes. 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.



Brake relay connector for FSA ... FSC Power Modules

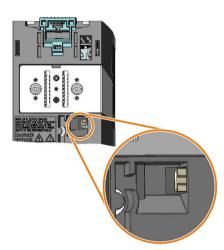
Brake relay connector for FSD ... FSF Power Modules

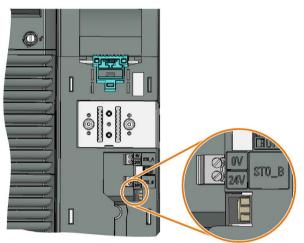
4.6 Connecting a motor holding brake via Safe Brake Relay

# 4.6.2 Connecting a Brake Relay to a PM240-2 Power Module

### Connecting the Brake Relay to the inverter

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

# Commissioning

# 5.1 About this chapter

## What can you find in this Chapter?

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

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

5.2 Commissioning guidelines

# 5.2 Commissioning guidelines

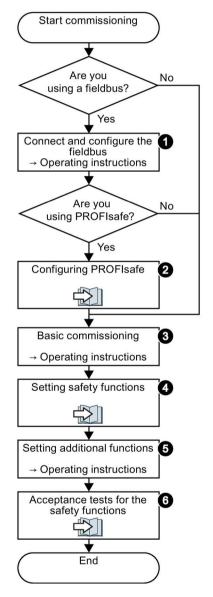
The following overview shows the procedure when commissioning an inverter with integrated safety functions.

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

#### Procedure

 $\square 2^1$ 

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



- 1. Connect the fieldbus to the inverter, and configure the communication in the higher-level control.
  - → manual of your control system
  - → operating instructions of your inverter
- 2. Configure the PROFIsafe communication in the higherlevel control system.

Configure PROFIsafe in the higher-level control system (Page 99).

3. Carry out the basic commissioning of the drive.

→ operating instructions of your inverter

4. Set the inverter safety functions.

The following pages in the Function Manual

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

 $\rightarrow$  operating instructions of your inverter

6. Perform an acceptance test for the safety functions.

Acceptance tests for the safety functions (Page 208)

You have commissioned the inverter 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 inverter 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 inverter messages on an HMI (http://support.automation.siemens.com/WW/view/en/61450312)
- Configuring communication via Shared Device (http://support.automation.siemens.com/WW/view/de/50207311)

# 5.4 Commissioning tools

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



# STARTER and Startdrive PC tools

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

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

# DVD article number

STARTER: 6SL3072-0AA00-0AG0 Startdrive: 6SL3072-4CA02-1XG0



## System requirements and download:

STARTER (<u>http://support.automation.siemens.com/WW/view/en/26233208</u>) Startdrive (http://support.automation.siemens.com/WW/view/en/68034568)

# Help regarding operation:

STARTER videos (http://www.automation.siemens.com/mcms/mc-drives/en/low-voltageinverter/sinamics-g120/videos/Pages/videos.aspx)

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

# Commissioning: Online or offline

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

• STARTER: Commission the safety functions online:

This manual provides a detailed description of the online commissioning procedure.

Notes on commissioning offline:

Contraction of the second seco

• Startdrive: Commission the safety functions online.

Exception: The PROFIsafe interface can only be configured offline.

# 5.5 Safety functions password

## What is the purpose of the password?

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

### Does the password need to be set?

The password does not need to be set.

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

The probabilities of failure (PFH) and the certification of the safety functions also apply when no password has been set.

## What do I do if I lose the password?

If you no longer know the password but still want to change the settings for safety functions, proceed as follows:

1. Create a new project for the inverter with STARTER or Startdrive.

Leave all the factory setting in the project.

2. Load the project in the inverter.

After loading, the inverter has the factory settings.

- 3. If a memory card inserted in the inverter, remove it.
- 4. Recommission the inverter.

You can obtain more information or learn about alternative procedures from Technical Support.

5.6 Resetting the safety functions to the factory setting

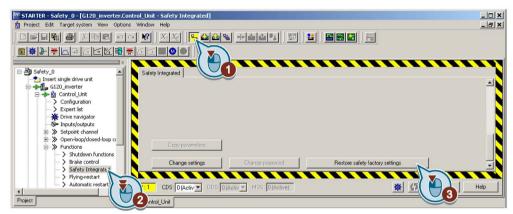
# 5.6 Resetting the safety functions to the factory setting

### Procedure with STARTER



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

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



- 4. Enter the password for the safety functions.
- 5. Confirm that the parameters have been saved (RAM to ROM).
- 6. Go offline.

- 7. Switch off the inverter supply voltage.
- 8. Wait until all LEDs on the inverter go dark.
- 9. Switch on the inverter supply voltage again.
- You have restored the safety functions in the inverter to the factory settings.

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

Resetting the password for the safety functions (Page 104)

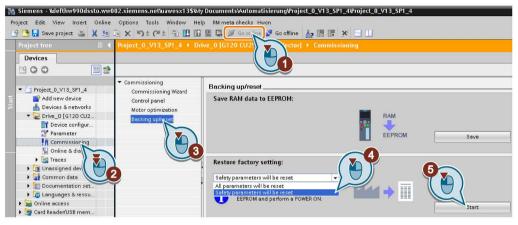
5.6 Resetting the safety functions to the factory setting

#### Procedure with Startdrive



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

1. Go online.



- 2. Select "Commissioning".
- 3. Select "Backing up/reset".
- 4. Select "Safety parameters are reset".
- 5. 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 inverter supply voltage.

10.Wait until all LEDs on the inverter go dark.

11.Switch on the inverter supply voltage again.

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

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

Resetting the password for the safety functions (Page 104)

Parameter	Description	
p0010	Drive commissioning parameter filter	
	0	Ready
	30	Parameter reset
p9761	<b>SI password entry</b> (factory setting: 0000 hex) Permissible passwords lie in the range 1 FFFF FFFF.	
p9762	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 inverter sets p0970 = 0.

5.7 Resetting the password for the safety functions

# 5.7 Resetting the password for the safety functions

## Procedure with STARTER

#### Precondition

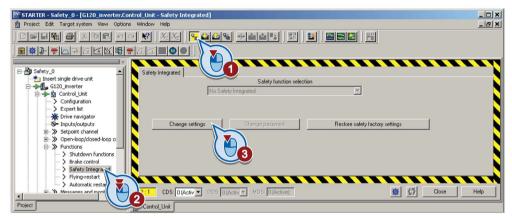
You know the actual password for the safety functions.

#### Procedure



Proceed as follows to reset the password for the safety functions:

- 1. Go online.
- 2. Open the screen form of the safety functions.
- 3. Select the "Change settings" button.



- 4. Enter the password for the safety functions.
- 5. Press the "Change password" button.



- If the password is set, then the input form is displayed to change the password.
   Enter the current password.
- 7. Set the new password = 0.
- 8. Select the "Activate settings" button.



9. STARTER responds to the reset password with the following message:



Close the message.

5.7 Resetting the password for the safety functions

10.Press the "Cancel" button.

Enter the current pass (default password: 0)		<u> </u>	
Enter the new passwo	ord:		
Repeat your entry:			
	nded that you enter		
Ihe changes	s made will be saved	Carpel	Help



You have reset the password for the safety functions.

#### Procedure with Startdrive

#### Precondition

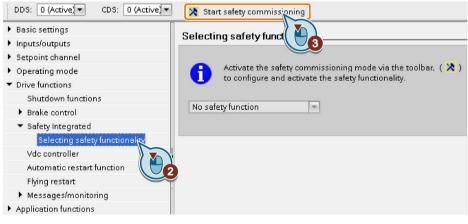
You know the actual password for the safety functions.

#### Procedure



Proceed as follows to reset the password for the safety functions:

- 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.

#### Commissioning

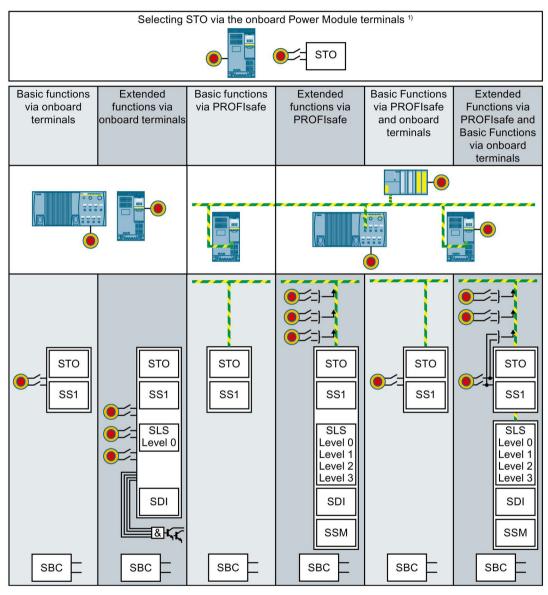
5.7 Resetting the password for the safety functions

Parameter	Description
p0010 = 95	Drive commissioning parameter filter Safety Integrated commissioning
p9761	<b>Enter a password</b> (factory setting: 0000 hex) Permissible passwords lie in the range 1 … FFFF FFFF.
p9762	New password
p9763	Confirm password
p9701 = DC hex	<b>Confirm data change</b> (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 inverter has saved the parameters in a non-volatile fashion, then p0971 = 0.

# 5.8 Configuring safety functions

You define the following when configuring the safety functions:

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



- <sup>1)</sup> The "STO via Power Module terminals" function is only possible with the Power Module PM240-2, FSD ... FSE. 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.

Image 5-1 Overview of the possible configurations

#### Commissioning

5.8 Configuring safety functions

Selected configuration	Functional scope of the configuration
Selecting STO via the onboard Power Module terminals	Select STO via the Power Module terminals
Basic functions via onboard terminals	<ul> <li>Select STO via F-DI.</li> <li>Additionally, with CU250S-2:</li> <li>Select SS1 via F-DI.</li> <li>Control the motor holding brake via SBC.</li> </ul>
Extended functions via onboard terminals	<ul> <li>Select safety functions via F-DI.</li> <li>Only one monitoring limit of SLS can be used (SLS level 0). In addition, for inverters with safety-related output:</li> <li>Evaluate the status of the safety functions via a safety-related output.</li> </ul>
Basic functions via PROFIs- afe	<ul> <li>Select STO via PROFIsafe.</li> <li>Additionally, with CU250S-2:</li> <li>Select SS1 via PROFIsafe.</li> <li>Control the motor holding brake via SBC.</li> </ul>
Extended functions via PROFIsafe	<ul> <li>Select safety functions via PROFIsafe.</li> <li>All four monitoring limits of SLS can be used (SLS levels 0 3)</li> <li>Evaluate the state of the safety-related inputs via PROFIsafe.</li> </ul>
Basic functions via PROFIs- afe and onboard terminals	<ul> <li>Select STO via F-DI as well as also via PROFIsafe.</li> <li>Additionally, with CU250S-2:</li> <li>Select SS1 via F-DI or PROFIsafe.</li> <li>Control the motor holding brake via SBC.</li> </ul>
Extended functions via PROFIsafe and basic func- tions via onboard terminals	<ul> <li>Select safety functions via PROFIsafe.</li> <li>Additionally select STO via F-DI.</li> <li>All four monitoring limits of SLS can be used (SLS levels 0 3)</li> <li>Evaluate the state of the safety-related inputs via PROFIsafe.</li> <li>Additionally, with CU250S-2:</li> <li>Select SS1 basic function via F-DI.</li> <li>Control the motor holding brake via SBC.</li> </ul>

## 5.8.1 Configuring using STARTER

## 5.8.1.1 Configuring safety functions

### Procedure with STARTER



To configure the safety functions, proceed as follows:

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

TARTER - Safety_0 - [G120_inverter.Control_Unit - Safety Integrated]	_ 🗆 🗙
n Project Edit Targetsystem View Options Window Help	_ & ×
I BARACINALCINO   D	
Safety_0	
Safety function selection	
B → Control Unit No Safety Integrated	
Configuration	
-> Expert list	
* Drive navigator	
-S- Inputs/outputs Change settings Change password Restore safety factory settings	j 💊
B → Setpoint channel B → Setpoint channel	
Shutdown functions	
> Brake control	
-> Safety Integra	
-> Flying-restart	
Automatic resta	
👔 🐨 🔊 Messanes and mont 🚰 💦 🚺 CDS: 0 (Activ 🔽 DDS: 0 (Activ 🝸 MDS: 0 (Active) 🕱 💆 _	Close Help
Project Control Unit	

- 4. Define the configuration of the safety functions:
  - (A) This option is only available with a PM240-2 FSD ... FSF Power Module.

Select this option if you only wish to use the "STO via Power Module terminals" function.

Safety Integ	rated
	Safety function selection
	No safety function
-	No safety function
	STO selection via PM onboard terminals
Basic functions via onboard terminals	
B Basic functions via PROFIsafe	
-in:	Basic functions via PROFIsafe and onboard terminal
	Extended functions via onboard terminals
C	Extended functions via PROFIsafe
	Extended functions via PROFIsafe and basic functions via onboard terminals

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

5.

If you selected the onboard terminals as interface, you have completed the configuration of the safety functions.

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

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

5.8 Configuring safety functions

Parameter	Description			
p0010 = 95	Drive commissioning parameter filter Safety Integrated commissioning			
p9601	Enable	functions integrated in the d	<b>rive</b> (factor	y setting: 0000 bin)
		Functions that have been enabled:		Functions that have been enabled:
	0 hex	None	80 hex	STO via Power Module terminals
	1 hex	Basic functions via onboard terminals	81 hex	<ul> <li>Basic functions via onboard ter- minals</li> <li>STO via Power Module terminals</li> </ul>
	4 hex	Extended functions via onboard terminals	84 hex	<ul> <li>Extended functions via onboard terminals</li> <li>STO via Power Module terminals</li> </ul>
	8 hex	Basic functions via PROFIsafe	88 hex	<ul><li>Basic functions via PROFIsafe</li><li>STO via Power Module terminals</li></ul>
	9 hex	<ul> <li>Basic functions via PROFIsafe</li> <li>Basic functions via onboard terminal</li> </ul>	89 hex	<ul> <li>Basic functions via PROFIsafe</li> <li>Basic functions via onboard terminals</li> <li>STO via Power Module terminals</li> </ul>
	C hex	Extended functions via PROFIsafe	8C hex	<ul> <li>Extended functions via PROFIs- afe</li> <li>STO via Power Module terminals</li> </ul>
	D hex	Extended functions     via PROFIsafe	8D hex	Extended functions via PROFIs- afe
		Basic functions via     onboard terminals		Basic functions via onboard ter- minals
				• 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	Confirm password		

## 5.8.1.2 Configuring PROFIsafe via basic functions

Telegram 30 is preset as default in the inverter.

## Setting the PROFIsafe address

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

dress / ID   Address confi	iguration Parameter Assignm	ent PROFIsafe	
Parameter name	Value	Hex	Change value
F_Check_SeqNr	No Check	Constanting of the second	Change value
F_SIL	SIL 2		
F CRC Length	3 Byte CRC		
F Par Version	ParVersion 1		
F_Source_Add	2002		
F Dest Add	100	64	
F WD Time	200		

Image 5-2 Example: PROFIsafe address 64 hex of the inverter in the STEP 7 hardware configuration

PROFIsafe Address 0064H	STO	 STO selected Channel 2	extended settings
	AI		



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

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

5.8 Configuring safety functions

## 5.8.1.3 Configuring PROFIsafe via extended functions

Telegram 30 is preset in the inverter as default.

## Setting the PROFIsafe address



To set the PROFIsafe address, proceed as follows:

- 1. Press the "Configuration" button.
- 2. Enter the same PROFIsafe address in hexadecimal format that you defined in the hardware configuration.

Safetv function selection Extended functions via PRDFIsafe	
[1] Safety without encoder with braking ramp (SBR)	Configuration
Safety inputs Configuration Motion ( Sichere Basis, (STD) Safe stop functions (SS1, SBR)	FROFIsale address       Mechanics configuration       Act. val. acquisition configuration         Test stop selection       Forced dorm. error detection of the shutdown paths       Forced dorm.art error detection required         7722.4 : C0/BD: CU digital inp       T

- 3. Close the screen form.
- You have set the PROFIsafe address.

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

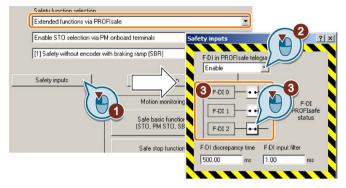
## Configuring telegram 900

## Procedure



Proceed as follows to configure PROFIsafe telegram 900:

1. Press the "Safety inputs" button.



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

#### Note

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

4. Close the screen form.

You have configured the PROFIsafe telegram 900 in the inverter.

Control word 5 and status word 5 (Page 56).

Parameter	Description		
p9501.30	<b>Enable F-DI in PROFIsafe telegram</b> (Factory setting: 0 bin) 0 signal: F-DI is inhibited in the PROFIsafe telegram 1 signal: F-DI is enabled in PROFIsafe telegram		
p10050	0 <b>Transfer PROFIsafe F-DI</b> (Factory setting: 0000 bin)		
	Bit 0	0 signal: No transfer 1 signal: PROFIsafe status word 5 transfers the status of F-DI 0	
	Bit 1	0 signal: No transfer 1 signal: PROFIsafe status word 5 transfers the status of F-DI 1	
	Bit 2	0 signal: No transfer 1 signal: PROFIsafe status word 5 transfers the status of F-DI 2	
Settings for t	he discrep	ancy time and the signal filter of the safety-related inputs:	
Setting	g the filter	for safety inputs (Page 154)	

5.8 Configuring safety functions

## 5.8.2 Configuring with Startdrive

#### 5.8.2.1 Configuring safety functions

#### Precondition

You are offline with Startdrive.

#### Procedure with Startdrive

- Proceed as follows to configure the safety functions:
- 1. Select "Select safety functionality".

Basic settings	Selecting safety functionality		
Inputs/outputs	Selecting safety functionality		
Setpoint channel			
Operating mode	No sofety function		
<ul> <li>Drive functions</li> </ul>	No safety function		
Shutdown functions			
Brake control			
<ul> <li>Safety Integrated</li> </ul>			
Selecting safety functionality			
Vdc controller			
Automatic restart function 🏾 🎽	1		
Flying restart	0		
Messages/monitoring			
<ul> <li>Application functions</li> </ul>			

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

electing safety function	ality
No safety function	▼
No safety function	
Basic functions	
Extended functions	
STO über PM-Klemmen	

- (C) This option is only available with a PM240-2 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.

<ul> <li>Safety Integrated</li> </ul>	
Selecting safety functionality	Control type:
Actual value sensing	control (gpc)
<ul> <li>Functions</li> </ul>	via terminals
Control type/safety functions	🔪 🔿 via PROFIsafe
STO	via terminals (basic) and PROFIsafe (extended)
551	F-DI assignment
SLS	
SDI	The second se
SSM	·
Test stop	
F-DI / F-DO / PROFIsafe	
Acceptance	

4. Define the interface for controlling the safety functions.

5.8 Configuring safety functions

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

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

You must configure the PROFIsafe interface for control via PROFIsafe.

5.

Parameter	Descript	tion			
p0010 = 95		mmissioning parameter filter ntegrated commissioning			
p9601	Enable	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	88 hex	Basic functions via PROFIsafe	
		PROFIsafe		• STO via Power Module terminals	
	9 hex	Basic functions via     PROFIsafe	89 hex	Basic functions via PROFIsafe	
		Basic functions via		Basic functions via onboard terminals	
		onboard terminal		• STO via Power Module terminals	
	C hex	Extended functions via PROFIsafe	8C hex	Extended functions via PROFIs- afe	
				• STO via Power Module terminals	
	D hex	Extended functions     via PROFIsafe	8D hex	Extended functions via PROFIs- afe	
		Basic functions via     onboard terminals		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 pas	New password			
p9763	Confirm	password			

5.8 Configuring safety functions

## 5.8.2.2 Configuring PROFIsafe

## Precondition

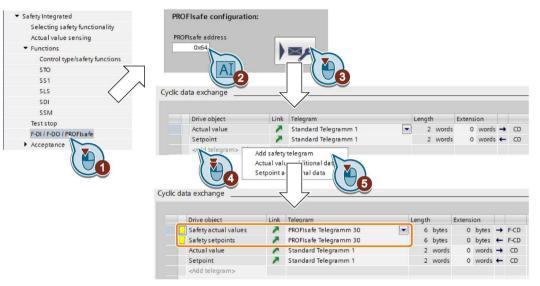
You are offline with Startdrive.

## Procedure



Proceed as follows to set the PROFIsafe address and telegram 30:

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



- 2. Enter the same address as hexadecimal value that you defined in the hardware configuration for the higher-level control system.
- 3. Press the "Telegram configuration" button.

Startdrive opens "Properties" of the cyclic data transfer.

- 4. Select "Add telegram".
- 5. Insert a "Safety telegram".

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

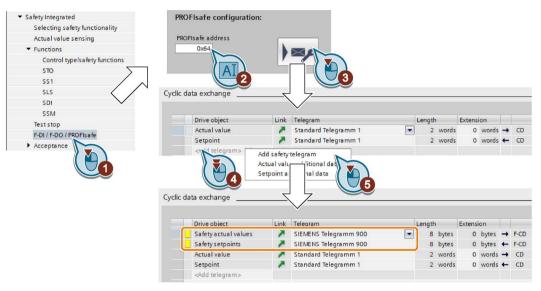
Parameter	Description
p9610	PROFIsafe address (factory setting: 0000 hex)

## Configuring telegram 900

## Procedure



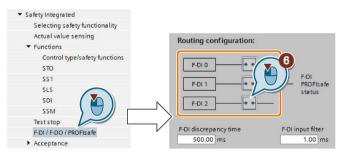
- Proceed as follows to configure PROFIsafe telegram 900:
- 1. Select "F-DI / F-DO / PROFIsafe".



2. Press the "Telegram configuration" button.

Startdrive opens the "Properties" of the cyclic data exchange.

- 3. Select "Add telegram".
- 4. Insert a "Safety telegram"
- 5. Set telegram 900.
- 6. Set which F-DI status of the inverter is transferred via PROFIsafe status word 5.



### Note

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

You have configured PROFIsafe telegram 900.

Control word 5 and status word 5 (Page 56).

5.8 Configuring safety functions

Parameter	Description	
p9501.30	<b>Enable F-DI in PROFIsafe telegram</b> (Factory setting: 0 bin) 0 signal: F-DI is inhibited in the PROFIsafe telegram 1 signal: F-DI is enabled in PROFIsafe telegram	
p10050	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 safety-related inputs:		
Setting the filter for safety inputs (Page 154)		

## 5.8.2.3 Activate settings

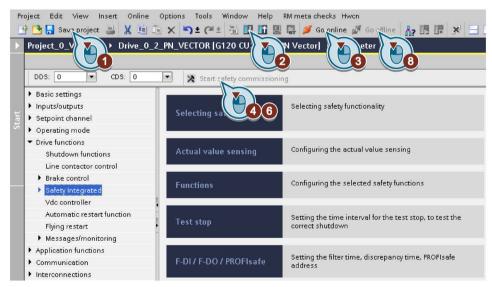
## Loading the settings into the drive

### Procedure



Proceed as follows to activate the safety functions settings in the drive:

- 1. Save the project.
- 2. Select "Load to device".



- 3. Connect Startdrive online with the drive.
- 4. Press the "Start safety commissioning" button.

5. Enter the password for the safety functions.

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

- 6. Select the "Exit safety commissioning" button.
- 7. Confirm the prompt for saving your settings (copy RAM to ROM).
- 8. Disconnect the online connection.
- 9. Switch off the inverter supply voltage.

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

11.Switch on the inverter supply voltage again.

Your settings are now active.

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

# 5.9 Setting basic functions

## 5.9.1 Interconnecting the "STO active" signal

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

#### Precondition

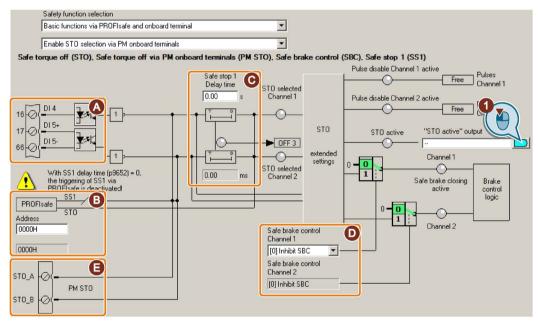
You are online with STARTER or Startdrive.

#### Procedure with STARTER and Startdrive

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



1. Select the button for the feedback signal.

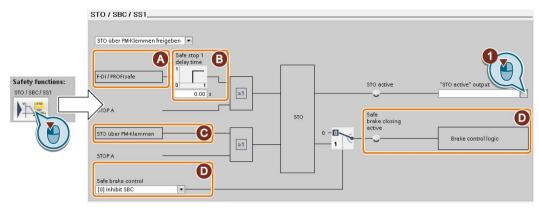


The screen form varies depending on the inverter and the interface that has been selected.

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

Image 5-4 Interconnecting "STO active" in STARTER

5.9 Setting basic functions



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

(A) Control type

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

Image 5-5 Interconnecting "STO active" in Startdrive

2. Select the signal that matches your particular application.

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

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

## 5.9.2 Setting the filter for safety inputs

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

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

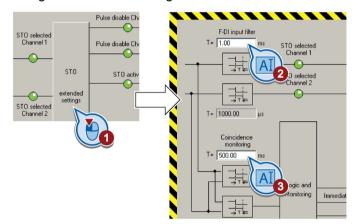
#### Requirement

You are online with STARTER or Startdrive online.

### Procedure with STARTER and Startdrive



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



1. Navigate to the filter settings.

Image 5-6 Input filter and simuntaneity monitoring in STARTER

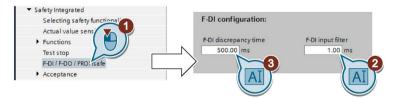


Image 5-7 Input filter and simuntaneity monitoring in Startdrive

- 2. Set the debounce time for the F-DI input filter.
- 3. Set the discrepancy for the simultaneity monitoring.
- 4. Only applies to STARTER: Close the screen form.
- You have set the input filter and the simultaneity monitoring of the safety-related input.

## Description of the signal filter

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

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

#### Tolerance time for the simultaneity monitoring

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

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

When appropriately set, the inverter tolerates brief discrepancies.

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

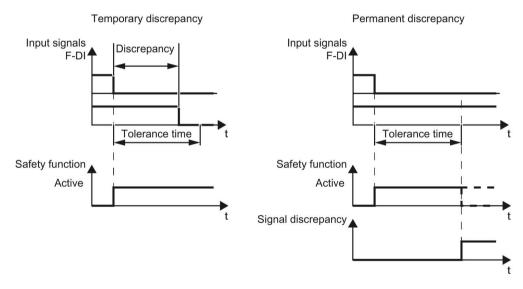


Image 5-8 Tolerance regarding discrepancy

### Filter to suppress short signals

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

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

5.9 Setting basic functions

a control module, the inverter responds to these test signals. A signal change during a bit pattern test usually lasts:

- On test: 1 ms
- Off test: 4 ms

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

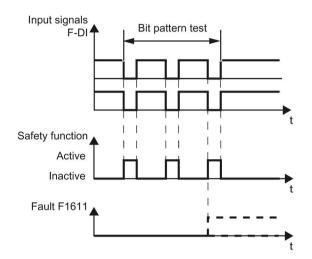


Image 5-9 Inverter response to a bit pattern test

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

The filter increases the inverter response time. The inverter only selects its safety function after the debounce time has elapsed.

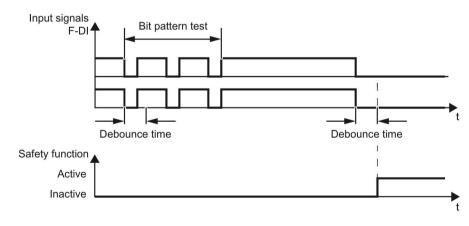


Image 5-10 Filter for suppressing temporary signal changes

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

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

#### Debounce times for standard and safety functions

The debounce time p0724 for "standard" digital inputs does not influence the safety-related input signals. Conversely, the same applies: The F-DI debounce time does not affect the signals of the "standard" inputs.

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

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

5.9 Setting basic functions

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

## Requirement

You are online with STARTER or Startdrive online.

## Procedure with STARTER and Startdrive



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

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

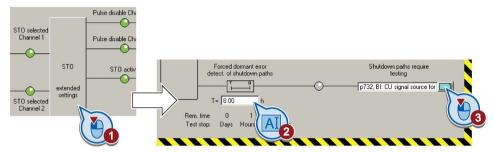


Image 5-11 Setting the forced checking procedure with STARTER

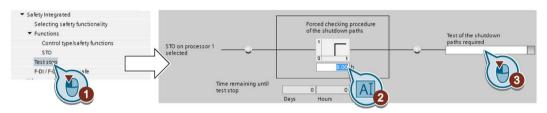


Image 5-12 Setting the forced checking procedure with Startdrive

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

Interconnect this signal with an inverter signal of your choice.

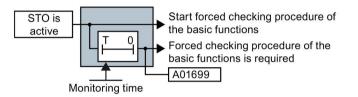
- 4. Only applies to STARTER: Close the screen form.
- You have set the forced checking procedure (test stop) for the basic functions.

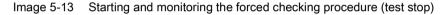
## Description

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

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

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





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

5.9 Setting basic functions

## 5.9.4 Setting STO via Power Module terminals

## Precondition

You are online with STARTER or Startdrive.

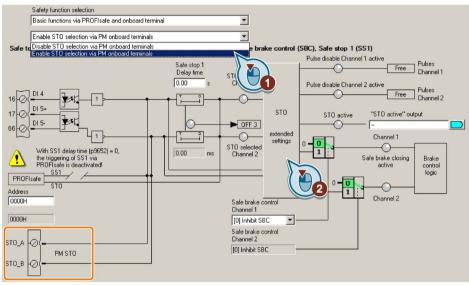
## Procedure with STARTER



Proceed as follows to set the "STO via Power Module terminals" function:

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

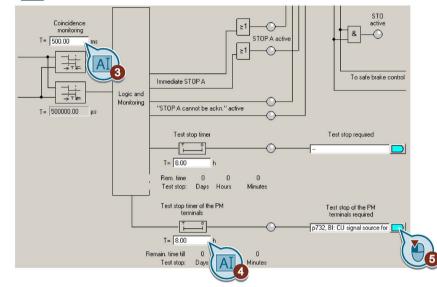
Terminals STO\_A and STO\_B of the Power Module appear in STARTER.



2. Press the "STO extended settings" button.

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

The setting not only applies for the terminals of the Power Module, but also for the safety-related input on the Control Unit for selecting STO.



Setting the filter for safety inputs (Page 122)

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



5.9 Setting basic functions

## Procedure with Startdrive

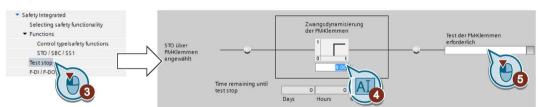


Proceed as follows to set the "STO via Power Module terminals" function:

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

	STO / SBC / SS1
Safety Integrated Selecting safety function Functions Control type/safety fu STO / SBC / SS1 Test st F-DI / F	STO über PM-Kilemmen speren

- 3. Select "Test stop"
- 4. Set the monitoring time to a value to match your application.
- 5. Using this signal, the inverter signals that a forced checking procedure (test stop) is required for the "STO via Power Module terminals" function.

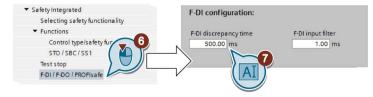


- 6. Select "F-DI / F-DO / PROFIsafe".
- 7. Set the discrepancy time (simultaneity monitoring) of the terminals on the Power Module.

The setting not only applies for the terminals of the Power Module, but also for the safetyrelated input on the Control Unit for selecting STO.

Setting the filter for safety 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.

5.9 Setting basic functions

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.	

5.9 Setting basic functions

## 5.9.5 Setting the delay time for SS1

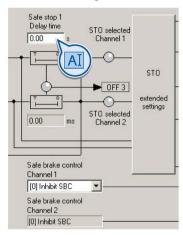
### Precondition

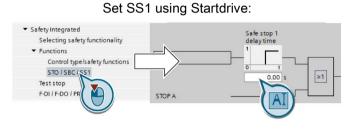
You are online with STARTER or Startdrive.

## Procedure

Set a delay time > OFF3 ramp down time.

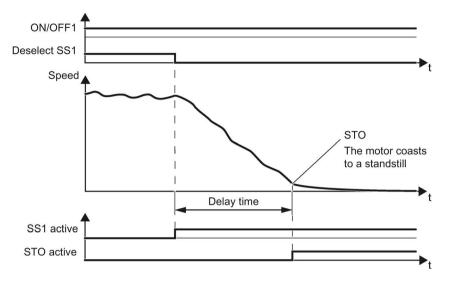
Set SS1 using STARTER:





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

## Safety Integrated - SINAMICS G110M, G120, G120C, G120D and SIMATIC ET 200pro FC-2 Function Manual, 01/2016, FW V4.7 SP6, A5E34261271B AC



Description: the SS1 function without monitoring the speed

Image 5-14 SS1 without monitoring the speed

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

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

5.9 Setting basic functions

## 5.9.6 Enabling SBC

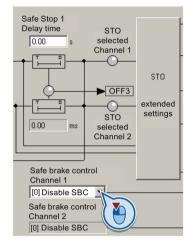
### Precondition

You are online with STARTER or Startdrive.

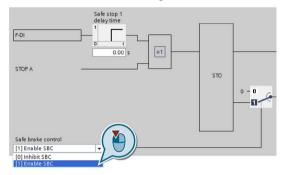
## Procedure

Set "[1] enable SBC".

Enable SBC using STARTER:







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

## 5.9.7 Final steps when commissioning online

## Activate settings

## Requirement

You are online with STARTER or Startdrive online.

### Procedure with STARTER



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

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



- 2. Press the "Activate settings" button.
- 3. If the password is the factory default, you are prompted to change the password. If you try to set a password that is not permissible, the old password will not be changed.
- 4. Confirm the prompt for saving your settings (copy RAM to ROM).
- 5. Switch off the inverter supply voltage.
- 6. Wait until all LEDs on the inverter go dark (no voltage condition).
- 7. Switch on the inverter supply voltage again.
- Your settings are now active.

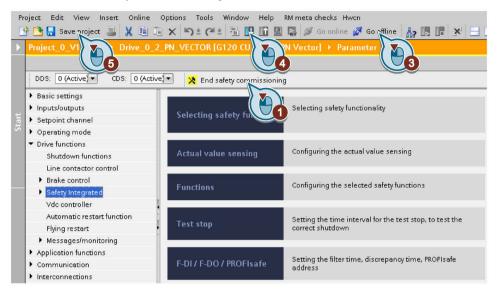
5.9 Setting basic functions

### Procedure with Startdrive



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

1. Click the "End safety commissioning" button.



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

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

## Checking the connection of digital inputs

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

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

#### Procedure with STARTER



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

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

	Provide a Patrice to a factor of the second statements of the second st	
🖃 🎒 Safety_0	Digital inputs Relay outputs Analog inputs Analog outputs Measuring Input	-
- 📩 Insert single drive unit	Current I/O configuration: 12	
🖻 🕂 🕼 G120_inverter		
🖻 🚸 🙆 Control_Unit		
Configuration		
Expert list	DLD Terminal eval.  Digital input 0 Digital input 0 Digital input 0 inverted	
Drive navigator	5 C Terminal eval. Digital input 0 Inverted	
S Inputs/outp		
Setpoint chai     Setpoint chai     Open-loop/clc	6 Digital input 1 Digital input 1 Digital input 1 inverted	
E->> Functions		
Shutdown VI	7 0 Digital input 2 Digital input 2 Digital input 2 Digital input 2 inverted	
> Brake control		
> Safety Integrated	8 DI 3 Terminal eval. Digital input 3 Digital input 3	
> Flying-restart		
> Automatic restart	3 16 2 DI 4 Terminal eval. ▼ Digital input 4 Digital input 4 inverted	
	DI 5 Terminal eval. F-DI 0 Digital input 5 Digital input 5 Digital input 5	
E ≫ Commissioning		
E ≫ Communication		
⊡ ≫ Diagnostics	DI 11 Digital input 11 Digital input 11 Digital input 11 inverted	
Documentation     SINAMICS LIBRARIES		
SINAMICS LIBRARIES	DI 12 Terminal eval. V Digital input 12 Digital input 12 inverted	
HIM MONITOR	10 0 12 Terminal eval.	
	9 🔁 🗕 +24V Note:	
	28 0 Activation of the terminals via internal or external 24 V power supply (see online help).	
	2. 24 A hower solvhill (see on mue neh):	
а — — — — — — — — — — — — — — — — — — —	CDS: 0 (Activ 🗾 DDS: 0 (Activ 🗹 MDS: 0 (Active) 🕸 🚮 Close Help	>
and and a second		
Project	A Control Unit	

Image 5-15 Removing the DI 4 and DI 5 digital-input connections

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

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

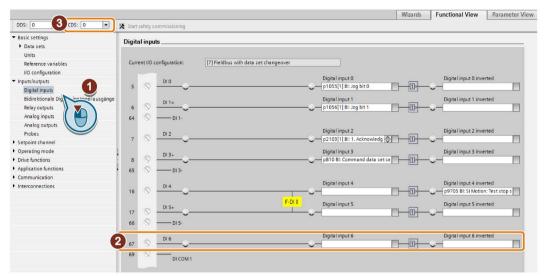
You have ensured that the safety-related inputs only control safety functions in the inverter.

### Procedure with Startdrive



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

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



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

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

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

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

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

#### Preconditions

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

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

#### Procedure with STARTER



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

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

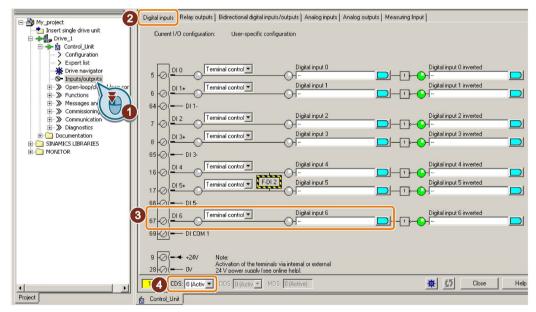


Image 5-16 Removing the interconnection of the feedback signal input DI 6 for the CU250S-2

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

### Procedure with Startdrive



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

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

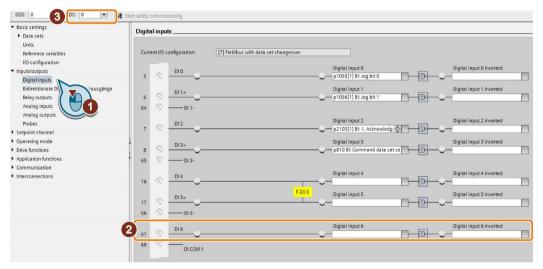


Image 5-17 Removing the interconnection of the feedback signal input DI 6 for the CU250S-2

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

# 5.10 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 142).

2. If necessary, interconnect the safety-related inputs and outputs. See sections:

Setting safety inputs (Page 152)

- Setting a safety output (Page 165).
- 3. Adapt the safety functions that you are using to suit your application. See Sections:
  - Setting SS1 (Page 174)
  - Setting SLS (Page 183)
  - Setting SSM (Page 188)
  - Setting SDI (Page 192)
- 4. Complete commissioning.

Final steps when commissioning online (Page 197).

5.10 Setting extended functions

## 5.10.1 Basic settings

#### 5.10.1.1 Enabling the safety functions

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

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

When controlling via PROFIsafe:

In the higher-level control, set the corresponding bit in control word 1 to 1.

PROFIsafe telegrams (Page 52).

• When controlling via safety-related inputs:

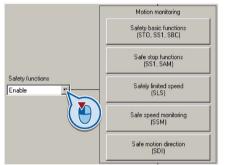
In the inverter, set the corresponding signal to "Statically deselected".

Interconnecting a safety function with a safety input (Page 152)

#### Precondition

You are online with STARTER or Startdrive.

#### Procedure with STARTER

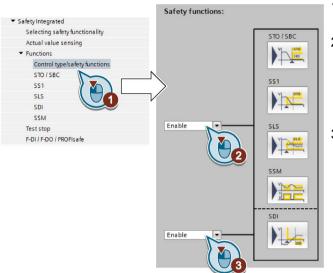


Enable the safety functions.

### Procedure with Startdrive



Proceed as follows to enable the safety functions:



- 1. Select "Control type/safety functions".
- 2. Enable safety functions STO ... SSM.

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

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

You have enabled the safety functions in the inverter.

Parameter	Description		
p9501	Enable	ble safety functions	
	.00	1 signal: Enable the extended functions (without SDI)	
	.17	1 signal: Enable SDI	

5.10 Setting extended functions

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

#### Precondition

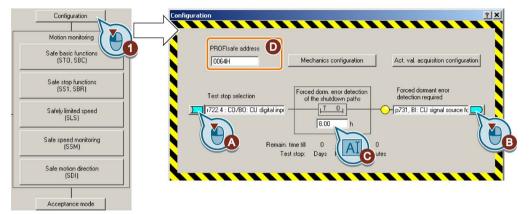
You are online with STARTER or Startdrive.

### Procedure with STARTER



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

1. Select the "Configuration" button:



Set the following:

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

Configuring PROFIsafe via extended functions (Page 112).

2. Close the screen form.

3. Press the "Safe basic functions" button:

Configuration	Safe torque off	<u>? ×</u>
Safe basic functions (STD, SPC)	Safe torque off (STO)	
Safe stop fit	Pulse suppression active Blocked Pulses STD selected	
Safely limited speed (SLS) Safe speed monitoring	Forced dormant error detection of the shuldown paths Shutdown paths require testing	B
Safe motion direction (SDI)		59 nutes
Acceptance mode		

Set the following:

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

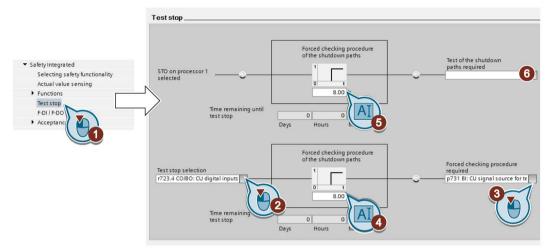
You have set the forced checking procedure (test stop) of the extended functions.

### Procedure with Startdrive



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

1. Select "Test stop":



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

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

6. Setting not required

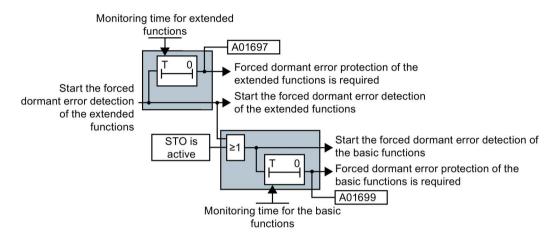
You have set the forced forced checking procedure (test stop) of the extended functions.

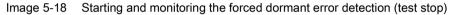
## Description

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

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

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





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

5.10 Setting extended functions

# 5.10.1.3 Setting encoderless actual value sensing

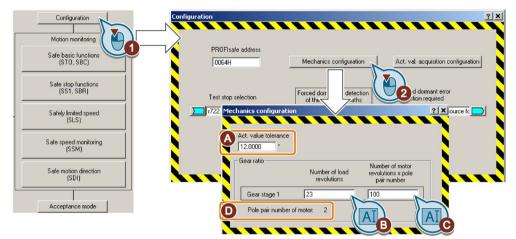
## Precondition

You are online with STARTER or Startdrive.

## Procedure with STARTER

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

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



Set the following:

- (A) Actual value tolerance:

In most cases, you do not have to change this value. If, in operation, the inverter issues message C01711 or C30711 (fault value 3 or 44  $\dots$  57), increase this value step-by-step until the message to longer occurs.

**Note:** If you increase this value, the speed monitoring of the inverter becomes less sensitive to limit violations.

## - (B), (C)Gearbox ratio:

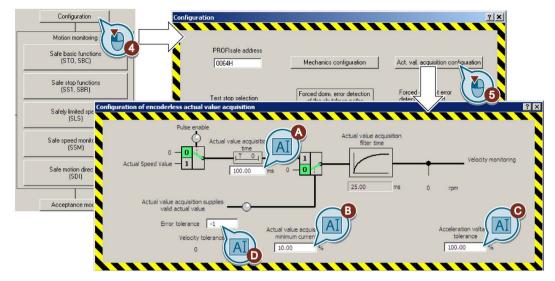
Read the motor pole pair number (D), and enter the data of your machine according to the following table.

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

- **Example**: The drive has a gearbox with a load/motor speed ratio = 23/50

 $\Rightarrow$  Value (B) = 23, value (C) = 50 × number of pole pairs (D)

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



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

Set the following:

### (A) Delay time actual value sensing:

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

### - (B) Minimum current actual value sensing:

In most cases you do not have to change this setting. If the inverter responds with a fault when the current drawn by the motor is low, then reduce these values in 1 % increments until the fault no longer occurs.

### - (C) Voltage tolerance acceleration:

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

### - (D) Fault tolerance:

In most cases you do not have to change this parameter. This parameter can suppress sporadic faults of the safety functions. The parameter defines how often the inverter tolerates its internal plausibility monitoring per second.

6. Close the screen forms.

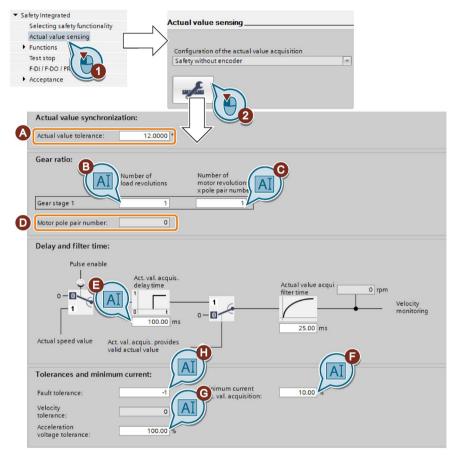
You have set the encoderless actual value sensing.

### Procedure with Startdrive



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

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



Set the following:

- (A) Actual value tolerance:

In most cases you do not have to change this value. If, in operation, the inverter issues message C01711 or C30711 (fault value 3 or 44 ... 57), increase this value step-by-step until the message to longer occurs.

**Note:** If you increase this value, the speed monitoring of the inverter becomes less sensitive to limit violations.

### - (B), (C)Gearbox ratio:

Read the number of pole pairs (D) of the motor, and set the data of your machine according to the following table.

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

- Example: The drive has a gearbox with a load/motor speed ratio = 23/50

 $\Rightarrow$  Value (B) = 23, value (C) = 50 × number of pole pairs (D)

- (E) Delay time actual value sensing:

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

### (F) Minimum current actual value sensing:

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

#### - (G) Voltage tolerance acceleration:

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

### - (H) Fault tolerance:

In most cases you do not have to change this parameter. This parameter can suppress sporadic faults of the safety functions. The parameter defines how often the inverter tolerates its internal plausibility monitoring per second.

3. Close the screen form.

You have set the encoderless actual value sensing.

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

5.10 Setting extended functions

# 5.10.2 Setting safety inputs

# 5.10.2.1 Interconnecting a safety function with a safety input

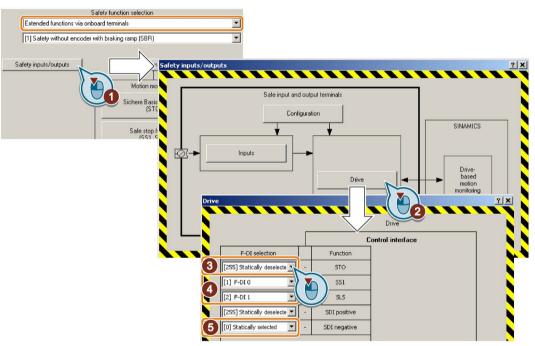
## Preconditions

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

## Procedure with STARTER



- To interconnect the safety-related inputs with safety functions, proceed as follows:
- 1. Press the "Safety inputs/outputs" button.
- 2. Press the "Drive" button.



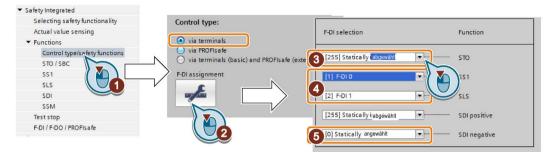
- 3. If you do not use a safety function, then set the associated "Select F-DI" = "[255] statically deselected".
- 4. Interconnect the safety-related inputs with the corresponding safety functions.
- 5. If a safety function should always be active, set the associated "Select F-DI" = "[0] Statically active".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

## Procedure with Startdrive



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

- 1. Select "Control type/safety functions".
- 2. Press the "F-DI assignment" button.



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

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

5.10 Setting extended functions

# 5.10.2.2 Setting the filter for safety inputs

## With STARTER: Control via onboard terminals

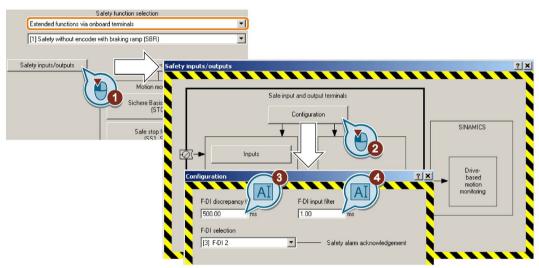
## Preconditions

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

## Procedure



- To set the filters for the safety-related inputs, proceed as follows:
- 1. Press the "Safety inputs/outputs" button.
- 2. Press the "Configuration" button.



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

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

## With STARTER: Control via PROFIsafe and onboard terminals

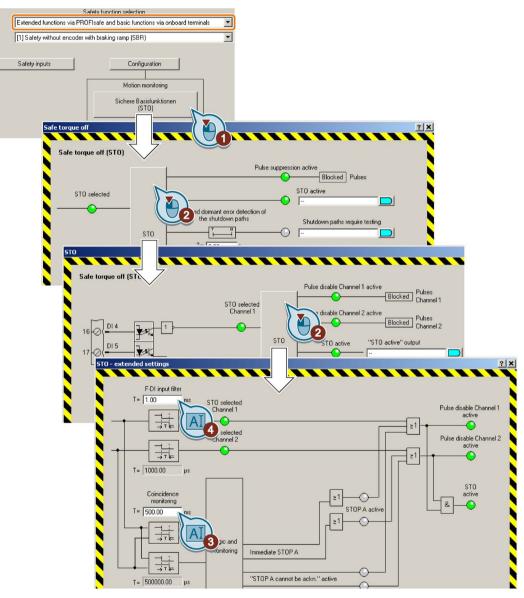
### Preconditions

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

### Procedure



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



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

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

5.10 Setting extended functions

## With Startdrive

### Preconditions

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

### Procedure



- To set the filters for the safety-related inputs, proceed as follows:
- 1. Select "F-DI / F-DO / PROFIsafe".

<ul> <li>Safety Integrated</li> </ul>	
Selecting safety functionality	
Actual value sensing	
<ul> <li>Functions</li> </ul>	
Control type/safety functions	
STO / SBC	 F-DI configuration:
SS1	
SLS	F-DI discrepancy time F-DI input filter
SDI	500.00 ms 1.00 ms
SSM	
Test stop	F-DI selecti AL
F-DI / F-DO / PROFIsafe	 [0] Statically alarms
Acceptance	

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

## Description of the signal filter

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

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

### Tolerance time for the simultaneity monitoring

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

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

When appropriately set, the inverter tolerates brief discrepancies.

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

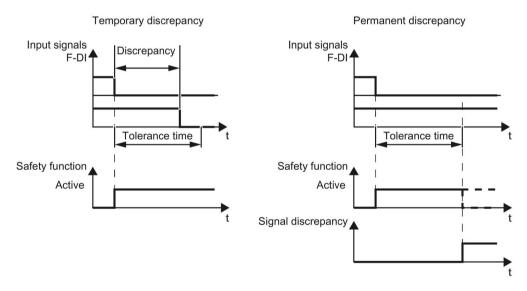


Image 5-19 Tolerance regarding discrepancy

### Filter to suppress short signals

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

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

a control module, the inverter responds to these test signals. A signal change during a bit pattern test usually lasts:

- On test: 1 ms
- Off test: 4 ms

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

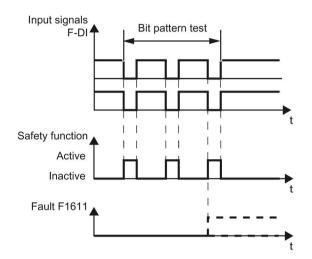


Image 5-20 Inverter response to a bit pattern test

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

The filter increases the inverter response time. The inverter only selects its safety function after the debounce time has elapsed.

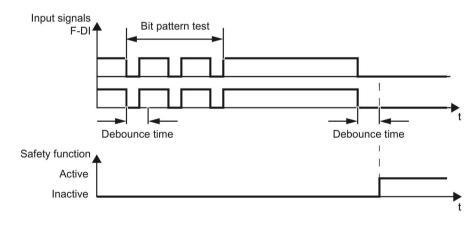


Image 5-21 Filter for suppressing temporary signal changes

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

### Debounce times for standard and safety functions

The debounce time p0724 for "standard" digital inputs does not influence the signals of the safety inputs F-DI. Conversely, the same applies: The F-DI debounce time does not affect the signals of the "standard" inputs.

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

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

5.10 Setting extended functions

## 5.10.2.3 Interconnecting the signal for fail-safe acknowledgment

### Preconditions

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

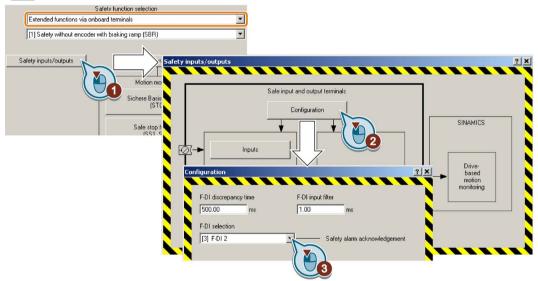
### Procedure with STARTER

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

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

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

### Acknowledging using a fail-safe signal (Page 299)



4. Close the screen forms.

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

### Procedure with Startdrive



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

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

<ul> <li>Safety Integrated</li> </ul>	
Selecting safety functionality	
Actual value sensing	
<ul> <li>Functions</li> </ul>	
Control type/safety functions	F-DI configuration:
STO / SBC	· · · · · · · · · · · · · · · · · · ·
SS1	F-DI discrepancy time F-DI input filter
SLS	500.00 ms
SDI	
SSM	
Test stop	F-DI selection
F-DI / F-DO / PROFIsate	[3] F-DI 2 Acknowledgement of safety alarms
Acceptance	

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

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

Acknowledging using a fail-safe signal (Page 299)

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

5.10 Setting extended functions

# 5.10.3 Setting STO via Power Module terminals

## Precondition

You are online with STARTER or Startdrive.

# Procedure with STARTER

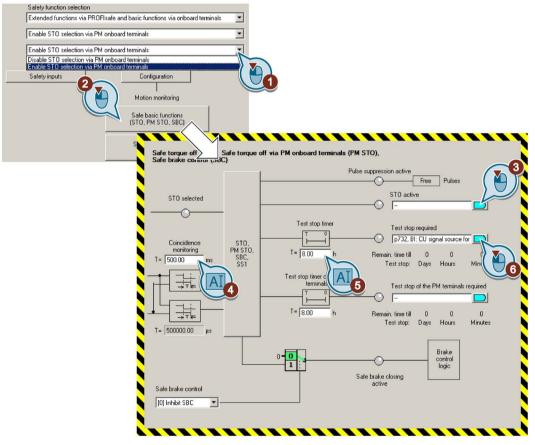


Proceed as follows to set the "STO via Power Module terminals" function:

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

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

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



- 3. If required, in the higher-level control, interconnect the feedback signal "STO active".
- 4. Set the discrepancy time (simultaneity monitoring) of the terminals on the Power Module.

The setting not only applies for the Power Module terminals, but also for selecting the basic STO function via F-DI.

Setting the filter for safety inputs (Page 154)

5. Set the monitoring time to a value to match your application.

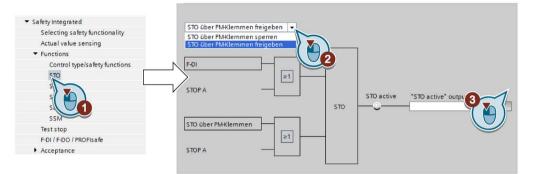
- 6. Using this signal, the inverter signals that a forced checking procedure (test stop) is required for the "STO via Power Module terminals" function.
- 7. Close the screen forms.
- You have set the "STO via Power Module terminals" function.

### Procedure with Startdrive

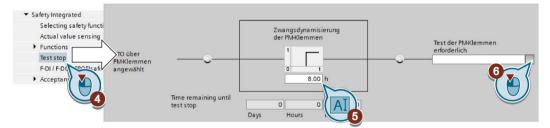
Proceed as follows to set the "STO via Power Module terminals" function:

1. Select "STO".

2. Select "Enable STO via PM terminals".

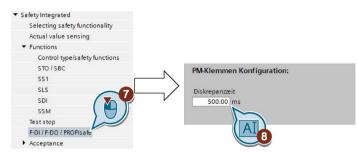


- 3. If required in the higher-level control, interconnect the feedback signal "STO active".
- 4. Select "Test stop".



- 5. Set the monitoring time to a value to match your application.
- 6. Using this signal, the inverter signals that a forced checking procedure (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 basic STO function via F-DI.

Setting the filter for safety inputs (Page 154).

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

Parameter	Desc	Description	
p9601.7	Enab	able functions integrated in the drive (factory setting: 0)	
	1 sigr	nal: STO via the Power Module terminals has been enabled	
p9650	F-DI	F-DI switchover discrepancy time (Factory setting: 500 ms)	
p9661	Force	orced checking procedure STO via PM terminals time (Factory setting: 8 h)	
r9662	Force	orced checking procedure STO via PM terminals remaining time	
r9773	SI sta	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.	

# 5.10.4 Setting a safety output

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

### Requirements

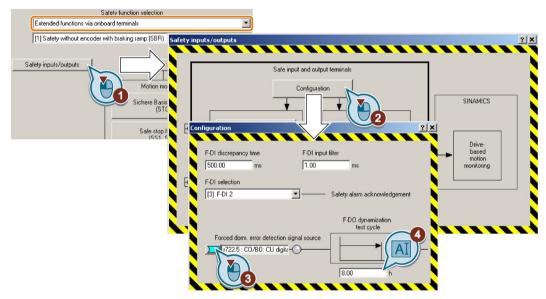
- You are online with STARTER or Startdrive.
- You have selected the extended functions via onboard terminals.

### Procedure with STARTER



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

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



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

We recommend that the safety-related output is tested together with the forced dormant error detection of the safety functions. To do this, interconnect the signal source with the same signal as the forced checking procedure of the safety functions.

Setting the forced dormant error detection (test stop) (Page 144)

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

The time must be longer than or equal to the time for monitoring the forced dormant error detection of the extended functions.

Setting the forced dormant error detection (test stop) (Page 144)

- 5. Close the two screen forms.

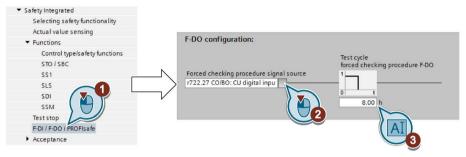
You have defined which signal the inverter uses to start the forced dormant error detection (test stop) of its safety-related output.

### Procedure with Startdrive



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

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



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

We recommend that the safety-related output is tested together with the forced dormant error detection of the safety functions. To do this, interconnect the signal source with the same signal as the forced checking procedure of the safety functions.

Setting the forced dormant error detection (test stop) (Page 144)

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

The time must be longer than or equal to the time for monitoring the forced dormant error detection of the extended functions.

Setting the forced dormant error detection (test stop) (Page 144)

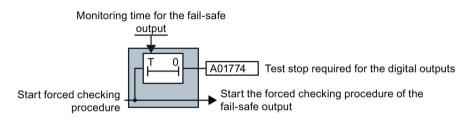
You have defined which signal the inverter uses to start the forced dormant error detection (test stop) of its safety-related output.

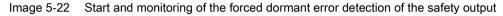
## Description: Forced dormant error detection of the safety output

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

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

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





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

5.10 Setting extended functions

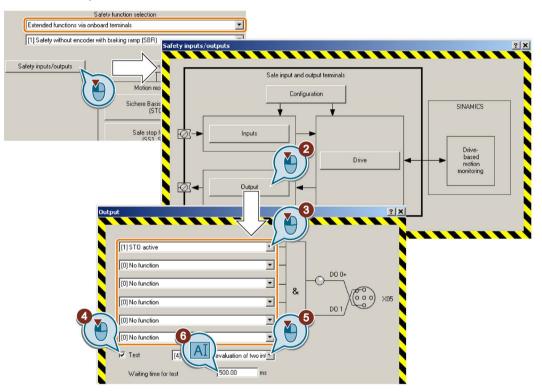
## 5.10.4.2 Output signal and setting the test mode

### Requirements

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

### Procedure with STARTER

- To set the safety-related output, proceed as follows:
  - 1. Press the "Safety inputs/outputs" button.
  - 2. Press the "Output" button.



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

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

- The inverter ignored inputs without interconnection.
- If none of the inputs is interconnected, then the output signal = 0.
- 4. Activate the test for the safety-related output.
- 5. Select the test mode that is compatible with your application.

- 6. Adjust the wait time. The following lower limits apply for the setting:
  - The wait time must be longer than the response time  $t_R$  of the connected actuator.
  - The wait time must be longer than or equal to 24 ms.
  - The wait time must be longer than the time for the input filter of the feedback input (p10017).

Setting the filter for safety inputs (Page 154)

7. Close the screen forms.

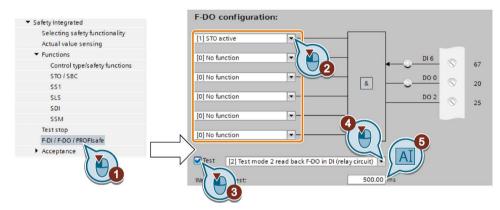
You have defined which signal the inverter transfers via its safety output, and how the inverter tests its safety-related output.

#### Procedure with Startdrive



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

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



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

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

- The inverter ignored inputs without interconnection.
- If none of the inputs is interconnected, then the output signal = 0.
- 3. Activate the test for the safety-related output.
- 4. Select the test mode that is compatible with your application.
- 5. Adjust the wait time. The following lower limits apply for the setting:
  - The wait time must be longer than the response time  $t_R$  of the connected actuator.
  - The wait time must be longer than or equal to 24 ms.
  - The wait time must be longer than the time for the input filter of the feedback input (p10017).

Setting the filter for safety inputs (Page 154)

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

5.10 Setting extended functions

## Signal "Safestate"

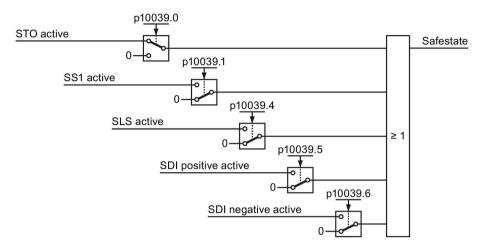


Image 5-23 The Safetstate signal in the factory setting

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

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

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

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

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

Connecting the safety output for SINAMICS G120D (Page 94)

Connecting the safety output for SINAMICS G120 (Page 92)

### Test mode 1

For test mode 1, the inverter switches the two outputs on and off alternating - and evaluates the voltage signal at output DO 2.

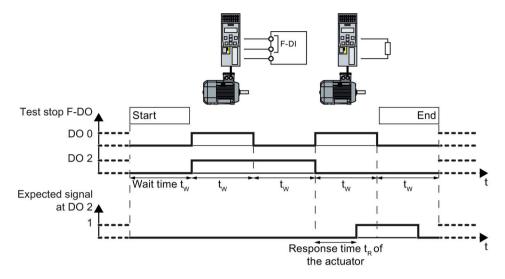


Image 5-24 Expected response at digital output DO 2 for test mode 1

### Test mode 2

For test mode 2, the inverter switches the two outputs on and off alternating, and evaluates the feedback via a digital input.

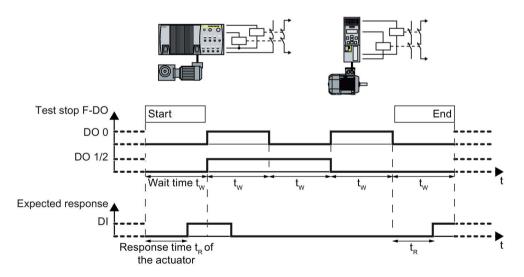


Image 5-25 Expected response at the digital input for test mode 2

### Test mode 3

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

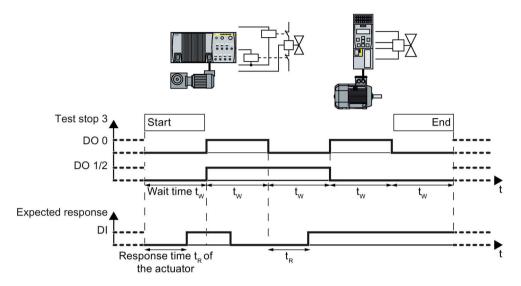


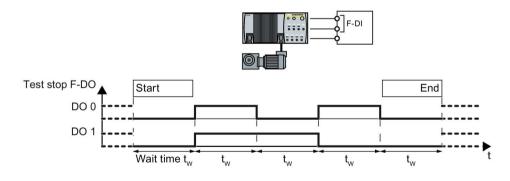
Image 5-26 Expected response at the digital input for test mode 3

### Test mode 4

When testing the safety-related output, the inverter switches the two outputs on and off alternating.

SINAMIC G120D inverters monitor their transistor outputs using internal signals.

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



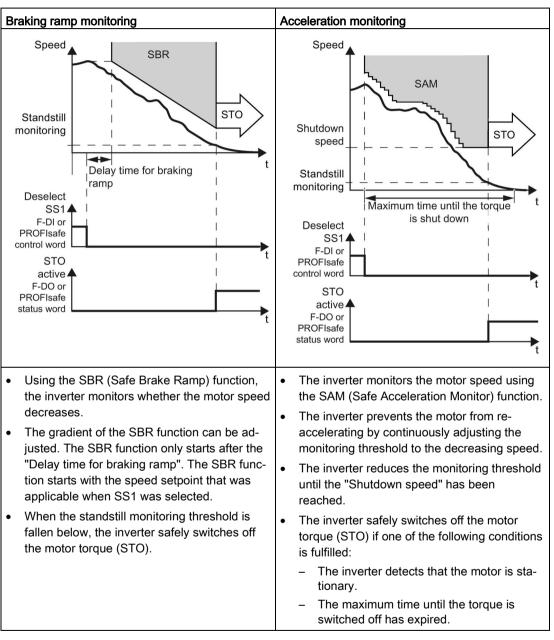


Parameter	Description
p10039	<b>Safe State signal selection</b> (factory setting: 0000 0001 bin) Setting the signals for the "Safe State" signal.
p10042[05]	<b>F-DO signal sources</b> (Factory setting: 0) Setting the 6 signal sources for F-DO.
p10046	<b>F-DO feedback signal input activation</b> (Factory setting: 0000 bin) Activation of the feedback input for the safety-related output.
p10047	<b>F-DO test mode</b> (Factory setting: 0100 bin) Setting the test mode for the safety-related output
p10001	Wait time for the forced checking procedure at DO (Factory setting: 500 ms) Within this time, for a forced checking procedure of the safety-related output, the signal must have been detected via the corresponding feedback input (p10047).
	The inverter always waits for a minimum of 24 ms.

# 5.10.5 Setting SS1

# Monitoring modes

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



## 5.10.5.1 Setting SS1 with braking ramp monitoring

### Requirement

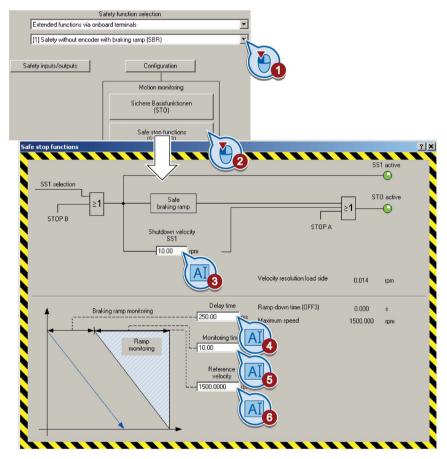
You are online with STARTER or Startdrive.

### Procedure with STARTER



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

- 1. Select "[1] Safety without encoder with braking ramp (SBR)".
- 2. Press the "Safe stop functions" button.



- 3. The shutdown speed SS1 is a condition for the transition into the STO function.
- 4. If the ramp-down time (OFF3) in your application is less than 10 seconds, then leave the delay time at its factory setting. If SS1 goes into a fault condition during the function test, increase this value until the motor brakes normally without a fault. If the ramp-down time (OFF3) is set to several minutes, you must extend the delay time to several seconds in order to avoid any unwanted faults when selecting SS1.
- 5. The monitoring time defines the gradient of the monitoring curve when braking the load. If the monitoring curve should be parallel to the down ramp of the load, then you must set the following: Monitoring time = ramp-down time (OFF3) / gear ratio. Gear ratio = load/motor revolutions.

Example: Gear ratio =  $1/3 \Rightarrow$  monitoring time = ramp-down time (OFF3) × 3.

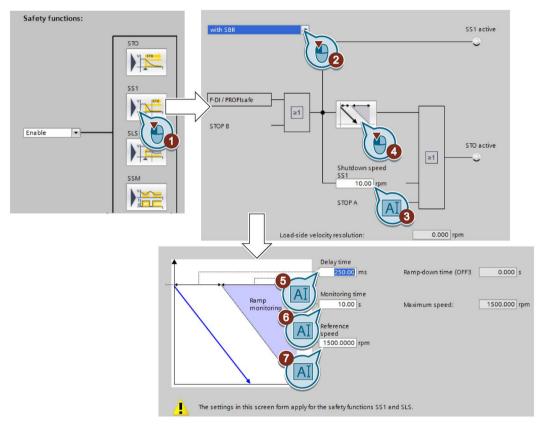
A monitoring time shorter than the above calculated value does not make sense, as the inverter can reduce its monitoring curve faster than the load can be braked. The longer you set the monitoring times, the more tolerant the monitoring.

- 6. Set the reference speed to the value of the maximum speed.
- 7. Close the screen form.

You have set the SS1 function with braking ramp monitoring.

### Procedure with Startdrive

- To set the SS1 function with braking ramp monitoring, proceed as follows:
- 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 =  $1/3 \Rightarrow$  monitoring time = ramp-down time (OFF3) × 3. A monitoring time shorter than the above calculated value does not make sense, as the inverter can reduce its monitoring curve faster than the load can be braked. The longer you set the monitoring times, the more tolerant the monitoring.

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

You have set the SS1 function with braking ramp monitoring.

### Description: SS1 with braking ramp monitoring

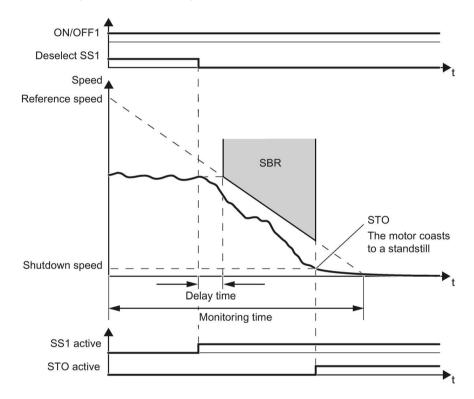


Image 5-28 SS1 with braking ramp monitoring

#### Reference speed and monitoring time

The two values define the gradient of the SBR monitoring .

### **Delay time**

The SBR function only starts after an adjustable time. To begin with, the inverter monitors the speed setpoint that applied when SS1 was selected.

### Braking

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

5.10 Setting extended functions

### Shutdown speed

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

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

## 5.10.5.2 Setting SS1 with acceleration monitoring

### Requirement

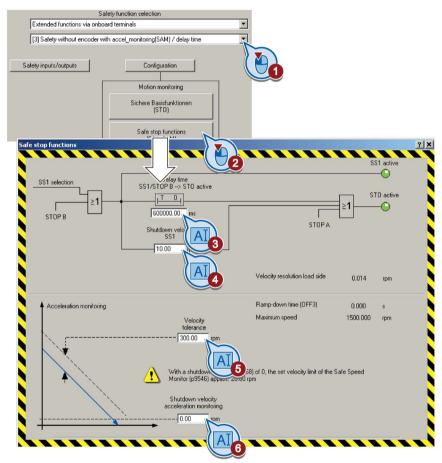
You are online with STARTER or Startdrive.

### Procedure with STARTER



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

- 1. Select "[3] Safety without encoder with accel\_monitoring (SAM)/delay time".
- 2. Press the "Safe stop functions" button.



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

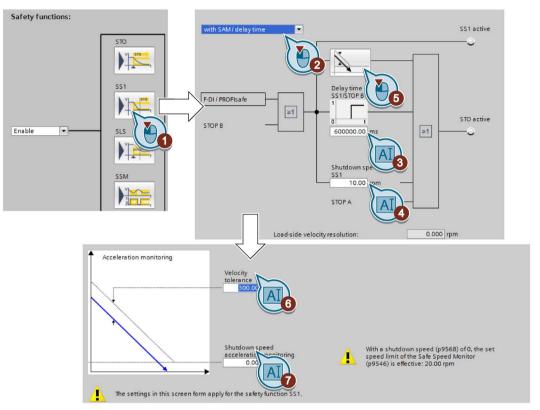
You have set the SS1 function with acceleration monitoring.

### Procedure with Startdrive



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

- 1. Press the button for the SS1 function.
- 2. Select "with SAM/delay time".



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

5.10 Setting extended functions

#### Description: SS1 with acceleration monitoring

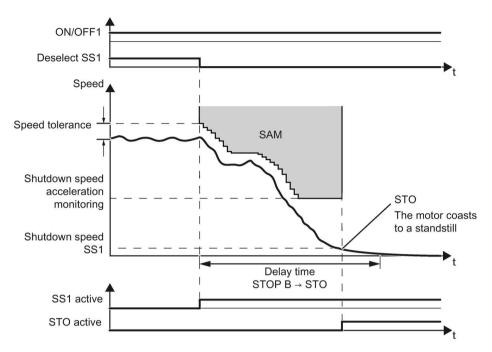


Image 5-29 SS1 with acceleration monitoring

#### Speed tolerance

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

#### Shutdown speed acceleration monitoring

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

#### Shutdown speed SS1 and delay time

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

- The actual speed reaches the value of the shutdown speed SS1.
- The delay time has expired.

#### Commissioning

5.10 Setting extended functions

Parameter	Dese	Description		
p9501.00		<b>1 signal:</b> Enable extended functions. <b>0 signal:</b> Disable extended functions.		
p9506	Fund	Function specification: (Factory setting: 1)		
	3:	With acceleration monitoring		
p9548	Spe	Speed tolerance (Factory setting: 300 rpm)		
p9556	Dela	Delay time STOP B → STO (Factory setting: 600000 ms)		
p9560	Shut	Shutdown speed SS1 (Factory setting: 10 rpm)		
p9568	Shut	Shutdown speed acceleration monitoring (Factory setting: 0 rpm)		
r9714	Spe	Speed diagnostics [rpm]		
	[0]	[0] <b>Load-side speed actual value</b> Electrical speed of the motor. For induction motors, the mechanical speed is obtained from the electrical speed and slip.		
	[1]	[1] Actual SAM/SBR speed limit		
r9722.1	1 sig	1 signal: SS1 active		
r9723.16	1 sig	1 signal: SAM/SBR active		
p1226		Standstill detection, speed threshold (Factory setting: 20 rpm)The inverter switches off the motor torque if the speed either fulfills		
p1227			the condition for standstill detec- tion or the shutdown speed p9569 has been reached.	

## 5.10.6 Setting SLS

### 5.10.6.1 Setting the monitoring functions

#### Requirement

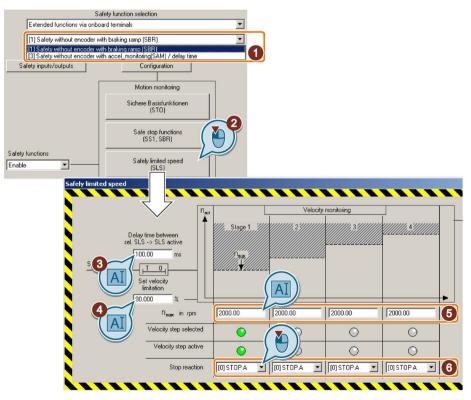
You are online with STARTER or Startdrive.

#### Procedure with STARTER



To set the SLS function, proceed as follows:

- 1. In the main screen form of the extended functions, select one of the two monitoring modes:
  - [1] Safety without encoder with braking ramp (SBR)
  - [3] Safety without encoder with accel\_monitoring (SAM)/delay time
- 2. Select the SLS safety function.



- 3. The delay time only appears if you have selected acceleration monitoring (SAM). The delay time must be longer than the time, when SLS is selected, that the motor needs to brake with the maximum load from the maximum speed down to the lowest SLS level.
- 4. Setpoint speed limiting as a % of the currently selected SLS level. The inverter limits the speed to this value when SLS is active.
- 5. Load speed to be monitored. Levels 2 ... 4 are only possible when PROFIsafe is selected as interface.

5.10 Setting extended functions

6. Response when monitoring responds.

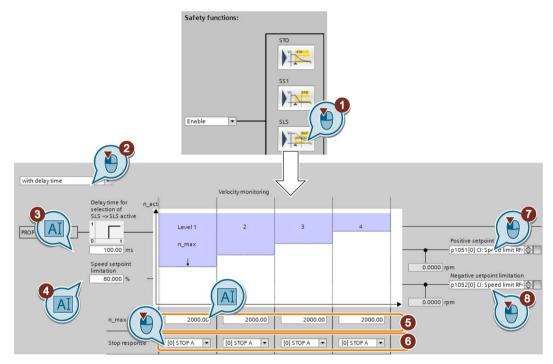
Stop responses (Page 294)

7. Close the screen form.

You have set the SLS function.

#### Procedure with Startdrive

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



- 2. Select between one of the two monitoring modes:
  - with delay time
  - with SBR
- 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 175)

- 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 294)

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



You have set the SLS function.

#### Description of the SLS function

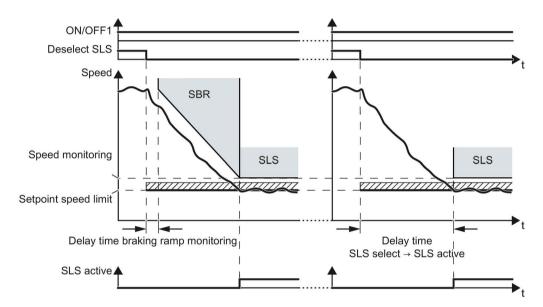


Image 5-30 Behavior after selecting SLS. Left: with braking ramp monitoring; right: without braking ramp monitoring

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

Setting SS1 with braking ramp monitoring (Page 175)

#### Commissioning

5.10 Setting extended functions

Parameter	Des	cription
p1051	<b>Speed limit RFG positive direction of rotation</b> (Factory setting depends on the Control Unit)	
p1052	<b>Speed limit RFG negative direction of rotation</b> (Factory setting depends on the Control Unit)	
p1135	OFF	3 ramp-down time
p9501.00		gnal: Enable SLS and extended functions. gnal: Inhibit SLS and extended functions.
p9506	Fun	ction specification: (Factory setting: 1)
	1:	With braking ramp monitoring
	3:	Without braking ramp monitoring
p9531[03]	Spe	ed monitoring (Factory setting for all levels: 2000 rpm)
p9533	<b>Setpoint speed limiting</b> (Factory setting: 80 %) The inverter limits the setpoint to the value r9733. r9733[0] = p9531[x] × p9533.	
p9551		ay time SLS selection → SLS active (Factory setting: 100 ms) active for braking ramp monitoring.
p9563[03]	SLS	-specific stop response (Factory setting: STOP A)
	0:	STOP A
	1:	STOP B
p9581	Refe	erence speed (Factory setting: 1500 rpm)
p9582	Dela	ay time (Factory setting: 250 ms)
p9583	Monitoring time (Factory setting: 10 s) The gradient of the braking ramp depends on p9581 and p9583.	
r9714	Spe	ed diagnostics [rpm]
	[0]	<b>Load-side speed actual value</b> Electrical speed of the motor. For induction motors, the mechanical speed is obtained from the electrical speed and slip.
	[1]	Actual SAM/SBR speed limit
	[2]	Actual SLS speed limit
r9722.04	1 signal: SLS active 0 signal: SLS not active	
r9733	Effe	ctive setpoint speed limiting
	[0]	Positive setpoint limitation
	[1]	Negative setpoint limitation
	[2]	Absolute setpoint speed limitation

### 5.10.6.2 Settings for acceptance test

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

STARTER offers you the possibility to temporarily deactivating speed limiting.

#### Requirement

You are online with STARTER or Startdrive.

#### Procedure with STARTER and Startdrive

To prepare for acceptance, proceed as follows:

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



Image 5-31 Set the time for the acceptance mode in STARTER



Image 5-32 Set the time for the acceptance mode in Startdrive

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

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

- 3. Only applies to STARTER: Close the screen form.
- You have made the preparations for the function to be accepted.

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

#### Commissioning

5.10 Setting extended functions

### 5.10.7 Setting SSM

#### Requirement

You are online with STARTER or Startdrive.

#### Procedure with STARTER and Startdrive



- To set the SSM function, proceed as follows:
- 1. Open the screen form for the SSM safety function.

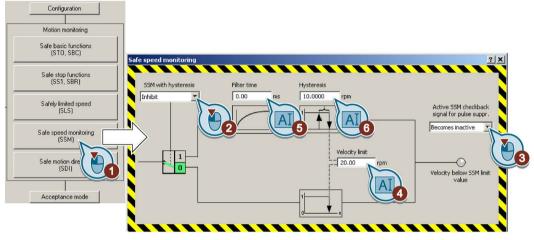


Image 5-33 Open the screen form for SSM in STARTER

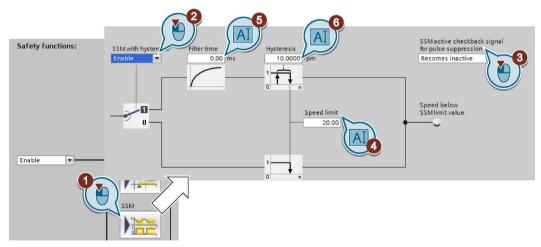


Image 5-34 Open the screen form for SSM in Startdrive

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

If you have set the SSM feedback signal for pulse cancellation as "remains active", when switching on the motor, you must maintain a specific signal sequence.

Switching on the motor when SSM is active (Page 278)

4. Set the speed to be monitored.

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

You have set the SSM function.

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

#### SSM without hysteresis

#### Speed monitoring

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

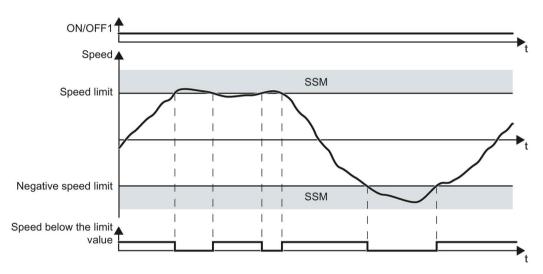


Image 5-35 Time response of the SSM safety function without hysteresis

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

#### Commissioning

5.10 Setting extended functions

#### SSM with hysteresis

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

#### Speed monitoring

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

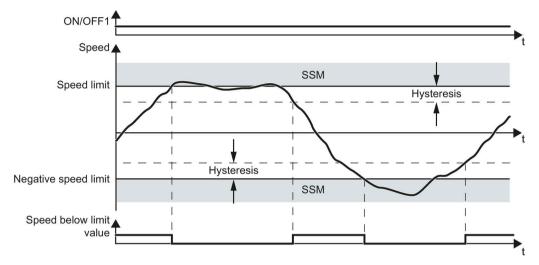


Image 5-36 Time response of the SSM safety function with hysteresis

#### Filter

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

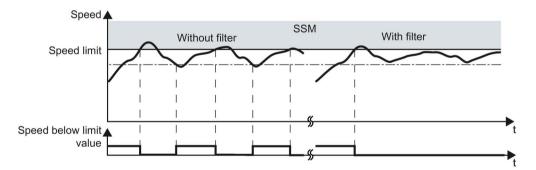


Image 5-37 Mode of operation of the filter of the SSM function

5.10 Setting extended functions

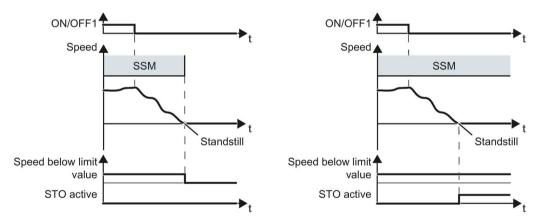
Parameter	Description
p9501.00	<ol> <li>1 signal: Enable extended functions.</li> <li>0 signal: Disable extended functions.</li> </ol>
p9501.16	<b>1 signal:</b> Enable hysteresis and filtering <b>0 signal:</b> Disable hysteresis and filtering
p9545	Filter time (Factory setting: 0 ms)
p9546	Speed limit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

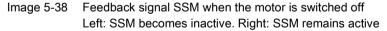
#### Feedback signal SSM when the motor is switched off

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





Switching off the motor when SSM is active (Page 273)

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

#### Commissioning

5.10 Setting extended functions

### 5.10.8 Setting SDI

#### 5.10.8.1 Setting the monitoring functions

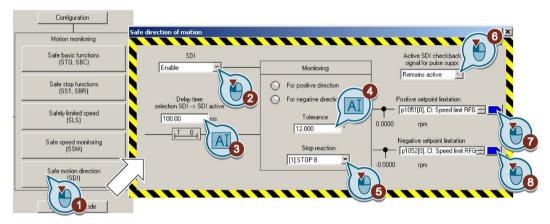
#### Requirement

You are online with STARTER or Startdrive.

#### Procedure with STARTER



- Proceed as follows to set the SDI function:
- 1. Press the button for SDI.



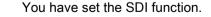
- 2. Enable the function.
- 3. Delay time up to active monitoring.
- 4. Tolerance for motion in the monitored direction.
- 5. Response when the monitoring function responds.

Stop responses (Page 294)

6. The response when the motor is switched off.

Switching off the motor when SDI is active (Page 283)

- 7. If you leave this signal interconnection at the factory setting, when SDI- is selected, the inverter limits the speed.
- 8. If you leave this signal interconnection at the factory setting, when SDI+ is selected, the inverter limits the speed.
- 9. Close the screen form.

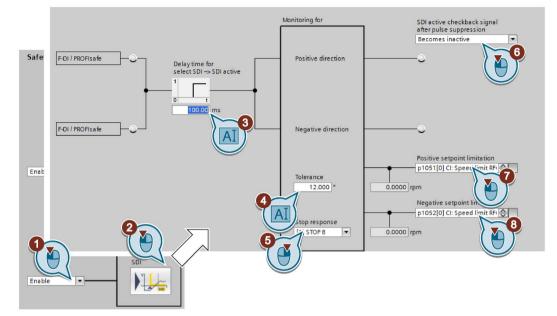


#### Procedure with Startdrive



Proceed as follows to set the SDI function:

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



- 3. Delay time up to active monitoring.
- 4. Tolerance for motion in the monitored direction.
- 5. Response when the monitoring function responds.

Stop responses (Page 294)

6. Behavior when the motor is switched off.

Switching off the motor when SDI is active (Page 283)

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

#### Commissioning

5.10 Setting extended functions

### The SDI function

#### Time response

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

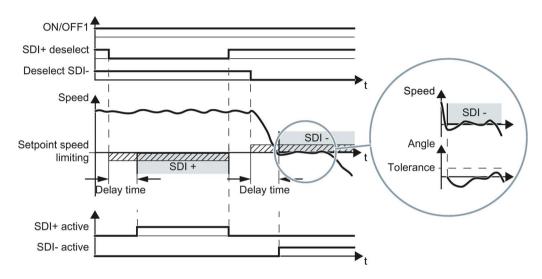


Image 5-39 Delay time and tolerance

#### **Delay time**

The inverter monitors the direction of rotation of the motor after the delay time has expired. When SDI is selected, the delay time must be longer than the time that the motor requires to brake the maximum load from maximum speed down to standstill. The inverter brakes the motor with the OFF3 ramp-down time.

#### Tolerance

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

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

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

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

5.10 Setting extended functions

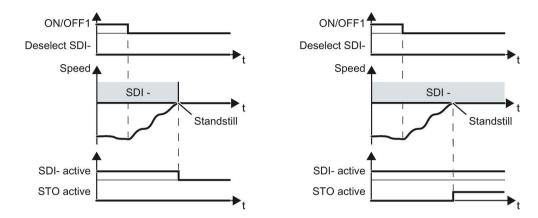


Image 5-40 Feedback signal SDI when the motor is switched off Left: SDI becomes inactive. Right: SDI remains active

Switching off the motor when SDI is active (Page 283)

Parameter	Description		
p1051	<b>Speed limit RFG positive direction of rotation</b> (Factory setting depends on the Control Unit)		
p1052	-	<b>Speed limit RFG negative direction of rotation</b> (Factory setting depends on the Control Unit)	
p1135	OFF	3 ramp-down time	
p9501.00		<b>nal:</b> Enable extended functions. <b>nal:</b> Disable extended functions.	
p9501.17		1 signal: Enable SDI 0 signal: Inhibit SDI	
p9509.08		<b>1 signal:</b> SDI becomes inactive when the motor is switched off <b>0 signal:</b> SDI remains active when the motor is switched off	
p9564	Tole	Tolerance (Factory setting: 12 degrees)	
p9565	Dela	Delay time (Factory setting: 100 ms)	
p9566	Stop	Stop response (Factory setting: 1)	
0: STOP		STOP A	
	1:	STOP B	
r9714[0]	<b>Load-side speed actual value</b> [rpm] Electrical speed of the motor. For induction motors, the mechanical speed is obtained from the electrical speed and slip.		
r9722.12	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	

#### Commissioning

5.10 Setting extended functions

### 5.10.8.2 Settings for acceptance test

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

STARTER offers you the possibility to temporarily deactivating speed limiting.

#### Requirement

You are online with STARTER or Startdrive.

#### Procedure with STARTER and Startdrive

To prepare for acceptance, proceed as follows:

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



Image 5-41 Set the time for the acceptance mode in STARTER



Image 5-42 Set the time for the acceptance mode in Startdrive

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

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

- 3. Only applies to STARTER: Close the screen form.
- You have made the preparations for the function to be accepted.

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



## 5.10.9 Final steps when commissioning online

### Activate settings

### Requirement

You are online with STARTER or Startdrive online.

#### Procedure with STARTER



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

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



- 2. Press the "Activate settings" button.
- 3. If the password is the factory default, you are prompted to change the password. If you try to set a password that is not permissible, the old password will not be changed.
- 4. Confirm the prompt for saving your settings (copy RAM to ROM).
- 5. Switch off the inverter supply voltage.
- 6. Wait until all LEDs on the inverter go dark (no voltage condition).
- 7. Switch on the inverter supply voltage again.
- Your settings are now active.

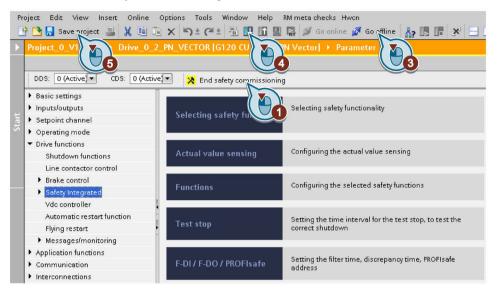
5.10 Setting extended functions

#### Procedure with Startdrive



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

1. Click the "End safety commissioning" button.



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

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

### Checking the connection of digital inputs

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

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

#### Procedure with STARTER



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

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

E A Safety_0	Digital inputs Relay outputs Analog inputs Analog outputs Measuring Input
Insert single drive unit	Current I/O configuration: 12
🖃 🕂 💭 G120_inverter	Current 1/D contiguration: 12
😑 🛖 👩 Control_Unit	
Configuration	
Expert list	
🛛 💥 Drive navigator	5 Digital input 0 inverted
≫ Setpoint char	6 DI 1 Terminal eval. Digital input 1 Digital input 1 Digital input 1 inverted
⊕ ≫ Open-loop/clc/ ▼	
E-> Functions	DI 2 Terminal eval.
-> Shutdown	7 0 p2103(0), Bl: 1. Acknowledge fe
> Brake control	DI 3 Terminal eval. V Digital input 3 Digital input 3
Safety Integrated	s logical input 3 Digital input 3 Digital input 3 Inverted
> Flying-restart > Automatic restart	3 te O DI 4 Terminal eval. T Digital input 4 Digital input 4 Digital input 4 invested
Messages and monitoring	3 16 0 Digital input 4 inverted Digital input 4 inverted Digital input 4 inverted Digital input 4 inverted
E ≫ Technology controller	EDIO Distribute E
E → Commissioning	17 O Terminal eval Terminal ev
E Communication	
T Diagnostics	
Documentation	DI 11 Digital input 11
E SINAMICS LIBRARIES	
E C MONITOR	Digital input 12 Digital input 12 Digital input 12 Digital input 12
	9 - + +24V Note: Activation of the terminals via internal or external
	28 Q = 0V 24 V power supply (see online help).
	7
	4 CDS: 0 (Activ 🔽 DDS: 0 (Activ 🝸 MDS: 0 (Active) 🕸 💋 Close Help
Project	A Control Unit

Image 5-43 Removing the DI 4 and DI 5 digital-input connections

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

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

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

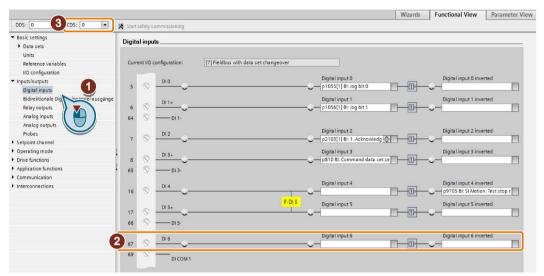
5.10 Setting extended functions

#### Procedure with Startdrive



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

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



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

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

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

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

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

#### Preconditions

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

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

#### Procedure with STARTER



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

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

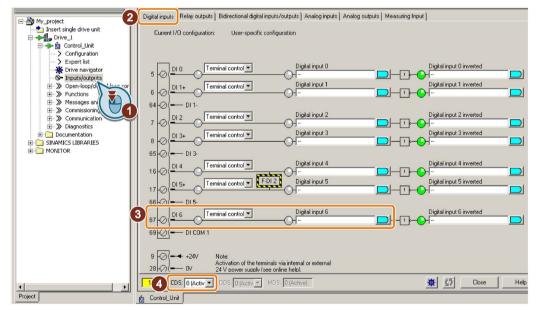


Image 5-44 Removing the interconnection of the feedback signal input DI 6 for the CU250S-2

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

5.10 Setting extended functions

#### Procedure with Startdrive



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

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

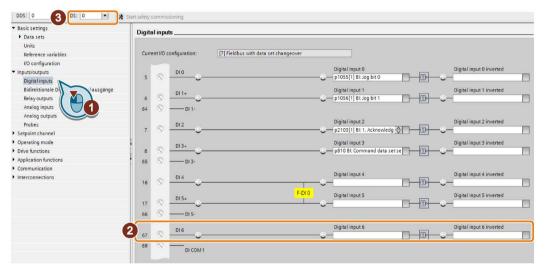


Image 5-45 Removing the interconnection of the feedback signal input DI 6 for the CU250S-2

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

# 5.11 Activating Shared Device

### **Enabling Shared Device**

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

#### Requirement

You are online with STARTER or Startdrive.

### Procedure with STARTER and Startdrive



- To configure communication via "Shared Device" in the inverter, proceed as follows:
- 1. In STARTER change to the expert list, or in Startdrive, to the parameter view.
- 2. Set p8929 = 2.

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

5.12 Starting communication via PROFIsafe

# 5.12 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.

# 5.13 Offline commissioning using STARTER

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

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

### Setting the safety functions offline

#### Procedure



To set the safety functions offline, proceed as follows:

- 1. Select the safety functions in STARTER.
- 2. Set the check mark "Copy parameters after download":

	(331, 351)
Safety functions	Safely limited speed (SLS)
	Safe speed monitoring (SSM)
	Safe motion direction (SDI)
Copy parameters after download	Acceptance mode

Set the safety function parameters offline.
 When doing this, orientate yourself to the descriptions of the online commissioning

Configuring safety functions (Page 109)

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

You have set the safety functions of the inverter offline, and saved them to your PC or PG. In the next step, you must transfer the settings from your PC or PG to the inverter. 5.13 Offline commissioning using STARTER

### Loading the settings into an inverter using STARTER

#### Procedure



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

- Go online with STARTER and start to download to the inverter using the button after the download, the inverter signals faults. Ignore these faults, as they will be automatically acknowledged by the following steps.
- 2. Select the screen form for the safety functions.
- 3. Select the button to change the settings.
- 4. Activate the settings using the associated button.
- 5. Save your settings (copy RAM to ROM).
- 6. Switch off the inverter supply voltage.
- 7. Wait until all LEDs on the inverter go dark.
- 8. Switch on the inverter supply voltage again.
- The inverter has taken the settings from the STARTER project.

# 5.14 Series commissioning

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

### Procedure



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

- 1. Save your project to your PC or PG.
- 2. Loading your backed up settings to a second inverter:

Offline commissioning using STARTER (Page 205)

3. If you control your inverter via PROFIsafe, you have to modify the PROFIsafe address.

Configuring safety functions (Page 107)

4. Perform a reduced acceptance for the safety functions.

Reduced acceptance after a component has been replaced and a firmware change (Page 361)

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

5.15 Acceptance tests for the safety functions

## 5.15 Acceptance tests for the safety functions

#### 5.15.1 Acceptance test

#### What is an acceptance?

The machine manufacturer is responsible in ensuring that his plant or machine functions perfectly. As a consequence, after commissioning, the machine manufacturer must check those functions or have them checked by specialist personnel, which represent an increased risk of injury 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.
  - $\rightarrow$  Acceptance test.
- Generate an "Acceptance report" that describes the test results.
  - $\rightarrow$  Documentation.

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

#### Acceptance test of the machine or plant

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

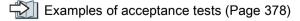
Testing the safety-related functions includes, e.g. the following:

- Are all safety equipment such as protective door monitoring devices, light barriers or emergency-off switches connected and ready for operation?
- Does the higher-level control respond as expected to the safety-relevant feedback signals of the inverter?
- Do the inverter settings match the configured safety-relevant function in the machine?

#### Acceptance test of the inverter

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

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



5.15 Acceptance tests for the safety functions

### Documentation of the inverter

The following must be documented for the inverter:

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

The STARTER commissioning tool logs the settings of the integrated drive functions, if necessary.

Documentation for acceptance (Page 412)

The documentation must be signed.

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

Personnel from the machine manufacturer, who, on account of their technical qualifications and knowledge of the safety functions, are in a position to perform the acceptance test in the correct manner are authorized to perform the acceptance testing of the inverter. 5.15 Acceptance tests for the safety functions

### 5.15.2 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.

Measure	Acceptance test	Documentation
Changing a single limit (e.g. SLS level).	Check the modified limit value.	<ul> <li>Supplement function table</li> <li>Log modified settings</li> <li>Document the changed checksum and time stamp <sup>1)</sup></li> <li>Countersignature</li> </ul>
Functional expansion of the machine (additional drive).	Check the safety functions of the new drive.	<ul> <li>Supplement machine overview</li> <li>Supplement article number and firmware version of the drive</li> <li>Supplement function table</li> <li>Log the settings of the new drive</li> <li>Document the changed checksum and time stamp <sup>1)</sup></li> <li>Countersignature</li> </ul>
Functional expansion of a drive (e.g. additional SLS level or new safety function following a firmware update).	Check the additional functions.	<ul> <li>Supplement function table</li> <li>Log modified settings</li> <li>Document the changed checksum and time stamp <sup>1)</sup></li> <li>Countersignature</li> </ul>
Transfer of inverter settings to other identi- cal machines by means of series commissioning.	Check the control and feedback signal of all safety functions.	<ul> <li>Supplement machine description</li> <li>Log modified settings</li> <li>Check the changed checksum and time stamp <sup>1)</sup></li> <li>Check the firmware versions</li> </ul>

 Table 5-1
 Reduced acceptance test after expanding the function

<sup>1)</sup> The inverter 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 361)

# Operation

## 6.1 About this chapter

### What can you find in this Chapter?

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

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

6.2 Regularly testing the safety functions

# 6.2 Regularly testing the safety functions

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

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

• The inverter must test its safety-related input if you are using a safety input.

Testing safety inputs (Page 213)

• The inverter must test its safety functions:

Testing the basic functions (Page 214)

Testing the extended functions (Page 216)

• The inverter must test its safety output if you are using a safety-related output.

Testing a safety output (Page 218)

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

You must initiate the following function tests at least once every three months in order to maintain the guaranteed failure probability of the "STO via Power Module terminals" function:

• The inverter must test the safety-related input on the Power Module.

Testing safety inputs (Page 213)

• The inverter must test the "STO via Power Module terminals" function.

Testing the basic functions (Page 214)

## 6.2.1 Testing safety inputs

#### Testing sensors and safety inputs

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

#### Procedure



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

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

You have checked the safety-related inputs.

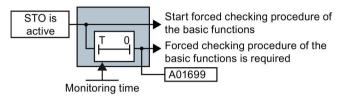
Inverter signals	Parameter	Included in the PROFIsafe telegram	Can be intercon- nected with	
			F-DI	F-DO
Internal event	r9722.7	1		~
STO active (basic functions)	r9773.1	1		~
STO active (extended functions)	r9722.0	1		$\checkmark$
SS1 active (basic functions)	r9773.6	1		~
SS1 active (extended functions)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

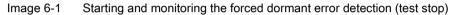
6.2 Regularly testing the safety functions

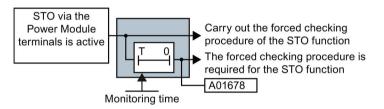
## 6.2.2 Testing the basic functions

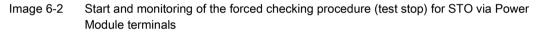
### Time

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









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

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

Inverter signals	Parameter	Included in the PROFIsafe telegram	Can be intercon- nected with	
			F-DI	F-DO
STO active (basic functions)	r9773.1	$\checkmark$		$\checkmark$
STO deselection (basic functions)	r9773.0	$\checkmark$	$\checkmark$	
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			

6.2 Regularly testing the safety functions

### Carry out a forced checking procedure of the basic functions

#### Preconditions

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

#### Procedure



- To start the forced dormant error detection, proceed as follows:
- 1. Select the STO function.
- 2. The inverter checks its safety-related circuits. This check takes several milliseconds.
- 3. Deselect the STO function.
- 4. Check that alarm A01699 is no longer present.
- You have performed the forced dormant error detection.

### Carry out 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



- To start the forced dormant error detection, proceed as follows:
- 1. Select the "STO via Power Module terminals" function.
- 2. The inverter 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 dormant error detection.

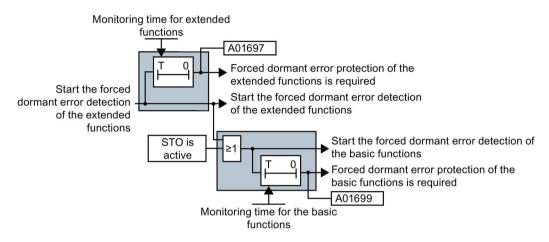
#### Operation

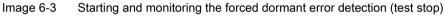
6.2 Regularly testing the safety functions

### 6.2.3 Testing the extended functions

#### Time

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





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

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

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

## Performing a forced checking procedure (test stop)

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

#### Preconditions

• STO is not active.

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

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

#### Procedure



- To start the forced dormant error detection of the extended functions, proceed as follows:
- 1. Start the forced dormant error detection using a signal of your choice, for example a digital input.
- 2. The inverter checks its safety-related circuits. During the check, the inverter outputs alarms C01798 and C30798. This check takes several milliseconds.
- 3. Set the signal to start the forced dormant error detection to zero.
- 4. Check that neither alarm A01699 nor alarm A01697 is active.
- 5. Check the safety-related inputs of the inverter.

Testing safety inputs (Page 213)

6. Check the safety-related output of the inverter.

Testing a safety output (Page 218)

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

#### Operation

6.2 Regularly testing the safety functions

## 6.2.4 Testing a safety output

#### Time of the test

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

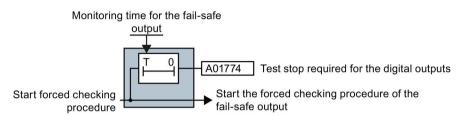


Image 6-4 Start and monitoring of the forced dormant error detection (test stop) of the safety-related output

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

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

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

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

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

#### Procedure



- To test the safety-related output, proceed as follows:
- 1. Switch on the motor (ON/OFF1 command = 1).

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

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

6.2 Regularly testing the safety functions

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

Output signal and setting the test mode (Page 168)

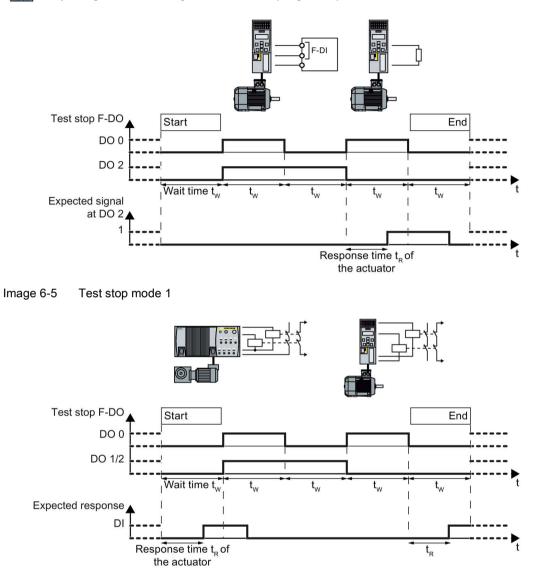


Image 6-6 Test stop mode 2

6.2 Regularly testing the safety functions

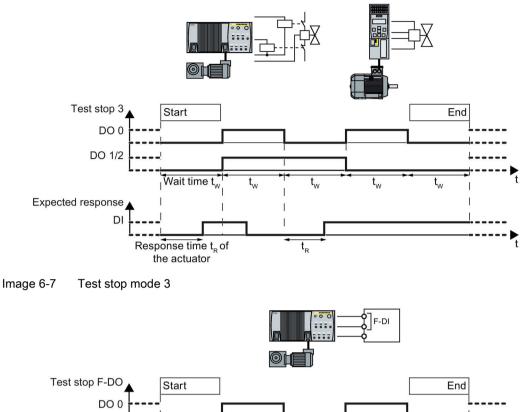




Image 6-8 Test stop mode 4

# 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 deselecting STO	Selecting and deselecting STO when the motor is switched on (Page 222)
Discrepancy in the input signal	The safety input to select STO identifies an error. Response to a discrepancy when STO is active (Page 224)

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

	Switching on the motor (ON/OFF1 = $0 \rightarrow 1$ )	Switching off the motor (ON/OFF1, OFF2 or OFF3 = $1 \rightarrow 0$ )		
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 Safe Torque Off (STO)

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

## Select STO

#### Function

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

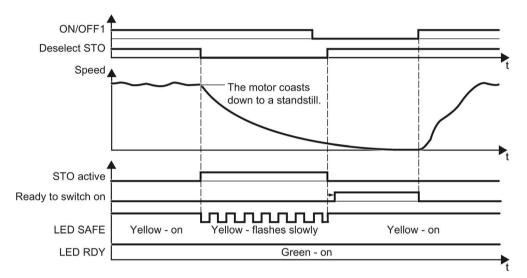


Image 6-9 Time response of the STO safety function (Safe Torque Off)

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

## Switching on the motor once STO is active

#### Procedure



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

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

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

- 3. Switch on the motor: ON/OFF1 = 1.
- You have switched on the motor.

#### Operation

6.3 Safe Torque Off (STO)

## 6.3.3 Response to a discrepancy when STO is active

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

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

- You are using the basic functions according to SIL  $2 \rightarrow$  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

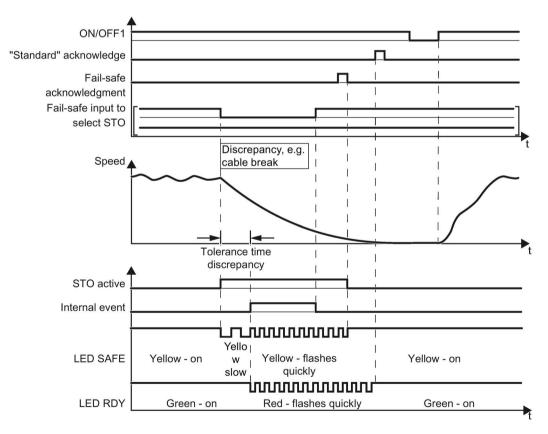


Image 6-10 Inverter response for discrepancy of the input signal for STO (example: Cable break in the channel of processor P1)

Inverter messages after the tolerance time has expired:

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

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

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

6.3 Safe Torque Off (STO)

## Case 1: Switching on the motor after a discrepancy

#### Procedure



- To switch the motor on again, proceed as follows:
- 1. Remove the discrepancy.
- 2. Acknowledge the internal event.

Selected setting	Selected setting How can the internal event be acknowledged?				
	F-DI	PROFIsafe	Alternative		
Basic functions via onboard terminals	Select and deselect STO (F-DI = $1 \rightarrow 0 \rightarrow 1$ )		Switch off the power supply voltage and switch on again.		
Basic functions via PROFIsafe and onboard terminals	Select and deselect STO (F-DI = $1 \rightarrow 0 \rightarrow 1$ )	Select and deselect STO (PROFIsafe control word 1, bit $0 = 1 \rightarrow 0 \rightarrow 1$ ) or Select and deselect SS1 (PROFIsafe control word 1, bit $1 = 1 \rightarrow 0 \rightarrow 1$ ) or Fail-safe acknowledgment (PROFIsafe control word 1, bit $7 = 0 \rightarrow 1 \rightarrow 0$ )	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 = $1 \rightarrow 0 \rightarrow 1$ )	Select and deselect STO (PROFIsafe control word 1, bit $0 = 1 \rightarrow 0 \rightarrow 1$ ) or Select and deselect SS1 (PROFIsafe control word 1, bit $1 = 1 \rightarrow 0 \rightarrow 1$ ) or Fail-safe acknowledgment (PROFIsafe control word 1, bit $7 = 0 \rightarrow 1 \rightarrow 0$ )	Switch off the power supply voltage and switch on again.		

- 3. Acknowledge the inverter with the "standard" acknowledge signal.
- 4. Issue an OFF1 command (ON/OFF1 = 0).
- 5. Switch on the motor (ON/OFF1 = 1).
- You have acknowledged the discrepancy message, and switched on the motor again.

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

ON/OFF1 "Standard" acknowledge Fail-safe acknowledgment Ĩ I Fail-safe input to select Т STO Discrepancy, e.g. Speed cable break Tolerance time discrepancy STO active ாா LED SAFE Yellow - on Yellow - slow Yellow - on immmmmi LED RDY Green - on Red - flashes quickly Green - on

You have selected the extended functions via onboard terminals.

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

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

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

Inverter signal	Parameter	Included in the PROFIsafe telegram	Can be intercon- nected with	
			F-DI	F-DO
Internal event	r9722.7	$\checkmark$		$\checkmark$
STO active (extended functions)	r9722.0	$\checkmark$		$\checkmark$
Deselect STO (extended functions)	r9720.0	$\checkmark$	$\checkmark$	
"Standard" acknowledgment	p2103			
Fail-safe acknowledgment	r9720.7	1	$\checkmark$	
ON/OFF1	r0054.0			

6.3 Safe Torque Off (STO)

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

#### Procedure



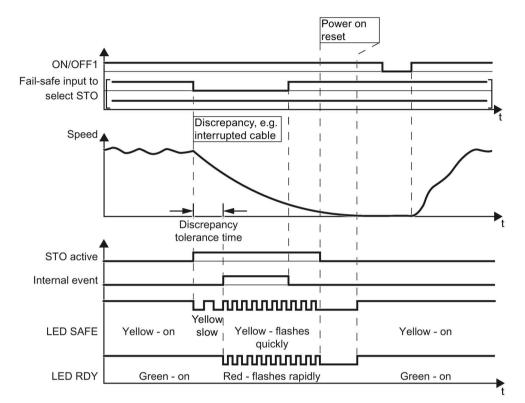
To switch the motor on again, proceed as follows:

- 1. Remove the discrepancy.
- 2. Acknowledge the discrepancy message with a fail-safe acknowledge signal via a safety-related input: F-DI = 0  $\rightarrow$  1  $\rightarrow$  0.

Alternatively: Switch off the power supply voltage and switch on again.

- 3. Acknowledge the inverter using the "standard" acknowledgment signal.
- 4. Issue an OFF1 command (ON/OFF1 = 0).
- 5. Switch on the motor (ON/OFF1 = 1).
- You have acknowledged the discrepancy message, and switched on the motor again.

## Case 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 Power Module.

Inverter messages after the tolerance time has expired:

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

Inverter signal	Parameter	Included in the PROFIsafe telegram	Can be intercon- nected with	
			F-DI	F-DO
Internal event	r9722.7	$\checkmark$		$\checkmark$
STO active (basic functions)	r9773.1	$\checkmark$		~
STO deselection (basic functions)	r9773.0	$\checkmark$	$\checkmark$	
STO cause – selection via Power Module terminals	r9772.25			
"Standard" acknowledgment	p2103			
Fail-safe acknowledgment	r9720.7	$\checkmark$	$\checkmark$	
ON/OFF1	r0054.0			

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

6.3 Safe Torque Off (STO)

#### Case 3: Switch on the motor after a discrepancy

#### Procedure



- To switch the motor on again, proceed as follows:
- 1. Remove the discrepancy.
- 2. Acknowledge the discrepancy message

Selected setting	How can the internal	event be acknowledged?	
	F-DI <sup>1)</sup>	PROFIsafe	Alternative
Basic functions via onboard terminals	Select and deselect STO (F-DI = $1 \rightarrow 0 \rightarrow 1$ )		Switch off the power supply voltage and switch on again.
Basic Functions via PROFIsafe and onboard terminals or	Select and deselect STO (F-DI = $1 \rightarrow 0 \rightarrow 1$ )	Select and deselect STO (PROFIsafe control word 1, bit $0 = 1 \rightarrow 0 \rightarrow 1$ ) or	Switch off the power supply voltage and switch on again.
Extended Functions via PROFIsafe and Basic Functions via		Select and deselect SS1 (PROFIsafe control word 1, bit $1 = 1 \rightarrow 0 \rightarrow 1$ )	
onboard terminals		or Fail-safe acknowledgment (PROFIsafe control word 1, bit 7 = 0 $\rightarrow$ 1 $\rightarrow$ 0)	

- <sup>1)</sup> The message cannot be acknowledged using the Power Module terminals.
- 3. Acknowledge the inverter with the "standard" acknowledge signal.
- 4. Issue an OFF1 command (ON/OFF1 = 0).
- 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 inverter 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 inverter via the Safe Brake Relay, then the SBC function is active under the following conditions:

- 1. You have activated the "motor holding brake" function in the inverter.
- 2. You have enabled the SBC function.
- 3. The STO function is active in the inverter.

#### Selecting STO when the motor is at a standstill

#### Function

- 1. The higher-level control switches the motor off: ON/OFF1 = 0 or OFF3 = 0.
- 2. When the drive has come to a standstill, the control selects the STO function.

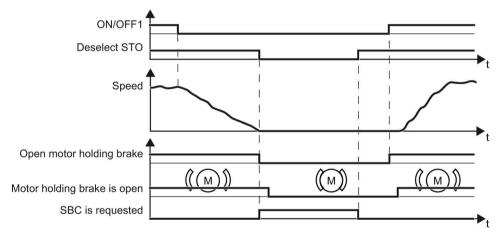


Image 6-13 Wait until standstill is reached and activate SBC with STO

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

Inverter signal	Parameter	Included in the PROFIsafe telegram	Can be intercon- nected with	
			F-DI	F-DO
STO deselection (basic functions)	r9773.0	√	$\checkmark$	
Deselect STO (extended functions)	r9720.0	1	$\checkmark$	
SBC requested (basic functions)	r9773.4			
ON/OFF1	r0054.0			
Release motor holding brake	r0899.12			
Close motor holding brake	r0899.13			

#### Operation

6.4 Safe Brake Control (SBC)

#### Selecting SS1 when the motor is rotating

#### Function

- 1. The higher-level control selects the SS1 function
- 2. The inverter brakes the motor with the OFF3 ramp-down time.
- 3. The inverter closes the motor holding brake once the motor is at a standstill.
- 4. If the standstill monitoring is undershot, or once the delay time has expired, the inverter activates the STO function and controls the brake with the SBC function.

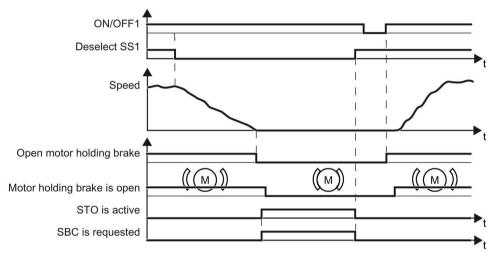


Image 6-14 When selecting SS1, the motor holding brake closes at standstill

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

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

## Selecting STO when the motor is rotating

#### Function

- 1. The higher-level control selects the STO function.
- 2. The inverter closes the brake without taking the current speed into consideration.

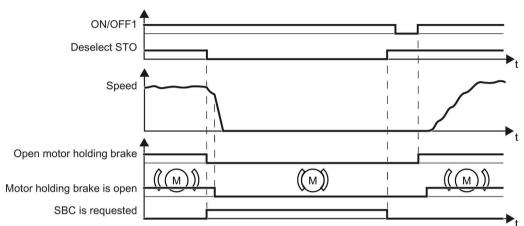


Image 6-15 The motor holding brake closes after selecting STO

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

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

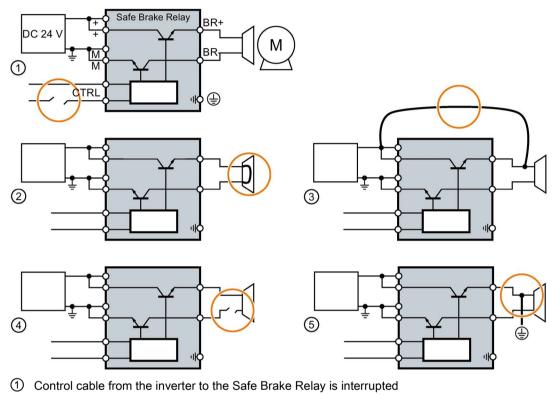
#### Operation

6.4 Safe Brake Control (SBC)

## 6.4.2 Response to faults in the brake control

#### Faults in the brake control

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



- 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

Image 6-16 Examples of faults in the brake control

#### Drive response

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

## 6.5 Safe Stop 1 (SS1)

## 6.5.1 Overview

## What can you find in this Chapter?

The relevant operating cases for the SS1 function are described in this chapter.

Table 6-3 Response of the SS1 function when the motor is switched on (ON/OFF1 = 1)

Select and deselect SS1	Selecting and deselecting SS1 when the motor is switched on (Page 236)
Discrepancy in the input signal	The safety input to select SS1 identifies an error. Response to a discrepancy when SS1 is active (Page 244)
Limit value violation	The speed of the motor violates the SS1 monitoring that has been set. Limit value violation when SS1 is active (Page 249) 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 = $0 \rightarrow 1$ )	Switching off the motor (ON/OFF1, OFF2 or OFF3 = $1 \rightarrow 0$ )
SS1 is not active	If SS1 is not active, then there are no res off the motor.	trictions for switching on and switching
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 242)

6.5 Safe Stop 1 (SS1)

## 6.5.2 Selecting and deselecting SS1 when the motor is switched on

#### 6.5.2.1 SS1 basic function

#### Select SS1

#### Function

- 1. The higher-level control selects the SS1 function via a safety-related input or via the PROFIsafe safe communication.
- 2. If the motor is switched on when SS1 is selected, the inverter brakes the motor with the OFF3 ramp-down time.
- 3. After the delay time, the inverter safely switches off the motor torque with the STO safety function.

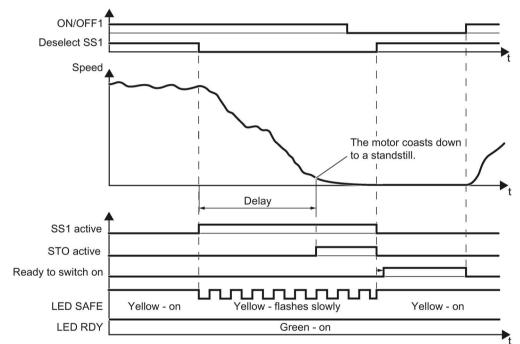


Image 6-17 Braking behavior and diagnostics of the safety function SS1 (Safe Stop 1)

Inverter signal	Parameter	Included in the PROFIsafe telegram	Can be intercon- nected with	
			F-DI	F-DO
STO active (basic functions)	r9773.1	$\checkmark$		~
SS1 active (basic functions)	r9773.6	$\checkmark$		$\checkmark$
Deselect SS1 (basic functions)	r9773.5	$\checkmark$	$\checkmark$	
Ready to switch on	r0052.0			
ON/OFF1	r0054.0			

## Switching on the motor once SS1 is active

#### Procedure



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

- 1. Deselect SS1.
- 2. After deselecting SS1, wait until the inverter is "ready to switch on".

Alternatively: After deselecting SS1, wait a certain time before switching on. We recommend a wait time of 200 ms.

- 3. Switch on the motor: ON/OFF1 = 1.
- You have switched on the motor.

6.5 Safe Stop 1 (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 safety-related input or via the PROFIsafe safe communication.
- 2. If the motor has already been switched off when selecting SS1, then the inverter safely switches off the motor torque with the safety function STO.

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

3. The inverter safely switches off the motor torque using the STO safety function if the load speed reaches the "standstill monitoring".

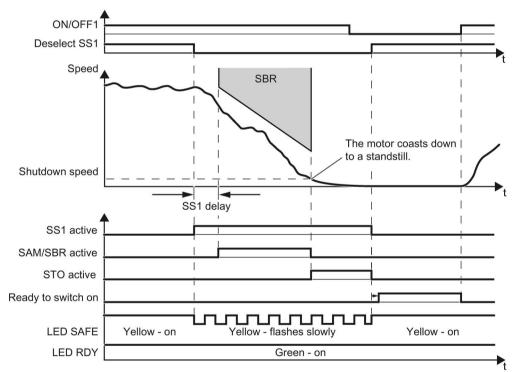


Image 6-18 Braking behavior and diagnostics of the safety function SS1 (Safe Stop 1)

Inverter signal	Parameter	Included in the PROFIsafe telegram	Can be intercon- nected with	
			F-DI	F-DO
STO active (extended functions)	r9722.0	1		$\checkmark$
SS1 active (extended functions)	r9722.1	√		$\checkmark$
Deselect SS1 (extended functions)	r9720.1	1	$\checkmark$	
SAM/SBR active	r9723.16			
Ready to switch on	r0052.0			
ON/OFF1	r0054.0			

## Switching on the motor once SS1 is active

#### Procedure



- To switch on the motor again once SS1 is active, proceed as follows:
- 1. Deselect SS1.
- 2. After deselecting SS1, wait until the inverter is "ready to switch on".

Alternatively: After deselecting SS1, wait a certain time before switching on. We recommend a wait time of 200 ms.

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

Yo Yo

You have switched on the motor.

6.5 Safe Stop 1 (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 safety-related input or via the PROFIsafe safe communication.
- 2. If the motor has already been switched off when selecting SS1, then the inverter safely switches off the motor torque with the safety function STO.

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

- 3. The inverter safely switches off the motor torque with the STO safety function if one of the two conditions is fulfilled:
  - The actual speed reaches the value of the "standstill monitoring".
  - The delay time has expired.

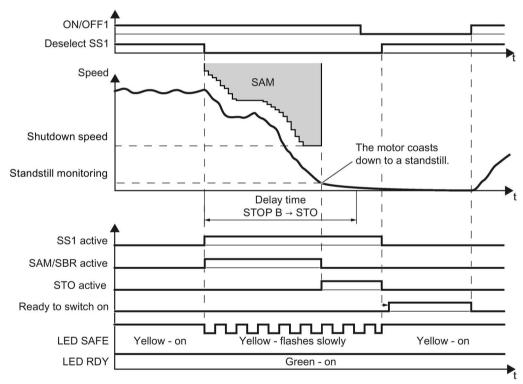


Image 6-19 Braking behavior and diagnostics of the safety function SS1 (Safe Stop 1)

Inverter signal	Parame- ter	Included in the PROFIsafe telegram	Can be intercon- nected with	
			F-DI	F-DO
STO active (extended functions)	r9722.0	$\checkmark$		~
SS1 active (extended functions)	r9722.1	$\checkmark$		~
Deselect SS1 (extended functions)	r9720.1	$\checkmark$	1	
SAM/SBR active	r9723.16			
Ready to switch on	r0052.0			
ON/OFF1	r0054.0			

## Switching on the motor once SS1 is active

#### Procedure



- To switch on the motor again once SS1 is active, proceed as follows:
- 1. Deselect SS1.
- 2. After deselecting SS1, wait until the inverter is "ready to switch on".

Alternatively: After deselecting SS1, wait a certain time before switching on. We recommend a wait time of 200 ms.

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

Π Y

You have switched on the motor.

## 6.5.3 Switching off the motor when SS1 is active

#### Description

If you switch the motor off with the OFF1 or OFF3 command while the SS1 safety function is active, for example when limit switches are reached, this does not affect how the motor behaves. SS1 remains active and the inverter brakes the motor until the standstill detection threshold is reached.

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

• SS1 without speed monitoring:

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

• SS1 with speed monitoring:

The inverter switches off the motor torque with the STO safety function. The motor then coasts to a standstill.

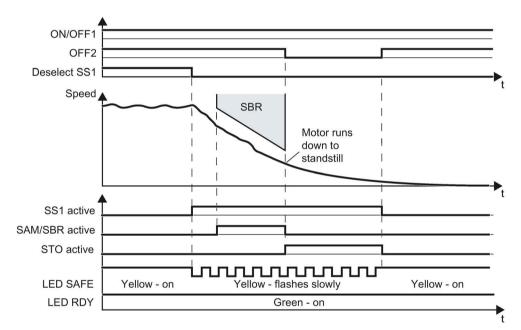


Image 6-20 OFF2 command when the SS1 safety function is active (example: SS1 with braking ramp monitoring)

6.5 Safe Stop 1 (SS1)

Inverter signal	Parame- ters	Included in the PROFIsafe telegram	Can be intercon- nected with	
			F-DI	F-DO
STO active (extended functions)	r9722.0	<b>~</b>		$\checkmark$
Deselect SS1 (basic functions)	r9773.5	✓	~	
SS1 active (extended functions)	r9722.1	✓		$\checkmark$
Deselect SS1 (extended functions)	r9720.1	✓	~	
SAM/SBR active	r9723.16			
ON/OFF1	r0054.0			
OFF2	r0054.1			

## 6.5.4 Response to a discrepancy when SS1 is active

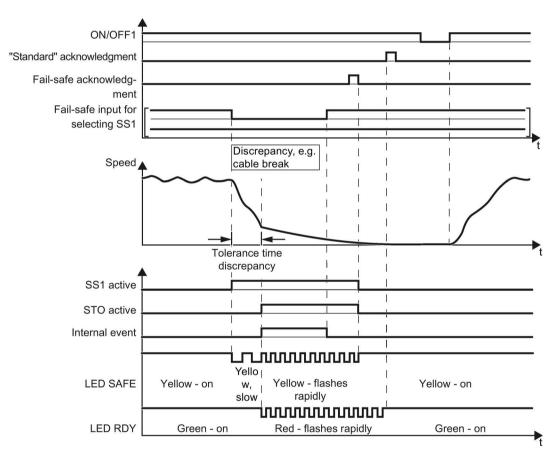
The inverter responds with the active safety function SS1 to a discrepancy at the safety-related input.

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

## 1. case: Response of the drive for SS1 of the basic functions

You have selected one of the following settings:

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



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

Inverter messages after the tolerance time has expired:

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

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

Inverter signal	Parameters	Included in the PROFIsafe telegram	Can be intercon- nected with	
			F-DI	F-DO
Internal event	r9722.7	$\checkmark$		~
STO active (basic functions)	r9773.1	$\checkmark$		$\checkmark$
SS1 active (basic functions)	r9773.6	$\checkmark$		✓
Deselect SS1 (basic functions)	r9773.5	$\checkmark$	$\checkmark$	
"Standard" acknowledgment	p2103			
Fail-safe acknowledgment	r9720.7	$\checkmark$	$\checkmark$	
ON/OFF1	r0054.0			

#### Operation

6.5 Safe Stop 1 (SS1)

## Switching on the motor after a discrepancy

#### Procedure



- To switch the motor on again, proceed as follows:
- 1. Remove the discrepancy.
- 2. Acknowledge the internal event.

Selected setting	How can the internal	event be acknowledged?	
	F-DI	PROFIsafe	Alternative
Basic Functions via onboard terminals	Select and deselect SS1 (F-DI = $1 \rightarrow 0 \rightarrow 1$ )		Switch off the power supply voltage and switch on again.
Basic Functions via PROFIsafe and onboard terminals	Select and deselect SS1 (F-DI = $1 \rightarrow 0 \rightarrow 1$ )	Select and deselect STO (PROFIsafe control word 1, bit $0 = 1 \rightarrow 0 \rightarrow 1$ ) or Select and deselect SS1 (PROFIsafe control word 1, bit $1 = 1 \rightarrow 0 \rightarrow 1$ ) or Fail-safe acknowledgment (PROFIsafe control word 1, bit $7 = 0 \rightarrow 1 \rightarrow 0$ )	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 = $1 \rightarrow 0 \rightarrow 1$ )	Select and deselect STO (PROFIsafe control word 1, bit $0 = 1 \rightarrow 0 \rightarrow 1$ ) or Select and deselect SS1 (PROFIsafe control word 1, bit $1 = 1 \rightarrow 0 \rightarrow 1$ ) or Fail-safe acknowledgment (PROFIsafe control word 1, bit $7 = 0 \rightarrow 1 \rightarrow 0$ )	Switch off the power supply voltage and switch on again.

- 3. Acknowledge the inverter with the "standard" acknowledge signal.
- 4. Issue an OFF1 command (ON/OFF1 = 0).
- 5. Switch on the motor (ON/OFF1 = 1).
- You have acknowledged the discrepancy message, and switched on the motor again.

## 2. case: Response of the drive for SS1 of the extended functions

ON/OFF1 "Standard" acknowledge T 1 Fail-safe acknowledgment Fail-safe input to select SS1 Discrepancy, e.g. Speed cable break SS1 Shutdown speed Tolerance time Discrepancy SS1 active STO active LED SAFE Yellow - on Yellow - flashes slowly Yellow - on LED RDY Green - on Green - on Red - flashes quickly

You have selected the extended functions via onboard terminals.

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

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

Inverter signal	Parameter	Included in the PROFIsafe telegram	Can be intercon- nected with	
			F-DI	F-DO
STO active (extended functions)	r9722.0	$\checkmark$		$\checkmark$
SS1 active (extended functions)	r9722.1	1		1
Deselect SS1 (extended functions)	r9720.1	√	$\checkmark$	
SAM/SBR active	r9723.16			
"Standard" acknowledgment	p2103			
Fail-safe acknowledgment	r9720.7	√	~	
ON/OFF1	r0054.0			

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

#### Operation

6.5 Safe Stop 1 (SS1)

## Switching on the motor after a discrepancy

#### Procedure



- To switch the motor on again, proceed as follows:
- 1. Remove the discrepancy.
- 2. Acknowledge the discrepancy message with the fail-safe acknowledge signal via a safety-related input: F-DI =  $0 \rightarrow 1 \rightarrow 0$ .

Alternatively: Switch off the power supply voltage and switch on again.

- 3. Acknowledge the inverter with the "standard" acknowledge signal.
- 4. Issue an OFF1 command (ON/OFF1 = 0).
- 5. Switch on the motor (ON/OFF1 = 1).
- You have acknowledged the discrepancy message, and switched on the motor again.

## 6.5.5 Limit value violation when SS1 is active

#### **Drive response**

If motion monitoring detects a fault when SS1 is active, the inverter safely switches off the motor torque (STOP A).

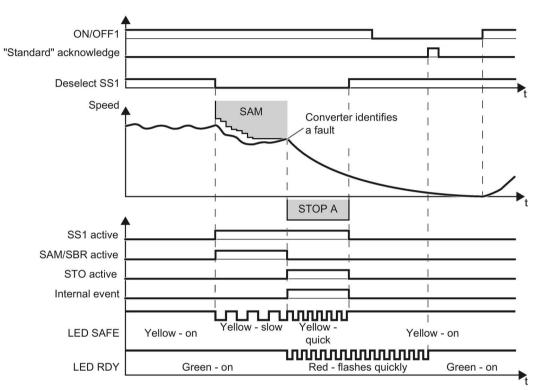


Image 6-23 General fault response of safety function SS1 (as an example: SS1 with acceleration monitoring)

Inverter signal	Parameter	Included in the PROFIsafe telegram	Can be intercon- nected with	
			F-DI	F-DO
Internal event	r9722.7	✓		$\checkmark$
STO active (extended functions)	r9722.0	$\checkmark$		$\checkmark$
SS1 active (extended functions)	r9722.1	✓		$\checkmark$
Deselect SS1 (extended functions)	r9720.1	1	$\checkmark$	
SAM/SBR active	r9723.16			
"Standard" acknowledgment	p2103			
ON/OFF1	r0054.0			

#### Operation

6.5 Safe Stop 1 (SS1)

## Switching the motor on after an internal event

#### Procedure



To switch the motor on after an internal event while SS1 is active, proceed as follows:

- 1. Deselect function SS1.
- 2. Issue an OFF1 command (ON/OFF1 = 0).
- 3. Acknowledge the inverter with the "standard" acknowledge signal.
- 4. Switch on the motor again (ON/OFF1 = 1).
- You have acknowledged the internal event and switched on the motor again.

# 6.6 Safely Limited Speed (SLS)

## 6.6.1 Overview

## What can you find in this Chapter?

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

Table 6- 5	Response of the SLS function when the motor is switched on (ON/OFF1 = 1)
------------	--

Selecting and deselecting SLS	Selecting and deselecting SLS when the motor is switched on (Page 252)
Switching over SLS levels when SLS is active	Switching over from a higher SLS level to a lower SLS level (and vice versa).
Discrepancy in the input signal	The safety input to select SLS identifies an error. Response to a discrepancy when SLS is active (Page 267)
Limit value violation	The speed of the motor exceeds the set SLS limit value.

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

	Switching on the motor (ON/OFF1 = $0 \rightarrow 1$ )	Switching off the motor (ON/OFF1, OFF2 or OFF3 = $1 \rightarrow 0$ )	
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. Sustiching on the motor when SLS is active (Page 265)	The drive response depends on the signal that you use to switch off the motor. Switching off the motor when SLS is active (Page 263)	

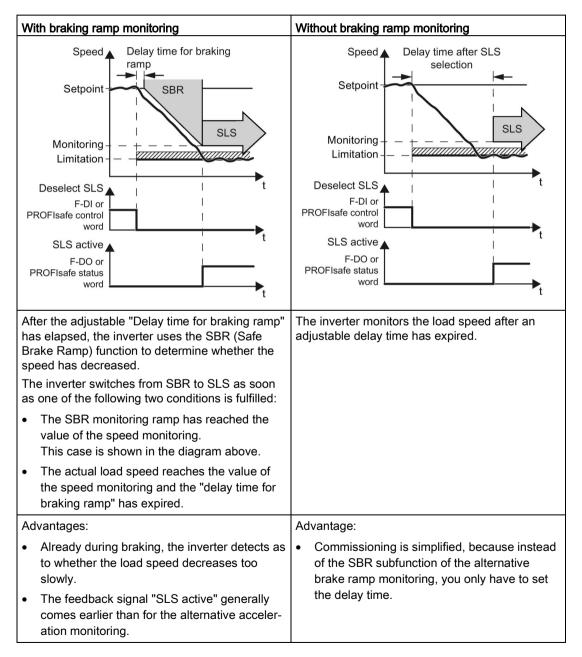
6.6 Safely Limited Speed (SLS)

## 6.6.2 Selecting and deselecting SLS when the motor is switched on

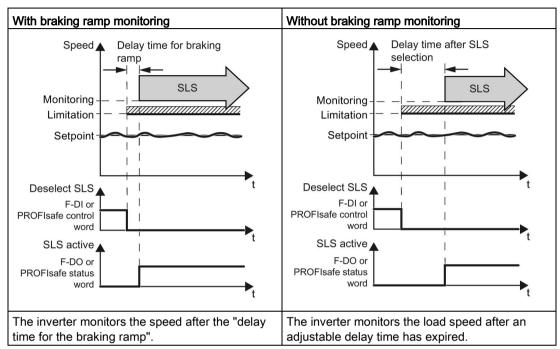
#### Selecting SLS when the motor is switched on

As soon as the inverter detects the selection of SLS via a safety input or via the PROFIsafe safe communication, the following happens:

- The inverter limits the speed to a value below the SLS monitoring and brakes the motor with the OFF3 ramp-down time.
- You can select whether the inverter monitors motor braking using the SMR (Safe Brake Ramp) function or not.



### Selecting SLS at low motor speeds



If the motor speed when selecting SLS is less than the SLS limit, then the drive responds as follows:

## **Deselect SLS**

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

6.6 Safely Limited Speed (SLS)

## 6.6.2.1 SLS with braking ramp monitoring

#### Selecting and deselecting SLS

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

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

- 1. The motor continues to follow the speed setpoint.
- 2. The inverter monitors the speed after the delay time has expired.

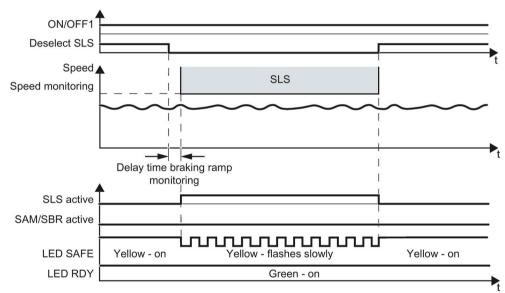


Image 6-24 Selecting and deselecting the SLS safety function at low speeds

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

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

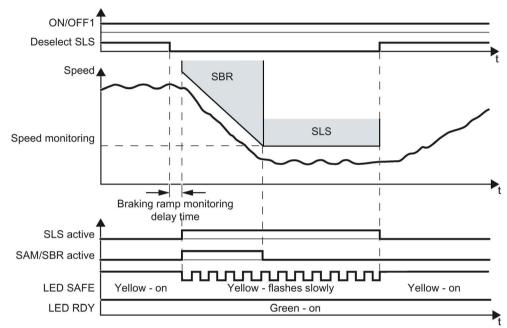


Image 6-25 Selecting and deselecting the SLS safety function at high speeds

Inverter signal	Parameter	Included in the PROFIsafe telegram	Can be intercon- nected with	
			F-DI	F-DO
SLS active	r9722.4	$\checkmark$		$\checkmark$
Deselect SLS	r9720.4	$\checkmark$	$\checkmark$	
SAM/SBR active	r9723.16			
ON/OFF1	r0054.0			

6.6 Safely Limited Speed (SLS)

## 6.6.2.2 SLS without braking ramp monitoring

#### Selecting and deselecting SLS

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

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

- 1. The motor continues to follow the speed setpoint.
- 2. The inverter monitors the speed after the delay time has expired.

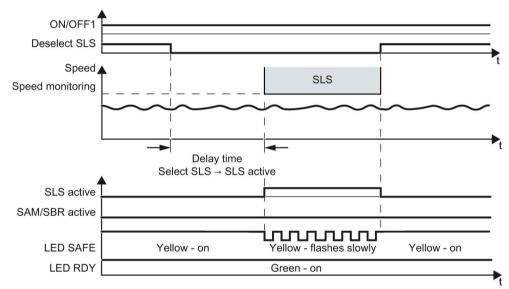


Image 6-26 Selecting and deselecting the SLS safety function at low speeds

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

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

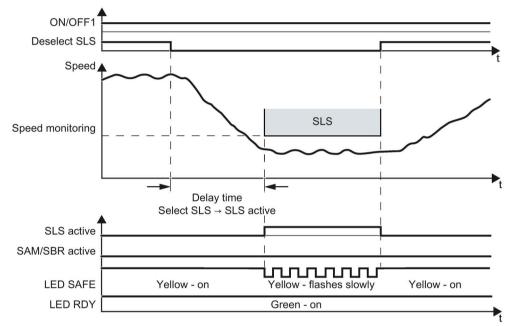


Image 6-27 Selecting and deselecting the SLS safety function at high speeds

Inverter signal	Parameters	Included in the PROFIsafe telegram	Can be intercon- nected with	
			F-DI	F-DO
SLS active	r9722.4	$\checkmark$		~
Deselect SLS	r9720.4	$\checkmark$	$\checkmark$	
SAM/SBR active	r9723.16			
ON/OFF1	r0054.0			

6.6 Safely Limited Speed (SLS)

## 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
Speed 🔺	Speed 🔺
Limit level 2	Limiting stage 2
Limit level 1	Limiting stage 1
Select t SLS level	Select I t SLS level I
PROFIsafe Level Level 1	PROFIsafe Level Level 1
Active I t SLS level	Active I t SLS level
PROFIsafe Level 2 Level 1	PROFIsafe status word Level 2 Level 1
The inverter monitors the motor as it brakes using the SBR (Safe Brake Ramp) function.	After an adjustable time, the inverter switches the SLS monitoring from the higher SLS level to the lower SLS level.

## 6.6.3.1 SLS with braking ramp monitoring

#### Switching over SLS levels

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

#### Note

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

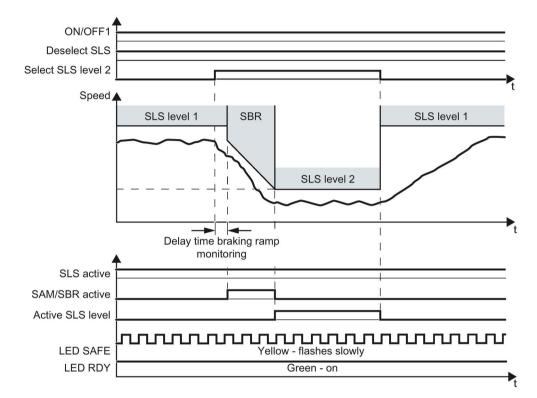
Control word 1 and status word 1 (extended functions) (Page 54)

#### Function

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

- 1. The inverter brakes the motor.
- 2. Once the delay time has expired, the inverter monitors the motor speed using the SBR (Safe Brake Ramp) function.
- 3. The inverter switches from SBR monitoring to SLS monitoring as soon as one of the following two conditions is fulfilled:
  - The SBR monitoring ramp has reached the value of the SLS monitoring. This case is shown in the diagram above.
  - The load speed has decreased down to the value SLS monitoring and the "delay time for braking ramp" has expired.

6.6 Safely Limited Speed (SLS)



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

Image 6-28 Switching between different monitoring thresholds

Inverter signal	Parameter	Included in the PROFIsafe telegram	Can be intercon- nected with	
			F-DI	F-DO
SLS active	r9722.4	$\checkmark$		$\checkmark$
Deselect SLS	r9720.4	$\checkmark$	$\checkmark$	
SLS level active	r9722.9, r9722.10	$\checkmark$		~
Select SLS level	r9720.9, r9720.10	$\checkmark$	$\checkmark$	
SAM/SBR active	r9723.16			
ON/OFF1	r0054.0			

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

Control word 1 and status word 1 (extended functions) (Page 54)

## 6.6.3.2 SLS without braking ramp monitoring

#### Switching over SLS levels

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

#### Note

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

Control word 1 and status word 1 (extended functions) (Page 54)

#### Function

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

- 1. The inverter brakes the motor.
- 2. Once the delay time has expired, the inverter monitors the speed using the lower speed monitoring level.

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

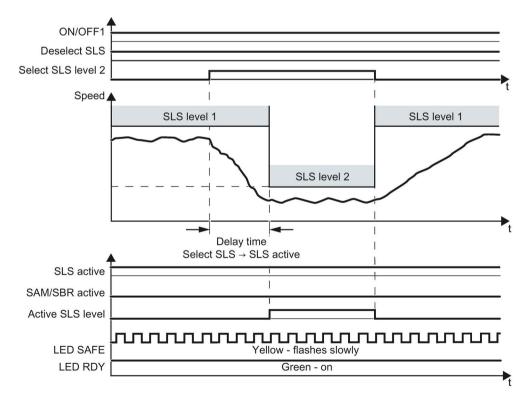


Image 6-29 Switching between different monitoring thresholds

#### Operation

6.6 Safely Limited Speed (SLS)

Inverter signal	Parameter	Included in the PROFIsafe telegram	Can be intercon- nected with	
			F-DI	F-DO
SLS active	r9722.4	$\checkmark$		$\checkmark$
Deselect SLS	r9720.4	$\checkmark$	$\checkmark$	
SLS level active	r9722.9, r9722.10	$\checkmark$		~
Select SLS level	r9720.9, r9720.10	$\checkmark$	$\checkmark$	
SAM/SBR active	r9723.16			
ON/OFF1	r0054.0			

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

Control word 1 and status word 1 (extended functions) (Page 54)

## 6.6.4 Switching off the motor when SLS is active

#### Description

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

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

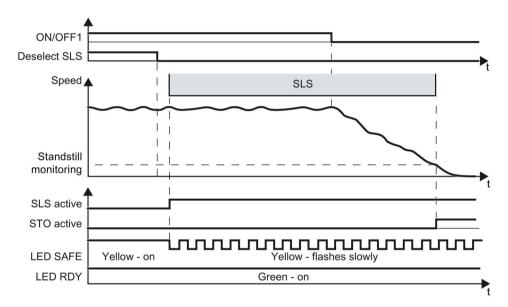


Image 6-30 OFF1 command when the SLS safety function is active

#### Operation

6.6 Safely Limited Speed (SLS)

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

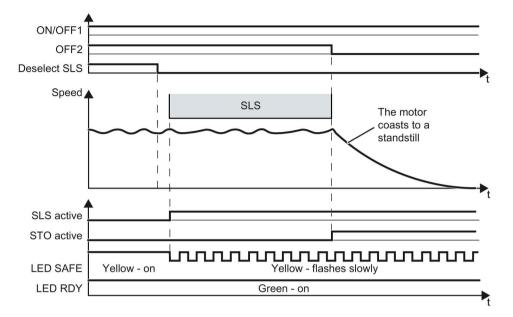


Image 6-31 OFF2 command when the SLS safety function is active

Inverter signal	Parameter	Included in the PROFIsafe telegram	Can be intercon- nected with	
			F-DI	F-DO
STO active (extended functions)	r9722.0	$\checkmark$		$\checkmark$
SLS active	r9722.4	$\checkmark$		$\checkmark$
Deselect SLS	r9720.4	$\checkmark$	$\checkmark$	
ON/OFF1	r0054.0			
OFF2	r0054.1			

## 6.6.5 Switching on the motor when SLS is active

## Switch on motor

### Procedure

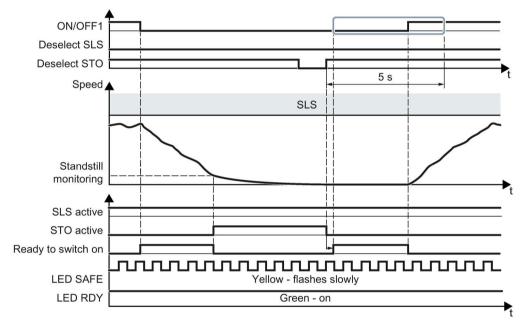


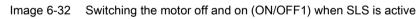
To switch the motor on with SLS active, proceed as follows:

- 1. Select STO (or SS1).
- 2. Deselect STO (or SS1).
- 3. After deselecting STO, wait until the inverter is "ready to switch on".

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

4. Switch on motor within 5 s after deselecting STO (ON command).





You have switched on the motor.

Inverter signal	Parameter	Included in the PROFIsafe telegram	Can be intercon- nected with	
			F-DI	F-DO
STO active (extended functions)	r9722.0	1		~
Deselect STO (extended functions)	r9720.0	1	$\checkmark$	
SLS active	r9722.4	1		~
Deselect SLS	r9720.4	1	$\checkmark$	
Ready to switch on	r0052.0			
ON/OFF1	r0054.0			

#### Operation

6.6 Safely Limited Speed (SLS)

### You have not switched on the motor within 5 seconds

If you do not switch on the motor within 5 seconds after deselecting STO, the following happens:

- The inverter goes back into the STO state.
- The inverter no longer responds to the ON command.
- The inverter outputs Alarm A01795.

To switch on the motor you must repeat the procedure described above.

## 6.6.6 Response to a discrepancy when SLS is active

### Drive response

The inverter responds with the active SLS safety function to a discrepancy at the safetyrelated input.

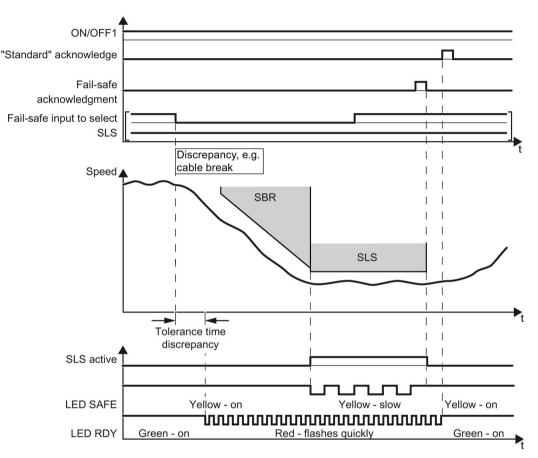


Image 6-33 Behavior of the inverter for discrepancy of the input signal for SLS

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

After the tolerance time has expired, the inverter signals the discrepancy (Alarm C01770 or C30770). The SLS function remains active, and the motor remains switched on.

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

6.6 Safely Limited Speed (SLS)

Inverter signal	Parame- ters	Included in the PROFIsafe telegram	Can be intercon- nected with	
			F-DI	F-DO
SLS active	r9722.4	$\checkmark$		~
Deselect SLS	r9720.4	$\checkmark$	$\checkmark$	
"Standard" acknowledgment	p2103			
Fail-safe acknowledgment	r9720.7	$\checkmark$	$\checkmark$	
ON/OFF1	r0054.0			

### Deselecting SLS after a discrepancy

#### Procedure



- To deselect SLS, proceed as follows:
- 1. Remove the discrepancy.
- 2. Acknowledge the discrepancy message with the fail-safe acknowledge signal via a safety-related input: F-DI =  $0 \rightarrow 1 \rightarrow 0$ .

Alternatively, you can acknowledge the message in one of the following ways. However, the drive stops in these cases:

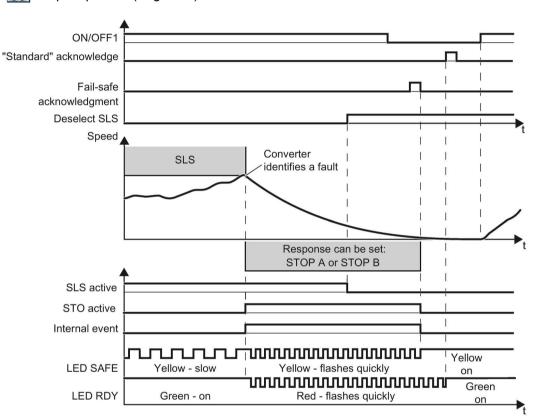
- Select the STO function and then deselect again: F-DI =  $1 \rightarrow 0 \rightarrow 1$ .
- Select the SS1 function and then deselect again: F-DI =  $1 \rightarrow 0 \rightarrow 1$ .
- Switch off the inverter power supply voltage and on again.
- 3. Acknowledge the inverter with the "standard" acknowledge signal.

You have acknowledged the discrepancy message and deselected SLS.

## 6.6.7 Limit value violation when SLS is active

### Drive response

When motion monitoring detects a fault when SLS is active, the inverter responds by triggering a STOP A or STOP B. The inverter response is parameterized during commissioning.



Stop responses (Page 294)

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

Inverter signal	Parameter	Included in the PROFIsafe telegram	Can be intercon- nected with	
			F-DI	F-DO
Internal event	r9722.7	√		~
STO active (extended functions)	r9722.0	1		√
SLS active	r9722.4	√		~
Deselect SLS	r9720.4	1	$\checkmark$	
"Standard" acknowledgment	p2103			
Fail-safe acknowledgment	r9720.7	1	√	
ON/OFF1	r0054.0			

#### Operation

6.6 Safely Limited Speed (SLS)

## Switching the motor on after an internal event

#### Procedure



To switch the motor on after an internal event while SLS is active, proceed as follows:

- 1. Deselect the SLS function.
- 2. Issue an OFF1 command (ON/OFF1 = 0).
- 3. Acknowledge the internal event in one of the following ways:
  - Fail-safe acknowledgment using PROFIsafe control word 0, bit 7 =  $0 \rightarrow 1 \rightarrow 0$
  - Fail-safe acknowledge signal via a safety-related input: F-DI =  $0 \rightarrow 1 \rightarrow 0$ .
  - Select the STO function and deselect again (PROFIsafe control word 0, bit 0 or F-DI).  $1 \rightarrow 0 \rightarrow 1$ ).
  - Select the SS1 function and deselect again (PROFIsafe control word 0, bit 1 or F-DI).  $1 \rightarrow 0 \rightarrow 1$ ).
  - Switch off the inverter power supply voltage and on again.
- 4. Acknowledge the inverter with the "standard" acknowledge signal.
- 5. Switch on the motor (ON/OFF1 = 1).
- You have acknowledged the internal event and switched on the motor again.

# 6.7 Safe Speed Monitor (SSM)

## 6.7.1 Overview

## What can you find in this Chapter?

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

Table 6-7 Response of the SSM function when the motor is switched on (ON/OFF1 = 1)

Feedback signal	The SSM function signals as to whether the motor speed is above or below the set SSM limit value.
	Selecting SSM when the motor is switched on (Page 272)

Table 6-8	Switching the motor on and off when SSM is active or not active
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	Switching on the motor (ON/OFF1 = $0 \rightarrow 1$ )	Switching off the motor (ON/OFF1, OFF2 or OFF3 = $1 \rightarrow 0$ )		
SSM is not active	If SSM is not active, then there are no restrictions for switching on and switch off the motor.			
SSM is active	If SSM is active, you must take into account several special issues when switching on the motor.	The drive response depends on the signal that you use to switch off the motor.		
	Switching on the motor when SSM is active (Page 278).	Switching off the motor when SSM is active (Page 273)		

6.7 Safe Speed Monitor (SSM)

## 6.7.2 Selecting SSM when the motor is switched on

### Description

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

- You have enabled one or several extended safety functions.
- For the SSM function, you have set a monitoring speed of > 0.

After switching on the power supply voltage, initially the inverter always sets the feedback signal "Speed below limit value" of the SSM function to 0.

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

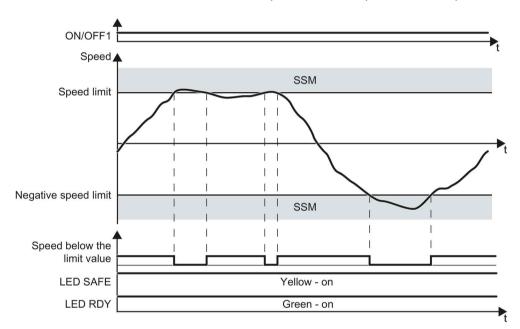


Image 6-35 Time response of the safety function SSM (Safe Speed Monitor)

Inverter signal	Parameter	Included in the PROFIsafe telegram	Can be intercon- nected with	
			F-DI	F-DO
SSM feedback signal active (speed below limit value)	r9722.15	$\checkmark$		~
ON/OFF1	r0054.0			

## 6.7.3 Switching off the motor when SSM is active

#### Description

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

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

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

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

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

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

1. Feedback signal "SSM active" for pulse inhibit remains active:

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

2. Feedback signal "SSM active" for pulse inhibit becomes inactive:

When the motor is switched off, the inverter sets "Status SSM" = 0.

#### Operation

6.7 Safe Speed Monitor (SSM)

The inverter brakes the motor down to a standstill using the OFF1 or OFF3 command and then switches it off.

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

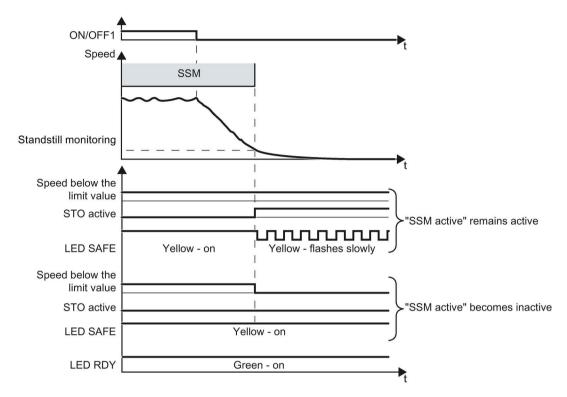


Image 6-36 OFF1 command when the SSM safety function is active

The inverter immediately switches off the motor with the OFF2 command.

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

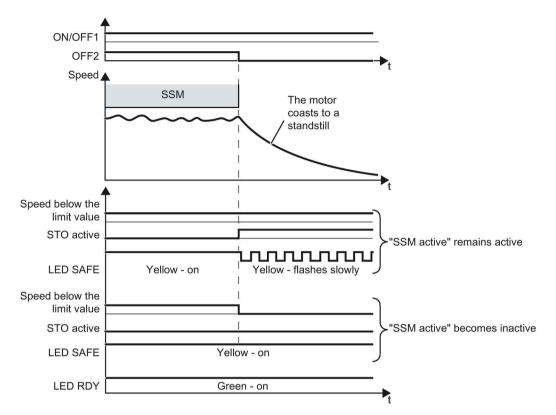


Image 6-37 OFF2 command when the SSM safety function is active

Inverter signal	Parameter	Included in the PROFIsafe telegram	Can be intercon- nected with	
			F-DI	F-DO
STO active (extended functions)	r9722.0	$\checkmark$		$\checkmark$
SSM feedback signal active (speed below limit value)	r9722.15	$\checkmark$		~
ON/OFF1	r0054.0			
OFF2	r0054.1			

6.7 Safe Speed Monitor (SSM)

### When switching off, the speed is higher than the SSM limit value

The inverter brakes the motor down to a standstill using the OFF1 or OFF3 command and then switches it off.

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

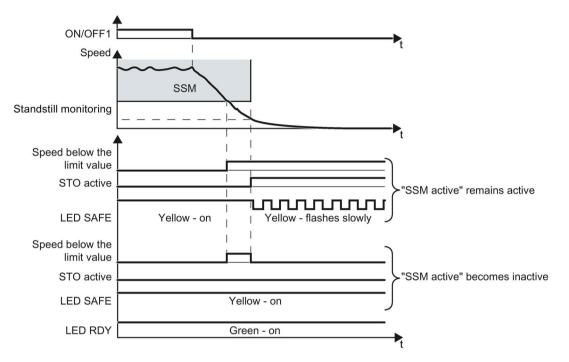
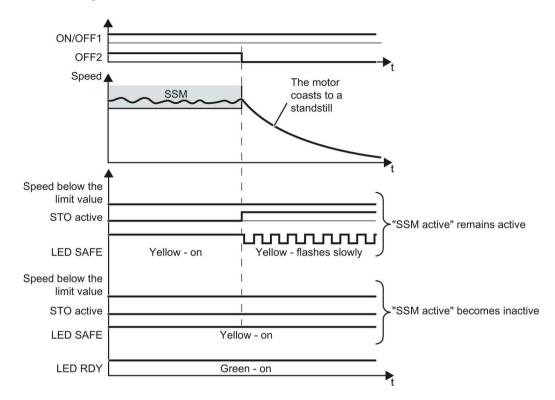


Image 6-38 OFF1 command when the SSM safety function is active

The inverter immediately switches off the motor with the OFF2 command.

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



The feedback signal "SSM active" remains = 0.

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

Inverter signal	Parameter	Included in the PROFIsafe telegram	Can be intercon- nected with	
			F-DI	F-DO
STO active (extended functions)	r9722.0	✓		$\checkmark$
SSM feedback signal active (speed below limit value)	r9722.15	$\checkmark$		$\checkmark$
ON/OFF1	r0054.0			
OFF2	r0054.1			

6.7 Safe Speed Monitor (SSM)

## 6.7.4 Switching on the motor when SSM is active

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

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

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

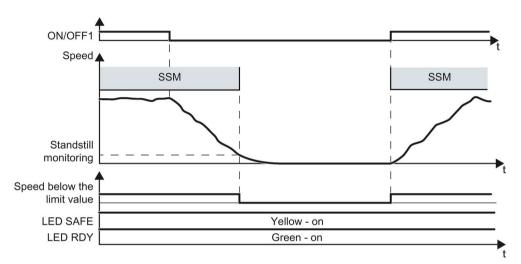


Image 6-40 Switching on the motor when the SSM function is active, interrupting SSM

Inverter signal	Parameter	Included in the PROFIsafe telegram	Can be intercon- nected with	
			F-DI	F-DO
SSM feedback signal active (speed below limit value)	r9722.15	$\checkmark$		~
ON/OFF1	r0054.0			

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

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

#### Procedure



To switch the motor on, proceed as follows:

- 1. Select STO (or SS1) after the motor has been switched off.
- 2. Deselect STO (or SS1) again before you switch on the motor.
- 3. After deselecting STO, wait until the inverter is "ready to switch on".

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

4. Switch on motor within 5 s after deselecting STO (ON command).

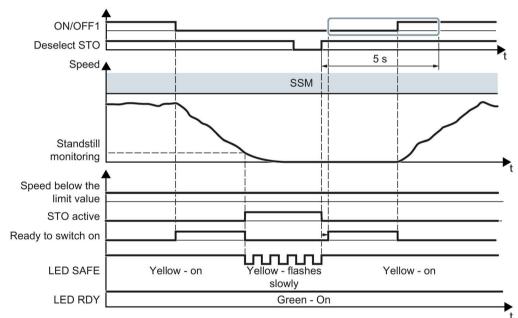


Image 6-41 Switching on the motor when SSM is active

You have switched on the motor.

Inverter signal	Parameter	Included in the PROFIsafe telegram	Can be intercon- nected with	
			F-DI	F-DO
STO active (extended functions)	r9722.0	$\checkmark$		$\checkmark$
Deselect STO (extended functions)	r9720.0	$\checkmark$	$\checkmark$	
SSM feedback signal active (speed below limit value)	r9722.15	$\checkmark$		~
ON/OFF1	r0054.0			
Ready to switch on	r0052.0			

#### Operation

6.7 Safe Speed Monitor (SSM)

### You have not switched on the motor within 5 seconds

If you do not switch on the motor within 5 seconds after deselecting STO, the following happens:

- The inverter goes back into the STO state.
- The inverter no longer responds to the ON command.
- The inverter outputs Alarm A01795.

To switch on the motor you must repeat the procedure described above.

# 6.8 Safe Direction (SDI)

## 6.8.1 Overview

## What can you find in this Chapter?

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

Table 6-9 Response of the SDI function when the motor is switched on (ON/OFF1 = 1)

Selecting and deselecting SDI	Selecting and deselecting SDI when the motor is switched on (Page 282)
Discrepancy in the input signal	The safety input to select SDI identifies an error. Response to a discrepancy when Safe Direction is active (SDI) (Page 288)
Limit value violation	The motor rotates in the monitored direction. Limit value violation when Safe Direction (SDI) is active (Page 290)

Table 6-10 Switching the motor on and off when SDI is active or not active

	Switching on the motor (ON/OFF1 = $0 \rightarrow 1$ )	Switching off the motor (ON/OFF1, OFF2 or OFF3 = $1 \rightarrow 0$ )
SDI is not active	If SDI is not active, then there are no rest the motor.	trictions for switching on and switching off
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 285)	The drive response depends on the signal that you use to switch off the motor. Switching off the motor when SDI is active (Page 283)

## 6.8.2 Selecting and deselecting SDI when the motor is switched on

## Select SDI

#### Function

- 1. The higher-level control selects the SDI safety function via a safety-related input or via the PROFIsafe safe communication.
- 2. The inverter limits the speed to the permitted direction of rotation. When SDI is selected, if the motor rotates in the impermissible direction, then the inverter brakes the motor down to standstill.
- 3. After the delay time has expired, the inverter monitors the selected direction of rotation of the motor.

The inverter tolerates brief motion in the monitored direction of rotation up to an adjustable angle of rotation of the motor shaft.

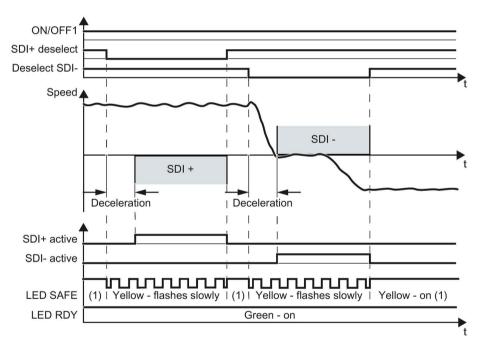


Image 6-42 Time response of the safety function SDI (Safe direction)

Inverter signal	Parameters	Included in the PROFIsafe telegram	Can be intercon- nected with	
			F-DI	F-DO
SDI+ active	r9722.12	$\checkmark$		~
SDI+ deselect	r9720.12	$\checkmark$	$\checkmark$	
SDI- active	r9722.13	$\checkmark$		✓
Deselect SDI-	r9720.13	$\checkmark$	$\checkmark$	
ON/OFF1	r0054.0			

## 6.8.3 Switching off the motor when SDI is active

#### Description

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

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

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

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

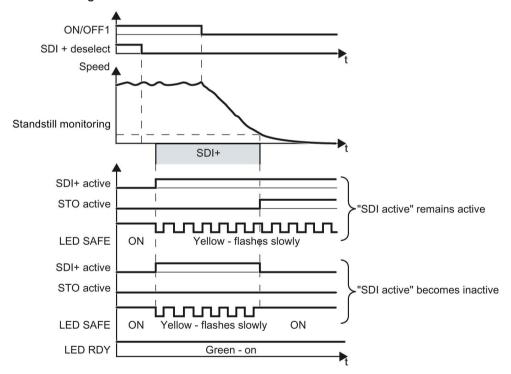
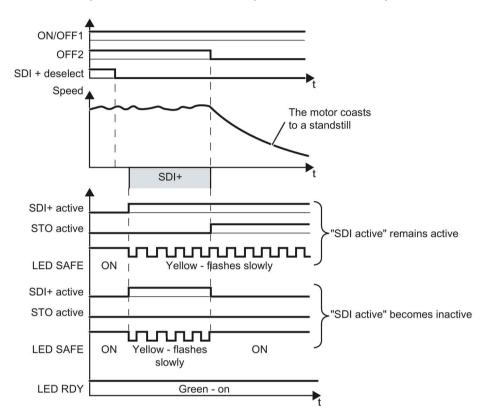


Image 6-43 OFF1 command when the SDI safety function is active

6.8 Safe Direction (SDI)



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

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

Inverter signal	Parameters	Included in the PROFIsafe telegram	Can be intercon- nected with	
			F-DI	F-DO
STO active (extended functions)	r9722.0	$\checkmark$		$\checkmark$
SDI+ active	r9722.12	$\checkmark$		$\checkmark$
SDI+ deselect	r9720.12	$\checkmark$	$\checkmark$	
SDI- active	r9722.13	$\checkmark$		$\checkmark$
Deselect SDI-	r9720.13	$\checkmark$	$\checkmark$	
ON/OFF1	r0054.0			
OFF2	r0054.1			

## 6.8.4 Switching on the motor when SDI is active

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

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

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

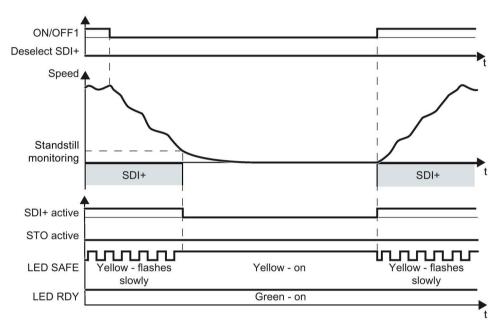


Image 6-45 Switching the motor off and on when SDI is active, interrupts the feedback signal from SDI

Inverter signals	Parameters	Included in the PROFIsafe telegram	Can be intercon- nected with	
			F-DI	F-DO
STO active (extended functions)	r9722.0	✓		$\checkmark$
SDI+ active	r9722.12	✓		~
SDI+ deselect	r9720.12	✓	$\checkmark$	
SDI- active	r9722.13	$\checkmark$		~
Deselect SDI-	r9720.13	$\checkmark$	~	
ON/OFF1	r0054.0			

6.8 Safe Direction (SDI)

## The feedback signal "SDI active" for pulse inhibit remains active

#### Procedure



To switch the motor on, proceed as follows:

- 1. Select STO (or SS1).
- 2. Deselect STO (or SS1) again.
- 3. After deselecting STO, wait until the inverter is "ready to switch on".

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

4. Switch on motor within 5 s after deselecting STO (ON command).

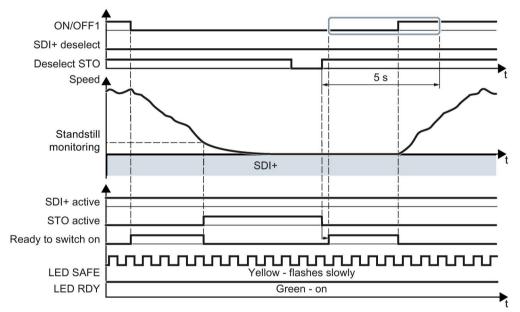


Image 6-46 Switching the motor off and on when SDI is active

You have switched on the motor again.

Inverter signals	Parameters	Included in the PROFIsafe telegram	Can be intercon- nected with	
			F-DI	F-DO
STO active (extended functions)	r9722.0	$\checkmark$		~
Deselect STO (extended functions)	r9720.0	$\checkmark$	$\checkmark$	
SDI+ active	r9722.12	$\checkmark$		~
SDI+ deselect	r9720.12	$\checkmark$	$\checkmark$	
SDI- active	r9722.13	$\checkmark$		~
Deselect SDI-	r9720.13	$\checkmark$	~	
ON/OFF1	r0054.0			
Ready to switch on	r0052.0			

### You have not switched on the motor within 5 seconds

If you do not switch on the motor within 5 seconds after deselecting STO, the following happens:

- The inverter goes back into the STO state.
- The inverter no longer responds to the ON command.
- The inverter outputs Alarm A01795.

To switch on the motor you must repeat the procedure described above.

## 6.8.5 Response to a discrepancy when Safe Direction is active (SDI)

### Drive response

The inverter responds with the active SDI safety function to a discrepancy at the safetyrelated input.

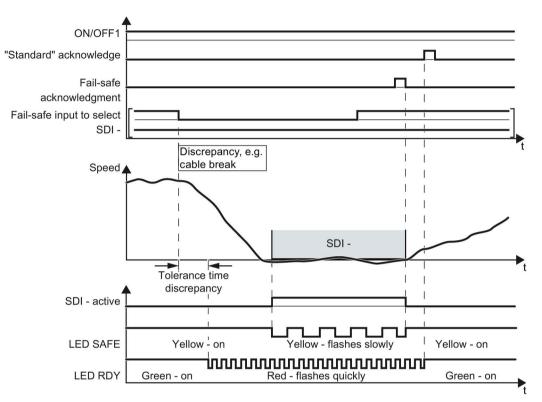


Image 6-47 Response of the inverter for discrepancy of the input signal for SDI (SDI- as example)

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

After the tolerance time has expired, the inverter signals the discrepancy (Alarm C01770 or C30770). The SDI function remains active, and the motor remains switched on.

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

Inverter signals	Parameters	Included in the PROFIsafe telegram		intercon- d with
			F-DI	F-DO
STO active (extended functions)	r9722.0	$\checkmark$		~
SDI+ active	r9722.12	$\checkmark$		~
SDI+ deselect	r9720.12	$\checkmark$	$\checkmark$	
SDI- active	r9722.13	$\checkmark$		$\checkmark$
Deselect SDI-	r9720.13	$\checkmark$	$\checkmark$	
"Standard" acknowledgment	p2103			
Fail-safe acknowledgment	r9720.7	$\checkmark$	$\checkmark$	
ON/OFF1	r0054.0			

### Deselecting SDI after a discrepancy

#### Procedure



- To deselect SDI, proceed as follows:
- 1. Remove the discrepancy.
- 2. Acknowledge the discrepancy message with the fail-safe acknowledge signal via a safety-related input: F-DI =  $0 \rightarrow 1 \rightarrow 0$ .

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 =  $1 \rightarrow 0 \rightarrow 1$ .
- Select the SS1 function and then deselect again: F-DI =  $1 \rightarrow 0 \rightarrow 1$ .
- Switch off the power supply voltage of the inverter and switch on again.
- 3. Acknowledge the inverter with the "standard" acknowledge signal.
- You have acknowledged the discrepancy message and deselected SDI.

## 6.8.6 Limit value violation when Safe Direction (SDI) is active

### Drive response

When motion monitoring detects a fault when SDI is active, the inverter responds by triggering a STOP A or STOP B. The inverter response is parameterized during commissioning.

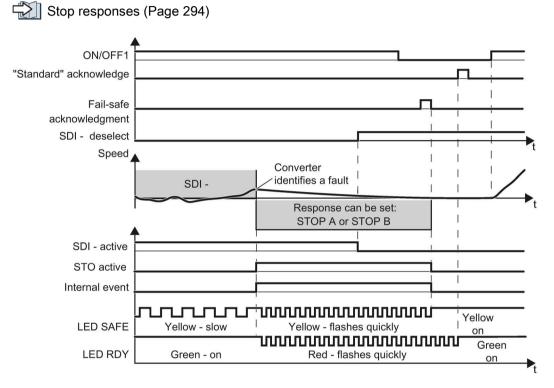


Image 6-48 Limit value violation of safety function SDI. Example with STOP A as fault response

Inverter signals	Parameters	Included in the PROFIsafe telegram		ntercon- d with
			F-DI	F-DO
Internal event	r9722.7	$\checkmark$		$\checkmark$
STO active (extended functions)	r9722.0	$\checkmark$		$\checkmark$
SDI+ active	r9722.12	$\checkmark$		$\checkmark$
SDI+ deselect	r9720.12	$\checkmark$	$\checkmark$	
SDI- active	r9722.13	$\checkmark$		$\checkmark$
Deselect SDI-	r9720.13	$\checkmark$	~	
"Standard" acknowledgment	p2103			
Fail-safe acknowledgment	r9720.7	$\checkmark$	$\checkmark$	
ON/OFF1	r0054.0			

Safety Integrated - SINAMICS G110M, G120, G120C, G120D and SIMATIC ET 200pro FC-2 Function Manual, 01/2016, FW V4.7 SP6, A5E34261271B AC

### Switching the motor on after an internal event

### Procedure



To switch the motor on after an internal event while SDI is active, proceed as follows:

- 1. Deselect the SDI function.
- 2. Issue an OFF1 command (ON/OFF1 = 0).
- 3. Acknowledge the internal event in one of the following ways:
  - Fail-safe acknowledgment using PROFIsafe control word 0, bit 7 = 0  $\rightarrow$  1  $\rightarrow$  0
  - Fail-safe acknowledge signal via a safety-related input: F-DI =  $0 \rightarrow 1 \rightarrow 0$ .
  - Select the STO function and deselect again (PROFIsafe control word 0, bit 0 or F-DI).  $1 \rightarrow 0 \rightarrow 1$ ).
  - Select the SS1 function and deselect again (PROFIsafe control word 0, bit 1 or F-DI).  $1 \rightarrow 0 \rightarrow 1$ ).
  - Switch off the power supply voltage of the inverter and switch on again.
- 4. Acknowledge the inverter with the "standard" acknowledge signal.
- 5. Switch on the motor (ON/OFF1 = 1).
- You have acknowledged the internal event and switched on the motor again.

6.9 Response to a discrepancy in the signals transferred via PROFIsafe

## 6.9 Response to a discrepancy in the signals transferred via PROFIsafe

### Drive response

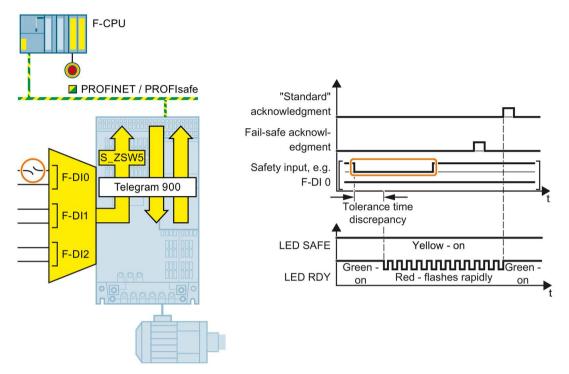


Image 6-49 Behavior of the inverter in the event of a discrepancy in a safety-related input in PROFIsafe telegram 900

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

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

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

Inverter signals	Parameter	Included in the PROFIsafe telegram	Can be intercon nected with	
			F-DI	F-DO
Internal event	r9722.7	$\checkmark$		~
"Standard" acknowledgment	p2103			
Fail-safe acknowledgment	r9720.7	$\checkmark$	$\checkmark$	

6.9 Response to a discrepancy in the signals transferred via PROFIsafe

### Acknowledging a discrepancy message

#### Procedure



- To acknowledge the discrepancy message, proceed as follows:
- 1. Remove the discrepancy.
- 2. Acknowledge the discrepancy message in one of the following ways:

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 $0 = 1 \rightarrow 0 \rightarrow 1$ ) or Select and deselect SS1 (PROFIsafe control word 1, bit $1 = 1 \rightarrow 0 \rightarrow 1$ ) or Fail-safe acknowledgment (PROFIsafe control word 1,	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 = $1 \rightarrow 0 \rightarrow 1$ )	bit $7 = 0 \rightarrow 1 \rightarrow 0$ ) Select and deselect STO (PROFIsafe control word 1, bit $0 = 1 \rightarrow 0 \rightarrow 1$ ) or Select and deselect SS1 (PROFIsafe control word 1, bit $1 = 1 \rightarrow 0 \rightarrow 1$ ) or Fail-safe acknowledgment (PROFIsafe control word 1, bit $7 = 0 \rightarrow 1 \rightarrow 0$ )	Switch off the power supply voltage and switch on again.

3. Acknowledge the inverter with the "standard" acknowledge signal.

You have acknowledged the discrepancy message

6.10 Stop responses

## 6.10 Stop responses

### Internal event

An "internal event" is a major fault that causes the inverter to bring the motor to a standstill as quickly as possible by triggering a STOP reaction. For example, an "internal event" can be caused by one of the following:

- The inverter detects an internal fault in its hardware or its firmware on the basis of a data cross-check (F01611).
- The inverter identifies when a limit value is violated as a result of an inadmissible motor speed (C01714).

An "internal event" can only be acknowledged using a fail-safe signal.

Fail-safe acknowledgment (Page 299)

### STOP A

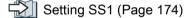
For a STOP A, the inverter safely switches off the torque of the connected motor immediately.

### STOP B

For a STOP B, the inverter brakes the motor with the OFF3 ramp-down time until standstill is detected. This is then followed by a STOP A.

If you operate the motor with torque control, then the inverter switches over the control mode to speed control.

The inverter monitors the braking of the motor. The type of monitoring corresponds to the monitoring mode of SS1.



With braking ramp monitoring

With acceleration monitoring

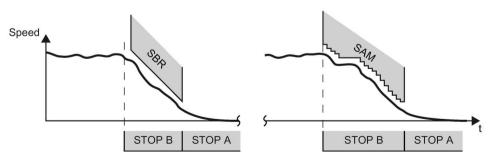


Image 6-50 Speed monitoring for a STOP B

If the motor does not follow the defined braking ramp, the inverter interrupts the braking of the motor and responds with a STOP A.

### STOP F

If a safety function is active <sup>1</sup>), a STOP F initiates a STOP A or STOP B:

- Fault F01611 immediately initiates a STOP A.
- For message C01711, the inverter response depends on the active safety function:
  - When STO is active, then the inverter initiates a STOP A.
  - In all other cases, the inverter initiates a STOP B.

If none of the safety functions are active, then the inverter responds as follows:

- Fault F01611 immediately initiates a STOP A.
- There is no immediate stop response for message C01711. However, the message is kept. When selecting a safety function, the inverter responds with a stop as described above.

<sup>1)</sup> The SSM function is considered as active safety function if the SSM filter and the SSM hysteresis have been enabled.

6.10 Stop responses

## 6.10.1 Example 1: Internal event with STO active

### Drive response

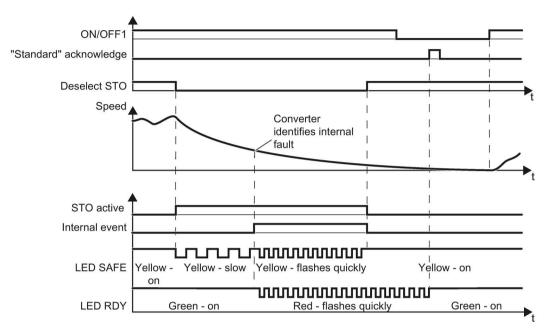


Image 6-51 Internal event when the STO safety function is active

The inverter signals an internal event.

Inverter signals	Parameter	Included in the PROFIsafe telegram	Can be intercon- nected with	
			F-DI	F-DO
Internal event	r9722.7	$\checkmark$		$\checkmark$
STO active (extended functions)	r9722.0	$\checkmark$		$\checkmark$
Deselect STO (extended functions)	r9720.0	$\checkmark$	$\checkmark$	
"Standard" acknowledgment	p2103			
ON/OFF1	r0054.0			

### Switching the motor on after an internal event

#### Procedure



- To switch the motor on after an internal event, proceed as follows:
- 1. Deselect the STO function.
- 2. Issue an OFF1 command (ON/OFF1 = 0).
- 3. Acknowledge the inverter with the "standard" acknowledge signal.
- 4. Switch on the motor (ON/OFF1 = 1).
- You have acknowledged the internal event and switched on the motor again.

### 6.10.2 Example 2: Internal event with SSM active

#### Internal event when the motion monitoring function is active

If an active safety function with motion monitoring (SS1, SSL, SDI or SSM) is interrupted with an internal event, the inverter responds with a STOP F.

A STOP F does not unconditionally stop the motor.

Stop responses (Page 294)

#### The drive response

The motor behavior is explained using the SSM function and a STOP B with acceleration monitoring as an example:

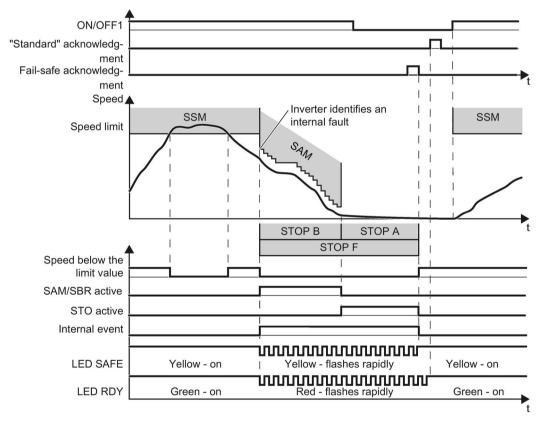


Image 6-52 Response of the SSM safety function to an internal event

6.10 Stop responses

Inverter signals	Parameter	Included in the PROFIsafe telegram	Can be i necte	intercon- d with
			F-DI	F-DO
Internal event	r9722.7	$\checkmark$		✓
STO active (extended functions)	r9722.0	$\checkmark$		$\checkmark$
SSM feedback signal active (speed below limit value)	r9722.15	$\checkmark$		~
SAM/SBR active	r9723.16			
"Standard" acknowledgment	p2103			
Fail-safe acknowledgment	r9720.7	$\checkmark$	$\checkmark$	
ON/OFF1	r0054.0			

### Switching the motor on after an internal event

#### Procedure



- To switch the motor in the example above on again, proceed as follows:
- 1. Issue an OFF1 command (ON/OFF1 = 0).
- 2. Acknowledge the internal event in one of the following ways:
  - Fail-safe acknowledgment using PROFIsafe control word 0, bit 7 = 0  $\rightarrow$  1  $\rightarrow$  0
  - Fail-safe acknowledge signal via a safety-related input: F-DI =  $0 \rightarrow 1 \rightarrow 0$ .
  - Select the STO function and deselect again (PROFIsafe control word 0, bit 0 or F-DI).  $1 \rightarrow 0 \rightarrow 1$ ).
  - Select the SS1 function and deselect again (PROFIsafe control word 0, bit 1 or F-DI).  $1 \rightarrow 0 \rightarrow 1$ ).
  - Switch off the power supply voltage of the inverter and switch on again.
- 3. Acknowledge the inverter with the "standard" acknowledge signal.
- 4. Switch on the motor (ON/OFF1 = 1).Switching on the motor when SSM is active (Page 278)
- You have acknowledged the internal event and switched on the motor again.

# 6.11 Fail-safe acknowledgment

## 6.11.1 Acknowledging using a fail-safe signal

You must acknowledge the majority of safety function faults using a fail-safe signal. The following options are available.

- Acknowledging using a safety-related input F-DI
- Acknowledging via PROFIsafe
- Acknowledging by selecting and deselecting STO
- Acknowledging by switching the power supply voltage on and off

### Acknowledging using a safety-related input F-DI

#### Procedure



- To acknowledge the inverter using a safety-related input F-DI, proceed as follows:
- 1. Acknowledge the fault with F-DI =  $0 \rightarrow 1 \rightarrow 0$ .
- 2. Then, acknowledge the inverter with the "standard" acknowledgement signal.
- You have acknowledged the inverter in a fail-safe fashion.

### Acknowledging via PROFIsafe

#### Procedure



- To acknowledge the inverter via PROFIsafe, proceed as follows:
- 1. Acknowledge the fault with bit 7 of the control word 0: Bit 7 = 0  $\rightarrow$  1  $\rightarrow$  0.
- 2. Then, acknowledge the inverter with the "standard" acknowledgement signal.
- You have acknowledged the inverter in a fail-safe fashion.

### Acknowledging by selecting and deselecting STO

#### Procedure



To acknowledge the inverter by selecting and deselecting STO, proceed as follows:

1. Select the safety function STO or SS1 and then deselect again.

- F-DI =  $1 \rightarrow 0 \rightarrow 1$
- PROFIsafe control word 1, bit 0 or 1 = 1  $\rightarrow$  0  $\rightarrow$  1
- 2. Then, acknowledge the inverter with the "standard" acknowledgement signal.



You have acknowledged the inverter in a fail-safe fashion.

### Acknowledging by switching the power supply on and off

You can acknowledge faults by temporarily shutting off the power supply voltage of the inverter and then switching it on again.

6.11 Fail-safe acknowledgment

## 6.11.2 Response to a discrepancy of the fail-safe acknowledge signal

### Drive response

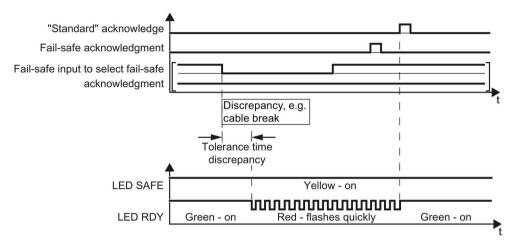


Image 6-53 Behavior of the inverter for discrepancy of the input signal for fail-safe acknowledgment

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

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

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

Inverter signals	Parameter	Included in the	Can be interconnec	ted with
		PROFIsafe telegram	F-DI	F-DO
"Standard" acknowledgment	p2103			
Fail-safe acknowledgment	r9720.7	$\checkmark$	$\checkmark$	

### Acknowledging a discrepancy message

#### Procedure



- To acknowledge the discrepancy message, proceed as follows:
- 1. Remove the discrepancy.
- 2. Acknowledge the discrepancy message in one of the following ways:
  - Select the STO function and then deselect again: F-DI =  $1 \rightarrow 0 \rightarrow 1$ .
  - Select the SS1 function and then deselect again: F-DI =  $1 \rightarrow 0 \rightarrow 1$ .
  - Switch off the power supply voltage of the inverter and switch on again.
- 3. Acknowledge the inverter with the "standard" acknowledge signal.
- You have acknowledged the discrepancy message

The table below lists the notes regarding the behavior of your drive if you select more than one safety function at the same time.

Some cases do not affect the behavior of your drive. If, for example, the safety function STO is active, the motor torque remains switched off regardless of which inverter function you also select.

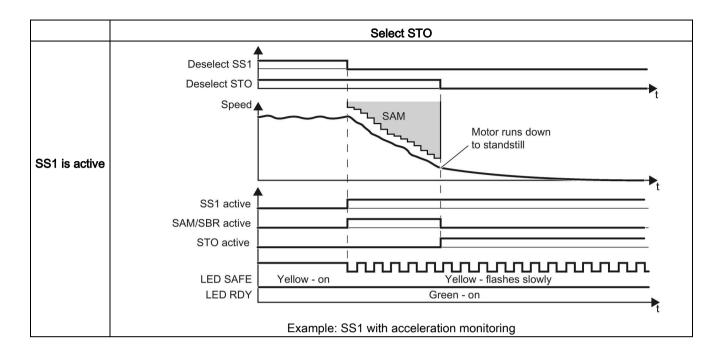
Table 6-11 Interaction between two safety functions

	Select STO	Select SS1	Select SLS	Select SDI
STO is active		No effect	No effect	No effect
SS1 is active	See below		No effect 1)	No effect 1)
SLS is active	See below	See below		See below
SDI is active	See below	See below	See below	
SSM is active	See below	See below	See below	See below

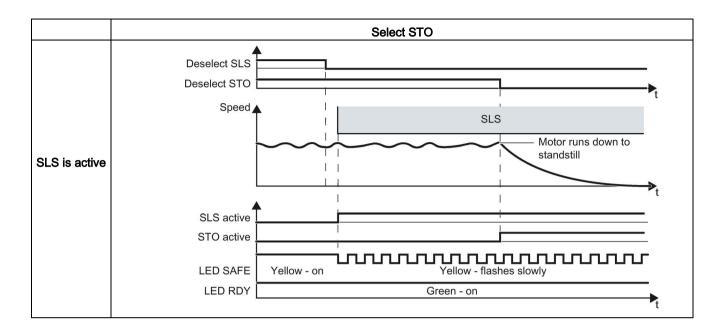
<sup>1)</sup> When SS1 is active and the following conditions are simultaneously satisfied, the inverter initiates a STOP A:

- The motor speed exceeds the SLS limit or exits the SDI tolerance window

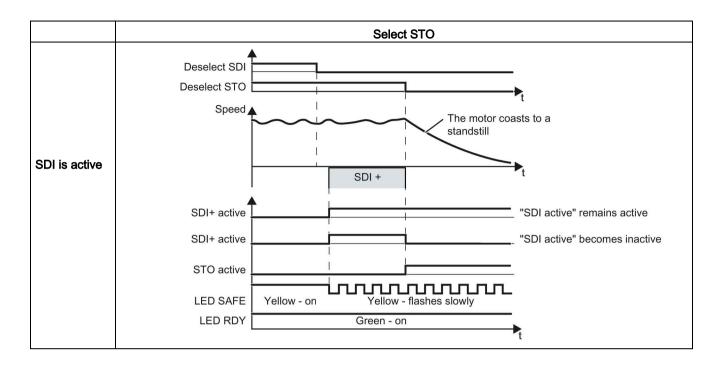
- STOP A is set as fault response for SLS or SDI



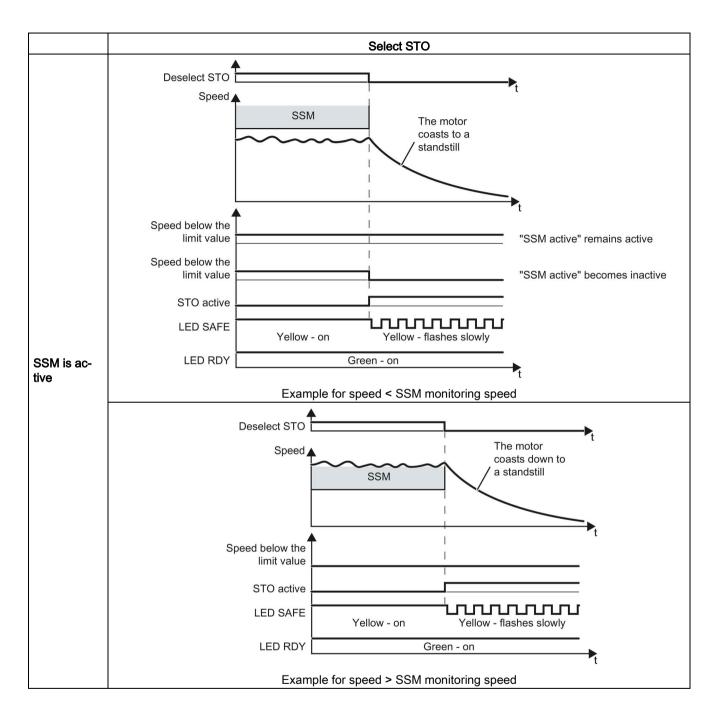
Inverter signals	Parameters	Included in the PROFIsafe telegram		erconnected ith
			F-DI	F-DO
STO active (basic functions)	r9773.1	$\checkmark$		~
STO deselection (basic functions)	r9773.0	$\checkmark$	$\checkmark$	
STO cause, selection via terminal on the Power Mod- ule	r9772.25			
STO active (extended functions)	r9722.0	$\checkmark$		~
Deselect STO (extended functions)	r9720.0	$\checkmark$	$\checkmark$	
SS1 active (extended functions)	r9722.1	$\checkmark$		$\checkmark$
Deselect SS1 (extended functions)	r9720.1	$\checkmark$	✓	
SAM/SBR active	r9723.16			
ON/OFF1	r0054.0			



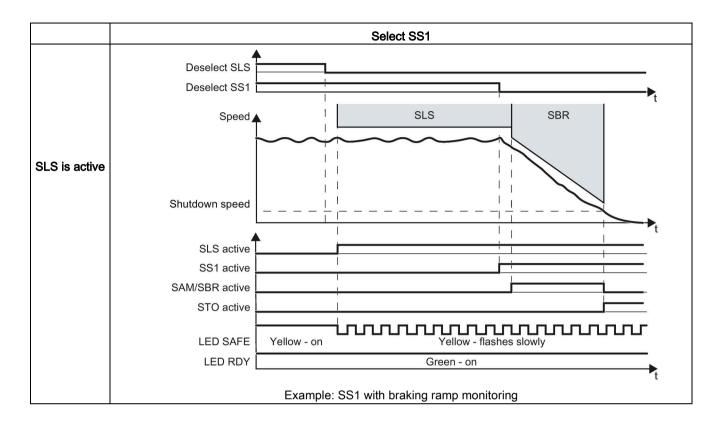
Inverter signals	Parameters	Included in the PROFIsafe telegram	Can be inte wi	
			F-DI	F-DO
STO active (basic functions)	r9773.1	✓		1
STO deselection (basic functions)	r9773.0	√	$\checkmark$	
STO cause, selection via terminal on the Power Module	r9772.25			
STO active (extended functions)	r9722.0	1		1
Deselect STO (extended functions)	r9720.0	√	$\checkmark$	
SLS active	r9722.4	$\checkmark$		✓
Deselect SLS	r9720.4	$\checkmark$	$\checkmark$	



Inverter signals	Parameter	Parameter Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
STO active (basic functions)	r9773.1	1		$\checkmark$
STO deselection (basic functions)	r9773.0	1	✓	
STO cause, selection via terminal on the Power Module	r9772.25			
STO active (extended functions)	r9722.0	1		✓
Deselect STO (extended functions)	r9720.0	1	√	
SDI+ active	r9722.12	1		✓
SDI+ deselect	r9720.12	1	✓	
SDI- active	r9722.13	1		√
Deselect SDI-	r9720.13	1	✓	

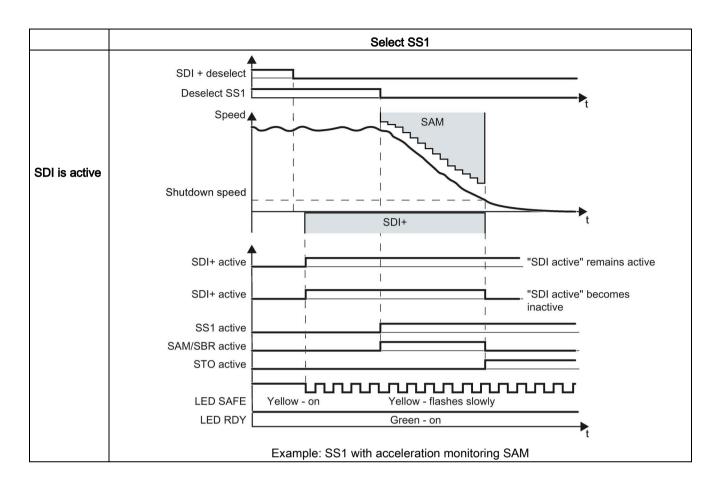


Inverter signals	Parameter	Included in the PROFIsafe telegram	Can be inte wi	erconnected ith
			F-DI	F-DO
STO active (basic functions)	r9773.1	✓		~
STO deselection (basic functions)	r9773.0	√	$\checkmark$	
STO cause, selection via terminal on the Power Mod- ule	r9772.25			
STO active (extended functions)	r9722.0	1		~
Deselect STO (extended functions)	r9720.0	√	$\checkmark$	
SSM feedback signal active (speed below limit value)	r9722.15	$\checkmark$		$\checkmark$

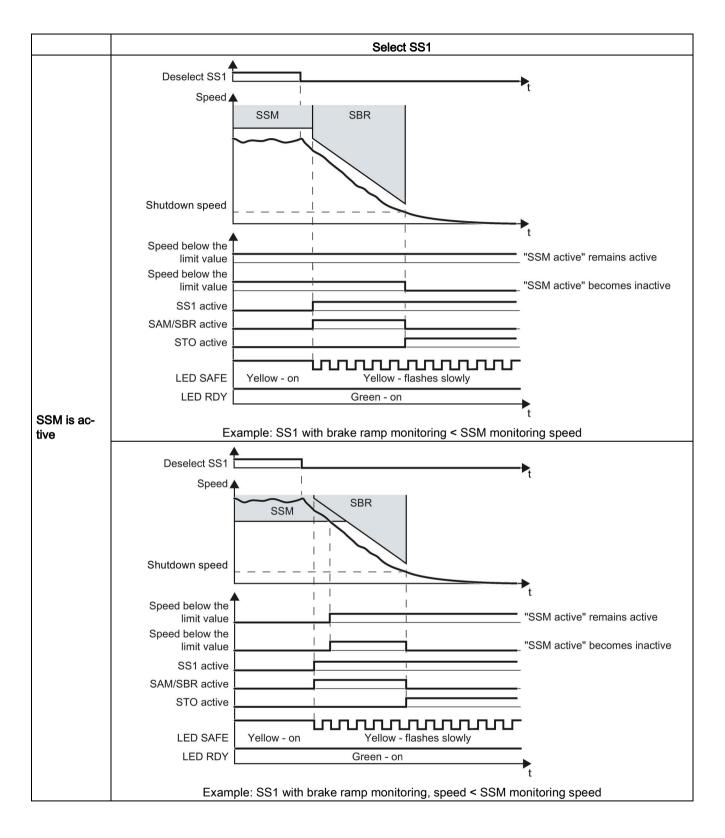


Inverter signals	Parameter	Included in the PROFIsafe telegram		erconnected ith
			F-DI	F-DO
STO active (extended functions)	r9722.0	1		✓
SS1 active (basic functions)	r9773.6	1		✓
Deselect SS1 (basic functions)	r9773.5	1	1	
SS1 active (extended functions)	r9722.1	1		✓
Deselect SS1 (extended functions)	r9720.1	1	1	
SLS active	r9722.4	1		✓
Deselect SLS	r9720.4	1	1	
SAM/SBR active	r9723.16			

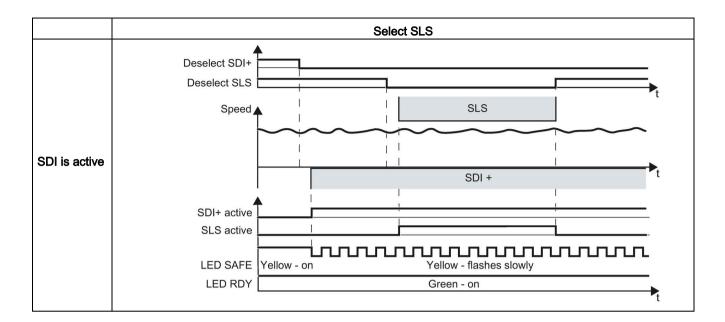
Operation



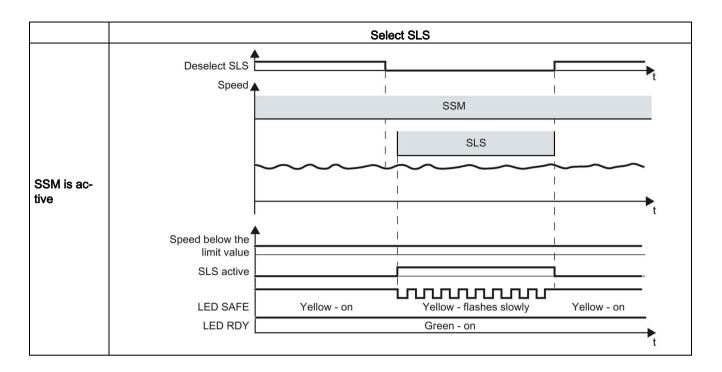
Inverter signals	Parameter	Included in the PROFIsafe telegram		erconnected ith
			F-DI	F-DO
STO active (extended functions)	r9722.0	1		~
SS1 active (basic functions)	r9773.6	1		$\checkmark$
Deselect SS1 (basic functions)	r9773.5	1	$\checkmark$	
SS1 active (extended functions)	r9722.1	1		✓
Deselect SS1 (extended functions)	r9720.1	1	$\checkmark$	
SDI+ active	r9722.12	1		~
SDI+ deselect	r9720.12	1	$\checkmark$	
SDI- active	r9722.13	1		✓
Deselect SDI-	r9720.13	1	$\checkmark$	
SAM/SBR active	r9723.16			



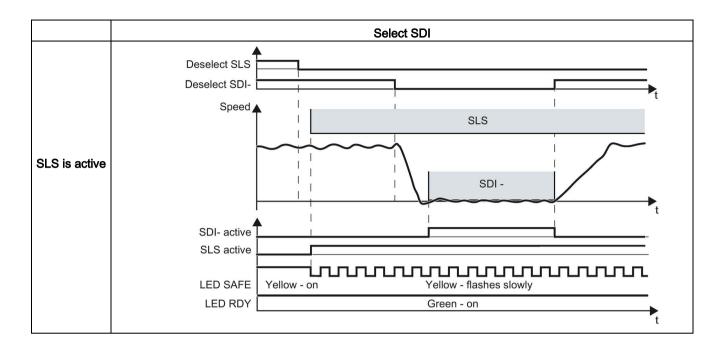
Inverter signals	Parameter	Included in the PROFIsafe telegram	Can be inte w	erconnected ith
			F-DI	F-DO
STO active (extended functions)	r9722.0	1		√
SS1 active (basic functions)	r9773.6	$\checkmark$		$\checkmark$
Deselect SS1 (basic functions)	r9773.5	✓	✓	
SS1 active (extended functions)	r9722.1	$\checkmark$		$\checkmark$
Deselect SS1 (extended functions)	r9720.1	1	√	
SSM feedback signal active (speed below limit value)	r9722.15	1		√
SAM/SBR active	r9723.16			



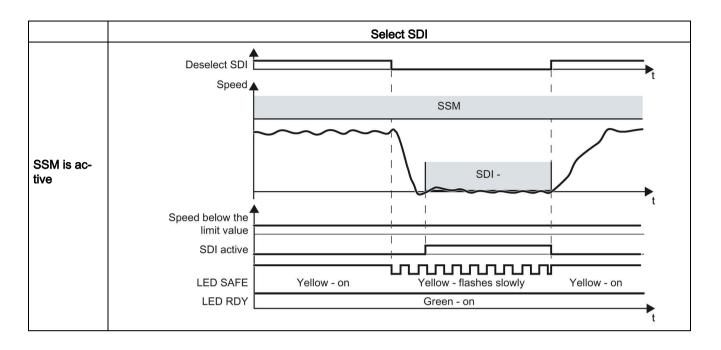
Inverter signals	Parameter	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
SLS active	r9722.4	1		$\checkmark$
Deselect SLS	r9720.4	√	$\checkmark$	
SSM feedback signal active (speed below limit value)	r9722.15	1		$\checkmark$
SDI+ active	r9722.12	√		$\checkmark$
SDI+ deselect	r9720.12	1	$\checkmark$	
SDI- active	r9722.13	1		$\checkmark$
Deselect SDI-	r9720.13	1	$\checkmark$	



Inverter signals	Parameter	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
SLS active	r9722.4	$\checkmark$		$\checkmark$
Deselect SLS	r9720.4	$\checkmark$	1	
SSM feedback signal active (speed below limit value)	r9722.15	√		$\checkmark$



Inverter signals	Parameter	Included in the PROFIsafe telegram	Can be interconnected with	
			F-DI	F-DO
SLS active	r9722.4	√		1
Deselect SLS	r9720.4	$\checkmark$	$\checkmark$	
SDI+ active	r9722.12	$\checkmark$		1
SDI+ deselect	r9720.12	$\checkmark$	$\checkmark$	
SDI- active	r9722.13	✓		1
Deselect SDI-	r9720.13	$\checkmark$	$\checkmark$	



Inverter signals	Parameter	Included in the PROFIsafe telegram	Can be inte w	
			F-DI	F-DO
SSM feedback signal active (speed below limit value)	r9722.15	1		1
SDI+ active	r9722.12	1		1
SDI+ deselect	r9720.12	1	✓	
SDI- active	r9722.13	1		1
Deselect SDI-	r9720.13	1	✓	

# 6.13 Overview of the inverter signals relevant for operation

The following table lists the signals relevant for using the safety functions: Most of the signals are included in the PROFIsafe telegram, or can be interconnected using a safety-related input or output.

Inverter signals	Parameter	Included in the PROFIsafe telegram		intercon- d with
			F-DI	F-DO
Internal event	r9722.7	✓		~
STO active (basic functions)	r9773.1	1		$\checkmark$
STO deselection (basic functions)	r9773.0	✓	✓	
STO cause, selection via terminal on the Power Module	r9772.25			
STO active (extended functions)	r9722.0	1		✓
Deselect STO (extended functions)	r9720.0	1	✓	
SBC requested (basic functions)	r9773.4			
SS1 active (basic functions)	r9773.6	1		✓
Deselect SS1 (basic functions)	r9773.5	1	✓	
SS1 active (extended functions)	r9722.1	1		✓
Deselect SS1 (extended functions)	r9720.1	1	✓	
SLS active	r9722.4	1		✓
Deselect SLS	r9720.4	1	✓	
SLS level active	r9722.9, r9722.10	1		1
Select SLS level	r9720.9, r9720.10	1	1	
SSM feedback signal active (speed below limit value)	r9722.15	√		1
SDI+ active	r9722.12	1		√
SDI+ deselect	r9720.12	1	1	
SDI- active	r9722.13	1		√
Deselect SDI-	r9720.13	1	1	
SAM/SBR active	r9723.16			
Forced checking procedure (test stop) of the STO terminals on the PM240-2 Power Module required	r9773.30			
Forced checking procedure (test stop) required for the basic functions	r9773.31			
Forced checking procedure (test stop) required for the extended functions	r9723.0			
Forced checking procedure (test stop) required for the extended functions	p9705			
Start the forced checking procedure (test stop) of the safety-related output	p10007			
"Standard" acknowledgment	p2103			
Fail-safe acknowledgment	r9720.7	1	√	

6.13 Overview of the inverter signals relevant for operation

Inverter signals	Parameter	Included in the PROFIsafe telegram	Can be i necte	ntercon- d with
			F-DI	F-DO
Ready to switch on	r0052.0			
ON/OFF1	r0054.0			
OFF2	r0054.1			
OFF3	r0054.2			
Release motor holding brake	r0899.12			
Close motor holding brake	r0899.13			

# 6.14 List of alarms and faults

### Syntax for faults and alarms

A67890 Alarm 67890

C01700 Message 1700 for safety functions

These messages are either alarms or faults, see the following table.

The table in this manual only contains the alarms and faults of the safety functions. The complete list of all alarms and faults of the inverter, detailed causes and remedial measures can be found in the List Manual.

Signal	Cause	Remedy
	Complete information on the messa	ges is available in the List Manual.
F01600	STOP A initiated. Fault value r0949 provides more	The remedy depends on the fault value. The complete list of the fault values is provided in the List Manual.
	detailed information.	0: Stop request from processor 2.
		1005: Pulses are canceled, although neither is STO selected nor an internal STOP A active.
		Cause 1: Defective hardware. Remedy:
		1. Select STO and then deselect again.
		2. Switch off the power supply voltage of the inverter and switch on again.
		3. Replace the Power Module if it cannot be acknowledged.
		Cause 2: 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 inverter fail-safe.
		3. Replace the Power Module if it cannot be acknowledged.
		1010 1011: For details, please refer to the List Manual. Remedy:
		1. Select STO and then deselect again.
		2. Switch off the power supply voltage of the inverter and switch on again.
		<ol> <li>Replace the Power Module if it cannot be acknowledged.</li> <li>1030: Discrepancy at terminals STO_A and STO_B on the PM240-2 Power Module. Remedy:</li> </ol>
		1. Remove the discrepancy at the terminals.
		2. Acknowledge the inverter fail-safe.
		<ol> <li>Replace the Power Module if it cannot be acknowledged.</li> <li>9999: Subsequent response to fault F01611.</li> </ol>

Signal	Cause	Remedy
	Complete information on the messa	ges is available in the List Manual.
F01611	Defect in a monitoring channel. Fault value r0949 provides more	The remedy depends on the fault value. The complete list of the fault values is provided in the List Manual.
	detailed information.	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 inverter monitors the signal to select a safety function after a signal change.
		If the signal state continues to change in shorter intervals than en- tered in p9650, after the time 5 × p9650 the inverter outputs fault F1611:
		Select safety $p9650$ $p9650$ $p9650$ $p9650$ $r F1611$ function $p9650$ $p9650$ $p9650$ $t$ $t$ $t$ $5 * p9650$ $p9650$ $t$
		Remedy:
		Check the F-DI wiring (contact problems).
		<ul> <li>Resolve the contact problems or faults at the PROFIBUS mas- ter/PROFINET controller.</li> </ul>
		The inverter terminates the monitoring and does not signal any faults if the signal state remains stable before the time $5 \times p9650$ expires, longer than p9650:
		Select safety $p9650$ function $p9650$ $t$ < 5 * p9650
		1001, 1002: Initialization error, change timer/check timer.
		<ul> <li>Remedy: Switch off the power supply voltage of the inverter and switch on again.</li> </ul>
		2000: Status of the STO selection for the two monitoring channels is different.
		Response to a discrepancy when STO is active (Page 224)
		2001: Checkback signal of the safe pulse suppression for the two monitoring channels is different.

Signal	Cause	Remedy
	Complete information of	n 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 224)
		Response to a discrepancy when SS1 is active (Page 244)
		2003: Status of the STO terminal at processor 1 and processor 2 is different.
		Remedy for 2000, 2001, and 2003:
		<ul> <li>Check the F-DI changeover tolerance time. Increase the value (p9650).</li> </ul>
		Check the F-DI wiring (contact problems).
		<ul> <li>Check the causes of the STO selection in r9772.</li> <li>6000: Internal software fault</li> </ul>
		• Switch off the power supply voltage of the inverter 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 inverter
		<ul> <li>Check the PROFIsafe address at processor 1 (p9610) and processor 2 (p9810).</li> </ul>
		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 inverter has received an inconsistent or out-of-date PROFIsafe telegram after the power supply voltage is switched off and switched on again or after the PROFIBUS/PROFINET line has been inserted.
		Check the configuration and communication in the inverter.
		<ul> <li>Check the value of the F_WD_Time F-parameter in the inverter. Increase the value.</li> </ul>
		6166: Time monitoring fault in reception of the PROFIsafe telegram.
		Check the configuration of the communication in the inverter.
		<ul> <li>Check the setting of the F_WD_Time value in the inverter. In- crease the value.</li> </ul>
		• Evaluate the diagnostic information in the F host.
		Check the PROFIsafe connection.

Signal	Cause	Remedy		
	Complete information on the messages is available in the List Manual.			
A01620, F01620	Safe torque off active	Not necessary.		
A01621, F01621	Safe Stop 1 active	Not necessary.		
F01625	Sign-of-life error in the Safety data	1. Select STO, and then deselect again.		
		2. If it cannot be acknowledged, replace the Control Unit.		
F01630	Brake control defective	Depending on the fault value, check the following:		
	Fault value r0949 provides more detailed information.	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 wind- ing		
		50: Fault in the Safe Brake Relay, in the Control Unit or in the Power Module.		
A01631	Motor holding brake / SBC configura-	Check and correct the parameterization of the motor holding brake:		
	tion does not make sense	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 compo- nent has been replaced, acknowl- edgment/data save is necessary	Corrective maintenance (Page 329)		
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 208)		
F01651	Synchronization, safety time slices unsuccessful.	<ol> <li>Switch off the Control Unit power supply and then on again.</li> <li>If it cannot be acknowledged, replace the Control Unit.</li> </ol>		
F01653	PROFIBUS/PROFINET configuration error	Check the PROFIBUS or PROFINET configuration of the safety slot on the master side and on the Control Unit.		
A01654	PROFIBUS configuration differs	Check the PROFIsafe configuring in the higher-level control.		
		<ul> <li>Alarm value r2124 = 1: In the higher-level F control, remove the PROFIsafe configuring, or enable PROFIsafe in the drive.</li> </ul>		
		<ul> <li>Alarm value r2124 = 2: In the higher-level F control, configure the appropriate PROFIsafe telegram.</li> </ul>		
F01655	Aligning the monitoring functions	<ol> <li>Check that the control cabinet design and cable routing are in compliance with EMC regulations.</li> </ol>		
		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 unsuit- able	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.		
		<ul> <li>If PROFIsafe is enabled (p9601.3 = 1), you must select a PROFIsafe telegram in p60022.</li> </ul>		
		<ul> <li>If transfer of the F-DI via PROFIsafe is selected (p9501.30 = 1), you must select telegram 900 in p60022.</li> </ul>		
F01659	Write task for parameter rejected	Check the setting of the safety functions.		
		You can find possible reasons for the message in the List Manual.		
F01660	Safety functions not supported	Use a Power Module that supports the safety functions.		
		Restrictions when using safety functions (Page 26)		
F01661	Simulation of the safety inputs active	Exit the simulation of the digital inputs of the Control Unit for the F-DI (p0795).		
F01662	Error, internal communications	1. Switch off the Control Unit power supply and then on again.		
		2. Contact Technical Support if it cannot be acknowledged.		
F01663	Copying the SI parameters rejected	1. Set p9700 = 0.		
		2. Check: p9501 ≠ 0 and/or p9601 ≠ 0.		
		If this is the case, then correct both parameters.		
		3. Start the copy function again by entering the corresponding value into p9700.		
F01665	System is defective	The inverter has identified a defect:		
		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 Power Module:		
		<ol> <li>Set the switch for the safety-related input of the Power Module (STO_A and STO_B) into the "OFF" position.</li> </ol>		
A01666, F01666	Static 1 signal at the F-DI for safe acknowledgement	Set the signal at the F-DI to acknowledge the safety functions for a logical 0 signal.		
A01669	Unsuitable combination of motor and power unit.	The ratio between the rated power unit current (r0207[0]) and rated motor current (p0305) should be greater than 5.		
		In operation, message C01711 or C30711 can be sporadically output with values		
		1041 1044.		
		Use a suitable power unit with a lower power rating or a motor with a higher power rating.		

Signal	Cause	Remedy			
	Complete information on the messages is available in the List Manual.				
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.			
F01680	Checksum error safe monitoring	1. Check the safety-related parameters.			
	functions	2. Switch off the power supply voltage of the inverter and switch on again.			
F01681	Incorrect parameter value	Correct the parameter value:			
		Fault value (r0949) yyyyxxxx decimal, yyyy = supplementary infor- mation, 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 inverter and switch on again.			
F01690	Data backup problem involving the NVRAM	Please contact Technical Support.			
F01692	Parameter value not permitted for encoderless	1. From r0949, read out the (decimal) parameter number with the incorrect value.			
		2. Correct the parameter value of the checksums.			
A01693, F01693	Safety parameterization changed, POWER ON required	<ol> <li>Save the parameters so that they are protected against power failure (RAM → ROM).</li> </ol>			
		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 dormant error detection of the extended func- tions 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	SAM/SBR limit exceeded	1. Check the motor braking response.			
(alarm or fault) <sup>1)</sup>		2. Adapt the tolerance for the parameterization of the "safe braking ramp".			

Signal	Cause	Remedy
	Complete information on the messa	ges is available in the List Manual.
C01711 (alarm) <sup>1)</sup>	Defect in a monitoring channel Fault value r2124 provides more	The complete list of the r2124 fault values is provided in the List Manual.
	detailed information.	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 148)
		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 be- tween the two monitoring channels.
		Setting encoderless actual value sensing (Page 148)
		58 999: Fault in data cross-check between processor 1 and pro- cessor 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 inverter and switch on again.
		Upgrade inverter firmware
		1005: Pulses already canceled for test stop selection.
		1011: Acceptance test status between the monitoring channels differ.
		Diagnostics in the List Manual under r9571.
		1020: Cyclic communication failure between the monitoring channels.
		• Remedy: Switch off the power supply voltage of the inverter and switch on again.
		Replace the Control Unit or the inverter.
		1041: Current value too low for encoderless actual value acquisition.
		• Reduce the minimum current (p9588).
		1042: Current or voltage plausibility error.
		• Increase the ramp-up and ramp-down time (p1120/p1121).
		• Check whether the current and speed control settings are correct (torque-forming, field-forming current 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 265)
		Switching on the motor when SSM is active (Page 278)
		Switching on the motor when SDI is active (Page 285)

Signal	Cause	Remedy			
	Complete information on the messages is available in the List Manual.				
		1043: Too many acceleration processes.			
		Increase the voltage tolerance (p9589).			
		Increase the ramp-up and ramp-down time (p1120/p1121).			
		• Check whether the current and speed control settings are correct (torque-generating, field-generating current and speed actual value must not fluctuate).			
		<ul> <li>Reduce the dynamic response of the setpoint.</li> <li>1044: Actual current value plausibility error.</li> </ul>			
		6000 6166: The significance of the message values is described in the safety fault F01611 with the fault value r0949.			
C01712	Defect when processing F-IO	1. Check the F-DI wiring.			
(alarm) <sup>1)</sup>		2. Check the setting of the safety functions.			
		3. Perform an acceptance test.			
C01714 (alarm) <sup>1)</sup>	Safely limited speed exceeded	<ol> <li>Check the speed setpoint received from the higher-level control.</li> <li>Check the SLS limits.</li> </ol>			
C01716 (fault)	Tolerance for safe direction of motion exceeded	Check the tolerance setting for the SDI function.			
C01770 (fault)	Discrepancy error of the safety- related inputs or outputs.	Check the F-DI wiring.			
A01772	Test stop for safety-relevant output is running	The alarm automatically disappears after successfully ending or canceling (error) the forced checking procedure (test stop).			
F01773	Test stop for safety-relevant output	1. Check the wiring of the safety-related output.			
	has an error condition	2. Start the forced dormant error detection.			
A01774	Test stop for safety-relevant output required	The time to carry out the forced checking procedure (test stop) has expired (p10003).			
		Start the forced dormant error detection of the safety-related output.			
A01788	Automatic test stop waits for STO to be deselected via the motion monitor- ing functions	The inverter 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.			
A01790	Powering up stopped due to "STO via Power Module terminals	After the power supply voltage has been switched on, the inverter 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 inverter is presently carry out the forced checking procedure (test stop) for the extended functions. The inverter withdraws the message after the end of the test stop.			
C01799 (alarm)	Acceptance test mode active	Not necessary. The inverter withdraws the message after the end of the acceptance test mode.			

Signal	Cause	Remedy		
-	Complete information on the messages is available in the List Manual.			
F30600	STOP A initiated. Fault value r0949 provides more	The remedy depends on the fault value. The complete list of the fault values is provided in the List Manual.		
	detailed information.	0: Stop request from processor 2.		
		1005: Pulses are canceled, although neither is STO selected nor an internal STOP A active.		
		Cause 1: Defective hardware. Remedy:		
		1. Select STO and then deselect again.		
		2. Switch off the power supply voltage of the inverter and switch on again.		
		3. Replace the Power Module if it cannot be acknowledged.		
		Cause 2: 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:		
		<ol> <li>Set both switches on the PM240-2 Power Module to the "OFF" setting, or enable the function in the Control Unit.</li> </ol>		
		2. Acknowledge the inverter fail-safe.		
		3. Replace the Power Module if it cannot be acknowledged.		
		1010 1011: For details, please refer to the List Manual. Remedy:		
		1. Select STO and then deselect again.		
		2. Switch off the power supply voltage of the inverter and switch on again.		
		<ol> <li>Replace the Power Module if it cannot be acknowledged.</li> <li>1030: Discrepancy at terminals STO_A and STO_B on the PM240-2 Power Module. Remedy:</li> </ol>		
		1. Remove the discrepancy at the terminals.		
		2. Acknowledge the inverter fail-safe.		
		3. Replace the Power Module if it cannot be acknowledged.		
		9999: Subsequent response to fault F01611.		
F30611	Defect in a monitoring channel. Fault value r0949 provides more detailed information.	Fault values and remedies are described under fault F01611.		
A30620, F30620	Safe torque off active	Not necessary.		
A30621, F30621	Safe Stop 1 active	Not necessary.		
F30625	Sign-of-life error in the Safety data	1. Select STO.		
		2. Deselect STO.		
		3. If it cannot be acknowledged, replace the Control Unit.		
F30630	Brake control defective	<ol> <li>Check the following:         <ul> <li>p1278 = 0.</li> <li>Motor holding brake connection</li> <li>Motor holding brake function</li> </ul> </li> </ol>		
		<ul> <li>EMC-compliant control cabinet design and cable routing</li> <li>Collect CTO, and there desclore a using</li> </ul>		
		2. Select STO, and then deselect again.		

#### Operation

6.14 List of alarms and faults

Signal	Cause	Remedy			
	Complete information on the message	Complete information on the messages is available in the List Manual.			
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 208)			
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	<ol> <li>Check that the control cabinet design and cable routing are in compliance with EMC regulations.</li> </ol>			
		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 inverter 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 func- tions.			
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 infor- mation, 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.			
A30693, F30693	Safety parameterization changed, POWER ON required	<ol> <li>Save the settings so that they are protected against power failure (RAM → ROM).</li> </ol>			
		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.			

Signal	Cause	Remedy	
	Complete information on the messages is available in the List Manual.		
C30706 (alarm or fault) <sup>1)</sup>	SAM/SBR limit exceeded	<ol> <li>Check the motor braking response.</li> <li>Adapt the tolerance for the parameterization of the "safe braking ramp".</li> </ol>	
C30711 (alarm) <sup>1)</sup>	Defect in a monitoring channel. Fault value r2124 provides more detailed information.	Diagnostics for the fault values and remedies are described under message C01711.	
C30712 (alarm) <sup>1)</sup>	Defect when processing F-IO	<ol> <li>Check the F-DI wiring.</li> <li>Check the setting of the safety functions.</li> <li>Perform an acceptance test.</li> </ol>	
C30714 (alarm) <sup>1)</sup>	Safely limited speed exceeded	<ol> <li>Check the speed setpoint received from the higher-level control.</li> <li>Check the SLS limits.</li> </ol>	
C30716 (fault)	Tolerance for safe direction of motion exceeded	Check the tolerance for the "SDI" function.	
C30770 (fault)	Discrepancy error of the safety inputs or outputs.	Check the F-DI wiring.	
A30772	Test stop for safety-relevant output is running	The alarm automatically disappears after successfully ending or canceling (error) the forced checking procedure (test stop).	
F30773	Test stop for safety-relevant output has an error condition	<ol> <li>Check the wiring of the safety-related output.</li> <li>Start the forced dormant error detection.</li> </ol>	
A30788	Automatic test stop: Wait for STO to be deselected via SMM	<ul> <li>Deselect STO of the extended functions.</li> <li>Remove the cause for active safety messages and acknowledg the messages</li> </ul>	
C30798 (alarm)	Test stop for motion monitoring is running	Not necessary. The inverter withdraws the message after the end of the test stop.	
C30799 (alarm)	Acceptance test mode active	Not necessary. The inverter withdraws the message after the end of the acceptance test mode.	
1) If the safe	ty functions of the inverter have been en	abled, then this alarm initiates a STOP response and an inverter fault.	

#### Operation

6.14 List of alarms and faults

# Corrective maintenance

## 7.1 About this chapter

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

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

- Where can I obtain the necessary information to maintain the operational safety and reliability of my system or machine?
- How do I replace defective components of the inverter or the inverter itself?
- How do I ensure that the safety functions are still working correctly after making a replacement?

7.2 Maintaining operational safety

# 7.2 Maintaining operational safety

## Responsibility for operational safety

As company operating plants or machines or as supplier of plants and machines with safetyrelated 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.

# 

## Risk of death by using incorrect components in safety-related plants and systems

Disregarding current product developments and features can result in an increased risk of accidents in safety-related plants and machines.

- 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



Proceed as follows to subscribe to the "Safety Integrated Newsletter":

1. In the Internet, open the following page:



- Siemens automation technology (www.automation.siemens.com).
- 2. On this page, open the folder "Presales info".
- 3. In folder "Presales info", select the "Newsletter" link.
- 4. Select "Login/registration" and log in with your access data.
- 5. In the "Newsletter system", select the "All newsletters" tab.
- 6. Open folder "Products and solutions".
- 7. Subscribe to the "Safety Integrated Newsletter".
- You have subscribed to the "Safety Integrated Newsletter".

## 7.3 Replacing components of the SINAMICS G120 or G120D inverters

## 

Danger to life as a result of unexpected machine movement when the hardware or firmware is changed

The drive can malfunction after replacing drive components or updating the firmware. This can place people at risk or cause material damage.

- Before switching on the power supply voltage again, ensure that nobody is in the dangerous area around the machine.
- Close the protective devices available before you switch on the power supply voltage.
- Check the stability of the closed-loop control, for example, by briefly moving the drive in both directions of rotation.
- Perform a reduced acceptance test.

## 7.3.1 Overview of replacing converter components

#### Permissible replacement of components

In the event of a long-term function fault, you must replace the Power Module or Control Unit. The inverter's Power Module and Control Unit can be replaced independently of each other.

Replacing the Power Module		Replacing the Control Unit	
Replacement:	Replacement:	Replacement:	Replacement:
Same type	Same type	Same type	Same type
Same power rating	<ul><li>Same frame size</li><li><i>Higher</i> power rating</li></ul>	Same firmware version	<ul> <li><i>higher</i> firmware version (e.g. replace FW V4.2 by FW V4.3)</li> </ul>
x kW x kW	y kW > x kW	Firmware A Firmware A	Firmware A > Firmware B
	Power Module and motor must be adapted to one another (ratio of motor and Power Module rated power > 1/8)	After replacing the Control Unier's settings.	it, you must restore the invert-

In the following cases you will need to replace the inverter:

7.3 Replacing components of the SINAMICS G120 or G120D inverters

## 

#### Risk of injury due to uncontrolled drive motion

Replacing inverters of different types can result in uncontrolled motion of the drive.

• In all cases that are not permitted according to the table above, recommission the drive after replacing an inverter.

# Special issue relating to communication via PROFINET: Device replacement without removable data storage medium

The inverter supports the PROFINET functionality, replacing the device without data storage medium. After replacing the Control Unit, the inverter is automatically assigned its device name from the IO controller.

Independent of this, after replacing the inverter, you must transfer the settings of the old inverter to the new inverter.

Details of the device replacement without removable storage medium can be found in the Internet:



PROFINET system description

(http://support.automation.siemens.com/WW/view/en/19292127).

## 7.3.2 Replacing a Control Unit with enabled safety function

#### Replacing a Control Unit with data backup on a memory card

If you use a memory card with firmware, after the replacement, you obtain a precise copy (firmware and settings) of the replaced Control Unit.

#### Precondition

You have a memory card with the actual settings of the Control unit to be replaced.

#### Procedure



To replace the Control Unit, proceed as follows:

- Disconnect the line voltage to the Power Module and (if installed) the external 24 V supply or the voltage for the digital outputs of the Control Unit.
- 2. Remove the signal cables from the Control Unit.
- 3. Remove the defective Control Unit.
- 4. Remove the memory card from the old Control Unit and insert it in the new Control Unit.
- Mount the new Control Unit on the Power Module. The new Control Unit must have the same article number and the same or higher firmware version as the Control Unit that was replaced.
- 6. Reconnect the signal cables of the Control Unit.
- 7. Switch on the line voltage again.
- 8. The inverter loads the settings from the memory card.
- 9. Check what the inverter reports after loading.
  - Alarm A01028:

The loaded settings are not compatible with the inverter.

Clear the alarm with p0971 = 1 and recommission the drive.

– Fault F01641:

Acknowledge the message.

Perform a reduced acceptance test.

Reduced acceptance after a component has been replaced and a firmware change (Page 361)

You have replaced the Control Unit and transferred the safety function settings from the memory card to the new Control Unit.

7.3 Replacing components of the SINAMICS G120 or G120D inverters

### Replacing a Control Unit with data backup in STARTER

#### Precondition

You have backed up the actual settings of the Control Unit to be replaced to a PC using STARTER.

#### Procedure



- To replace the Control Unit, proceed as follows:
- 1. Disconnect the line voltage to the Power Module and (if installed) the external 24 V supply or the voltage for the digital outputs of the Control Unit.
- 2. Remove the signal cables of the Control Unit.
- 3. Remove the defective Control Unit.
- 4. Mount the new Control Unit on the Power Module.
- 5. Reconnect the signal cables of the Control Unit.
- 6. Switch on the line voltage again.
- 7. Open the project in the PC the matches the drive.
- Go online and transfer the settings from the PC to the inverter by pressing the inverter signals faults after the download. Ignore these faults, as they will be automatically acknowledged by the following steps.
- 9. Select the screen form for the safety functions.
- 10.Select the "Change settings" button.
- 11.Select the "Activate settings" button.
- 12.Save your settings (copy RAM to ROM).
- 13.Switch off the inverter power supply.
- 14. Wait until all LEDs on the inverter go dark.
- 15.Switch on the inverter power supply again.
- 16.Perform a reduced acceptance test.

Reduced acceptance after a component has been replaced and a firmware change (Page 361)

You have replaced the Control Unit and transferred the safety function settings from the PC to the new Control Unit.

### Replacing a Control Unit with data backup in Startdrive

#### Precondition

You have backed up the actual settings of the Control Unit to be replaced to a PC using Startdrive.

#### Procedure



- To replace the Control Unit, proceed as follows:
- 1. Disconnect the line voltage to the Power Module and (if installed) the external 24 V supply or the voltage for the digital outputs of the Control Unit.
- 2. Remove the signal cables of the Control Unit.
- 3. Remove the defective Control Unit.
- 4. Mount the new Control Unit on the Power Module.
- 5. Reconnect the signal cables of the Control Unit.
- 6. Switch on the line voltage again.
- 7. Open the project in the PC the matches the drive.
- 8. Select "Load to device".
- 9. Connect Startdrive online with the drive.

The inverter signals faults after the download. Ignore these faults, as they will be automatically acknowledged by the following steps.

- 10.Press the "Start safety commissioning" button.
- 11.Enter the password for the safety functions.
- 12. Confirm the prompt for saving your settings (copy RAM to ROM).
- 13.Disconnect the online connection.
- 14.Switch off the inverter power supply.
- 15.Wait until all LEDs on the inverter go dark.
- 16.Switch on the inverter power supply again.
- 17.Perform a **reduced** acceptance test.

Reduced acceptance after a component has been replaced and a firmware change (Page 361)

You have replaced the Control Unit and transferred the safety function settings from the PC to the new Control Unit.

7.3 Replacing components of the SINAMICS G120 or G120D inverters

#### Replacing the Control Unit with data backup in the operator Panel

#### Precondition

You have backed up the actual settings of the Control Unit to be replaced to an Operator Panel.

#### Procedure



- To replace the Control Unit, proceed as follows:
- 1. Disconnect the line voltage to the Power Module and (if installed) the external 24 V supply or the voltage for the digital outputs of the Control Unit.
- 2. Remove the signal cables of the Control Unit.
- 3. Remove the defective Control Unit.
- 4. Mount the new Control Unit on the Power Module.
- 5. Reconnect the signal cables of the Control Unit.
- 6. Switch on the line voltage again.
- 7. Plug the Operator Panel into the Control Unit or connect the Operator Panel handheld device with the inverter.
- 8. Transfer the settings from the Operator Panel to the inverter.
- 9. Wait until the transfer is complete.
- 10.After loading, check whether the inverter outputs alarm A01028.
  - Alarm A01028:

The loaded settings are not compatible with the inverter.

Clear the alarm with p0971 = 1 and recommission the drive.

- No alarm A01028: Proceed with the next step.
- 11.Switch off the inverter power supply.
- 12. Wait until all LEDs on the inverter go dark.
- 13.Switch on the inverter power supply again.

The inverter reports the faults F01641, F01650, F01680 and F30680. Ignore these faults, as they will be automatically acknowledged by the following steps.

- 14.Set p0010 to 95.
- 15.Set p9761 to the safety password.
- 16.Set p9701 to AC hex.
- 17.Set p0010 to 0.
- 18.Back up the settings so they are not lost when the power fails:
  - BOP-2 in the menu "EXTRAS" "RAM-ROM".
  - IOP in the menu "SAVE RAM TO ROM".
- 19.Switch off the inverter power supply.
- 20.Wait until all LEDs on the inverter go dark.

- 21.Switch on the inverter power supply again.
- 22.Perform a **reduced** acceptance test.

Reduced acceptance after a component has been replaced and a firmware change (Page 361)



You have replaced the Control Unit and transferred the safety function settings from the Operator Panel to the new Control Unit.

## 7.3.3 Replacing the Control Unit without data backup

If you do not backup the settings, then you must recommission the drive after replacing the Control Unit.

#### Procedure



To replace the Control Unit without backed-up settings, proceed as follows:

- 1. Disconnect the line voltage to the Power Module and (if installed) the external 24 V supply or the voltage for the digital outputs of the Control Unit.
- 2. Remove the signal cables of the Control Unit.
- 3. Remove the defective Control Unit.
- 4. Mount the new Control Unit on the Power Module.
- 5. Reconnect the signal cables of the Control Unit.
- 6. Switch on the line voltage again.
- 7. Recommission the drive.
- The Control Unit replacement has been completed after the drive has been successfully commissioned.

7.3 Replacing components of the SINAMICS G120 or G120D inverters

## 7.3.4 Replacing a Power Module with enabled safety function



#### 

#### Danger from touching energized Power Module connections

After switching off the line voltage, it will take up to 5 minutes until the capacitors in the Power Module are sufficiently discharged for the residual voltage to be safe. Death or serious injury will result if energized parts are touched.

• Check the safe isolation of the Power Module connections before carrying out installation work.

#### NOTICE

#### Material damage from swapping the motor's connection lines

The direction in which the motor rotates switches if you swap the two phases of the motor line. A motor running backwards may damage the machine or installation.

- Connect the three phases of the motor lines in the right order.
- After replacing the Power Module, check the direction of motor rotation.

#### Procedure



To replace the Power Module, proceed as follows:

- Switch off the line voltage of the Power Module. You can leave any external 24 V supply to the Control Unit switched on.
- 2. Remove the connecting cables of the Power module.
- 3. Remove the Control Unit from the Power Module.
- 4. Replace the Power Module.
- 5. Mount the Control Unit onto the new Power Module.
- 6. Connect up the new Power Module using the connecting cables.
- 7. Switch on the line supply and, if necessary, the 24 V supply for the Control Unit.
- 8. The inverter reports F01641.
- 9. Perform a reduced acceptance test.

Reduced acceptance after a component has been replaced and a firmware change (Page 361)

You have successfully replaced the Power Module.

## 7.4 Replacing the SINAMICS G120C converter

## 

Danger to life as a result of unexpected machine movement when the hardware or firmware is changed

The drive can malfunction after replacing drive components or updating the firmware. This can place people at risk or cause material damage.

- Before switching on the power supply voltage again, ensure that nobody is in the dangerous area around the machine.
- Close the protective devices available before you switch on the power supply voltage.
- Check the stability of the closed-loop control, for example, by briefly moving the drive in both directions of rotation.
- Perform a reduced acceptance test.

## 7.4.1 Overview of how to replace an inverter

#### Permissible replacement

You must replace the inverter if it continually malfunctions.

In the following cases you will need to replace the inverter:

Replacement:	Replacement:	Replacement:	Replacement:
<ul><li>Same power rating</li><li>Same firmware version</li></ul>	<ul> <li>Same power rating</li> <li><i>Higher</i> firmware version (e.g. replace FW V4.2 by FW V4.3)</li> </ul>	<ul> <li>Same frame size</li> <li><i>Higher</i> power rating</li> <li>Same firmware version</li> </ul>	<ul> <li>Same frame size</li> <li><i>Higher</i> power rating</li> <li><i>Higher</i> firmware version (e.g. replace FW V4.2 by FW V4.3)</li> </ul>
x kW Firmware A x kW Firmware A	x kW Firmware B B > A x kW Firmware A	y kW Firmware A y > x x kW Firmware A	y kW Firmware B y > x B > A x kW Firmware A
		Inverter and motor must be adapted to one another (ratio of the motor and inverter rated power > 1/8)	

After you have carried out the replacement, you must restore the inverter's settings.

## 

#### Risk of injury due to uncontrolled drive motion

Replacing inverters of different types can result in uncontrolled motion of the drive.

• In all cases that are not permitted according to the table above, recommission the drive after replacing an inverter.

# Special issue relating to communication via PROFINET: Device replacement without removable data storage medium

The inverter supports the PROFINET functionality, replacing the device without data storage medium.

#### Precondition

The topology of the PROFINET IO system with the IO device involved is configured in your higher-level control system.

#### Replacing the device

The inverter can be replaced without having to insert a removable data storage medium (e.g. a memory card) with the saved device names in the inverter – or having to reassign the device names with a PG.

Details of the device replacement without removable storage medium can be found in the Internet:



PROFINET system description

(http://support.automation.siemens.com/WW/view/en/19292127).

## 7.4.2 Replacing a converter with enabled safety function



## 

#### Danger from touching energized Power Module connections

After the power supply has been switched off, it takes up to 5 min. until the capacitors in the inverter have discharged so that the remaining voltage is at a non-hazardous level. Death or serious injury can result when live parts are touched.

• Check that the inverter connections are in a no-voltage condition before you carry out any installation work.

#### NOTICE

#### Material damage from swapping the motor's connection lines

The direction in which the motor rotates changes if you interchange the two phases of the motor cable. A motor running backwards may damage the machine or installation.

- Connect the three phases of the motor cables in the correct sequence.
- After replacing the inverter, check the direction in which the motor rotates.

#### Replacing an inverter with data backup on a memory card

#### Procedure



To replace the inverter, proceed as follows:

- 1. Disconnect the line voltage to the inverter and (if installed) the external 24 V supply or the voltage for the digital outputs of the inverter.
- 2. Remove the connecting cables of the inverter.
- 3. Remove the defective inverter.
- 4. Install the new inverter.
- 5. Remove the memory card from the old inverter, and insert this into the new inverter.
- 6. Connect all of the cables to the inverter.
- 7. Reconnect the line voltage, and (if being used) the external 24 V supply or the voltage for the digital outputs of the inverter.
- 8. The inverter loads the settings from the memory card.
- 9. After loading, check whether the inverter outputs Alarm A01028.
  - Alarm A01028:

The loaded settings are not compatible with the inverter.

Clear the alarm with p0971 = 1 and recommission the drive.

- No alarm A01028:

Perform a **reduced** acceptance test.

Reduced acceptance after a component has been replaced and a firmware change (Page 361)



You have replaced the inverter and transferred the safety function settings from the memory card to the new inverter.

#### Replacing an inverter with data backup in STARTER

#### Requirement

You have backed up the actual settings of the inverter to be replaced to a PC using STARTER.

#### Procedure



- To replace the inverter, proceed as follows:
- 1. Disconnect the line voltage to the inverter and (if installed) the external 24 V supply or the voltage for the digital outputs of the inverter.
- 2. Remove the connecting cables of the inverter.
- 3. Remove the defective inverter.
- 4. Install the new inverter.
- 5. Connect all of the cables to the inverter.
- 6. Reconnect the line voltage, and (if being used) the external 24 V supply or the voltage for the digital outputs of the inverter.
- 7. Open the project that matches the drive in STARTER.
- Go online and transfer the settings from the PC to the inverter by pressing the inverter signals faults after the download. Ignore these faults, as they will be automatically acknowledged by the following steps.
- 9. In STARTER, select the screen form for the safety functions.
- 10.Select the "Change settings" button.
- 11.Select the "Activate settings" button.
- 12.Save your settings (copy RAM to ROM).
- 13.Switch off the inverter power supply.
- 14.Wait until all LEDs on the inverter are dark.
- 15.Switch on the inverter supply voltage again.
- 16.Perform a **reduced** acceptance test.

Reduced acceptance after a component has been replaced and a firmware change (Page 361)

You have replaced the inverter and transferred the safety function settings from the PC to the new inverter.

#### Replacing an inverter with data backup in Startdrive

#### Requirement

You have backed up the actual settings of the inverter to be replaced to a PC using Startdrive.

#### Procedure



- To replace the inverter, proceed as follows:
- 1. Disconnect the line voltage to the inverter and (if installed) the external 24 V supply or the voltage for the digital outputs of the inverter.
- 2. Remove the connecting cables of the inverter.
- 3. Remove the defective inverter.
- 4. Install the new inverter.
- 5. Connect all of the cables to the inverter.
- 6. Reconnect the line voltage, and (if being used) the external 24 V supply or the voltage for the digital outputs of the inverter.
- 7. In Startdrive, open the project that matches the drive.
- 8. Select "Load to device".
- 9. Connect Startdrive online with the drive.

The inverter signals faults after the download. Ignore these faults, as they will be automatically acknowledged by the following steps.

- 10.Press the "Start safety commissioning" button.
- 11.Enter the password for the safety functions.
- 12. Confirm the prompt for saving your settings (copy RAM to ROM).
- 13.Disconnect the online connection.
- 14.Switch off the inverter supply voltage.
- 15.Wait until all LEDs on the inverter go dark.
- 16.Switch on the inverter supply voltage again.
- 17.Perform a reduced acceptance test.

Reduced acceptance after a component has been replaced and a firmware change (Page 361)



You have replaced the inverter and transferred the safety function settings from the PC to the new inverter.

#### Replacing the inverter with data backup in the Operator Panel (BOP-2 or IOP)

#### Procedure



To replace the inverter, proceed as follows:

- 1. Disconnect the line voltage to the inverter and (if installed) the external 24 V supply or the voltage for the digital outputs of the inverter.
- 2. Remove the connecting cables of the inverter.
- 3. Remove the defective inverter.
- 4. Install the new inverter.
- 5. Connect all of the cables to the inverter.
- 6. Reconnect the line voltage, and (if being used) the external 24 V supply or the voltage for the digital outputs of the inverter.
- 7. Attach the Operator Panel to the inverter.
- Transfer the settings from the Operator Panel to the inverter, e.g. via menu "EXTRAS" -"FROM BOP" in the BOP-2.
- 9. Wait until the transfer is complete.
- 10.After loading, check whether the inverter outputs alarm A01028.
  - Alarm A01028:

The loaded settings are not compatible with the inverter.

Clear the alarm with p0971 = 1, and recommission the drive.

- No alarm A01028: Proceed with the next step.
- 11.Switch off the inverter supply voltage.
- 12.Wait until all LEDs on the inverter go dark.
- 13.Switch on the inverter supply voltage again.

The inverter reports the faults F01641, F01650, F01680 and F30680. Ignore these faults, as they will be automatically acknowledged by the following steps.

- 14.Set p0010 to 95.
- 15.Set p9761 to the safety password.
- 16.Set p9701 to AC hex.
- 17.Set p0010 to 0.
- 18.Back up the settings so they are not lost when the power fails:
  - For BOP-2, in the menu "EXTRAS" "RAM-ROM".
  - For IOP, in the menu "SAVE RAM TO ROM".

19.Switch off the inverter power supply.

20.Wait until all LEDs on the inverter are dark.

21.Switch on the inverter supply voltage again.

22.Perform a reduced acceptance test.

Reduced acceptance after a component has been replaced and a firmware change (Page 361)

You have replaced the inverter and transferred the safety function settings from the Operator Panel to the new inverter.

## 7.4.3 Replacing a converter without data backup

If the settings have not been backed up, after replacing the inverter, you must recommission the drive.

#### Procedure



To replace the inverter, proceed as follows:

- 1. Disconnect the line voltage to the inverter and (if installed) the external 24 V supply or the voltage for the digital outputs of the inverter.
- 2. Remove the connecting cables of the inverter.
- 3. Remove the defective inverter.
- 4. Install the new inverter.
- 5. Connect all of the cables to the inverter.
- 6. Reconnect the line voltage, and (if being used) the external 24 V supply or the voltage for the digital outputs of the inverter.
- 7. Recommission the drive.
- Inverter commissioning has been completed after it has been commissioned.

## 

Danger to life as a result of unexpected machine movement when the hardware or firmware is changed

The drive can malfunction after replacing drive components or updating the firmware. This can place people at risk or cause material damage.

- Before switching on the power supply voltage again, ensure that nobody is in the dangerous area around the machine.
- Close the protective devices available before you switch on the power supply voltage.
- Check the stability of the closed-loop control, for example, by briefly moving the drive in both directions of rotation.
- Perform a reduced acceptance test.

## 7.5.1 Overview of replacing converter components

#### Permissible replacement of components

In the event of a long-term function fault, you must replace the Power Module or Control Unit. The inverter's Power Module and Control Unit can be replaced independently of each other.

Replacing the Power Module		Replacing the Control Unit	
Replacement:	Replacement:	Replacement:	Replacement:
Same power rating	Higher power rating	Same firmware version	<ul> <li><i>higher</i> firmware version (e.g. replace FW V4.7 by FW V4.7 SP3)</li> </ul>
x kW x kW	y kW × kW	Firmware A Firmware A	Firmware A Firmware B
	Power Module and motor must be adapted to one another (ratio of motor and Power Module rated power > 1/8)	After replacing the Control Unier's settings.	t, you must restore the invert-

In the following cases you will need to replace the inverter:

## 

#### Risk of injury due to uncontrolled drive motion

Replacing inverters with different firmware can result in uncontrolled motion of the drive.

 In all cases that are not permitted according to the table above, recommission the drive after replacing an inverter.

# Special issue relating to communication via PROFINET: Device replacement without removable data storage medium

The inverter supports the PROFINET functionality, replacing the device without data storage medium.

#### Precondition

The topology of the PROFINET IO system with the IO device involved is configured in your higher-level control system.

#### Replacing the device

The Control Unit can be replaced without having to insert a removable data storage medium (e.g. a memory card) with the saved device names in the inverter – or having to reassign the device names with a PG.

Details of the device replacement without removable storage medium can be found in the Internet:

PROFINET system description

(http://support.automation.siemens.com/WW/view/en/19292127).

## 7.5.2 Replacing a Control Unit with enabled safety function



## 

#### Danger from touching energized Power Module connections

After switching off the mains voltage, it will take up to 5 minutes until the capacitors in the Power Module are sufficiently discharged for the residual voltage to be safe. Death or serious injury can result when live parts are touched.

• Check that the Power Module connections are in a no-voltage condition after you have removed the cables from the Power Module.

#### Replacing a Control Unit with data backup on a memory card

If you use a memory card with firmware, after the replacement, you obtain a precise copy (firmware and settings) of the replaced Control Unit.

#### Precondition

You have a memory card with the actual settings of the Control unit to be replaced.

#### Procedure



To replace the Control Unit, proceed as follows:

- 1. Switch off the inverter power supply voltage.
- 2. Remove all cables from the inverter.
- 3. After 5 minutes, check whether the device is in a no-voltage condition.
- 4. Release the four Power Modules screws.
- 5. Remove the Power Module.
- 6. Withdraw the ribbon cable to the CPI module from the Control Unit.
- 7. Release the four screws from the Control Unit.
- 8. Remove the defective Control Unit.
- 9. Mount the new Control Unit. The new Control Unit must have the same article number and the same or higher firmware version as the Control Unit that was replaced.

10.Insert the ribbon cable to the CPI module back into the Control Unit.

11. Mount the Power Module on the Control Unit.

- 12.Reconnect all of the cables to the inverter.
- 13.Switch on the power supply voltages again.
- 14. The inverter loads its settings from the memory card.
- 15.Check what the inverter reports after loading.
  - Alarm A01028:

The loaded settings are not compatible with the inverter.

Clear the alarm with p0971 = 1 and recommission the drive.

– Fault F01641:

Acknowledge the message.

Perform a reduced acceptance test.

Reduced acceptance after a component has been replaced and a firmware change (Page 361)

You have replaced the Control Unit and transferred the safety function settings from the memory card to the new Control Unit.

#### Replacing a Control Unit with data backup in STARTER

#### Precondition

You have backed up the actual settings of the Control Unit to be replaced to a PC using STARTER.

#### Procedure



- To replace the Control Unit, proceed as follows:
- 1. Switch off the inverter power supply voltage.
- 2. Remove all cables from the inverter.
- 3. After 5 minutes, check whether the device is in a no-voltage condition.
- 4. Release the four Power Modules screws.
- 5. Remove the Power Module.
- 6. Withdraw the ribbon cable to the CPI module from the Control Unit.
- 7. Release the four screws from the Control Unit.
- 8. Remove the defective Control Unit.
- 9. Mount the new Control Unit. The new Control Unit must have the same article number and the same or higher firmware version as the Control Unit that was replaced.
- 10.Insert the ribbon cable to the CPI module back into the Control Unit.
- 11. Mount the Power Module on the Control Unit.
- 12.Reconnect all of the cables to the inverter.
- 13.Switch on the power supply voltages again.
- 14.Open the right project for the drive in the PC.
- 15.Select the screen form for the safety functions.
- 16.Go online and transfer the settings from the PC to the inverter by pressing the inverter signals faults after the download. Ignore these faults, as they will be automatically acknowledged by the following steps.
- 17.Select the "Change settings" button.
- 18.Select the "Activate settings" button.
- 19.Save your settings (copy RAM to ROM).
- 20.Switch off the inverter supply voltage.
- 21.Wait until all LEDs on the inverter go dark.
- 22.Switch on the inverter supply voltage again.
- 23.Perform a reduced acceptance test.

Reduced acceptance after a component has been replaced and a firmware change (Page 361)

You have replaced the Control Unit and transferred the safety function settings from the PC to the new Control Unit.

## Replacing a Control Unit with data backup in Startdrive

## Precondition

You have backed up the actual settings of the Control Unit to be replaced to a PC using Startdrive.

## Procedure



- To replace the Control Unit, proceed as follows:
- 1. Switch off the inverter power supply voltage.
- 2. Remove all cables from the inverter.
- 3. After 5 minutes, check whether the device is in a no-voltage condition.
- 4. Release the four Power Modules screws.
- 5. Remove the Power Module.
- 6. Withdraw the ribbon cable to the CPI module from the Control Unit.
- 7. Release the four screws from the Control Unit.
- 8. Remove the defective Control Unit.
- 9. Mount the new Control Unit. The new Control Unit must have the same article number and the same or higher firmware version as the Control Unit that was replaced.
- 10.Insert the ribbon cable to the CPI module back into the Control Unit.
- 11.Mount the Power Module on the Control Unit.
- 12.Reconnect all of the cables to the inverter.
- 13.Switch on the power supply voltages again.
- 14.Open the right project for the drive in the PC.
- 15.Select "Load to device".
- 16.Connect Startdrive online with the drive.

The inverter signals faults after the download. Ignore these faults, as they will be automatically acknowledged by the following steps.

- 17.Press the "Start safety commissioning" button.
- 18. Enter the password for the safety functions.
- 19. Confirm the prompt for saving your settings (copy RAM to ROM).
- 20.Disconnect the online connection.
- 21.Switch off the inverter supply voltage.
- 22. Wait until all LEDs on the inverter go dark.
- 23.Switch on the inverter supply voltage again.
- 24.Perform a **reduced** acceptance test.

Reduced acceptance after a component has been replaced and a firmware change (Page 361)

You have replaced the Control Unit and transferred the safety function settings from the PC to the new Control Unit.

#### Replacing the Control Unit with data backup in the operator Panel

#### Precondition

You have backed up the actual settings of the Control Unit to be replaced to an operator panel.

#### Procedure



- To replace the Control Unit, proceed as follows:
- 1. Switch off the inverter power supply voltage.
- 2. Remove all cables from the inverter.
- 3. After 5 minutes, check whether the device is in a no-voltage condition.
- 4. Release the four Power Modules screws.
- 5. Remove the Power Module.
- 6. Withdraw the ribbon cable to the CPI module from the Control Unit.
- 7. Release the four screws from the Control Unit.
- 8. Remove the defective Control Unit.
- 9. Mount the new Control Unit. The new Control Unit must have the same article number and the same or higher firmware version as the Control Unit that was replaced.
- 10.Insert the ribbon cable to the CPI module back into the Control Unit.
- 11. Mount the Power Module on the Control Unit.
- 12.Reconnect all of the cables to the inverter.
- 13.Switch on the power supply voltages again.
- 14.Connect the handheld operator panel to the inverter.
- 15. Transfer the settings from the Operator Panel to the inverter.
- 16.Wait until the transfer is complete.
- 17. After loading, check whether the inverter outputs alarm A01028.
  - Alarm A01028:

The loaded settings are not compatible with the inverter.

Clear the alarm with p0971 = 1 and recommission the drive.

- No alarm A01028: Proceed with the next step.
- 18.Switch off the inverter supply voltage.
- 19. Wait until all LEDs on the inverter go dark.
- 20.Switch on the inverter supply voltage again.

The inverter reports the faults F01641, F01650, F01680 and F30680. Ignore these faults, as they will be automatically acknowledged by the following steps.

- 21.Set p0010 to 95.
- 22.Set p9761 to the safety password.

23.Set p9701 to AC hex.

24.Set p0010 to 0.

25.Back up the settings so they are not lost when the power fails: "SAVE RAM TO ROM".

26.Switch off the inverter supply voltage.

27.Wait until all LEDs on the inverter go dark.

28.Switch on the inverter supply voltage again.

29.Perform a reduced acceptance test.

Reduced acceptance after a component has been replaced and a firmware change (Page 361)

You have replaced the Control Unit and transferred the safety function settings from the operator panel to the new Control Unit.

## 7.5.3 Replacing the Control Unit without data backup

If you do not backup the settings, then you must recommission the drive after replacing the Control Unit.

#### Procedure



To replace the Control Unit without backed-up settings, proceed as follows:

1. Switch off the inverter power supply voltage.

2. Remove all cables from the inverter.

3. Wait for 5 minutes until the device is in a no-voltage condition.

4. Release the four Power Modules screws.

5. Remove the Power Module.

6. Withdraw the ribbon cable to the CPI module from the Control Unit.

7. Release the four screws from the Control Unit.

8. Remove the defective Control Unit.

9. Mount the new Control Unit.

10. Insert the ribbon cable to the CPI module back into the Control Unit.

11. Mount the Power Module on the Control Unit.

12. Reconnect all of the cables to the inverter.

13.Switch on the power supply voltages again.

14.Recommission the drive.

The Control Unit replacement has been completed after the drive has been successfully commissioned.

## 7.5.4 Replacing a Power Module with enabled safety function



### 

#### Danger from touching energized Power Module connections

After switching off the mains voltage, it will take up to 5 minutes until the capacitors in the Power Module are sufficiently discharged for the residual voltage to be safe. Death or serious injury will result if energized parts are touched.

• Check that the Power Module connections are in a no-voltage condition after you have removed the cables from the Power Module.

#### Procedure



To replace the Power Module, proceed as follows:

- 1. Switch off the inverter power supply voltage.
- 2. Remove all cables from the inverter.
- 3. After 5 minutes, check whether the device is in a no-voltage condition.
- 4. Release the four Power Modules screws.
- 5. Remove the Power Module.
- 6. If a memory card is inserted in the Power Module, remove the memory card and insert it into the new Power Module.
- 7. Mount the new Power Module on the Control Unit.
- 8. Reconnect all of the cables to the inverter.
- 9. Switch on the power supply voltages again.
- 10.The inverter reports F01641.
- 11.Perform a reduced acceptance test.

Reduced acceptance after a component has been replaced and a firmware change (Page 361)

You have successfully replaced the Power Module.

# 7.6 Replacing the SIMATIC ET 200pro FC-2 inverter

## 

Danger to life as a result of unexpected machine movement when the hardware or firmware is changed

The drive can malfunction after replacing drive components or updating the firmware. This can place people at risk or cause material damage.

- Before switching on the power supply voltage again, ensure that nobody is in the dangerous area around the machine.
- Close the protective devices available before you switch on the power supply voltage.
- Check the stability of the closed-loop control, for example, by briefly moving the drive in both directions of rotation.
- Perform a reduced acceptance test.

## 7.6.1 Overview of how to replace an inverter

#### Permissible replacement

You must replace the inverter if it continually malfunctions.

If you replace a defective inverter by a new inverter with the same or higher firmware version, the settings of the defective inverter can be loaded to the new inverter.

You must recommission the drive if the defective inverter has a higher firmware version then the new inverter.

## 7.6.2 Replacing a converter with enabled safety function



#### 

Risk of fatal injury when touching energized Power Module connections

After the power supply has been switched off, it takes up to 5 min. until the capacitors in the inverter have discharged so that the remaining voltage is at a non-hazardous level. Death or serious injury can result when live parts are touched.

• Check that the inverter connections are in a no-voltage condition before you carry out any installation work.

#### Replacing an inverter with data backup on a memory card

#### Procedure



To replace the inverter, proceed as follows:

- 1. Disconnect the line voltage to the inverter.
- 2. Remove the inverter connecting cables.
- 3. Remove the defective inverter.
- 4. Remove the memory card from the old inverter, and insert it into the new inverter.
- 5. Install the new inverter.
- 6. Install the connecting cables of the inverter.
- 7. Connect up the line voltage again.
- 8. The inverter loads the settings from the memory card.
- 9. After loading, check whether the inverter outputs Alarm A01028.
  - Alarm A01028:

The loaded settings are not compatible with the inverter.

Clear the alarm with p0971 = 1 and recommission the drive.

- No alarm A01028:

Perform a **reduced** acceptance test.

Reduced acceptance after a component has been replaced and a firmware change (Page 361)

You have replaced the inverter and transferred the safety function settings from the memory card to the new inverter.

#### Replacing an inverter with data backup in STARTER

#### Requirement

You have backed up the actual settings of the inverter to be replaced to a PC using STARTER.

#### Procedure



- To replace the inverter, proceed as follows:
- 1. Disconnect the line voltage to the inverter.
- 2. Remove the inverter connecting cables.
- 3. Remove the defective inverter.
- 4. Install the new inverter.
- 5. Install the connecting cables of the inverter.
- 6. Connect up the line voltage again.
- 7. Open the right project for the drive in STARTER.
- Go online and transfer the settings from the PC to the inverter by pressing the inverter signals faults after the download. Ignore these faults, as they will be automatically acknowledged by the following steps.
- 9. In STARTER, select the screen form for the safety functions.
- 10.Select the "Change settings" button.
- 11.Select the "Activate settings" button.
- 12.Save your settings (copy RAM to ROM).
- 13.Switch off the inverter power supply.
- 14.Wait until all LEDs on the inverter are dark.
- 15.Switch on the inverter power supply voltage again).
- 16.Perform a reduced acceptance test.
  - Reduced acceptance after a component has been replaced and a firmware change (Page 361)

You have replaced the inverter and transferred the safety function settings from the PC to the new inverter.

#### Replacing an inverter with data backup in Startdrive

#### Requirement

You have backed up the actual settings of the inverter to be replaced to a PC using Startdrive.

#### Procedure



- To replace the inverter, proceed as follows:
- 1. Disconnect the line voltage to the inverter.
- 2. Remove the inverter connecting cables.
- 3. Remove the defective inverter.
- 4. Install the new inverter.
- 5. Install the connecting cables of the inverter.
- 6. Connect up the line voltage again.
- 7. In Startdrive, open the project that matches the drive.
- 8. Select "Load to device".
- 9. Connect Startdrive online with the drive.

The inverter signals faults after the download. Ignore these faults, as they will be automatically acknowledged by the following steps.

10.Press the "Start safety commissioning" button.

- 11.Enter the password for the safety functions.
- 12. Confirm the prompt for saving your settings (copy RAM to ROM).
- 13.Disconnect the online connection.
- 14.Switch off the inverter supply voltage.
- 15. Wait until all LEDs on the inverter go dark.
- 16.Switch on the inverter supply voltage again.
- 17.Perform a reduced acceptance test.

Reduced acceptance after a component has been replaced and a firmware change (Page 361)

You have replaced the inverter and transferred the safety function settings from the PC to the new inverter.

#### Replacing an inverter with data backup in the operator panel

#### Procedure



To replace the inverter, proceed as follows:

- 1. Disconnect the line voltage to the inverter.
- 2. Remove the inverter connecting cables.
- 3. Remove the defective inverter.
- 4. Install the new inverter.
- 5. Install the connecting cables of the inverter.
- 6. Connect up the line voltage again.
- 7. Connect the inverter to the operator panel.
- 8. Transfer the settings from the Operator Panel to the inverter.
- 9. Wait until the transfer is complete.
- 10.After loading, check whether the inverter outputs alarm A01028.
  - Alarm A01028:

The loaded settings are not compatible with the inverter.

Clear the alarm with p0971 = 1, and recommission the drive.

- No alarm A01028: Proceed with the next step.
- 11.Switch off the inverter supply voltage.
- 12.Wait until all LEDs on the inverter go dark.
- 13.Switch on the inverter supply voltage again.

The inverter reports the faults F01641, F01650, F01680 and F30680. Ignore these faults, as they will be automatically acknowledged by the following steps.

- 14.Set p0010 to 95.
- 15.Set p9761 to the safety password.
- 16.Set p9701 to AC hex.
- 17.Set p0010 to 0.

- 18.Back up the settings so they are not lost when the power fails: Menu "SAVE RAM TO ROM".
- 19.Switch off the inverter power supply.
- 20.Wait until all LEDs on the inverter are dark.
- 21.Switch on the inverter supply voltage again.
- 22.Perform a reduced acceptance test.

Reduced acceptance after a component has been replaced and a firmware change (Page 361)

You have replaced the inverter and transferred the safety function settings from the operator panel to the new inverter.

## 7.6.3 Replacing a converter without data backup

If the settings have not been backed up, after replacing the inverter, you must recommission the drive.

#### Procedure



- To replace the inverter, proceed as follows:
- 1. Disconnect the line voltage to the inverter and (if installed) the external 24 V supply or the voltage for the digital outputs of the inverter.
- 2. Remove the connecting cables of the inverter.
- 3. Remove the defective inverter.
- 4. Install the new inverter.
- 5. Connect all of the cables to the inverter.
- 6. Reconnect the line voltage, and (if being used) the external 24 V supply or the voltage for the digital outputs of the inverter.
- 7. Recommission the drive.
- Inverter commissioning has been completed after it has been commissioned.

#### Reduced acceptance after a component has been replaced and a 7.7 firmware change

After a component has been replaced or the firmware updated, a reduced acceptance test of the safety functions must be performed.

Measure	Acceptance test	Documentation
Replacing the Control Unit or the inverter with an identical type	An acceptance test for the safety functions is not re- quired. Only check the motor's direc- tion of rotation.	<ul> <li>Supplement the inverter data</li> <li>Document the modified checksum and time stamp <sup>1</sup>)</li> <li>Countersignature</li> </ul>
Replacing a Power Module with an identical type		Supplement the hardware version in the inverter data.
Replacing the motor with an iden- tical pole pair number		No change
Replacing the gearbox with an identical ratio		
Replacing the Safe Brake Relay	Check the SBC function.	Supplement the hardware version in the inverter data.
Replacing the safety-related pe- ripherals (e.g. Emergency Stop switch).	Check the control of the safety functions affected by the components that have been replaced.	No change
Inverter firmware update	An acceptance test for the safety functions is not re- quired. Check as to whether the firmware update was suc- cessful and the inverter functions as expected.	<ul> <li>Supplement firmware version in the inverter data</li> <li>Document the modified checksum and time stamp <sup>1</sup>)</li> <li>Countersignature</li> </ul>

Table 7-1 Reduced acceptance test after component replacement

<sup>1)</sup> The inverter changes the following parameters after replacing converter components and after a firmware update:

- checksum r9781
- time stamp r9782



Acceptance tests for the safety functions (Page 208)

7.7 Reduced acceptance after a component has been replaced and a firmware change

# System properties

# 8.1 About this chapter

### What can you find in this Chapter?

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

- How long may I operate my inverter?
- In what time intervals must I initiate an inverter self test?
- What are the probabilities of failure of the safety functions of my inverter?
- How long does it take for my drive to respond when selecting a safety function?
- How long does it take for my drive to respond when the safety function is active and the motor malfunctions?
- According to which standards are the safety functions of my inverter certified?
- Where can I find the inverter certificate?
- What are the technical data of the Safe Brake Relay?

8.2 Probability of failure of the safety functions (PFH value)

#### 8.2 Probability of failure of the safety functions (PFH value)

The specified probability of failure values apply under the following preconditions:

- The service life of the inverter has not expired.
- The test interval has not expired.

### Service life

You may not operate inverters with integrated safety functions for longer than 20 years. The 20 years starts when the device is delivered. The service life cannot be extended. This is the case even if a service department checks the inverter - or in the meantime, the inverter was decommissioned.

### Test interval

You must test the safety-related circuits of the inverter at least once every year. This process is called "forced dormant error detection" or "test stop".



 $\square$  Regularly testing the safety functions (Page 212).

### Probability of failure

Table 8-1 Probability of failure of the safety functions

Safety function	PFH, PFH <sub>D</sub> <sup>1)</sup>	PFD <sup>2)</sup>
STO, SBC <sup>3)</sup> , SS1, SLS, SDI, SSM	5×10⁻ଃ 1/h	5×10⁻³

- <sup>1)</sup> PFH, PFH<sub>D</sub>: Probability of failures per hour. PFH according to IEC 61800-5-2, PFH<sub>D</sub>according to IEC 62061.
- PFD: For a low demand rate of the safety function: Mean probability of dangerous failure when the safety function is demanded according to IEC 61508.
- <sup>3)</sup> Including Safe Brake Relay

The machine manufacturer must specify a probability of failure in the form of a PFH value for every safety function of a machine.

The integrated inverter safety functions are only ever part of a complete machine safety function. A complete safety function comprises the following components, for example:

- A dual-channel sensor for detecting an open protective door.
- A central fail-safe controller for processing the sensor signal further.
- An inverter for safely stopping (SS1) a motor if a protective door is opened.

IEC 62061 explains how to calculate the PFH<sub>D</sub> value for the complete safety function from the PFH<sub>D</sub> values of the components used for the safety function.

You can find a free-of-charge tool in the Internet to calculate the PFH<sub>D</sub> value of a complete machine:



Safety Evaluation Tool (www.siemens.com/safety-evaluation-tool).

Application examples for the probability of failure PFH and PFD are available in the Internet:

Application example (http://support.automation.siemens.com/WW/view/en/76254308).

# 8.3 Certification

# Certifications

The safety functions fulfill the following requirements:

"STO via Power Module terminals" Control via terminals STO_A and STO_B in the SINAMICS G120 PM240-2 Power Module, FSD FSF	All other safety functions of the SINAMICS G110M, G120, G120C, G120D and SIMATIC ET 200pro FC-2 inverters	
Category 3 and Performance Level (PL) e according to EN ISO 13849-1: 2008	Category 3 and Performance Level (PL) d according to EN ISO 13849-1: 2008	
• Safety integrity level 3 (SIL 3) to IEC 61508: 2010	• Safety integrity level 2 (SIL 2) to IEC 61508: 2010	
EC Declaration of Conformity	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 (http://support.automation.siemens.com/WW/view/en/36426537/134200)

- 2. Filter according to Certificate type "Functional safety/machine safety".
- 3. Select the certificate according to the inverter article number.
  - There is an EC type-examination certificate and a manufacturer declaration for each inverter family.
  - Each certificate includes lists with the associated firmware and hardware.

### System properties

8.3 Certification

Product list Entry li	ist	
Filter settings:		
Entry type:	Certificates	
Certificate Type:	Functional Safety/Safety of Mac Certificate: all	
Approval office:	all Y: all	
Search item(s):		G
		-
Title		Date
Certificate	S Functional Safety/Safety of Machinery, Manufacturer	2013-09-24
	s Functional Safety/Safety of Machinery, Manufacturer	
3	Mart in Super Anno 1	
3	: 6SL3255-0BT01-0PA0	**150084
3 for products Certificate	: 6SL3255-0BT01-0PA0 Is Functional Safety/Safety of Machinery, Type Examination	
3 for products Certificate Certificate,	: 6SL3255-0BT01-0PA0	2013-03-28
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3 for products Certificate, Certificate, Certificate, Certificate Certificate, Certificate o	: 6SL3265-0BT01-0PA0 SF Functional Safety/Safety of Machinery, Type Examination TUV (technischer Überwachungsverein) of Origin, Z10 12 06 59719 007 : 6SL3210-1PE11-8AL0; 6SL3210-1PE11-8AL1; 6SL32 more>> SF Functional Safety/Safety of Machinery, Type Examination TUV (technischer Überwachungsverein) f origin SIL 2, Z10120659719005	2013-03-26 ID: 68849043 2013-03-26
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3 for products Certificate Certificate Certificate Certificate Certificate Certificate Certificate Certificate Certificate	: 6SL3256-0BT01-0PA0 s Functional Safety/Safety of Machinery, Type Examination TÜV (technischer Überwachungsverein) f Origin, Z10 12 06 59719 007 : 6SL3210-1PE11-8AL0; 6SL3210-1PE11-8AL1; 6SL32 more>> s Functional Safety/Safety of Machinery, Type Examination TÜV (technischer Überwachungsverein) f origin SIL 2, Z10120669719006 : 6SL3244-0BB12-1BA0; 6SL3244-0BB12-1BA1; 6SL32 more>> s Functional Safety/Safety of Machinery, SIL-Declaration of	2013-03-26 ID: 68849049 2013-03-26 ID: 68812830 2013-03-22
3 for products Certificate Certificate, Certificate, Certificate Certificate Certificate Certificate Certificate Certificate Certificate Certificate	: 6SL3265-0BT01-0PA0 SF Functional Safety/Safety of Machinery, Type Examination TUV (technischer Überwachungsverein) of Origin, Z10 12 06 59719 007 : 6SL3210-1PE11-8AL0; 6SL3210-1PE11-8AL1; 6SL32 more>> SF Functional Safety/Safety of Machinery, Type Examination TUV (technischer Überwachungsverein) of origin SIL 2, Z10120659719005 : 6SL3244-0BB12-1BA0; 6SL3244-0BB12-1BA1; 6SL32 more>>	2013-03-26 ID: 68849049 2013-03-26 ID: 68812830



You have loaded certificates relevant for Safety Integrated from the Internet.

### EC Declaration of Conformity

According to Annex IV of the machinery directive, drives equipped with Safety Integrated are defined as "Logic units for safety functions" and therefore as a safety component. The machinery directive specifies that safety components should be handled just like machines. As a consequence, safety components require a CE marking.

As machine builder, you must provide documentation that you create for the CE marking of the machine, together with the EC Declaration of Conformity for the products that have been installed.

The current EC Declarations of Conformity for the inverter are in the Internet:



EC Declaration of Conformity

(http://support.automation.siemens.com/WW/view/en/67385845)

# 8.4 Safe Brake Relay

Technical data of the Safe Brake Relay

Technical data	Property		
Supply voltage	20.4 to 28.8 V DC We recommend that you use a power supply with a minimum rated voltage of 26 V in order to compensate for voltage drops along the brake cable.		
Current drawn at 24 V DC	0.05 A + the current drawn by the motor brake		
Maximum current	2 A		
Conductor cross section, max.	2.5 mm <sup>2</sup>		
Dimensions (W x H x D)	69 mm x 63 mm x 33 mm		
Weight	approx. 0.17 kg		

# 8.5 Response times after selection

### 8.5.1 General information

The response times depend on the following conditions:

- Safety function setting
  - Basic function
  - Extended function
- PROFIBUS or PROFINET
- Selected via safety-related input or PROFIsafe

The "worst case values" in the following tables mean the following:

Worst case for a fault-free inverter:	The response time is less than or equal to the specified value.
Worst case for an inverter fault:	The response time is less than or equal to the specified value. The response time is applicable for fault causes within the inverter itself, e.g. for a defective microprocessor.

# 8.5.2 Safe Torque Off (STO) and Safe Brake Control (SBC)

The response time of the STO function is the time between selecting the function and the function becoming active.

### Response times when selected via PROFIsafe

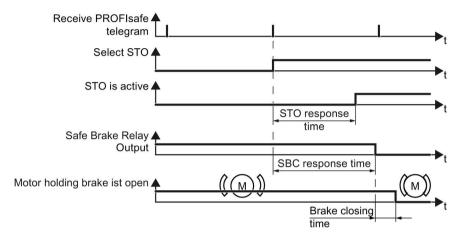


Image 8-1 Response times when selected via PROFIsafe

Function	Selection via	Response	Response time	
			Worst case for a fault-free drive system	Worst case when a fault exists
STO	PROFIBUS	STO is active	14 ms	14 ms
	PROFINET		14 ms + bus cycle time <sup>1)</sup>	14 ms + bus cycle time 1)
SBC	PROFIBUS	Signal change at	16 ms	30 ms
	PROFINET	the output of the Safe Brake Relay	16 ms + bus cycle time <sup>1)</sup>	30 ms + bus cycle time <sup>1)</sup>

Table 8-2 Response times when using the basic functions

<sup>1)</sup> Bus cycle time: Time for cyclic data exchange via PROFINET

 Table 8-3
 Response times when using the extended functions

Function	Selection via	Response	Response time	
			Worst case for a fault-free drive system	Worst case when a fault exists
STO	PROFIBUS	STO is active	54 ms	56 ms
	PROFINET		54 ms + bus cycle time 1)	56 ms + bus cycle time <sup>1)</sup>
SBC	PROFIBUS	Signal change at	56 ms	62 ms
	PROFINET	the output of the Safe Brake Relay	56 ms + bus cycle time <sup>1)</sup>	62 ms + bus cycle time <sup>1)</sup>

<sup>1)</sup> Bus cycle time: Time for a cyclic data exchange via PROFINET.

### Response times when selected via a safety-related input

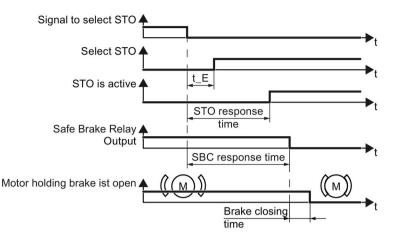


Image 8-2 Response times when selected via a safety-related input

Function	Selection via	Response	Response time	
			Worst case for a fault- free drive system	Worst case when a fault exists
STO	F-DI	STO is active	4 ms + t_E 1)	6 ms + t_E <sup>1)</sup>
	Terminals STO_A, STO_B on the PM240-2 Power Module.		20 ms	
SBC	F-DI	Signal change	8 ms + t_E <sup>1)</sup>	22 ms + t_E 1)
	Terminals STO_A, STO_B on the PM240-2 Power Module.	at the output of the Safe Brake Relay	24 ms	

Table 8-4 Response times when using the basic functions

<sup>1)</sup> When p9651 > 0: t\_E = p9651 + 3 ms; p9651: Delays

When p9651 = 0: t\_E = 4 ms

Table 8-5	Response times when using the extended functions
-----------	--

Function	Selection	Response	Response time	
	via		Worst case for a fault- free drive system	Worst case when a fault exists
STO	F-DI	STO is active	50 ms + t_E <sup>1)</sup>	52 ms + t_E <sup>1)</sup>
SBC		Signal change at the output of the Safe Brake Relay	52 ms + t_E <sup>1)</sup>	60 ms + t_E <sup>1)</sup>

<sup>1)</sup> 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

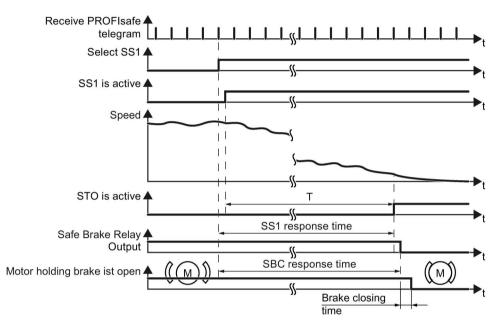


Image 8-3 Response times when selected via PROFIsafe

Function	Selection via	Response	Response time	
			Worst case for a fault-free drive system	Worst case when a fault exists
SS1	PROFIBUS	STO is active	14 ms + T <sup>2)</sup>	14 ms + T <sup>2)</sup>
	PROFINET		14 ms + T <sup>2)</sup> + bus cycle time <sup>1)</sup>	14 ms + T <sup>2)</sup> + bus cycle time <sup>1)</sup>
SBC	PROFIBUS	Signal change	16 ms + T <sup>2)</sup>	30 ms + T <sup>2)</sup>
	PROFINET	at the output of the Safe Brake Relay	16 ms + T <sup>2)</sup> + bus cycle time <sup>1)</sup>	30 ms + T <sup>2)</sup> + bus cycle time <sup>1)</sup>

Table 8-6 Response times when using the basic functions

<sup>1)</sup> Bus cycle time: Time for cyclic data exchange via PROFINET

<sup>2)</sup> T = p9652

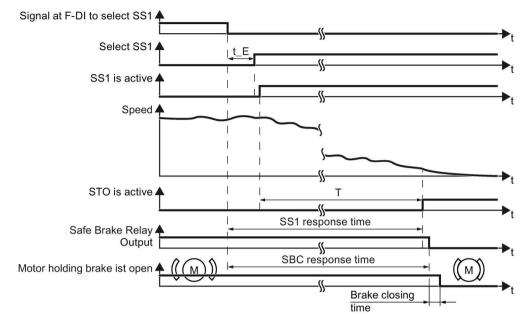
Function	Selection via	Response	Response time		
			Worst case for a fault-free drive system	Worst case when a fault exists	
SS1	PROFIBUS	STO is active	54 ms + T <sup>2)</sup>	56 ms + T <sup>2)</sup>	
	PROFINET		54 ms + T <sup>1)</sup> + bus cycle time <sup>1)</sup>	56 ms + T <sup>1)</sup> + bus cycle time <sup>1)</sup>	
SBC	PROFIBUS	Signal change	56 ms + T <sup>2)</sup>	62 ms + T <sup>2)</sup>	
	PROFINET	at the output of the Safe Brake Relay	56 ms + T <sup>2)</sup> + bus cycle time $^{1)}$	62 ms + T <sup>2)</sup> + bus cycle time <sup>1)</sup>	

Table 8- 7	Response times when using the extended functions
	The spense times when using the extended functions

<sup>1)</sup> Bus cycle time: Time for cyclic data exchange via PROFINET

<sup>2)</sup> 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 safety-related input of the Control Unit

Image 8-4 Response times when selected via a safety-related input F-DI

Table 8-8	Response times when using the basic functions
-----------	---

Function	Selection	Response	Response time	
	via		Worst case for a fault-free drive system	Worst case when a fault exists
SS1	F-DI	STO is active	4 ms + T <sup>1)</sup> + t_E <sup>2)</sup>	6 ms + T <sup>1)</sup> + t_E <sup>2)</sup>
SBC		Signal change at the output of the Safe Brake Relay	8 ms + T <sup>1)</sup> + t_E <sup>2)</sup>	22 ms + T <sup>1)</sup> + t_E <sup>2)</sup>

<sup>1)</sup> T = p9652

<sup>2)</sup> When p9651 > 0: t\_E = p9651 + 3 ms; p9651: Delays

When p9651 = 0: t\_E = 4 ms

Function	Selection	Response	Response time	
	via		Worst case for a fault-free drive system	Worst case when a fault exists
SS1	F-DI	STO is active	50 ms + T <sup>1)</sup> + t_E <sup>2)</sup>	52 ms + T <sup>1)</sup> + t_E <sup>2)</sup>
SBC		Signal change at the output of the Safe Brake Relay	52 ms + T <sup>1)</sup> + t_E <sup>2)</sup>	60 ms + T <sup>1)</sup> + t_E <sup>2)</sup>

 Table 8-9
 Response times when using the extended functions

<sup>1)</sup> 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

<sup>2)</sup> When p10017 > 0: t\_E = p10017 + 3 ms; p10017: Debounce time

When p10017 = 0: t\_E = 4 ms

8.6 Response times when a monitoring function responds

# 8.6 Response times when a monitoring function responds

### Response times when limit values are violated

Function	Response	Response times		
		Worst case for a fault-free drive system	Worst case when a fault exists	
SS1	STOP A	67 ms <sup>1)</sup>	101 ms <sup>1)</sup>	
SLS	STOP A or STOP B	67 ms <sup>1)</sup>	113 ms <sup>1)</sup>	
SDI	STOP A or STOP B	61 ms <sup>1)</sup>	107 ms <sup>1)</sup>	
SSM	Signal change in PROFIs- afe bit S_STW1.7	101 ms <sup>1)</sup>	135 ms <sup>1)</sup>	
	Signal change of the safe- ty-relevant output F-DO:	77 ms <sup>1)</sup>	113 ms <sup>1)</sup>	

Table 8- 10 Response times

<sup>1)</sup> Immediately after switching-on the motor, the response times are extended by p9586 (Delay time actual value sensing).

### Response time after PROFIsafe communication interruption

The inverter receives the PROFIsafe monitoring time from the higher-level-level, fail-safe control (F-CPU).

If the PROFIsafe telegram is not received before the end of the PROFIsafe monitoring time, the inverter activates the STO function.

Depending when the interruption takes place, the inverter can signal the following faults:

- Basic functions have been enabled: Fault F01611
- Extended functions have been enabled: Message C01711

8.6 Response times when a monitoring function responds

# Appendix

# A.1 About this chapter

### What can you find in this Chapter?

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

- What does a typical acceptance for safety functions look like?
- As machine manufacturer or company operating a machine, what standards and regulations must I observe?
- Where can I find more information on my inverter?

# A.2 Examples of acceptance tests

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

### Recommendations for the acceptance test

- Perform the acceptance test with the maximum possible velocity and acceleration to test the expected maximum braking distances and braking times.
- The trace function in the STARTER and Startdrive PC tools can simplify the acceptance test in certain applications: for example, if a drive in the machine is difficult to access. Therefore, we recommend that you use the trace function for some acceptance tests.
- If you have recorded a trace for an acceptance test, you have to proceed as follows:
  - When you save the trace, enter the storage location in the acceptance report.
  - If you print the trace, append the printout to the acceptance report.
- If you can carry out the acceptance test without the trace function, there is no need to use the trace.
- Alarm A01697:

This alarm is issued following each system startup and is not critical for acceptance.

After the acceptance test of the inverter's safety functions, you must also check whether the safety-related functions in the machine or system are functioning correctly.

Acceptance test (Page 208)

### Acceptance support by the STARTER application

The "Safety Acceptance Test" application guides you semi-automatically through the acceptance test of the safety functions. The application logs its settings as an Excel file.



Application acceptance test (http://support.automation.siemens.com/WW/view/en/73102423).

# A.2.1 Acceptance test STO (basic functions)

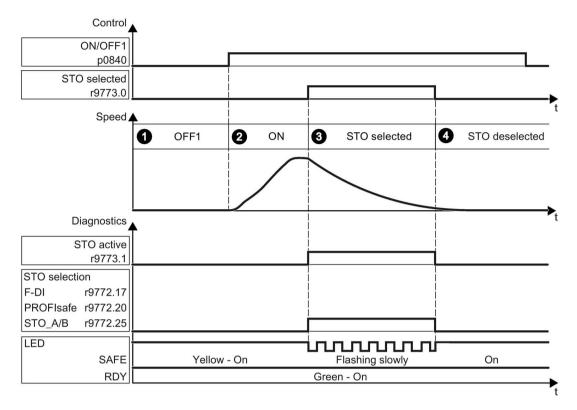


Image A-1 Acceptance test for STO (basic functions)

### Procedure



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

					Status
1.	The in	verter is ready			
		e inverter signals neither fa 122[0…7]).	ults nor alarms of the safet	y functions (r0945[07],	
	• ST	O is not active (r9773.1 = 0	)).		
2.	Switch	n on motor			
	2.1.	Enter a speed setpoint ≠ 0	Э.		
	2.2.	Switch on the motor (ON	command).		
	2.3.	Check that the correct mo	otor is running.		
3.	Select	I STO			
	3.1.	Select STO while the mot	-		
		-	vation, e.g. via digital inputs	s and PROFIsafe.	
	3.2.	Check the following:	Γ	1	
		When controlled via PROFIsafe	When controlled via fail- safe digital inputs (F-DI)	When controlled via terminals STO_A and STO_B on Power Mod- ule PM240-2	
		<ul> <li>The inverter signals the following:</li> <li>"STO selection via PROFIsafe" (r9772.20 = 1)</li> </ul>	<ul> <li>The inverter signals the following: "STO Selection via terminal" (r9772.17 = 1)</li> </ul>	<ul> <li>The inverter signals the following: "STO Selection via terminal on Power Module" (r9772.25 = 1)</li> </ul>	
			is not available, the motor or rakes the motor and holds i		
		• The inverter signals ne (r0945[07], r2122[0.	either faults nor alarms of th 7]).	ne safety functions	
		<ul> <li>The inverter signals th "STO is selected" (r97 "STO is active" (r9773)</li> </ul>	73.0 = 1).		
4.	Desel	select STO			
	4.1.	Deselect STO.			
	4.2.	Check the following:			
		• STO is not active (r97	73.1 = 0).		
		• The inverter signals ne (r0945[07], r2122[0.	either faults nor alarms of th 7]).	ne safety functions	

You have performed the acceptance test of the STO function.

# A.2.2 Acceptance test STO (extended functions)

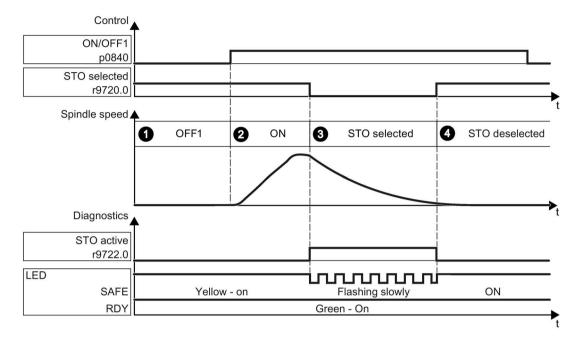


Image A-2 Acceptance test for STO (Extended functions)

### Procedure



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

			Status
1.	The in	verter is ready	
		e inverter signals neither faults nor alarms of the safety functions 945[07], r2122[07]).	
	• ST	O is not active (r9722.0 = 0).	
2.	Switch	i on motor	
	2.1.	Enter a speed setpoint ≠ 0.	
	2.2.	Switch on the motor (ON command).	
	2.3.	Check that the correct motor is running.	
3.	Select	STO	
	3.1.	Select STO while the motor is running.	
	3.2.	Check the following:	
		<ul> <li>If a mechanical brake is not available, the motor coasts down.</li> <li>A mechanical brake brakes the motor and holds it to ensure that it remains at a standstill.</li> </ul>	
		• The inverter signals neither faults nor alarms of the safety functions (r0945[07], r2122[07]).	
		• The inverter signals the following: "STO is active" (r9722.0 = 1).	
4.	Desele	ect STO	
	4.1.	Deselect STO.	
	4.2.	Check the following:	
		• STO is not active (r9722.0 = 0).	
		<ul> <li>The inverter signals neither faults nor alarms of the safety functions (r0945[07], r2122[07]).</li> </ul>	

You have performed the acceptance test of the STO function.

# A.2.3 SS1 acceptance test (basic functions)

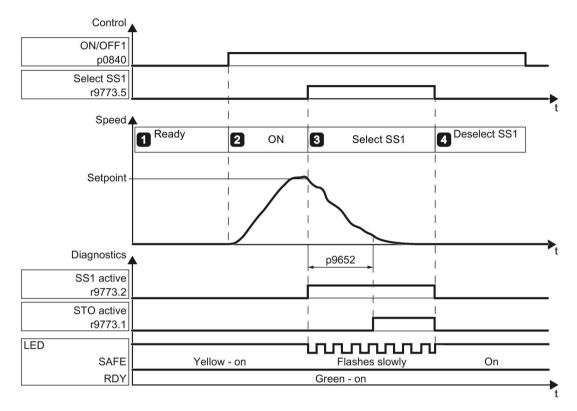


Image A-3 SS1 acceptance test for basic functions

### Appendix

A.2 Examples of acceptance tests

### Procedure



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

			Status		
1.	The inverter is ready				
	Cheo	k the following:			
		he inverter signals neither faults nor alarms of the safety functions 0945[07], r2122[07]).			
	• S	S1 is not active (r9773.6 = 0).			
2.	Swite	ch on motor			
	2.1.	Enter a speed setpoint ≠ 0.			
	2.2.	Switch on the motor (ON command).			
	2.3.	Check that the correct motor is running.			
3.	Sele	ct SS1			
	3.1.	Select SS1 while the motor is switched on.			
		Test each configured activation, e.g. via digital inputs and PROFIsafe.			
	3.2.	In your machine, check the following:			
		The motor brakes on the OFF3 ramp.			
		• SS1 is active (r9773.6 = 1).			
		• After the p9652 time has expired, the inverter signals: "STO is active" (r9773.1 = 1).			
4.	Dese	elect SS1			
	4.1.	Deselect SS1.			
	4.2.	Check the following:			
		• SS1 is not active (r9773.6 = 0).			
		• The inverter signals neither faults nor alarms of the safety functions (r0945[07], r2122[07]).			

You have completed the acceptance test of the SS1 function.

### A.2.4 SS1 acceptance test (extended functions)

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

- Diagram 1: After SS1 has been selected, the inverter monitors the speed using braking ramp monitoring.
- Diagram 2: After SS1 has been selected, the inverter monitors the speed using the acceleration monitoring.

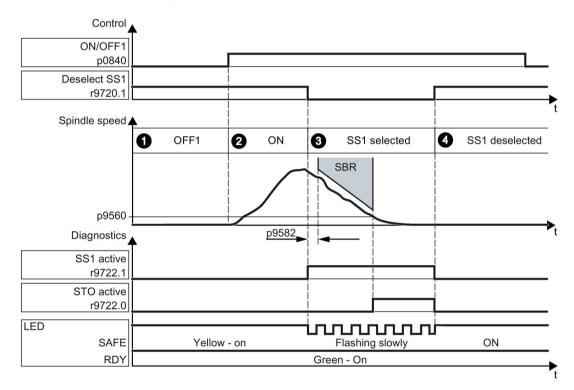


Image A-4 Diagram 1 - acceptance test SS1 with braking ramp monitoring

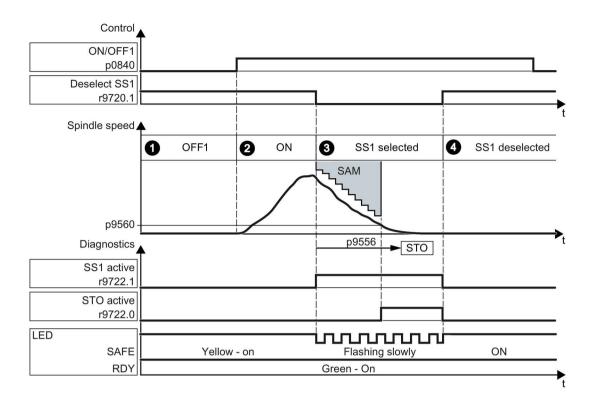


Image A-5 Diagram 2 - acceptance test for SS1 with acceleration monitoring

### Procedure

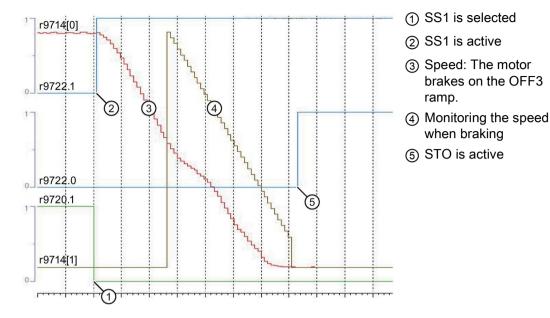


To perform the acceptance test of the SS1 function, proceed as follows:

_		Status	
The	inverter is ready		
	The inverter signals neither faults nor alarms of the safety functions r0945[07], r2122[07]).		
•	SS1 is not active (r9722.1 = 0).		
Go	online with the STARTER and configure the following trace:		
•	Frigger on variable - bit pattern (r9720.1 = 0)		
Record the following values: r9714[0], r9714[1], r9722			
	Display the bits r9722.0/.1		
	Select the time interval and pretrigger so you can recognize the selection of SS1 and the transition into the subsequent STO state.		
•	Start the trace.		
Swi	ch on motor		
2.1	Enter a speed setpoint ≠ 0.		
2.2	Switch on the motor (ON command).		
2.3			
Select SS1			
3.1			
	Test each configured activation, e.g. via digital inputs and PROFIsafe.		
3.2	Check: The inverter signals neither faults nor alarms of the safety func- tions (r0945[07], r2122[07]).		
3.3	Analyze the trace.		
	• SS1 is active after selecting SS1 (r9722.1 = 1).		
	The motor brakes on the OFF3 ramp.		
	• STO becomes active if the velocity drops below the shutdown ve- locity p9560 (r9722.0 = 1).		
	The recorded curves of r9714[0] and r9714[1] are approximately parallel.		
Des	elect SS1		
4.1	Deselect SS1.		
4.2	Check the following:		
	• SS1 is not active (r9722.1 = 0).		
	• The inverter signals neither faults nor alarms of the safety functions (r0945[07], r2122[07]).		

You have completed the acceptance test of the SS1 function.

# Example of a trace



# A.2.5 SBC acceptance test

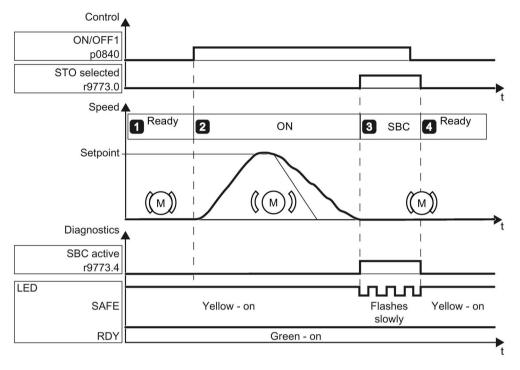


Image A-6 Acceptance test for SBC

### Appendix

A.2 Examples of acceptance tests

### Procedure



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

			Status
1.	The in		
		e inverter signals neither faults nor alarms of the safety functions 945[07], r2122[07]).	
	• SE	C is not active (r9773.4 = 0).	
2.	Switch	) on motor	
	2.1.	Enter a speed setpoint ≠ 0.	
	2.2.	Switch on the motor (ON command).	
	2.3.	Check that the correct motor is running.	
	2.4.	Enter a speed setpoint = 0.	
3.	Select	SBC	
	3.1.	Select the STO function or the SS1 function.	
	3.2.	Check: The inverter signals "SBC is active" (r9773.4 = 1).	
4.	inverte	er is ready	
	4.1.	Deselect STO.	
	4.2.	Check the following:	
		• The inverter signals "SBC is not active" (r9773.4 = 0).	
		• The inverter signals neither faults nor alarms of the safety func- tions (r0945[07], r2122[07]).	



You have performed the acceptance test of the SBC function.

### A.2.6 Acceptance test SLS

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

- Diagram 1: With a limit value violation, the drive responds with a STOP A.
- Diagram 2: With a limit value violation, the drive responds with a STOP B.

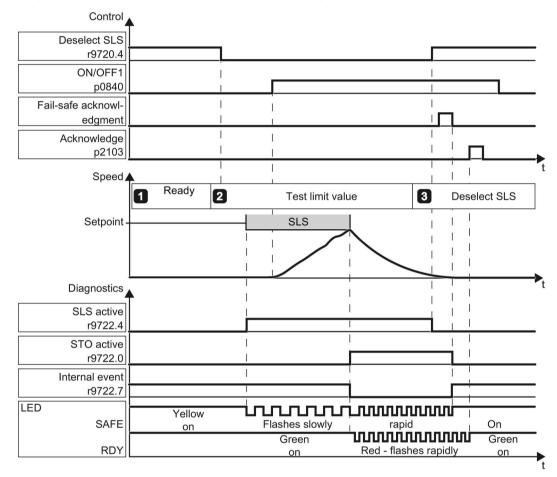


Image A-7 Diagram 1 - acceptance test for SLS with stop reaction STOP A

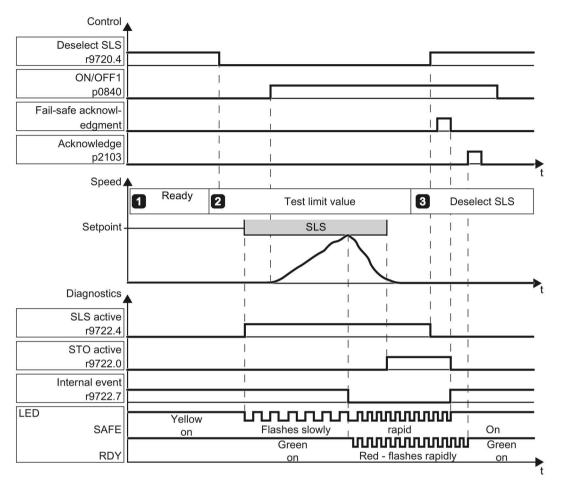


Image A-8 Diagram 2 - acceptance test SLS with stop reaction STOP B

### Procedure



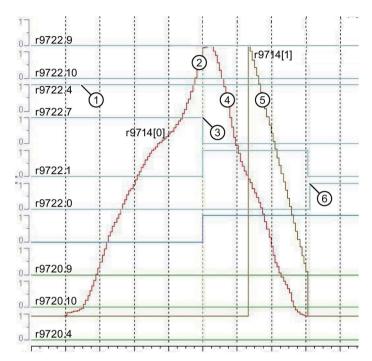
To perform the acceptance test of the SLS function, proceed as follows:

	Status
e using multiple SLS levels, repeat the test for each of the SLS levels.	I
eck the following:	
The inverter signals neither faults nor alarms of the safety functions (r0945[07],	-
r2122[07]).	
SLS is not active (r9722.4 = 0).	
online with the STARTER and configure the following trace:	
Trigger on variable - bit pattern (r9722.7 = 0)	
Record the following values: r9714[0], r9714[1], r9722	
Display the bits r9722.0/.4/.7/.9/.10	
Select the interval and pretrigger so you can recognize when the active SLS limit has been exceeded and the subsequent drive responses.	
tch on motor	
Enter a speed setpoint > SLS level.	
2. Select SLS with the SLS level to be tested.	
3. Activate the acceptance mode: In STARTER: Safe speed monitoring (SSM) Safe motion direction (SDI) Acceptance mode (SDI) Acceptance mode	
In Startdrive: Safety Integrated Selecting safety functionality Actual value sensing Functions F-DI / F-DO / PROFIse Acceptance mode Acceptance mode Acceptance mode Acceptance test time limit Acceptance test time limit has expired WARNING	
Machine motion hazard In the following test, speed limitation of the SLS function is deactivated. The increased motor speed can lead to material damage or physical injury.	
	In the following test, speed limitation of the SLS function is deactivated. The

				Status
	2.4. Switch on the motor within 5 seconds after selecting SLS (ON command).			
		If you wait longer than 5 seconds for the ON command, then STO is activated. In this case, deselect SLS and then select it again.		
	2.5. Check that the correct motor is running.			
		The following tests depend on how you have set the SLS function during com- missioning:		
		Diagram 1:	Diagram 2:	
		The inverter responds with STOP A in the event of a limit violation.	The inverter responds with STOP B in the event of a limit violation.	
	2.6.	The inverter signals the following:	The inverter signals the following:	
		C01714 and C30714 (safe velocity limit exceeded)	C01714 and C30714 (safe velocity limit exceeded)	
		<ul> <li>C01700 and C30700 (STOP A initiated)</li> </ul>	<ul> <li>C01701 and C30701 (STOP B initiated)</li> </ul>	
			<ul> <li>C01700 and C30700 (STOP A initiated)</li> </ul>	
	2.7. Analyze the trace.			
		• After SLS is selected, the inverter signals "SLS is active" (r9722.4 = 1).		
•		<ul> <li>The inverter signals the selected SLS level (r9722.9 and r9722.10).</li> <li>If r9714[0] exceeds the active SLS limit, the inverter signals an internal even (r9722.7 = 0).</li> </ul>		
		STOP A in the event of a limit value violation	STOP B in the event of a limit value violation	
		<ul> <li>If r9714[0] exceeds the active SLS limit, the motor coasts down to a standstill (r9722.0 = 1).</li> </ul>	• If r9714[0] exceeds the active SLS limit, the motor brakes on the OFF3 ramp (r9722.1 = 1).	
•			• After braking, STO is active (r9722.0 = 1).	
3.	Desel	eselect SLS		
	3.1.	Deselect SLS.		
	3.2.	Check: SLS is not active (r9722.4 = 0).		
	3.3.	3.3. Acknowledge the messages for the safety functions.		

You have performed the acceptance test of the SLS function.

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



- ① SLS is active
- ② Speed: The motor accelerates to the active SLS level
- ③ The speed exceeds the active SLS level
- ④ Speed: STOP B is active the motor brakes on the OFF3 ramp
- (5) Monitoring the speed when braking
- (6) STO as a consequence of STOP B being active

### A.2.7 SSM acceptance test

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

- Diagram 1: The "speed below limit value" checkback signal remains active when the motor is switched off.
- Diagram 2: The "speed below limit value" checkback signal becomes inactive when the motor is switched off.

The diagrams show the setting "SSM without hysteresis" as an example.

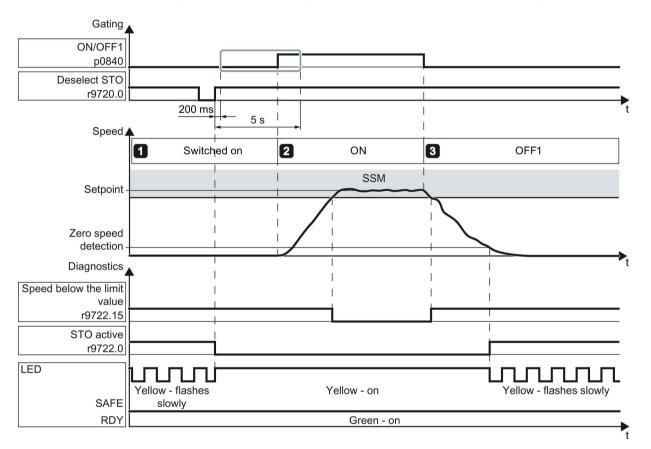


Image A-9 Diagram 1 - acceptance test SSM with active feedback signal when the motor is switched off

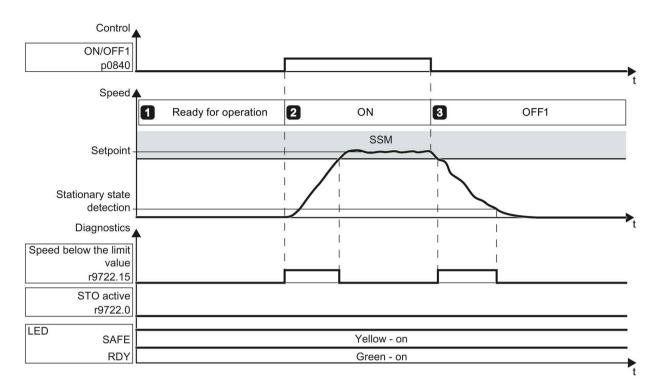


Image A-10 Diagram 2 - acceptance test SSM with inactive feedback signal when the motor is switched off

#### Appendix

A.2 Examples of acceptance tests

#### Procedure



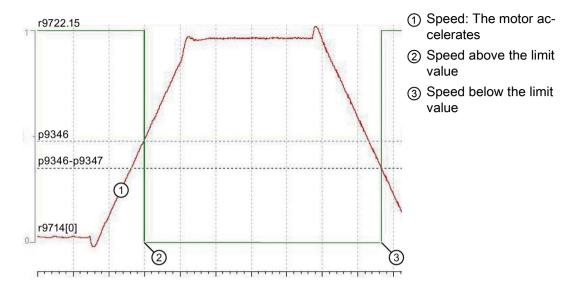
To perform the acceptance test of the SSM function, proceed as follows:

					Status
1.	The in	verter is	ready		
		<ul> <li>Check: The inverter signals neither faults nor alarms of the safety functions (r0945[07], r2122[07]).</li> </ul>			
	Go on	line with	the STARTER and configure th	e following trace:	
	• Tri	igger on	variable - bit pattern (r9722.15 =	= 0)	
	Record the following values: r0899, r9714[0], r9722				
	Display the following bits:				
	– r0899.11				
	-	r9722.1	5		
			interval and pretrigger so you ca and subsequently falls below it a	an recognize when the level exceeds the Igain.	
2.	Switch	n on mot	or		
	2.1.	Specify	a speed setpoint which is abov	e the SSM limit.	
	2.2.		lowing procedure depends on h ssioning:	ow you have set the SSM function during	
		Diagrai	<i>m 1:</i>	Diagram 2:	
		back si	peed below limit value" check- ignal remains active when the s switched off.	The "speed below limit value" check- back signal becomes inactive when the motor is switched off.	
		2.2.1.	Select STO.	Switch on the motor (ON command).	
		2.2.2.	Deselect STO again.		
		2.2.3.	Switch on motor within 5 s of deselecting STO (ON command).		
	2.3.	Check	that the correct motor is running	l.	
	2.4.	Wait ur	itil the motor speed reaches the	setpoint.	
3.	Switch	h off the	motor		
	3.1.	Switch	off the motor (OFF1 command)		
	3.2.	Analyze	e the trace:		
		• If r9	714[0] > velocity limit p9346, r9	722.15 = 0 applies.	
		SSM w	ithout hysteresis:	SSM with hysteresis:	
			714[0] < velocity limit p9546, 22.15 = 1 applies.	<ul> <li>If r9714[0] &lt; velocity limit p9546 - hysteresis p9547, r9722.15 = 1 ap- plies.</li> </ul>	
		back si	peed below limit value" check- ignal remains active when the s switched off:	The "speed below limit value" check- back signal becomes inactive when the motor is switched off:	
		(r08	e motor is switched off 99.11 = 0), then r9722.15 = 1 lies.	<ul> <li>If the motor is switched off (r0899.11 = 0), then r9722.15 = 0 applies.</li> </ul>	



You have completed the acceptance test of the SSM function.

# Example of a trace



# A.2.8 Acceptance test SDI

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

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

# Acceptance test for SDI positive

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

- Diagram 1: The "SDI active" feedback signal remains active when the motor is switched off.
- Diagram 2: The "SDI active" feedback signal becomes inactive when the motor is switched off.

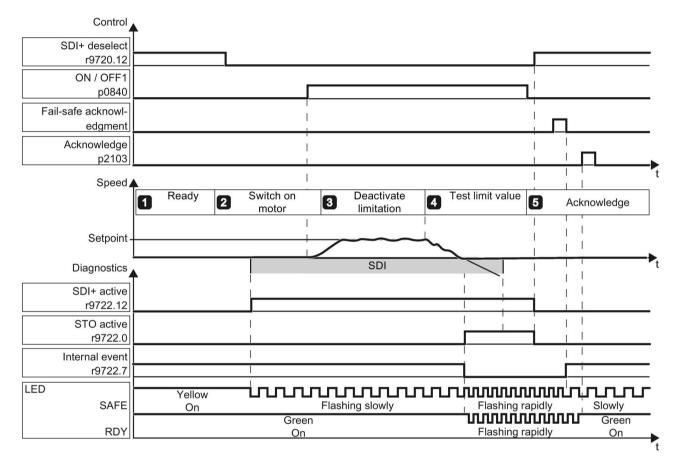


Image A-11 Diagram 1 - acceptance for SDI+, "SDI active" remains active when the motor is switched off

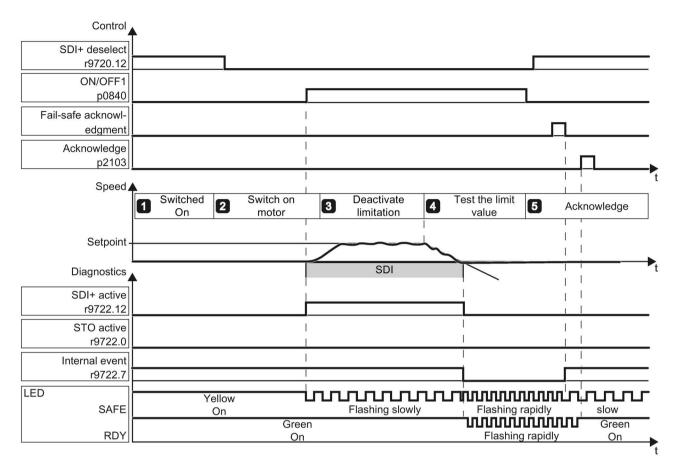


Image A-12 Diagram 2 - acceptance for SDI+, "SDI active" becomes inactive when the motor is switched off

### Procedure



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

				Status
1.	The in	verter is ready		
	Check the following:			
	• The inverter signals neither faults nor alarms of the safety functions (r0945[0. r2122[07]).		ns of the safety functions (r0945[0…7],	
	• SE	DI+ is not active (r9722.12 = 0).		
	Go on	line with the STARTER and configure th	e following trace:	
	• Tri	igger on variable - bit pattern (r9722.7 =	0).	
	Record the following values: r9713[0], r9722			
	Di	splay the bits r9722.0/.1/.7/.12		
	<ul> <li>Select the interval and pretrigger so you can recognize when the SDI tolerance has been exceeded and the subsequent drive responses.</li> </ul>			
2.	Switch on motor			
	2.1.	2.1. Enter a positive speed setpoint.		
	2.2. Select SDI+ so that only positive speeds are permitted.		ds are permitted.	
	2.3.	The next steps depend on how you ha sioning:	ve set the SDI function during commis-	
		Diagram 1:	Diagram 2:	
		The "SDI active" feedback signal remains active when the motor is switched off.	The "SDI active" feedback signal be- comes inactive when the motor is switched off.	
		Switch on motor within 5 seconds after deselecting SDI (ON command).	Switch on the motor (ON command).	
		If you wait longer than 5 seconds for the ON command, then STO is acti- vated. In this case, deselect SDI and then select it again.		
	2.4.	Check that the correct motor is rotating	in the expected direction.	

1-		Stat
	activate the setpoint limitation for the accep	otance test
	ivate the Acceptance mode:	
In S	STARTER:	
	Safe speed monitoring (SSM) Safe motion direction (SDI) Acceptance mode Acceptance mode	Time limit for acceptance mode 40000.00 ms Acceptance mode acive Time limit expired
In S	Startdrive:	
,	afety Integrated Selecting safety functionality Actual value sensing Functions Test stop F-DI/F-DO / PROFIse Acceptance Acceptance mode	Acceptance test time limit 40000.00 ms Acceptance test active Time limit has expired
Tes	t the set limit value	
4.1	L. Enter a negative speed setpoint.	
4.2	<ol> <li>The following test depends on how you missioning:</li> </ol>	I have set the SDI function during com-
	STOP A in the event of a limit value violation	STOP B in the event of a limit value violation
	• The inverter signals the following:	• The inverter signals the following:
	<ul> <li>C01716 and C30716 (toler- ance for safe direction of mo- tion exceeded)</li> </ul>	<ul> <li>C01716 and C30716 (tolerance for safe direction of motion ex- ceeded)</li> </ul>
	<ul> <li>C01700 and C30700 (STOP A initiated)</li> </ul>	<ul> <li>C01701 and C30701 (STOP B initiated)</li> </ul>
		<ul> <li>C01700 and C30700 (STOP A initiated)</li> </ul>
4.3	3. Analyze the trace:	
	• When SDI+ is selected, the inverter	r signals: SDI+ is active (r9722.12 = 1).
	<ul> <li>If r9713[0] &gt; SDI tolerance, then the (r9722.7 = 0).</li> </ul>	e inverter signals an internal event
	STOP A in the event of a limit value violation	STOP B in the event of a limit value violation
	• The motor coasts down to a standstill (r9722.0 = 1).	• The inverter brakes the motor on the OFF3 ramp (r9722.1 = 1).
1		After braking, STO is active

			Status
5.	5. Acknowledge fault		
	5.1.	Deselect SDI+.	
	5.2. Check: SDI+ is not active (r9722.12 = 0).		
	5.3.	Acknowledge the messages for the safety functions.	

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

### Acceptance test for SDI negative

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

- Diagram 1: The "SDI active" feedback signal remains active when the motor is switched off.
- Diagram 2: The "SDI active" feedback signal becomes inactive when the motor is switched off.

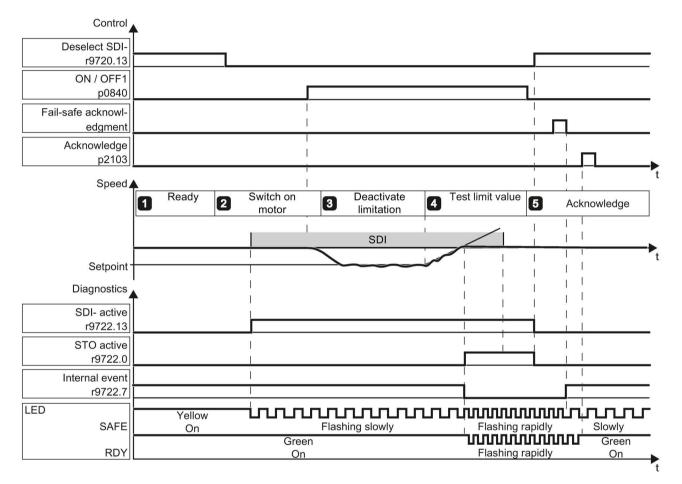


Image A-13 Diagram 1 - acceptance for SDI-, "SDI active" remains active when the motor is switched off

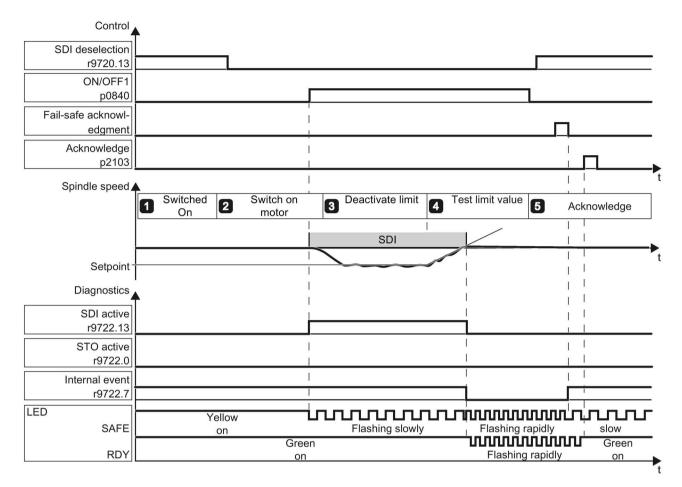


Image A-14 Diagram 2 - acceptance for SDI-, "SDI active" becomes inactive when the motor is switched off

#### Procedure



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

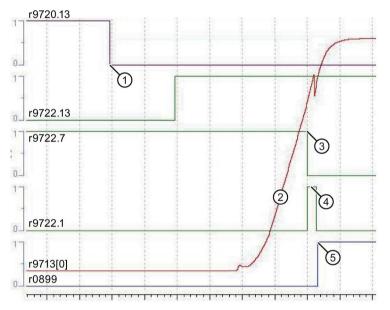
				Status
1.	The in	The inverter is ready		
	Check the following:			
	• SE	0I- is not active (r9722.13 = 0).		
The inverter signals neither faults nor alarms of the safety functions (r0 r2122[07]).		is of the safety functions (r0945[07],		
	Go online with the STARTER and configure the following trace:		e following trace:	
	• Tri	gger on variable - bit pattern (r9722.7 = 0	)).	
	• Re	ecord the following values: r9713[0], r972	2	
	Dis	splay the bits r9722.0/.1/.7/.13		
	<ul> <li>Select the interval and pretrigger so you can recognize when the SDI tolerance has been exceeded and the subsequent drive responses.</li> </ul>			
2.	Switch	n on motor		
	2.1. Enter a negative speed setpoint.			
	2.2.	Select SDI- so that only negative speed	s are permitted.	
	2.3.	The next steps depend on what settings ing:	s you made for SDI during commission-	
		Diagram 1:	Diagram 2:	
		The "SDI active" feedback signal re- mains active when the motor is switched off.	The "SDI active" feedback signal be- comes inactive when the motor is switched off.	
		Switch on motor within 5 seconds after deselecting SDI (ON command).	Switch on the motor (ON command).	
		If you wait longer than 5 seconds for the ON command, then STO is acti- vated. In this case, deselect SDI and then select it again.		
	2.4.	Check that the correct motor is rotating	in the expected direction.	

				Status
3.	Deact	tivate the setpoint limitation for the accept	tance test	
		ite the Acceptance mode:		
	In ST/	ARTER:		
		Safe speed monitoring [SSM] Safe motion direction [SDI] Acceptance mode Acceptance mode	Time limit for acceptance mode 40000.00 ms Acceptance Time limit expired Time limit expired	
	In Sta	rtdrive:		
	Sel Act Fur Tes F-D T-Act	Vintegrated lecting safety functionality tual value sensing inctions st stop JVF-DO / PROFISe Acceptance Acceptance mode	Acceptance test time limit 40000.00 ms Acceptance test active	
4.	Test the set limit value			
	4.1.	1. Enter a positive speed setpoint.		
	4.2. The following test depends on how you have set the SD missioning:		have set the SDI function during com-	
		STOP A in the event of a limit value violation	STOP B in the event of a limit value violation	
		The inverter signals the following:	The inverter signals the following:	
		• C01716 and C30716 (tolerance for safe direction of motion exceeded)	• C01716 and C30716 (tolerance for safe direction of motion exceeded)	
		C01700 and C30700 (STOP A initiated)	C01701 and C30701 (STOP B initiated)	
			C01700 and C30700 (STOP A initiated)	
	4.3.	Analyze the trace		
		• When SDI- is activated, the inverter	signals: SDI- is active (r9722.13 = 1).	
	<ul> <li>If r9713[0] &gt; SDI tolerance, then the (r9722.7 = 0).</li> </ul>		inverter signals an internal event	
		STOP A in the event of a limit value violation	STOP B in the event of a limit value violation	
		• The motor coasts down to a stand- still (r9722.0 = 1).	• The inverter brakes the motor on the OFF3 ramp (r9722.1 = 1).	
			<ul> <li>After braking, STO is active (r9722.0 = 1).</li> </ul>	

			Status
5.	5. Acknowledge fault		
	5.1.	Deselect SDI	
	5.2.	i.2. Check: SDI- is not active (r9722.13 = 0).	
	5.3.	Acknowledge the messages for the safety functions.	

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

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



- (1) SDI is selected
- ② Position actual value: The motor starts to rotate
- ③ The position actual value of the drive deviates from the permissible tolerance
- ④ STOP B is active the motor brakes on the OFF3 ramp
- (5) STO as a consequence of STOP B being active

# A.2.9 Acceptance test for F-DI status in PROFIsafe telegram 900

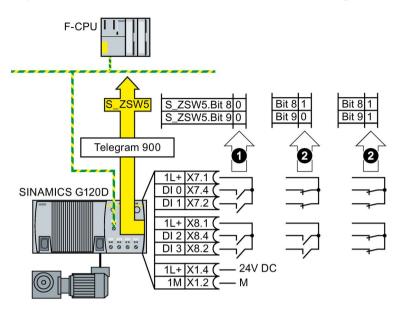


Image A-15 Acceptance test for the status of the safety-related inputs using the example of a SINAMICS G120D

### Procedure



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

	-		Status
-	- The inverter is ready		
		e inverter signals neither faults nor alarms of the safety functions (r0945[07], 122[07]).	
1.	Check	the "Low" status of the safety-related input	
	1.1.	Switch the signal of the safety-related input to be tested to low.	
	1.2.	In the F-CPU, check whether in status word S_ZSW5 the corresponding bit has the value 0.	
2.	Check	the "High" status of the safety-related input	
	2.1.	Switch the signal of the safety-related input to be tested to high.	
	2.2.	In the F-CPU, check whether in status word S_ZSW5 the corresponding bit has the value 1.	

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

A.3 Documentation for acceptance

# A.3 Documentation for acceptance

# A.3.1 Creating logs with the settings of the safety functions

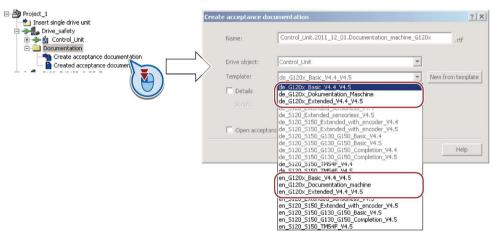
STARTER creates a log of the settings of the safety functions, which you can use for your machine documentation.

### Procedure



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

1. In STARTER, select "Create acceptance documentation":



STARTER has templates in German and English.

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

de\_G120x\_Dokumentation\_Maschine: German document

en\_G120x\_Documentation\_machine: English document

- Report of the settings for the basic functions, from firmware version V4.4 onwards: de\_G120x\_Basicc\_V4.4...: German report en\_G120x\_Basic\_V4.4...: English report
- Report of the settings for the extended functions, from firmware version V4.4 onwards: Protokoll\_de\_G120x\_Extended\_V4.4...: German report
   Protocol\_en\_G120x\_Extended\_V4.4...: English report

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

Project_1		
⊡	Created acceptance documentation	<u>? ×</u>
Created acceptance documentation	Created acceptance documentation  Drive_safety  Control_Unit.2011_12_01.Documentation_machine_G120x  Control_Unit.2011_12_01.Protocol_en_G120x_Basic_V4.4+	

4. Archive the protocols and the machine documentation.

You have generated the documents to accept the safety functions.

You can find the logs and the machine documentation in the following sections.

A.3 Documentation for acceptance

# A.3.2 Example of machine documentation

# Machine or system description

Designation	
Туре	
Serial number	
Manufacturer	
End user	
Block diagram of the machine a	nd/or plant:

# Inverter data

Table A- 1	Hardware version of the safety-related inverter
------------	---

Labeling the drive	Article number and hardware version of the inverter

## **Function table**

Table A-2 Active safety functions depending on the operating mode and safety equipment

Operating mode	erating mode Safety equipment Drive Selected safety function		Selected safety function	Checked
Example:				
Production	Protective door closed	Conveyor belt		
	Protective door open	Conveyor belt	SS1 (braking in 2 seconds)	
	Emergency Stop button pressed	Conveyor belt	STO	
Setting up	Protective door closed	Conveyor belt		
	Protective door open	Conveyor belt	SLS level 1 (300 rpm)	
	Emergency Stop button pressed	Conveyor belt	STO	

A.3 Documentation for acceptance

# Logging the settings

File name of the log:	

# Data backup

Data	Storage medium			Holding area
	Archiving type	Designation	Date	
Log of the settings				
Acceptance tests				
STARTER traces				
PLC program				
Circuit diagrams				

## Countersignatures

### Commissioning engineer

This confirms that the tests and checks have been carried out properly.

Date	Name	Company/dept.	Signature

## Machine manufacturer

This confirms that the settings documented above are correct.

Date	Name	Company/dept.	Signature

#### Appendix

A.3 Documentation for acceptance

# A.3.3 Documenting the settings for the basic functions, firmware V4.4 ... V4.7 SP6

# Drive = <pDO-NAME\_v>

#### Table A- 3 Firmware version

Name	Number	Value
Control Unit firmware version	r18	<r18_v></r18_v>
SI version, safety functions integrated in the drive (processor 1)	r9770	<r9770_v></r9770_v>

#### Table A- 4 Monitoring cycle

Name	Number	Value
SI monitoring clock cycle (processor 1)	r9780	<r9780_v></r9780_v>

#### Table A- 5 Checksums

Name	Number	Value
SI module identifier, Control Unit	r9670	<r9670_v></r9670_v>
SI module identifier, Power Module	r9672	<r9672_v></r9672_v>
SI reference checksum SI parameters (processor 1)	p9799	<p9799_v></p9799_v>
SI reference checksum SI parameters (processor 2)	p9899	<p9899_v></p9899_v>

#### Table A- 6 Settings of the safety functions

Name		Number	Value
SI enable, functions integ	grated in the drive	p9601	<p9601_v></p9601_v>
Only for the CU250S-2 Control Unit	SI enable safe brake control	p9602	<p9602_v></p9602_v>
SI PROFIsafe address		p9610	<p9610_v></p9610_v>
F-DI switch over discrepancy time		p9650	<p9650_v></p9650_v>
SI STO debounce time		p9651	<p9651_v></p9651_v>
Only for the CU250S-2 Control Unit	SI Safe Stop 1 delay time	p9652	<p9652_v></p9652_v>
SI forced dormant error detection timer		p9659	<p9659_v></p9659_v>
SI forced checking procedure STO via PM terminals time		p9661	<p9661_v></p9661_v>

#### Table A- 7 Safety logbook

Name	Number	Value
SI checksum to check changes	r9781[0]	<r9781[0]_v></r9781[0]_v>
SI checksum to check changes	r9781[1]	<r9781[1]_v></r9781[1]_v>
SI change control time stamp	r9782[0]	<r9782[0]_v></r9782[0]_v>
SI change control time stamp	r9782[1]	<r9782[1]_v></r9782[1]_v>

# A.3.4 Protocol of the settings for the extended functions, firmware V4.4 ... V4.7 SP6

# Drive = <pDO-NAME\_v>

#### Table A- 8 Firmware version

Name	Number	Value
Control Unit firmware version	r18	<r18_v></r18_v>
SI motion, version safe motion monitoring functions	r9590	<r9590_v></r9590_v>
SI Version safety functions integrated in the drive		<r9770_v></r9770_v>

#### Table A- 9 Monitoring cycle

Name	Number	Value
SI monitoring clock cycle		<r9780_v></r9780_v>

#### Table A- 10 Checksums

Name	Number	Value
SI Motion reference checksum SI parameters (processor 2)	p9399[0]	<p9399[0]_v></p9399[0]_v>
	p9399[1]	<p9399[1]_v></p9399[1]_v>
SI module identifier, Control Unit	r9670	<r9670_v></r9670_v>
SI module identifier, Power Module	r9672	<r9672_v></r9672_v>
SI reference checksum SI parameters (processor 1)	p9799	<p9799_v></p9799_v>
SI Motion reference checksum SI parameters (processor 1)	p9729[0]	<p9729[0]_v></p9729[0]_v>
	p9729[1]	<p9729[1]_v></p9729[1]_v>
	p9729[2]	<p9729[2]_v></p9729[2]_v>
SI reference checksum SI parameters (processor 2)	p9899	<p9899_v></p9899_v>

#### Table A- 11 Safety functions

Name	Number	Value
SI Motion enable safety functions	p9501	<p9501_v></p9501_v>
SI Motion function specification	p9506	<p9506_v></p9506_v>
SI Motion function configuration	p9507	<p9507_v></p9507_v>
SI Motion response during pulse suppression	p9509	<p9509_v></p9509_v>
SI Motion gearbox motor/load denominator	p9521	<p9521_v></p9521_v>
SI Motion gearbox motor/load numerator	p9522	<p9522_v></p9522_v>
SI Motion SLS limit values, limit value SLS1	p9531[0]	<p9531[0]_v></p9531[0]_v>
SI Motion SLS limit values, limit value SLS2	p9531[1]	<p9531[1]_v></p9531[1]_v>
SI Motion SLS limit values, limit value SLS3	p9531[2]	<p9531[2]_v></p9531[2]_v>
SI Motion SLS limit values, limit value SLS4	p9531[3]	<p9531[3]_v></p9531[3]_v>
SI Motion SLS speed setpoint limiting	p9533	<p9533_v></p9533_v>
SI motion, actual value comparison tolerance (crosswise)	p9542	<p9542_v></p9542_v>

Safety Integrated - SINAMICS G110M, G120, G120C, G120D and SIMATIC ET 200pro FC-2 Function Manual, 01/2016, FW V4.7 SP6, A5E34261271B AC A.3 Documentation for acceptance

Name			Value
SI Motion SSM filter time	p9545	<p9545_v></p9545_v>	
SI Motion SSM speed limit	p9546	<p9546_v></p9546_v>	
SI Motion SSM speed hysteresis		p9547	<p9547_v></p9547_v>
SI Motion SAM actual speed tolerance		p9548	<p9548_v></p9548_v>
SI Motion SLS changeover delay time		p9551	<p9551_v></p9551_v>
SI Motion pulse suppression delay time		p9556	<p9556_v></p9556_v>
SI Motion acceptance test mode time limit		p9558	<p9558_v></p9558_v>
SI Motion forced checking procedure timer		p9559	<p9559_v></p9559_v>
SI Motion pulse suppression shutdown velo	city	p9560	<p9560_v></p9560_v>
SI Motion SLS-specific stop response, limit	value SLS1	p9563[0]	<p9563[0]_v></p9563[0]_v>
SI Motion SLS-specific stop response, limit	value SLS2	p9563[1]	<p9563[1]_v></p9563[1]_v>
SI Motion SLS-specific stop response, limit	value SLS3	p9563[2]	<p9563[2]_v></p9563[2]_v>
SI Motion SLS-specific stop response, limit	value SLS4	p9563[3]	<p9563[3]_v></p9563[3]_v>
SI Motion SDI tolerance		p9564	<p9564_v></p9564_v>
SI Motion SDI delay time		p9565	<p9565_v></p9565_v>
SI Motion SDI stop response		p9566	<p9566_v></p9566_v>
SI Motion SAM speed limit		p9568	<p9568_v></p9568_v>
SI Motion acceptance test mode			<p9570_v></p9570_v>
SI Motion braking ramp reference value		p9581	<p9581_v></p9581_v>
SI Motion braking ramp delay time		p9582	<p9582_v></p9582_v>
SI Motion braking ramp monitoring time		p9583	<p9583_v></p9583_v>
<i>From firmware V4.5</i> SI Motion fault tolera coderless	nce actual value acquisition en-	p9585	<p9585_v></p9585_v>
SI Motion delay time of the evaluation encoderless			<p9586_v></p9586_v>
SI Motion encoderless actual value acquisiti	on filter time	p9587	<p9587_v></p9587_v>
SI Motion actual value acquisition encoderle	ess minimum current	p9588	<p9588_v></p9588_v>
SI Motion voltage tolerance acceleration		p9589	<p9589_v></p9589_v>
SI enable, functions integrated in the drive		p9601	<p9601_v></p9601_v>
Only for the CU250S-2 Control Unit	Enable safe brake control	p9602	<p9602_v></p9602_v>
SI PROFIsafe address		p9610	<p9610_v></p9610_v>
F-DI switchover discrepancy time		p9650	<p9650_v></p9650_v>
SI STO debounce time	p9651	<p9651_v></p9651_v>	
Only for the CU250S-2 Control Unit	Safe Stop 1 delay time	p9652	<p9652_v></p9652_v>
SI forced checking procedure timer		p9659	<p9659_v></p9659_v>
SI forced checking procedure STO via PM terminals time		p9661	<p9661_v></p9661_v>
F-DI switchover discrepancy time		p10002	<p10002_v></p10002_v>
SI acknowledgment internal event F-DI		p10006	<p10006_v></p10006_v>
SI digital inputs debounce time		p10017	<p10017_v></p10017_v>
SI STO input terminal		p10022	<p10022_v></p10022_v>
SI SS1 input terminal		p10023	<p10023_v></p10023_v>
SI SLS input terminal		p10026	<p10026_v></p10026_v>
SI SDI positive input terminal		p10030	<p10030_v></p10030_v>

Name	Number	Value
SI SDI negative input terminal	p10031	<p10031_v></p10031_v>
SI F-DI monitoring status	r10049	<r10049_v></r10049_v>
SI PROFIsafe transfer F-DI	p10050	<p10050_v></p10050_v>

Table A- 12 Fail-safe output in SINAMICS G120D with CU240/250D-2 DP/PN F and in SINAMICS G120 with CU250S-2

Name	Number	Value
SI wait time for test stop at DO	p10001	<p10001_v></p10001_v>
SI forced checking procedure timer	p10003	<p10003_v></p10003_v>
SI forced checking procedure F-DO signal source	p10007	<p10007_v></p10007_v>
SI safe state signal selection	p10039	< p10039_v>
SI F-DO 0 signal sources	p10042[0]	<p10042[0]_v></p10042[0]_v>
	p10042[1]	<p10042[1]_v></p10042[1]_v>
	p10042[2]	<p10042[2]_v></p10042[2]_v>
	p10042[3]	<p10042[3]_v></p10042[3]_v>
	p10042[4]	<p10042[4]_v></p10042[4]_v>
	p10042[5]	<p10042[5]_v></p10042[5]_v>
SI F-DO feedback signal input activation	p10046	<p10046_v></p10046_v>
SI F-DO test stop mode	p10047	<p10047_v></p10047_v>

#### Table A- 13 Safety logbook

Name	Number	Value
SI change control checksum	r9781[0]	<r9781[0]_v></r9781[0]_v>
SI change control checksum	r9781[1]	<r9781[1]_v></r9781[1]_v>
SI change control time stamp	r9782[0]	<r9782[0]_v></r9782[0]_v>
SI change control time stamp	r9782[1]	<r9782[1]_v></r9782[1]_v>

# A.4 Standards and specifications

# A.4.1 General information

### A.4.1.1 Aims

Manufacturers and operating companies of equipment, machines, and products are responsible for ensuring the required level of safety. This means that plants, machines, and other equipment must be designed to be as safe as possible in accordance with the current state of the art. For this purpose, companies describe in the various standards the current state of the art covering all aspects relevant to safety. If it can be justifiably assumed that all of the relevant standards are complied with, this ensures that state-of-the-art technology has been utilized and, in turn, a plant builder or a manufacturer of a machine or a piece of equipment has fulfilled his appropriate responsibility.

Safety systems are designed to minimize potential hazards for both people and the environment by means of suitable technical equipment, without restricting industrial production and the use of machines more than is necessary. The protection of man and environment must be assigned equal importance in all countries based on internationally harmonized rules and regulations. This is also intended to avoid competitive advantages or disadvantages due to different safety requirements in different countries.

There are different concepts and requirements in the various regions and countries of the world when it comes to ensuring the appropriate degree of safety. The legislation and the requirements of how and when proof is to be given and whether there is an adequate level of safety are just as different as the assignment of responsibilities.

The most important thing for manufacturers of machines and companies that set up plants and systems is that the legislation and regulations in the country where the machine or plant is being operated apply. For example, the control system for a machine that is to be used in the US must fulfill local US requirements even if the machine manufacturer (OEM) is based in the European Economic Area (EEA).

## A.4.1.2 Functional safety

Safety, from the perspective of the object to be protected, cannot be split-up. The causes of hazards and, in turn, the technical measures to avoid them can vary significantly. This is why a differentiation is made between different types of safety (e.g. by specifying the cause of possible hazards). "Functional safety" is involved if safety depends on the correct function.

To ensure the functional safety of a machine or plant, the safety-related parts of the protection and control devices must function correctly. In addition, the systems must behave in such a way that either the plant remains in a safe state or it is brought into a safe state if a fault occurs. In this case, it is necessary to use specially qualified technology that fulfills the requirements described in the associated Standards. The requirements to implement functional safety are based on the following basic goals:

- Avoiding systematic faults
- Controlling random faults or failures

Benchmarks for establishing whether or not a sufficient level of functional safety has been achieved include the probability of hazardous failures, the fault tolerance, and the quality that is to be ensured by avoiding systematic faults. This is expressed in the standards using specific classification. In IEC/EN 61508, IEC/EN 62061 "Safety Integrity Level" (SIL) and EN ISO 13849-1 "Category" and "Performance Level" (PL).

# A.4.2 Safety of machinery in Europe

The EU Directives that apply to the implementation of products are based on Article 95 of the EU contract, which regulates the free exchange of goods. These are based on a new global concept ("new approach", "global approach"):

- EU Directives only specify general safety goals and define basic safety requirements.
- Technical details can be defined by means of standards by Standards Associations that have the appropriate mandate from the commission of the European Parliament and Council (CEN, CENELEC). These standards are harmonized in line with a specific directive and listed in the official journal of the commission of the European Parliament and Council. Legislation does not specify that certain standards have to be observed. When the harmonized Standards are observed, it can be assumed that the safety requirements and specifications of the Directives involved have been fulfilled.
- EU Directives specify that the Member States must mutually recognize domestic regulations.

The EU Directives are equal. This means that if several Directives apply for a specific piece of equipment or device, the requirements of all of the relevant Directives apply (e.g. for a machine with electrical equipment, the Machinery Directive and the Low-Voltage Directive apply).

### A.4.2.1 Machinery Directive

The basic safety and health requirements specified in Annex I of the Directive must be fulfilled for the safety of machines.

The protective goals must be implemented responsibly to ensure compliance with the Directive.

Manufacturers of a machine must verify that their machine complies with the basic requirements. This verification is facilitated by means of harmonized standards.

### A.4.2.2 Harmonized European Standards

The two Standards Organizations CEN (Comité Européen de Normalisation) and CENELEC (Comité Européen de Normalisation Électrotechnique), mandated by the EU Commission, drew-up harmonized European standards in order to precisely specify the requirements of the EC directives for a specific product. These standards (EN standards) are published in the official journal of the commission of the European Parliament and Council and must be included without revision in domestic standards. They are designed to fulfill basic health and safety requirements as well as the protective goals specified in Annex I of the Machinery Directive.

When the harmonized standards are observed, it is "automatically assumed" that the Directive is fulfilled. As such, manufacturers can assume that they have observed the safety aspects of the Directive under the assumption that these are also covered in this standard. However, not every European Standard is harmonized in this sense. Key here is the listing in the official journal of the commission of the European Parliament and Council.

The European Safety of Machines standard is hierarchically structured. It is divided into:

- A standards (basic standards)
- B standards (group standards)
- C standards (product standards)

#### Type A standards/basic standards

A standards include basic terminology and definitions relating to all types of machine. This includes EN ISO 12100 (previously EN 292-1) "Safety of Machines, Basic Terminology, General Design Principles".

A standards are aimed primarily at the bodies responsible for setting the B and C standards. The measures specified here for minimizing risk, however, may also be useful for manufacturers if no applicable C standards have been defined.

#### Type B standards/group standards

B standards cover all safety-related standards for various different machine types. B standards are aimed primarily at the bodies responsible for setting C standards. They can also be useful for manufacturers during the machine design and construction phases, however, if no applicable C standards have been defined.

A further sub-division has been made for B standards:

- Type B1 standards for higher-level safety aspects (e.g. ergonomic principles, safety clearances from sources of danger, minimum clearances to prevent parts of the body from being crushed).
- Type B2 standards for protective safety devices are defined for different machine types (e.g. EMERGENCY STOP devices, two-hand operating circuits, interlocking elements, contactless protective devices, safety-related parts of controls).

#### Type C standards/product standards

C standards are product-specific standards (e.g. for machine tools, woodworking machines, elevators, packaging machines, printing machines etc.). Product standards cover machine-specific requirements. The requirements can, under certain circumstances, deviate from the basic and group standards. Type C/product standards have the highest priority for machine manufacturers who can assume that it fulfills the basic requirements of Annex I of the Machinery Directive (automatic presumption of compliance). If no product standard has been defined for a particular machine, type B standards can be applied when the machine is constructed.

A complete list of the standards specified and the mandated draft standards are available on the Internet at the following address:

#### http://www.newapproach.org/

Recommendation: Due to the rapid pace of technical development and the associated changes in machine concepts, the standards (and C standards in particular) should be checked to ensure that they are up to date. Please note that the application of a particular standard may not be mandatory provided that all the safety requirements of the applicable EU directives are fulfilled.

# A.4.2.3 Standards for implementing safety-related controllers

If the functional safety of a machine depends on various control functions, the controller must be implemented in such a way that the probability of safety functions failing in a dangerous fashion is sufficiently minimized. EN ISO 13849-1 (formerly EN 954-1) and IEC61508 define principles for implementing safety-related machine controllers which, when properly applied, ensure that all the safety requirements of the EC Machinery Directive are fulfilled. These standards ensure that the relevant safety requirements of the Machinery Directive are fulfilled.

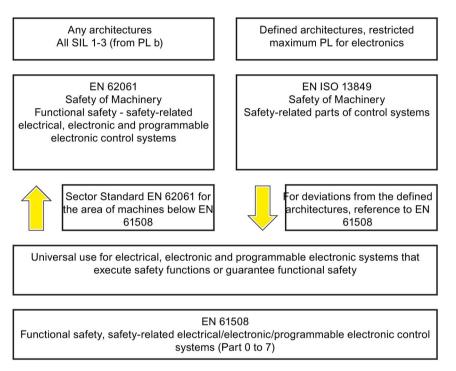


Image A-16 Standards for implementing safety-related controllers

The application areas of EN ISO 13849-1, EN 62061, and EN 61508 are very similar. To help users make an appropriate decision, the IEC and ISO associations have specified the application areas of both standards in a joint table in the introduction to the standards. EN ISO 13849-1 or EN 62061 should be applied depending on the technology (mechanics, hydraulics, pneumatics, electrics, electronics, programmable electronics), risk classification and architecture.

	Systems for executing safety-related control functions	EN ISO 13849-1	EN 62061
А	Non-electrical (e.g. hydraulic, pneumatic)	x	Not covered
В	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
С	Complex electronics (e.g. programmable elec- tronics)	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	X	x
	C standards combined with A standards and B standards	See comment 2	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.4.2.4 DIN EN ISO 13849-1 (replaces EN 954-1)

A qualitative analysis according to DIN EN 13849-1 is not sufficient for modern control systems due to their technology. Among other things, DIN EN ISO 13849-1 does not take into account time behavior (e.g. test interval and/or cyclic test, lifetime). This results in the probabilistic approach in DIN EN ISO 13849-1 (probability of failure per unit time).

DIN EN ISO 13849-1 is based on the known categories of EN 954-1. It now also takes into account complete safety functions and all the devices required to execute these. With DIN EN ISO 13849-1, safety functions are investigated from a quantitative perspective going beyond the qualitative basis of EN 954-1. Performance levels (PL), which are based on the categories, are used. The following safety-related characteristic quantities are required for devices/equipment:

- Category (structural requirement)
- PL: Performance level
- MTTF<sub>d</sub>: 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.4.2.5 EN 62061

EN 62061 (identical to IEC 62061) is a sector-specific standard subordinate to IEC/EN 61508. It describes the implementation of safety-related electrical machine control systems and looks at the complete life cycle, from the conceptual phase to decommissioning. The standard is based on the quantitative and qualitative analyses of safety functions,

whereby it systematically applies a top-down approach to implementing complex control systems (known as "functional decomposition"). The safety functions derived from the risk analysis are sub-divided into sub-safety functions, which are then assigned to real devices, sub-systems, and sub-system elements. Both the hardware and software are covered. EN 62061 also describes the requirements placed on implementing application programs.

A safety-related control systems comprises different sub-systems. From a safety perspective, the sub-systems are described in terms of the SIL claim limit and  $PFH_D$  characteristic quantities.

Programmable electronic devices (e.g. PLCs or variable-speed drives) must fulfill IEC 61508. They can then be integrated in the controller as sub-systems. The following safety-related characteristic quantities must be specified by the manufacturers of these devices.

Safety-related characteristic quantities for subsystems:

- SIL CL: SIL claim limit
- PFH<sub>D</sub>:

Probability of dangerous failures per hour

T1: Lifetime

Simple sub-systems (e.g. sensors and actuators) in electromechanical components can, in turn, comprise sub-system elements (devices) interconnected in different ways with the characteristic quantities required for determining the relevant PFH<sub>D</sub> value of the sub-system.

Safety-related characteristic quantities for subsystem elements (devices):

• λ:

Failure rate

- B10 value: For elements that are subject to wear
- T1:

Lifetime

For electromechanical devices, a manufacturer specifies a failure rate  $\lambda$  with reference to the number of operating cycles. The failure rate per unit time and the lifetime must be determined using the switching frequency for the particular application.

Parameters for the sub-system, which comprises sub-system elements, that must be defined during the design phase:

- T2: Diagnostic test interval
- 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.4.2.6 Series of standards IEC 61508 (VDE 0803)

This series of standards describes the current state of the art.

IEC 61508 is not harmonized in line with any EU directives, which means that an automatic presumption of conformity for fulfilling the protective requirements of a directive is not implied. The manufacturer of a safety-related product, however, can also use IEC 61508 to fulfill basic requirements of European directives in accordance with the latest conceptual design, for example, in the following cases:

- If no harmonized standard exists for the application in question. In this particular case, the manufacturer may use IEC 61508. although no presumption of conformity exists here.
- A harmonized European standard (e.g. EN 62061, EN ISO 13849, EN 60204-1) references IEC 61508. This ensures that the appropriate requirements of the directives are fulfilled ("standard that is also applicable"). When manufacturers apply IEC 61508 properly and responsibly in accordance with this reference, they can use the presumption of conformity of the referencing standard.

IEC 61508 covers all the aspects that must be taken into account when E/E/PES systems (electrical, electronic, and programmable electronic system) are used in order to execute safety functions and/or to ensure the appropriate level of functional safety. Other hazards (e.g. electric shock) are not part of the standard, similar to DIN ISO 13849.

IEC 61508 has recently been declared the "International Basic Safety Publication", which makes it a framework for other sector-specific standards (e.g. EN 62061). As a result, this standard is now accepted worldwide, particularly in North America and in the automotive industry. Today, many regulatory bodies already stipulate it (e.g. as a basis for NRTL listing).

Another recent development with respect to IEC 61508 is its system approach, which extends the technical requirements to include the entire safety installation from the sensor to the actuator, the quantification of the probability of hazardous failure due to random hardware failures, and the creation of documentation covering all phases of the safety-related lifecycle of the E/E/PES.

### A.4.2.7 Risk analysis/assessment

Risks are intrinsic in machines due to their design and functionality. For this reason, the Machinery Directive requires that a risk assessment be performed for each machine and, if necessary, the level of risk reduced until the residual risk is less than the tolerable risk. To assess these risks, the following standards must be applied:

- EN ISO 12100 "Safety of Machinery General Design Principles Risk Assessment and Minimizing Risks"
- EN ISO 13849-1 (successor to EN 954-1) "Safety-related parts of control systems"

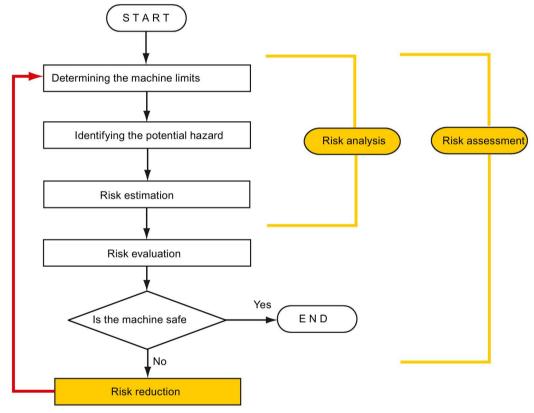
EN ISO 12100 focuses on the risks to be analyzed and the design principles for minimizing risk.

The risk assessment is a procedure that allows hazards resulting from machines to be systematically investigated. Where necessary, the risk assessment is followed by a risk reduction procedure. When the procedure is repeated, this is known as an iterative process. This can help eliminate hazards (as far as this is possible) and can act as a basis for implementing suitable protective measures.

The risk assessment involves the following:

- Risk analysis
  - Determines the limits of the machine (EN ISO 12100)
  - Identification of hazards (EN ISO 12100)
  - Estimating the level of risk (EN 1050 Paragraph 7)
- Risk evaluation

As part of the iterative process to achieve the required level of safety, a risk assessment is carried out after the risk estimation. A decision must be made here as to whether the residual risk needs to be reduced. If the risk is to be further reduced, suitable protective measures must be selected and applied. The risk assessment must then be repeated.



Minimizing risks and selecting suitable protective measures are not part of the risk assessment

Image A-17 Iterative process for achieving safety

Risks must be reduced by designing and implementing the machine accordingly (e.g. by means of controllers or protective measures suitable for the safety-related functions).

If the protective measures involve the use of interlocking or control functions, these must be designed according to EN ISO 13849-1. For electrical and electronic control systems, EN 62061 can be applied instead of EN ISO 13849-1. Electronic controllers and bus systems must also comply with IEC 61508.

### A.4.2.8 Risk reduction

Risk reduction measures for a machine can be implemented by means of safety-related control functions in addition to structural measures. To implement these control functions, special requirements must be taken into account, graded according to the magnitude of the risk. These are described in EN ISO 13849-1 or, in the case of electrical controllers (particularly programmable electronics), in EN 61508 or EN 62061. The requirements regarding safety-related controller components are graded according to the magnitude of the risk and the level to which the risk needs to be reduced.

**EN ISO 13849-1** defines a risk flow chart that instead of categories results in hierarchically graduated Performance Levels (PL).

**IEC/EN 62061** uses "Safety Integrity Level" (SIL) for classification purposes. This is a quantified measure of the safety-related performance of a controller. The required SIL is also determined in accordance with the risk assessment principle according to ISO 12100 (EN 1050). Annex A of the standard describes a method for determining the required Safety Integrity Level (SIL).

Regardless of which standard is applied, steps must be taken to ensure that all the machine controller components required for executing the safety-related functions fulfill these requirements.

### A.4.2.9 Residual risk

In today's technologically advanced world, the concept of safety is relative. The ability to ensure safety to the extent that risk is ruled out in all circumstances – "zero-risk guarantee" – is practically impossible. The residual risk is the risk that remains once all the relevant protective measures have been implemented in accordance with the latest state of the art.

Residual risks must be clearly referred to in the machine/plant documentation (user information according to EN ISO 12100).

# A.4.3 Machine safety in the USA

A key difference between the USA and Europe in the legal requirements regarding safety at work is that, in the USA, no legislation exists regarding machinery safety that is applicable in all of the states and that defines the responsibility of the manufacturer/supplier. A general requirement exists stating that employers must ensure a safe workplace.

### A.4.3.1 Minimum requirements of the OSHA

The Occupational Safety and Health Act (OSHA) from 1970 regulates the requirement that employers must offer a safe place of work. The core requirements of OSHA are specified in Section 5 "Duties".

The requirements of the OSH Act are managed by the "Occupational Safety and Health Administration" (also known as OSHA). OSHA employs regional inspectors who check whether or not workplaces comply with the applicable regulations.

The OSHA regulations are described in OSHA 29 CFR 1910.xxx ("OSHA Regulations (29 CFR) PART 1910 Occupational Safety and Health"). (CFR: Code of Federal Regulations.)

#### http://www.osha.gov

The application of standards is regulated in 29 CFR 1910.5 "Applicability of standards". The concept is similar to that used in Europe. Product-specific standards have priority over general standards insofar as they cover the relevant aspects. Once the standards are fulfilled, employers can assume that they have fulfilled the core requirements of the OSH Act with respect to the aspects covered by the standards.

In conjunction with certain applications, OSHA requires that all electrical equipment and devices that are used to protect workers be authorized by an OSHA-certified, "Nationally Recognized Testing Laboratory" (NRTL) for the specific application.

In addition to the OSHA regulations, the current standards defined by organizations such as NFPA and ANSI must be carefully observed and the extensive product liability legislation that exists in the US taken into account. Due to the product liability legislation, it is in the interests of manufacturing and operating companies that they carefully maintain the applicable regulations and are "forced" to fulfill the requirement to use state-of-the-art technology.

Third-party insurance companies generally demand that their customers fulfill the applicable standards of the standards organizations. Self-insured companies are not initially subject to this requirement but, in the event of an accident, they must provide verification that they have applied generally-recognized safety principles.

## A.4.3.2 NRTL listing

To protect employees, all electrical equipment used in the USA must be certified for the planned application by a "Nationally Recognized Testing Laboratory" (NRTL) certified by the OSHA. NRTLs are authorized to certify equipment and material by means of listing, labeling, or similar. Domestic standards (e.g. NFPA 79) and international standards (e.g. IEC/EN 61508 for E/E/PES systems) are the basis for testing.

#### A.4.3.3 NFPA 79

Standard NFPA 79 (Electrical Standard for Industrial Machinery) applies to electrical equipment on industrial machines with rated voltages of less than 600 V. A group of machines that operate together in a coordinated fashion is also considered to be one machine.

For programmable electronics and communication buses, NFPA 79 states as a basic requirement that these must be listed if they are to be used to implement and execute safety-related functions. If this requirement is fulfilled, then electronic controls and communication buses can also be used for Emergency Stop functions, Stop Categories 0 and 1 (refer to NFPA 79 9.2.5.4.1.4). Just the same as EN 60204-1, NFPA 79 no longer specifies that the electrical energy must be disconnected by electromechanical means for emergency stop functions.

The core requirements regarding programmable electronics and communication buses are: system requirements (see NFPA 79 9.4.3)

- 1. Control systems that contain software-based controllers must:
  - In the event of a single fault
    - (a) Initiate that the system switches to a safe shutdown mode
    - (b) Prevent the system from restarting until the fault has been rectified
    - (c) Prevent an unexpected restart
  - Offer the same level of protection as hard-wired controllers
  - Be implemented in accordance with a recognized standard that defines the requirements for such systems.
- 2. IEC 61508, IEC 62061, ISO 13849-1, ISO 13849-2 and IEC 61800-5-2 are specified as suitable standards in a note.

**Underwriter Laboratories Inc. (UL)** has defined a special category for "Programmable Safety Controllers" for implementing this requirement (code NRGF). This category covers control devices that contain software and are designed for use in safety-related functions.

A precise description of the category and a list of devices that fulfill this requirement can be found on the Internet at the following address:

http://www.ul.com  $\rightarrow$  Online Certifications Directory  $\rightarrow$  UL Category code/Guide information  $\rightarrow$  search for category "NRGF"

TUV Rheinland of North America, Inc. is also an NRTL for these applications.

#### A.4.3.4 ANSI B11

ANSI B11 standards are joint standards developed by associations such as the Association for Manufacturing Technology (AMT) and the Robotic Industries Association (RIA).

The hazards of a machine are evaluated by means of a risk analysis/assessment. The risk analysis is an important requirement in accordance with NFPA 79, ANSI/RIA 15.06, ANSI B11.TR-3 and SEMI S10 (semiconductors). The documented 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.4 Standards and specifications

### A.4.4 Machine safety in Japan

The situation in Japan is different from that in Europe and the US. Legislation such as that prescribed in Europe does not exist. Similarly, product liability does not play such an important role as it does in the US.

Instead of legal requirements to apply standards have been defined, an administrative recommendation to apply JIS (Japanese Industrial Standard) is in place: Japan bases its approach on the European concept and uses basic standards as national standards (see table).

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

Table A- 14 Japanese standards

### A.4.5 Equipment regulations

In addition to the requirements of the guidelines and standards, company-specific requirements must be taken into account. Large corporations in particular (e.g. automobile manufacturers) make stringent demands regarding automation components, which are often listed in their own equipment specifications.

Safety-related issues (e.g. operating modes, operator actions with access to hazardous areas, EMERGENCY STOP concepts, etc.) should be clarified with customers early on so that they can be integrated in the risk assessment/risk reduction process.

A.4 Standards and specifications

#### A.4.6 Other safety-related issues

#### A.4.6.1 Additional references

- Safety Integrated, The Safety Program for Industries of the World (5th Edition and Supplement), Article No. 6ZB5 000-0AA01-0BA1
- Safety Integrated Terms and Standards Machine Safety Terminology (Edition 04/2007), Article No. E86060-T1813-A101-A1

#### A.4.6.2 Information sheets issued by the Employer's Liability Insurance Association

Safety-related measures to be implemented cannot always be derived from directives, standards, or regulations. In this case, supplementary information and explanations are required.

Some regulatory bodies issue publications on an extremely wide range of subjects.

#### 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 following Internet address (website is in German, although some of the sheets are available in English):

Employer's Liability Insurance Association (www.bghm.de)

First select the area "Arbeitsschützer", followed by the menu item "Praxishilfen" and finally "DGUV-Informationen".

# A.5 Manuals and technical support

## A.5.1 Overview of the manuals



You can find manuals here with additional information that can be downloaded

Operating instructions

Installing, commissioning and maintaining the inverter. Advanced commissioning



- CU250S-2 operating instructions (<u>https://support.industry.siemens.com/cs/ww/en/view/109478829</u>)
- CU240B/E-2 operating instructions (https://support.industry.siemens.com/cs/ww/en/view/109478828)
- SINAMICS G120C operating instructions. (https://support.industry.siemens.com/cs/ww/en/view/109478830)
- 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 G110M operating instructions (https://support.industry.siemens.com/cs/ww/en/view/109478193)
- SIMATIC ET200proFC-2 operating instructions (https://support.industry.siemens.com/cs/ww/en/view/109478246)

Function Manuals

- "Safety Integrated" function manual (<u>https://support.industry.siemens.com/cs/ww/en/view/109477367</u>) Configuring PROFIsafe. Installing, commissioning and operating fail-safe functions of the inverter (this manual).
- "Fieldbus" function manual (<u>https://support.industry.siemens.com/cs/ww/en/view/109477369</u>) Configuring fieldbuses
- "Basic positioner" function manual (<u>https://support.industry.siemens.com/cs/ww/en/view/109477922</u>) Commissioning the basic positioner

A.5 Manuals and technical support



#### Finding the most recent edition of a manual

If there a multiple editions of a manual, select the latest edition:

Modbus, P1	COFINET, PROFIBUS, EtherNet/IP, CANopen, USS, Bacnet, anual, A5E34229197B AA 1PA0, 6SL3244-0BB13-1FA0, All products
04/2015, FW V4.7.3	<b>*</b>
04/2015, FW V: 7.3 04/2014, FW V:	

08/11/2014 ID: 99685159 ★★☆☆(3)

#### Configuring a manual

Further information about the configurability of manuals is available in the Internet:



MyDocumentationManager (<u>https://www.industry.siemens.com/topics/global/en/planning-</u>efficiency/documentation/Pages/default.aspx).

Select "Display and configure" and add the manual to your "mySupport-documentation":

Function manual Function Manual		mySupport Cockpit
Article number of the documentation:	A5E34229197B AA	Trans I delevant
Description / topic	04/2014, FW V4.7,	> Add to mySupport favorites
- Show and configure Cownload (5644 KB)		<ul> <li>&gt; Add to mySupport documentation</li> <li>&gt; Fav</li> </ul>

Not all manuals can be configured.

The configured manual can be exported in RTF, PDF or XML format.

A.5 Manuals and technical support

#### A.5.2 Configuring support

#### Catalog



Catalog D31 for download or online catalog (Industry Mall):

Everything about SINAMICS G120 (www.siemens.en/sinamics-g120)

### SIZER

The configuration tool for SINAMICS, MICROMASTER and DYNAVERT T drives, motor starters, as well as SINUMERIK, SIMOTION controllers and SIMATIC technology



SIZER on DVD:

Article number: 6SL3070-0AA00-0AG0

Download SIZER (https://support.industry.siemens.com/cs/ww/en/view/54992004)

#### EMC (electromagnetic compatibility) technical overview

Standards and guidelines, EMC-compliant control cabinet design



EMC overview (https://support.industry.siemens.com/cs/ww/en/view/103704610)

#### **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 Integrated for novices technical overview

Application examples for SINAMICS G drives with Safety Integrated



Safety Integrated for novices (https://support.industry.siemens.com/cs/ww/en/view/80561520)

#### 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:



Safety Evaluation Tool (www.siemens.com/safety-evaluation-tool)

### A.5.3 Product Support



Additional information about the product and more is available in the Internet: Product support (http://www.siemens.com/automation/service&support).

This address provides the following:

- Actual product information (Update), FAQ (frequently asked questions), downloads.
- The Newsletter contains the latest information on the products you use.
- The Knowledge Manager (Intelligent Search) helps you find the documents you need.
- Users and specialists from around the world share their experience and knowledge in the Forum.
- You can find your local representative for Automation & Drives via our contact database under "Contact & Partner".
- Information about local service, repair, spare parts and much more can be found under "Services".

A.6 Mistakes and improvements

# A.6 Mistakes and improvements

If you come across any mistakes when reading this manual or if you have any suggestions for how it can be improved, then please send your suggestions to the following address or by E-mail:

Siemens AG Digital Factory Motion Control Postfach 3180 91050 Erlangen, Germany

E-mail (mailto:docu.motioncontrol@siemens.com)

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# **Additional information**

SINAMICS inverters: www.siemens.com/sinamics

Safety Integrated: www.siemens.com/safety-integrated

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