SIEMENS

SINUMERIK 840D sl/ SINAMICS S120

SINUMERIK Safety Integrated

Function Manual

Valid for

Control
SINUMERIK 840D sl
SINUMERIK 840D sl (export version)

Drive
SINAMICS S120

Software version
CNC-Software 4.4
HMI Advanced 7.6
SINUMERIK Operate 4.4

09/2011 Edition

SINUMERIK® documentation

Printing history

Brief details of this edition and previous editions are listed below.

The status of each edition is shown by the code in the "Remarks" column.

Status code in the "Remarks" column:

A . . . . . New documentation.
B . . . . . Unrevised reprint with new Order No.
C . . . . . Revised edition with new status.
If factual changes have been made on the page since the last edition, this is indicated by a new edition coding in the header on that page.

Edition	Order No.	Remarks
03/06	6FC5 397-4BP10-0BA0	A
03/07	6FC5 397-4BP10-1BA0	C
02/08	6FC5 397-4BP10-2BA0	C
05/09	6FC5 397-4BP10-3BA0	C
03/10	6FC5 397-4BP10-4BA0	C
09/11	6FC5 397-4BP40-2BA0	C

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Printed in the Federal Republic of Germany

Siemens-Aktiengesellschaft

Preface

SINUMERIK documentation

The SINUMERIK documentation is organized in three parts:

- General documentation
- User documentation
- Manufacturer/service documentation

Additional information

Information on the following topics is provided under the link www.siemens.com/motioncontrol/docu:

- Ordering documentation/overview of documentation
- Additional links to download documents
- Using documentation online (finding and searching in manuals/information)

Please send any questions about the technical documentation (e.g. suggestions for improvement, corrections) to the following address:
(mailto:docu.motioncontrol@siemens.com)

My Documentation Manager (MDM)

Under the following link you will find information to individually compile OEM-specific machine documentation based on the Siemens content:
MDM (www.siemens.com/mdm)

Training

For information about the range of training courses, refer to:

- SITRAIN (www.siemens.com/sitrain) - Siemens training for products, systems and solutions in automation technology
- SinuTrain (www.siemens.com /sinutrain) - training software for SINUMERIK

FAQs

You can find Frequently Asked Questions in the Service&Support pages under Product Support (www.siemens.com/automation/service&support).

SINUMERIK

You can find information on SINUMERIK under the following link:
(www.siemens.com/sinumerik)

Target group

This documentation is intended for manufacturers/end users of machine tools and production machines who use SINUMERIK 840D sl and SINAMICS S120 and the integrated safety functions (SINUMERIK Safety Integrated®).

Benefits

The intended target group can use the Function Manual to test and commission the system or the plant correctly and safely.

Standard scope

This documentation only describes the functionality of the standard version. Additions or revisions made by the machine manufacturer are documented by the machine manufacturer.
Other functions not described in this documentation might be executable in the control. This does not, however, represent an obligation to supply such functions with a new control or when servicing.
For the sake of simplicity, this documentation does not contain all detailed information about all types of the product and cannot cover every conceivable case of installation, operation, or maintenance.

Technical support

You can find telephone numbers for other countries for technical support in the Internet under "Contact" (www.siemens.com/automation/service&support).

CompactFlash cards for users:

- SINUMERIK CNC supports the file systems FAT16 and FAT32 for CompactFlash cards. You may need to format the memory card if you want to use a memory card from another device or if you want to ensure the compatibility of the memory card with the SINUMERIK. However, formatting the memory card will permanently delete all data on it.
- Do not remove the memory card while it is being accessed. This can lead to damage of the memory card and the SINUMERIK as well as the data on the memory card.
- If you cannot use a memory card with the SINUMERIK, it is probably because the memory card is not formatted for the control system (e.g. Ext3 Linux file system), the memory card file system is faulty, or it is the wrong type of memory card.
- Insert the memory card carefully with the correct orientation into the memory card slot (observe indicators such as arrow or similar). This way you avoid mechanical damage to the memory card or the device.

- Only use memory cards that have been approved by Siemens for use with SINUMERIK. Even though the SINUMERIK keeps to the general industry standards for memory cards, it is possible that memory cards from some manufacturers will not function perfectly in this device or are not completely compatible with it (you can obtain information on compatibility from the memory card manufacturer or supplier).
- The CompactFlash card from SanDisk "CompactFlash®5000 Industrial Grade" has been approved for SINUMERIK (Order Number 6FC5313-5AG00.0AA0).

Standard scope

The main areas covered by this description of functions are as follows:

- Regulations and Standards
- Brief description
- System Features
- Safety functions integrated in the drive
- Basics on the safety functions integrated in the system/drive
- Safety functions integrated in the system/drive
- Connecting sensors/actuators
- Data Description
- Commissioning
- Diagnostics
- Interaction with other functions

Separate documents are available for the user-oriented activities. These include, for example, the creation of part programs and operation of the control systems.

Separate information is also available for operations that the machine tool manufacturer must carry out. These include, for example, configuring/engineering, installation and programming the PLC.

Notes on how to use this manual

The following help functions are available with this description of functions:

- Overall table of contents
- Appendix with abbreviations and references, glossary
- Index

If you require information about a certain term, please look for this particular term under the chapter Index in the Appendix. Both the chapter number and the page number, where you will find this particular information are listed there.

Documentation Edition 09/11

Note

The documentation Edition 09/11 describes the scope of functions for the following products and software release:

SINUMERIK 840D sl with software release 4.4

Note

Not all of the HMI functions shown are available in all of the HMI versions (HMI Embedded, SINUMERIK Operate, HMI Advanced).

Safety information

This manual contains information which you should observe to ensure your own personal safety as well as to protect the product and connected equipment. The notices referring to your personal safety are highlighted in the manual by a safety alert symbol; notices referring to property damage only have no safety alert symbol. Depending on the hazard level, warnings are displayed in descending order as follows.

Danger

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

Warning

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

Caution

with a warning triangle indicates that minor personal injury can result if proper precautions are not taken.

Caution

without warning triangle indicates that material damage can result if proper precautions are not taken.

Notice

indicates that an unintended event or situation can occur if the corresponding information is not taken into account.

In the event of a number of levels of danger occurring simultaneously, the warning corresponding to the highest level of danger is always used. A warning on a warning triangle indicating possible personal injury may also include a warning relating to material damage.

Qualified personnel

The associated device/system must only be set up and operated using this documentation. The equipment / system may only be commissioned and operated by **qualified personnel**. Qualified persons are defined as persons who are authorized to commission, to ground, and to tag circuits, equipment, and systems in accordance with established safety practices and standards.

Proper use of Siemens products

Please observe the following:

Warning

Siemens equipment may only be used for the applications indicated in the catalog and in the relevant technical documentation. If third-party products and components are used, they must be recommended or approved by Siemens. To ensure trouble-free and safe operation of the products, they must be appropriately transported, stored, assembled, installed, commissioned, operated and maintained. The permissible ambient conditions must be adhered to. Notices in the relevant documentation must be observed.

Additional information

Note

This symbol always appears in the document where further information is provided.

Test certificates

The attachments to the following test certificates with the certified software and hardware releases are not included in this documentation. If you require the appropriate attachments, then please use the address specified in the corrections/suggestions sheet (last page).

A list of the already certified software releases and hardware versions is provided with each "Certificate of License (CoL)" of the SINUMERIK Safety Integrated options. If you have any questions relating to current certifications or those that have not been completed, please contact your local Siemens office.

Certificate of TÜV Rheinland

TÜVRheinland®

ZERTIFIKAT
CERTIFICATE

Nr./No. 968/EZ 293.00/08

Prüfgegenstand **Product tested**	Sinumerik Safety Integrated machine control	**Zertifikatsinhaber** **Licence holder** **Hersteller** **Manufacturer**	Siemens AG Industry Sector, DT MC Frauenauracher Straße 80 91056 Erlangen Germany See licence holder
Typbezeichnung **Type designation**	SINUMERIK 840D sl/ SINUMERIK 840DE sl with SINAMICS S120	**Verwendungs-zweck** **Intended application**	Machine control for safety functions: standstill/torque off, stop 1, stops A-E, brake control, operating stop, reduced speed, software cams, software limit switches, “n<nx”, acceleration monitor, I/O (PROFIsafe-Master), programmable logic, brake test
Prüfgrundlagen **Codes and standards forming the basis of testing**		IEC 61508, Part 1 - 7:1998-2000 ISO 13849-1:2006 ISO 13849-2:2003 IEC 61800-5-1:2007 IEC 61800-5-2:2007	IEC 61800-3:2004 IEC 60204-1:2006 NFPA 79:2007 UL 1998:2004
Prüfungsergebnis **Test results**		The system is suitable for safety related applications up to SIL 2 according to IEC 61508, Category 3 and Performance Level 'd' in accordance with ISO 13849-1. The test functionality Safe Brake Test (SBT) achieves Cat. 2 according to ISO 13849-1.	
Besondere Bedingungen **Specific requirements**		The information provided in the "Function Manual" must be considered.	

Functional Safety
Type Approved
TÜVRheinland® FS

Der Prüfbericht-Nr.: 968/EZ 293.00/08 vom 17.09.2008 ist Bestandteil dieses Zertifikates.
Der Inhaber eines für den Prüfgegenstand gültigen Genehmigungs-Ausweises ist berechtigt, die mit dem Prüfgegenstand übereinstimmenden Erzeugnisse mit dem abgebildeten Prüfzeichen zu versehen.

The test report-no.: 968/EZ 293.00/08 dated 2008-09-17 is an integral part of this certificate.
The holder of a valid licence certificate for the product tested is authorized to affix the test mark shown opposite to products, which are identical with the product tested.

TÜV Rheinland Industrie Service GmbH
Geschäftsfeld ASI
Automation, Software und Informationstechnologie
Am Grauen Stein, 51105 Köln
Postfach 91 09 51, 51101 Köln

H. Gall

Datum/Date	Firmenstempel/Company Seal	Dipl.-Ing. Heinz Gall
2008-09-17		

NRTL listing of TÜV Rheinland of North America Page 1

Certificate

TÜVRheinland

Certificate no. US 72090078 01

License Holder:	Manufacturing Plant:
Siemens AG, I DT MC Frauenauracher Str. 80 91056 Erlangen Germany	Siemens AG, I DT MC Frauenauracher Str. 80 91056 Erlangen Germany

Test report no.: USA-MHA 30881956 001 **Client Reference:** Dietmar Wanner

Tested to:
UL 508:1999 R7.05
UL 508C R7.03
UL 1998:1998 R5.04
NFPA 79:2007 ER 1
IEC 61508-1:1998
see also additional page[s]

Certified Product: Sinumerik Safety Integrated Machine Control **License Fee - Units**

Listing Category: Industrial Control Equipment
for Safety-Related Functions and E-Stop (per NFPA 79):

Model Designation: SINUMERIK 840D sl,
SINUMERIK 840DE sl with SINAMICS S120

Rated Voltage: DC 600V
Rated Current: 3.3A - 210.0A
Protection Class: I
Output Ratings: AC 0-480V, 3-200.0A

contd.

Appendix: 1, 1-9

Licensed Test mark:

TÜV Rheinland of North America, Inc. US

Signature

Martin Glagla

Dipl.-Ing. M. Glagla
QA Certification Officer

Date of Issue (day/mo/yr)
29/01/2009

TUV Rheinland of North America, Inc., 12 Commerce Road, Newtown, CT 06470, Tel (203) 426-0888 Fax (203) 426-4009

NRTL listing of TÜV Rheinland of North America Page 2

Certificate

TÜVRheinland®

Certificate no. US 72090078 02

License Holder:	Manufacturing Plant:
Siemens AG, I DT MC Frauenauracher Str. 80 91056 Erlangen Germany	Siemens AG, I DT MC Frauenauracher Str. 80 91056 Erlangen Germany

Test report no.: USA-MHA 30881956 001 **Client Reference:** Dietmar Wanner

Tested to: IEC 61508-2:2000
IEC 61508-3:1998
IEC 61508-4:1998
see also previous page[s]

Certified Product: Sinumerik Safety Integrated Machine Control **License Fee - Units**

contd.

Additional Test Standards: see above

Special Remarks: To be installed according to the licensee's installation instructions.

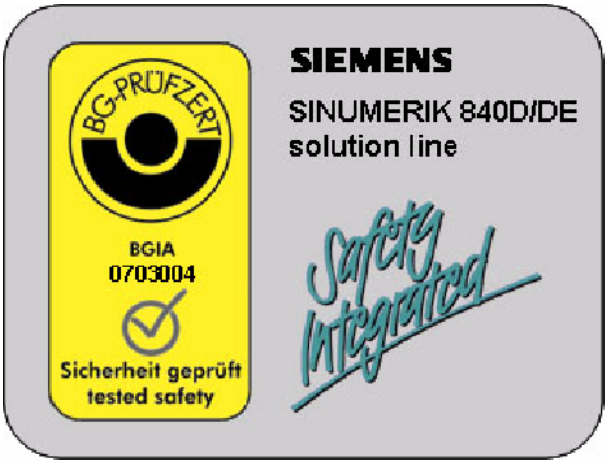
Licensed Test mark:	Signature	Date of Issue (day/mo/yr)
TÜV Rheinland of North America, Inc. US	Martin Glagla Dipl.-Ing. M. Glagla QA Certification Officer	29/01/2009

TUV Rheinland of North America, Inc., 12 Commerce Road, Newtown, CT 06470, Tel (203) 426-0888 Fax (203) 426-4009

PRÜFZERT symbol

When the ”SINUMERIK Safety Integrated” option is ordered, in addition to the Certificate of License, an adhesive label is included in the supplementary pack that must only be used for certified software releases and hardware versions.

PRÜFZERT symbol for certification acc. to DIN EN ISO 13849-1 / DIN EN 61508



Symbol of the BGIA [BG Institute for Occupational Safety and Health]

Test symbol for certification according to ISO 13849-1 / IEC 61508

Symbol of TÜV Rheinland

Table of Contents

Regulations and Standards 1

1.1 General information

1.1.1 Objective

Manufacturers and operators of technical equipment and products are responsible in minimizing the risk from plants, machines and other technical equipment corresponding to state-of-the-art technology. Regulations and standards are essential documents that define the minimum requirements to minimize risks. By maintaining these minimum requirements, the company erecting a plant or a manufacturer of a machine or a piece of equipment can prove that they have fulfilled their obligation to exercise care and diligence.

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. Protection of man and the environment is to be standardized using internationally harmonized safety standards. Further, unfair competition due to different local requirements is to be avoided.

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.

For manufacturers of machines and companies that erect plants and systems it is important that the local legislation and regulations always apply for that country where the machine or plant is being operated. For instance, the control system of a machine, that is to be used in the US, must fulfill the local US requirements even if the machine manufacturer (OEM) is based in the European Economic Area (EEA).

1.1.2 Functional safety

Safety, from the perspective of the object to be protected, cannot be split-up. The causes of hazards and therefore also the technical measures to avoid them can vary significantly. This is the reason that 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.

In order to achieve the functional safety of a machine or plant, it is necessary that the safety-related parts of the protection and control devices function correctly. And not only this, when faults develop, they must behave so that either the plant remains in a safe state or it is brought into a safe state.
In this case, it is necessary to use specially qualified technology that fulfills the requirements described in the associated Standards. The requirements to achieve functional safety are based on the following basic goals:

- Avoiding systematic faults
- Controlling systematic faults
- Controlling random faults or failures

The level of the functional safety achieved is expressed using different terms in the standards. In EN 61508, EN 62061, EN 61800-5-2: "Safety Integrity Level" (SIL) and EN ISO 13849-1 "Performance Level" (PL).

1.2 Safety of machinery in Europe

The EC 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"):

- EC directives only specify general protection 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 complied with. When the harmonized standards are complied with, then it can be assumed that all of the applicable safety requirements and specifications of the directives involved are fulfilled.

In order to market or sell a product in the European Economic Area (EEA), this product must fulfill the protective goals and requirements of all of the applicable EC directives. For machines, in addition to the machinery directive, these can also include e.g. the EMC directive, the noise protection directive, the guideline for explosion protection, the low-voltage directive.

1.2.1 Machinery directive (2006/42/EC)

With the introduction of a European Economic Area, a decision was made that the domestic standards and regulations of all of the EEA Member States – that are involved with the technical implementation of machines – would be harmonized. This means that the machinery directive had to be implemented – as an internal market directive – as far as the content was concerned – in the domestic legislation of the individual Member States. For the Machinery Directive, this was realized with the aim of achieving standard protective goals and, in turn, removing technical trade barriers. Corresponding to its definition ”a machine is an assembly of linked parts or components – at least one of which moves”, this directive is extremely extensive. The revised version from 2006, which shall be binding as of Dec. 29, 2009 without transitional period, has expanded its area of application and now includes ”Logic units to ensure safety functions”.

The machinery directive involves the implementation of machines. 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 responsibly implemented in order to fulfill the requirements for conformity with the directive.

The manufacturer of a machine must provide proof that his machine is in compliance with the basic requirements. This verification is facilitated by means of harmonized standards.

1.2.2 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 Typicals (EN Typicals) are published in the official journal of the commission of the European Parliament and Council and must be included without revision in domestic Typicals. 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 complied with, then there is an ”automatic assumption” that the directive is fulfilled. This means that the manufacturer may then assume that he has complied with the safety aspects of the directive under the assumption that they are also handled in that particular standard. However, not every European standard is harmonized in this sense. The listing in the official journal of the European Parliament and Council is decisive.

The European Typicals regarding the safety of machines are structured in a hierarchical manner as follows:

- A Typicals (basic Typicals)
- B Typicals (group Typicals)
- C Typicals (product Typicals)

Regarding type A standards/basic standards

A Typicals include basic terminology and definitions relating to all types of machine.
A Typicals are aimed primarily at the bodies responsible for setting the B and C Typicals. The measures specified here for minimizing risk, however, may also be useful for manufacturers if no applicable C Typicals have been defined.

Type B Typicals/group Typicals

B Typicals cover all safety-related Typicals for various different machine types. B Typicals are aimed primarily at the bodies responsible for setting C Typicals. They can also be useful for manufacturers during the machine design and construction phases, however, if no applicable C Typicals have been defined.

A further sub-division has been made for B Typicals:

- **Type B1 standards** for higher-level safety aspects, e.g. basic ergonomic principles, safety clearances from hazards, minimum clearances to avoid crushing parts of the body.
- **Type B2 standards** for protective safety devices are defined for various machine types - e.g. Emergency Stop devices, two-hand operating circuits, interlocking elements, contactless protective devices, safety-related parts of controls.

Type C Typicals/product Typicals

C standards are standards for specific products - for instance, machine tools, woodworking machines, elevators, packaging machines, printing machines etc. Product standards list requirements for specific machines. The requirements can, under certain circumstances, deviate from the basic and group Typicals. Type C/ product standards have the highest priority for machine manufacturers. The machine manufacturer can then assume that it fulfills the basic requirements of Attachment I of the machinery directive (automatic presumption of compliance).
If no product standard has been defined for a particular machine, type B Typicals can be applied when the machine is constructed.

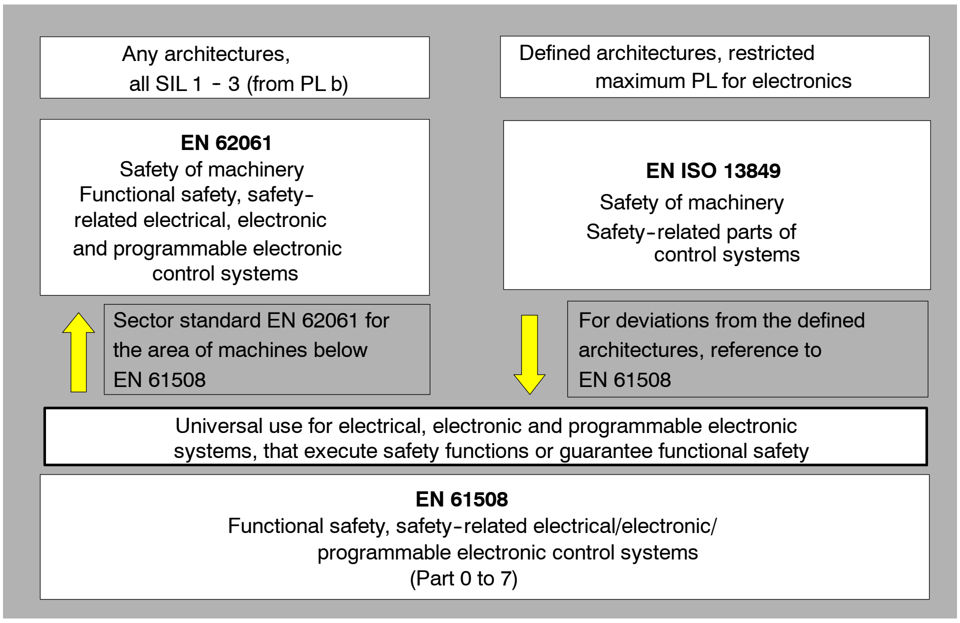
A complete list of the Typicals specified and the mandated draft Typicals are available on the Internet at the following address:

http://www.newapproach.org/

Recommendation: Due to the rapid pace of technical development and the associated changes in machine concepts, the Typicals (and C Typicals in particular) should be checked to ensure that they are up to date. Where appropriate, note that the application of a particular standard may not be mandatory provided that all the safety requirements of the applicable EC directive are fulfilled.

1.2.3 Standards for implementing safety-related controllers

If the functional safety of the machine depends on control functions, then the control must be implemented so that the probability of failure of the safety-related functions is sufficiently low. The standards EN ISO 13849-1 (previously EN 954-1) and EN 62061 define guidelines for implementing safety-related machine controllers which, when properly applied, ensure that all the safety requirements of the EC machinery directive are fulfilled. When these standards are applied, then it can be assumed that the relevant safety requirements of the machinery directive are fulfilled.



The areas of application of EN ISO 13849-1, EN 62061, and the series of EN 61508 standards are very similar. In order to help users make a decision, the application areas of both standards are listed in a common table in the introduction to the standard. Either EN ISO 13849-1 or EN 62061 are applied depending on the technology (mechanical, hydraulic, pneumatic, electrical, electronic, programmable electronic), risk classification, or architecture.

	Systems for executing safety-related control functions	EN ISO 13849-1	EN 62061
A	Non-electrical (e.g. hydraulic, pneumatic)	X	Not covered
B	Electromechanical (e.g. relay and/or basic electronics)	Restricted to the designated architectures (see comment 1) and max. up to PL = e	All architectures and max. up to SIL 3
C	Complex electronics (e.g. programmable electronics)	Restricted to the designated architectures (see comment 1) and max. up to PL = d	All architectures and max. up to SIL 3
D	A combined with B	Restricted to the designated architectures (see comment 1) and max. up to PL = e	X See comment 3
E	C combined with B	Restricted to the designated architectures (see comment 1) and max. up to PL = d	All architectures and max. up to SIL 3
F	C combined with A or C combined with A and B	X See comment 2	X See comment 3
”X” indicates that the point is covered by this standard. Comment 1: Designated architectures are described in Annex B of EN ISO 13849-1 and provide a simplified basis for the quantification Comment 2: For complex electronics: Using designated architectures in compliance with EN ISO 13849-1 up to PL = d or every architecture in compliance with EN 62061 Comment 3: For non-electrical systems: Use parts/components that correspond to EN ISO 13849-1 as subsystems			

1.2.4 EN ISO 13849-1 (previously EN 954-1)

The qualitative approach acc. to EN 954-1 is not sufficient for state-of-the-art controls. EN 954-1 does not take into account, among other things, time behavior (e.g. test interval and/or cyclic test, lifetime). This results in the probabilistic basis in EN ISO 13849-1 (probability of failure per unit time).

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 EN ISO 13849-1, safety functions are investigated from a quantitative perspective going beyond the qualitative basis of EN 954-1. Performance levels (PL), which are based on the categories, are used. The following safety-related characteristic quantities are required for devices/equipment:

- Category (structural requirement)
- PL: Performance Level
- $MTTF_d$: Meantime time up to a dangerous failure

- DC: Diagnostics Coverage
- CCF: Common Cause Fault

The standard describes how the performance level (PL) is calculated for safety-related components of the controller on the basis of designated architectures. In the event of any deviations from this, EN ISO 13849-1 refers to EN 61508.

When combining several safety-related parts to form a complete system, the Standard explains how to determine the resulting PL.

Note

Since May 2007, EN ISO 13849-1 has been harmonized as part of the machinery directive. EN 954-1 can still be applied up until November 30, 2009.

1.2.5 EN 62061

EN 62061 (this is identical to IEC 62061) is a sector-specific standard below EN 61508. It describes the implementation of safety-related electrical control systems of machines and takes into account the complete lifecycle - from the conceptual phase to de-commissioning. The standard is based on the quantitative and qualitative analyses of safety functions, whereby it systematically applies a top-down approach to implementing complex control systems (known as "functional decomposition"). The safety functions derived from the risk analysis are sub-divided into sub-safety functions, which are then assigned to real devices, sub-systems, and sub-system elements. Both the hardware and software are covered. EN 62061 also describes requirements regarding the implementation of application programs.

A safety-related control systems comprises different sub-systems. From a safety perspective, the sub-systems are described by means of the characteristic quantities (SIL claim limit and PFH_D).

Programmable electronic devices, e.g. PLCs or variable-speed drives must comply with EN 61508. They can then be integrated as sub-systems into the control. The following safety-related characteristic quantities must be specified by the manufacturers of these devices.

Safety-related characteristic quantities for subsystems:

- SIL CL: SIL claim limit
- PFH_D: probability of dangerous failures per hour
- T1: lifetime

Basic subsystems, e.g. sensors and actuators comprising electromechanical components, can, in turn, comprise different interconnected subsystem elements (devices) with the characteristic quantities to determine the corresponding PFH_D value of the subsystem.

Safety-related characteristic quantities for subsystem elements (devices):

- λ : failure rate
- B10 value: For elements that are subject to wear
- T1: lifetime

For electro-mechanical devices, a manufacturer specifies a failure rate λ referred 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:

- Using devices and subsystems that already comply with EN ISO13849-1 or EN 61508 and/or EN 62061. The standard provides information specifying how qualified devices can be integrated when safety functions are implemented.
- Develop own subsystems.
  - Programmable, electronic systems and complex systems: Application of EN 61508 or EN 61800-5-2.
  - Simple devices and subsystems: Application of EN 62061.

EN 62061 does not include information about non-electric systems. The standard provides detailed information on implementing safety-related electrical, electronic, and programmable electronic control systems. EN 954-1/EN ISO 13849-1 should be applied for non-electrical systems.

Note

Details of simple subsystems that have been implemented and integrated are available as functional examples.

Note

IEC 62061 has been ratified as EN 62061 in Europe and harmonized as part of the Machinery Directive.

1.2.6 Series of standards EN 61508 (VDE 0803)

This series of standards describes state of the art technology.

EN 61508 is not harmonized in line with any EC directives. which means that an automatic presumption of conformity for fulfilling the protective requirements of a directive is not implied. However, the manufacturer of a safety-related product can use EN 61508 to fulfill basic requirements from the European directives according to the new concept. For instance in the following cases:

- If no harmonized standard exists for the application in question. In this case, the manufacturer can use EN 61508, although no presumption of conformity exists here.
- A harmonized European standard (e.g. EN 62061, EN 954 or EN ISO 13849, EN 60204-1) makes reference to EN 61508. This ensures that the appropriate requirements of the directives are complied with ("standard that is also applicable"). If the manufacturer correctly applies EN 61508 in the sense of this reference and acts responsibly, then he uses the presumption of conformity of the referencing standard.

EN 61508 covers all the aspects that must be taken into account when E/E/PES systems (**E**lectrical, **E**lectronic, and **P**rogrammable **E**lectronic **S**ystem) are used in order to execute safety functions and/or to ensure the appropriate level of functional safety. Other hazards, e.g. hazards as a result of electric shock are - similar to EN 954 - not included in the standard.

A new aspect of EN 61508 is its international positioning as ”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 specify it, e.g. as basis for NRTL listing.
Another recent development with respect to EN 61508 is its system approach, which extends the technical requirements to include the entire safety installation from the sensor to the actuator, the quantification of the probability of hazardous failure due to random hardware failures, and the creation of documentation covering all phases of the safety-related lifecycle of the E/E/PES.

1.2.7 EN 60204-1

The European standard EN 60204-1 is based on the modified ISO edition IEC 60204-1. It includes general requirements and recommendations for the electrical, electronic and programmable electronic equipment of machines with rated voltages up to and including 1000 V AC/ 1500 V DC at rated frequencies up to and including 200 Hz, in order to promote

- the safety of persons and material objects
- maintain the correct functioning
- simplify service and maintenance.

The equipment, which is covered by EN 60204-1, starts at the point of connection to the line supply of the electrical equipment of the machine and ends at the motor shaft.

1.2.8 EN 61800-5-2

The European product standard EN 61800-5-1 has taken the international standard IEC 61800-5-2 without any changes.
It defines requirements and gives recommendations for designing and developing, integrating and validating safety-relevant power drive systems with adjustable speed (PDS(SR)) regarding their functional safety.
This standard is only applicable if the functional safety of a PDS(SR) is used and the PDS(SR) is operated in a mode with a higher or continuous demand (demand mode). The EN 61508 series of standards should be used for operating modes with a low demand (low demand mode).
This part of EN 61800 discusses the safety-related evaluation of a PDS(SR) within the framework of the EN 61508 series of standards and introduces requirements placed on a PDS(SR) as sub-systems of a safety-relevant system. This therefore permits the implementation of the electrical/electronic/programmable electronic (E/E/PE) elements of a PDS(SR) taking into account the safety-relevant performance of the safety function(s) of a PDS.

Manufacturers and suppliers of PDS(SR) can prove to users (i.e. integrators of control systems, developers of machines and plants etc.) the safety-relevant performance of their equipment by implementing the specifications laid down in EN 61800-5-2. When this part of EN 61800 is complied with, all of the requirements of the EN 61508 series of standards, which are specified for a PDS(SR), are fulfilled.

This part of EN 61800 is only valid for PDS(SR), which implement safety functions up to SIL 3.

The following basic requirements of the EC machinery directive are covered in EN 61800-5-2:

- Safety and reliability of controls
- Faults in control circuits.

1.2.9 Risk analysis/assessment

Risks are intrinsic in machines due to their design and functionality. For this reason, the Machinery Directive requires that a risk assessment be performed for each machine and, if necessary, the level of risk reduced until the residual risk is less than the tolerable risk. To assess these risks, the following standards must be applied:

- EN ISO 12100-1 "Safety of Machinery - basic terminology, general principles for design"
- EN ISO 13849-1 (previously EN 954-1) "Safety of machinery"
- EN ISO 14121-1 (previously EN 1050, Paragraph 5) "Safety of machinery - guidelines for risk assessment"

EN ISO 12100-1 mainly describes the risks to be considered and the design principles to minimize risks; EN ISO 14121-1 describes the iterative process when assessing and reducing risks to achieve the appropriate degree of safety.

The risk assessment is a sequence of steps that allows hazards, as a result of machines, to be systematically investigated. Where necessary, the risk assessment is followed by a risk reduction procedure. When this procedure is repeated, an iterative process is obtained (see Fig. 1-1), which can then be used to eliminate hazards as far as possible and so that the appropriate protective measures can be taken.

The risk assessment involves the following

- Risk analysis
  a) Determines the limits of the particular machine (EN ISO 12100-1, EN ISO 14121-1 Para. 5)
  b) Identifies the hazards (EN ISO 12100-1, EN ISO 14121-1 Para. 6)
  c) Techniques to estimate risk (EN 1050 Para. 7)
- Risk assessment (EN ISO 14121-1 Paragraph 8)

As part of the iterative process to achieve the appropriate degree of safety, after the risk has been analyzed the risk is assessed. Then, a decision must be made as to whether the residual risk must 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.

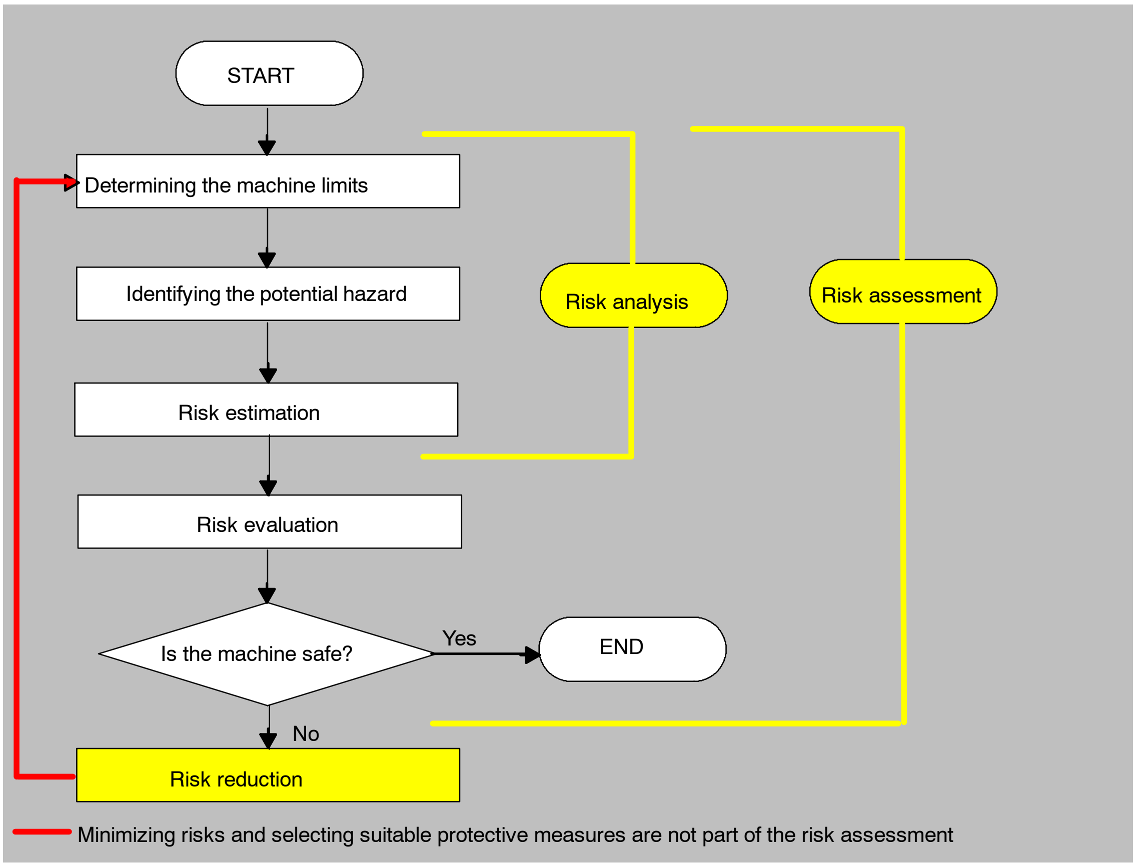


Fig. 1-1 Iterative process to achieve the required level of safety to ISO 14121-1

Risks must be reduced by suitably designing and implementing the machine. For instance a control system 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 in accordance with EN ISO 13849-1. For electrical and electronic controls, EN 62061 can be used as an alternative to EN ISO 13849-1. Electronic controls and bus systems must also comply with EN 61508.

1.2.10 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 graded according to the magnitude of the risk must be taken into account. These are described in EN ISO 13849-1 (previously 954-1) and, 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 954-1 defines "Categories" for this purpose. In its Annex B, it also describes a technique to select a suitable category to design and implement the safety-related part of a control system.

EN ISO 13849-1 defines a risk graph, which can be used instead of the categories to create hierarchical performance levels (PL).

EN 62061 and the series of **EN 61508** standards use the "Safety Integrity Level" (SIL) to make this type of classification. This is a quantified measure of the safety-related performance of a controller.
The necessary SIL is also determined using the principle of risk assessment according to EN ISO 14121 (EN 1050). A technique to determine the required Safety Integrity Level (SIL) is described in Annex A of EN 62061.

It is always important, independent of which standard is applied, that all parts of the machine control that are involved in executing safety-related functions fulfills these requirements.

1.2.11 Residual risk

In today's technologically advanced world, the concept of safety is relative. In practice, safety cannot be implemented that guarantees a "zero risk" situation. The residual risk is the risk that remains once all the relevant protective measures have been implemented in accordance with the latest science and technology.

Residual risks must be clearly referred to in the machine/plant documentation (user information according to EN ISO 12100-2).

1.3 Machine safety in the USA

An essential difference in the legal requirements regarding safety at work between the US and Europe is the fact that in the US there is no legislation regarding machinery safety that is applicable in all of the US states and that defines the responsibility of the manufacturers/sales&marketing organizations. On the other hand, there is a general requirement that the employer must offer a safe workplace.

1.3.1 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 in Section 5 ”Duties”.

The requirements of the OSH Act are administered by the Occupational Safety and Health Administration (also known as OSHA). OSHA employs regional inspectors that check whether workplaces are in compliance with the valid regulations.

The regulations of OSHA, relevant for safety at work, 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. Standards for specific products have priority over general standards if the relevant aspects are handled there. When the standard is fulfilled, the employer can assume that he has fulfilled the core requirements of the OSM Act regarding the aspects handled by the standards.

In conjunction with certain applications, OSHA specifies that all electrical equipment and devices that are used to protect workers must be authorized by an OSHA-certified, Nationally Recognized Testing Laboratory (NRTL) for the specific application.

In addition to the OSHA regulations, it is important that the current standards from organizations such as NFPA and ANSI are carefully observed as well as the extensive product liability legislation that exists in the US. 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. Initially, self-insured companies do not have this requirement, but, in the case of an accident, they must prove that they have applied generally recognized safety principles.

1.3.2 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 such as the NFPA 79 and also international standards such as e.g. the series of IEC 61508 standards for E/E/PES systems form the basis for testing.

1.3.3 NFPA 79

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 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 like IEC 60204-1, NFPA 79 no longer specifies that the electrical energy must be disconnected by electromechanical means for Emergency Stop functions.

<u>The core requirements placed on programmable electronics and communication buses include:</u>
System requirements (refer to NFPA 79 9.4.3)

- Control systems that include software-based controllers, must,
  (1) If an individual fault occurs,
    - bring the system into a safe state to shut it down
    - prevent restarting until the fault has been removed
    - prevent unexpected starting
  (2) Provide protection comparable to hard-wired controls
  (3) Be implemented corresponding to a recognized standard that defines the requirements for such systems.
- EN 61508, EN 62061, ISO 13849-1/-2, EN 61800-5-2 are mentioned in a note that they are suitable standards.

  Underwriter Laboratories (UL) has defined a special Category for ”Programmable Safety Controllers” for implementing this requirement (code NRGF). This category covers control devices that contain software and are designed for use in safety-related functions.
  A precise description of the category and a list of devices that fulfill this requirement can be found on the Internet at the following address:

  http://www.ul.com -> certifications directory -> UL Category code/Guide information -> search for category ”NRGF”

  TUV Rheinland of North America, Inc. is also an NRTL for these applications.

1.3.4 ANSI B11

ANSI B11 standards are joint standards, that were developed by associations such as e.g. 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. Risk analysis is an important requirement in accordance with NFPA79, ANSI/RIA 15.06, ANSI B11.TR-3 and SEMI S10 (semiconductors). The documented findings of a risk analysis can be used to select a suitable safety system based on the safety class of the application in question.

1.4 Machine safety in Japan

The situation in Japan is different than that in Europe and the US. Legislation such as that prescribed in Europe does not exist. Further, product liability does not play a role such as it is in the US.

There are no legal requirements to apply standards. Instead, there is an administrative recommendation to apply JIS (Japanese Industrial Standard):

Japan bases its approach on the European concept and uses basic standards as its national standards (see Table 1-1).

Table 1-1 Japanese standards

ISO/IEC number	JIS number	Remark
ISO12100-1	JIS B 9700-1	Earlier designation TR B 0008
ISO12100-2	JIS B 9700-2	Earlier designation TR B 0009
ISO14121-1 / EN1050	JIS B 9702	
ISO13849-1	JIS B 9705-1	
ISO13849-2	JIS B 9705-1	
IEC60204-1	JIS B 9960-1	Without annex F or route map of the European foreword
IEC61508-0 to -7	JIS C 0508	
IEC 62061		JIS number not yet assigned

1.5 Equipment regulations

In addition to the requirements of the guidelines and Typicals, company-specific requirements must be taken into account. Especially large corporations - e.g. automobile manufacturers - place high requirements on the automation components, that are then often listed in their own equipment specifications.

Safety-related subjects (e.g. operating modes, operator actions with access to hazardous areas, Emergency Stop concepts) should be clarified with customers at an early phase so that they can be integrated in the risk assessment/risk reduction.

1.6 Other safety-related issues

1.6.1 Information sheets from the various regulatory bodies

Safety-related measures to be implemented cannot always be derived from directives, standards, or regulations. In this case, supplementary information and explanations are required.

Some regulatory bodies issue publications on an extremely wide range of subjects. Information sheets covering the following areas are available, for example:

- Process monitoring in production environments
- Axes subject to gravitational force
- Roller pressing machines
- Lathes and turning centers - purchasing/selling

These information sheets handling specific subjects and issues can be ordered from all parties interested - e.g. for providing support in operations, when drawing-up regulations or for implementing safety-related measures at machines, plants and systems. These information sheets provide support in machinery construction, production systems, steel construction.

Under the following Internet address, under "Service and Contact" -> "Downloads" -> "Information sheets FA MFS" you can download fact sheets (not only for axes that can fall due to gravity, but also regarding process monitoring):

http://www.bg-metall.de

1.6.2 Additional references

- Safety Integrated: The Safety System for Industry (5th Edition and supplement), Order No. 6ZB5 000-0AA01-0BA1
- Safety Integrated - Terms and Standards - Machine Safety Terminology (04/2007 Edition), Order No. E86060-T1813-A101-A1

Brief Description 2

2.1 Control/drive system

In order to implement safety-related measures, up until now, external equipment and devices were used – e.g. contactors, switches, cams and monitoring devices. If a hazardous situation is detected, these devices generally interrupt the power circuit thus stopping the motion, see Fig. 2-1.

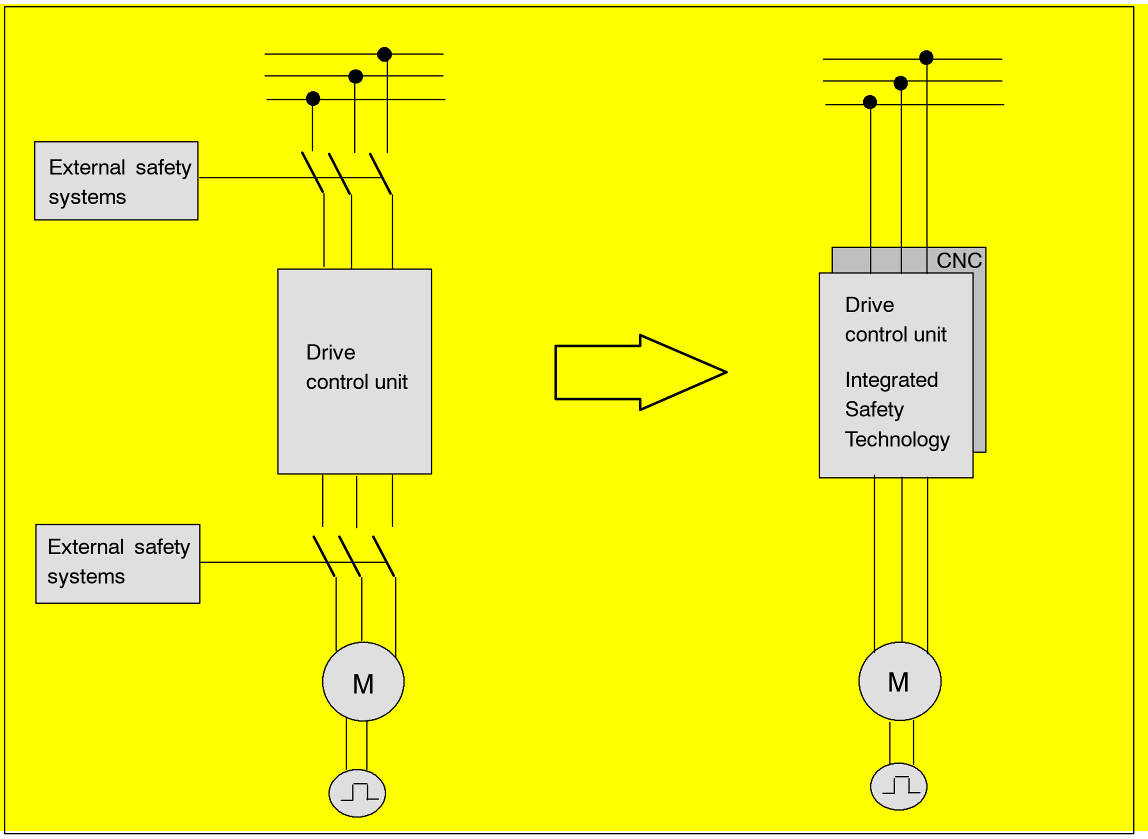


Fig. 2-1 Safety systems: External --> Integrated

With the integration of safety functions, drive systems and CNC controls perform safety functions in addition to their functional tasks. Very short response times can be achieved because of the short data paths from acquisition of the safety-related information – e.g. speed or position – up to evaluation.

The systems with integrated safety technology generally respond very quickly when the permissible limit values are violated, e.g. position and velocity limit values. They can be of decisive importance for the required monitoring result. The integrated safety technology can directly access the power semiconductors in the drive controller without using electromechanical switching devices in the power circuit. This helps reduce the susceptibility to faults - and the integration also reduces the amount of cabling.

A combination of safety technology integrated in the system and drive can be used for each axis at a machine tool.

2.2 Safety technology integrated in the system

SINUMERIK Safety Integrated

Using the SINUMERIK Safety Integrated function, for SINUMERIK 840D sl, for all power/performance classes, integrated safety functions are available in conjunction with the SINAMICS S120 drive system; these are used to monitor standstill (zero speed), velocity and position.
SINAMICS S120 is used in conjunction with 1FT6/1FK6/1FK7 three-phase servo-motors and 1FN linear motors for feed drives as well as 1FE and 1PH motors for main spindle drives.
The safety-related sensors and actuators are connected through distributed I/O via PROFIBUS-DP, PROFINET with the PROFIsafe profile, e.g. ET 200S, ET 200pro, ET 200eco, DP/AS-i F-Link.
This means that a complete digital system is available that is suitable for complex machining tasks.
A two-channel, diverse system structure is formed on the basis of an existing multi-processor structure.

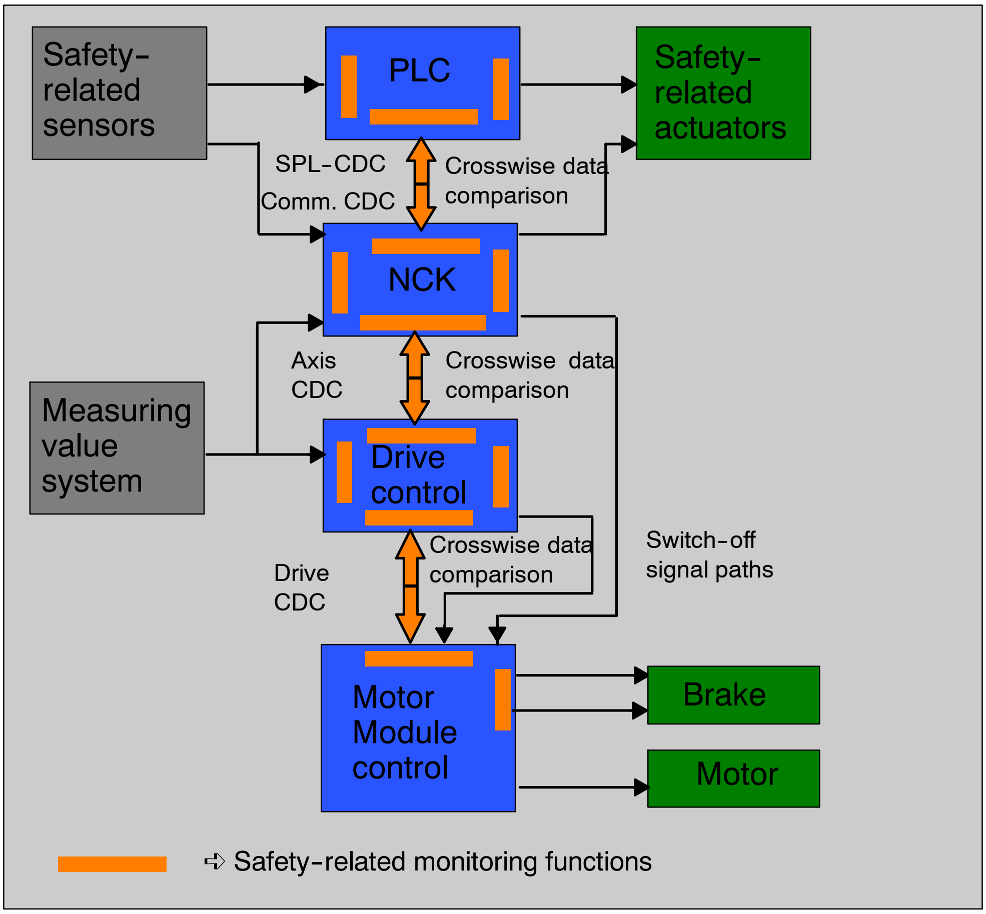


Fig. 2-2 Evaluation/logic with monitoring functions

Features of the two-channel, diverse structure

A two-channel, diverse structure is characterized by the following features:

- Two-channel structure with at least 2 independent computers (i.e. computers with different hardware and software).
- Crosswise result and data comparison with forced checking procedure for the purpose of detecting internal errors even in functions that are not often used (dormant errors).
- The computers can access data, reaction-free and decoupled at the shared (common) interfaces (e.g. actual value input).

Sensing

The actual values of the individual axes are sensed by the sensor modules through two channels and are provided to the drive and control.

In order to connect sensors and actuators in a safety-related fashion, their process signals must be connected-in for further processing.

Evaluation

The safety-related functions are executed independently of one another by the NCK-CPU, PLC-CPU and the drive CPUs. The CPUs cyclically and mutually compare their safety-related data and results (crosswise data comparison). A test can be carried out - initiated by the CPUs - to check the shutdown paths and actuators (forced checking procedure).

Respond

When the integrated safety-related functions respond, the drive processors, the PLC processor and/or the NCK processor can act on the connected actuators in a safety-related fashion in-line with the actual situation. For example, the appropriate stop responses for the drives can be initiated and the actuators shutdown via the shutdown paths.

2.2.1 Overview of the safety functions integrated in the system

The safety-related functions are available in all of the operating modes and can communicate with the process via safety-related input/output signals. These can be implemented individually for each axis.

- **Safe stopping process**
  When a monitoring function or a sensor responds (e.g. a light grid), the drives are safely controlled down to standstill, optimally adapted to the actual operating state of the machine.

- **Safe acceleration monitoring (SBR)**
  Monitors the speed characteristic. The speed must be reduced after a stop request has been issued.
- **Safe standstill (SH)**
  The drive pulses are cancelled. The energy feed is safely and electronically disconnected.
- **Safe operating stop (SBH)**
  Monitors the drives during standstill (to ensure that they remain stationary). The drives remain fully functional in closed-loop control.
- **Safely reduced speed (SG) including override**
  Configured speed limits are monitored, e.g. when setting-up without using an agreement button.
- **Safe velocity range detection ”$n<n_x$”**
  This is used to detect the velocity range of a drive in a safety-related fashion.
- **Safe software limit switches (SE)**
  Variable traversing range limits
- **Safety software cams and safety cam track (SN)**
  To detect ranges
- **Safety-related input/output signals (SGE/SGA)**
  Interface to the process
- **Safety-related communication via standard bus**
  Distributed I/Os for process and safety signals are connected via PROFIBUS and PROFINET using the PROFIsafe profile.
- **Safety CPU-CPU communication**
  Safety-relevant communication between safety-relevant controls to implement hierarchic systems, e.g. transfer lines.
- **Safe programmable logic (SPL)**
  All of the safe signals and internal logic are directly connected.
- **Safe brake management (SBM)**
  Safety-related two-channel brake control (SBC) and cyclic brake test (SBT).
- **Integrated acceptance test**
  Partially automated acceptance test for all safety-related functions. Simple operation of the test process, automatic configuration of Trace functions and automatic generation of an acceptance report.

2.3 Safety technology integrated in the drive

SINAMICS Safety Integrated

The SINAMICS S120 drive system provides the Safety Integrated Basic Functions and the Safety Integrated Extended Functions.
Under certain limitations and constraints (refer to the system prerequisites, Chapter 3), the Safety Integrated Basic Functions can be used together with SINUMERIK 840D sl.
They can be activated via terminals on the power unit and at the NCU or on the NX module

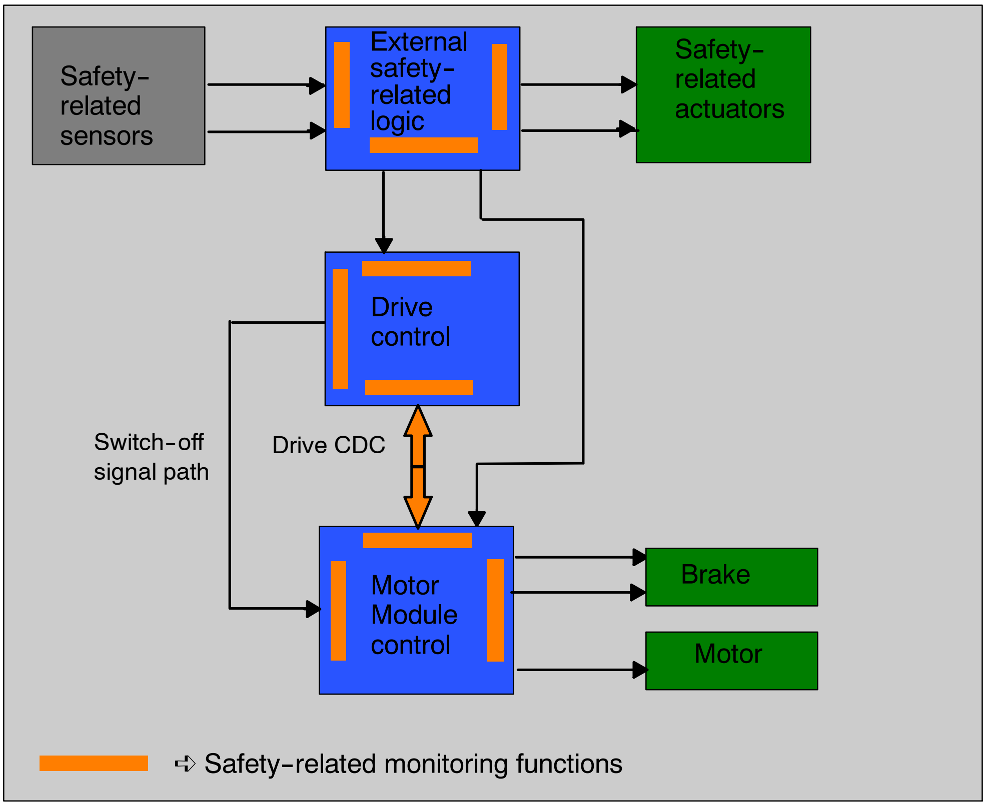


Fig. 2-3 Safety functions integrated in the drive in conjunction with SINUMERIK

Features of the two-channel, diverse structure

A two-channel, diverse structure is characterized by the following features:

- Two-channel structure with at least 2 independent computers (i.e. computers with different hardware and software).
- Crosswise result and data comparison with forced checking procedure for the purpose of detecting internal errors even in functions that are not often used (dormant errors).

Sensing

In order to connect sensors and actuators in a safety-related fashion, their process signals must be connected-in for further processing.

Evaluation

The two drive CPUs independently execute the safety-related functions. The CPUs cyclically and mutually compare their safety-related data and results (crosswise data comparison). A test can be carried out - initiated by the CPUs - to check the shutdown paths and actuators (forced checking procedure).

Respond

When the integrated safety-related functions respond, the drive processors can act on the connected actuators in a safety-related fashion in-line with the actual situation. For example, the appropriate stop responses for the drives can be initiated and/or the brakes activated.

2.3.1 Overview of the safety functions integrated in the drive

The safety-related functions are available in all of the operating modes and can communicate with the process via safety-related input/output signals. These can be implemented individually for each axis.

- **Safe torque off (STO)**
  The drive pulses are cancelled and therefore the energy feed is safely and electronically disconnected
- **Safe Brake Control (SBC)**
  The brake is directly controlled at the Motor Module ➔ through two channels and monitored
- **Safe Stop 1 (SS1)**
  Braking along the OFF3 ramp, monitoring the stopping time and transition into STO

2.4 Comparison of the function names

Function name SINUMERIK Safety Integrated			Function name according to EN 61800-5-2		
German	English	Abbr.	German	English	Abbr.
Sicherer Halt (STOP A)	Safe standstill (STOP A)	SH	Sicher abgeschaltetes Moment	Safe Torque Off	STO
STOP B	STOP B	–	Sicherer Stop 1	Safe Stop 1	SS1
STOP C	STOP C	–	Sicherer Stop 2	Safe Stop 2	SS2
STOP D	STOP D	–	Sicherer Stop 2	Safe Stop 2	SS2
STOP E	STOP E	–	Sicherer Stop 2	Safe Stop 2	SS2
Sicherer Stop 1	Safe Stop 1	SS1	Sicherer Stop 1	Safe Stop 1	SS1
Sichere Überwachung auf Beschleunigung	Safe acceleration monitoring	SBR	–	–	–
Sicherer Betriebshalt	Safe Operating Stop	SBH	Sicherer Betriebshalt	Safe Operating Stop	SOS
Sicher reduzierte Geschwindigkeit	Safely reduced speed	SG	Sicher begrenzte Geschwindigkeit	Safely-limited speed	SLS
SG-spezifische Sollwertbegrenzung	Safely reduced speed - specific setpoint limiting	–	–	–	–
Sichere Software-Endschalter	Safe software limit switch	SE	Sicher begrenzte Lage	Safely-limited position	SLP
Sicheres Bremsenmanagement	Safe Brake Management	SBM	–	–	–
Sichere Bremsenansteuerung	Safe Brake Control	SBC	Sichere Bremsenansteuerung	Safe Brake Control	SBC
Sicherer Bremsentest	Safe Brake Test	SBT	–	–	–
Sichere Software-Nocken bzw. Nockenspur	Safe software cam, safe cam track	SN	Sichere Nocken	Safe cams	SCA
$n < n_x$	$n < n_x$	–	Sichere Drehzahlüberwachung	Safe Speed Monitor	SSM
Sicherheitsgerichtete Ein-/Ausgabesignale	Safety-related I/O	SGE/SGA F-DI/F-DO	–	–	–
Sichere programmierbare Logik	Safe Programmable Logic	SPL	–	–	–
Sicheres Software Relais	Safe software relay	–	–	–	–

3 System Features

3.1 System requirements

- Software option ”SINUMERIK Safety Integrated”

SI-Basic (including 1 axis/spindle, up to 4 SPL I/Os)	6FC5800-0AM63-0YB0
SI-Comfort (including 1 axis/spindle, up to 64 SPL I/Os)	6FC5800-0AM64-0YB0
SI-axis/spindle (in addition for each axis /spindle)	6FC5800-0AC70-0YB0
SI axis/spindle package (in addition, 15 axes/spindles)	6FC5800-0AC60-0YB0

- SINUMERIK 840D sl; software release:
  From 1.3.1 for safety functions integrated in the drive (SH/SBC via terminals, Chapter 4)
  From 1.3.2 for safety functions integrated in the system (Chapters 5 to 7)
- Step7, V5.5

Warning

In a system configuration, the firmware versions of the DRIVE-CLiQ components can only differ from the versions on the CF card, if either

a) the automatic upgrade/downgrade (parameter p7826) is deactivated, or
b) components with a new firmware version can no longer be downgraded to the status of the version available on the CF card.

Case a) is not permitted when Safety Integrated is used. The automatic upgrade/downgrade must never be disabled when Safety Integrated is used. (automatic firmware update (p7826) must be equal to 1)

Case b) is only permissible if this combination has been explicitly approved by the manufacturer.

- SINUMERIK 840D sl; all NCU types can be used
- The measuring circuit cables must comply with the specifications of the SINAMICS S120

- Safety-related devices/modules, that correspond to open-type devices according to UL 50, may only be operated in enclosure-type housings/cabinets that have as a minimum degree of protection IP54 in accordance with EN 60529. Further, chassis units with degree of protection IP20 and IPXXB should be operated corresponding to EN 60529 in higher-level enclosures.
- The state of a deleted/clear safety-related input or output (i.e. the state logical ”0” of an SGE/SGA and electrical ”low” of an associated I/O terminal) or the state of a drive where the pulses are cancelled that can be achieved by the user as well by the fault response of the ”SINUMERIK Safety Integrated” system, is defined as the so-called ”fail-safe state”. This is the reason that the system is only suitable for applications where this state corresponds to the safe state of the process controlled by SINUMERIK Safety Integrated.
- Drives with slip cannot be used for SE and SN.
- SINUMERIK Safety Integrated functions can be used in conjunction with the SINAMICS Booksize and SINAMICS Chassis units.
- For the Safety Integrated function, only the explicitly released encoder systems may be used. A list of the Siemens encoders and motors permissible for Safety Integrated functions can be obtained from your local Siemens contact partner.
- SINUMERIK Safety Integrated can be operated with a maximum of two chassis units.

The following applies specifically for safety functions integrated in the drive:

- The Safety Integrated Extended Functions of SINAMICS cannot be used in conjunction with SINUMERIK.
- SINUMERIK Safety Integrated can be operated with a maximum of 2 chassis units.
- A software option is not required when using the SINAMICS Safety Integrated Basic Functions.

The following specifically applies for fail-safe SIMATIC modules:

- STEP7 F configuration tool (F Configuration Pack) as supplement to STEP7
  This F configuration tool is required so that ET 200 F modules or the DP/AS-i F-Link can be integrated into the HW configuration.
  The F configuration tool can be downloaded from the A&D Service&Support pages under the **Subject F-Configuration-Pack**. Which F configuration tool can be used for which STEP7 version is also specified there.

  http://support.automation.siemens.com/WW/view/en/15208817

  When using ET 200 F modules or DP/AS-i F-Link it should be noted that a version of the F configuration tool should be used that the module already supports.
  Which modules can be configured with which versions that can be downloaded are also specified in the download area.

Note

Only the F-Configuration Pack is necessary to connect fail-safe SIMATIC modules to SINUMERIK. Neither SIMATIC S7 Distributed Safety nor SIMATIC S7 F systems are required.

3.2 Current information

Important note for maintaining the operational safety of your system.

Warning

Systems with safety-related characteristics are subject to special operational safety requirements on the part of the operating company. The supplier is also obliged to maintain certain measures regarding his product. For this reason, we publish a special newsletter containing information on product developments and features that are (or could be) relevant when operating safety-related systems. By subscribing to the appropriate newsletter, you will ensure that you are always up-to-date and able to make changes to your system, when necessary.

Go into the Internet under:

http://automation.siemens.com

To subscribe to the newsletter, please proceed as follows:

1. Select the desired language for the webpage.
2. Click on the menu item "Support".
3. Click on the menu item "Newsletter".

Note

You have to register and log in if you want to subscribe to any newsletters. You will be led automatically through the registration process.

4. Click on "Login" and log in with your access data. If you do not yet have a login and password, select "Yes, I would like to register now".
   You can subscribe to the individual newsletters in the following window.
5. Select the document type you wish to be informed about under "Select document type for topic and product newsletters".
6. Under the "Product Support" heading on this page, you can see which newsletter is currently available.
7. Open the subject area "Safety Engineering - Safety Integrated". You will now be shown which newsletter is available for this particular subject area or topic. You can subscribe to the appropriate newsletter by clicking on the box. If you require more detailed information on the newsletters then please click on this box. A small supplementary window is opened from which you can take the appropriate information.

Your subscription should cover the following product areas:

- SINUMERIK Safety Integrated
- SINAMICS Safety Integrated
- SIMATIC S7-300
- Distributed I/O
- SIMATIC software

3.3 Certification

The safety functions fulfill the requirements according to EN 61508 for use up to and including SIL2 in an operating mode with a high requirement rate and Category 3 as well as PL d acc. to EN ISO 13849-1. The average time up to a hazardous failure $MTTF_d$ and the probability of hazardous failures per hour PFH_d depend on the degree of expansion of the system.

The "Safe brake test" function complies with Category 2 acc. to EN ISO 13849-1.

The test certificates and test mark that have already been issued are listed in the Preface.
The attachments to the test certificates with the certified software and hardware releases are not included in this documentation. If you require the appropriate attachments, then please use the address specified in the corrections/suggestions sheet (last page).

Additional information on the certification (test certification, PRÜFZERT mark) is provided in the Preface.

3.4 Probability of failure

For evaluation of a safety function (PFH value) we provide you, with the Safety Evaluation Tool (SET), a TÜV (German Technical Inspectorate) certified and free online tool. With the help of this tool, safety functions according to IEC 62061 or ISO 13849 can be calculated. As result you will receive a standards-compliant report that can be integrated in the machine documentation as proof of safety.

See: www.siemens.de/safety-integrated

For additional information, please contact your local Siemens office.

3.5 Safety information & instructions and residual risks

Note

There are additional safety information & instructions and residual risks in other chapters, which are listed in the relevant locations in this documentation.

3.5.1 General residual risks for PDS (Power Drive Systems)

Danger

The control and drive components for a Power Drive System (PDS) are certified for use in industrial and commercial applications connected to industrial line supplies. Their use connected to public line supplies requires a different configuration and/or additional measures.

These components may only be operated in closed housings or in higher-level control cabinets and when all of the protective devices and protective covers are used.

These components may only be handled by qualified and trained technical personnel who are knowledgeable and observe all of the safety information and instructions on the components and in the associated technical user documentation.

When carrying out a risk assessment of the machine in accordance with the EC machinery directive, the machine manufacturer must consider the following residual risks associated with the control and drive components of a Power Drive System.

1. Unintentional movements of driven machine components during commissioning, operation, maintenance, and repairs caused by, for example:
   - Hardware defects and/or software errors in the sensors, control, actuators, and connection system
   - Response times of the control and the drive
   - Operating and/or ambient conditions not within the scope of the specification
   - Parameterization, programming, cabling, and installation errors
   - Use of radio devices/cellular phones in the immediate vicinity of the control
   - External influences / damage
2. Exceptional temperatures as well as emissions of light, noise, particles, or gas caused by, for example:
   - Component malfunctions
   - Software errors
   - Operating and/or ambient conditions not within the scope of the specification
   - External influences / damage

Danger

3. Hazardous touch voltages, e.g. as a result of:
   - Component malfunctions
   - Influence of electrostatic charging
   - Induced voltages for moving motors
   - Operating and/or ambient conditions not within the scope of the specification
   - Condensation / conductive contamination
   - External influences / damage
4. Electrical, magnetic, and electromagnetic fields that can pose a risk to people with a pacemaker and/or implants if they are too close.
5. Emission of pollutants if components or packaging are not disposed of properly.

For more information about residual risks, refer to the relevant chapters in the technical user documentation.

3.5.2 Additional safety information & instructions and residual risks for Safety Integrated

Danger

Safety Integrated can be used to minimize the level of risk associated with machines and plants.
Safe operation of the machine or plant with Safety Integrated is however only possible if the machine manufacturer

- Precisely knows and observes this technical user documentation – including the documented limitations, safety information and residual risks.
- Carefully constructs and configures the machine/plant. A careful and thorough acceptance test must then be performed by qualified personnel and the results documented.
- Implements and validates all the measures required in accordance with the machine/plant risk analysis by means of the programmed and configured Safety Integrated functions or by other means.

Depending on the risk assessment of the machine or plant, the safety information & instructions and residual risks listed in this documentation must also be assigned, when required, to a hazardous level other than that specified in this documentation.

The use of Safety Integrated does not replace the risk assessment of the machine or plant to be performed by the machine manufacturer as specified in the EC machinery directive!
In addition to Safety Integrated, further risk reduction measures must be implemented.

As a result of the fault analysis, the machine manufacturer is in a position to define the residual risk at his machine regarding Safety Integrated. The following residual risks are known.

Warning

- Safety Integrated is only activated if all of the system components are powered-up and have been booted.
- Faults in the absolute track (C-D track), cyclically interchanged phases of motor connections (V-W-U instead of U-V-W) and a reversal in the control direction can cause an increase in the spindle speed or axis motion. Category 1 and 2 Stop functions according to EN 60204-1 (defined as Stop B to E in Safety Integrated) that are provided are however not effective due to the fault. Category 0 stop function according to EN 60204-1 (defined as Stop A in Safety Integrated) is not activated until the transition or delay time set via machine data has expired. When SBR is active, these faults are detected (STOP B/C) and the Category 0 stop function according to EN 60204-1 (STOP A in Safety Integrated) is activated as early as possible irrespective of this delay (see Chapter 6.4, "Safe Acceleration Monitoring"). Electrical faults (defective components etc.) can also result in the response described above.
- When incremental encoders are used, the functions "Safe software limit switches" (SE) and "Safe software cams or cam tracks" (SN) can only be used after referencing has been successfully completed.
- When no user agreement has been given (see Chapter 5.4.4, "User agreement"), the safe software limit switches (SE) are not operative; the safe software cams or cam tracks (SN) are operative, but are not safe as defined by Safety Integrated.
- The simultaneous failure of two power transistors (one in the upper and the other offset in the lower inverter bridge) in the inverter may cause the axis to move briefly.
  The maximum movement can be:
  Synchronous rotary motors: Max. movement = 180° / number of pole pairs
  Synchronous linear motors: max. movement = pole width
  Example: Synchronous motor:
  For a 6-pole synchronous motor, the axis can move by a maximum of 30 degrees. With a ballscrew that is directly driven by, e.g. 20 mm per revolution, this corresponds to a maximum linear motion of approximately 1.6 mm.
  Example, synchronous linear motor:
  For a synchronous linear motor, the movement can be a maximum of one pole width. This corresponds to the following distances:

1FN1-07	27 mm
1FN1-12/-18/-24	36 mm
1FN3	20 mm

Warning

- The “Automatic restart“ function of SINAMICS S120 must not be used in conjunction with safety functions since this is prohibited in EN 60204-1, Chapter 9.2.5.4.2. (Deselecting a safety shutdown function alone must not result in machine restarting.)
- For a 1-encoder system, encoder faults are detected by various HW and SW monitoring functions. It is not allowed to disable these monitoring functions and they must be parameterized carefully. Depending on the fault type and which monitor responds, a Category 0 or Category 1 stop function according to EN 60204-1 (defined as STOP A or B in SINUMERIK Safety Integrated) is activated.
- The Category 0 stop function according to EN 60204-1 (defined as STOP A in Safety Integrated) means that the spindles/axes are not braked to zero speed, but coast to a stop (this may take an appropriately long time depending on the level of kinetic energy involved) or can even be accelerated by drawing/pulling loads. This must be included in the protective door locking mechanism logic (e.g. with the logic operation $n<n_x$.
- When a limit value is violated, the speed may exceed the set value briefly or the axis/spindle may overshoot the setpoint position to a greater or lesser degree during the period between error detection and system response. This depends on the dynamic response of the drive and the parameters/machine data settings that have been entered (see Chapter 6, ”System/drive integrated safety functions”).
- A position-controlled axis may be forced out of the safe operating stop state (SBH) by mechanical forces that are greater than the maximum torque of the drive motor. In such cases, a stop function, Category 1 according to EN 60204-1 (STOP B) is activated.
- Safety Integrated is not capable of detecting parameterization and programming errors made by the machine manufacturer. The required safety level can only be reached by by means of an elaborate acceptance test.
- Motor modules and motors must always be replaced with the same equipment type. If this is not the case, the parameters will no longer match the actual configuration - causing Safety Integrated to respond incorrectly. The axis involved must be re-commissioned if an encoder is replaced.
- If an internal or external fault occurs, none or only some of the parameterized safety functions are available during the STOP-F response triggered by the fault. This must be taken into account when parameters are assigned for a delay time between STOP F and STOP B. This applies in particular to vertical axes.
- An additional residual risk is obtained as a result of the possible random hardware faults for electronic systems, arising from their very principle, which is expressed using this PFH value.

Warning

- If, for a 1-encoder system,
  a) a single electrical fault in the encoder
  b) a break of the encoder shaft (or loose encoder shaft coupling), or a loose encoder housing will cause a static state of the encoder signals (that is, they no longer follow a movement while still returning a correct level), and prevent fault detection while the axis is in a stop state (e.g. in SBH). Generally, the axis is held by the active closed-loop control. Especially for vertical (suspended) axes, from a closed-loop control-related perspective, it is conceivable that such an axis could move downwards without this being detected. The risk described under a) of an electrical fault in the encoder is only possible for a few encoder types due to the principle of operation (e.g. encoders with microprocessor-controlled signal generation, e.g. EQI from the Heidenhain company, HEAG 159/160 from the Hübner company, measuring systems from the AMO company with sin/cos output).
  All of the faults described above must be included in the risk analysis of the machine manufacturer. This analysis will indicate that for hanging/vertical axes or loads that drive the motor, additional protective measures are required, e.g. to exclude the fault under a):

  - Use of an encoder with analog signal generation or
  - Use a 2-encoder system

  and to exclude the fault under b):

  - Carry out an FMEA regarding encoder shaft breakage (or the encoder shaft coupling slips) or if the encoder housing becomes loose and apply a fault exclusion process according to e.g. EN 61800-5-2 or
  - Use a 2-encoder system (in this case it is not permissible that the encoders are mounted on same shaft).

  A list of the Siemens encoders and motors permissible for Safety Integrated functions can be obtained from your local SIEMENS contact partner.

Space for your notes

Safety Functions Integrated in the Drive 4

Note

This Chapter describes the safety functions that are integrated in the drive – ”Safe Torque Off” (STO), ”Safe Brake Control” (SBC) and ”Safe Stop 1” (SS1), which are controlled via the drive terminals. The safety functions SH and SBC from the context of the safety-related motion monitoring functions are described in Chapter 6 ”System/drive-integrated safety functions”. The SS1 safety function essentially corresponds there to STOP B. Control via terminals and from the motion monitoring functions is in parallel and can be used independently of one another.

4.1 General information about SINAMICS Safety Integrated

4.1.1 Explanations and terminology

Note

The Control Unit is part of the NCU in general.

Two-channel monitoring structure

All the main hardware and software functions for Safety Integrated are implemented in two independent monitoring channels (e.g. shutdown signal paths, data management, data comparison).

The two drive monitoring channels are implemented using the following components:

- via the Control Unit
- via the Motor Module/Power Module belonging to a drive

The monitoring functions in each monitoring channel work on the principle that a defined status must prevail before each action is carried out and a specific feedback signal provided after each action.

If this expected response in a monitoring channel is not fulfilled, the drive coasts to a standstill (two channel) and an appropriate message is output.

Switch-off signal paths

There are two independent shutdown paths. All switch-off signal paths are low active This ensures that the system is always switched to a safe status if a component fails or in the event of cable breakage.

If a fault is discovered in the shutdown paths, the "Safe Torque Off" function is activated and a system restart inhibited.

Monitoring cycle

The safety-relevant drive functions are executed cyclically in the monitoring clock cycle.

The safety monitoring clock cycle is a minimum of 4 ms. Increasing the current controller cycle (p0110[0]) also increases the safety monitoring clock cycle.

Crosswise data comparison

A cyclic crosswise comparison of the safety-related data in the two monitoring channels is carried out.

If any data are inconsistent, a stop response is triggered with any Safety function.

Overview of parameters (see SINAMICS S120/S150 List Manual)

- r9780 SI Monitoring clock cycle (Control Unit)
- r9880 SI monitoring clock cycle (Motor Module)

Comparison of function names

Table 4-1 Comparison of safety function names, SINUMERIK <–> SINAMICS

SINUMERIK		SINAMICS (acc. to EN 61800-5-2)	
Abbreviation	Name	New abbreviation	New name
SH	Safe standstill	STO	Safe Torque Off
SGA	Safety-related output	F-DO	Failsafe Digital Output
SGE	Safety-related input	F-DI	Failsafe Digital Input

4.1.2 Supported functions

The following Safety Integrated functions (SI functions) are available:

- Safety Integrated Basic Functions

  These functions are part of the standard scope of the drive.

  - Safe torque off (STO)
    STO is a safety function that prevents the drive from restarting unexpectedly, in accordance with EN 60204-1, Section 5.4.
  - Safe Stop 1 (SS1, time controlled)
    The SS1 function is based on the "Safe Torque Off" function. This means that a Category 1 stop in accordance with EN 60204-1 can be implemented.
  - Safe Brake Control (SBC)
    The SBC function permits the safe control of a holding brake.
    SBC is supported by Power/Motor Modules in a chassis format only with order number ...3 or higher

4.1.3 Parameter, checksum, version, password

Properties of Safety Integrated parameters

The following applies to Safety Integrated parameters:

- They are kept separate for each monitoring channel.
- At power up, a checksum (Cyclic Redundancy Check, CRC) over the Safety parameters is generated and checked. The display parameters are not contained in the CRC.
- Data management: The parameters are stored on the non-volatile CompactFlash card.
- Factory settings for safety parameters

You can only reset the safety parameters to the factory setting on a drive-specific basis using p0970 or p3900 when the safety functions are not enabled (p9601 = p9801 = 0).

All the factory settings can be restored (p0976 = 1 and p0009 = 30 on the Control Unit) even when the safety functions are enabled (p9601 = p9801 ≠ 0).

- They are password-protected against accidental or unauthorized changes.

Notice

The following safety parameters are not protected by the safety password:

- p9370 SI Motion acceptance test mode (Motor Module)
- p9570 SI Motion acceptance test mode (Control Unit)

Checking the checksum

For each monitoring channel, the safety parameters include one parameter for the actual checksum for the safety parameters that have undergone a checksum check.

During commissioning, the actual checksum must be transferred in the corresponding parameters of the specified reference checksum. This can be done for all checksums of a drive object at the same time with parameter p9701.

Basic functions

- r9798 SI actual checksum SI parameters (Control Unit)
- p9799 SI reference checksum SI parameters (Control Unit)
- r9898 SI actual checksum SI parameters (Motor Module)
- p9899 SI reference checksum SI parameters (Motor Module)

During each ramp-up procedure, the actual checksum is calculated via the safety parameters and then compared with the setpoint checksum.

If the actual and specified reference checksums are different, fault F01650 or F30650 is output and an acceptance test requested.

Safety Integrated versions

The safety software versions on the Control Units and on the Motor Modules have their own version ID.

For the basic functions:

- r9770 SI version, safety functions integrated in the drive (Control Unit)
- r9870 SI version (Motor Module)

Warning

In a system configuration, the firmware versions of the DRIVE-CLiQ components can only differ from the versions on the CF card, if either

a) the automatic upgrade/downgrade (parameter p7826) is deactivated, or
b) components with a new firmware version can no longer be downgraded to the status of the version available on the CF card.

Case a) is not permitted when Safety Integrated is used. The automatic upgrade/downgrade must never be disabled when Safety Integrated is used. (automatic firmware update (p7826) must be equal to 1)

Case b) is only permissible if this combination has been explicitly approved by the manufacturer.

http://support.automation.siemens.com/WW/view/en/28554461

Password

Note

A password allocation is not relevant in the SINUMERIK environment. It is only used in conjunction with Starter (commissioning tool used for SINAMICS).

The safety password protects the safety parameters against unauthorized write access.

In the commissioning mode for Safety Integrated (p0010 = 95), you cannot change safety parameters until you have entered the valid safety password in p9761 for the drives.

- When Safety Integrated is commissioned for the first time, the following applies:
  - Safety password = 0
  - Default setting for p9761 = 0

  This means that:
  The safety password does not need to be set during initial commissioning.
- In the case of a series commissioning of Safety or if a spare part is replaced, the following applies:
  - The Safety password remains on the memory card
  - A Safety password is not required if a part is replaced
- Changing the password for the drives
  - p0010 = 95 commissioning mode (refer to Chapter 4.7 ”Commissioning the functions STO, SBC and SS1”)
  - p9761 = Enter ”old safety password”

- p9762 = Enter ”new password”
- p9763 = Confirm ”new password”
- The new and confirmed safety password is valid immediately.

If you need to change safety parameters but you do not know the safety password, proceed as follows:

1. Restore the factory setting of the complete drive unit (Control Unit with all connected drives/components).
2. Recommission the drive unit and drives
3. Recommission Safety Integrated

Or contact your regional Siemens office and ask for the password to be deleted (complete drive project must be made available).

Parameter overview (see Chapter 8.2.2 ”Description of the parameters”)

- p9761 enter SI password
- p9762 new SI password
- p9763 confirm SI password

4.1.4 Forced checking procedure

Forced checking procedure and test of the shutdown paths

The forced checking procedure of the shutdown paths is used to detect software/ hardware faults at both monitoring channels in time and is automated by means of activation/deactivation of the ”Safe Torque Off” function.

To fulfill the requirements of ISO 13849-1:2006 regarding timely error detection, the two switch-off signal paths must be tested at least once within a defined time to ensure that they are functioning properly. This must be realized using the manual or process-automated trigger of the forced checking procedure.

A timer ensures that forced dormant error detection is carried out as quickly as possible.

- p9659 SI timer for the forced checking procedure

The forced checking procedure of the shutdown paths must be carried out at least once during the time set in this parameter.

Once this time has elapsed, an alarm is output and remains present until forced dormant error detection is carried out.

The timer returns to the set value each time the STO function is deactivated.

When the appropriate safety devices are implemented (e.g. protective doors), it can be assumed that running machinery will not pose any risk to personnel. For this reason, an alarm is only output to inform the user that a forced dormant error detection run is due and to request that this be carried out at the next available opportunity. This alarm does not affect machine operation.

The user must set the time interval for carrying out the forced checking procedure to between 0.00 and 9000.00 hours depending on the components used and the application (factory setting: 8.00 hours).

The 9000 hours are only applicable for STO, SBC, SS1 functions that are integrated in the drive and controlled via local terminals.

When using the safety-related motion monitoring functions according to Chapter 6, the value should be set to 9000 hours so that the alarm to carry out the forced checking procedure is no longer output. After carrying out the forced checking procedure from STO, the forced checking procedure timer is also re-started by the motion monitoring functions.

Examples of when to carry out forced dormant error detection:

- When the drives are at a standstill after the system has been switched on.
- When the protective door is opened.
- In defined cycles (e.g. every 8 hours).
- In the automatic mode (time and event dependent).

4.2 Safety information

Safety notices

Warning

After changing or replacing hardware and/or software components, it is only permissible to power up the system and activate the drives after the protective equipment has been closed. Personnel must not be present in the danger zone.

Depending on the change made or what has been replaced, it may be necessary to carry-out a partial or complete acceptance test (see Chapter 4.8 "Acceptance test").

Before allowing anybody to re-enter the danger zone, you should test steady control response by briefly moving the drives in forward and reverse direction (+/-).

At power on, observe the following:

The safety functions are only available and can only be activated after the system has completely booted (powered-up).

Warning

The Category 0 stop function according to EN 60204-1 (defined as STO in Safety Integrated) means that the drives are not braked to zero speed, but coast to a stop (this may take some time depending on the level of kinetic energy involved). This must be included in the protective door locking mechanism logic, e.g. with the logic operation $n<n_x$.

Warning

Safety Integrated is not capable of detecting parameterization errors made by the machine manufacturer. The required level of safety can only be assured by thorough and careful acceptance testing.

Warning

The automatic firmware update via p7826 = 1 (upgrade and downgrade) must never be deactivated under any circumstances when using Safety Integrated.

Warning

If two power transistors in the power unit fail at the same time (one in the upper bridge and one in the lower bridge of the inverter), this can cause brief, limited movement.

The maximum movement can be:

- Synchronous rotary motors: Max. movement = 180° / number of pole pairs
- Synchronous linear motors: max. movement = pole width

Caution

The "automatic restart" function may not be used together with the safety functions STO/SBC and SS1. The reason for this is that EN 60204-1 Chapter 9.2.5.4.2 does not permit this (merely de-selecting a safety shutdown function must not cause the machine to restart).

4.3 Safe Torque Off (STO)

In conjunction with a machine function or in the event of a fault, the "Safe Torque Off (STO)" function is used to safely disconnect the torque-generating power feed to the motor.

When the function is selected, the drive unit is in a "safe state". The switching on inhibit function prevents the drive unit from being restarted.

The two-channel pulse cancellation function integrated in the Motor Modules / Power Modules is a basis for this function.

Functional features of Safe Torque Off

- This function is integrated in the drive, i.e. a higher-level control is not required.
- The function is drive specific. This means that each drive has the function and it must be individually commissioned.
- The function must be enabled via parameter.
- When the Safe Torque Off function is selected, the following applies:
  - The motor cannot be started accidentally.
  - The pulse suppression safely disconnects the torque-generating energy feed to the motor.
  - The power unit and motor are not electrically isolated.
- The signals of the components connected at the terminals (e.g. pushbuttons, switches, ...) can be debounced in order to prevent false tripping due to signal disturbances. The filter times are set using parameters p9651 and p9851.

Warning

Appropriate measures must be taken to ensure that the motor does not move once the motor power supply has been disconnected ("coast down") (e.g. enable the "Safe brake control" function for a vertical axis).

Warning

If two power transistors in the Motor Module fail at the same time (one in the upper and one in the lower bridge of the inverter), this can cause brief, limited movement.

The maximum movement can be:

- Synchronous rotary motors: Max. movement = 180° / number of pole pairs
- Synchronous linear motors: max. movement = pole width

- The status of the Safe Torque Off function is displayed using parameters.

Enabling the Safe Torque Off function

The Safe Torque Off function is enabled via the following parameters:

- STO via terminals:
  - p9601.0 = 1, p9801.0 = 1

Selecting/deselecting Safe Torque Off

Safe Torque Off is selected as follows:

- Each monitoring channel triggers safe pulse suppression via its switch-off signal path.
- A motor holding brake is closed (if connected and configured).

Deselecting Safe Torque Off represents an internal safety acknowledgement.
The following processes occur:

- Each monitoring channel cancels safe pulse suppression via its switch-off signal path.
- The safety prompt ”Close motor holding brake” is canceled.
- Any pending STOP F or STOP A commands are canceled (see r9772 / r9872).
- The cause of the fault must be removed.
- The messages in the fault memory also need to be reset using the general acknowledgment mechanism.

Note

If Safe Torque Off is de-selected and selected again through one channel within the time in p9650/p9850, the pulses are canceled but a signal is not output.

If you want a message to be displayed in this case, N001620/N30620 must be reconfigured to be either an alarm or fault using p2118 and p2119.

Restart after the Safe Torque Off function has been selected

1. Deselect the function in each monitoring channel via the input terminals.
2. Issue drive enable signals.
3. Revoke ”closing lockout” and switch the drive back on.
   - 1/0 edge at input signal ”ON/OFF1” (cancel switch-on inhibit)
   - 0/1pulse edge at input signal ”ON/OFF1” (switch on drive)
4. Run the drives again.

Status for Safe Torque Off

The status of the Safe Torque Off (STO) function is displayed using the parameters r9772, r9872, r9773 and r9774:

As an alternative, the status of the function can be displayed using the configurable messages N01620 and N30620 (configured using p2118 and p2119).

Response times for the Safe Torque Off function

The following values can be specified for the response times when the function is selected/deselected via the input terminals:

- Typical response time
  2 x safety monitoring clock cycle CU (r9780) + input/output time sampling time (p0799)
- Maximum response time that can occur when a fault develops:
  4 x safety monitoring clock cycle CU (r9780) + input/output time sampling time (p0799)

Examples, booksize

Assumption
Safety monitoring clock cycle CU (r9780) = 4 ms and
Inputs/outputs sampling time (r0799) = 4 ms

t_{R_type} = 2x r9780 (4 ms) + r0799 (4 ms) = 12 ms
t_{R_max} = 4x r9780 (4 ms) + r0799 (4 ms) = 20 ms

Parameter overview (see Chapter 8.2.1 ”Overview of parameters”)

- p0799 ”CU inputs/outputs, sampling time”
- r9780 ”SI monitoring clock cycle (Control Unit)”
- r9880 ”SI monitoring clock cycle (Motor Module)”

Internal armature short-circuit with the Safe Torque Off function

The function ”internal armature short-circuit” can be configured together with the ”STO” function. However, only one of the two functions can be selected, as an OFF2 is also always triggered when STO is selected. This OFF2 disables the function ”Internal armature short-circuit”.

When simultaneously selected, the STO safety function has the priority. If the STO function is initiated, then an activated internal armature short-circuit is disabled.

4.4 Safe Stop 1 (SS1, time controlled)

General description

With function Safe Stop 1 (SS1), stopping according to EN 60204-1: 2006, Stop Category 1 can be implemented. After ”Safe Stop 1” has been selected, the drive brakes with the OFF3 ramp (p1135), and after the delay time set in p9652/p9852, changes to the status Safe Torque Off (STO).

Caution

Once the SS1 (time-controlled) function has been selected by parameterizing a delay in p9652/p9852, STO can no longer be selected directly via the terminals.

Functional features of Safe Stop 1

SS1 is enabled when p9652 and p9852 (delay time) are not equal to ”0”.

- The function can be selected only in conjunction with Safe Torque Off.
- When SS1 is selected, the drive is braked along the OFF3 ramp (p1135) and STO/SBC are automatically initiated after the delay time (p9652/p9852) has expired.

  After the function has been selected, the delay timer runs down - even if the function is deselected during this time. In this case, after the delay time has expired, the STO/SBC function is selected and then again de-selected immediately.

Note

So that the drive is able to travel down the OFF3 ramp completely and any motor holding brake present can be applied before the pulse is switched off, the delay time can be set as follows:

- Motor holding brake parameterized: Delay time $\geq$ p1135 + p1228 + p1217
- Motor holding brake not parameterized: Delay time $\geq$ p1135 + p1228

- The selection is realized through two channels – however braking along the OFF3 ramp, only through one channel.
- The signals of the components connected at the terminals (e.g. pushbuttons, switches, ...) can be debounced in order to prevent false tripping due to signal disturbances. The filter times are set using parameters p9651 and p9851.

Enabling the SS1 function

The function is enabled using the following parameters:

- SS1 via terminals:
  - By entering the delay time in p9652 and p9852,

Prerequisite

The Safe Torque Off function must be enabled.

In order that the drive can brake down to a standstill even when selected through one channel, the time in p9652/p9852 must be shorter than the sum of the parameters for the crosswise data comparison (p9650/p9850 and p9658/p9858).

The time in p9652/p9852 must be dimensioned so that after selection, the drive brakes down to a standstill.

Status for Safe Stop 1

The status of the Safe Stop 1 function is displayed using parameters r9772, r9872, r9773 and r9774.

Alternatively, the status of the functions can be displayed using the configurable messages N01621 and N30621 (configured using p2118 and p2119).

Overview, important parameters (see Chapter8.2.2 ”Description of parameters”)

- p1135[0...n] OFF3 ramp-down time
- p9652 SI Safe Stop 1 delay time (Control Unit)
- p9852 SI Safe Stop 1 delay time (Motor Module)
- r9772 SI status (Control Unit)
- r9773 SI status (Control Unit + MotorModule)
- r9774 SI status (group STO) / SI stat group STO
- r9872 SI status (MotorModule)

Response time for the Safe Stop 1 function (SS1)

The following values can be specified for the selection (up until braking is initiated):

- Typical response time
  2x safety monitoring clock cycle CU (r9780) + inputs/outputs, sampling time (p0799) + 2 ms
- Maximum response time that can occur when a fault develops
  4x safety monitoring clock cycle CU (r9780) + inputs/outputs, sampling time (p0799) + 2 ms

4.5 Safe Brake Control (SBC)

Description

Safe Brake Control is used to control actuators that function according to the closed-circuit principle (e.g. brake).

The command for releasing or applying the brake is transmitted to the Motor Module/Power Module via DRIVE-CLiQ. The Motor Module then carries out the action and activates the outputs for the brake.

Brake activation via the brake connection on the Motor Module is carried out using a safe, two-channel method.

Note

This function is only supported by chassis components that can be identified by the MLFB ending ...xxx3.

Warning

The Safe Brake Control function does not detect faults in the brake itself - such as e.g. brake winding short-circuit, worn brakes and similar.

If a cable breaks, this is only recognized by the Safe Brake Control function when the status changes, i.e. when the brake is applied/released.

Functional features of Safe Brake Control (SBC)

- When Safe Torque Off is selected or when safety monitoring functions respond, SBC is performed with safe pulse cancelation.
- Unlike conventional brake control, SBC is executed via p1215 through two channels.
- SBC is initiated independently of the brake control mode set in p1215. However, SBC is not recommended for p1215 = 0 or 3.
- The function must be enabled via parameter.
- Each time Safe Torque Off is selected, the holding brake is applied immediately and a forced checking procedure carried out.
- When the state changes, electrical faults, such as e.g. a short-circuit in the brake winding or wire breakage can be detected.
- The signals of the components connected at the terminals (e.g. pushbuttons, switches, ...) can be debounced in order to prevent false tripping due to signal disturbances. The filter times are set using parameters p9651 and p9851.

Enabling the Safe Brake Control (SBC) function

The Safe Brake Control function is enabled via the following parameters:

- p9602 "SI enable Safe Brake Control (Control Unit)"
- p9802 "SI enable Safe Brake Control (Motor Module)"

The Safe Brake Control function is only selected if at least one safety monitoring function is enabled (i.e. p9601 = p9801 $\neq$ 0).

Two-channel brake control

The brake is controlled from the Control Unit. Two signal paths are available for applying the brake.

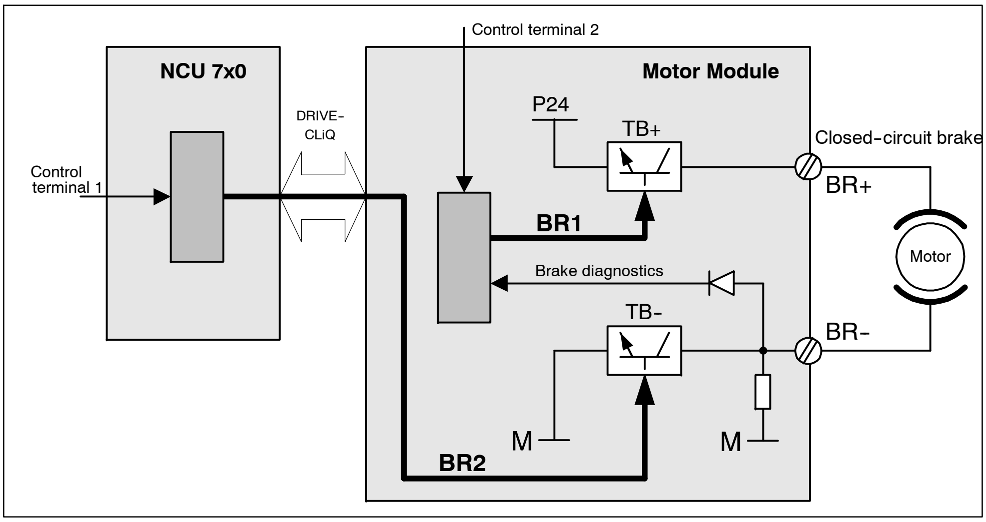


Fig. 4-1 Two-channel brake control, booksize

The Motor Module carries out a check to ensure that the Safe Brake Control function is working properly and ensures that, if the Control Unit fails or is faulty, the brake current is interrupted and the brake applied.

The brake diagnosis can only reliably detect a malfunction in either of the switches (TB+, TB-) when the status changes (when the brake is released or applied).

If the Motor Module or Control Unit detects a fault, the brake current is switched off and the safe status is reached.

Safe Brake Control for Motor Modules in the

Chassis format

To be able to control the high rating brakes used with devices of this format, an additional Safe Brake Adapter (SBA) module is needed. You can find more information on the connection and wiring of the Safe Brake Adapter in the Equipment Manual.

Parameters p9621/p9821 are used to define which digital input the Safe Brake Adapter's feedback (brake released or applied) is channeled to the Control Unit or the Motor Module.

The additional functionality and the control of the brake, in other words, reaching a safe state, are in this case essentially the same as the sequence for booksize units.

Response time with the Safe Brake Control function

The following values can be specified for the response times when the function is selected/deselected via input terminals:

- Typical response time
  4x safety monitoring clock cycle CU (r9780) + inputs/outputs, sampling time (p0799)
- Maximum response time that can occur when a fault develops
  8x safety monitoring clock cycle CU (r9780) + inputs/outputs, sampling time (p0799)

Example:

Assumption
Safety monitoring clock cycle CU (r9780) = 4 ms and
Inputs/outputs sampling time (r0799) = 4 ms

t_{R_type} = 4x r9780 (4 ms) + r0799 (4 ms) = 20 ms
t_{R_max} = 8x r9780 (4 ms) + r0799 (4 ms) = 36 ms

Parameter overview (see Chapter 8.2.1 "Overview of parameters")

- p0799 CU inputs/outputs sampling time
- p9621 BI: SI signal source for SBA (Control Unit)
- r9780 SI monitoring clock cycle (Control Unit)
- p9821 BI: SI signal source for SBA (Motor Module)
- r9880 SI monitoring clock cycle (Motor Module)

4.6 Control via terminals on the Control Unit and the power unit

Characteristics

- Only for the STO, SS1 (time-controlled) and SBC functions
- Two-channel structure via two digital inputs (Control Unit/power unit)
- The signals of the components connected at the terminals (pushbuttons, switches, ...) can be debounced in order to prevent false tripping due to signal disturbances or non-symmetrical test signals. The filter times are set using parameters p9651 and p9851.
- Different terminal strips depending on design

Terminals for STO, SS1 (time-controlled), SBC

The functions are separately selected/deselected for each drive using two terminals.

- 1. Switch-off signal path, Control Unit
  The required input terminal for Safe Torque Off (STO) is selected via the BICO interconnection (BI: p9620[0]).
  Digital input DI 0 ... DI 7 on the Control Unit can be used as a signal source (NCU). NX modules have DI 0 to DI 3.
- 2. Motor Module shutdown path
  The input terminal is the "EP" ("Enable Pulses") terminal.
  The EP terminal is periodically interrogated with a sampling time, which is rounded off to an integer multiple of the current controller cycle; however, it is a minimum of 1 ms.
  (Example: t_i = 400 µs, t_{EP} => 3x, t_i = 1.2 ms)

Both terminals must be operated simultaneously, otherwise a fault will be issued.

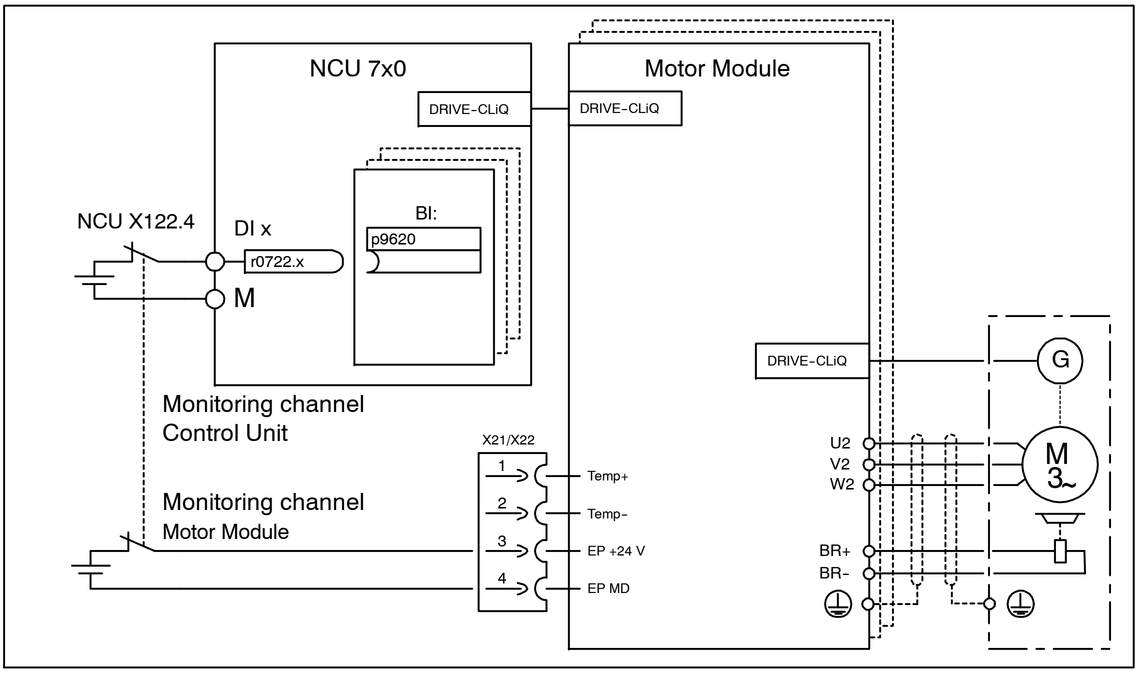


Fig. 4-2 Terminals for ”Safe Torque Off”: example for Motor Modules Booksize and NCU7x0

Grouping drives

To ensure that the function works for more than one drive at the same time, the terminals for the corresponding drives must be grouped together as follows:

- 1. Switch-off signal path, Control Unit
  By connecting the binector input to the joint input terminal on the drives in one group.
- 2. Motor Module shutdown path
  By appropriately connecting terminal ”EP” for the individual Motor Modules belonging to a group.

Note

The grouping must be identical in both monitoring channels.

If a fault in a drive results in a Safe Torque Off (STO), this does not automatically mean that the other drives in the same group also switch to Safe Torque Off (STO).

The assignment is checked while testing the shutdown paths. The operator selects Safe Torque Off for each group. The check is drive-specific.

Example: Grouping the terminals

It must be possible to select/deselect the Safe Torque Off function separately for group 1 (drive 1 and 2) and group 2 (drive 3 and 4).

For this purpose, the same grouping for Safe Torque Off must be performed on both the Control Unit and the Motor Modules.

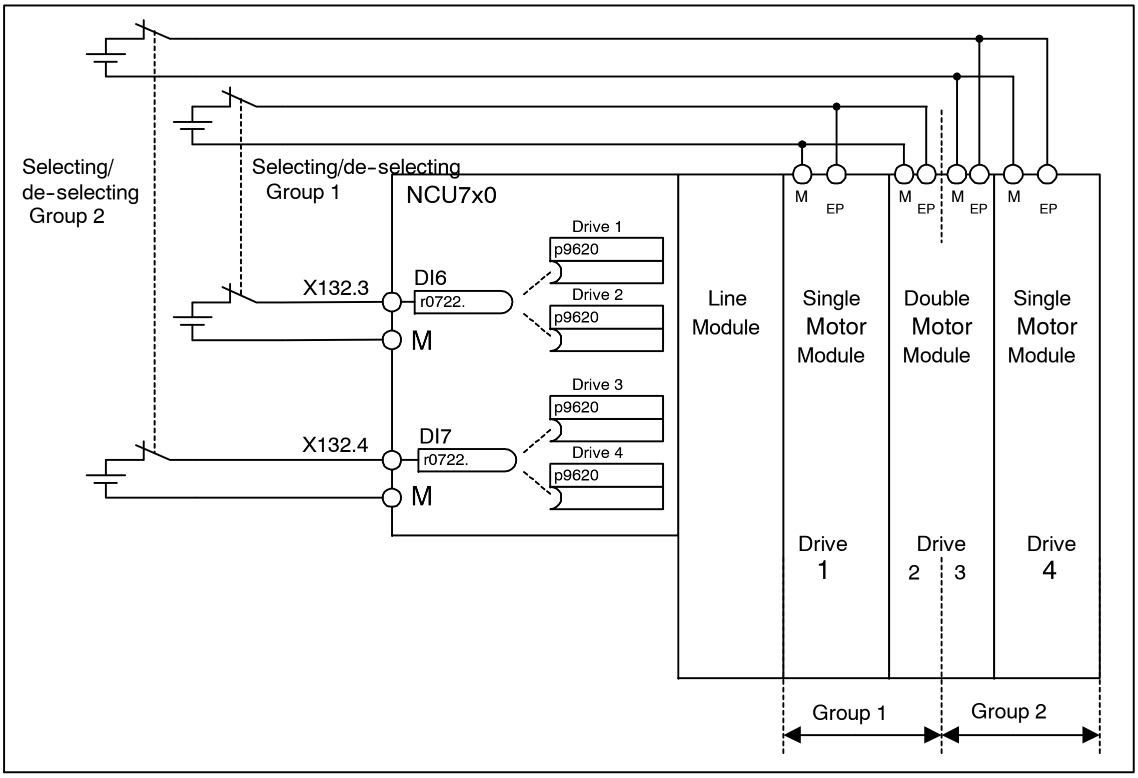


Fig. 4-3 Example: Grouping the terminals for Motor Modules, booksize format

Simultaneity and tolerance time of the two monitoring channels

The functions must be selected/deselected simultaneously in both monitoring channels using the input terminals and act only on the associated drive.

1 signal: Deselection of the function

0 signal: Selection of the function

”Simultaneously” means:

The changeover must be completed in both monitoring channels within the parameterized tolerance time.

- p9650 SI SGE changeover tolerance time (Control Unit)
- p9850 SI SGE changeover tolerance time (Motor Module)

Note

To avoid incorrect triggering of fault messages, at these outputs the tolerance time must always be set smaller than the shortest time between two switching events (ON/OFF, OFF/ON).

If the Safe Torque Off function is not selected/deselected within the tolerance time, this is detected by the crosswise data comparison, and fault F01611 or F30611 (STOP F) is output. In this case, the pulses have already been canceled as a result of the selection of Safe Torque Off in one channel.

4.6.1 Bit pattern test

Bit pattern test of fail-safe outputs

The inverter normally responds immediately to signal changes at its fail-safe inputs. This is not desirable in the following case: Several control modules test their fail-safe outputs using bit pattern tests (on/off tests) to identify faults due to either short or cross circuits. When you interconnect a fail-safe input of the converter with a fail-safe output of a control module, the converter responds to these test signals.

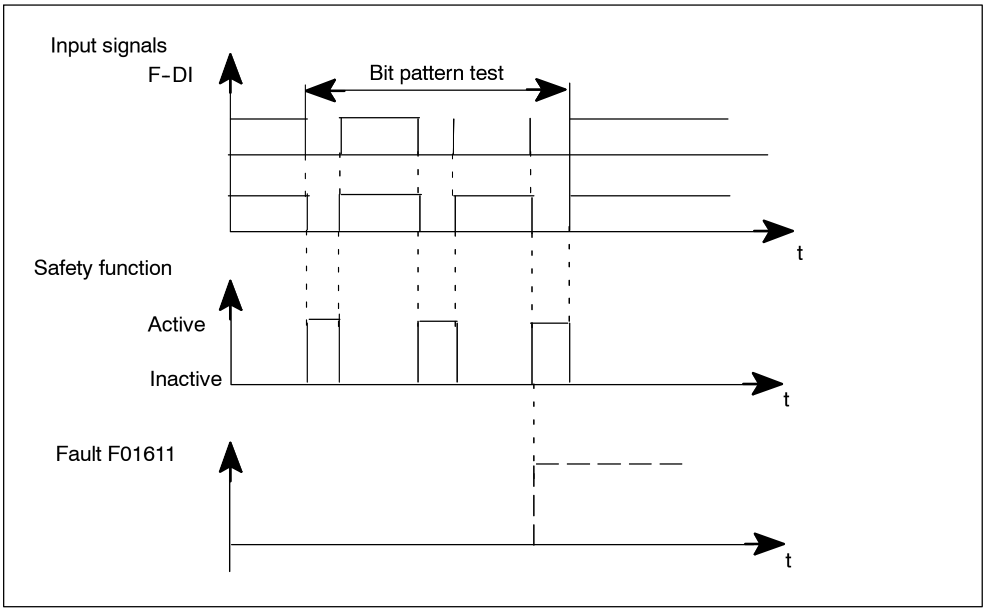


Fig. 4-4 Converter response to a bit pattern test

Note

If the test pulses lead to unintended triggering of the Safety Integrated functions, a filtering (p9651/p9851 SI STO/SBC/SS1 debounce time) of the terminal inputs must be parameterized.

Overview of important parameters (see SINAMICS S120/S150 List Manual)

- p9651 SI STO/SBC/SS1 debounce time (Control Unit)
- p9851 SI STO/SBC/SS1 debounce time (Motor Module)

4.7 Commissioning the STO, SBC and SS1 functions

4.7.1 General information about commissioning safety functions

Note

- The ”STO”, ”SBC” and ”SS1” functions are drive specific, which means that the functions must be commissioned individually for each drive.
- To support the ”STO” and ”SBC” functions, the following (minimum) safety versions are required:

  Control Unit: V02.01.01 (r9770[0...2])

  Motor Module: V02.01.01 (r9870[0...2])
- To support the SS1 function, the following (minimum) safety version is required:

  Control Unit: V02.04.01 (r9770[0...2])

  Motor Module: V02.04.01 (r9870[0...2])
- If the version in the Motor Module is incompatible, the Control Unit responds as follows during the switchover to safety commissioning mode (p0010 = 95):
  - Fault F01655 (SI CU: Align the monitoring functions) is output. The fault initiates stop response OFF2.

    The fault cannot be acknowledged until the safety commissioning mode (p0010 $\neq$ 95) is exited.
  - The Control Unit triggers a safe pulse suppression via its own safety switch-off signal path.
  - If parameterized (p1215), the brake is closed.
  - The Safety functions cannot be enabled (p9601/p9801 and p9602/p9802).

Prerequisites for commissioning the safety functions

1. Commissioning of the drives must be completed.
2. The non safety-related pulse cancellation must be present, e.g. via OFF1 = ”0” or OFF2 = ”0”

   If a brake is connected and has been parameterized, then the brake is closed.
3. The terminals for ”Safe Torque Off” must be connected up.
   - Control Unit: Digital input DI 0 ... DI 7 (NCU)
     Digital input DI 0 ... DI 3 (NX)
   - Motor Module: Terminal ”EP”
4. For operation with SBC, the following applies:

   A brake must be connected to the appropriate Motor Module connector.

Standard commissioning of the safety functions

1. A drive archive can be transferred to another drive unit, keeping the safety parameterization.
2. If the source and target devices have different firmware versions, it may be necessary to adapt the reference checksums (p9799, p9899). This is indicated by the faults F01650 (fault value: 1000) and F30650 (fault value: 1000).
3. Once the project has been downloaded to the target device, an acceptance must be carried out. This is indicated by fault F01650 (fault value: 2005).

Notice

Once a project has been downloaded, it must be stored on the non–volatile memory card (copy from RAM to ROM).

Replacement of Motor Modules with later firmware version

1. After a Motor Module fails, a more recent firmware version can be installed on the new Motor Module.
2. If the old and new devices have different firmware versions, it may be necessary to adjust the reference checksums (p9899) (see following table). This is indicated by fault F30650 (fault value: 1000).

For 840D sl, checksums can be confirmed at the HMI in the ”Commissioning” operating area using the softkey ”Confirm SI data” followed by power on. The data must be saved before power on.

Table 4-2 Adapting the reference checksum (p9899)

No.	Parameters	Description/comments
1	p0010 = 95	Sets the Safety Integrated commissioning mode
2	p9899 = ”r9898”	Adapt the reference checksum on the Motor Module
3	p0010 = Value not equal to 95	Exit Safety Integrated commissioning mode
4	POWER ON	Execute POWER ON

4.7.2 Sequence when commissioning STO, SBC and SS1

In the SINUMERIK environment, commissioning can be simplified by using the softkeys ”Activate drive commissioning” and ”Deactivate drive commissioning”.

With ”Activate drive commissioning”, p0010 is set to 95; the required functions can then be enabled and the settings entered (also refer to Table 4-3 ”Commissioning STO, SBC and SS1, Steps 3 to 9).

With ”Deactivate drive commissioning” the checksums (p9799 = r9798, p9899 = r9898) are set to the same value and p0010 is set to 0.

To commission the STO, SBC and SS1 functions, carry out the following steps:

Table 4-3 Commissioning the ”STO”, ”SBC” and ”SS1” functions

No.	Parameters	Description/comments
1	p0010 = 95	**Sets the Safety Integrated commissioning mode** • The following alarms and faults are output: – A01698 (SI CU: Commissioning mode active) During first commissioning only: – F01650 (SI CU: acceptance test required) with fault value = 130 (no Safety parameters exist for the Motor Module). – F30650 (SI MM: acceptance test required) with fault value = 130 (no Safety parameters exist for the Motor Module). For information on the acceptance test and acceptance report, see step 15. • The pulses are safely canceled and monitored by the Control Unit and Motor Module. • The safety sign of life is monitored by the Control Unit and Motor Module. • The function for exchanging stop responses between the Control Unit and Motor Module is active. • An existing and parameterized brake has already been closed. • In this mode, fault F01650 or F30650 with fault value = 2003 is output after a Safety parameter is changed for the first time. This behavior applies for the entire duration of safety commissioning, which means that the STO function cannot be selected/deselected while safety commissioning mode is active because this would constantly force safe pulse cancellation.
2	p9761 = ”Value”	**Sets the safety password** When Safety Integrated is commissioned for the first time, the following applies: • Safety password = 0 • Default setting for p9761 = 0 This means that the safety password does not need to be set during initial commissioning.

Table 4-3 Commissioning the "STO", "SBC" and "SS1" functions, continued

No.	Parameters	Description/comments
3	 p9601.0 p9801.0	**Enable Safe Torque Off function** STO via Control Unit terminals STO via Motor Module terminals • The parameters are not changed until safety commissioning mode has been exited (i.e. when p0010 ≠ 95 is set). • Both parameters are included in the data cross-check and must, therefore, be identical.
4	 p9602 = 1 p9802 = 1	**Enables the safe brake control function** Enables SBC on the Control Unit Enables SBC on the Motor Module • The parameters are not changed until safety commissioning mode has been exited (i.e. when p0010 ≠ 95 is set). • Both parameters are included in the data cross-check and must, therefore, be identical. • The safe brake control function only becomes active if at least one safety monitoring function is enabled (i.e. p9601 = p9801 ≠ 0).
5	 p9652 > 0 p9852 > 0	**Enable Safe Stop 1 function** Enable SS1 on the Control Unit Enable SS1 on the Motor Module • The parameters are not changed until safety commissioning mode has been exited (i.e. when p0010 ≠ 95 is set). • Both parameters are included in the data cross-check and must, therefore, be identical. • The Safe Stop 1 function only becomes active if at least one safety monitoring function is enabled (i.e. p9601 = p9801 ≠ 0).
6	 p9620 = "Value" Terminal "EP"	**Set terminals for Safe Torque Off (STO)** Set the signal source for STO on the Control Unit Wire terminal "EP" (enable pulses) on the Motor Module. • Control Unit monitoring channel: By appropriately interconnecting BI: p9620 for the individual drives, the following is possible: – Selecting/deselecting STO – Grouping the terminals for STO Digital input DI 0 ... DI 7 on the Control Unit can be used as a signal source (NCU). DI 0 ... DI 3 (NX). • Motor Module monitoring channel: By wiring the "EP" terminal accordingly on the individual Motor Modules, the following is possible: – Selecting/deselecting STO – Grouping the terminals for STO **Note:** The STO terminals must be grouped identically in both monitoring channels.

Table 4-3 Commissioning the ”STO”, ”SBC” and ”SS1” functions, continued

No.	Parameters	Description/comments
7	p9651 = ”Value” p9851 = ”Value”	**Set the filter time for the STO terminals** Parameterize the filter time for the STO terminals p9651/p9851 as necessary.
8	 p9650 = ”Value” p9850 = ”Value”	**Set F-DI changeover tolerance time** F-DI changeover tolerance time on Control Unit F-DI changeover tolerance time on Motor Module • The parameters are not changed until safety commissioning mode has been exited (i.e. when p0010 ≠ 95 is set). • Due to the different runtimes in the two monitoring channels, an F-DI changeover (e.g. selection/deselection of STO) does not take place simultaneously. After an F-DI changeover, dynamic data is not subject to a crosswise data comparison during this tolerance time. • Both parameters are included in the crosswise data comparison and must, therefore, be identical. A difference of one safety monitoring clock cycle is tolerated for the values.
9	 p9658 = ”Value” p9858 = ”Value”	**Sets the transition time from STOP F to STOP A** Transition time from STOP F to STOP A on the Control Unit Transition time from STOP F to STOP A on Motor Module • The parameters are not changed until safety commissioning mode has been exited (i.e. when p0010 ≠ 95 is set). • STOP F is the stop response initiated by fault F01611 or F30611 (SI defect in a monitoring channel) when the crosswise data comparison is violated. STOP F normally initiates ”No stop response”. • Once the parameterized time has elapsed, STOP A (immediate safety pulse cancellation) is initiated by fault F01600 or F30600 (SI STOP A initiated). The default setting for p9658 and p9858 is 0, i.e. STOP F immediately results in STOP A. • Both parameters are included in the data cross-check and must, therefore, be identical. A difference of one safety monitoring clock cycle is tolerated for the values.
10	p9659 = ”Value”	**Sets the time to carry out the forced checking procedure and testing the safety shutdown paths** • After this time has expired, using alarm A01699 (SI CU: Shutdown paths must be tested), the user is requested to test the shutdown paths (i.e. select/deselect STO). • The commissioning engineer can change the time required for carrying out the forced dormant error detection and testing the safety switch-off paths.

Table 4-3 Commissioning the ”STO”, ”SBC” and ”SS1” functions, continued

No.	Parameters	Description/comments
11	 p9799 = ”r9798” p9899 = ”r9898”	**Adapt the specified reference checksums** Specified checksum on the Control Unit Specified checksum on the Motor Module The current checksums for the Safety parameters that have undergone a checksum check are displayed as follows: • Actual checksum on the Control Unit: r9798 • Actual checksum on the Motor Module: r9898 By setting the actual checksum in the parameter for the specified checksum, the commissioning engineer confirms the Safety parameters in each monitoring channel.
12	 p9762 = ”Value” p9763 = ”Value”	**Sets a new safety password** Enter a new password Confirm the new password In the SINUMERIK environment we recommend that an axial password is not used. The commissioning area is sufficiently protected using the password protection at the HMI and an axial password makes further commissioning steps more difficult. • The new password is not valid until it has been entered in p9762 and confirmed in p9763. • From now on you must enter the new password in p9761 so that you can change safety parameters. • Changing the safety password does not mean that you have to change the checksums in p9799 and p9899.
13	p0010 = Value not equal to 95	**Exit Safety Integrated commissioning mode** • If at least one safety monitoring function is enabled (p9601 = p9801 $\neq$ 0), the checksums are checked: If the reference checksum on the Control Unit has not been correctly adapted, then fault F01650 (SI CU: Acceptance test required) is output with fault code 2000 and it is not possible to exit the safety commissioning mode. If the reference checksum on the Motor Module has not been correctly adapted, then fault F01650 (SI CU: Acceptance test required) is output with fault code 2001 and it is not possible to exit the safety commissioning mode. • If a safety monitoring function has not been enabled (p9601 = p9801 = 0), safety commissioning mode is exited without the checksums being checked. When safety commissioning mode is exited, the following is carried out: • The new Safety parameters are active on the Control Unit and Motor Module.
13		All drive parameters (entire drive group or only single axis) must be manually saved from RAM to ROM. This data is not saved automatically!
14	–	**Execute POWER ON** After commissioning, a POWER ON reset must be carried out.

Table 4-3 Commissioning the "STO", "SBC" and "SS1" functions, continued

No.	Parameters	Description/comments
15	–	**Carry out an acceptance test and prepare an acceptance report** Once safety commissioning has been completed, the commissioning engineer must carry out an acceptance test for the enabled safety monitoring functions. The results of the acceptance test must be documented in an acceptance report (see Chapter 4.8 "Acceptance test and acceptance report").

4.7.3 Safety faults

The fault messages of the Safety Basic Functions are saved in the standard message buffer and can be read out from there.

Stop response

When Safety Integrated faults occur, the following stop responses can be initiated:

Table 4-4 Stop responses for Safety Integrated Basic Functions

<table>
<tr><th>Stop response</th><th>Action</th><th>Effect</th><th>Triggered ...</th></tr>
<tr><td>STOP A
cannot be acknowledged</td><td rowspan="2">Trigger safe pulse suppression via the switch-off signal path for the relevant monitoring channel.
For operation with SBC: The brake is closed.</td><td rowspan="2">The motor coasts to a standstill or is braked by the holding brake.</td><td>For all non-acknowledgeable Safety faults with pulse suppression.</td></tr>
<tr><td>STOP A</td><td>For all acknowledgeable safety faults with pulse disable.
As a subsequent response to STOP F.</td></tr>
<tr><td></td><td colspan="3">STOP A is identical to stop Category 0 to EN 60204-1:2006.
With STOP A, the motor is switched directly to zero torque via the Safe Torque Off (STO) function.
A motor at standstill cannot be started again accidentally.
A moving motor coasts to standstill. This can be prevented by using external braking mechanisms, e.g. holding or operational brake.
When STOP A is present, Safe Torque Off (STO) is active.</td></tr>
<tr><td>STOP F</td><td>Transition into STOP A (after a delay time that can be parameterized)</td><td>No 1) (before transition into STOP A)</td><td>If a fault occurs in the crosswise data comparison.</td></tr>
</table>

Table 4-4 Stop responses for Safety Integrated Basic Functions, continued

Stop response	Action	Effect	Triggered ...
	STOP F is permanently assigned to the crosswise data comparison (CDC). In this way, errors are detected in the monitoring channels. After STOP F, STOP A is initiated. When STOP A is present, Safe Torque Off (STO) is active.		

1) If STOP F is output by the crosswise data comparison of the two input signals when the Safe Torque Off function is selected, this means that the pulses were already canceled when Safe Torque Off was selected in one channel.

Warning

With a vertical axis or pulling load, there is a risk of uncontrolled axis movements when STOP A/F is initiated. This can be prevented by using safe brake control (SBC) and a brake with sufficient holding force (not safe).

Acknowledging safety faults

Faults associated with Safety Integrated Basic Functions must be acknowledged as follows:

1. Remove the cause of the fault.
2. Select/deselect Safe Torque Off (STO).
3. Acknowledge the fault.

If the safety commissioning mode is exited when the safety functions are switched off (p0010 = value not equal to 95 when p9601 = p9801 = 0), all the safety faults can be acknowledged.

Once Safety commissioning mode has been selected again (p0010 = 95), all the faults that were previously present reappear.

Notice

Safety faults can also be acknowledged (as with all other faults) by switching the drive unit off and then on again (power on).

If the fault cause has still not been resolved, then the fault is immediately displayed again after booting.

Description of faults and alarms

See also Chapter 10.3.

Note

The faults and alarms for SINAMICS Safety Integrated are described in the following documentation:

Reference: /LH1/ SINAMICS S120/S150 List Manual

4.8 Acceptance test and acceptance report

See Chapter 9.5 "Acceptance test"

4.9 Overview of parameters and function diagrams

Parameter overview

Table 4-5 Safety Integrated parameters

No. Control Unit (CU)	No. Motor Module (MM)	Name	Can be changed in
p9601	p9801	Enables safety-related functions	Safety Integrated commissioning (p0010 = 95)
p9602	p9802	Enables safe brake control	
p9620	–	Signal source for Safe Torque Off	Safety Integrated commissioning (p0010 = 95)
p9621	p9821	Safe Brake Adapter signal source	
p9622[0...1]	p9822[0...1]	SBA relay wait times	
p9650	p9850	Tolerance time SGE changeover	Safety Integrated commissioning (p0010 = 95)

Table 4-5 Safety Integrated parameters, continued

No. Control Unit (CU)	No. Motor Module (MM)	Name	Can be changed in
p9651	p9851	STO/SBC/SS1 debounce time	
p9652	p9852	Safe Stop 1 delay time	Safety Integrated commissioning (p0010 = 95)
p9658	p9858	Transition time STOP F to STOP A	
p9659	–	Timer for forced checking procedure	
p9761	–	Enter password	In every operating mode
p9762	–	New password	Safety Integrated commissioning (p0010 = 95)
p9763	–	Password confirmation	
p9697	p9897	Pulse cancellation failsafe delay time	
r9770[0...3]	r9870[0...3]	Version, drive-autonomous safety function	–
r9771	r9871	Shared functions	–
r9772	r9872	Status	–
r9773	–	Status (Control Unit + Motor Module)	–
r9774	–	Status (Safe Torque Off group)	–
r9780	r9880	Monitoring cycle	–
r9794	r9894	Cross comparison list	–
r9795	r9895	Diagnostics for STOP F	–
r9798	r9898	Actual checksum SI parameters	–
p9799	p9899	Reference checksum SI parameters	Safety Integrated commissioning (p0010 = 95)

Description of parameters

Note

The SINAMICS Safety Integrated parameters are described in the following reference:

Reference: /LH1/ SINAMICS S List Manual

Function diagram overview

- 2800 Parameter manager
- 2802 Monitoring functions and faults/alarms
- 2804 Status words
- 2810 Safe Torque Off (STO)
- 2814 Safe Brake Control (SBC)

Also see Chapter 8.2.2 ”Description of parameters”.

4.10 PLC drives

SINUMERIK 840D sl allows both NC controlled as well as PLC controlled axes to be operated. The PLC controlled axes are addressed exclusively via the PLC user program.

For implementing the safety functions, for the PLC axes, the Safety Integrated Basic and Extended Functions of the SINAMICS drive family are available.

For further information on PLC-controlled axes, refer to the Commissioning Guide of SINUMERIK 840D sl. The Safety Integrated Basic and Extended Functions are described in the Function Manual ”SINAMICS S120 Safety Integrated” or in the respective function manuals.

Basics on the Safety Functions Integrated in the System/Drive

5

Motion monitoring functions with a higher-level control

The motion monitoring functions are carried out using a higher-level control. The higher-level control and the drive are the two monitoring channels. Just like the monitoring functions integrated in the drive, also here, each channel must be assigned a shutdown path so that when a fault develops, the pulses can be cancelled independently of the other channel.

- The shutdown path of the Control Unit is assigned to the drive monitoring channel.
- The shutdown path of the Motor Module is assigned the control monitoring channel.

5.1 Monitoring cycle

Setting the monitoring clock cycle time

The axial safety-related functions are monitored cyclically in the monitoring clock cycle that can be set jointly for all axes/spindles using the following machine data:

<u>for 840D sl</u>
MD 10090: $MN_SAFETY_SYSCLOCK_TIME_RATIO
The specified clock cycle is checked and rounded-off to the next possible value when the control boots and every time the machine data changes.
The resulting monitoring clock cycle is displayed using MD 10091: $MN_INFO_SAFETY_CYCLE_TIME
(refer to Chapter 8.1.2, "Description of machine data").

<u>for SINAMICS S120</u>
p9500 SI Motion monitoring clock cycle (Control Unit)
(refer to Chapter 8.2.2, "Description of parameters")

Warning

The monitoring clock cycle determines the response time of the safety-related functions. It must therefore be selected to be <= 25 ms. The higher the monitoring cycle setting, the greater the amount by which the monitored limit value is violated in the event of an error and the more that the drive(s) overshoots.

5.2 Crosswise data comparison (CDC)

The continuous comparison of the safety-related data in the monitoring channels carried out in the SI monitoring clock cycle is known as "crosswise data comparison" (CDC).

The following apply to the axial monitoring functions: In the case of "non-steady-state" data, tolerance values defined using machine data are used by which amount the results of the two channels may deviate from one another without initiating a response (e.g. tolerance for crosswise data comparison of actual positions).

A distinction is made between:

- Drive CDC between the drive and Motor Module (refer to Chapter 4 "Safety Functions Integrated in the Drive").
- Axis CDC between the NCK and drive (refer to Chapter 6 "Safety functions integrated in the system/drive").
- Communication CDC between the NCK and PLC (refer to Chapter 7.2, "Connecting I/O via PROFIsafe" and Chapter 7.4 "Safety-relevant CPU-CPU communication (F_DP communication)").
- SPL-CDC between the NCK and PLC (refer to Chapter 7.5, "Safe programmable logic (SPL)").

Error response

If the crosswise data comparison (CDC) identifies an error, then this results in a stop response (refer to Chapter 6.3, "Safe Stops A-F").

In addition, safety alarms are output.

Note

If SGEs are quickly changed over several times this can initiate a STOP F.

Displays the crosswise data comparison clock cycle

To display the actual crosswise data comparison cycle time between the NCK and drive, the axial MD 36992 is used: $MA_SAFE_CROSSCHECK_CYCLE and the general MD 10092: $MN_INFO_CROSSCHECK_CYCLE_TIME. If the monitoring clock cycle is modified, then the crosswise comparison clock cycle is also changed.

5.3 Forced checking procedure

Forced checking procedure, general (extract from /6/)

”...A forced checking procedure must be carried out for all static (steady-state) signals and data. Within the required time (8 h), the state must change from a logical 1 to a logical 0 - or vice versa. If the state remains static in a fault situation, then this is detected at the latest as a result of this forced checking procedure and the subsequent comparison.

A forced checking procedure must be used, e.g. for components that are required to stop a process (e.g. contactors and power semiconductors) - the so-called shutdown path and for the shutdown condition. Generally, it is not possible to test a shutdown condition, e.g. violation of a limit value criterion, using other methods such as e.g. crosswise data comparison, when the machine is in an acceptable (good) condition. This also applies to errors along the entire shutdown path including associated hardware and software and circuit-breakers.
By integrating a test stop every eight hours with a comparison and expected status, faults can also be detected when the machine is in an acceptable (good) condition....”
Note: Acceptable (good) condition means that there are no machine faults that are apparent to the operator
Note: For Safety Integrated, a forced checking procedure interval of one year is permissible

Forced checking procedure with Safety Integrated

The forced checking procedure is used to detect faults/errors in the software and hardware of the two monitoring channels. In order to do this, the safety-related parts in both channels must be processed at least once during a defined period in all safety-related branches. Any faults/errors in the monitoring channel would cause deviations and will be detected by the cross-wise data comparison.

For Safety Integrated, the forced checking procedure interval is max. 1 year. This involves components from the SINUMERIK 840D sl / SINAMICS S120 system. Possible requirements relating to shorter forced checking procedure intervals of safety-related components (e.g. PROFIsafe I/O modules, sensors such as e.g. emergency stop buttons, actuators such as e.g. brakes, etc.) are not influenced.

The forced checking procedure must be initiated by the user or integrated in the process as an automatic procedure, e.g.:

- When the axes are stationary after the system has been powered-up
- When the protective door is opened
- In defined cycles (e.g. every 8 hours) The maximum permissible is every year).
- In the automatic mode, dependent on the time and event.

The forced checking procedure also includes testing the safety-related sensors and actuators at the safety-related inputs/outputs. In this case, the entire circuit including the Safe Programmable Logic (SPL) is tested to ensure that it is correctly functioning (refer to Chapter 7.1.2, "Forced checking procedure of SPL signals").

Warning

The test interval duration of max. 1 year may only be extended under the following conditions:

- In the time after the test interval has expired, no hazards for personnel may be allowed to occur - they must be completely excluded (e.g. the protective door is closed and is also interlocked)
- After the test interval has expired, before a possible hazard to personnel (e.g. for a request to open a protective door), a test stop or a forced checking procedure must be carried out to absolutely ensure the availability of the shutdown paths and the safety-related inputs/outputs.

This means that for the duration of the automatic mode (with the protective door closed and interlocked), a fixed cycle is not strictly specified. After expiry of the time, the forced checking procedure can be carried out before the next opening of the protective door.

Note

If the crosswise data comparison identifies an error, then this results in a stop response (refer to Chapter 6.3, "Safe Stops A-F").

5.4 Actual value conditioning

5.4.1 Encoder types

Basic types

The following basic encoder types can be used with a drive module to implement safety-related operation:

1. Incremental encoder via a Sensor Module and DRIVE-CLiQ
   with sinusoidal voltage signals A and B (signal A is shifted with respect to B through 90° and a reference signal R, e.g.: ERN 1387, LS 186, SIZAG2
2. Absolute encoder via Sensor Module and DRIVE-CLiQ
   with an EnDat interface and incremental sinusoidal voltage signals A and B (signal A is shifted with respect to B through 90°), e.g.: EQN 1325, LC 181
3. Motor encoder (IMS) with integrated DRIVE-CLiQ interface, with the properties corresponding to 1. or 2.
4. Direct encoder (DMS, e.g. linear scale) with integrated DRIVE-CLiQ interface, with the properties corresponding to 1. or 2.

Combining encoder types

Various combinations can be derived from the basic types.

Table 5-1 Combining encoder types

Incremental encoder		Absolute encoder		
at the motor	**at the load**	**at the motor**	**at the load**	**Remarks**
x				1-encoder system*
		x		1-encoder system*
	x	x		2-encoder system*
x	x			2-encoder system*
x			x	2-encoder system*
		x	x	2-encoder system*
Note: x -> encoder connection *A list of the Siemens encoders and motors permissible for Safety Integrated functions can be obtained from your local SIEMENS contact partner.				

1-encoder system

For a 1-encoder system, the motor encoder is used for the safety-related actual values of the NC and drive.
The actual values are generated in a safety-related fashion either directly in the encoder or in the Sensor Module and are provided - with no-reaction - to the NCK and the drive using safety-related communications via DRIVE-CLiQ.

Special feature regarding linear motors:
For linear motors, the motor encoder (linear scale) is also the measuring system at the load. IMS and DMS are one measuring system. The connection is made at the IMS input of the Sensor Module or directly via DRIVE-CLiQ.

Significance of the coarse encoder position:
For a 1-encoder system, for all position monitoring functions, the accuracy of the redundant actual value must be assumed to apply. This accuracy depends on the encoder evaluation. For all encoder evaluation functions that can be used with Safety Integrated (SMI, SME, SMC, motor/encoder with DRIVE-CLiQ), a redundant position value is generated and the closed-loop control is made available.
The machine manufacturer must select the appropriate encoder with the necessary encoder pulse number for his particular requirements. To do this, the encoder resolution must be converted to the accuracy on the load side. This conversion is dependent on the type of encoder mounting and the type of axis. Further, gearbox factors, the spindle pitch for linear axes and the radius of the rotary table for rotary axes must also be taken into account.

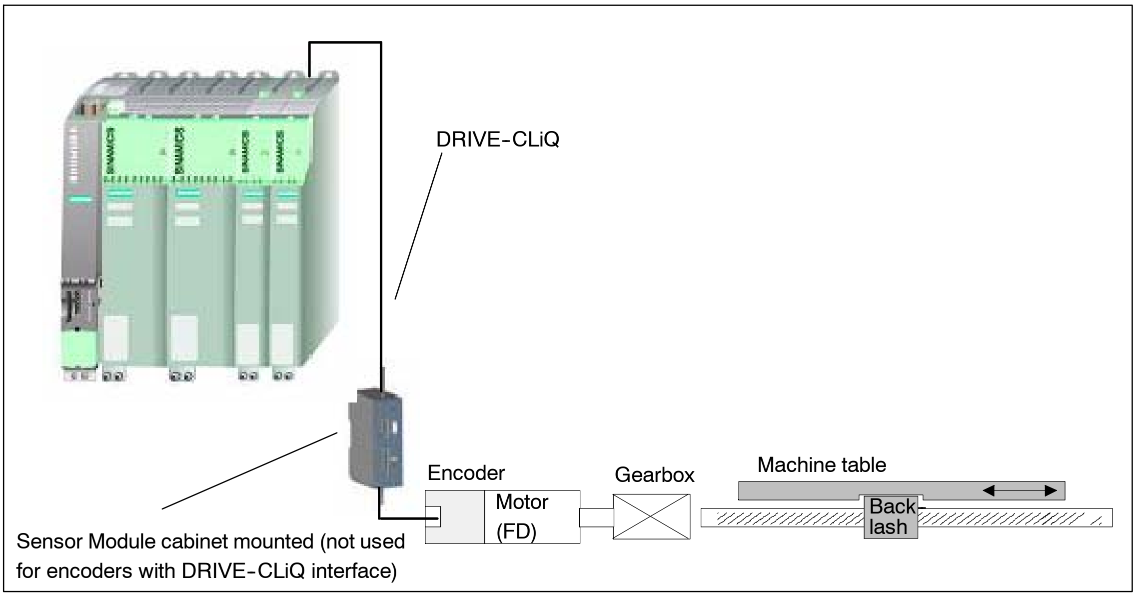


Fig. 5-1 1-encoder system for a feed drive (FD)

Warning

The specific residual risks for 1 encoder systems (refer to Chapter 3.5 ”Residual risks”) must be carefully taken into consideration.

2-encoder system

In this case, the safety-related actual values for an axis are supplied from 2 separate encoders. In standard applications, the drive evaluates the motor encoder (IMS) and the NC, the measuring system (DMS). The actual values are generated in a safety-related fashion either directly in the encoder or in the Sensor Module and are provided - with no-reaction - to the NCK and the drive using safety-related communications via DRIVE-CLiQ. A separate connection or a separate Sensor Module is required for every measuring system.

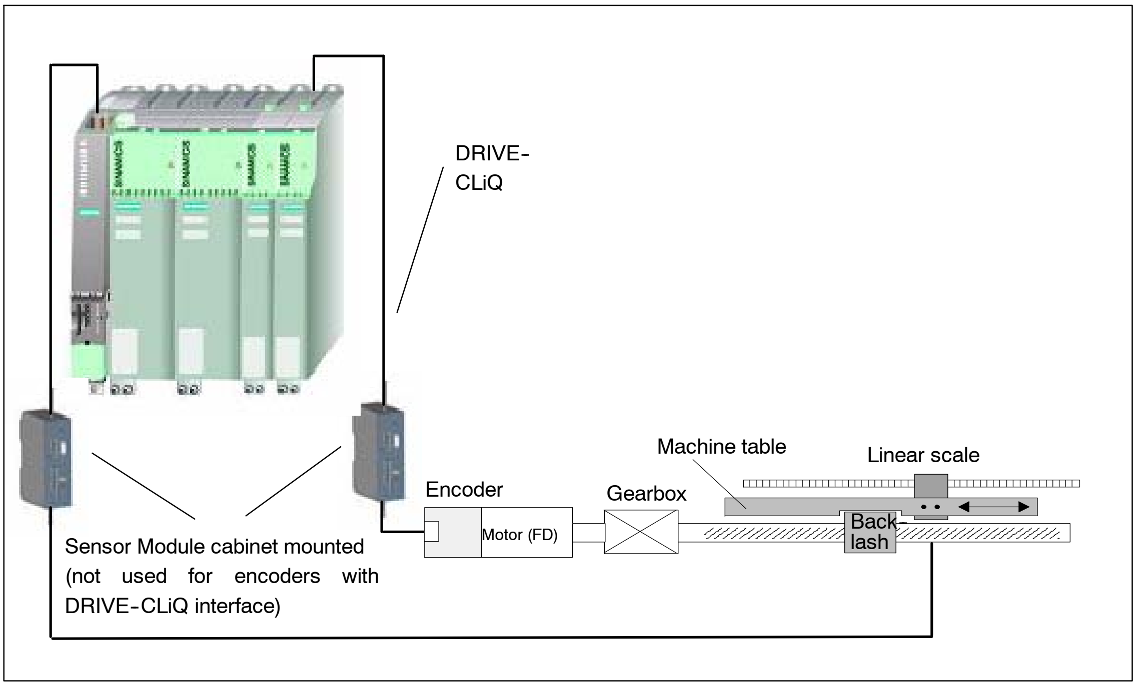


Fig. 5-2 2-encoder system for a feed drive (FD), connected through 2 Sensor Modules

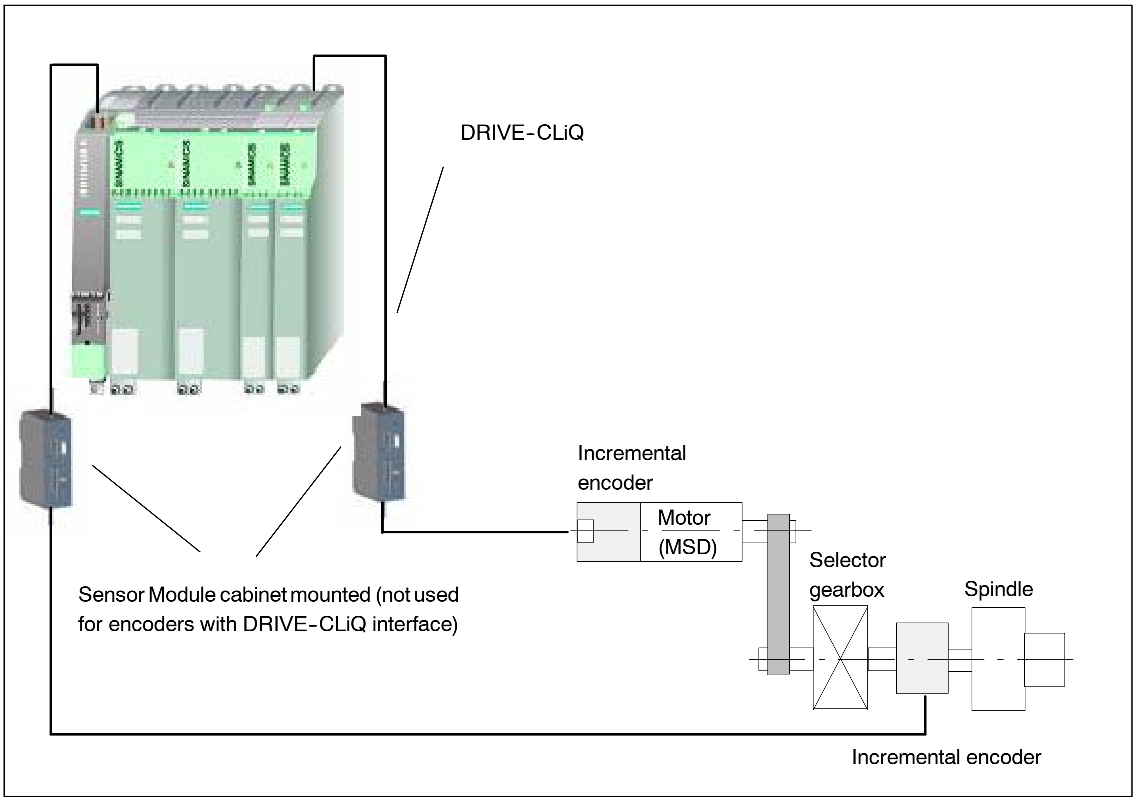


Fig. 5-3 2-encoder system for the main spindle, connected via 2 Sensor Modules

Note
For systems with slip, see Chapter 5.4.6 "Actual value synchronization (slip for 2-encoder systems)".

DRIVE-CLiQ encoder

If a DRIVE-CLiQ encoder is connected for the NCK monitoring channel, in addition to the parameter field r0979, additional drive parameters that define the redundant coarse position value in more detail must be read-out. When booting, these parameters are directly read-out of the encoder and saved in the NCK machine data.

The additional parameters for the DRIVE-CLiQ encoder are listed in the following table:

Drive parameters	Meaning	NCK machine data
r0470	Valid bits of the redundant coarse position value	$MA_SAFE_ENC_NUM_BITS[0]
r0471	Fine resolution of the redundant coarse position value	$MA_SAFE_ENC_NUM_BITS[1]

Drive parameters	Meaning	NCK machine data
r0472	Relevant bits of the redundant coarse position value	$MA_SAFE_ENC_NUM_BITS[2]
r0474	Configuration of the redundant coarse position value Bit 0: Count direction, up/down Bit 1: CRC 16: LSB/MSB first Bit 2: MSB/LSB justified	$MA_SAFE_ENC_CONF
r0475 = r0470 – r0471	Safety MSB of the redundant coarse position value	$MA_SAFE_ENC_NUM_BITS[3]

For DRIVE–CLiQ encoders. the resolution of the redundant position value is less than for SMx encoder evaluation. The information as to how many bits of the redundant position value are relevant is located in drive parameter r0472. A lower safety–related position accuracy is obtained from this lower resolution. In turn, a lower safe maximum velocity results from the parameterization in r0475 (safety MSB of the redundant coarse position). For these reasons, when making a change between DRIVE–CLiQ encoders and SMx encoder evaluation, it is necessary to perform a complete acceptance test of the safety functions of the axis involved. This is indicated using Alarm 27036, ”Axis %1 encoder parameterization MD %2[%3] was adapted”.

5.4.2 Encoder adjustment, calibrating the axes

Adjusting the motor encoder

Generally, for 1–encoder systems, the integrated encoder is an integral component of the motor (the encoder is adjusted to match the motor). Data relating to distance, speed and rotor position (for synchronous drives) is obtained from one encoder. It is no longer possible to adjust the encoders in motor measuring systems in the conventional sense.

Calibrating the machine

The machine zero and encoder zero are calibrated purely on the basis of the offset value (the machine must be calibrated). This procedure must be carried out for both absolute and incremental encoders.

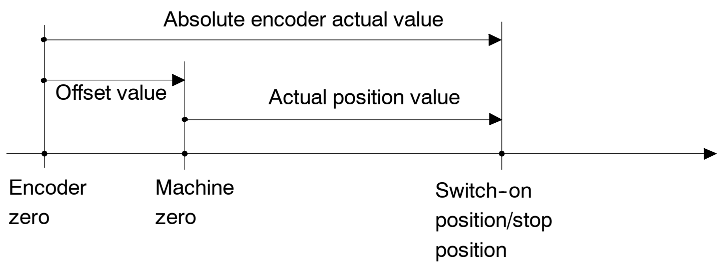


Fig. 5-4 Positions and actual values

When calibrating the machine, a known or measured position is approached using a dial gauge, fixed stop, etc. and the offset determined. This offset is then entered into the appropriate machine data. Calibration must always be carried out for position-controlled (closed-loop) axes/spindles.

Reference: /IAD/, Commissioning Manual SINUMERIK 840D sl
/FBD/, Description of Functions, SINUMERIK 840D sl, R1, "Reference point approach"

5.4.3 Axis states

"Axis not referenced" state

The axis state "axis not referenced" is reached after the power supply has been powered-up and the drive and control system have completely booted. This state is indicated using the axis-specific interface signal "reference point reached" as follows:

Interface signal
"Reference point reached" = "1" Axis state "Axis referenced"
"Reference point reached" = "**0**" Axis state "**Axis not referenced**"

for 840D sl DB31-61, DBX60.4 / DBX60.5

(refer to Fig. 5-5 "Axis states when referencing")

”Axis referenced” state

For **incremental encoders**, the position actual value is lost when the NC is powered-down. When the NC is powered-up, a reference point approach must be carried out. If this is executed correctly, then the axis is referenced and goes into the ”axis referenced” state (refer to 5-5 ”Axis states when referencing”).

Contrary to incremental encoders, **absolute encoders** do not require a reference point approach after the NC has been powered-up. These encoders track the absolute position, e.g. using a mechanical gear, both when powered-up and powered-down. The absolute position is transferred implicitly via a serial interface when the NC is powered-up. After the position data has been transferred and the offset value has been taken into account, the axis also goes in the axis state ”axis referenced” (refer to Fig. 5-5 ”Axis states when referencing”).

This axis state ”axis referenced” is indicated using the axis-specific interface signal ”reference point reached” as follows:

Interface signal
”Reference point reached” = ”**1**” Axis state ”**Axis referenced**”
”Reference point reached” = ”0” Axis state ”Axis not referenced”

for 840D sl DB31-61, DBX60.4 / DBX60.5

Reference: /IAD/, Commissioning Manual, SINUMERIK 840D sl

”Axis safely referenced” state

In order to reach the axis state ”axis safely referenced”, the axis state ”axis referenced” must have been reached, and either

- the user confirms the current position using the user agreement (refer to Chapter 5.4.4 ”User agreement”

or

- a saved and set user agreement and saved stop position when the system was powered-down must exist. The position associated with the saved data must match the current position within a tolerance window. This is checked both in the drive and in the NC.

(refer to Fig. 5-5 ”Axis states when referencing”).

The axis state ”axis safely referenced” is displayed using the SGA ”axis safely referenced”. A safety-related position evaluation can only be carried out for the SE and SN functions after this state has been reached.

Saved user agreement

The state of the user agreement function is saved in non-volatile memories. This saved user agreement forms, together with the stop position, also saved in a non-volatile fashion the prerequisite for the axis state ”axis safely referenced”.

Saved stop position

The saved stop position data is combined with the permanently saved user agreement to form the previous history.

The following must be noted when the stop position is saved:

The following applies when SE/SN is active:

- The stop position is cyclically saved.
- If the axis is moved with the system powered-down, then the saved stop position no longer matches the current position.

As described under ”axis safely referenced” the ”axis safely referenced” state can also be achieved using a saved and set user agreement and a saved stop position.

The following conditions must be fulfilled:

- The saved user agreement must be available.
- The difference between the ”reference position” (power-on position with absolute measuring systems or reference position for incremental measuring systems) and the saved stop position (including the traversing distance to the reference point with ERN) must be within a tolerance window specified using the appropriate machine data.

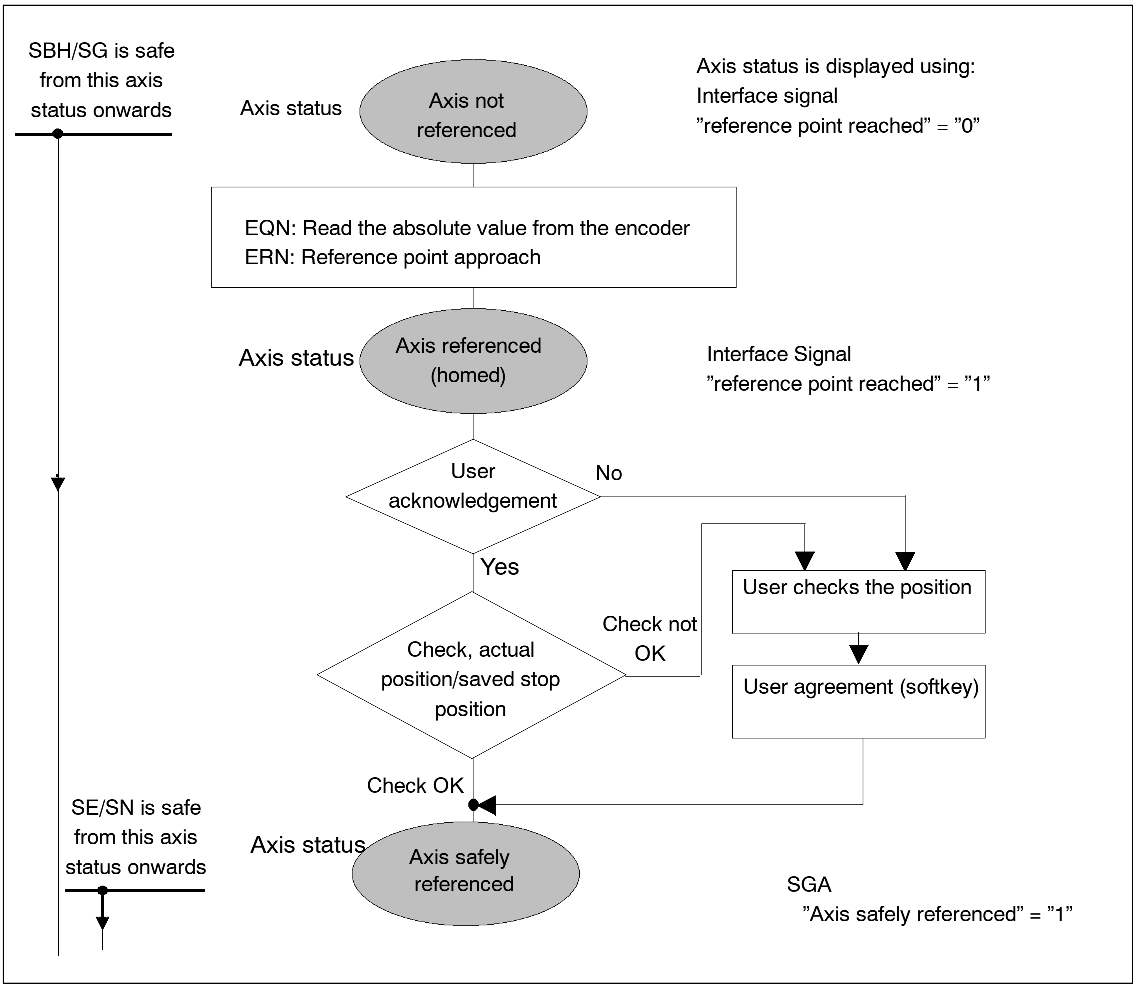


Fig. 5-5 Axis states when referencing

5.4.4 User acknowledgement

Description

With a user agreement, an appropriately authorized person confirms that the currently displayed SI actual position of an axis corresponds to the actual position at the machine.
This can be checked by traversing the axis to a known position (e.g. a visual mark) or the axis is adjusted/calibrated and the SI actual position is therefore compared in the ”user agreement” screen.

An axis/spindle with integrated safety functions can have the following status:
User agreement = yes, or
User agreement = no

All safety axes are listed in the HMI display ”user agreement” for which safety end stops and/or safety cams have been activated. The following data are displayed:

- Machine-axis name
- SI position
- User acknowledgement

When does a user agreement have to be given?

A user agreement is always required if an axis/spindle is to be monitored for SE, SN.

A user agreement is only required:

- when the axis/spindle is commissioned for the first time.
- when the user intends or needs to again manually and safely reference the axis/spindle.
- If, after Power On, the stop position did not correspond with the actual position and the control cancelled the user agreement.
- after parking an axis/spindle
(only if the change in position is greater than that defined using MD 36944: $MA_SAFE_REFP_POS_TOL tolerance actual value comparison (referencing) is defined).

Note

An axis/spindle must have the status User agreement = yes before the SN and SE functions can be used.

For axes/spindles without the safety ”SE” and ”SN” functions, the saved stop position position is not evaluated.

Warning

If the drive has not been safely referenced and a user agreement has not been given, then the following applies:
- the ”Safe software cams” and/or ”Safe cam track” are active, but are not safety-relevant.
- The ”Safe software limit switches” are not active

The user agreement can only be set by an authorized user.

The user agreement can be cancelled by the user or as a result of a function being selected (e.g. new gear stage) or also an incorrect state (e.g. inconsistency in the user agreement between the NC and drive). When the user agreement is cancelled, the axis state ”axis safely referenced” is always reset
(refer to Fig. 5-5 ”Axis states when referencing”).

Interlocking the user agreement

Before a user agreement can be issued, the interlock must be cancelled:

- Keyswitch
  in setting 3 -> the user agreement can be issued

After the user agreement has been issued, the interlocking must be again set (e.g. key switch position 3 must be left and the key withdrawn).

5.4.5 Taking into account control gears

The possible gearbox ratios must be known in order that the NC and drive can evaluate the position actual values referred to the load.

For this purposes, various gearbox ratios can be selected on an axis-for-axis basis in the machine data and selected using the "Safety-related inputs/outputs" (SGEs/SGAs).

The following points must be carefully observed for drives with control gears (these are generally used with spindles).

- If the drive is operated with an (indirect) encoder (motor measuring system), i.e. the safety-related actual value for the NCK and drive are derived from the same measuring system, then the gearbox ratios (gearbox stage selection for Safety Integrated) must also be selected for both monitoring channels. The state of the SGE signal ratio selection (bits 0..2) is not subject to a crosswise data comparison; however, the safety-related actual values from the NCK and drive are compared to evaluate if there is any deviation (< 36942 $MA_SAFE_POS_TOL or parameter p9542 SI motion, actual value comparison tolerance (crosswise) (Control Unit).
- If the drive is operated with an (indirect) motor encoder and a (direct) spindle encoder, the safety-related actual values are derived from the direct encoder and those of the drive from the indirect encoder. For the direct encoder, the gearbox changeover is not relevant and the gearbox stage changeover only has to be configured/engineered for the drive.
- Using the two machine data fields
  36921[0..7] $MA_SAFE_ENC_GEAR_DENOM[n] denominator, gearbox encoder/load and
  MD 36922[0..7] $MA_SAFE_ENC_GEAR_NUMERA[n] numerator, gearbox encoder/load
  or
  p9521[0..7] SI motion gearbox encoder/load denominator (Control Unit) and
  p9522[0..7] SI motion gearbox encoder/load numerator (Control Unit)

8 different gearbox stage pairs for NCK/drive can be defined. For this definition, there is no special function for an index value – e.g. interdependency on the operating mode of the spindle. These 8 pairs must be parameterized and selected depending on the encoder configuration.

- As a result of the gearbox stage changeover, the encoder evaluation for the safety-related actual values change. Ideally, the gearbox stage for Safety Integrated is changed-over at standstill. However, this is generally not in-line with what is required in practice. This means that the actual value offset when changing-over the gearbox stage (e.g. using oscillation) may not be greater than the already mentioned actual value tolerance window (MD 36942 / p9542).
- If, for the axis with control gear, position-dependent monitoring functions are activated – such as SE or SN – the user agreement (assuming that it was previously set) is withdrawn when changing-over the gearbox ratio and the SGA ”axis safely referenced” is set to 0. When the gearbox stage is changed from the PLC and/or by selecting a new ratio, a new gearbox ratio is detected using the appropriate SGEs.
- After the gearbox stage has been selected, the spindle must be re-synchronized. When re-synchronizing the spindle, the two safety-related actual values (NCK and drive) are re-initialized with the newly synchronized actual value.
A possible difference that was previously present between the two safety-related actual values is therefore corrected.
- In order to be able to re-use the SN or SE function after the gearbox ratio has been selected (changed), the user must bring the spindle into the state ”axis safely referenced” – the user agreement must be re-issued.
- For 2-encoder systems, the gearbox ratio does not have to be selected in a safety-related fashion and can be implemented through one channel. On the other hand, for a 1-encoder system, the ratio selection must implemented using safety-related technology – i.e. using two channels.

Warning

When a new stage is selected for a control gear (the ratio changed), an axis is parked or the mounting situation is modified (encoder and motor replaced), this means that the load and encoder have been decoupled. The NC and drive cannot detect this. The state ”axis safety referenced” is no longer applicable.
The user is responsible in bringing the axis back into the ”axis safely referenced” state if the functions ”safe software limit switch” or ”safe cams” are used.

5.4.6 Actual value synchronization (slip for 2-encoder systems)

Description of function

When a 2-encoder system is used, SI actual values from the NC and the drive drift apart for systems that have inherent slip. The reason for this is that the drive evaluates the motor measuring system and the NC evaluates the direct measuring system after the gearbox.

There are the following two alternatives in order to avoid this:

- 1-encoder system without actual value synchronization
- 2-encoder system with actual value synchronization and therefore additional monitoring of the load side

Slip tolerance

The actual value is synchronized through two channels. In both channels, machine data 36949: $MA_SAFE_SLIP_VELO_TOL / parameter p9549 ”SI motion slip velocity tolerance” is used in which the maximum offset between the NCK and drive actual value is entered as velocity. The tolerance value entered in MD 36942: $MA_SAFE_POS_TOL is not relevant.

For the actual value synchronization, both channels correct their SI actual position to half the determined actual value difference. Please note that the two SI actual positions no longer display the correct absolute position. The NC actual position and the two SI actual positions are different.

The actual values are synchronized in the crosswise data comparison clock cycle. Actual value synchronization is also performed when a crosswise data comparison of the SI actual position outputs an error.

Actual values are also synchronized after ”referencing” and for ”parking axis”.

The currently determined and the maximum SI speed difference since the last reset are displayed in the axis-specific service screen for diagnostic purposes.

In order to define the slip tolerance, in MD 36949: $MA_SAFE_SLIP_VELO_TOL the maximum differential speed is set. As a result of an action, such as e.g. maximum acceleration when starting, gearbox stage changes with oscillation, a situation is created where the actual values drift apart. This value can be taken as nominal value from the diagnostics screen ”Maximum velocity difference”, multiplied by a factor of 1.5 and then entered into MD 36949.

Note

Actual values are only synchronized when there is an actual value difference between the two channels of 2 µm or 2 m degrees in each SI monitoring clock cycle.

Supplementary conditions

The two SI actual positions no longer display the correct absolute machine position. The correct position can now only be read out via the NC actual position.

The safety monitoring functions SG, SBH, SBR and "$n<n_x$" still only respond to actual value changes from the particular actual value acquisition channel - not to changes in the actual value resulting from the actual value synchronization. A single-channel SG violation only initiates an alarm in the channel in which this speed violation was detected. The associated stop response is therefore still initiated through two channels.

SGA "$n<n_x$" can also assume different static states in the two monitoring channels.

Note

It is not possible to activate the safe SE and SN functions for an axis/spindle where slip can occur between the motor and the load.

Activation

The actual value synchronization is selected by setting bit 3 in machine data 36901: $MA_SAFE_FUNCTION_ENABLE or parameter p9501:" SI motion, enable safety-related functions". In addition, SI function "SBH/SG monitoring" must also be enabled.

Actual value synchronization is only permissible if a monitoring function with absolute reference has not been simultaneously enabled. If SE and/or SN are also selected, power on Alarms 27033 and F01688 are also output when booting.

The actual value synchronization is only permissible for 2-encoder systems. If this function is enabled for a single-encoder system, Alarm 27033/F01688 is output.

5.4.7 Encoder frequency limit

For safety-related operation, it is not permissible that the encoder limit frequency of 500 kHz exceeded.
For this purposes, Safety Integrated monitors for the encoder limit frequency being exceeded depending on the situation (depending on the context); when the encoder limit frequency is exceeded, an appropriate alarm is output (refer to Chapter 6.5 "Safely reduced speed")

5.5 Enabling the safety-related functions

Global enable

SINUMERIK Safety Integrated (SI) with the safety-related functions is enabled using options.
The enable signal determines the number of axes/spindles for which SI can be activated. Using an additional options, in addition, the number of possible SPL-SGE/SGAs is defined.
The SH/SBC/SS1 function is completely implemented in SINAMICS S120 and is, as a function integrated in the drive, included in the basic drive scope.

Enabling safety-related functions

Which safety functions are to be effective can be individually selected for each axis using the following machine data:

<u>for 840D sl</u>
MD 36901: $MA_SAFE_FUNCTION_ENABLE
(see Chapter 8.1, "Machine data for SINUMERIK 840D sl")

<u>for S120</u>
p9501: SI motion enable safety functions (Control Unit)
(see Chapter 8.2, "Parameters for SINAMICS S120")

Among others, the following functions can be individually enabled:

- SBH/SG
- SE
- SN
- SG override
- Actual value synchronization
- External STOPs
- Cam synchronization
- STOP E
- Expansion $n<n_x$

Note

- To ensure that SBH can always be selected in the event of an error, the function SBH/SG must be activated and appropriately parameterized when the function SE and/or SN are(is) enabled.
- The axis-specific enable data in the NCK must match those in the drive, otherwise, the crosswise data comparison signals an error.
- An SI axis is treated as an axis in terms of the global option if at least one safety-related function is activated via the axis-specific enable data.
- The maximum number of axes that may operate with SI and SPL SGE/SGAs is the number that was enabled using the options.

5.6 Switching the system on/off

Warning
In a system configuration, the firmware versions of the DRIVE-CLiQ components can only differ from the versions on the CF card, if either

a) the automatic upgrade/downgrade (parameter p7826) is deactivated, or
b) components with a new firmware version can no longer be downgraded to the status of the version available on the CF card.

Case a) is not permitted when Safety Integrated is used. The automatic upgrade/downgrade must never be disabled when Safety Integrated is used. (automatic firmware update (p7826) must be equal to 1)

Case b) is only permissible if this combination has been explicitly approved by the manufacturer.

http://support.automation.siemens.com/WW/view/en/28554461

Warning

After hardware and/or software components have been changed or replaced, it is only permissible to boot the system and activate the drives when the protective devices are closed. Personnel must not be present in the danger zone.

Depending on the change made or what has been replaced, it may be necessary to carry-out a partial or complete acceptance test (see Chapter 9.5 "Acceptance test").

Before allowing anybody to re-enter the danger zone, you should test steady control response by briefly moving the drives in forward and reverse direction (+/-).

This is especially important specifically for high-speed linear or torque motors.

What has to be observed when switching on?

The safety-related functions are only available and can only be activated after the system has completely booted.

We recommend that the safe operating stop (SBH) function is selected.

For axes with SE/SN, the stop position is used to internally check the position when powering-up.

Warning

System startup is a critical operating state with increased risk. In this phase, especially when activating drives, it is not permissible that personnel are close to the hazardous area.
Further, for vertical axes, it is very important to ensure that the drives are in a state with the pulses cancelled.

A complete forced checking procedure is necessary after powering-up (refer to Chapter 5.3, "Forced checking procedure").

What has to be observed when switching off?

- When SE/SN is activated, the following applies:
  The stop position is cyclically saved.
  For this reason, the user should only switch-off the control when the axes/spindles with safety functions have stopped moving.

Note

If the axis is moved with the system switched-off, then the saved stop position no longer matches the current position. For axes with safety-related functions SE and SN, when switching-on, a user agreement is again required after the position has been checked.

Space for your notes

Safety Functions Integrated in the System/ Drive

6

6.1 Safe standstill (SH)

Note

This Chapter describes the safety function safe standstill (SH), controlled from the safety-related motion monitoring functions. The function is based on the safety functions STO/SBC of the drive (see Chapter 4). Fig. 6-1 shows the interrelationships.
The safety functions STO, SBC and SS1, integrated in the drive, controlled via the drive terminals, are described in Chapter 4. Control via terminals and from the motion monitoring functions is in parallel and can be used independently of one another.
A Stop A/STO initiated in the drive (i.e. a system error in the drive or STO/SBC/SS1 selection via terminal) is however not available as two-channel SGA "STOP A/B active" for the safety-related motion monitoring functions. There is only a single-channel signal "pulses cancelled" present.

Description

The safe standstill function is based on the pulse cancellation (start inhibit) function integrated in the Motor Modules of the SINAMICS S120 (see Chapter 4.3, "Safe Torque Off (STO)".

There are two shutdown paths that are independent of one another that ensure that when a component fails, the drive is always brought into a safe condition.

The safe standstill function safely disconnects the energy feed to the motor in the event of a fault or in conjunction with a machine function.

The following must be carefully observed when controlling/energizing SH from the motion monitoring functions.

- The safety functions STO/SBC/SS1 integrated in the drive are, corresponding to the description in Chapter 4 "Safety Functions Integrated in the Drive" fully effective (parameters, alarms etc.). The standard pre-assignment (default setting) of the associated parameters is generally sufficient in the context of the motion monitoring functions.

- The safety function STO integrated in the drive does not have to be explicitly enabled; this is implicitly enabled by enabling the motion monitoring functions (p9501 < > 0). If the safety function SBC integrated in the drive is to be additionally activated when selecting STO, then this however must be explicitly enabled.
- The PROFIsafe drive address must be set.

Warning

If the safe standstill function or ”STOP A” is activated, the motor can no longer generate any torque. This is the reason that potentially hazardous motion can occur, e.g. for the following:

- When an external force acts on the drive axes
- Vertical and inclined axes without weight equalization
- Axes that are moving (coasting down)
- Direct drives with low friction and low self-locking
- Notching torques (depending on the motor type, bearing design and friction characteristics, up to half a pole pitch in a direction that cannot be predicted).

Possible hazards must be clearly identified using a risk analysis that must be carried out by the manufacturer. With an assessment, based on this risk analysis, it should be defined as to which additional measures are required, e.g. external brakes.

Features

The main features of the safe standstill function are as follows:

- The motor cannot be started unintentionally or accidentally
- The energy feed to the motor is safely disconnected
- The Motor Module and motor are not electrically isolated from one another

Selecting/deselecting SH

The safe standstill function corresponds to an external STOP A. This makes it possible to explicitly select SH, not only using internal events (STOP A when a limit value is violated), but also via SGE.

- Safe standstill is activated after a STOP A.
- Safe standstill is automatically activated from every monitoring channel when testing the shutdown paths.

Note

When SH is selected/deselected, motion monitoring functions such as SBH, SG, $n<n_x$, SE, SN are not influenced. For instance, when manually turning a spindle in the SH state, with SBH simultaneously selected, then this results in Alarm 27010. The user must take this into account when required in the safe programmable logic (SPL).

Warning

After the machine has been powered-up, the safe standstill function must always be tested for all of the axes/spindles by testing the shutdown path using Safety Integrated.

6.1.1 Switch-off signal paths

The interaction of the safety functions integrated in the drive and the motion monitoring functions (Motion Monitor) are shown in Fig. 6-1.

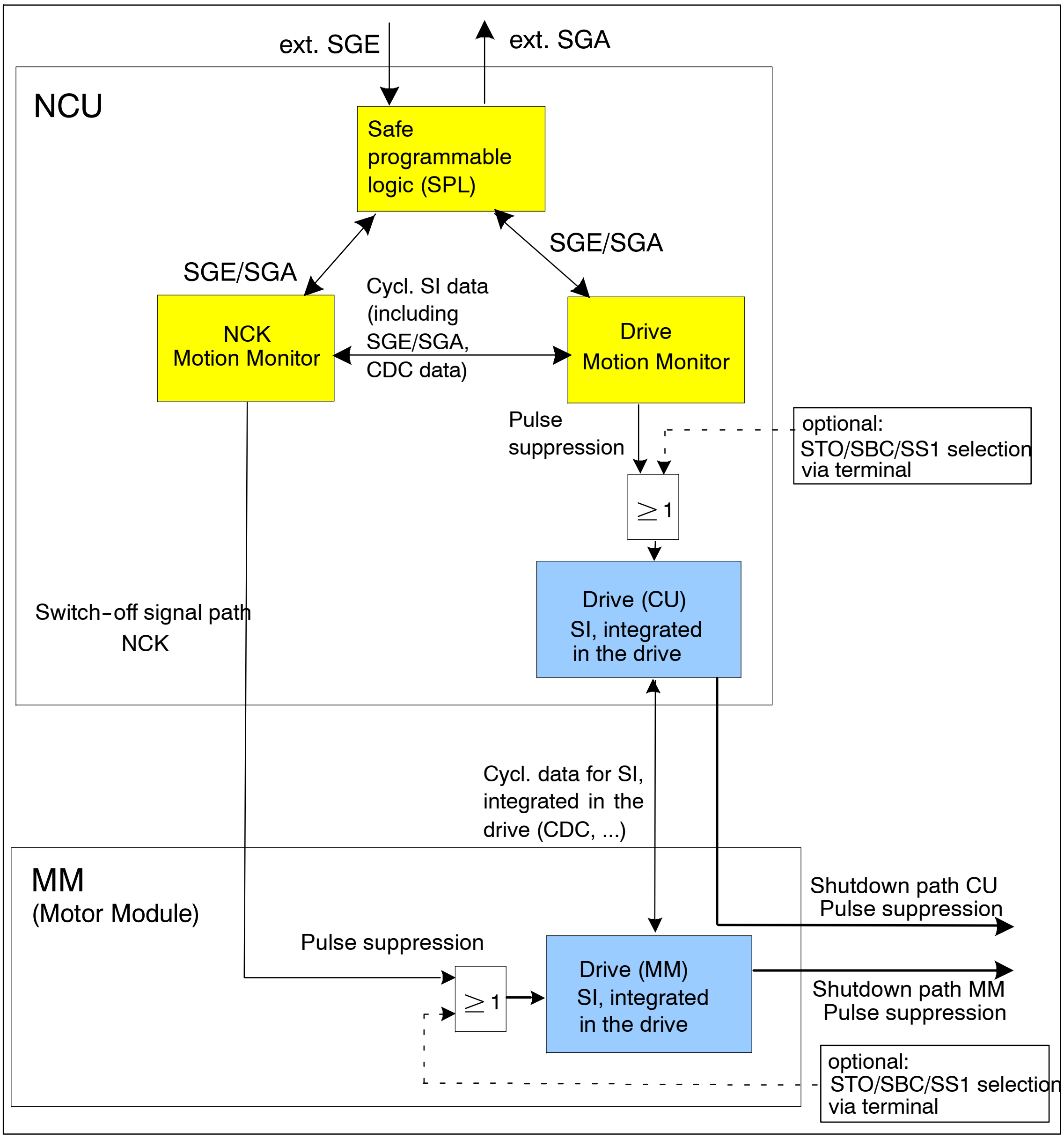


Fig. 6-1 Overview of the shutdown paths

Shutdown path of the monitoring channel, drive

The motion monitoring function in the CU signals the monitoring function integrated in the drive in the CU that the pulses must be cancelled in the SI monitoring channel integrated in the drive.

- Drive (CU) SI, integrated in the drive
  - The requirement to cancel the pulses is detected. Mechanisms then start that are also executed when STO is selected for the safety functions integrated in the drive:
    - Initiating the pulse cancellation
    - The timer routine is started to check the feedback. After the timer has expired (in the next monitoring clock cycle integrated in the drive), using the feedback signal, it is checked as to whether the pulses have been cancelled via this shutdown path.
    - If p9602=1, then safe brake control is executed.

Shutdown path of the monitoring channel, control

If the higher-level control with its motion monitoring identifies that it is necessary to cancel the pulses, then the following sequence applies:

- NCK Motion Monitor
  - The control communicates to the Motor Modules the requirements to cancel the pulses.
- Drive (MM), SI, integrated in the drive
  - If the drive-integrated monitoring function in the Motor Module identifies the requirement to cancel the pulses, then the same mechanisms are started that are carried out for an STO selection of the safety functions integrated in the drive and an STO is initiated:
    - Initiating the pulse cancellation
    - The timer routine is started to check the feedback. After the timer has expired (in the next monitoring clock cycle integrated in the drive), using the feedback signal, it is checked as to whether the pulses have been cancelled via this shutdown path.
    - If p9802=1, then safe brake control is executed.
  - If the Motor Module detects that communications to the NCK have failed, then this is identified by the safety functions integrated in the drive and an STO is initiated.

6.1.2 Test of switch-off signal paths

Description

The test stop is used to check the shutdown paths of both monitoring channels. There is a test stop input (drive SGE). The acknowledgement is realized via the drive SGA ”status pulses cancelled”. The pulse cancellation must be simultaneously initiated through both shutdown paths due to the fact that the Motor Modules and drive closed-loop control are cross-checked.

The user (machine manufacturer) must configure the execution of the test stop phase.

Note

A test stop can be simultaneously made for all axes of a drive unit.

Instant in time of the test stop

The shutdown paths must be tested (forced checking procedure) at a suitable instant in time, refer to Chapter 5.3 ”Forced checking procedure”.

Note

The machine manufacturer should define the ”test shutdown paths” time in an appropriate ”test block”.

Note

If the brake control is enabled, then when the test stop is initiated, the brake is also controlled.

Prerequisites for the test stop

- At the start, the pulses must still be enabled; further, it is not permissible that SH is selected at the start.
- For vertical (suspended) axes, the manufacturer must ensure that these are locked (to stop them falling).

Note

The test stop can be carried out independently of the status of the standard pulse cancellation.

Message

The ”test stop running” message is displayed during the ”test stop”.

6.2 Safe operating stop (SBH)

Description

The SBH function safely monitors the stop position (zero speed) of an axis/spindle in closed-loop position or speed control.

When SBH is active (SGA ”SBH active” = 1), operating personnel can, for example, enter protected machine areas in the setting-up mode without first having to power-down the machine.

An incremental encoder is sufficient to implement this function. The actual position value is monitored for a change.

In this case, the encoder coarse position must be taken into account for a 1-encoder system (see Chapter 5.4 ”Actual value conditioning”).

Features

The features of the SBH function are as follows:

- The axis remains in closed-loop control
- Parameterizable SBH tolerance window
- STOP B is the stop response after SBH has responded

Standstill tolerance

The standstill of the axis/spindle is monitored using an SBH tolerance window that is parameterized using the following machine data:

for 840D sl:
MD 36930: $MA_SAFE_STANDSTILL_TOL

for SINAMICS S120:
p9530: SI motion standstill tolerance (Control Unit)

Note

The width of the SBH tolerance window should be based on the standstill (zero speed) monitoring limit and should lie slightly above it. Otherwise, the standard monitoring functions of the control could be ineffective. In this case, the encoder coarse position must be taken into account for a 1-encoder system (see Chapter 5.4 ”Actual value conditioning”).

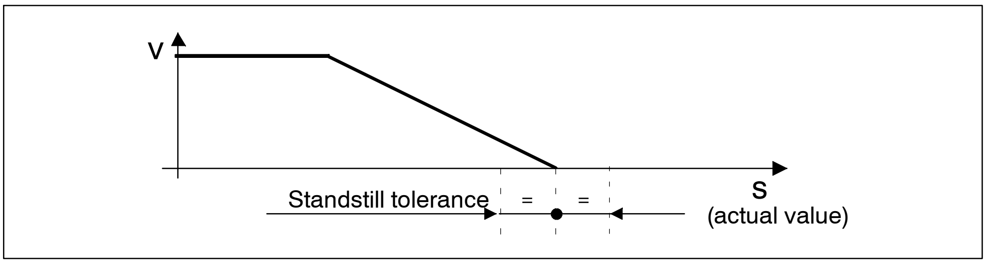


Fig. 6-2 Standstill tolerance

Preconditions

The following prerequisites must be fulfilled (see Chapter 3.1, ”System requirements”):

- The option and functions must be enabled in the axis–specific machine data
- The SGEs ”SBH/SG deselection” and ”SBH deselection” must be supplied in the NCK and drive monitoring channel

6.2.1 Selecting/deselecting the safe operating stop

Selecting SBH

The safe operating stop function is selected using the following SGEs:

Table 6-1 Selecting/deselecting SBH

SGE		**SGA**	
SBH/SG deselection	**SBH deselection**	**SBH active**	**Meaning**
= 1	x	0	SBH and SG are deselected
= 0	= 0	1	SBH is selected
= 0	= 1	0	SG is selected (see Chapter 6.5, ”Safely reduced speed (SG)”), [1]
Note: x –> Any signal state [1] The active SG stage is displayed using SGA ”SGA active bit 0” and ”SG active bit 1”.			

Note

If safely reduced speed was not active prior to the selection of SBH, any moving axis/spindle is stopped with STOP B/A.

The actual status of the function is displayed using the SGA ”SBH active”.

The SGEs and SGAs are described in Chapter 7.1 ”Safety-related input/output signals (SGE/SGA)”.

Internal control request for SBH

When the SG or SE responds (STOP C, D, E) the drive is internally switched to the safe operating stop state in the control. In such cases, the external circuit of the SGEs (SBH/SG deselection and SBH deselection) is ignored and both are internally set to ”0”.

Selecting SBH from SG

The changeover from safely reduced speed to safe operating stop is initiated using the SGE ”SBH deselection”. A delay time that is parameterized in the following machine data is simultaneously started with the changeover to SBH (”signal ”SBH deselection”=0):

<u>for 840D sl</u>

MD 36951: $MA_SAFE_VELO_SWITCH_DELAY

<u>for SINAMICS S120</u>

p9551: SI motion SLS(SG) changeover delay time (Control Unit)

SBH is activated as soon as the delay time expires.

Note

If the SBH function is selected while an axis/spindle is moving, the machine manufacturer must initiate the braking process such that the axis/spindle is in position – i.e. stationary – after the delay time has expired. This can be performed automatically using the ”setpoint speed limiting” function. If the axis moves out of the standstill tolerance window after the delay has expired, an alarm is generated (for 840D sl: 27010, for SINAMICS S120: F01707) and STOP B/A initiated!

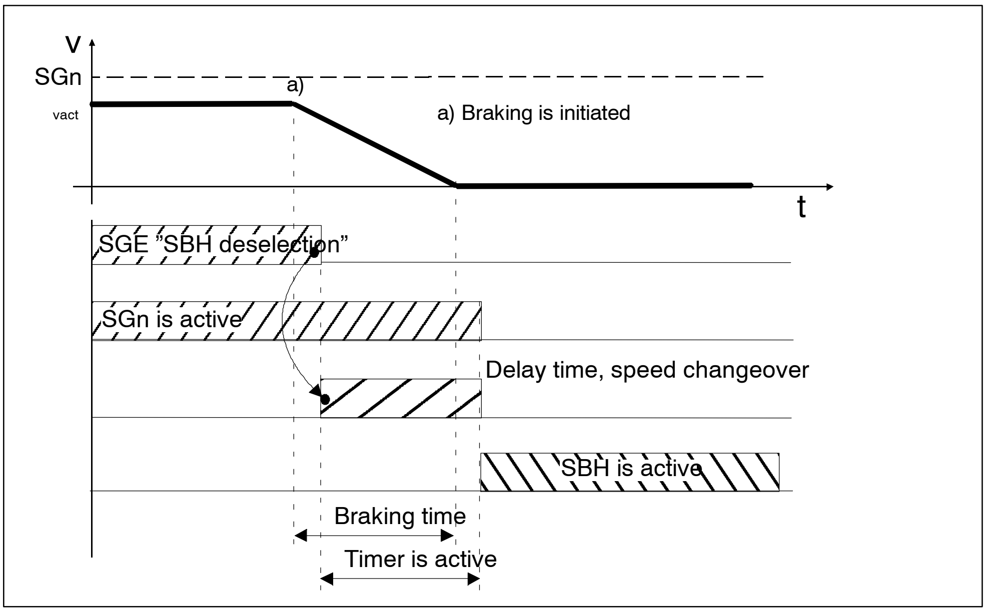


Fig. 6-3 Timing when SBH is selected from SG

Deselecting SBH

Safe operating stop can be deselected using SGE ”SBH/SG deselection” (= ”1” signal); this results in a general deactivation of SBH and SG. The SBH function is also deselected when the SG function is selected using the SGE ”SBH deselection”.

Note

The delay time must be selected as a function of the distance to the hazardous location. The speeds to be taken into account in this respect are stipulated in Standard DIN EN ISO 13855.

Configuring NCK-SGAs

The NCK-SGA ”SBH active” is configured using the following machine data:

for 840D sl

MD 36981: $MA_SAFE_SS_STATUS_OUTPUT

Configuring NCK-SGEs

for 840D sl

MD 36971: $MA_SAFE_SS_DISABLE_INPUT

SGA ”SBH active”

If this SGA is set, then safe operating stop (SBH) is active. This means that the axis is safely monitored for zero speed. This SGA can be used, for example, to implement protective door interlocking functions.

6.2.2 Effects when the limit is exceeded for SBH

Warning

If the safe operating stop function is activated, when a fault situation occurs, the axis mechanical system can exhibit jerky, uneven motion. The magnitude of this movement depends on the following parameters:

- Design of the mechanical system and gear ratio between the motor and mechanical system
- Speed and acceleration capability of the motor
- Magnitude of the selected monitoring clock cycle
- Magnitude of the selected SBH tolerance window

If the axis/spindle is being monitored (SGA ”SBH active”=1) and leaves, for example, the standstill tolerance window as the result of an external influence or an undefined setpoint input, the effects are as follows:

Effects

- The axis switches to STOP A/B configured using the following MDs:
  for 840D sl: 36956: $MA_SAFE_PULSE_DISABLE_DELAY
  for S120: p9556 SI motion pulse cancelation delay time (Control Unit)
  and
  for 840D sl: 36960: $MA_SAFE_STANDSTILL_VELO_TOL
  for S120: p9560 SI motion pulse cancelation shutdown speed (Control Unit)

- An alarm is generated (for 840D sl: 27010, for S120: F01707)

Timing when the limit value is exceeded

If the safe operating stop function is active, the timing response when the limit value is exceeded is as follows:

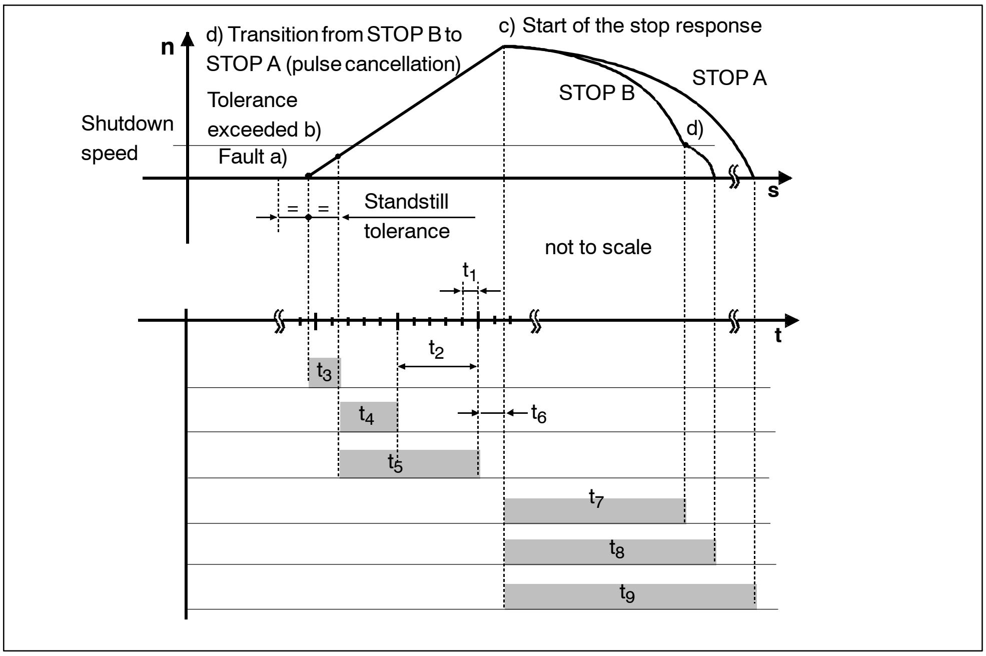


Fig. 6-4 Timing response when the limit value is exceeded for SBH

Table 6-2 Explanation of the figure

Time	Explanation
t_1	The position control clock cycle, defined by the following MDs: for 840D sl: MD 10050: $MN_SYSCLOCK_CYCLE_TIME MD 10060: $MN_POSCTRL_SYSCLOCK_TIME_RATIO
t_2	Monitoring clock cycle, defined by the following MDs: for 840D sl: MD 10090: $MN_SAFETY_SYSCLOCK_TIME_RATIO for SINAMICS S120: r9500: SI motion monitoring clock cycle (Control Unit)
t_3	Time until the standstill tolerance value is exceeded
t_4	Time until it has been detected that the standstill tolerance value has been exceeded (typical 0.5 monitoring clock cycles, maximum 1 monitoring clock cycle + 1 position controller clock cycle)
t_5	Response time required to initiate the configured stop response (typical 1.5 monitoring clock cycles, maximum 2 monitoring clock cycles + 1 position controller clock cycle)
t_6	Time until the stop response that was initiated starts (typical 2 position controller clock cycles, maximum 2 position controller clock cycles)
t_7	Time required to reach the shutdown speed for STOP B.
t_8	Time required to stop the axis for a STOP B.

Table 6-2 Explanation of the figure

Time	Explanation
t_9	Time required to stop the axis for a STOP A.
Note: Each axis must be measured during commissioning (start-up) to determine the distance that it travels between the limit switch being violated and it coming to a standstill.	

6.3 Safe Stops A-F

6.3.1 General information

Safe Stops are used to stop drive motion and bring it to a standstill. A distinction is made between internal and external Stops. The internal Stop responses, initiated by safety-related functions when limit values are violated, initiate an alarm. The external Stop responses selected by SGEs do not issue an alarm and are acknowledged when the SGEs are deselected.

Stop responses SBH and SH

Fig. 6-5 shows the relationship between the stop responses and the safe operating stop (SBH) or the safe standstill (SH).

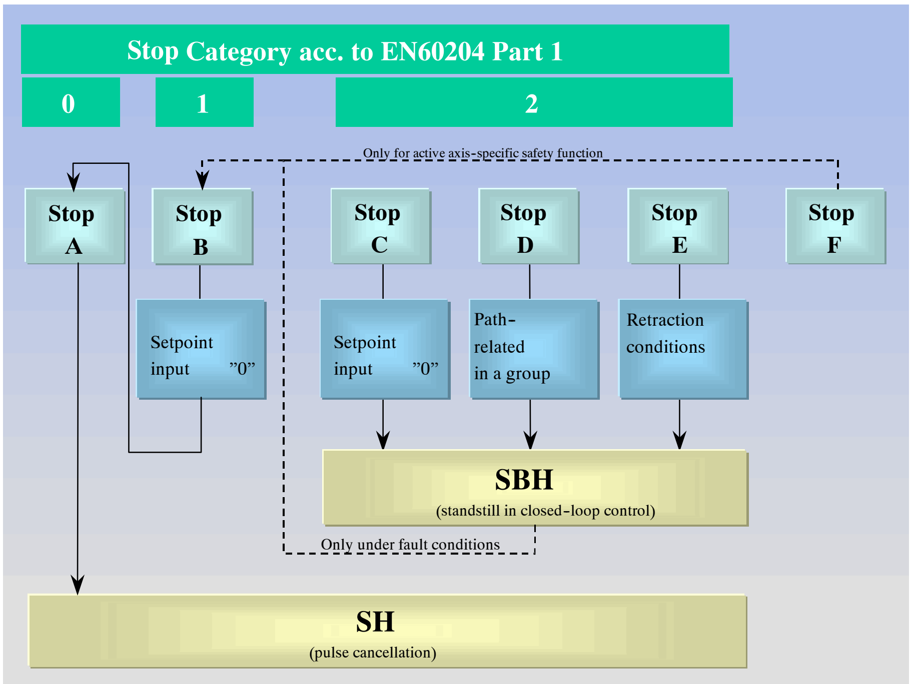


Fig. 6-5 Stop responses, safe operating stop (SBH), safe standstill (SH)

A high degree of security against faults/errors is afforded by the two-channel system structure with its permanent, crosswise data comparison. Alarms and stop responses are initiated when differences are detected between the two channels. The purpose of the stop responses is to safely stop the drives in a controlled fashion according to the actual machine requirements. A differentiation is made between the stop responses STOP A, B, C, D, E, F and the test stop. The type of stop response that occurs in the event of a fault/error can either be pre-determined by the system or configured by the machine manufacturer.

Stops A, C, D and E can also be externally selected as a function of an event via safety-related inputs (SGE).

Warning

Protection of personnel must be given top priority when stop responses are configured. The objective is to stop the drives in a way that best suits the situation. The time stages of the stops must be configured with the smallest possible value corresponding to the application.

Table 6-3 Overview of stop responses

STOP	Action	Effect	Initiated in response to	Changes to	Alarm
A	Pulses are immediately cancelled	Drive coasts down	SBR/SG	SH	POWER ON
B	0 speed setpoint is immediately entered + timer t_B started t_B =0 or n_{act} < $n_{shutdown}$: STOP A	The drive brakes along the OFF3 ramp – transition into STOP A	SBH/SG	SH	POWER ON
C	0 speed setpoint is immediately entered + timer t_C started t_C =0: SBH is activated	The drive is braked along the OFF3 ramp SBH active	SG/SE	SBH	RESET
D	Motor is braked along the acceleration + timer t_D started t_D =0: SBH is activated	Drive is braked as part of a group along the path SBH active	SG/SE	SBH	RESET
E	Results in stopping and retraction + timer t_E started t_E =0: SBH is activated	Drive is braked along the programmed retraction and stopping motion (ESR). SBH active	SG/SE	SBH	RESET

Table 6-3 Overview of stop responses

STOP	Action	Effect	Initiated in response to	Changes to	Alarm
F	Depending on the particular situation				
	a) Safety function inactive (no SBH, SG, SE and SN active): Saved (latched) message to the operator	a) NC start and traversing interlock		a) --	a) RESET
	b) Safety function active (SBH, SG, SE or SN active) STOP B/A is initiated (can be configured)	b) Transition to STOP B/A	Crosswise data comparison	b) SH	b) POWER ON
	c) Safety function active and STOP C, D or E initiated: Saved (latched) message to the operator	c) NC start and traversing interlock		c) --	c) RESET
Note: The timers can be set using the appropriate machine data.					

Configurable stop responses

The stop responses that occur when limit values are violated can be selected by the machine manufacturer using the appropriate machine data. These limit values are defined using the corresponding machine data:

Table 6-4 Configurable stop responses

Safety-related function	Configurable stop responses
SBH	STOP B* (cannot be configured)
SG	STOP A, B*, C, D, E
SE	STOP C, D, E
SN	No internal stop response When required, the user can configure the appropriate safe stop responses using the SGAs SN1, SN2, ...
SBR	STOP A (cannot be configured)
CDC: STOP F cannot be configured Note: * There is an immediate transition from STOP B to A if $t_B = 0$ or the parameterized speed threshold is exceeded.	

Assignment table for stop responses

Table 6-5 Stop responses for SI acc. to EN 60204-1

Stop response for SINUMERIK Safety Integrated	Stop function acc. to EN 60204-1
STOP A	Category 0
STOP B, STOP F 1)	Category 1
STOP C, STOP D, STOP E	Category 2
Note: 1): STOP F initiates STOP B if at least one safety-related function is active.	

Priority of the stop responses

Table 6-6 Priority for the stop responses

Priority level	Stop response
Highest priority	STOP A
. . . .	STOP B
. . . .	SGE test stop selection
. . . . .	STOP C
. . .	STOP D
.	STOP E
Lowest priority	STOP F

Note

A stop response listed in Table 6-6 ”Priorities for stop responses” can only be initiated if at least one safety-related function is active (except for STOP F).

Once a stop response has occurred, the sequence of operations it involves will be completed even if the cause of the stop no longer exists.

It is possible to advance to stop responses that have a higher priority. It is not possible to advance to stop responses that have a lower priority.

When the external stops are selected, there is still the exception that the actual low-priority STOP F can be initiated in spite of this.

Stop response sequence

If a stop response is initiated in the drive, a signal is sent to the NC that responds by initiating the same stop response (two-channel safety). Likewise, if a stop response is initiated in the NC, the drive is automatically signaled and responds by requesting the same stop response.
This mechanism ensures that stop responses are managed with a high degree of safety.

External stops

Using this function, the user can stop the drive using SGEs.
The drives can be brought to a standstill in the following ways:

- By canceling the drive pulses SGE ”deselect ext. STOP A”
- Braking with n_{set} = 0 SGE ”deselect ext. STOP C”
- Braking along a path SGE ”deselect ext. STOP D”
- Initiate an ESR SGE ”deselect ext. STOP E”

Enabling and activating the function

The function ”external STOPs” is enabled and activated using the following machine data:

- Enabling the function
  MD 36901 / parameter p9501: $MA_SAFE_FUNCTION_ENABLE/
  ”SI motion, enable safety functions”
  Bit 0: Enable SBH/SG (see note)
  Bit 6: Enable external STOPs
  Bit 4: Enable external STOP E

Note

- In addition to enabling the function ”external STOPs”, function SBH/SG must also be enabled as a minimum requirement.
- The external STOP E must be enabled with bit 4 = 1 in addition to bit 6 ”enable external STOPs”.

Configuring NCK-SGEs

for 840D sl:

MD 36977: $MA_SAFE_EXT_STOP_INPUT[n]:
(input assignment, external stop request) with n = 0, 1, 2, 3.

Note

- For stopping types that are **not used**, the assignment must be inverted by appropriately parameterizing MD 36977[n]. This means that they are set to a "1" signal and are permanently "inactive".

Exception:

- STOP E is interlocked by its own enable signal.

An external Stop E can also be initiated as an error response to a crosswise data comparison of NCK and PLC-SPL or for PROFIsafe errors, instead of a STOP D. Parameterization on the NCK side is carried out using MD10097: $MN_SAFE_SPL_STOP_MODE = 4, on the PLC side using DB 18.DBX36.1=1. This parameterization is checked in the crosswise data comparison between PLC-SPL and NCK-SPL (see Chapter 7.5 "Safe programmable logic").

If the value 4 is parameterized in MD 10097, without enabling the external Stop E in all axes with SI function enable, then Alarm 27033 is output for all of these axes.

SGE to stop the drive

The following SGE are available to stop the drive:

Table 6-7 SGE to stop the drive

SGE	Stopping type	Priority
Deselect ext STOP A (= SH deselection)	Pulse suppression	High
Deselect ext. STOP C	Braking with n_{set} = 0	...
Deselect ext. STOP D	Braking along a path	...
Deselect ext. STOP E	ESR is initiated	Low

Notes:
SGE " ... " = 1 Stopping is not initiated (it is deselected)
SGE " ... " = 0 Stopping is initiated (it is selected)
If a stop request is selected simultaneously using several SGEs, then that with the highest priority is executed.
If one of these SGEs changes, the "tolerance time for SGE changeover" is activated (36950/p9550).
Feedback signals:
for SGE "deselect ext. STOP A": via SGA "status pulses cancelled" and SGA "STOP A/B active"
for SGE "deselect ext. STOP C": via SGA "STOP C active"
for SGE "deselect ext. STOP D": via SGA "STOP D active"
for SGE "deselect ext. STOP E": via SGA "STOP E active"

Note

- For external STOPs, alarms are not displayed. This means that the user himself must configure the required message/signal.

Combinations for external STOPs

The following input bit combinations are obtained for the SGEs ”deselect ext. STOP A”, ”deselect ext. STOP C”, ”deselect ext. STOP D” and ”deselect ext. STOP E”:

Table 6-8 Input bit combinations

SGE				
Deselect external STOP E	**Deselect external STOP D**	**Deselect external STOP C**	**Deselect external STOP A**	**Description**
x	x	x	0	”Pulse cancellation” is initiated
x	x	0	1	”Braking with n_{set} = 0” is initiated
x	0	1	1	”Braking along a path” is initiated
0	1	1	1	”ESR” is initiated
1	1	1	1	External STOPs are not selected

Acknowledging a stop request

After requesting a specific stop type via SGE, this sequence can be cancelled by one of the following events:

- Deselecting the stop request
- Selecting a stop request using an SGE with a higher priority
- A higher stop request (STOP A; B; C or D) with a higher priority is received from an internal monitoring function

Effects of the stop responses on other axes/spindles

If a stop response is initiated, then this has the following effects on all of the other axes in the same channel:

STOP E: Extended stopping and retraction is initiated

STOP D: Braking along a path

STOP C: NCK: IPO fast stop (braking at the current limit)

STOP A: IPO fast stop (braking at the current limit)

The effect on the other axes in the channel can be influenced using MD 36964: $MA_SAFE_IPO_STOP_GROUP. This allows, for example, the pulses of a spindle to be safely cancelled (using an external STOP A), in order that this spindle can be manually turned and the axes can still be moved while being safely monitored.

STOP	$MA_SAFE_IPO_STOP_GROUP = 0	$MA_SAFE_IPO_STOP_GROUP = 1
C	Axes that interpolate with the involved axis brake at the current limit. All other axes brake along the parameterized braking ramp.	Axes that interpolate with the involved axis brake at the current limit. All other axes do not brake.
D	Axes/spindles brake along the path or along the parameterized braking ramp.	Axes that interpolate with the involved axis brake along the parameterized braking ramp. All other axes do not brake.
E	<u>ESR enabled and active:</u> ESR is initiated <u>ESR neither active nor enabled:</u> After a delay time of max. 2 Ipo clock cycles, the behavior as described for STOP D is initiated.	

6.3.2 Description of STOP A

When STOP A is activated, safe standstill (SH) is effective, see Chapter 6.1.1 ”Shutdown paths”.

Action in the drive monitoring channel:
Pulses are immediately cancelled using the internal signal ”cancel pulses”. In addition, the pulses in the gating unit are cancelled by a software function.

Action in the NCK monitoring channel:
the pulses are cancelled via the internal shutdown path of the NCK monitoring channel

- Effect:
  The drive coasts to a standstill if no external braking mechanism such as an armature short-circuit and/or holding brake is used. The axis-specific alarm results in a mode group stop, i.e. as the result of the error in one axis, all axes and spindles in a mode group are stopped. Safe standstill becomes effective at the end of STOP A.
- Alarm message for an internally initiated STOP A:
  The alarm message ”STOP A initiated” is displayed.
- Acknowledgement for an internally initiated STOP A:
  An unintentional restart is prevented for STOP A. The error can only be acknowledged from the drive and control using a power on.

SGA STOP A/B active
This signal indicates that STOP A/B is active.
0 signal: STOP A/B is not active.
1 signal: STOP A/B is active.

Warning

If the safe standstill function or ”STOP A” is activated, the motor can no longer generate any torque. This is the reason that potentially hazardous motion can occur, e.g. for the following:

- When an external force acts on the drive axes
- Vertical and inclined axes without weight equalization
- Axes that are moving (coasting down)
- Direct drives with low friction and low self-locking
- Notching torques (depending on the motor type, bearing design and friction characteristics, up to half a pole pitch in a direction that cannot be predicted)

Possible hazards must be clearly identified using a risk analysis that must be carried out by the manufacturer. With an assessment, based on this risk analysis, it should be defined as to which additional measures are required, e.g. external brakes.

SGE deselect external STOP A

”Pulse cancellation” can be requested and executed using this SGE.
The safe functions currently active (SG/SBH/SN/SE) are not influenced by this SGE.
If one of the currently active limits is violated, an appropriate alarm is initiated. The associated shutdown response cannot be activated because the pulses have already been cancelled. As soon as the stop request is cancelled via the SGE ”deselect ext. STOP A” any queued shutdown responses become active.

If a stop request is active, SGA ”STOP A/B is active” is set in the same way as it would be for an internally triggered STOP A.

Using MD 36977: $MA_SAFE_EXT_STOP_INPUT[0] is used to define the selection/deselection of the external brake request, in this case, ”deselect external STOP A” (SH, pulse cancellation).

6.3.3 Description of STOP B

Action in the drive monitoring channel:
The drive is braked along the OFF3 ramp by entering a speed setpoint = 0. If the speed setpoint falls below the value entered into p9560: ”SI motion, pulse cancellation shutdown speed”, or if the timer p9556: ”SI motion, delay time expired”, then the system automatically changes into a STOP A.

Action in the NCK monitoring channel:
Essentially the same as the drive, the control enters a speed setpoint of 0 and when the value in MD 36960: $MA_SAFE_STANDSTILL_VELO_TOL is fallen below or after the timer MD 36956: $MA_SAFE_PULSE_DISABLE_DELAY has expired, then a transition is automatically made to STOP A.

If the timer in data 36956: $MA_SAFE_PULSE_DISABLE_DELAY or p9556: ”SI motion pulse cancellation, delay time” is set to zero, then for a STOP B, the system immediately changes over to a STOP A.

The shutdown speed for the pulse cancellation is generally reached faster than the delay time for the pulse cancellation.

- Effect:
  The drive is braked along the OFF3 ramp under closed-loop speed control and brought to a safe standstill.
- Alarm message for an internally initiated STOP B
  The alarm message ”STOP B initiated” is displayed.
- Alarm message for an internally initiated STOP B:
  An unintentional restart is prevented using a STOP A. The error can only be acknowledged from the drive and control using a power on.

SGA STOP A/B is active
This signal indicates that the STOP A/B is active.

0 signal:	STOP A/B is not active
1 signal:	STOP A/B is active

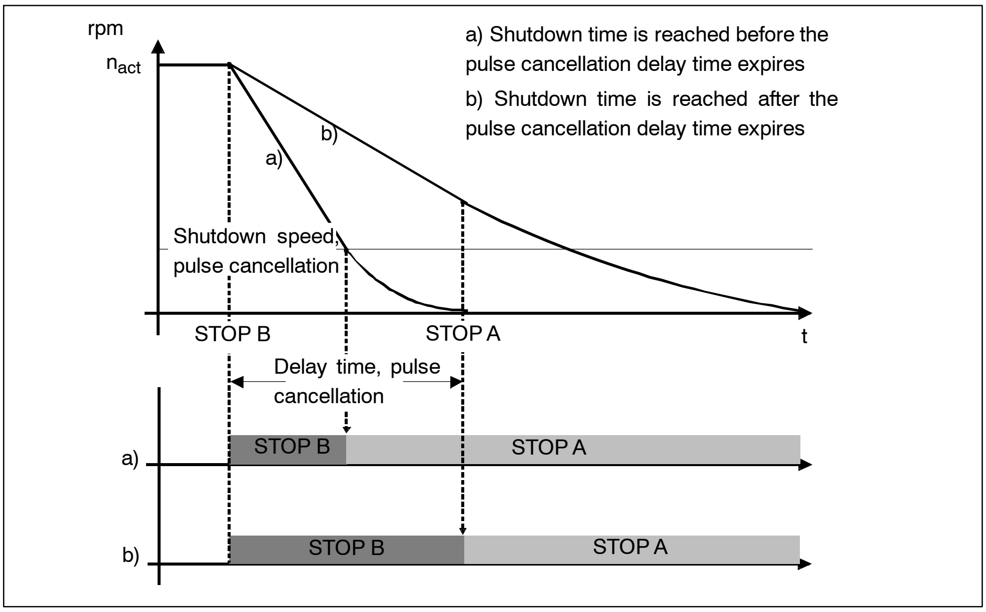


Fig. 6-6 Transition from STOP B to STOP A

It is possible that the stop for the NCK becomes effective one safety monitoring clock cycle earlier than for the drive. This means that braking along the current limit can become effective before the OFF3 ramp of the drive becomes effective. In order to reduce the level of stress of the mechanical system of the machine (if required) the braking torque can be reduced. To realize this, bit 4 ”Torque limiting active in motoring/regenerating mode” can be set in parameter p1400 and parameter p1521 ”Torque limit lower/regenerative” can be set to the required lower torque. In this case, it should be noted that the braking distance (stopping distance) of the axis is extended.

6.3.4 Description of STOP C

Action in the drive monitoring channel:
The drive is braked along the STOP2 ramp in response to a speed setpoint input = 0 and in parallel, the timer via parameter p9552: ”Transition time from STOP C to SBH” is started. The SBH function is automatically activated after the timer expires.

Action in the NCK monitoring channel:
Essentially the same as the drive, the speed setpoint = 0 is specified by the control and the interface signal ”Position controller active” (DB 31, ... DBX 61.5) of the drive involved is set to zero.
At the same time, the timer via MD 36952: $MA_SAFE_STOP_SWITCH_TIME_C is started. The SBH function is automatically activated after the timer expires.

- Effect:
  The drive is braked along the STOP2 ramp under closed-loop speed control and brought into SBH.
- Alarm message for an internally initiated STOP C:
  The alarm message ”STOP C initiated” is output (see Chapter 10.2, ”Alarms for SINUMERIK 840D sl”).
- Acknowledgement for an internally initiated STOP C:
  An unintentional restart is prevented for a STOP C. The error can be acknowledged using the NC–RESET key.

SGA STOP C is active
This signal indicates that STOP C is active.
0 signal: STOP C is not active.
1 signal: STOP C is active.

It is possible that the stop for the NCK becomes effective one safety monitoring clock cycle earlier than for the drive. This means that braking along the current limit can become effective before the STOP2 ramp of the drive becomes effective. In order to reduce the level of stress of the mechanical system of the machine (if required) the braking torque can be reduced. To realize this, bit 4 ”Torque limiting active in motoring/regenerating mode” can be set in parameter p1400 and parameter p1521 ”Torque limit lower/regenerative” can be set to the required lower torque. In this case, it should be noted that the braking distance (stopping distance) of the axis is extended.

SGE deselect external STOP C

If a stop request is active, SGA ”STOP C is active” is set in the same way as it would be for an internally initiated STOP C.

Using MD 36977: $MA_SAFE_EXT_STOP_INPUT[1] is used to define the selection/deselection of the external braking request; in this case ”deselect external STOP C” (braking along the current limit).

6.3.5 Description of STOP D

Action in the drive monitoring channel:
The drive monitoring channel requests a path stop or braking along the actual acceleration characteristic. In parallel, the timer is started via parameter 9553: ”transition time from STOP D to SBH” is started. The SBH function is automatically activated after the timer expires.

Action in the NCK monitoring channel:
Essentially the same as the drive, the NC monitoring channel requests a path stop or braking along the acceleration characteristic. At the same time, the timer via MD 36953: $MA_SAFE_STOP_SWITCH_TIME_D is started. The SBH function is automatically activated after the timer expires.

- Effect:
  The drive is braked in a group – including simultaneous axes – along the set traversing path.
  For axes, the acceleration characteristic is defined so that the axes stop within the time saved in MD 36953: $MA_SAFE_STOP_SWITCH_TIME_D. Therefore, ensuring stopping with low associated stress on the machine.
  When booting, for all of the axes, the control checks whether the braking time set in MD 36953 is sufficient for the active acceleration characteristic of the axis. When violated, the suppressible alarm 22001 ”Channel %1 Block%2 Axis %3: Braking ramp longer than STOP D time. Reason: %4” is output.
  For spindles, the actual acceleration characteristic is not adapted. The control checks whether the braking time, set in MD 36953 $MA_SAFE_STOP_SWITCH_TIME_D, is sufficient for all spindle operating modes and configured gear stages. When violated, suppressible alarm 22002 ”Channel %1 Spindle%2: Braking ramp longer than STOP D time. Gear stage %3. Reason: %4” is output. If the spindle is in axis operation, then it behaves just like an axis.
  For an active axis or spindle coupling (with the exception of the synchronous spindle coupling), the coupling is no longer taken into consideration, if synchronous stopping of the coupled group is no longer safely possible within the time parameterized in MD $MA_SAFE_STOP_SWITCH_TIME_D. For a coupled group, this is the reason that for all axes of the coupled group, a STOP D must be set.
  For the synchronous spindle coupling, when synchronous operation is reached, the coupling is always maintained. The coupling group is always braked via the leading spindle. If the following spindle requires a longer braking time than the leading spindle, then MD $MA_SAFE_STOP_SWITCH_TIME_D must be appropriately increased for the leading spindle.
  When a synchronous spindle is active, STOP D should also be initiated for the leading and following spindle.
  Endlessly rotating axes are braked at the acceleration limit. The SBH function is automatically activated after the timer expires.
- Alarm message for an internally initiated STOP D:
  The alarm message ”STOP D initiated” is output.
- Acknowledgement for an internally initiated STOP D:
  An unintentional restart is prevented for STOP D. The error can be acknowledged using the NC–RESET key.

SGA STOP D is active
This signal indicates that STOP D is active.

0 signal:	STOP D is not active.
1 signal:	STOP D is active.

SGE deselect external STOP D

If a stop request is active, SGA ”STOP D is active” is set in the same way as it would be for an internally triggered STOP D.

Using MD 36977: $MA_SAFE_EXT_STOP_INPUT[2] is used to define the selection/deselection of the external braking request, in this case ”deselect external STOP D” (path braking).

6.3.6 Description of STOP E

Action in the drive monitoring channel:
The drive monitoring channel requests an extended stop and retract (ESR), controlled from the NC. At the same time, timer in parameter p9554: ”SI motion transition time from STOP E to SBH” is started. The SBH function is automatically activated after the timer expires.

Action in the NCK monitoring channel:
An ESR is requested by the control monitoring channel. At the same time, timer in MD 36954: $MA_SAFE_STOP_SWITCH_TIME_E is started. The SBH function is automatically activated after the timer expires.

- Effect:
  The extended stop and retract that have been configured are started.
- Alarm message:
  The alarm message ”STOP E initiated” is displayed.
- Acknowledgment:
  For STOP E, an unintentional restart is prevented. The error can be acknowledged using the NC-RESET key.

SGA STOP E is active
This signal indicates that STOP E is active.
0 signal: STOP E is not active.
1 signal: STOP E is active.

The NC-controlled ESR is initiated by writing to the system variable $AC_ESR_TRIGGER=1 (also see /FB3/, M3 ”Axis coupling and ESR”). To obtain the criteria for initiating, the following SI system variables are used:

$VA_STOPSI:
Axial system variable that contains the present stop.
For a value of 4, a Stop E is active for this axis.

$A_STOPESI:
Global system variable that displays a value not equal to 0 to indicate that a Stop E is active on one of the axes. This variable saves the user having to search through all of the axes.

SGE deselect external STOP E

When a stop request is active, the SGA ”STOP E is active” is set.

Using MD 36977: $MA_SAFE_EXT_STOP_INPUT[3] defines the selection/deselection of the external braking request, in this case ”deselect external STOP E” (extended stopping and retraction plus path braking).

Note

STOP E only produces a different response than STOP D if the user has configured the ESR function - extended stop and retract - and initiation of the ESR is programmed depending on $VA_STOPSI or $A_STOPESI.
If ESR is not active, the STOP E behaves like a STOP D. However, if the ESR configuration is incorrect, there is a delay of up to 2 IPO cycles compared to STOP D until the braking operation is initiated. Possible causes:

- The initiation of the ESR as static synchronous action does not take into account the system variables $VA_STOPSI or $A_STOPESI.
- ESR is neither parameterized nor enabled.
- For individual PLC controlled axes, only the axis-specific ESR is used via $AA_ESR_TRIGGER. This trigger may be used in addition to the channel-specific trigger.

For other incorrect ESR programming, a delay by the time entered in $MC_ESR_DELAY_TIME1 and $MC_ESR_DELAY_TIME2 is possible. After these times have expired, braking is initiated at the current limit. Possible cause:

- The retraction position cannot be reached within the specified time.

Note

The ESR integrated in the drive can by triggered by writing to the system variable $AN_ESR_TRIGGER (see also /FB3/, M3 ”Axis couplings and ESR”). The STOP E delay time in MD 36954: $MA_SAFE_SWITCH_TIME_E or drive parameter in p9554 should be selected, so that the timer for ESR in p0892 is covered by the SINAMICS basic system.

See also Chapter 11.8.1 ”Delayed pulse cancellation in the event of a communication failure”.

6.3.7 Description of STOP F

The STOP F response is permanently assigned to the error handling (e.g. the crosswise result and data comparison, detecting communication and encoder faults).

If such as fault/error state is detected, then the following responses are triggered.

Response, if no safety functions are active:

Faults/errors are also detected if none of the safety-related functions are active (safety functions are SBH, SG, SE, SN, $n<n_x$ synchronization). The saved message ”defect in a monitoring channel” is output on both the drive and control sides and can only be acknowledged using the NC-RESET key. The message does not interrupt machining. A system restart is prevented by an internal NC start/traversing inhibit function. Dormant faults/errors are detected on the drive and control sides.

Response if one safety function is active:

Faults/errors are detected and a STOP B/A response is initiated in the drive and control system (see description of STOP B). The error can only be acknowledged from the drive and control using a power on.
Exception: If an internal STOP C/D/E is already present, because STOP F has a lower priority (see Chapter 6.3.1, Section ”Priority of the stop responses”).

- Alarm message:
  Alarms 27001 ”Error in a monitoring channel” and/or 2710x ”Difference in function...” and C01711 ”SI motion error in a monitoring channel” are displayed.
  For further diagnostics, for Alarm 27001, a fine error coding is displayed in the alarm line. The fine coding for the drive alarm can be found in r9725 ”SI Motion diagnostics for STOP F” or in the SI status display under STOP F.
  The significance of the error code is provided in Chapter10.2 under Alarm 27001 ”Defect in a monitoring channel”.

A delay time before STOP B is initiated can be parameterized using MD 36955 $MA_SAFE_STOP_SWITCH_TIME_F. During this time, the machine manufacturer can initiate an NC controlled response, e.g. ESR. After this time has expired, the involved axis is braked with STOP B. This is also true if, in the meantime, a stop with a higher priority than STOP F (STOP E, D, C) is present. The system variables $VA_XFAULTSI and $A_XFAULTSI, bit 1 can be used to detect whether a STOP F was initiated that is then followed by a STOP B. In the delay time up to the STOP B, an ESR or braking along the programmed path can be initiated (e.g. by writing to $AC_ESR_TRIGGER or initiating an external STOP D).
During the delay time up to initiating STOP B, additional, non-safety-related monitoring functions can already result in other braking responses. A STOP D or the initiation of ESR can be influenced due to harder braking responses of the drive (the same as e.g. the configured braking response when an encoder fails).

Note

For STOP F, when monitoring functions are active (SBH, SG, SE, not "$n<n_x$", however, "Synchronization, hysteresis and filtering "$n<n_x$"), STOP B (braking at the current limit with speed setpoint = 0) is defined as the following stop.

Warning

If an internal or external fault occurs, as a result of the fault, during the STOP F response the parameterized safety functions are either no longer available or only with restrictions. This must be carefully taken into account when parameterizing the delay time between STOP F and STOP B (MD 36955 / p9555) and must be taken into account in the risk analysis performed by the machine manufacturer. This applies in particular to vertical axes.

Note

A delay time between STOP F and STOP B should only be set, if, during this time, an alternative response is initiated by evaluating the system variables $VA_XFAULTSI and $A_XFAULTSI.

Further, when using the delay time, a monitoring function should always be active - also in the automatic mode (e.g. SE, SN, SG with high limit switch). For example, if the SBH monitoring function is only active on the drive side, for example because of the (single-channel) failure of a door switch, then although this results in a STOP F, the STOP F -> STOP B delay time on the NCK side is not started if previously no monitoring function was active. This means that in this case, the drive responds with a STOP B (however this is also initiated in the NCK due to the exchange of the stop responses), but this is not displayed in the NCK variables $VA_XFAULTSI and $A_XFAULTSI.
The appropriate monitoring functions of the drive (e.g. when SBH is selected) are also executed instantaneously without any delay.

Note

The ESR integrated in the drive can by triggered by writing to the system variable $AN_ESR_TRIGGER (see also /FB3/, M3 "Axis couplings and ESR"). The STOP F delay time in MD 36955: $MA_SAFE_STOP_SWITCH_TIME_F or drive parameter in p9555 should be selected, so that the timer for ESR in p0892 is covered by the SINAMICS basic system.

See also Chapter 11.8.1 "Delayed pulse cancellation in the event of a communication failure".

Comment:
When combined with "ESR managed from the control", theoretically the following error is possible: Both monitoring channels (NCK and drive) trigger a STOP F; however, a safety function is only active on the drive side (errors in the two SPL channels, which are then most probably responsible for the STOP F). In this case, the NCK does not trigger an ESR, because for the NCK no subsequent STOP B can be identified. Conversely, this statement is also valid for the combination with "ESR integrated in the drive" and a safety function is only active in the NCK. The ESR integrated in the drive is then not started.

Example 1 – delaying the transition from STOP F to STOP B:

The speed characteristics of an axis for parameterized stopping are shown in Fig. 6-7. In this case, the axis should continue 500 ms and then brake along the parameterized ramp. A delay time of 2.5 s is selected until STOP B is initiated ($MA_SAFE_STOP_SWITCH_TIME_F).

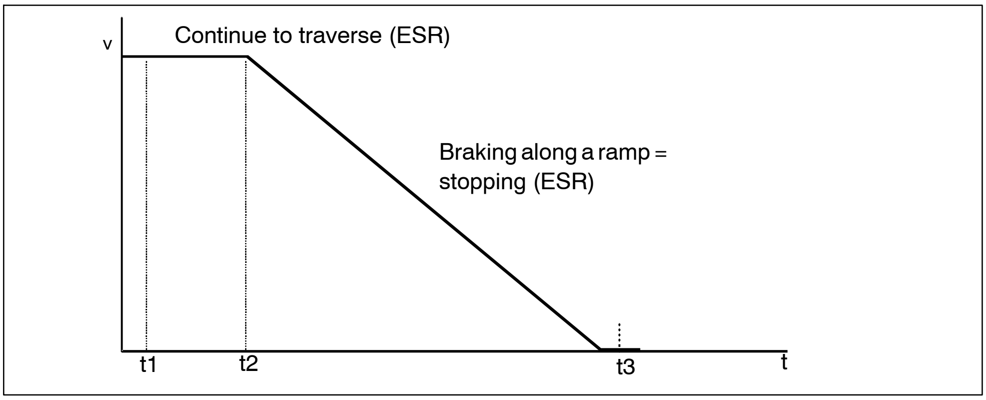


Fig. 6-7 Velocity characteristic of an SI axis when stopping with STOP F

The following actions take place at the following instants in time:

t1:
STOP F occurs, ESR is started
t2:
500 ms after t1, braking starts along the parameterized ramp
t3:
STOP B is initiated 2.5 s after t1. The axis is already stationary at this time, which means that the pulses can be immediately cancelled.

Example 2 – delaying the transition from STOP F to STOP B

The same parameterization as in Example 1 is shown in Fig. 6-8. However, when a STOP F occurs, no monitoring function is active. At instant in time t2, a monitoring function is activated. ESR is only started if there is a STOP F with active monitoring function.

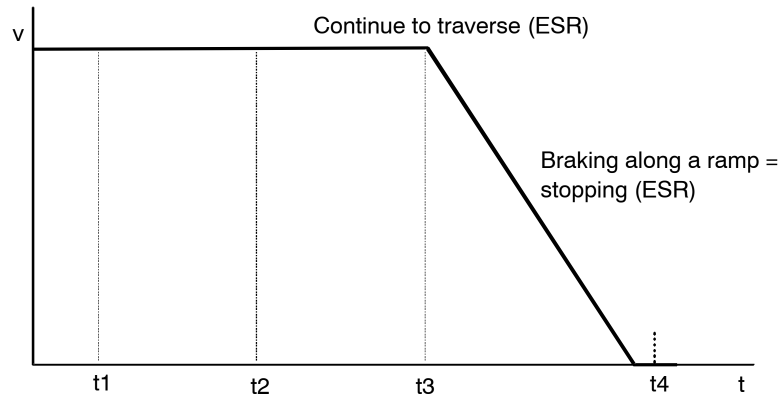


Fig. 6-8 Velocity characteristic of an SI axis when stopping with STOP F

The following actions take place at the following instants in time:

t1:
STOP F occurs, no response
t2:
At any time after t1, a monitoring function is activated. At this instant in time, the transition to a STOP B is started and bits 1 in $A_XFAULTSI and $VA_XFAULTSI of this axis are set.
t3:
500 ms after t2, braking starts along the parameterized ramp
t4:
STOP B is initiated 2.5 s after t2. The axis is already stationary at this time, which means that the pulses can be immediately cancelled.

6.3.8 Forced checking procedure of the external STOPs

The following applies for the test stop of external STOPs:
All stop SGEs that are used are switched one after the other in each channel and the positive response evaluated using the associated SGA ”STOP x is active”.

Note

Only the enabled and activated external standstill functions have to be tested.

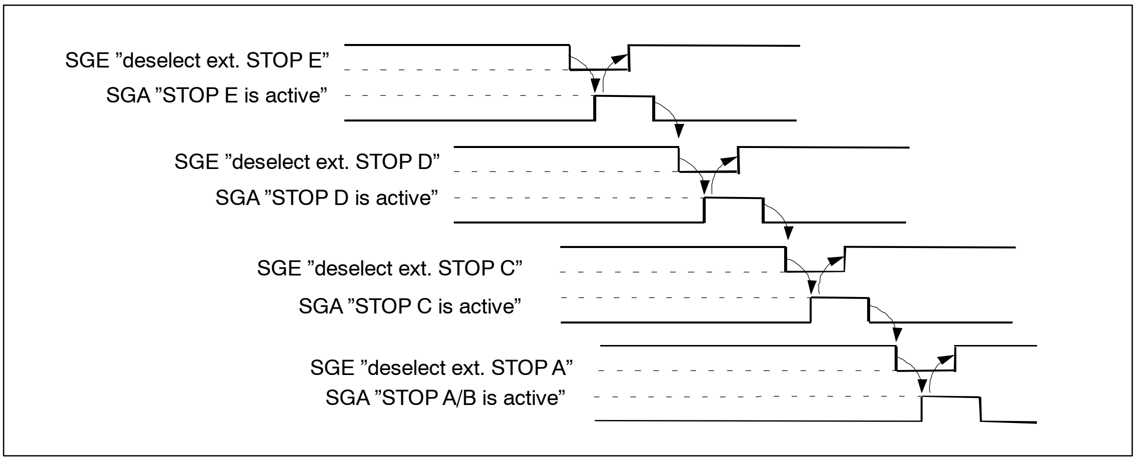


Fig. 6-9 Sequence of the test stop for external STOPs. Example: External STOPs A, C, D, E are used

Which SGE/SGA are required for the test stop of external STOPs?

The following SGE/SGA can be used to perform the test stop for external STOPs:

Table 6-9 SGEs/SGAs for the test stop, external STOPs

NCK monitoring channel	NCK-SGE "deselect ext. STOP A" NCK-SGA "STOP A/B is active" NCK-SGE "deselect ext. STOP C" NCK-SGA "STOP C is active" NCK-SGE "deselect ext. STOP D" NCK-SGA "STOP D is active" NCK-SGE "deselect ext. STOP E" NCK-SGA "STOP E is active"
Drive monitoring channel	PLC-SGE "deselect ext. STOP A" PLC-SGA "STOP A/B is active" PLC-SGE "deselect ext. STOP C" PLC-SGA "STOP C is active" PLC-SGE "deselect ext. STOP D" PLC-SGA "STOP D is active" PLC-SGE "deselect ext. STOP E" PLC-SGA "STOP E is active"

6.4 Safe acceleration monitoring (SBR)

Description

Using this function, for STOPs B and C the system monitors as to whether the drive speed increases.

Features

The most important features include:

- Fastest possible detection if the axis starts to re-accelerate when braking
- SBR is automatically activated, when a STOP B or C has been initiated
- When SBR responds, a STOP A is initiated and Alarm 27013 ”Axis %1 safe monitoring for acceleration exceeded” and the drive messages C01706/C30706 ”Acceleration monitoring limit exceeded” initiated.

Activating the SBR

When a STOP B or C is initiated, the actual speed plus the speed tolerance, defined in the machine data/parameter, is activated as the speed limit. When the actual decreases, then this speed limit is correspondingly corrected; however, for an increased speed, it is not changed. If the drive speed exceeds the actual speed limit then a STOP A is initiated. If the axis starts to re-accelerate while braking, this is detected as quickly as possible and prevented.

Machine data/parameters for the SBR speed tolerance:

for 840D sl:
MD 36948: $MA_SAFE_STOP_VELO_TOL

for SINAMICS S120:
p9548: SI motion SBR actual speed tolerance (Control Unit)
The speed limit is corrected until the speed, defined in the following machine data, is undershot (fallen below). After that, the limit value of the SBR monitoring is frozen to the value in MD/parameter 36946/p9546 plus the value in MD/parameter 36948/p9548.

for 840D sl:
MD 36946: $MA_SAFE_VELO_X (speed limit $n<n_x$)

for SINAMICS S120:
p9546: SI motion SSM (SGA n < nx) speed limit (CU)

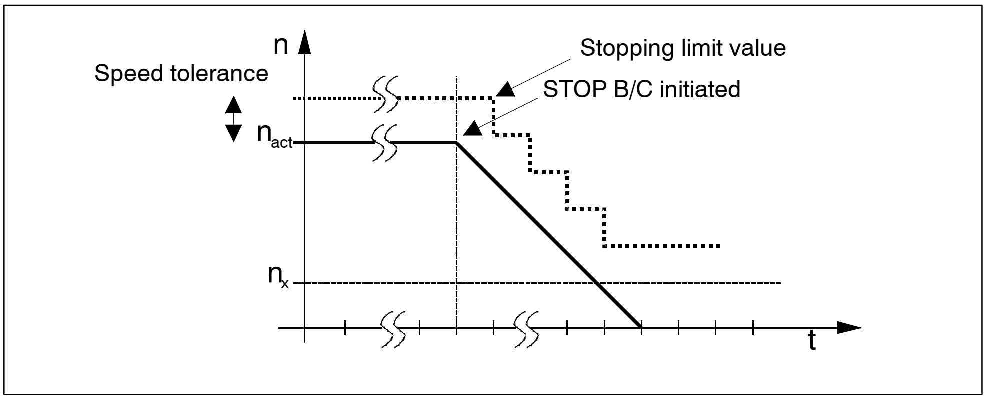


Fig. 6-10 Characteristic of the stopping limit value for SBR

Calculating SBR tolerance of the actual speed

The following rules are valid for the parameterization of SBR tolerance:

The possible speed increase after initiating a STOP B/C is obtained from the effective acceleration a and the duration of the acceleration phase. The acceleration phase lasts from one monitoring clock cycle ÜT (delay from detecting a STOP B/C until n_{set} = 0):

SBR tolerance
Actual speed SBR = acceleration * acceleration duration

The following setup rule is derived thereof:

For a linear axis:
SBR tolerance [mm/min] = a [m/s^2] * ÜT [s] * 1000 [mm/m] * 60 [s/min]

For rotary axis/spindle:
SBR tolerance [rev/min] = a [rev/s^2] * ÜT [s] * 60 [s/min]

The following machine data should be taken into account when determining the acceleration:

MD 32300: MAX_AX_ACCEL
MD 35200: GEAR_STEP_SPEEDCTRL_ACCEL
MD 35210: GEAR_STEP_POSCTRL_ACCEL
MD 35410: SPIND_OSCILL_ACCEL

Recommendation:
The value entered for the SBR tolerance should be approx. 20% higher than the calculated value.

Timing when the actual stop limit value is exceeded

If the safe acceleration monitoring function is active, then the following timing is obtained when the actual stop limit value is exceeded:

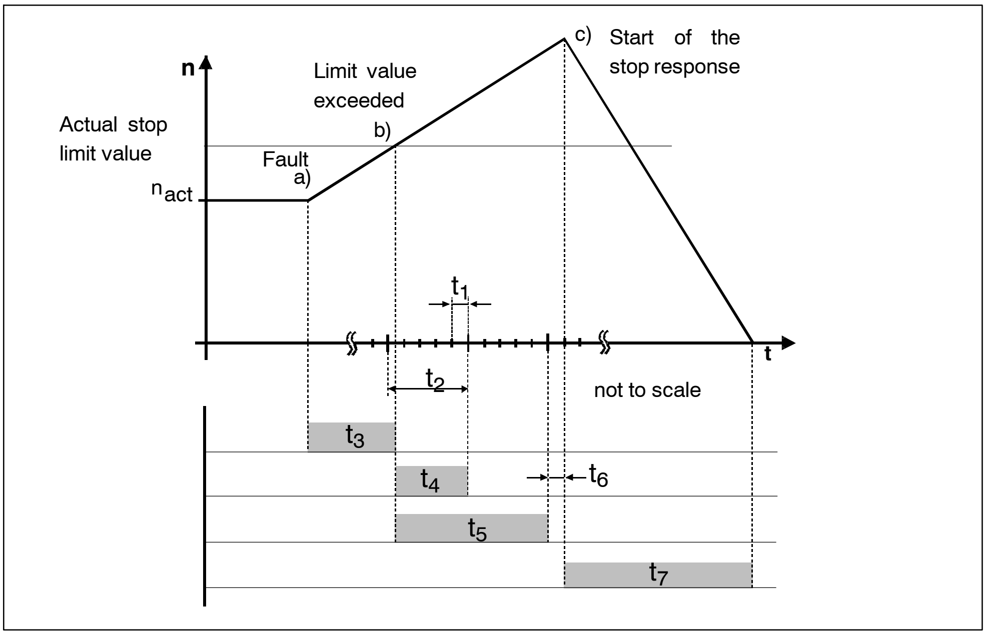


Fig. 6-11 Timing when the actual stop limit value for SBR is exceeded

Table 6-10 Explanation of the figure

Time	Explanation
t_1	The position control clock cycle, defined by the following MDs: MD 10050: $MN_SYSCLOCK_CYCLE_TIME MD 10060: $MN_POSCTRL_SYSCLOCK_TIME_RATIO
t_2	Monitoring clock cycle, defined by the following MDs: for 840D sl: MD 10090: $MN_SAFETY_SYSCLOCK_TIME_RATIO for SINAMICS S120: r9500 SI motion monitoring clock cycle (Control Unit)
t_3	Time between an error occurring and a limit value being reached
t_4	Time until a limit value violation is detected (typical 1 monitoring clock cycle, maximum 1.5 monitoring clock cycles + 1 position controller clock cycle)
t_5	Response time that is required to introduce the stop response (typical 2 monitoring clock cycles, maximum 2.5 monitoring clock cycles + 1 position controller clock cycle)
t_6	Time until the stop response that was initiated starts (typical 2 ms, maximum 3 position controller clock cycles + 8 ms)
t_7	Time required to bring the axis to a standstill. This time and thus the residual distance traveled by the axis is determined by the axis design (motor, mass, friction, ...).

Notice

During ”normal” operation, speed overshoot should not unintentionally initiate the SBR. Speed overshoot should therefore be checked by making the appropriate measurements.

Warning

If the safe standstill function or ”STOP A” is activated, the motor can no longer generate any torque. This is the reason that potentially hazardous motion can occur, e.g. for the following:

- When an external force acts on the drive axes
- Vertical and inclined axes without weight equalization
- Axes that are moving (coasting down)
- Direct drives with low friction and low self-locking
- Notching torques (depending on the motor type, bearing design and friction characteristics, up to half a pole pitch in a direction that cannot be predicted)

Possible hazards must be clearly identified using a risk analysis that must be carried out by the manufacturer. With an assessment, based on this risk analysis, it should be defined as to which additional measures are required, e.g. external brakes.

6.5 Safely-reduced speed (SG)

Description

The purpose of the SG (safely reduced speed) function is to safely monitor the load-side speed of an axis/spindle.
The actual speed of the axis/spindle is cyclically compared in the monitoring clock cycle with the speed limit value selected using SGEs. The speed limit values are defined in the following machine data/parameters:

for 840D sl:
MD 36931: $MA_SAFE_VELO_LIMIT[n]

for SINAMICS S120:
p9531: SI motion SLS (SG) limit values (Control Unit)

The speed limit values for SG1, SG2, SG3 or SG4 allow various applications/operating states on the machine to be monitored. The safely reduced speed function can therefore be used to implement protective measures for the operating personnel and machine in the setting-up mode or also in automatic operation.

Warning
For control gears, it is important to select the correct gear ratio!

Features

The features of the SG function are as follows:

- Load-side speed limit values are safely monitored
- Monitoring limit values are adapted to various operating states (e.g. test, setting-up, automatic modes)
- Configurable stop response when the SG responds

Preconditions

The following prerequisites must be fulfilled (see Chapter 3.1, ”System prerequisites”):

- The option and functions must be enabled in the axis-specific machine data
- The SGEs ”SBH/SG deselection” and ”SBH deselection” must be configured

Specifying velocities and speeds

The requirements regarding speeds and velocities that are stipulated for individual processes (milling, turning, grinding, etc.) vary depending on the different C Standards. For example, the following could be specified for the setting-up mode:
Safely reduced speed with 2 m/min for feed drives and
50 RPM for spindle drives or standstill within 2 revolutions.

The machine manufacturer must parameterize SI in such a way as to ensure full compliance with the EC Machinery Directive. The relevant standards provide the necessary guidelines and support.

Quantities that influence the parameterization include, e.g. the drive dynamic response, the set parameters with their delay times, electrical and mechanical gear ratios and all of the mechanical properties and characteristics. The interrelationships between the drive dynamic response and internal delay times of SI are shown in Fig. 6-13 ”Timing when exceeding the limit value for SG”.

6.5.1 Speed monitoring, encoder limit frequency

When SBH/SG is active in a configuration with a 1-encoder, the speed is monitored to ensure that it does not exceed a maximum encoder limit frequency. An appropriate alarm is output if this limit is exceeded.

Encoder limit frequency

The encoder limit frequency is 500 kHz. When the encoder limit frequency in SG is exceeded, the SG-specific parameterized stop is initiated.

6.5.2 Selecting/deselecting safely reduced speed

Selecting SG

The following SGEs are used to select SG:

Table 6-11 Selecting/deselecting SG

SGE		
SBH/SG deselection	**SBH deselection**	**Meaning**
= 1	x	SBH and SG are deselected
= 0	= 0	SBH is selected (see Chapter 6.2, ”Safe operating stop (SBH)”
= 0	= 1	SG is selected
Note: x –> Any signal state		

Note

The actual status of the function is displayed using the SGA ”SBH/SG active” and SGA ”SBH active”.

Before activating the SG function it must be ensured that the speed of the axis/spindle is lower than the selected speed limit value. If it is higher, an alarm is generated that causes the drive to be shut down.

The SGEs and SGAs are described in Chapter 7.1 ”Safety-related input/output signals (SGE/SGA)”.

Selecting speed limit values

The maximum permissible speed of an axis/spindle in the setting-up mode is defined for individual machine types in the C Standards (product standards). The machine manufacturer is responsible for ensuring that the correct speed limit value is selected depending on the operating mode and the application.

The required speed limit is selected as follows by combining the following SGEs:

Table 6-12 Selecting speed limit values for SGs

SGE		Meaning
SG selection Bit 1	**SG selection Bit 0**	
= 0	= 0	Speed limit value for SG1 active
= 0	= 1	Speed limit value active for SG2 1)
= 1	= 0	Speed limit value for SG3 active
= 1	= 1	Speed limit value active for SG4 1)
Note: 1) The SG limit values SG2 and SG4 can be finely graduated using the SG override (see Chapter 6.5.4, ”Override for safely reduced speed”. The active SG stage is displayed using SGA ”SGA active bit 0” and ”SGA active bit 1”.		

Changeover of speed limits

A changeover from a lower to a higher speed limit value takes effect instantaneously without any delay.

When changing-over from a higher to a lower limit value, then a delay time is started that is parameterized using the machine data
(see Fig. 6-12, ”Timing when changing-over from a higher to a lower speed limit”).

for 840D sl:
MD 36951: $MA_SAFE_VELO_SWITCH_DELAY

for SINAMICS S120:
p9551: SI motion SLS (SG) changeover delay time (Control Unit) /

The axis/spindle must be braked sufficiently during the delay time so that it has reached the reduced speed that is below the new limit value when the delay time expires. However, if the actual speed is higher than the new limit value when the time has expired, an appropriate alarm is output with the configurable stop response.

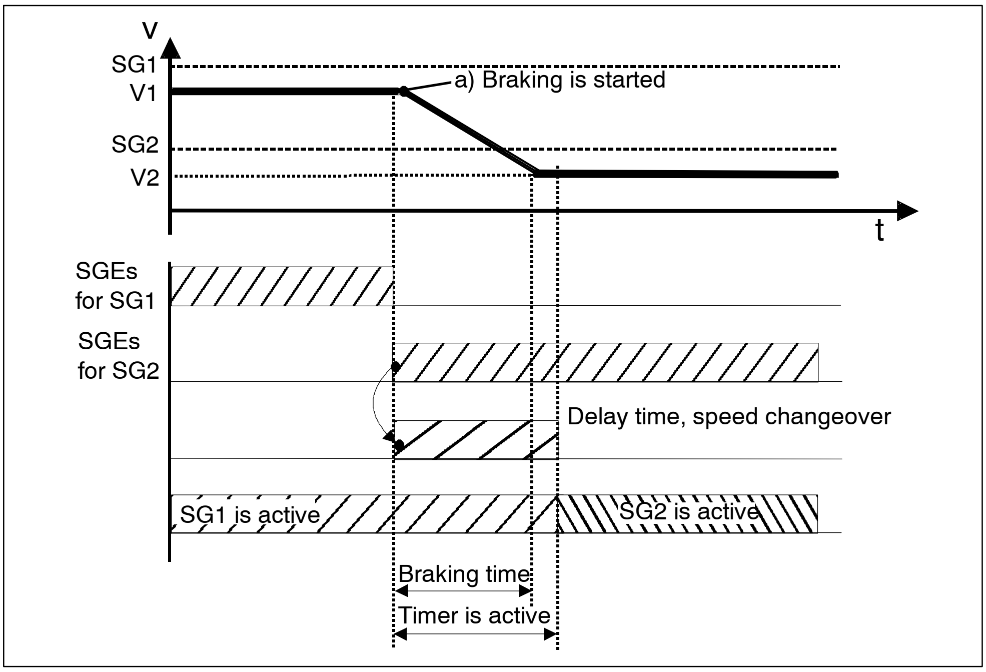


Fig. 6-12 Timing when changing-over from a higher to a lower speed limit.

Deselecting SG

The SG function can be deselected at any speed by activating the SGE ”SBH/SG deselection”.

Warning

The delay time must also be selected as a function of the distance to the hazardous location. The speeds to be taken into account (speed at which hands/arms are moved to appropriately arrange protective devices/guards) are specified in Standard DIN EN ISO 13855.

6.5.3 Effects when the limit value is exceeded for SG

Configurable stop response

When the selected speed limit value is violated, a stop response configured in the following machine data/parameters is generated:

for 840D sl:

MD 36961: $MA_SAFE_VELO_STOP_MODE
MD 36963: $MA_SAFE_VELO_STOP_REACTION[n]

for SINAMICS S120:

p9561: SI motion SLS (SG) stop response (Control Unit)
p9563[0...3]: SI motion SLS (SG)-specific stop response (Control Unit)

Note

- An alarm is displayed (for 840D sl: 27011, for SINAMICS S120: F01714). After the cause of the fault has been removed, the alarm can be acknowledged with RESET. The monitoring function is then again active.
- Depending on the selected monitoring clock cycle, the dynamic drives may cause a brief increase in speed on the monitored axis/spindle before the stop response sequence starts.
- For traversing modes which use a transformation with singularity points (e.g. 5-axis transformation and TRANSMIT), relatively high axial speeds occur at these points. These speeds can initiate stop responses even though the Cartesian motion of the tool center point (TCP) is below the selected speed limit value.
  The monitoring functions provided by SI are basically axis-specific. This means that it is not possible to directly monitor the TCP.

Timing when the limit value is exceeded

When the safely reduced speed function is active, then the timing is as follows when the limit value is violated:

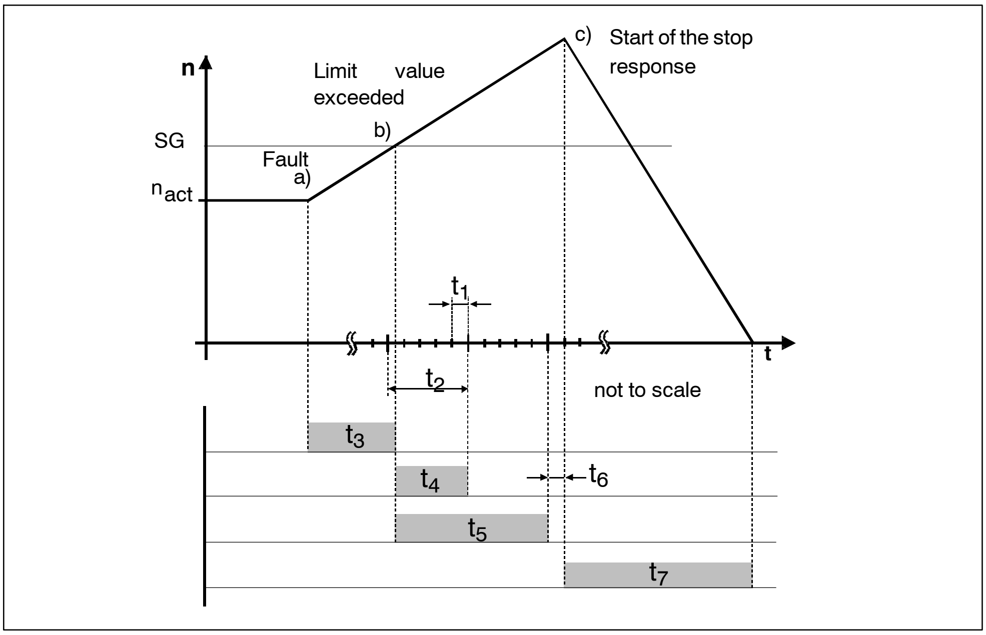


Fig. 6-13 Timing when the limit value is exceeded for SG

Table 6-13 Explanation of the figure

Time	Explanation
t_1	The position control clock cycle, defined by the following MDs: MD 10050: $MN_SYSCLOCK_CYCLE_TIME MD 10060: $MN_POSCTRL_SYSCLOCK_TIME_RATIO
t_2	Monitoring clock cycle, defined by the following MDs: for 840D sl: MD 10090: $MN_SAFETY_SYSCLOCK_TIME_RATIO for SINAMICS S120: r9500 SI motion monitoring clock cycle (Control Unit)
t_3	Time between an error occurring and a limit value being reached
t_4	Time until a limit value violation is detected (typical 1 monitoring clock cycle, maximum 1.5 monitoring clock cycles + 1 position controller clock cycle)
t_5	Response time required to initiate the configured stop response (typical 2 monitoring clock cycles, maximum 2.5 monitoring clock cycles + 1 position controller clock cycle)
t_6	Time until the stop response that was initiated starts (STOP A: typical 2 ms, maximum 3 position controller clock cycles + 8 ms) (STOP B/C: typical 2 position controller clock cycles, maximum 2 position controller clock cycles) (STOP D/E: typical 2 interpolation clock cycles, maximum 2 interpolation clock cycles + 2 monitoring clock cycles)

Table 6-13 Explanation of the figure

Time	Explanation
t_7	Time required to bring the axis to a standstill. This time and thus the residual distance traveled by the axis is determined by the axis design (motor, mass, friction, ...) and the configured stop response (STOP C is faster than STOP D).
Note: Each axis must be measured during commissioning (start-up) to determine the distance that it travels between the limit switch being violated and it coming to a standstill.	

Configurable SG specific stop responses

Using the configurable SG-specific stop response, a suitable braking behavior can be set for every SG stage in-line with the application when the particular speed limit value is exceeded.

For example, when:
SETTING-UP, the SG stage SG2 can be active with the configured stop response STOP C and
in the AUTOMATIC mode, the SG stage SG4 with the configured stop response STOP D.

Activation

The function is active if the MD / parameter 36961/p9561:
$MA_SAFE_VELO_STOP_MODE = 5 / SI motion SLS (SG) stop response (Control Unit) = 5.

Setting the configurable SG-specific stop responses

The SG-specific stop responses can be set using the following machine data:

<u>for 840D sl:</u>
MD 36963: $MA_SAFE_VELO_STOP_REACTION[n]

<u>for SINAMICS S120:</u>
p9563[0...3] SI motion SLS (SG)-specific stop response (Control Unit)

6.5.4 Override for safely reduced speed

General information

16 SG override stages for the limit values of safely reduced speeds 2 and 4 can be entered using SGEs. This means that the limit values for SG2 and SG4 can be more finely graduated.
Using the following machine data, an override stage can be assigned factors of between 1 and 100%:

for 840D sl:
MD 36932: $MA_SAFE_VELO_OVR_FACTOR[n]

for SINAMICS S120:
p9532[0...15]: SI motion SLS (SG) override factor (Control Unit)

Application example

For grinding applications, the limit value for the safely reduced speed can be adjusted to the variations in the grinding wheel peripheral speed using the SG override.

Activation

The following prerequisites must be fulfilled before the function can be used:

- The function is enabled via MD 36901 / parameter p9501: $MA_SAFE_FUNCTION_ENABLE, bit 5 / SI motion enable, safety functions, bit 5
- The SBH/SG function is enabled via MD36901 / parameter p9501: $MA_SAFE_FUNCTION_ENABLE, bit 0 / SI motion enable, safety functions (Control Unit), bit 0
- The required SGEs ”SG override selection bits 3, 2, 1, 0” have either been completely or partially configured
- The SG override factors have been entered into the appropriate MD 36932 / parameter p9532: $MA_SAFE_VELO_OVR_FACTOR[n] / p9532[0...15] SI motion SLS (SG) override factor (Control Unit) /
- Safely reduced speed 2 or 4 has been activated

Changing-over an SG override

SG override values are changed-over subject to the same conditions as those that apply to speed limit values.

Table 6-14 Changing-over SG override stages

Switchover	Description
From lower to higher	Instantaneous
From higher to lower	The time parameterized using MD 36951/p 9551 is started. The axis/spindle must be braked within this delay time.
Note: See Chapter 6.5.2, ”Selecting/deselecting safely reduced speed”	

Note

Changing between SGEs ”SG override selection, bits 3, 2, 1, 0” continuously and quickly may initiate a STOP F.

Selecting an SG override

The active speed limit value (SG1, 2, 3 or 4) is selected using SGEs ”SG selection bits 1 and 0”. The desired override is selected by combining SGEs ”SG override selection bits 3, 2, 1 and 0”. The override is only effective for the speed limit value for SG2 and SG4.

Table 6-15 Selecting the SG override for safely reduced speed

SGE						Meaning
SG selec-tion Bit 1	**SG selec-tion Bit0**	**SG override selection Bit 3**	**SG override selection Bit 2**	**SG override selection Bit 1**	**SG override selection Bit 0**	
= 0	= 0	x	x	x	x	Speed limit value for SG1 active
= 0	= 1	= 0	= 0	= 0	= 0	Speed limit value for SG2 active with override stage 0
– ” –		= 0	= 0	= 0	= 1	... with override stage 1
– ” –		= 0	= 0	= 1	= 0	... with override stage 2
– ” –		= 0	= 0	= 1	= 1	... with override stage 3
– ” –		= 0	= 1	= 0	= 0	... with override stage 4
– ” –		= 0	= 1	= 0	= 1	... with override stage 5
– ” –		= 0	= 1	= 1	= 0	... with override stage 6
– ” –		= 0	= 1	= 1	= 1	... with override stage 7
– ” –		= 1	= 0	= 0	= 0	... with override stage 8
– ” –		= 1	= 0	= 0	= 1	... with override stage 9
– ” –		= 1	= 0	= 1	= 0	... with override stage 10

Table 6-15 Selecting the SG override for safely reduced speed

SG selection Bit 1	SG selection Bit0	SG override selection Bit 3	SG override selection Bit 2	SG override selection Bit 1	SG override selection Bit 0	Meaning
– ” –		= 1	= 0	= 1	= 1	... with override stage 11
– ” –		= 1	= 1	= 0	= 0	... with override stage 12
– ” –		= 1	= 1	= 0	= 1	... with override stage 13
– ” –		= 1	= 1	= 1	= 0	... with override stage 14
– ” –		= 1	= 1	= 1	= 1	... with override stage 15
= 1	= 0	x	x	x	x	Speed limit value for SG3 active
= 1	= 1	= 0	= 0	= 0	= 0	Speed limit value for SG4 active with override stage 0
– ” –		= 0	= 0	= 0	= 1	... with override stage 1
– ” –		= 0	= 0	= 1	= 0	... with override stage 2
– ” –		= 0	= 0	= 1	= 1	... with override stage 3
– ” –		= 0	= 1	= 0	= 0	... with override stage 4
– ” –		= 0	= 1	= 0	= 1	... with override stage 5
– ” –		= 0	= 1	= 1	= 0	... with override stage 6
– ” –		= 0	= 1	= 1	= 1	... with override stage 7
– ” –		= 1	= 0	= 0	= 0	... with override stage 8
– ” –		= 1	= 0	= 0	= 1	... with override stage 9
– ” –		= 1	= 0	= 1	= 0	... with override stage 10
– ” –		= 1	= 0	= 1	= 1	... with override stage 11
– ” –		= 1	= 1	= 0	= 0	... with override stage 12
– ” –		= 1	= 1	= 0	= 1	... with override stage 13
– ” –		= 1	= 1	= 1	= 0	... with override stage 14
– ” –		= 1	= 1	= 1	= 1	... with override stage 15
x: Signal status is optional since override values are not effective for SG1 and SG3						

Configuring NCK-SGEs

NCK-SGEs (override selection bits 3, 2, 1, 0) are configured using the following machine data:

<u>for 840D sl:</u>
MD 36978: $MA_SAFE_OVR_INPUT[n]
(input assignment for override selection)

Defining SG override factors

The following machine data are used to define the SG override factors themselves (percentage values):

for 840D sl:
MD 36932: $MA_SAFE_VELO_OVR_FACTOR[n]

for SINAMICS S120
p9532[n]: SI motion SLS (SG) override factor (Control Unit)

6.5.5 Example: Override for safely reduced speed

Task

When safely reduced speeds are selected, the speed limit values must be set as follows.

Table 6-16 Application example of how override is used for safely reduced speed

SGE SG selection		SGE override selection				Effective speed limit value	
Bit 1	**Bit 0**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**		**Assumptions for the example**
0	0	x	x	x	x	Limit value 1	1000 mm/min
0	1	0	0	0	0	Limit value 2 with override stage 0	100 % = 2000 mm/min
– ” –		0	0	0	1	Limit value 2 with override stage 1	80 % = 1600 mm/min
– ” –		0	0	1	0	Limit value 2 with override stage 2	50 % = 1000 mm/min
– ” –		0	0	1	1	Limit value 2 with override stage 3	30 % = 600 mm/min
1	0	x	x	x	x	Limit value 3	4000 mm/min
1	1	0	0	0	0	Limit value 4 with override stage 0	100 % = 5000 mm/min
– ” –		0	0	0	1	Limit value 4 with override stage 1	80 % = 4000 mm/min
– ” –		0	0	1	0	Limit value 4 with override stage 2	50 % = 2500 mm/min
– ” –		0	0	1	1	Limit value 4 with override stage 3	30 % = 1500 mm/min
Notes: x: Signal status is optional since override values are not effective for SG1 and SG3 SGEs ”SG override selection bit 3 and bit 2” are not required to select an SG override - i.e. they do not need to be configured (they are internally set to ”0”).							

Assumptions for the example

- Defining the SGEs in the NCK monitoring channel
  I/O number for signal SG selection, bit 1: -> OUTSI[13]
  I/O number for signal SG selection, bit 0: -> OUTSI[14]
  I/O number for signal, override, bit 1: -> OUTSI[17]
  I/O number for signal, override, bit 0: -> OUTSI[18]

Defining machine data

Table 6-17 Supplying MDs for the speed limit values

	for 840D sl		for SINAMICS S120	
Limit	MD number	Value	Parameter No.	Value
SG1	36931[0]	1000	p9531[0]	1000
SG2	36931[1]	2000	p9531[1]	2000
SG3	36931[2]	4000	p9531[2]	4000
SG4	36931[3]	5000	p9531[3]	5000

Table 6-18 Supplying the MDs for the SGEs

Signal	Assignment	
SGE	MD number	Value
SG selection, bit 1	36972[1]	0401010D
SG selection, bit 0	36972[0]	0401010E
SG override selection, bit 1	36978[1]	04010111
SG override selection, bit 0	36978[0]	04010112

Table 6-19 Supplying MDs for override factors

Override	for 840D sl		for SINAMICS S120	
	MD number	Value	Parameter No.	Value
0	36932[0]	100	p9532[0]	100
1	36932[1]	80	p9532[1]	80
2	36932[2]	50	p9532[2]	50
3	36932[3]	30	p9532[3]	30

6.6 Safe velocity range detection ”n<n_x”

The safe velocity range detection function ”n<n_x” (SGA ”n<n_x”) is used to safely detect the velocity range of a drive. The speed range detection is evaluated on a user-for-user basis, e.g. in so much that a protective door can only be re-enabled if a spindle that is running-down has fallen below a certain speed.

The status signal ”n<n_x” is it generated through two channels. For this purpose, each monitoring channel compares the actual velocity with a velocity limit that can be adjusted via machine data (MD 36946 $MA_SAFE_VELO_X) - and resulting from this, the SGA ”n<n_x” is set or deleted.

The result of this monitoring function is exchanged between the NCK and drive monitoring channels and crosswise compared. In order that brief dynamic deviations of the actual velocity between the monitoring channels does not result in an error being initiated in the crosswise data comparison, a tolerance band is defined in which the crosswise data comparison does not immediately result in the above mentioned alarm. Alarm 27001 or 27106 is only output and the appropriate stop response initiated when the velocity deviation between the two monitoring channels is so large that this tolerance is exceeded (this corresponds to the behavior for the crosswise monitoring of the results to compare the actual position with the output cam positions).

The machine data $MA_SAFE_VELO_X is subject to a crosswise data comparison.

The function can be deactivated by writing the value of 0.0 to MD $MA_SAFE_VELO_X.

6.6.1 Basic function ”n<n$_x$”

If a value greater than 0.0 is parameterized in machine data $MA_SAFE_VELO_X, then safe velocity range detection ”n<n$_x$is generally enabled.

An extension of the basic functionality ”n<n$_x$” is possible by setting bit 16 in MD 36901 $MA_SAFE_FUNCTION_ENABLE: ”Synchronization, filtering, and hysteresis ”n<n$_x$”. This extension is described in detail in Chapter 6.6.2.

For the basic function ”n<n$_x$”, the following velocity monitoring is performed:

If the absolute actual velocity exceeds the limit value set in machine data $MA_SAFE_VELO_X, then the SGA ”n<n$_x$” is deleted. If the absolute actual velocity drops below the set limit value, then SGA ”n<n$_x$” is set again.

MD36942 $MA_SAFE_POS_TOL is used as tolerance for the crosswise comparison. Alarm 27001 or 27106 is only output and the appropriate stop response initiated when the velocity deviation between the two monitoring channels is so large that this tolerance is exceeded.

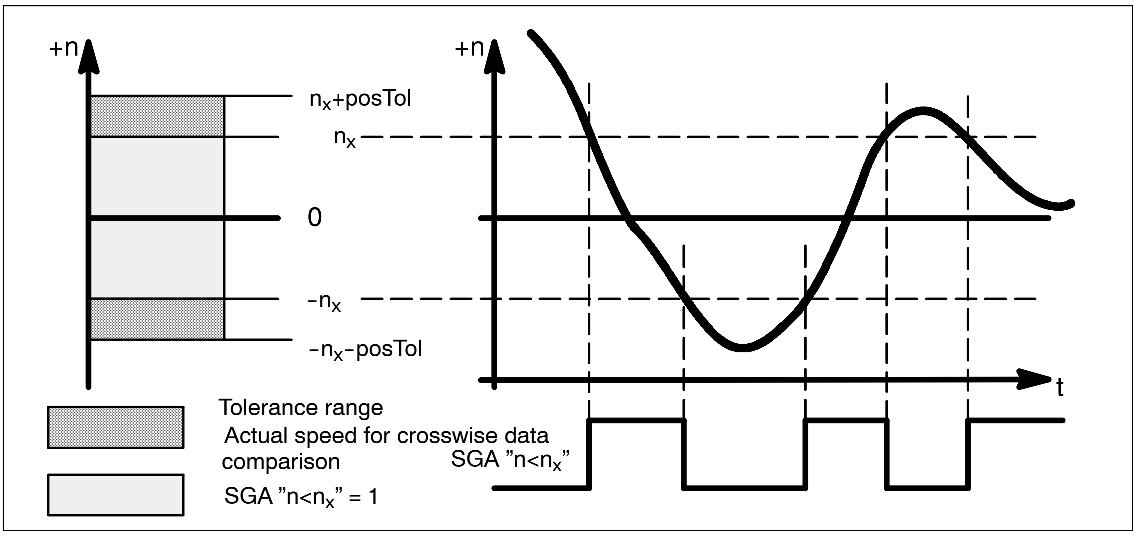


Fig. 6-14 n<nx value ranges

Defining n_x

The limit speed n_x is defined using the following MD / following parameters:

<u>for 840D sl:</u>
MD 36946 $MA_SAFE_VELO_X

<u>for SINAMICS S120:</u>
p9546 SI Motion SSM (SGA $n<n_x$) velocity limit (CU)

Response time and error responses

Typical response time for $n < n_x$:
1 interpolation clock cycle + 2 monitoring clock cycles

Maximum response times: 1 position controller clock cycle + 5.5 monitoring clock cycles + 2 interpolation clock cycles + 3 PLC cycles

---

Warning

A STOP F (displayed using Alarms 27001, 27101 and onwards or F01711) only results in a subsequent STOP B/A response, if at least one of the safety-related functions SBH, SG, SE, SN or $n<n_x$ synchronization is active or selected. If only the function ”$n < n_x$ is active, then a STOP F does not result in a subsequent STOP B/A response.
This means that if ”$n < n_x$” is used as a safety function, then at least one of the SBH, SG, SE or SN functions must be active or selected (e.g. by selecting a high SG level).

Note

If the axis/spindle runs at a speed n_x, then as a result of actual differences in the two monitoring channels, the SGA ”$n < n_x$” can have different states.
This must be taken into account in the safe processing of the SGAs.

6.6.2 Function ”Synchronization, hysteresis and filtering $n<n_x$”

As a result of actual value differences (dual-encoder system) in the two monitoring channels, static or dynamic differences can occur at the SGA ”$n<n_x$”, which makes it very difficult to externally further process the signals. This is the reason that the ”$n<n_x$” signals of the two monitoring channels associated with the NCK and the drive are synchronized before further processing.

In addition, a hysteresis is implemented to prevent the SGA ”$n<n_x$” from continually switching as a result of slight speed fluctuations around the threshold ”n_x”. For actual value fluctuations, for example caused by mechanical vibration at the machine, SGA ”$n<n_x$” is kept stable by filtering the speed actual value.

In order to be able to use the ”Synchronization, hysteresis and filtering” function, bit 16 must be set in machine data $MA_SAFE_FUNCTION_ENABLE. The specified 3 functions can only be enabled together. Further, the velocity monitoring function $n<n_x$ must always be activated by a value greater than 0.0

<u>For 840 D sl:</u>
MD 36946 $MA_SAFE_VELO_X

<u>for SINAMICS S120:</u>
p9546 SI Motion SSM (SGA $n<n_x$) velocity limit (CU)

The following diagram shows possible different speed characteristics in the NCK and drive, and the effect of synchronization and hysteresis on the SGA ”$n<n_x$”.

Tol = $MA_SAFE_VELO_X_HYSTERESIS

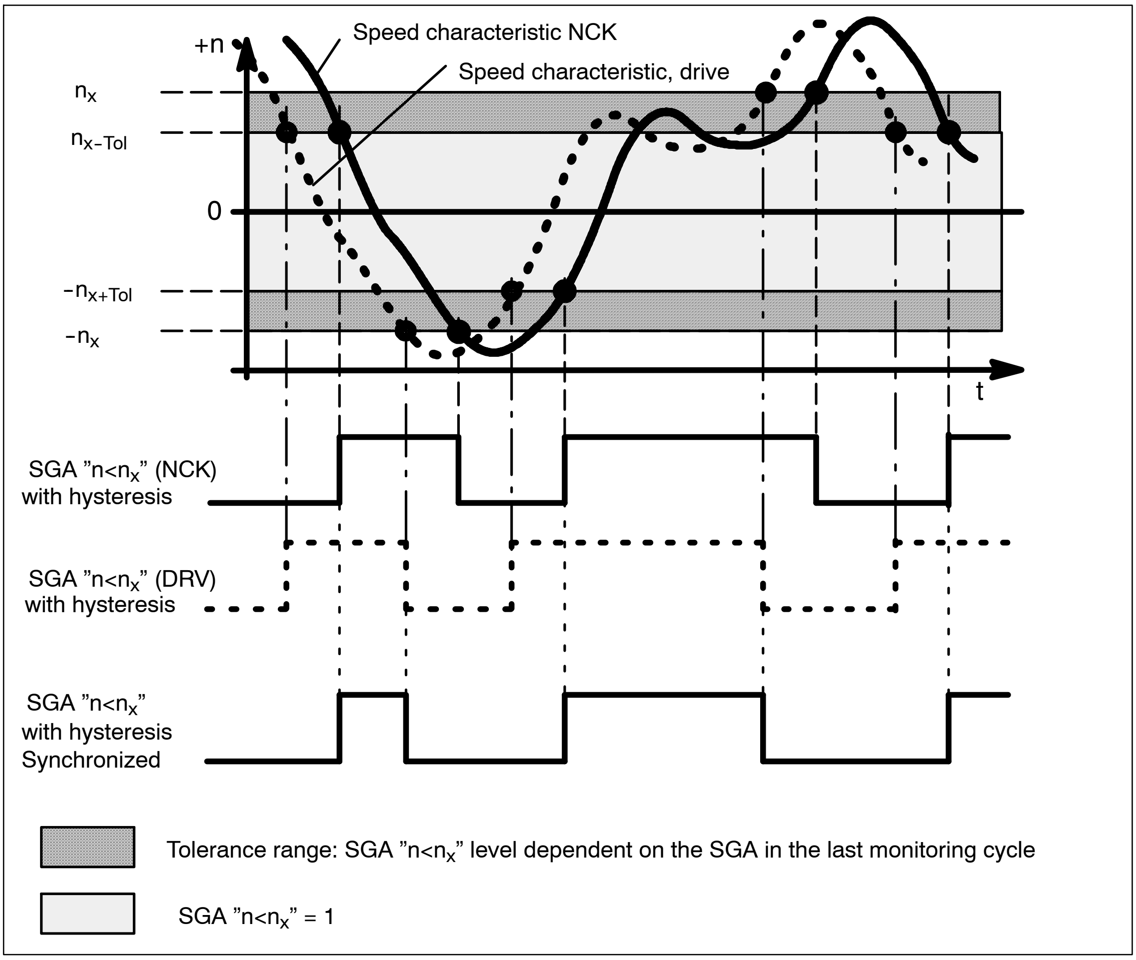


Fig. 6-15 $n<n_x$ value range with synchronization and hysteresis

Crosswise data comparison tolerance

As tolerance in the crosswise data comparison for the extended n_x functionality, machine data $MA_SAFE_POS_TOL is not used, but instead

<u>for 840D sl:</u>
MD 36947 $MA_SAFE_VELO_X_HYSTERESIS

<u>for SINAMICS S120:</u>
p9547 SI motion SSM (SGA n < nx) velocity hysteresis (CU)

This MD defines the maximum permissible velocity tolerance between the two monitoring channels, and during ramp-up, a plausibility check is made to the speed limit set in $MA_SAFE_VELO_X. In this case, the following must apply:

$MA_SAFE_VELO_X_HYSTERESIS ≤ 1/2 $MA_SAFE_VELO_X,

Otherwise, alarm 27033 ”Axis %1 parameterization of MD $MA_SAFE_VELO_X_HYSTERESIS invalid” is issued. A crosswise data comparison error is only detected when the velocity deviation between the two monitoring channels is greater than the tolerance in $MA_SAFE_VELO_X_HYSTERESIS; Alarm 27001 or 27106 is then output and the corresponding stop response is started.

The machine data $MA_SAFE_VELO_X_HYSTERESIS is subject to a crosswise data comparison.

Hysteresis

Similarly, the new machine data 36947 $MA_SAFE_VELO_X_HYSTERESIS is used to determine the magnitude of the hysteresis. As a result of the hysteresis, the switching point of the SGA ”n<nx” changes as a function of the velocity. As a consequence, the SGA ”n<nx” no longer precisely switches at the speed limit ”nx”, but instead, either at the nx threshold or at the nx threshold tolerance depending on the SGA level in the last monitoring cycle.

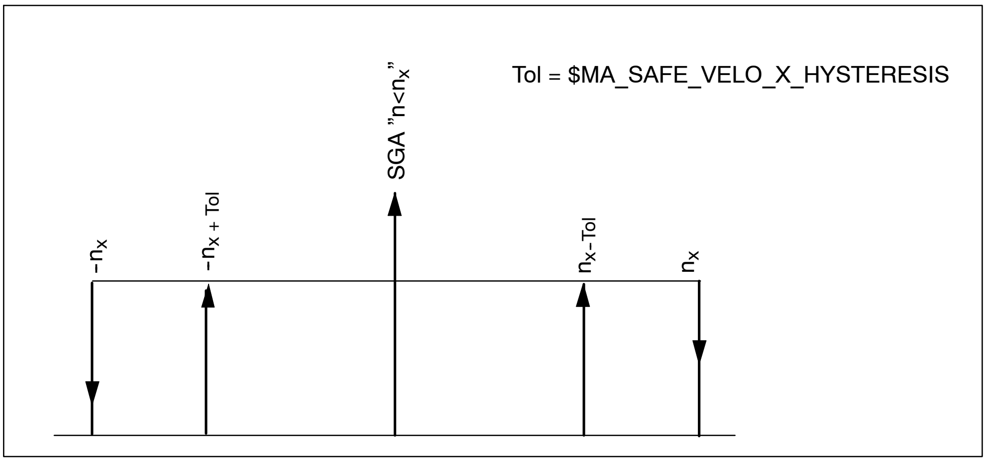


Fig. 6-16 Hysteresis SGA ”n<$_{nx}$”

The SGA ”n<nx” can therefore never have the value 1 at a speed greater than ”nx”!

Filtering

Filtering is realized using a PT1 filter with the filter time from

<u>for 840D sl:</u>
MD 36945 $MA_SAFE_VELO_X_FILTER_TIME

<u>for SINAMICS S120:</u>
p9545 SI Motion SSM (SGA n < nx) filter time (Control Unit)

and is also performed in the two monitoring channels, NCK and drive.

If filtering is not necessary due to low system vibration levels or not does not make sense, it can be deactivated by setting MD $MA_SAFE_VELO_X_FILTER_TIME to the value 0.

MD $MA_SAFE_VELO_X_FILTER_TIME and the smoothed actual velocity value with the tolerance from MD $MA_SAFE_VELO_X_HYSTERESIS are subject to crosswise data comparison.

The smoothed safe actual value of the NCK is also available in the servo trace (see Chapter 10.1.6 ”Servo trace signals”).

Synchronization

The synchronization of the SGA ”n<nx”, just like cam synchronization, is not performed between the NCK and drive due to possible telegram failures (see Chapter 6.8.1), but instead, between the NCK and PLC by AND’ing the SGA ”n<nx”.

In order to ensure that a monitoring channel does not continuously return a 0 – and hence the SGA ”n<nx” would permanently remain at 0 – SGA ”n<nx” is subject to a crosswise data comparison between the NCK and drive and checked for plausibility.

For the display of the SGA ”n<nx” in the service screen and servo trace, the following applies:

The value displayed in the SGA word contains the information from the relevant monitoring channel including the hysteresis that is applied, but without synchronization.

If the actual value synchronization function in $MA_SAFE_FUNCTION_ENABLE, bit 3 is enabled, then the velocity tolerance slip with velocity tolerance ”n<nx” must be checked for plausibility. If the velocity tolerance ”n<nx” is less than the slip tolerance, then Alarm 27033 ”Axis %1 parameterization of MD $MA_SAFE_VELO_X_HYSTERESIS invalid” is issued.

Warning

A STOP F (displayed using Alarms 27001, 27101 and onwards or F01711) only results in a subsequent STOP B/A response, if at least one of the safety-related functions SBH, SG, SE, SN or synchronization, hysteresis and filtering ”$n<n_x$” is active or has been selected. If only the function ”$n < n_x$ is active, then a STOP F does not result in a subsequent STOP B/A response.
This means that if ”$n < n_x$” is used as a safety function, then at least one of the SBH, SG, SE or SN functions must be active or selected (e.g. by selecting a high SG level).

6.7 Safe software limit switches (SE)

Note

The function ”safe software limit switches” (SE) is also known as ”safe limit positions”.

Description

The ”safe software limit switches” function (SE) can be used to implement protective functions for operating personnel and machinery or working zone/protection zone delimination for specific axes. For example, this function can replace hardware limit switches.

Two ”safe software limit switches” (SE1 and SE2) are available for each axis. If the SE function is active, limit switch position pair SE1 or SE2 can be selected as a function of SGE ”SE selection”.

Defining the upper and lower limit values

The position limit values for the software limit switch position pairs 1 and 2 are defined in the following machine data:

<u>for 840D sl:</u>
MD 36934: $MA_SAFE_POS_LIMIT_PLUS[n]
MD 36935: $MA_SAFE_POS_LIMIT_MINUS[n]

<u>for SINAMICS S120:</u>
p9534[n]: SI motion SLP (SE) upper limit values (Control Unit)
p9535[n]: SI motion SLP (SE) lower limit values (Control Unit)

Note

The upper and lower position limit values must be selected so that when the axis is traversing in this direction, the software limit switches – that are used as standard – are first reached.

Features

The most important features include:

- Software limit switches are safely defined and evaluated as a software function
- Configurable stop response when software limit switches are passed
- The stop response is implemented internally in the software (and is therefore faster than a hardware limit switch response) when software limit switches are passed (i.e. actuated)

Preconditions

The following prerequisites must be fulfilled for the ”safe software limit switches” function:

- The ”safe software limit switches” function must be enabled
- The axis/axes must have been safely referenced (user agreement)
- SGE ”SE selection” must be supplied (configured) in both channels

Warning

”Safe software limit switches” are only effective if the user agreement has been given.

6.7.1 Effects when an SE responds

Warning

The SE function does not predictively monitor the SW (software) limit switches. This means that the axis stops after passing the limit position. The distance traveled after the SE is dependent on:

- How the function was parameterized (monitoring clock cycle, stop response, ...)
- The actual speed
- The design of the axis

Configurable stop responses

When an axis passes (actuates) a ”safe software limit switch”, a stop response configured in the following machine data is generated:

for 840D sl:
MD 36962: $MA_SAFE_POS_STOP_MODE

for SINAMICS S120:
p9562: SI motion SLP (SE) stop response (Control Unit)

The user can select either STOP C, D or STOP E.

Effect

- The configured stop response is initiated
- The relevant alarm is displayed

Acknowledging and moving away

1. Withdraw the user agreement (SE is no longer active) or changeover to another SE.
2. Acknowledge the stop and alarm response.
3. Bring the axis into a range in which the monitoring no longer responds.

Timing when the safe software limit switches are actuated

If the ”safe software limit switches” function is active, the system timing is as follows when the software limit switches are actuated (passed):

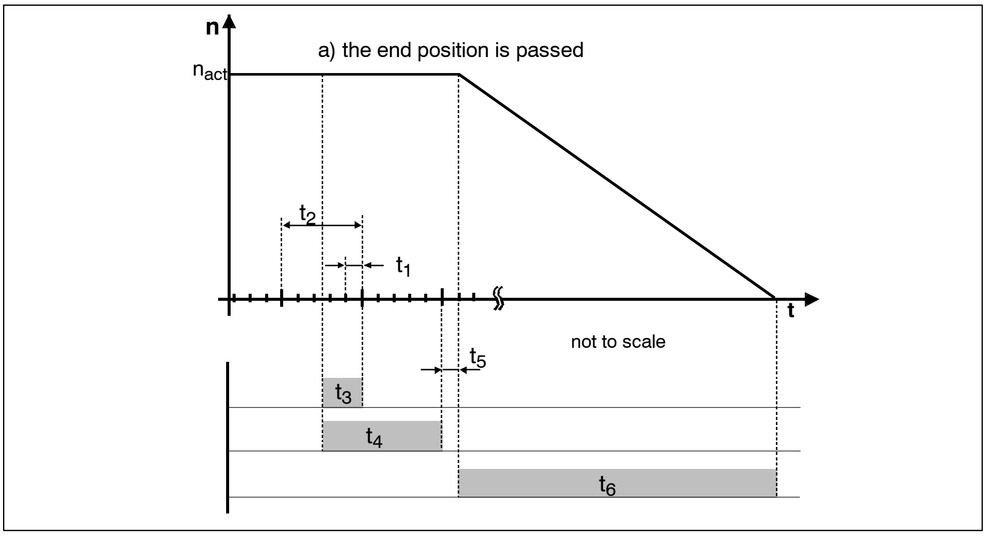


Fig. 6-17 Timing when a software limit switch is actuated

Table 6-20 Explanation of the figure

Time	Explanation
t_1	The position control clock cycle, defined by the following MDs: for 840D sl: MD 10050: $MN_SYSCLOCK_CYCLE_TIME MD 10060: $MN_POSCTRL_SYSCLOCK_TIME_RATIO
t_2	Monitoring clock cycle, defined by the following MDs: for 840D sl: MD 10090: $MN_SAFETY_SYSCLOCK_TIME_RATIO for SINAMICS S120: p9500: SI motion monitoring clock cycle (Control Unit)
t_3	Delay until the configured stop response is output (typical 0.5 monitoring clock cycles, maximum 1 monitoring clock cycle + 1 position controller clock cycle)
t_4	Time until the configured stop response becomes effective (typical 1.5 monitoring clock cycles, maximum 2 monitoring clock cycles + 1 position controller clock cycle)

Table 6-20 Explanation of the figure

Time	Explanation
t_5	Time until the stop response that was initiated actually starts STOP C: typical 2 position controller clock cycles, maximum 2 position controller clock cycles STOP D/E: typical 2 interpolation clock cycles, maximum 2 interpolation clock cycles + 2 monitoring clock cycles
t_6	Time required to bring the axis to a standstill. This time and thus the residual distance traveled by the axis is determined by the axis design (motor, mass, friction, ...) and the configured stop response (STOP C is faster than STOP D).
Note: Each axis must be measured during commissioning (start-up) to determine the distance that it travels between the limit switch being violated and it coming to a standstill.	

6.8 Safety software cams and safety cam track (SN)

Description

The ”safe software cams” function (SN) can be used to implement safe electronic cams, safe range detection or working zone/protection zone delimination for specific axes, thereby replacing the hardware solution.

Warning

The enabled cam signals are immediately output when the control system is powered–up, this output is however only safe after safe referencing (this is signaled using the SGA ”Axis safely referenced”).

The cams are only considered as being safe if they were safely referenced. This is the reason that the user must interlock this SGA with the cam SGA.

Features

The most important features include:

- Cam positions are safely defined and evaluated as a software function
- Working ranges/zones are defined

Tolerance for SN

Owing to variations in the clock cycle and signal run times (signal propagation times), the cam signals of the two monitoring channels do not switch simultaneously and not precisely at the same position. A tolerance bandwidth can therefore be specified for all cams using the following machine data/parameters. Within this bandwidth, the signal states for the same cam may be different in the two monitoring channels.

<u>for 840D sl:</u>
MD 36940: $MA_SAFE_CAM_TOL

<u>for SINAMICS S120:</u>
p9540: SI motion SCA (SN) tolerance (Control Unit)

Note

The lowest possible tolerance bandwidth (less than 5–10 mm) should be selected for the ”safe software cams” function. It makes sense to parameterize the cam tolerance greater than or equal to the actual value tolerance.

Effects when SN responds

Warning

When defining cam positions, please note that the function only monitors the actual position thus making (predictive) sensing of cam signals impossible.

The cams are only considered as being safe if they were safely referenced. This is the reason that the user must link this SGA in the SPL with the corresponding SGA of the cam functionality.

Response times

- Response times without cam synchronization
  typical 1 interpolation clock cycle + 1.5 monitoring clock cycles
  maximum 1 position controller clock cycle + 4 monitoring clock cycles + 2 interpolation clock cycles + 3 PLC cycles
- Response times with cam synchronization
  typical 1 interpolation clock cycle + 2.5 monitoring clock cycles
  maximum 1 position controller clock cycle + 5 monitoring clock cycles + 2 interpolation clock cycles + 3 PLC cycles

6.8.1 Safe software cams (4 cam pairs)

Note

If more than 4 cam pairs are required, then the ”safe cam track” function must be used (refer to Chapter 6.8.2, ”Safe cam track”).

Description

There are 4 pairs of cams (SN1, SN2, SN3, SN4) available for each axis. Each cam pair consists of a plus cam (SN1+, SN2+, SN3+, SN4+) and a minus cam (SN1-, SN2-, SN3-, SN4-). Each cam signal can be individually enabled and configured via machine data. The cam signals are output via SGAs.

Preconditions

The following prerequisites must be fulfilled for the ”safe software cams” function:

- The axis/axes must have been safely referenced (user agreement)

- The safe cams must be configured:

  The required cams are enabled using machine data
  for 840D sl:
  36901: $MA_SAFE_FUNCTION_ENABLE, bits 8...15 and parameter
  for SINAMICS S120:
  p9501: SI motion, enable safety functions, bits 8...15

  SGA assignment is defined using machine data
  for 840D sl:
  36988: $MA_SAFE_CAM_PLUS_OUTPUT[n] and
  36989: $MA_SAFE_CAM_MINUS_OUTPUT[n]

Defining the cam positions

The cam positions are defined in the following machine data/parameters:

for 840D sl:
MD 36936: $MA_SAFE_CAM_POS_PLUS[0...3]
MD 36937: $MA_SAFE_CAM_POS_MINUS[0...3]

for SINAMICS S120:
p9536[n]: SI motion SCA (SN) plus cam position (Control Unit)
p9537[n]: SI motion SCA (SN) minus cam position (Control Unit)

Special case for SN

If the axis is positioned precisely at the parameterized cam position, the cam signals may have different states owing to system-related variations in the actual values between the two monitoring channels.
This must be taken into account when safely processing the cam signals, e.g. by filtering the different signal states by means of a logic circuit (see "Synchronizing cam signals").

Synchronizing cam signals

As a result of system-related actual value differences, the cam signals of the monitoring channels can have different states. In order to prevent this, the cam synchronization can be activated. This rounds off the results of both channels.

The cam SGAs at the input position of the SPL are synchronized if the user has parameterized this using the function enable.

Cam signal synchronization is enabled using the following machine data / parameters:

for 840D sl:
MD 36901: $MA_SAFE_FUNCTION_ENABLE, bit 7

for SINAMICS S120:
p9501: SI Motion enable safety functions (Control Unit), bit 7

The cam SGAs including the hysteresis, but without synchronization are displayed in the service screen and servo trace.

Hysteresis of cam SGAs

When cam synchronization is activated, cam signals are output with a hysteresis that takes into account the approach direction (see Fig. 6-18, "Hysteresis of the cam SGAs"). This helps to prevent the SGAs from "flickering" if the axis is positioned exactly on the cam.
The magnitude of the hysteresis is determined by the following data:

for 840D sl:
MD 36940: $MA_SAFE_CAM_TOL
(tolerance for safe software cams)

for SINAMICS S120:
p9540: SI motion SCA (SN) tolerance (Control Unit)

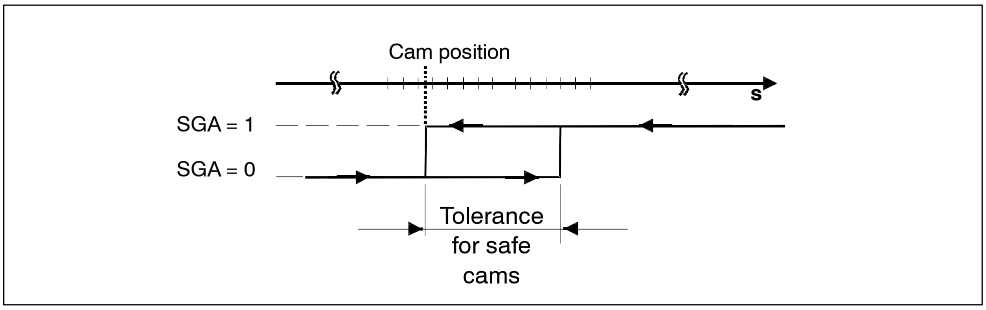


Fig. 6-18 Hysteresis of the cam SGA

If the cam is incorrectly/inadmissibly parameterized, then this is indicated by Alarm 27033.

Warning

As a result of the cam hysteresis, for increasing actual values, the cams SGA do not switch at the configured cam position (SN) but at the position increased by the cam tolerance (hysteresis) (SN+TOL).

Users must carefully take this into consideration when configuring the cam positions and cam tolerance.

Safe software cams for endlessly turning rotary axes

For rotary axes with cams, the modulo range (cam actual value range) can be set using the following machine data/parameters:

for 840D sl:
MD 36902: $MA_SAFE_IS_ROT_AX
for SINAMICS S120:
p9502: SI motion axis type (Control Unit)
for 840D sl:
MD 36905: $MA_SAFE_MODULO_RANGE
for SINAMICS S120:
p9505: SI motion SCA (SN) modulo value (Control Unit)

The cam actual value range should be selected as wide as the modulo display of the safe actual value.

For rotary axes, the modulo display of safe actual values is selected and parameterized using the following machine data:

for 840D sl:
MD 30300: $MA_IS_ROT_AX
MD 30320: $MA_DISPLAY_IS_MODULO
MD 30330: $MA_MODULO_RANGE

Limiting the cam positions

When parameterizing the cam positions, the following conditions close to the modulo limits must be maintained.

When cam synchronization is not active:

- – Mod_Pos + Pos_Tol < SN_Pos < Mod_Pos – Pos_Tol

When cam synchronization is active:

- – Mod_Pos + Pos_Tol + Cam_Tol < SN_Pos < Mod_Pos – Pos_Tol – Cam_Tol

Meanings:

Pos_Tol: Actual value tolerance
MD 36942: $MA_SAFE_POS_TOL for 840D sl
p9542: SI motion, actual value comparison tolerance (crosswise) (Control Unit) for SINAMICS S120

Cam_Tol: Cam tolerance
MD 36940: $MA_SAFE_CAM_TOL for 840D sl
p9540: SI motion SCA (SN) tolerance (Control Unit) for SINAMICS S120

Mod_Pos: Lower/upper modulo value:
MD 36905: $MA_SAFE_MODULO_RANGE for 840D sl
p9505: SI motion SCA (SN) modulo value (Control Unit) for SINAMICS S120

SN_Pos: Cam position:
MD 36936: $MA_SAFE_CAM_POS_PLUS[n] for 840D sl
p9536: SI motion SCA (SN) plus cam position (Control Unit) for SINAMICS S120
MD 36937: $MA_SAFE_CAM_POS_MINUS[n] for 840D sl
p9537: SI motion SCA (SN) minus cam position (Control Unit) for SINAMICS S120

When booting, the parameterization (parameter assignments) are checked in each monitoring channel. In the case of parameterization errors (a condition is not fulfilled), Alarm 27033 or F01687 is output after the control has been booted.

6.8.2 Safe cam track

Description

The ”safe cam track” function is used as an alternative to safe cams (refer to Chapter 6.8.1). The user has 4 cam tracks at his disposal. Up to 15 cams can be evaluated on a cam track. A total of 30 cams are available. The information as to which cam of a cam track is presently active is saved in the SGA ”cam range” (4 bits for each cam track) and can together with the SGA ”cam track” be evaluated in the safe programmable logic (SPL).

Further, the cams are available as SGA safe cam range bits.

Preconditions

The following prerequisites apply to the ”safe cam track” function:

- The axis/axes must have been safely referenced (user agreement)
- Either the ”safe cams” function or the ”safe cam track” function may only be used alternatively, i.e. simultaneous enable in the machine data or parameters MD 36903 $MA_SAFE_CAM_ENABLE / p9503 SI motion SCA (SN) enable (Control Unit) and
  MD 36901 $MA_SAFE_FUNCTION_ENABLE / p9501 SI motion enable safety functions (Control Unit)
  is not permissible and results in the alarm 27033 / C01681 ”Invalid parameterization”.
- The modulo function is not supported. If the ”safe cam track” function is enabled and a value > 0 entered in the MD 36905 $MA_SAFE_MODULO_RANGE / p9505 SI motion SCA (SN) modulo value (Control Unit), then alarm 27033 ”Axis %1 parameterization of the MD $MA_SAFE_REFP_STATUS_OUTPUT[0] invalid” is output with a reference to $MA_SAFE_MODULO_RANGE.

- The safe cams must be configured:

  The required cams are enabled using machine data
  for 840D sl:
  36903: $MA_SAFE_CAM_ENABLE, bits 0...29 and parameter
  for SINAMICS S120:
  p9503: SI motion SCA (SN) enable (Control Unit), bits 0...29

  SGA assignment is defined using machine data
  for 840D sl:
  36988: $MA_SAFE_CAM_PLUS_OUTPUT[n] and
  36989: $MA_SAFE_CAM_MINUS_OUTPUT[n]

Defining the cam positions

The cam positions are defined in the following machine data/parameters:

for 840D sl:
MD 36936: $MA_SAFE_CAM_POS_PLUS[0...29]
MD 36937: $MA_SAFE_CAM_POS_MINUS[0...29]

for SINAMICS S120:
p9536[0...29]: SI motion SCA (SN) plus cam position (Control Unit)
p9537[0...29]: SI motion SCA (SN) plus cam position (Control Unit)

Note

The minus position of cam x must be less than the plus position of cam x, otherwise alarm 27033 ”Invalid parameterization” is output. For an incorrect parameterization, also alarm F01686 ”SI Motion: Cam position parameterization not permissible” of the drive is also output.

Assignment, cam to cam track

The cams defined in $MA_SAFE_CAM_POS_PLUS[0...29] and $MA_SAFE_CAM_POS_MINUS[0...29] are assigned to a cam track as follows:

for 840D sl:
MD 36938: $MA_SAFE_CAM_TRACK_ASSIGN[0...29]

for SINAMICS S120:
p9538[0...29]: SI motion cam track assignment (Control Unit)

Range of values:

100...114 = cam range 0...14 at cam track 1
200...214 = cam range 0...14 at cam track 2
300...314 = cam range 0...14 at cam track 3
400...414 = cam range 0...14 at cam track 4
The ”hundreds” position defines which cam track is assigned to the cams. The ”tens” and ”ones” positions contain the numerical value that is signaled to the SPL as SGA ”cam range”.

The following should be noted:

- It is not possible to assign a cam a multiple number of times to several tracks. A multiple assignment only functions if an additional cam is parameterized with the same cam position and assigned to another cam track.
- Cam positions can be freely assigned to a cam range.
- Cams that have not been assigned do not appear on the cam track.
- The cams on a cam track must not overlap.
- The cams on a cam track must have a certain minimum length.
- The cams on a cam track must have a certain minimum distance between them.

Evaluation of the parameterization

For the evaluation, the following checks are made (for the NCK and drive):

- If $MA_SAFE_CAM_ENABLE > 0, then $MA_SAFE_FUNCTION_ENABLE, bits 8–15 must be = 0.
- If $MA_SAFE_CAM_ENABLE > 0, then it is not permissible that the enable bit for cam synchronization is set (($MA_SAFE_FUNCTION_ENABLE, bit 7 = 0)
- Modulo cams are not permissible ($MA_SAFE_MODULO_RANGE must be 0 if $MA_SAFE_CAM_ENABLE > 0).
- Checking the cam length:

  $MA_SAFE_CAM_POS_PLUS[0...29] – $MA_SAFE_CAM_POS_MINUS[0...29] >=
  $MA_SAFE_CAM_TOL + $MA_SAFE_POS_TOL
- Checking the distance between 2 cams on a cam track:

  $MA_SAFE_CAM_POS_MINUS[y] – $MA_SAFE_CAM_POS_PLUS[x] >=
  $MA_SAFE_CAM_TOL + $MA_SAFE_POS_TOL
- It is not permissible to parameterize two cams on the same track and range:

  Example:
  $MA_SAFE_CAM_TRACK_ASSIGN[2] = 205;
  $MA_SAFE_CAM_TRACK_ASSIGN[5] = 205;
  As a consequence, it is not possible to assign more than 15 cams to a cam track.
- If a cam is enabled in $MA_SAFE_CAM_ENABLE, then it must also be assigned.

If a violation is determined when making these checks, then alarm 27033 ”Parameterization invalid” / F01686 ”SI motion: Cam position parameterization not permissible” is output.

The generation of the new cam SGA is shown in Fig. 6-19:

Parameterization example for SGA ”cam track” and ”cam range”

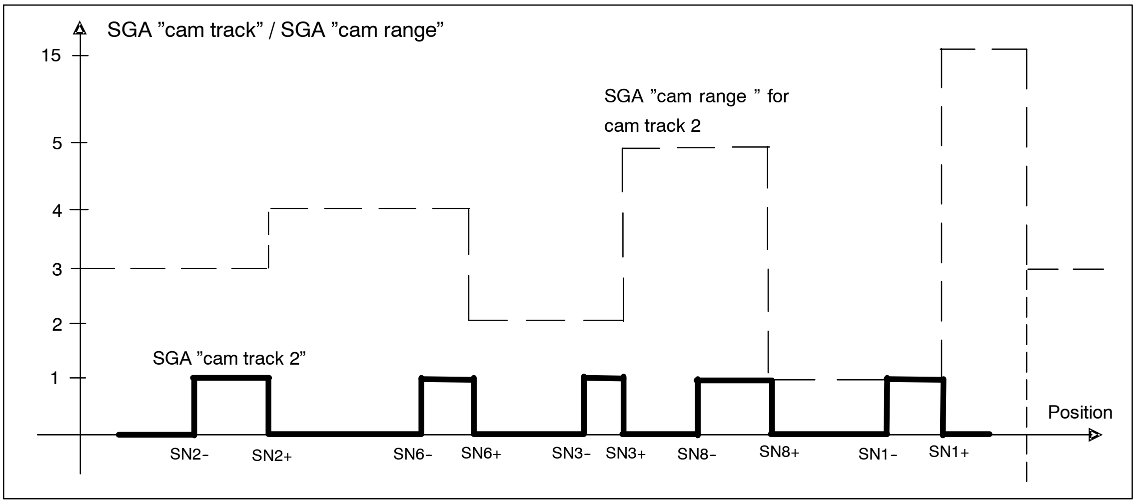


Fig. 6-19 SGA ”cam track” and ”cam range”

Note

The traversing range for rotary axes must lie within +/-2048 revolutions. This corresponds to the value range of the safety-related actual value.

Parameterization example for Fig. 6-19:

Enabling the cams SN1, SN2, SN3, SN6, SN8:

$MA_SAFE_CAM_ENABLE = 0xA7 (0000 0000 0000 0000 0000 0000 1010 0111);

Parameterizing the cam positions for the cams that have been enabled:

- SN1
  $MA_SAFE_CAM_POS_PLUS[0] = 480
  $MA_SAFE_CAM_POS_MINUS[0] = 455
- SN2
  $MA_SAFE_CAM_POS_PLUS[1] = 120
  $MA_SAFE_CAM_POS_MINUS[1] = 80
- SN3
  $MA_SAFE_CAM_POS_PLUS[2] = 320
  $MA_SAFE_CAM_POS_MINUS[2] = 300
- SN6
  $MA_SAFE_CAM_POS_PLUS[5] = 200
  $MA_SAFE_CAM_POS_MINUS[5] = 170
- SN8
  $MA_SAFE_CAM_POS_PLUS[7] = 380
  $MA_SAFE_CAM_POS_MINUS[7] = 350

Parameterizing the cam range assignment:
(all cams that have been enabled are assigned to cam track 2)

- $MA_SAFE_CAM_TRACK_ASSIGN[0] = 201
  (cam SN1 is assigned cam range 1)
- $MA_SAFE_CAM_TRACK_ASSIGN[1] = 203
  (cam SN2 is assigned cam range 3)
- $MA_SAFE_CAM_TRACK_ASSIGN[2] = 202
  (cam SN3 is assigned cam range 2)
- $MA_SAFE_CAM_TRACK_ASSIGN[5] = 204
  (cam SN6 is assigned cam range 4)
- $MA_SAFE_CAM_TRACK_ASSIGN[7] = 205
  (cam SN8 is assigned cam range 5)

Behavior of the SGA

The SGA ”cam track” is the OR logic operation of all individual cams on a cam track. If an axis is at a cam on a cam track, then the SGA of this cam track is set to 1. Together with the SGA ”cam range”, information is available as to which cam is presently active.

The SGA ”cam range” starts at the lower end of the traversing range with the range of the first cam – assigned in $MA_SAFE_CAM_TRACK_ASSIGN[n] – on this cam track, i.e. in this case ”3”. At the upper end after the last cam on this cam track, the range SGA is set to ”15”. The transition of the range to the next value is realized when moving in the positive direction always at the falling edge of an individual cam.

The enable machine data as well as all cam limit values and range assignments are compared crosswise between the NCK and drive.

The user can use the following to connect to the SPL interface ($A_INSI / $A_OUTSI)

- SGA ”cam track”, MD 37900:
  $MA_SAFE_CAM_TRACK_OUTPUT[0...3] and for the
- SGA ”cam range”, MD 37901–37904:
  $MA_SAFE_CAM_RANGE_OUTPUT_1/2/3/4[0...3] and for the
- SGA ”cam range bits”, machine data 37906–37909
  $MA_SAFE_CAM_RANGE_BIN_OUTPUT_1/2/3/4[0...14].

Specified machine data follow the generally valid rules when assigning the safety-related inputs/outputs.

Warning

In the case of a fault, SGAs can assume a value of ”0” (e.g. as a result of the cam synchronization between monitoring channels, loss of the safety-related referencing etc.). The user must take this into account so that when the SGAs are further processed, in a fault condition, no unsafe (hazardous) machine states can occur (that means, for example, safety door enabling only with value ”1”).

Further, the SGAs ”cam range” may only be evaluated as supplementary information to SGA ”cam track”. It is not permissible to evaluate the SGA ”cam range” alone without evaluating the SGA ”cam track”.

Hysteresis of cam SGAs

The hysteresis is applied both to the SGA ”cam track” as well as to SGA ”cam range” to prevent signal flutter. This means the SGAs are therefore generated as follows in the two monitoring channels, NCK and drive:

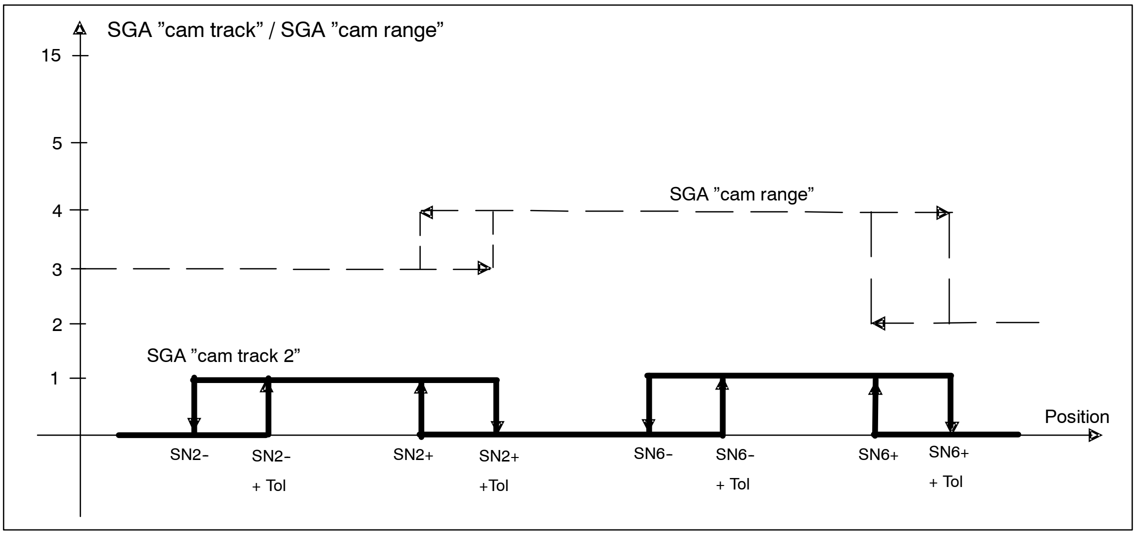


Fig. 6-20 SGA ”cam track” and ”cam range” with hysteresis

Warning

As a result of the cam hysteresis, for increasing actual values, the cams SGA do not switch at the configured cam position (SN) but at the position increased by the cam tolerance (hysteresis) (SN+TOL).

Users must carefully take this into consideration when configuring the cam positions and cam tolerance.

Synchronization

The synchronization of the cam SGA is carried out between the NCK and PLC. Both the SGA "cam track" as well as the SGA "cam range" must be synchronized.

The SGA "cam track" is synchronized by AND'ing the two signals from the NCK and drive monitoring channels. The logic operation is carried out for all 4 cam positions.

The 4-bit SGA "cam range" (value range 0...15) is synchronized according to the following rule:

If the SGA "cam range" as well as the SGA "cam track" is different in both monitoring channels and the SGA "cam track" of its own channel has a value of "1", then the SGA "cam range" of the other channel must be used.

Alternative evaluation of the cam signals

In order to simplify the evaluation of cam signals, the cam signals "cam track" and "cam range", generated from the axis monitoring channels NCK and drive can be mapped to 15 "cam range bits" for each cam track (for the cam ranges 0 ... 14).

The "cam range bits" are generated by logically combining the "cam track" and "cam range" signals in the NCK and in the PLC. If the axis is positioned at a cam, then the cam range bit of the cam range assigned to this cam is set to 1.

The SGA ”cam track”, ”cam range” and ”cam range bit” are shown in the Fig. 6-21 using an example:

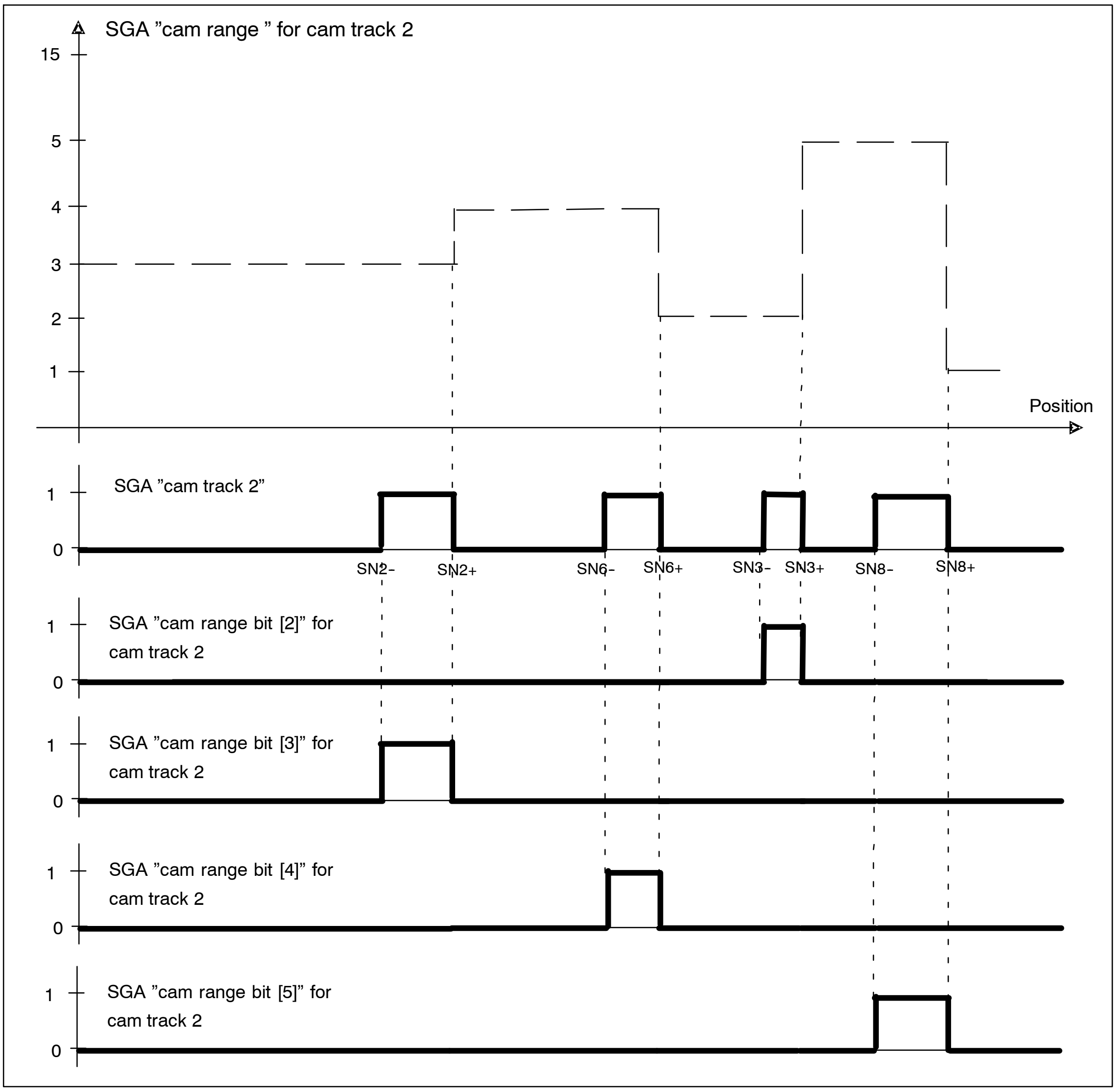


Fig. 6-21 SGA ”cam track” and ”cam range”

Explanation

- Cam SN2 is assigned to track 2 by parameterizing cam range 3 ($MA_SAFE_CAM_TRACK_ASSIGN[1] = 203). If the axis is at cam SN2, SGA ”cam range bit [3]” (index 3 stands for cam range 3) is set to 1.
- Cam SN6 is assigned to track 2 by parameterizing cam range 4 ($MA_SAFE_CAM_TRACK_ASSIGN[5] = 204). If the axis is at cam SN6, SGA ”cam range bit [4]” (index 4 stands for cam range 4) is set to 1.
- ...

Space for your notes

Connecting Sensors/Actuators 7

7.1 Safety-relevant input/output signals

7.1.1 Overview of the SGEs/SGAs and their structure

Description

The safety-related input and output signals (SGEs and SGAs) are the interface of the internal Safety Integrated functionality to the process.

SGE signals (safety-related input signals) control the active monitoring by deselecting or selecting the safety functions. This is realized, among other things, depending on the status (switching status) of sensors and transmitters.

SGA signals (safety-related output signals) are feedback signals from safety functions. They are, among other things, suitable for controlling actuators in a safety-related fashion.

Processing I/O signals for the NC and drive through two channels

A two-channel structure is used to input/output and process safety-related input/output signals (refer to Figure 7-1 ”NCK and drive monitoring channel”). All of the requests and feedback signals for safety-related functions should be entered or retrieved through both monitoring channels (two-channel structure).

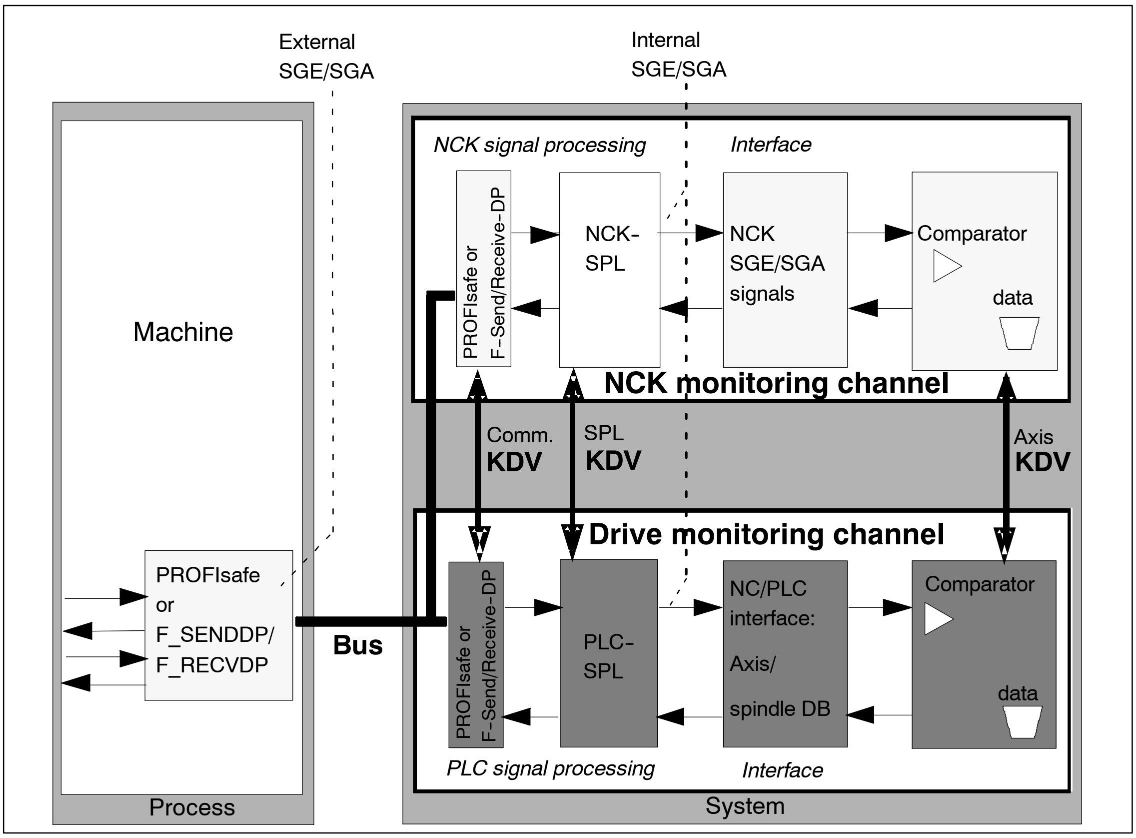


Fig. 7-1 NCK and drive monitoring channel

For the NCK monitoring channel, signals are input/output via the SPL – possibly processed by the NCK (see Chapter 7.1.5 ”Multiple distribution and multiple interlocking”) and emulated (mapped) in the NCK-SGE/SGA interface.

The signals from the drive monitoring channel are input/output via the SPL and sent to the drive via the interface axis/spindle DB.

Internal SGE/SGA (interface to the various axial safety functions) are, e.g. selecting and deselecting safety functions, changing-over limit values, output of status signals. They are defined for the particular Safety Integrated functions.

Sensors – e.g. switches, pushbuttons, protective door contacts, emergency stop buttons, light curtains, laser scanners – are connected to the external SGE (interface to the process, i.e. to the machine). Actuators – e.g. load contactors, valves, interlocking solenoids – are connected to the external SGA. The connection is established through the PROFIsafe I/O, also see Chapter 7.2. Generally, a brake is directly connected at the Motor Modules via terminals.

The external and internal SGE/SGA are freely interlocked (logically combined) by the user using the safe programmable logic (SPL), also see Chapter 7.5.

Crosswise data comparison is implemented between the monitoring channels that operate independently of one another. If there is inequality, then a STOP F is initiated (CDC between the drive and NCK).

A STOP D/E is triggered for an SPL-CDC error. SGE/SGA are set into the safe state if an error is detected by the communication CDC.

Note

As a result of the two-channel structure of Safety Integrated, the machine manufacturer must supply the SGE and SGA in both the NCK monitoring channel and the drive monitoring channel.

The actual signal state of the SGE/SGA is displayed using the "Service display" menu. Information regarding Safety Integrated data with the associated axis names and the axis number are displayed in the "Service SI" window.

For Safety Integrated, SGEs/SGAs are coupled via the PROFIsafe profile using standard PROFIBUS and PROFINET buses based on standard network components. See Chapter with 7.2 "Connecting I/O via PROFIsafe". Internal SGE/SGA signals are accessed via the SPL (see Chapter 7.5).

For instance, the following can be requested or signaled in each monitoring channel and for each/spindle with safety technology using SGE/SGA signals:

- Safety functions can be selected and deselected
- Limit values can be selected and changed-over
- States relating to safety operation can be fed back

Features

- SGE and SGA signals are processed through two channels
- Processed in the NCK monitoring channel
- Processed in the drive monitoring channel
- Safety functions are selected/deselected independent of the NC mode
- Differences in the active SGE/SGA in the monitoring channels are detected in the crosswise data/result comparison

The access to SGE/SGA signals is described in Chapter 7.2 "Connecting I/O via PROFIsafe", Chapter 7.4 "Safety-related CPU-CPU communication" and Chapter 7.5 "Safe programmable logic (SPL)".

Warning

The state of a deleted SGE/SGA (logical ”0”) that can be achieved both by the user as well as also using fault responses of the ”SINUMERIK Safety Integrated” system, are defined as so-called ”fail-safe state” of an SGE/SGA. This is the reason that the system is only suitable for applications where this state corresponds to the fail-safe state of the process controlled by ”SINUMERIK Safety Integrated”.

Which SGE/SGA are there?

For each axis/spindle, the following SGE and SGA are in each monitoring channel:

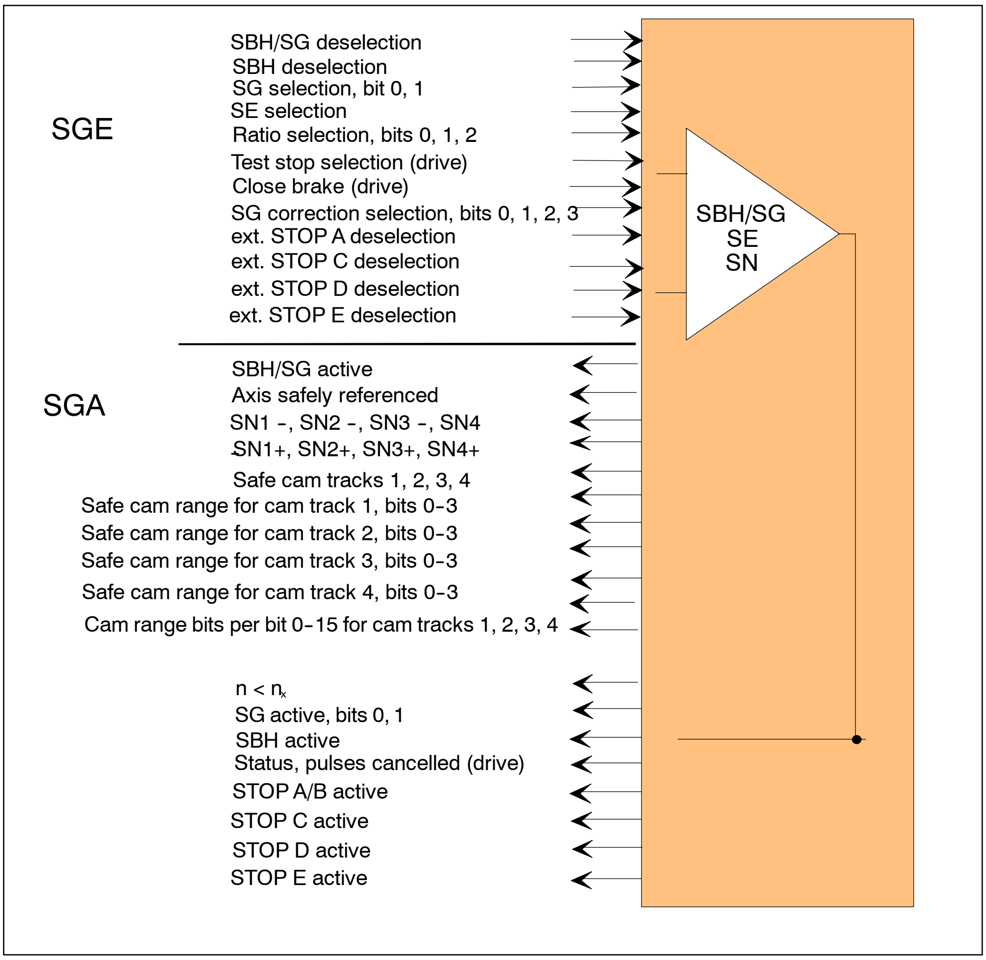


Fig. 7-2 SGE and SGA in every monitoring channel for each axis/spindle

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Note

The SGE/SGA signals are described in Chapter 8.6, ”Description of Interface signals”.

NCK-SGE/SGA

The signals are assigned to the NCK-SPL inputs/outputs using machine data.

Note

Only the NCK-SGE are assigned to an NCK-SPL output that are also required for the particular application. For axes, where for example, the gear ratio does not change, the NCK-SGE ”ratio selection bit 2 to 0” do not have to be assigned to SPL inputs. A value of 0 should be entered into the associated MD (i.e. the NCK-SGE does not have an SPL assignment and is set to 0). This does not apply to external STOPs that are not used.

PLC-SGE/SGA

For the drive monitoring channel, the NC/PLC interface (axis/spindle DB) represents the SGE/SGA interface between the PLC and the drive. The PLC user program must supply this interface.

Note

Only the PLC-SGE should be processed in the PLC user program that are also required for the particular application. SGE that are not used must be set to the value 0 - i.e. to a defined state. This does not apply to external STOPs that are not used.

See Chapter 6.3.8 ”Forced checking procedure of the external STOPs” for information about SGE/SGA for the test stop for external stops.

How many SGE/SGA are required as a minimum?

Depending on the particular application, only some of the maximum number of SGE/SGA available are required.

Table 7-1 Minimum SGE/SGA required

Function	Minimum SGEs required	Minimum SGAs required
Safe operating stop (SBH)	SBH/SG deselection Test stop selection (drive) External stops	SBH/SG active Status, pulses cancelled (drive) STOP A/B, C, D, E active (only if required)
	if gearbox stages are being used Gear ratio selection, bit 2 (only if it is necessary to select the ratio) Gear ratio selection, bit 1 (only if it is necessary to select the ratio) Gear ratio selection, bit 0 (only if it is necessary to select the ratio)	
Safely-reduced speed (SG)	SBH/SG deselection SBH deselection SG selection, bit 1 (only for SG changeover) SG selection, bit 0 (only for SG changeover) Test stop selection (drive) External stops	SBH/SG active Status, pulses cancelled (drive) STOP A/B, C, D, E active (only where required) active SG stage, bits 0, 1 (only where required)
	if gearbox stages are being used Gear ratio selection, bit 2 (only if it is necessary to select the ratio) Gear ratio selection, bit 1 (only if it is necessary to select the ratio) Gear ratio selection, bit 0 (only if it is necessary to select the ratio)	
Safe software limit switches (SE)	SE selection (only for SE changeover) Test stop selection (drive) SBH/SG deselection (at least for test during commissioning [start-up]) External stops	SBH/SG active Axis safely referenced Status, pulses cancelled (drive) STOP A/B, C, D, E active (only where required)
Safe software cams (SN)	Test stop selection (drive) SBH/SG deselection (at least for test during commissioning [start-up]) External stops	SBH/SG active STOP A/B, C, D, E active (only where required) Axis safely referenced SN1-, SN2-, ..., SN30- (only where required) SN1+, SN2+, ..., SN30+ (only where required) Status, pulses cancelled (drive)

Different signal run times in the channels

The signal timing in the two monitoring channels varies (the PLC cycle time takes up most of the available time in the drive monitoring channel). To prevent the crosswise data comparison function from being immediately activated after a signal change, a tolerance time is defined using the following machine data.

for 840D sl:
MD 36950: $MA_SAFE_MODE_SWITCH_TIME

for SINAMICS S120:
p9550: SI motion SGE changeover tolerance time (Control Unit)

This data specifies the time period for which different signal states may be tolerated after the SGEs have been changed-over before an error message is output.

Note

System-related minimum tolerance time
2 x PLC cycle time (maximum cycle) + 1 x IPO cycle time

7.1.2 Forced checking procedure of SPL signals

Fundamentals

Safety-related input/output signals including the connecting cables to the I/O (peripherals) and the sensors and actuators connected to them must always be subject to a forced-checking procedure (see Chapter 5.3 ”Forced checking procedure”).
The scope of the forced checking procedure should be implemented corresponding to the subsequent conditions.

This means that the selection of a suitable forced checking procedure concept depends on the specific application and the specific sensor and/or actuator; this decision must be made by the user. In this scope, the user must configure the forced checking procedure.

SPL signals

The forced checking procedure of SPL signals is a part of the SPL functionality (see Chapter 7.5 ”Safe programmable logic (SPL))”.
Once the external safety circuit has been wired, a two-channel SPL has been created and the relevant safety functions configured and checked with an acceptance test, the long-term reliability of this function, verified using an acceptance test, can be ensured:

- **External** inputs/outputs
  The external inputs/outputs of the SPL ($A_INSE or $A_OUTSE) must be subject to a forced checking procedure to ensure that faults do not accumulate over a period of time which would mean that both monitoring channels could fail.
- **Internal** inputs/outputs
  Internal inputs/outputs ($A_INSI, $A_OUTSI), markers ($A_MARKERSI) etc. ($A_TIMERSI) do not have to be subject to a forced checking procedure. It will always be possible to detect an error at these locations due to the differing two-channel responses of the external inputs/outputs or the NCK/drive monitoring channels; crosswise data comparison is carried out at both ends of the response chain to detect any errors.

Test signals

”**3-terminal concept” (**see Chapter 7.1.3 ”Connecting sensors - actuators using the 3-terminal concept”):

- If an input signal ($A_INSE)is, for example, evaluated through **two channels** , the associated test output signal can be implemented using **one channel**. It is extremely important that the input signal can be forced/changed and checked in both channels.
- In the same way, the assigned test input signal for two-channel output signals ($A_OUTSE) can be implemented in one channel if it is connected according to the following rule:
  The test input signal may only return an ”OK” status (”1” signal level) if **both** output signals function (i.e. both monitoring channels have output a ”0”).
  A **simultaneous test** in both channels allows the correct functioning in both channels to be checked using **one** feedback signal.

Trigger/test

The timer or event controlled triggering of the forced checking procedure is activated in one channel by the PLC.

If errors are detected, the PLC user program should respond by initiating an external ”STOP D/E” and switching the external SGAs into a safe state.

Notes to avoid errors

1. A ”2-terminal concept” in which a **single-channel net (useful) signal** is to be subject to a forced checking procedure using a **single-channel** test signal is **not permitted**. In this case, the two-channel SPL structure would be worthless and crosswise data comparison would have no effect.

   The following are admissible:

   - A ”full 4-terminal concept for sensors” (two-channel test signal for a two-channel useful [net] signal),

- the ”3-terminal concept for sensors/actuators” recommended above
- a ”2-terminal concept for sensors *without* test signals”, if the two-channel net (useful) signal to be tested automatically changes its level dynamically as a result of the process. For instance, for the input signals of a protective door,
- a ”2-terminal concept for sensors *without* test signals”, if the sensor is a safety-related component, e.g. light curtains,
- a ”2-terminal concept for actuators *without* test signals”, if the actuator is a safety-related component, e.g. safety valves,
- a ”2-terminal concept for actuators *without* test signals” if the feedback signal can be checked using other useful signals - e.g. for a valve that indirectly switches a BERO via the process and this is available for evaluation,
- a ”2-terminal concept for actuators *without* test signals” if the function of the mechanical system can be checked using other useful signals - e.g. for a brake that is checked using a separate brake test.

2. The signals ”**external STOPs”** are processed internally in a special way:
   - In order to increase the level of security that a requested ”external STOP” actually takes effect, the STOPs are internally exchanged between the two channels. Failure of the stop control function in **one** channel does **not** cause an error for these signals (in contrast to the mode changeover signals, e.g. ”SG/SBH active”) in the crosswise data comparison.
     While other signals can be subject to a forced checking procedure in parallel and in both channels (and should be - in order to avoid errors being triggered by the crosswise data comparison), the ”external STOPs” must be subject to a forced checking procedure **one after the other** in both channels.

7.1.3 Connecting sensors - actuators using the 3-terminal concept

Basic principle for safety-related signal processing

With the 3-terminal concept, three terminals (signals) are required to connect a sensor or actuator. Faults/errors in the sensors and actuators can be detected in conjunction with the SPL-CDC and forced checking procedure or the forced checking as a result of the process itself. The connecting cables are **generally monitored autonomously** by the fail-safe I/O.

The following applies to the safety-related sensor connection:
2 safety-related inputs + 1 standard test output.

The following applies to the safety-related actuator connection:
2 safety-related outputs + 1 standard test input.

Example of an actuator connection

2 outputs (to control through 2 channels via SGA) and 1 standard test input (for the forced checking procedure) are required to connect an actuator in a safety-related fashion. The test input is the feedback signal from the load circuit and is fed from the power supply voltage of a standard input module. The user should derive this as directly as possible from the process quantity.

Actuator control, P/M switching:

The actuator is directly controlled using a plus potential (P-switching) and minus potential (M-switching). If the actuator is not a qualified component (safety component or component with fault exclusion), then in the case that the actuator fails, the user must apply additional cascaded measures in order to bring the process into a safe condition.

Example:

The process quantity, e.g. hydraulic pressure, is switched using a standard valve that is controlled in a safety-related fashion. A pressure sensor signals the status of the process quantity. If the valve can no longer switch due to a fault condition, then using a safely controlled standard contactor, the motor that is generating the pressure, is shutdown. The advantage of this particular version is that components can be used that are already available as standard. As to whether this solution can be used, must be confirmed as a result of the risk assessment (see Fig. 7-3).

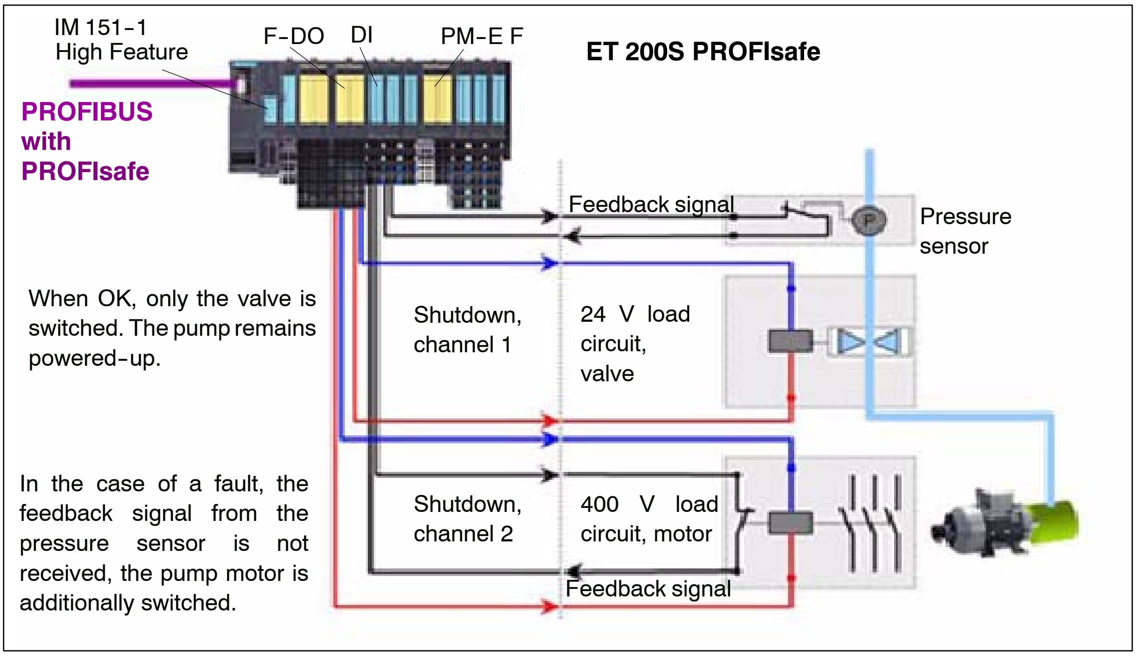


Fig. 7-3 Cascaded shutdown using fail-safe outputs

In other cases a second actuator must be connected in series in the load circuit (see Fig. 7-4).

In conjunction with the safety-related control of a brake, no feedback signal is available. The brake test will identify as to whether the actuator is correctly functioning from a mechanical perspective.

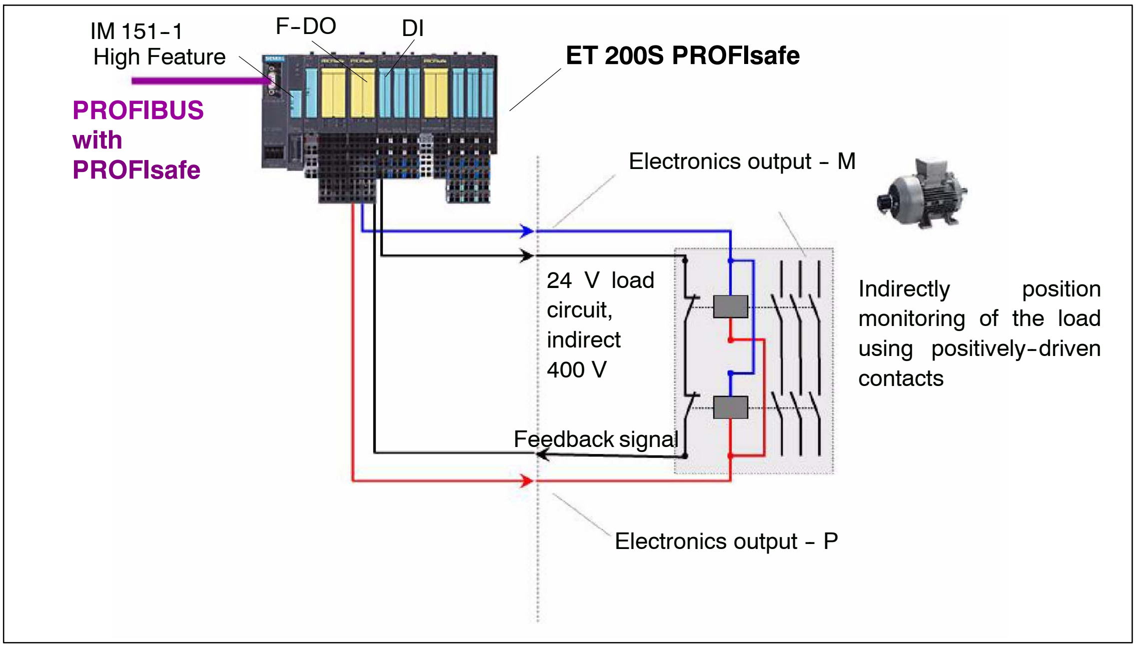


Fig. 7-4 Actuator connection via fail-safe outputs, e.g. 400 V load circuit - P/M-switching

Example of connecting a sensor

2 safety-related inputs (to read-in through 2 channels via SGE) and 1 standard test output (for the forced checking procedure) are required to connect a sensor in a fail-safe fashion. The test output is fed from the power supply voltage of the safety input module. For sensors with a self-test routine, the test output on the input module is not required. For the 3-terminal connection concept we recommend that sensors with non-equivalence contacts are used (NC contact/NO contact). If a P or M short-circuit or broken cable at both signal cables, then a signal state is obtained that is not logically permissible. This means, that a cross-circuit fault can be detected by the non-equivalence concept without having to carry out any test.

Note

Cross-circuit fault detection in the input module is not required.

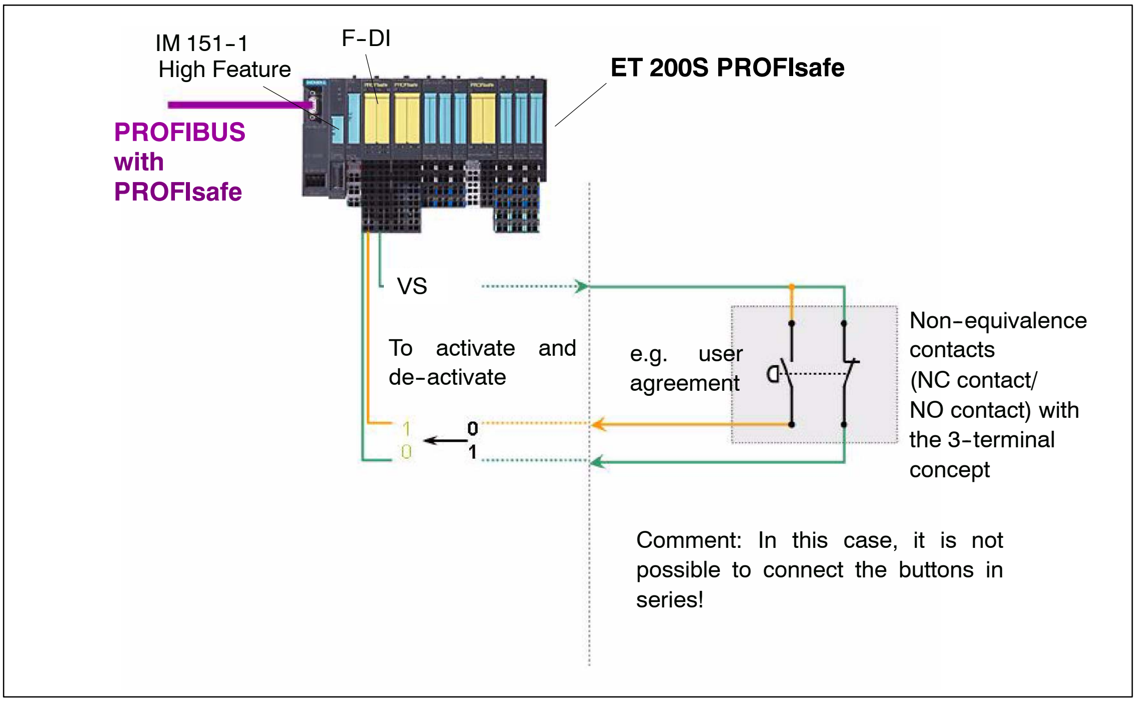


Fig. 7-5 Sensor connection using fail-safe inputs according to the 3-terminal concept

7.1.4 Sensor connection using the 4-terminal concept

For the 4-terminal concept, four terminals are required at the fail-safe input module to connect a sensor that utilizes a contact (e.g. Emergency Stop pushbutton). Faults/errors in the sensors and actuators can be detected in conjunction with the SPL-CDC and forced checking procedure or the forced checking as a result of the process itself. The connecting cables are generally monitored autonomously by the fail-safe input module.

The following applies to the safety-related sensor connection:
2 safety inputs + 2 standard test outputs

Example

2 inputs (to read-in the 2-channel sensor signals via SGE) and 2 standard test outputs (for the forced checking procedure) are required for the fail-safe connection of a sensor. The test outputs are supplied from the two power supply voltages (VS1, VS2) of the safety input module. For the connection concept with 4 terminals, both equivalence (NC contact/NC contact, NO contact/NO contact) as well as non-equivalence (NC contact/NO contact) contact versions are possible.

Note

Cross-circuit fault detection in the input module is not required. Measures against cross-circuit faults are required only for equivalence contacts (NC contact/NC contact, NO contact/NO contact) if the cable has been routed so that it is very exposed, e.g. for cables connecting handheld terminals. This can be mechanically implemented in the cable, e.g. using the appropriate shielding.

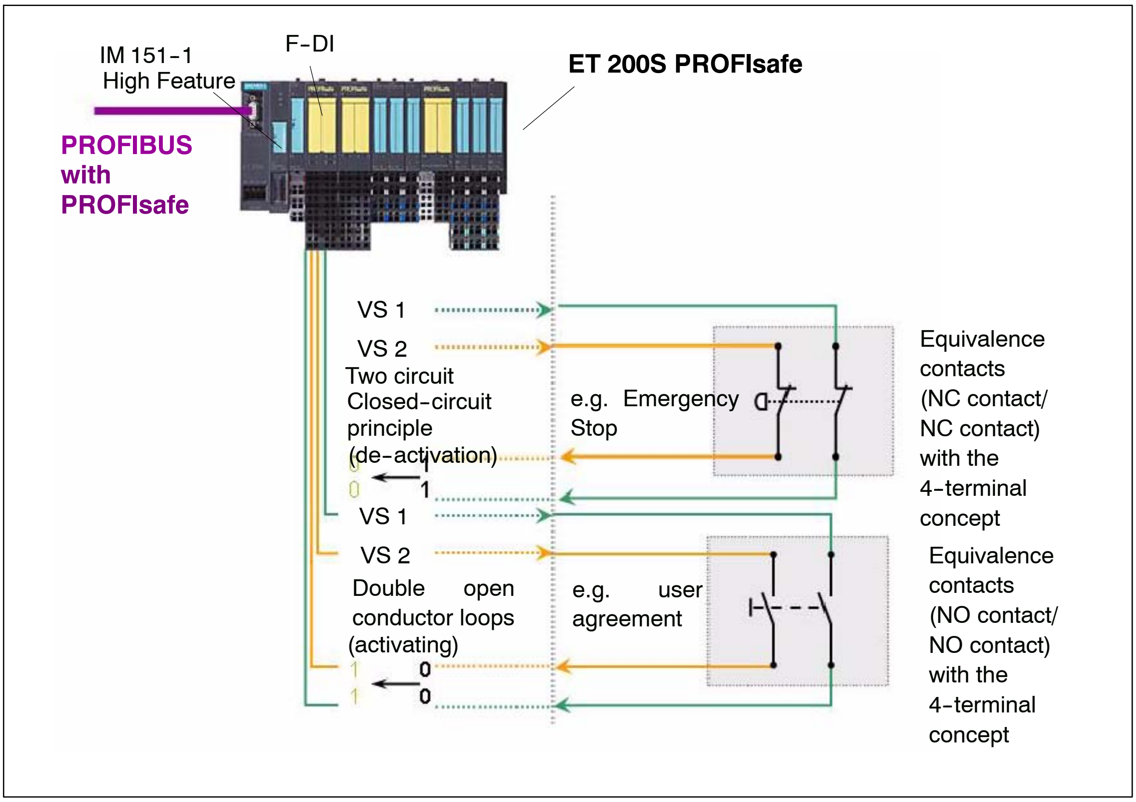


Fig. 7-6 Sensor connection using the 4-terminal concept

7.1.5 Multiple distribution and multiple interlocking

Interlocking functions between the SGE/SGA are implemented in the NCK channel in the NCK-SPL. However, in order to relieve the NCK-SPL, it is also possible to pre-process signals between the NCK-SPL and NCK monitoring channel using the ”multiple distribution” and ”multiple interlocking” functions.

Note

The multiple distribution/interlocking that can be parameterized in the NCK machine data must be programmed by the user on the PLC side.

Processing the NCK-SGE for 840D sl (multiple distribution)

Axis-specific/spindle-specific machine data is used to define which internal SPL output is to be used for which function and which axis/spindle. Under the condition that certain axes/spindles belong to the same safety group, it is possible to implement multiple distribution (1 NCK-SPL output is assigned, for example, to 3 axes with the same function). In addition, when an internal NCK-SPL output is selected via MD, it is also possible to define whether the inverted signal is also to be processed.

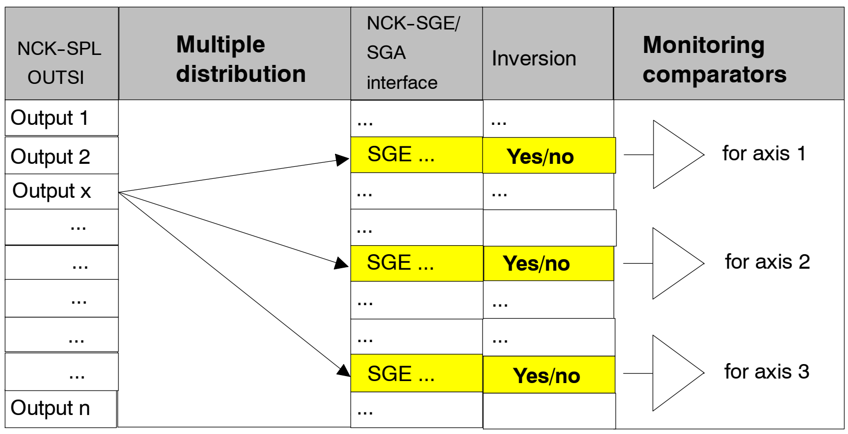


Fig. 7-7 Multiple distribution for NCK--SGE

Example

It must be possible to change over between the ”safe software limit switches” 1 or 2 for axes 1, 2 and 3 as a group using an internal NCK-SPL output (OUTSI x). The machine data must be parameterized as follows:

Axis 1: MD 36973: $MA_SAFE_POS_SELECT_INPUT = OUTSI x
Axis 2: MD 36973: $MA_SAFE_POS_SELECT_INPUT = OUTSI x
Axis 3: MD 36973: $MA_SAFE_POS_SELECT_INPUT = OUTSI x

Processing the NCK-SGA for 840D sl (multiple assignment)

Axis-specific/spindle-specific machine data is used to define which SGA from which axis/spindle must be assigned to which NCK-SPL input. It is possible to implement a multiple assignment (SGA from several axes are assigned to 1 input) provided that certain axes/spindles belong to the same safety group. The SGA are then ANDed and the result output at the NCK-SPL input. In addition, when an NCK output is selected via an MD, it is also possible to define whether the signal is to be output in an inverted form before it is ANDed.

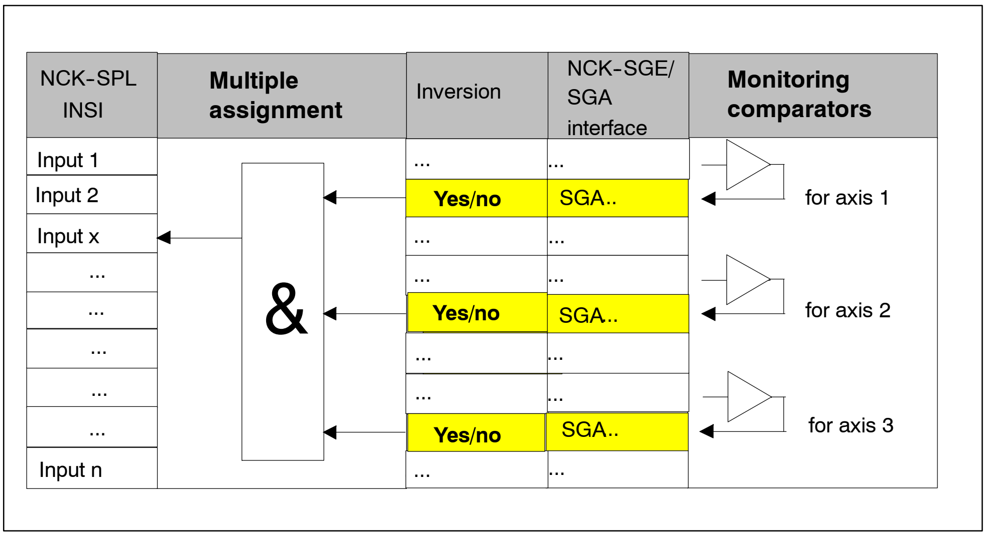


Fig. 7-8 Multiple assignment for NCK-SGA

Example

Axes 1, 2 and 3 belong to one safety area. For these axes, the message ”axis safely referenced” should be output at one NCK-SPL input (INSI) (this means that the message is output at the input if the message (signal) is present for all 3 axes). The machine data must be parameterized as follows:

Axis 1: MD 36987: $MA_SAFE_REFP_STATUS_OUTPUT = INSI x
Axis 2: MD 36987: $MA_SAFE_REFP_STATUS_OUTPUT = INSI x
Axis 3: MD 36987: $MA_SAFE_REFP_STATUS_OUTPUT = INSI x

7.2 Connecting I/O via PROFIsafe

7.2.1 Description of function

The fail-safe master (F master) integrated in SINUMERIK 840Dsl in conjunction with fail-safe I/O modules (F-modules), permits fail-safe communication as specified according to the PROFIsafe profile both on PROFIBUS DP as well as on PROFINET IO (PROFIsafe communication).

This means that the safety-related input/output signals of the process (machine) are coupled to the Safety Integrated function "safe programmable logic" (SPL) in the same way for both the PLC and NCK-SPL via the particular I/O bus . Fail-safe I/O devices can be connected via all I/O connections.

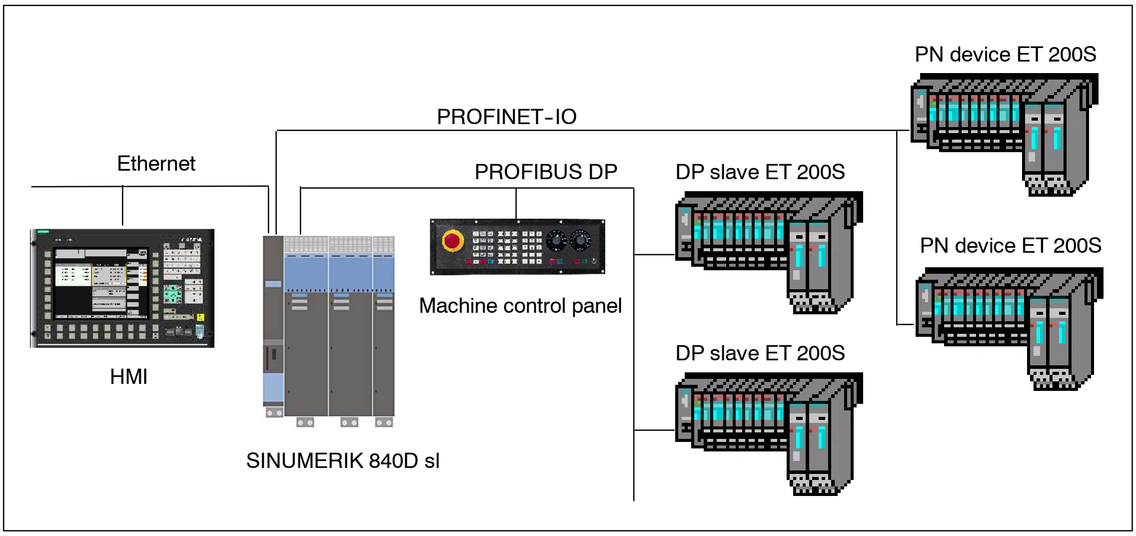


Fig. 7-9 SI I/Os using fail-safe modules connected to PROFIBUS DP

PROFIsafe

PROFIsafe is a communication profile for fail-safe data transfer between fail-safe components based on the field buses PROFIBUS and PROFINET. This represents an extension to the standard communication. This allows both standard components and fail-safe components to be simultaneously operated on a PROFIBUS/ PROFINET system.

The PROFIsafe profile is characterized by the fact that communication between the safe terminal nodes, i.e. the F-CPUs, the distributed slaves and the actuators/ sensors/field devices, uses standard PROFIBUS functions.

The useful (net) data of the safety function plus the safety measures are sent in a standard data telegram. This does not require any additional hardware components, since the protocol chips, drivers, repeaters, cables can still be used as they are.
SINUMERIK Safety Integrated supports PROFIsafe V1 and PROFIsafe V2.

Communication profiles in accordance with IEC 61784
CP 3/1: PROFIBUS
CP 3/4: PROFINET CLASS A
CP 3/5: PROFINET CLASS B
CP 3/6: PROFINET CLASS C (IRT)

- V1 mode
  This mode is designed for pure CP 3/1 networks (PROFIBUS DP).
- V2 mode
  This mode has been designed for pure CP 3/4 – CP 3/6 networks (Ethernet, PROFINET), but can also be used for CP 3/1 networks (PROFIBUS DP).

Note

The designations F master and F slave for PROFIBUS DP are in this documentation – also for the designations F host and the F device for PROFINET.

7.2.2 System structure

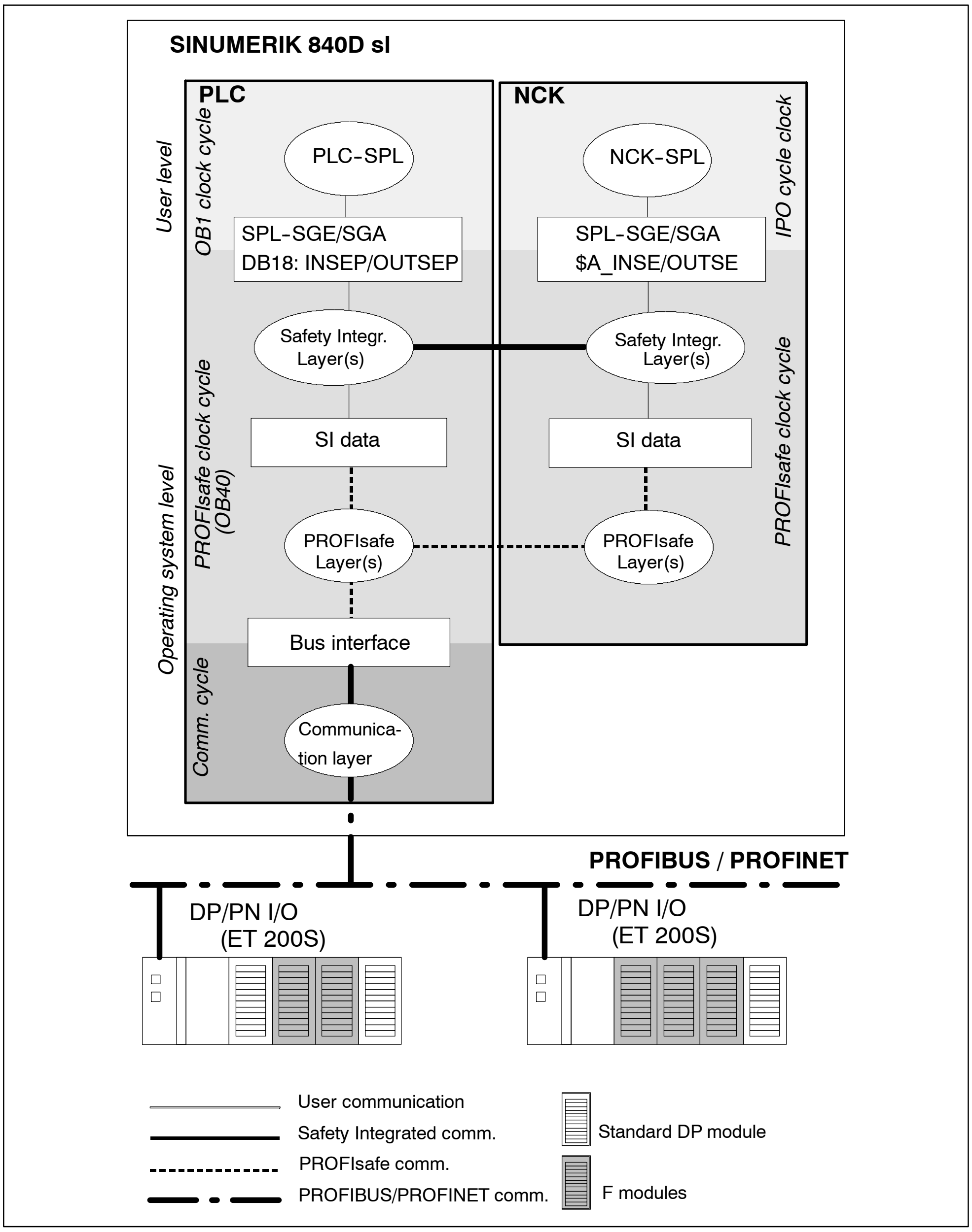


Fig. 7-10 System structure: SI I/O using F modules connected to PROFIBUS/PROFINET

Just like Safety Integrated, the PROFIsafe system structure also has a 2-channel diverse system design based on the PLC and NCK-PROFIsafe layer.

PROFIsafe communication

The principle of PROFIsafe communications between SINUMERIK 840D and the F modules is explained in detail below. This is based on the transfer of the SPL output data $A_OUTSE/$A_OUTSEP to the F-DO modules:

The PROFIsafe layer creates a PROFIsafe telegram (F telegram) in each PROFIsafe cycle with the ANDed SPL output data as F useful (net) data

F useful (net) data = (OUTSEP **AND** $A_OUTSE)

and the backup data (CRC and the consecutive number) and transfers it to the communication layer via the bus interface.

In each communication cycle independent of the PROFIsafe cycle, the PROFIBUS layer transfers a telegram with a PROFIsafe telegram generated from the F layer as user data to the slave devices.

Warning

It is not guaranteed that simultaneous changes to individual bits in the SPL (NCK and PLC OUTSE), which are interpreted as a contiguous associated bit pattern, are transferred together. It is possible that the receiver briefly receives an inconsistent bit pattern.

Configuring/parameterizing

The configuration and parameterization needed to connect the F modules to the external NCK/PLC-SPL interfaces entails the following steps:

1. Generating the configuration using SIMATIC STEP7.
2. Performing a standard SINUMERIK 840D sl commissioning (minimum requirement).
3. Loading the configuration and the PLC basic and user program modules into the SINUMERIK 840D sl PLC.
4. Parameterizing the PROFIsafe-relevant SINUMERIK 840D sl machine data. See Chapter 7.2.4 "Parameterizing the F master (NCK)".

7.2.3 Configuring and parameterizing the PROFIsafe I/O

The configuration at the PROFIBUS/PROFINET I/O connections on the PLC side of a SINUMERIK 840D sl is defined using the Step7 component HW Config. There are two options:

- Integrating Siemens fail-safe devices via the hardware catalog
- Integrating third-party fail-safe devices by importing the corresponding generic station description files.

This configuration is loaded into the PLC, the PLC evaluates this data and makes the information required for PROFIsafe communication with an F-device, available to the NCK and PLC-side Safety system SW for further evaluation of the F device configuration.

In addition, the NCK machine data for PROFIsafe parameterization is transferred from the NCK to PLC. Both components evaluate this machine data and compare the F devices, which are parameterized in this data, with the F-device configuration provided from the PLC.

The information on configuring and parameterizing the PROFIsafe I/O provided in this chapter essentially refers to the specific requirements of SIMATIC. Complete information on configuring and parameterizing PROFIsafe components from Siemens is provided in the SIMATIC Manuals:

References:

Distributed I/O System ET 200S, Manual

Distributed I/O System ET 200S, Fail-Safe Modules, Manual

Distributed I/O System ET 200pro, Fail-Safe Modules

Distributed I/O Station ET 200eco, Fail-Safe I/O Modules

Distributed I/O station ET 200 M, fail-safe I/O Modules

ASIsafe DP/AS-i F-Link

Configuration

The F I/O are configured while configuring the standard I/O bus configuration using STEP 7.

Parameterization

Both the standard and F parameterization of the F modules is carried out using the relevant properties dialog box of the module. Select the appropriate I/O device (e.g. IM 151-1) in the station window and then open the properties dialog box of the relevant F module in the detailed view.

Note

The parameter assignments specified in this chapter only refer to the ET 200 modules.

Parameter: Input/output address

The following conditions apply to the input/output addresses of an F module:

- Input address for PLC317 > 256
- Input address for PLC319 > 512
- Input address for PLC317 PN > User-defined limit of the process image
- Output address = input address

F parameterization

F parameterization is realized in the properties dialog box under:

Dialog: Properties

Tab: Parameters

Parameters > F parameters

The F parameters of the PROFIsafe components are automatically set to the F monitoring time of the HW Config and cannot be changed.

The displayed values of the F parameters

- F_Source_Address
- F_destination_address

must be entered into the machine data to parameterize the NCK in a subsequent parameterizing step.

Warning

The PROFIsafe addresses are for unique identification of source and target of safety-related communications.

The following applies to pure PROFIBUS-DP subnets:
The PROFIsafe target address must be unique network-wide* and station-wide** (system-wide). A maximum of 1022 different PROFIsafe target addresses can be assigned.

* A network consists of one or more subnets. "Network-wide" means across subnet boundaries.
** "Station-wide" means for a station with HW configuration (e.g. a Sinumerik 840D).

F parameters: F_source/target_address

F_Source_Address

The F-source-address is the decimal PROFIsafe address of the F master allocated automatically by HW Config. The F_source_address is formed from the "basis for PROFIsafe addresses" plus the PROFIBUS address of the PROFIBUS-DP interface.

Note

To clearly define the PROFIsafe communication, the PROFIsafe address of the F master - assigned by HW Config - must be saved in the F master. To do this, the PROFIsafe address of the F master must be converted from decimal into hexadecimal and entered into the machine data of SINUMERIK 840D sl. Refer to Chapter 7.2.4 "Parameterizing the F master (NCK)".

F_destination_address

The F_target_address is the decimal PROFIsafe address of the F module automatically allocated by HW Config (the user can change this).

Note

In order to parameterize the PROFIsafe communication relationships, the F master is informed, via the PROFIsafe address of the PROFIsafe component that this PROFIsafe component is assigned to it. To do this, the PROFIsafe address must be converted from decimal into hexadecimal and entered into the machine data of SINUMERIK 840D sl. Refer to Chapter 7.2.4 "Parameterizing the F master (NCK)".

The DIL switch setting shown corresponds to the PROFIsafe address to be set at the DIL switch of the F module.

F parameters: F_source/target_address(PROFINET IO)

F device

The F-addresses of the F device are assigned by the user when configuring. They must be unique within a sub-network.

Note
Sub-networks are connected through 2-port routers, which therefore also represent the natural limits of the sub-networks.

F host

The F address of the F host is the "Basis for PROFIsafe addresses" entered as default from STEP 7 under the "F parameter" tab. The user can subsequently change the F address in steps of 1000.

Valid F addressing range: 1 - $FFFE_H$ (1 - 65534_D)

F parameters: F monitoring time

The F monitoring time defines the maximum time that is tolerated when a PROFIsafe component is waiting for a new F telegram from its communication partner.

Note

If the F monitoring time is configured to be shorter than the PROFIsafe monitoring clock cycle set using the appropriate machine data, when the control runs-up an alarm is displayed:

Alarm 27242 ”PROFIsafe: F module %1, %*2* incorrect”

Parameter: DO/DI channel x

The channels of an F module are parameterized in the properties dialog box under:

Dialog: Properties

Tab: Parameters

Parameters > Module parameter > DO or DI channel x

F-DI module

The channels of the F-DI module are mapped differently to the NCK/PLC-SPL inputs $A_INSE/INSEP depending on the selected parameterization.

- 2v2 parameterization
  For 2v2 parameterization, the process signals of both channels in the F-DI module are combined to form one F useful (net) data signal and thus supply an SPL input data.

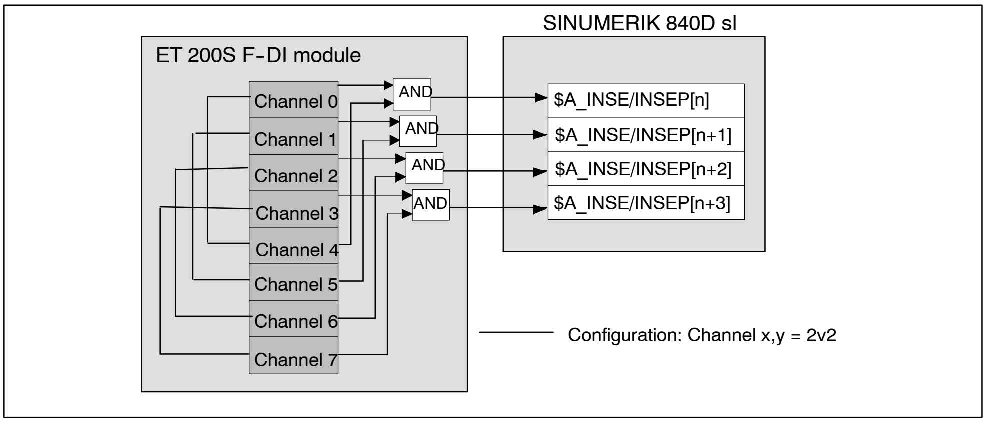


Fig. 7-11 2v2 mapping of the F-DI channels to SPL input data for ET 200S

- 1v1 parameterization
  For 1v1 parameterization, the process signals of both channels are transferred from the F-DI module and can thus supply 2 different SPL input data.

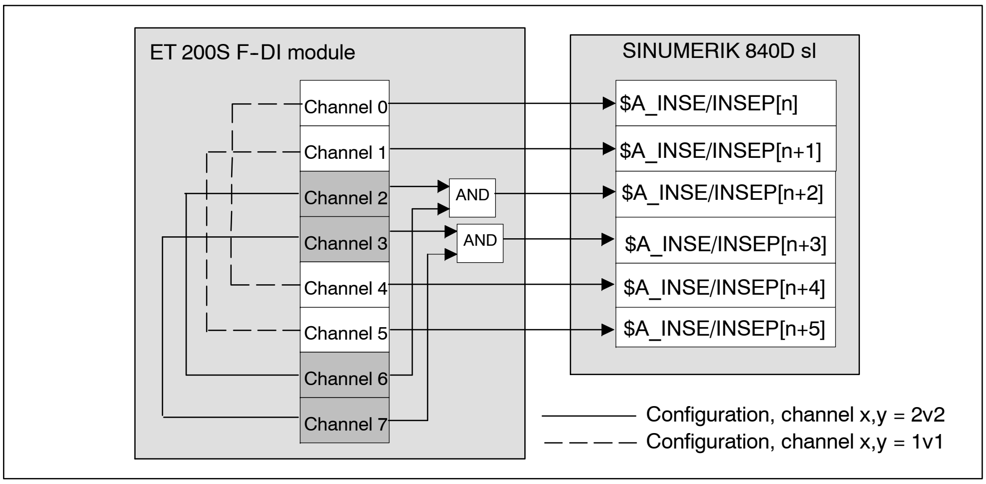


Fig. 7-12 2v2/1v1 mapping of the F-DI channels to SPL input data

Note

If mixed 2v2 and 1v1 parameterization is used in an F-DI module, this can reduce the number of SPL input data $A_INSE/INSEP that can be used. This is the reason that we recommend that 1v1 is first parameterized followed by 2v2.

If more pieces of F net data of an F-DI module are used then the number relevant bits that can be transferred by parameterizing the channels of the F-DI module, then the control does not recognize this.

Example:
For a 2v2 parameterization of all of the channels of the F-DI module:

- ET 200S F, F-DI module: 4/8 F-DI 24 V DC

The 8 transferred F net data bits contain 4 relevant (bit 0 - bit 3) and 4 non-relevant bits (bit 4 - bit 7).

F-DO module

The NCK/PLC-SPL outputs $A_OUTSE/OUTSEP are logically combined in the F driver to produce an F net (useful) data signal(implicit 2v2 parameterization) and mapped to the channels of the relevant F-DO module.

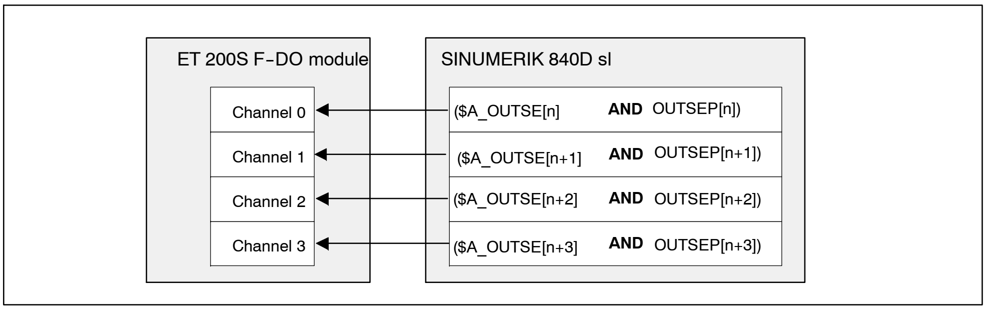


Fig. 7-13 Mapping the SPL output data to F-DO channels

PROFIsafe clock cycle and communication cycle time

When parameterizing the PROFIsafe clock cycle to ensure a correct PROFIsafe communication, the cyclic bus communication time must be observed. For the PROFIBUS bus system, this time can be determined as follows:

DP cycle time
After the station has been fully configured, the DP cycle time can be determined by activating the equidistant (isochronous) bus cycle:

Open the properties dialog box of PROFIBUS in HW Config: DP master of the configured station:

Dialog: Properties – DP master system
  Tab: General
    Subnetwork, button: Properties

Dialog: Properties – PROFIBUS
  Tab: Network settings
    Button: Options

Dialog: Options
  Tab: Constant bus cycle time
    Checkbox: **Activate equidistance bus cycle**/
    Re-calculate equidistant type

(*Note: Activate the equidistant bus cycle using the checkbox: "Activate equidistant bus cycle/recalculate equidistant time". This can be used to determine the DP cycle time. The equidistant bus cycle should then be deactivated again.*

Display field: **Equidistant bus cycle**

(*Note: The value calculated by HW Config and displayed in the display field: "Equidistant bus cycle" has the same significance as the DP cycle time*)

    Cancel

  Cancel

Cancel

A corresponding value should be determined for the PROFINET communication coupling.

Note

The communication cycle time is required as guideline when parameterizing the PROFIsafe clock cycle (refer to Chapter 7.2.5 "Parameterizing the PROFIsafe communication (NCK)").

The information and instructions in the online documentation should be carefully observed before changing the communication cycle time (button: "Help" of the relevant dialog box).

7.2.4 Parameterizing the F master (NCK)

The F master is parameterized in the machine data of the NCK and comprises the following sub areas:

- PROFIsafe communication
  - PROFIsafe address of the F master
  - PROFIsafe clock cycle

  See Chapter 7.2.5 "Parameterizing the PROFIsafe communication (NCK)".
- SPL-SGE/SGA interface
  - PROFIsafe address of the PROFIsafe component
  - F net data filter
  - SGE/SGA assignment

  SPL-SGE interface See Chapter 7.2.6 "Parameterizing the SPL-SGE interface (NCK)".

  SPL-SGA interface: See Chapter 7.2.7 "Parameterizing the SPL-SGA interface (NCK)".

7.2.5 Parameterizing the PROFIsafe communication (NCK)

Fail-safe master address

In order to define a unique and clear communication relationship between F slave and F master, in addition to the target address (PROFIsafe address of the F slave), the source address (PROFIsafe address of the F master) must be defined.

The PROFIsafe address of the F master is entered into the following machine data:

- MD10385: $MN_PROFISAFE_MASTER_ADDRESS[ ]
  (PROFIsafe address of the F master)

  Input format: 0s 00 aaaa
  - s: Bus segment information
    Range of values: 5 = PLC-side I/O connections
  - aaaa: <u>Hexadecimal</u> PROFIsafe address
    F parameters F_source_address (range of values: 1...64125)

In order to be able to handle different PROFIsafe master addresses at different bus connections (e.g. PROFIBUS, PROFINET), this MD is created as MD field so that it is possible to parameterize several PROFIsafe master addresses.

If the same PROFIsafe master address is configured for various I/O connections, then only this one PROFIsafe master address must be saved in the MD.

Note

The PROFIsafe address of the F master is provided under:

- HW Config > Properties dialog box of the F module > F parameter: F_Source_Address

---

PROFIsafe clock cycle

The PROFIsafe clock cycle defines the time grid in which new F telegrams are generated by the F master for transfer to the F modules. The PROFIsafe clock cycle is derived as standard from the interpolation cycle in the ratio 1:1.

As part of the PROFIsafe communications, a cyclic interrupt of the PLC user program (OB1) is made. This is realized in the PROFIsafe clock cycle via OB40.

In order to reduce the possible resulting computational load, machine data

- MD 10098: $MN_PROFISAFE_IPO_TIME_RATIO
  (factor, PROFIsafe communications clock cycle)

can be used to modify the ratio between the PROFIsafe and interpolation clock cycle.

In order to achieve a sufficiently fast response time regarding PROFIsafe-communications, the PROFIsafe clock cycle may not be parameterized greater than 25 ms. The selected PROFIsafe clock cycle is displayed in the machine data:

- MD 10099: $MN_INFO_PROFISAFE_CYCLE_TIME
  (PROFIsafe, communications clock cycle)

For a PROFIsafe clock cycle of greater than 25 ms, when the control boots the next time, an alarm is displayed:

- Alarm: 27200 ”PROFIsafe cycle time %1 [ms] is too long”

PROFIsafe clock cycle and DP cycle time

The PROFIsafe clock cycle should be parameterized longer than the DP clock cycle time displayed by STEP 7: HW Config. Otherwise, the load (in time) on the PLC user program is increased as a result of unnecessary OB40 interrupts.

Note

The PROFIsafe clock cycle should be parameterized so that the following applies:
12 ms < PROFIsafe clock cycle < 25 ms

PROFIsafe clock cycle overruns

Even if the parameterized software operates error-free in normal operation, run time fluctuations in the PLC operating system (e.g. processing diagnostic alarms) can mean that the processing of the OB40 interrupt was not able to be completed before the start of the next PROFIsafe clock cycle.

In this particular case, the NCK attempts, up to a limit of **50** ms after the last correctly processed PROFIsafe clock cycle, to initiate an OB40 interrupt. The repeated attempts to initiate the OB40 interrupt are no longer executed in the PROFIsafe clock cycle but in the IPO clock cycle.

After the **50** ms limit value is exceeded, Alarm 27253 "PROFIsafe communication error F master component %1, error %2" is output and the configured stop response (Stop D or E) is initiated. PROFIsafe communication processing is stopped. This means that the communication to F modules, type F-DO or F-DI/DO is interrupted. PROFIsafe drivers of Type F-DI or F-DI/DO F modules that have been stopped output fail-safe values (0) as F net data towards the SPL.

Further, an attempt is still made to initiate the OB40 interrupt and to maintain PROFIsafe communications.

The time up to initiating the next OB40 interrupt is displayed in the following NCK machine data:

- MD 10099: $MN_INFO_PROFISAFE_CYCLE_TIME
  (PROFIsafe, communications clock cycle)

If the PROFIsafe clock cycle is continuously exceeded and just not sporadically, then the following alarm is displayed:

- Alarm: 27256 "PROFIsafe actual cycle time %1 [ms] > parameterized cycle time"

7.2.6 Parameterizing the SPL-SGE interface

A bitwise assignment can be made using machine data to better link the SPL interfaces to the net (useful) data of the F modules.

Symbolic name

In order to be able to display the various PROFIsafe modules in accordance with symbols that can be specified by a machine manufacturer, using the MD fields

- $MN_PROFISAFE_IN/OUT_NAME[0...15]

it is possible to save symbolic names such as these. This name is used in the following situations:

- Alarms: If a symbolic name for a PROFIsafe connection has been saved in the MD mentioned, then this is displayed instead of the PROFIsafe address. This applies to the following alarms:

  27251 PROFIsafe: F module %1, %2 signals error %3 %1 = name
  27254 PROFIsafe: F module %1, error on channel %2; %3<ALSI> %1 = name
  27255 PROFIsafe: F module %1, general error %1 = name
  27257 PROFIsafe: %1 %2 signals system error %3 (%4) %2 = name
  only if %1 = ”F-module”

- Diagnostic screens: In addition to the PROFIsafe address, the symbolic name is also displayed in the diagnostic screens.

For PROFIsafe modules that are addressed in several MD blocks (several subslots or several SPL couplings), then the symbolic name, which is saved in the MD set with the lowest array index, is applicable. All other connection names are ignored.

The symbolic names can be freely selected and can be a maximum of 15 characters.

Machine data that contain symbolic names are not included in any checksum calculation. The name can therefore be changed without aligning the checksum. The value of the machine data becomes active after a control hot restart.

Note

The examples, now listed, to parameterize the SPL-SGE interface are based on the following specifications:

F-DI module

- F address: 114 = 90H
- F net data length: 8 bytes

Machine data

- MD10386 $MN_PROFISAFE_IN_ADDRESS[5] = 05 00 0090
- MD13300 $MN_PROFISAFE_IN_FILTER[5] = 000F 000F
- MD10388 $MN_PROFISAFE_IN_ASSIGN[5] = 008 001
- MD 13308 $MN_PROFISAFE_IN_NAME[5] = PS_IN_5

Assignment: PROFIsafe component to the F master

F net data of an F-DI module is sub-divided into units each 32 bits. Each of these 32 bit units are known as sub-slots. This sub-division, for assigning the F-DI module to the F master is expressed in the sub-slot address.

The machine data is used to assign the F-DI module to the F master:

- MD 10386: $MN_PROFISAFE_IN_ADDRESS[Index]
  (PROFIsafe address of the F-DI module)

  Input format: 0s 0x aaaa

  - s: Bus segment
    Range of values: 5 = PLC-side I/O connection
  - x: Sub-slot address
    Range of values: 0...1
    x = 0 addresses the F net data signals 1...32
    x = 1 addresses the F net data signals 33...64
    in the PROFIsafe telegram of the F slave
  - aaaa: Hexadecimal PROFIsafe address of the F module
    Range of values: 1...$FFFF_H$

Note

The PROFIsafe address of an F module is provided in STEP7 HW Config under:

Properties dialog box of the F module > F parameters: F_destination_address

The PROFIsafe address of the F module is displayed in the decimal format in HW Config but must be entered into the machine data in the hexadecimal format.

Example

Net data of the 1st sub-slot is used to supply the SPL-SGE of the F-DI module with the PROFIsafe address: 90H

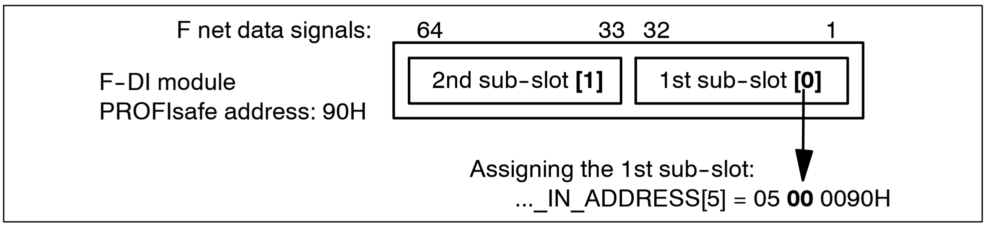


Fig. 7-14 F-DI addressing with the sub-slot

As a result of the possibility of flexibly assigning the F net data of an F-DI module to the SPL-SGE by combining the machine data now described (...IN_FILTER[n] and ...IN_ASSIGN[n]), it is possible and also makes sense to use the same PROFIsafe and sub-slot address a multiple number of times within the machine data:

- $MN_PROFISAFE_IN_ADDRESS[0...max. Index]

Possible or would make sense.

Note

All machine data to connect an F-DI module to the SPL-SGE are associated with one another through the common index of the machine data:

- $MN_PROFISAFE_IN_ADDRESS[**Index**]
- $MN_PROFISAFE_IN_FILTER[**Index**]
- $MN_PROFISAFE_IN_ASSIGN[**Index**]
- $MN_PROFISAFE_IN_NAME[**Index**]

F net data filter

If not all of the F net data signals of the sub-slots of an F-DI module are required for further processing within the SPL, then the relevant F-net data signal signals can be selected using the F-net data filter. Only these are then transferred to the SPL-SGE.

In the output direction, the F net data filter allows the selected SPL-SGA ($A_OUTSE) to be distributed across any F net data signals without any gaps via the machine data PROFISAFE_OUT_ASSIGN[Index].

The F net data filter is parameterized in the machine data:

- MD 13300: $MN_PROFISAFE_IN_FILTER[Index] (F net data filter IN)

Each F net data signal of the sub-slot is assigned to a filter bit. The filter bits of the F net data signals, that are to be transferred to SPL-SGE, should be set to 1. The filter bits of the F net data signals, that are not to be transferred, should be set to 0. The selected F net data signals are always transferred to the SPL-SGE as a consecutive bit field (i.e. a bit field without any gaps).

FFFF FFFFH is the default setting of the filter. This means that all F net data signals are transferred.

Example

8 F net data signals (bits 0...3 and bits 16...19) of the 1st sub-slot are filtered from the F net data of the F-DI module and transferred to the SPL-SGE.

- MD10386 $MN_PROFISAFE_IN_ADDRESS[5] = 05 00 0090
- **MD13300 $MN_PROFISAFE_IN_FILTER[5] = 000F 000F**
- MD10388 $MN_PROFISAFE_IN_ASSIGN[5] = 008 001

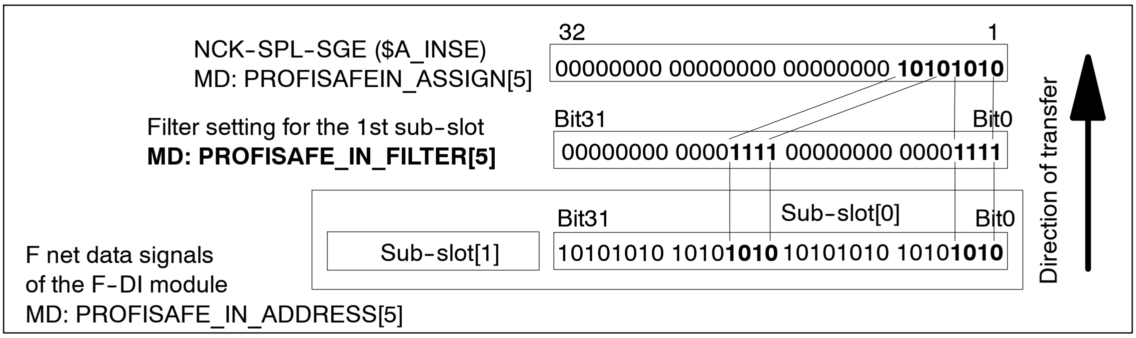


Fig. 7-15 Filtering the F net data signals in the input direction

SPL-SGE assignment

With this assignment, it is defined in which SPL-SGE ($A_INSE/$A_INSEP) the seamless (without gaps) F net data selected using the F net data filter are transferred.

The assignment is made using machine data:

- MD 10388: $MN_PROFISAFE_IN_ASSIGN[Index], (input assignment: F net data signals to $A_INSE)

  Input format: aaa bbb

  - aaa: Area limit 1, SPL-SGE $A_INSE/INSEP[**aaa**]
  - bbb: Area limit 2, SPL-SGE $A_INSE/INSEP[**bbb**]

Note

Area limits 1 and 2 are used to specify the area of the SPL input/output data to be written to/read from via the PROFIsafe connection. The sequence in which the upper and lower limit values are specified can be freely selected.
Example: The following data have the same significance
$MN_PROFISAFE_IN_ASSIGN[3] = 00**8** 00**5**
$MN_PROFISAFE_IN_ASSIGN[3] = 00**5** 00**8**

Example

8 F net data signals of the 1st sub-slot filtered from the F net data of the F-DI module are transferred in the SPL-SGE from $A_INSE[1]/INSEP[1]).

- MD10386 $MN_PROFISAFE_IN_ADDRESS[5] = 05 00 0090
- MD13300 $MN_PROFISAFE_IN_FILTER[5] = 000F 000F
- **MD10388 $MN_PROFISAFE_IN_ASSIGN[5] = 008 001**

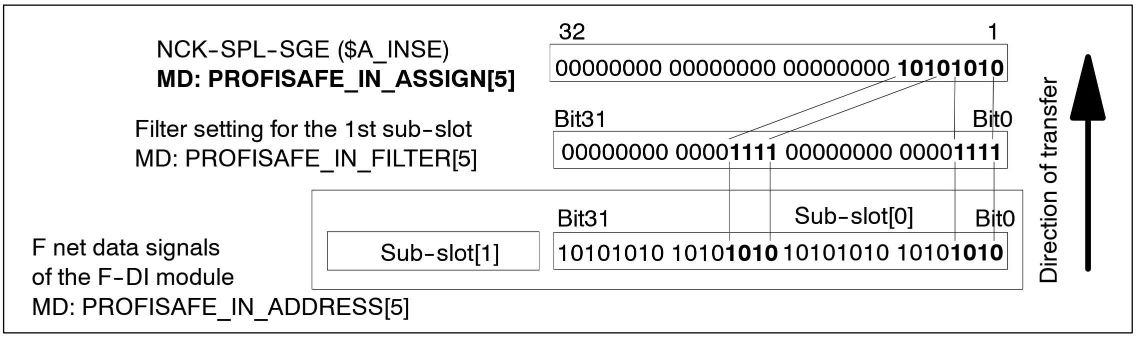


Fig. 7-16 Transfer: Filtered F net data signals in SPL-SGE

7.2.7 Parameterizing the SPL-SGA interface

Note

The following examples show the parameterization of the SPL-SGA interface based on the following specifications:

F-DO module

- F address: 256 = 100H
- F net data length: 6 bytes

Machine data

- MD10387 $MN_PROFISAFE_OUT_ADDRESS[3] = 05 00 0100
- MD13301 $MN_PROFISAFE_OUT_FILTER[3] = 0000 1031
- MD10389 $MN_PROFISAFE_OUT_ASSIGN[3] = 008 005
- MD13309 $MN_PROFISAFE_OUT_NAME[3] = PS_OUT_3

Assignment: PROFIsafe component to the F master

The F net data of an F-DO module are sub-divided into 32-bit units. Each of these 32 bit units are known as sub-slots. This sub-division, for assigning the F-DO module to the F master is expressed in the sub-slot address.

The machine data is used to assign the F-DO module to the F master:

- MD 10387: $MN_PROFISAFE_OUT_ADDRESS[Index]
  (PROFIsafe address of the F-DI module)

Input format: 0s 0x aaaa

- s: Bus segment
  Range of values: 5 = PLC-side I/O connection
- x: Sub-slot address
  Range of values: 0...1
  x = 0 addresses the F net data signals 1...32
  x = 1 addresses the F net data signals 33...64
  in the PROFIsafe telegram to the F slave
- aaaa: Hexadecimal PROFIsafe address of the F module
  Range of values: 1...$FFFF_H$

Note

The PROFIsafe address of an F module is provided in STEP7 HW Config under:

Properties dialog box of the F module > F parameters: F_destination_address

The PROFIsafe address of the F module is displayed in the decimal format in HW Config but must be entered into the machine data in the hexadecimal format.

Example

SPL-SGA are written - as F net data - into the 1st sub-slot of the F-DO module with PROFIsafe address: 100H.

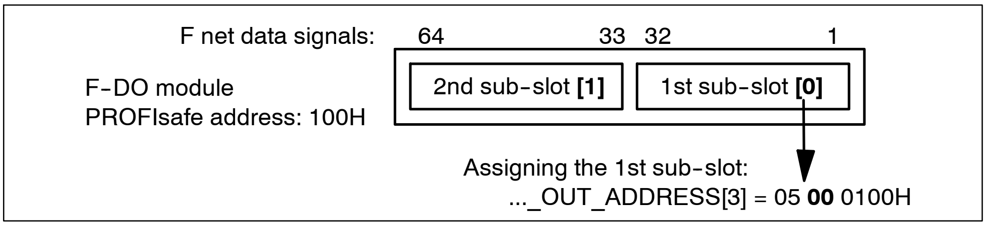


Fig. 7-17 F-DO addressing with sub-slot

As a result of the possibility of flexibly assigning the F net data of an F-DO module to the SPL-SGA by combining the machine data now described (...OUT_FILTER[n] and ...OUT_ASSIGN[n]), it is possible and also makes sense to use the same PROFIsafe and sub-slot address a multiple number of times within the machine data:

- $MN_PROFISAFE_OUT_ADDRESS[0...max. Index]

Note

All machine data to connect an F-DO module to the SPL-SGA are associated with one another through the common index of the machine data:

- $MN_PROFISAFE_OUT_ADDRESS[**Index**]
- $MN_PROFISAFE_OUT_FILTER[**Index**]
- $MN_PROFISAFE_OUT_ASSIGN[**Index**]
- $MN_PROFISAFE_OUT_NAME[**Index**]

F net data filter

The F net data filter allows the selected SPL-SGA - without any gaps - to distributed across any F net data signals within the sub-slot.

The F net data filter is parameterized in the machine data:

- MD 13301: $MN_PROFISAFE_OUT_FILTER[Index] (F net data filter OUT)

Every selected SPL-SGA is assigned a filter bit in an increasing sequence. The filter bits, which are used to transfer the SPL-SGA to the F net data signals, should be set to 1. The filter bits of the SPL-SGA that are not to be transferred, should be set to 0.

FFFF FFFFH is the default setting of the F net data filter; this means that all of the selected SPL-SGA, are transferred from F net data signal 1 onwards (bit 0) into the F net data of the F-DO module.

Example

4 SPL-SGA are transferred into the F net data of the 1st sub-slot of the F-DO module corresponding to the set filter bits:

- MD10386 $MN_PROFISAFE_OUT_ADDRESS[3] = 05 01 0100
- **MD13301 $MN_PROFISAFE_OUT_FILTER[3] = 0000 00F0**
- MD10389 $MN_PROFISAFE_OUT_ASSIGN[3] = 008 005

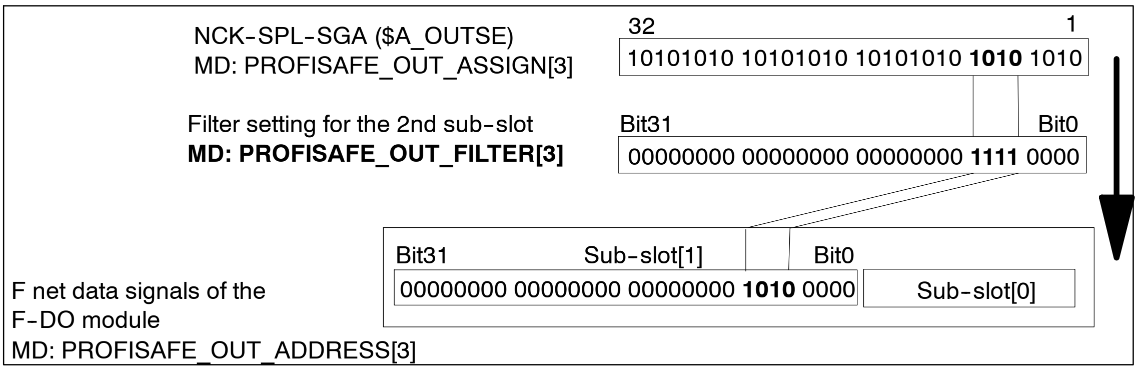


Fig. 7-18 Filtering the SPL-SGA in the output direction

SPL-SGA assignment

The assignment defines which SPL-SGA ($A_OUTSE/$A_OUTSEP) are transferred in the F net data of the F-DO module. The SPL-SGA can only be specified as a field of output signals without any gaps (consecutive field of output signals).

The assignment is made using machine data:

- MD 10389: $MN_PROFISAFE_OUT_ASSIGN[Index],
  (Output assignment: SPL-SGA to F net data signals)

  Input format: aaa bbb

  - aaa: Area limit 1 SPL-SGA $A_OUTSE/OUTSEP[**aaa**]
  - bbb: Area limit 2 SPL-SGA $A_OUTSE/OUTSEP[**bbb**]

Note

Area limits 1 and 2 are used to specify the area of the SPL input/output data to be written to/read from via the PROFIsafe connection. The sequence in which the upper and lower limit values are specified can be freely selected.
Example: The following data have the same significance
$MN_PROFISAFE_OUT_ASSIGN[3] = 00**8** 00**5**
$MN_PROFISAFE_OUT_ASSIGN[3] = 00**5** 00**8**

Example

From the SPL-SGA, 4 output signals $A_OUTSE/OUTSEP[5] to $A_OUTSE/OUTSEP[8] are selected for transfer in the F net data of the F-DO module:

- MD10386 $MN_PROFISAFE_OUT_ADDRESS[3] = 05 00 0100
- MD13301 $MN_PROFISAFE_OUT_FILTER[3] = 0000 1031
- **MD10389 $MN_PROFISAFE_OUT_ASSIGN[3] = 008 005**

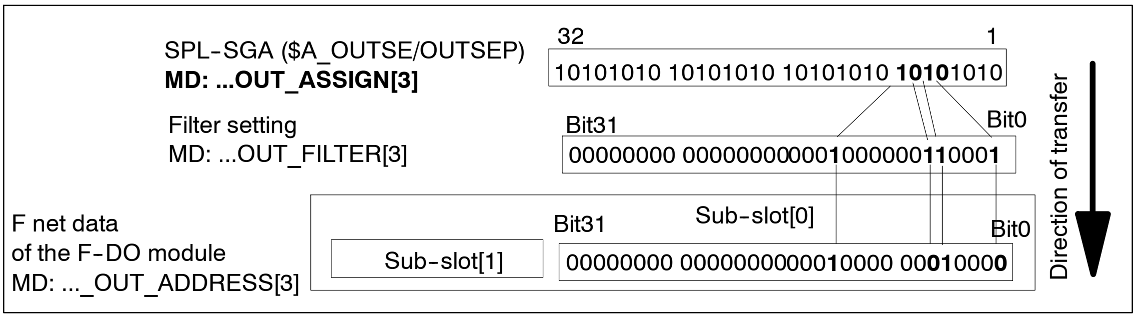


Fig. 7-19 Selecting the SPL-SGA for filtering

7.2.8 Module type (NCK)

The type of PROFIsafe component cannot be explicitly specified. The F master determines the type depending on the machine data in which a PROFIsafe address has been entered:

- $MN_PROFISAFE_IN_ADDRESS
- $MN_PROFISAFE_OUT_ADDRESS

Dependent on this, the PROFIsafe component is identified as either input, output or bidirectional I/O module.

Table 7-2 PROFIsafe component module types

..._IN_ADDRESS	..._OUT_ADDRESS	Type
F address	–	Input module
–	F address	Output module
F address	F address	Input/output module

7.2.9 Parameterizing the F master (PLC)

In the PLC, the F master does not have to be explicitly parameterized regarding the connection of F modules.

The PLC is parameterized explicitly as follows:

- Parameterizing the NCK
- Generating and downloading the configuration

Data block DB18

Two bit arrays in data block DB 18 are used to display which INSEP/OUTSEP bytes are only assigned to F modules as a result of the parameterization in the NCK machine data:

- MD 10388: $MN_PROFISAFE_IN_ASSIGN
- MD 10389: $MN_PROFISAFE_OUT_ASSIGN.

Data block DB18 (excerpt):

```
STRUCT
:
  SPL_DATA:STRUCT
     INSEP:          ARRAY[1 ... 64] OF BOOL;
     OUTSEP:         ARRAY[1 ... 64] OF BOOL;
:
  //External SPL input bytes(HW) with PROFIsafe slaves
  INSEP_PROFISAFE:   ARRAY[1 ... 8] OF BOOL;
```

```
  //External SPL output bytes(HW) with PROFIsafe slaves
  OUTSEP_PROFISAFE:  ARRAY[1 ... 8] OF BOOL;
:
END_STRUCT;
```

7.2.10 Response times

The response times listed here refer exclusively to the internal processing of the signals by the F master. The following applies:

- **T(FDI -> DB18)** or **T(FD I-> SPL-INSE)**
  The transfer time from the input area of the F-DI module to the input interface of the PLC-SPL or NCK-SPL
- **T(DB18 -> FDO)** or **T(SPL-OUTSE -> FDO)**
  The transfer time from the output interface of the PLC-SPL or NCK-SPL to the output area of the F-DO module.
- **T(FDI -> FDO)**
  Sum of the transfer times from:
  - T(FDI -> DB18) or T(FDI -> SPL-INSE)
  - Processing time by the user-specific SPL program.
  - T(DB18 -> FDO) or T(SPL-OUTSE -> FDO)

The following applies for the subsequent tables of the PLC and NCK processing times:

- Values in *italics* can increase by up to 50 ms due to delays in the communication path between the NCK and PLC.
- PST = 50 ms (PST = PROFIsafe clock cycle) is the permanently implemented maximum time to detect error-free communications between the NCK and PLC. A STOP response (STOP D/E) is initiated if this time is exceeded.
- OB1 = 150 ms is the maximum time set as standard in the PLC-CPU to monitor the user level. The PLC goes into the STOP state if this time is exceeded.
- 0...m * IPO: This time component only becomes applicable if delays are incurred on the PLC side. In this case, in each subsequent IPO clock cycle, it is determined as to whether the PLC is ready to communicate again.
- OB40_INT is the maximum permissible time to initiate the interrupt on the NCK side up to execution of the PROFIsafe software and a ready signal to the NCK. The time is mainly determined by the run time (propagation time) of the F driver implementation on the PLC side and the PLC user program to be run-through in the OB40 context. These times typically lie in the vicinity of a few milliseconds.
- The specified maximum times are theoretical values; it is extremely improbable that they actually occur in practice.

  Reason:

  - It is improbable that the run time of the PLC-F driver is delayed - in the OB40 context - by the maximum time of 50 ms. The reason for this is that the interrupting organizational blocks (OB8x) only have such long run times in extremely few cases.

- For the theoretical value, it would be necessary that two consecutive runs of the PLC-PROFIsafe master driver in the OB40 context are delayed by the permitted maximum of 50 ms - this is extremely improbable.
- The maximum time of 150 ms for the user program is not reached in any of the applications relevant in practice.

PLC processing times

Time:: T(FDI->DB18)		
Formula	2 * *PST* + 1 * OB1	
Max. times	2 * 50 ms + 1 * 150 ms	250 ms
Typical times 1)	2 * 16 ms + 1 * 30 ms	62 ms
Time:: T(DB18->FDO)		
Formula	2 * *PST* + 1 * OB1	
Max. times	2 * 50 ms + 1 * 150 ms	250 ms
Typical times 1)	2 * 16 ms + 1 * 30 ms	62 ms
Time:: T(FDI->FDO)		
Formula	4 * *PST* + 2 * OB1	
Max. times	4 * 50 ms + 2 * 150 ms	500 ms
Typical times 1)	4 * 16 ms + 2 * 30 ms	124 ms

1) Typical times: PST = 16ms; OB1 = 30ms

NCK processing times: PST $\leq$ 2 * IPO

Time:: T(FDI->SPL-INSE)		
Formula	2 * *PST* + 1 * IPO	
Max. times	2 * 50 ms + 25 ms	125 ms
Typical times 1)	2 * 16 ms + 8 ms	40 ms
Time:: T(SPL-OUTSE->FDO)		
Formula	IPO + 0...m * *IPO* + *OB40_INT*	
Max. times	25 ms + 50 ms + 50 ms	125 ms
Typical times 1)	8 ms + 2 ms	10 ms
Time:: T(FDI->FDO)		
Formula	2 * *PST* + 2 * IPO + 0...m * *IPO* + *OB40_INT*	
Max. times	100 ms + 50 ms + 50 ms + 50 ms	250 ms
Typical times 1)	2 * 16 ms + 2 * 8 ms + 2 ms	50 ms

1) Typical times: PST = 16ms; IPO = 8ms; OB40_INT = 2ms

NCK processing times: PST > 2 * IPO

Time:: T(FDI->SPL-INSE)		
Formula	2 * *PST* + 1 * IPO	
Max. times	2 * 48 ms + 8 ms	104 ms 2)
Typical times 1)	2 * 18 ms + 6 ms	42 ms
Time:: T(SPL-OUTSE->FDO)		
Formula	IPO + (n-2) * IPO + 0...m * *IPO* + *OB40_INT*	
Max. times	16 ms + 48 ms + 48 ms	112 ms 2)
Typical times 1)	6 ms + 6 ms + 2 ms	14 ms
Time:: T(FDI->FDO)		
Formula	2 * *PST* + PST + 0...m * *IPO* + *OB40_INT*	
Max. times	100 ms + 25 ms + 50 ms + 50 ms	225 ms 3)
Typical times 1)	2 * 18 ms + 18 ms + 2 ms	56 ms

where:

PST: PROFIsafe clock cycle

PST = n * IPO; with n = 1, 2, 3, ...

1) Typical times: PST = 18 ms; IPO = 6 ms; OB40_INT = 2 ms

2) This time is valid for the case: IPO = 8 ms, n=3 => PST = 24 ms; (maximum times for values n > 2)

3) This time is valid for the case: PST = n * IPO = 25 ms

This information always applies for communication via PROFINET. Specifications for the various bus systems do not need to be taken into account, except for the time, determined by the set baud rate and the bus expansion level.

7.2.11 Functionality of the SPL input/output data

The functionality of the SPL input/output data is exclusively defined by the user (machinery construction OEM) within the scope of the PROFIsafe communication

The SPL programs of NCK-SPL and PLC-SPL are not executed synchronously (from a time perspective). As a result of runtime differences in the SPL programs, brief differences can occur in the output data of both SPL programs (NCK: $A_OUTSE, PLC: $A_OUTSEP).

In order that the PLC and NCK use identical F net data for the two-channel generation of a PROFIsafe telegram, the SPL output data are exchanged between the two channels (PLC: $A_OUTSEP and NCK: $A_OUTSE) in each PROFIsafe clock cycle alternating, and are ANDed with one another before sending. For safety reasons, this is the reason that the user must select the functionality of SPL input/output data so that the value ”0” corresponds to the safe state of the functionality represented by this data. Only then can it be ensured that the corresponding function is only activated at the F slave output if the function has actually been activated in both SPL programs (PLC-SPL and NCK-SPL).

Warning

For safety reasons, this is the reason that the functionality of an SPL input or output data is selected so that the value ”0” corresponds to the safe state of the functionality represented by this data.

As a result of the synchronization of the SPL output data described above, it cannot be ensured that when several SPL output data are changed simultaneously - taking into account in the SPL program - that these are also transferred consistently (in time) in the PROFIsafe telegram. If, in a user application, several SPL output data are interpreted as a contiguous bit pattern, it must therefore be taken into account that intermediate values can briefly occur.

Example:
Three SPL output data are considered to be contiguous. The value is changed from 101 to 110 in both SPL programs (NCK-SPL and PLC-SPL).
Values transferred in the PROFIsafe telegram:

	NCK-SPL	**AND**	PLC-SPL	=	PROFIsafe telegram
Output value	101	&	101	=	101
Possible intermediate value	*110*	&	*101*	=	*100*
End value	110	&	110	=	110

Warning

Due to runtime differences in the NCK-SPL and PLC-SPL it cannot be guaranteed that when several SPL output data are simultaneously changed that these are then consistently transferred in the PROFIsafe telegram.

7.2.12 Functional secondary conditions

When connecting via SPL I/O using one safety-related bus (PROFIsafe), several secondary conditions and constraints must be taken into consideration when configuring and programming:

- Faults/errors in the PROFIsafe input devices (e.g. input signals that differ from one another) cause the associated SPL input signals ($A_INSE(P)) to be deleted (cleared). This initiates a STOP D/E.
- The transfer of the external SPL input signals in the DB18 interface for the $A_INSEP variables is realized inside the system. Only one signal state for both SPL channels is transferred to the master from the PROFIsafe input peripherals.
- The external SPL output signals of the DB18 interface ($A_OUTSEP variables) are transferred within the system to the relevant PROFIsafe output modules. A signal state is transferred to the output modules via PROFIsafe.
- It may be necessary to use single-channel signals (signals that are present only in the PLC or only in the NCK) to change over external SPL outputs (e.g. brake control). These single-channel signals must also be made available to the other program channel to align the logic and program synchronously. Direct communications between the NCK and PLC-SPL via DB18 is a good way to achieve this.
- In each PROFIsafe cycle, the PROFIsafe layer generates a PROFIsafe telegram with the logically AND'ed SPL output data as F net (useful) data.

PROFIsafe components

As far as the PROFIsafe components that can be operated with a SINUMERIK 840D sl, the following limitations apply:

- PROFIsafe components with dynamic i parameters are not supported.
- The maximum possible F net data width for each PROFIsafe component is 64 bits.
- The value range for the F address of PROFIsafe component is as follows: 1 - 65535_D or 1 - $FFFF_H$

Axial SGE/SGA

I/O (F net data) of an F module cannot be connected to axial SGE/ SGA. They can only be connected in the context of the SPL that must be installed for the purpose.

PLC SPL SGE/SGA

The basic PLC program automatically connects the I/O (F net data) of an F module to the SPL interface in data block DB18.

It is not possible to connect them in a PLC user program.

7.2.13 PROFIsafe communication behavior when system errors occur

A system error relating to PROFIsafe communication exists, if the PROFIsafe layer identifies erroneous behavior that is not as a result of a communication error defined in the PROFIsafe protocol, but which can only be caused by incorrect behavior of the system software or hardware.

Driver-specific system errors:

- Asynchronous fault state (StateFault)
  The NCK or PLC-PROFIsafe driver is in the fault state while the associated PROFIsafe driver of the 2nd channel is not in a fault state.
  => Alarm 27257

PROFIsafe communication-specific system fault

- The SPL input/output data are not updated (SPL I/O-communication)
  Data exchange between the SPL and the PROFIsafe drivers is interrupted.
  => Alarm 27257
- No longer any communications between the NCK and PLC
  The PLC was not able to execute the OB40 request for PROFIsafe communication within the maximum monitoring time of 50 ms.
  => Alarm 27253

Depending on the particular error, the cyclic processing of the PROFIsafe driver (driver-specific error) or the complete PROFIsafe communication (PROFIsafe communication-specific system error) is stopped and Alarm 27257 ”PROFIsafe: %1 %2 reports a system error %3 (%4)” is displayed. With the alarm, the NC start is locked and Stop D/E initiated.

Behavior regarding SPL:
PROFIsafe drivers of type F-DI or F-DI/DO F modules that have stopped output fail-safe values (0) as F net data in the direction of SPL.

Behavior regarding PROFIsafe slave:
Stopped PROFIsafe drivers no longer generate F telegrams. At the latest after the configured timeout time, the F modules (PROFIsafe slaves) identify the failure of the PROFIsafe communication and go into the safe state corresponding to the specifications of the PROFIsafe profile.

7.3 Modular PROFIsafe I/O interface

Using this function, it is easier for machinery manufacturers to connect PROFIsafe input and output modules for machine series with a modular design.

Example
The S7 configuration required for PROFIsafe communication, the appropriate NCK machine data parameterization as well as the SPL programs for NCK and PLC are in the control for the maximum expansion stage. Depending on the functionality available in a real machine, then either the maximum number of PROFIsafe modules are connected – or just a subset of the possible PROFIsafe modules

The PROFIsafe connection and the SPL connection for the particular PROFIsafe module are activated while the machine is being commissioned by activating the associated machine data set or slots. Activation is realized by setting one of the activation bits assigned to the particular machine data set.

Activation
The ”modular PROFIsafe I/O interface” function is activated using machine data 10095: $MN_SAFE_MODE_MASK, Bit 1 = 1.

The Step7 hardware configuration in the PLC must be available in the full scope.

7.3.1 PROFIsafe input modules

Activating a machine data set or slot

A machine data set for PROFIsafe communication and SPL interface of a PROFIsafe input module are activated using machine data 13302 $MN_PROFISAFE_IN_ENABLE_MASK. Bit n=1.

The machine data set of a slot includes the machine data:

- $MN_PROFISAFE_IN_ADDRESS[n]
- $MN_PROFISAFE_IN_FILTER[n]
- $MN_PROFISAFE_IN_ASSIGN[n]
- $MN_PROFISAFE_IN_SUBS_ENAB_MASK (see substitute values)
- $MN_PROFISAFE_IN_SUBS_ENAB_MASK (see substitute values)
- $MN_PROFISAFE_IN_NAME[n]

Substitute values

If, within the scope of a specific machine configuration, the corresponding PROFIsafe module for a slot is not connected, static substitute values can be parameterized to supply the associated SPL inputs ($A_INSE).

Parameterization

The substitute values are parameterized using machine data 13305: $MN_PROFISAFE_IN_SUBS[n]

The substitute value for the SPL input defined as area limit in MD 10388: $MN_PROFISAFE_IN_ASSIGN is parameterized in MD $MN_PROFISAFE_IN_SUBS, bit 0. In bit 1, the substitute value for the SPL input "lower area limit + 1" etc.

Thus, substitute values are input into MD $MN_PROFISAFE_IN_SUBS referred to the SPL input area defined in MD $MN_PROFISAFE_IN_ASSIGN. If substitute values outside this SPL input area are set to a value of 1 in MD $MN_PROFISAFE_IN_SUBS, then Alarm 27205 "PROFIsafe: number of signals in MD %1[%2] < > MD %3[%4]" is displayed.

Activation

In order to provide machinery manufacturers with the option of defining different substitute values for various machine constellations for the SPL input range belonging to a PROFIsafe input module, the output of parameterized substitute values is explicitly activated in a machine data set using:

MD 13304: $MN_PROFISAFE_IN_SUBS_ENAB_MASK, Bit n = 1

Slot mode

As a result of the possibility of being able to activate or deactivate a slot as well as to activate substitute values, the following slot modes are obtained:

- Active
  In the control, a PROFIsafe driver is active for the slot – and the F net data transferred from the associated PROFIsafe input module is output to the SPL inputs.
- Passive
  In the control, there is no PROFIsafe driver active for the slot, and the parameterized substitute values are output at the SPL inputs.
- Inactive
  In the control, there is no PROFIsafe driver active for the slot, and no data is output at the SPL inputs. The inputs assigned using MD 10388: $MN_PROFISAFE_IN_ASSIGN remain in the default state 0.

The following table shows the interrelationship between the machine data and the slot mode obtained from this.

PROFISAFE_IN_ENABLE_MASK Bit n	PROFISAFE_IN_SUBS_ENAB_MASK Bit n	Slot mode
1	0	Active
1	1	Passive
0	x	Inactive

SPL assignment for passive slots

For active slots, where the F net data of the associated PROFIsafe input module is transferred into the SPL inputs, the SPL input ranges assigned via MD $MN_PROFISAFE_IN_ASSIGN must not overlap. If this rule is violated, Alarm 27204 "PROFIsafe: Dual allocation MD %1 [%2] -MD %3 [%4]"is displayed.

To simplify parameter assignment, this rule does not apply to passive slots, whose SPL input range overlaps with one or several active slots. In this case, without any feedback to the user, the substitute values of the passive slot are automatically only transferred to the SPL inputs that are not allocated active slots.

Example:

Active slot 1, corresponding to machine data set 5, is assigned SPL input range 9 – 16.

$MN_PROFISAFE_IN_ASSIGN[5] = 009 016

Passive slot 2, corresponding to machine data set 7, is assigned SPL input range 5 – 12.

$MN_PROFISAFE_IN_ASSIGN[7] = 005 012

$MN_PROFISAFE_IN_SUBS[7] = 0000 00FF

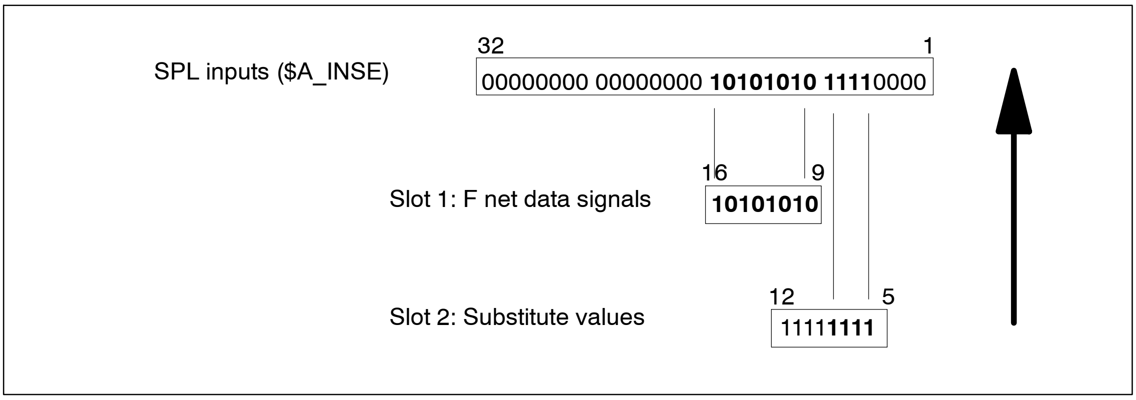


Fig. 7-20 Overlap of SPL input ranges of an active and passive slot

If SPL input areas assigned via MD 10388: $MN_PROFISAFE_IN_ASSIGN overlap with passive slots, then Alarm 27204 "PROFIsafe: Dual allocation MD %1 [%2] – MD %3 [%4]"is displayed.

7.3.2 PROFIsafe output modules

Activating a machine data set or slot

A machine data set or slot for PROFIsafe communication and SPL interface of a PROFIsafe output module are activated using:

MD 13303: $MN_PROFISAFE_OUT_ENABLE_MASK, Bit n = 1

The machine data set of a slot encompasses the data:

- MD $MN_PROFISAFE_OUT_ADDRESS[n]
- MD $MN_PROFISAFE_OUT_FILTER[n]
- MD $MN_PROFISAFE_OUT_ASSIGN[n]
- MD $MN_PROFISAFE_OUT_NAME[n]

Slot mode

The following slot modes are obtained as a result of the possibility of activating or deactivating a slot:

- Active
  In the control, a PROFIsafe driver is active for the slot and the SPL outputs are output as F net data at the associated PROFIsafe output module.
- Inactive
  In the control, there is no PROFIsafe driver active for the slot; the PROFIsafe master does not address the corresponding PROFIsafe I/O module.

The following table shows the interrelationship between the machine data and the slot mode obtained from this:

PROFISAFE_OUT_ENABLE_MASK, Bit n	Slot mode
1	Active
0	Inactive

Supplementary conditions

Consistency Check
In order that it is ensured that a consistent parameter assignment is also available for the maximum expansion stage, when the control boots, the complete PROFIsafe parameter assignments are always checked. This means a check is made as to whether each machine data set of a parameterized slot is in itself consistent and the appropriate PROFIsafe module is configured in the loaded S7 configuration. This especially applies to machine data sets of inactive slots.

A slot is considered to have been parameterized as soon as one of the following data of the machine data set is not equal to the particular default value:

- MD $MN_PROFISAFE_IN/OUT_ADDRESS
- MD $MN_PROFISAFE_IN/OUT_FILTER
- MD $MN_PROFISAFE_IN/OUT_ASSIGN

PROFIsafe input/output modules

For PROFIsafe input/output modules, the input and output direction are parameterized via dedicated slots. These can be parameterized independently of one another for each of the possible slot modes (active, passive or inactive).

7.4 Safety-related CPU-CPU communication (F_DP communication)

Overview

For safety-relevant CPU-CPU communication to the plant/system coupling, a fixed number of fail-safe data is transferred between the safety programs in the F-CPUs. Data transfer is realized using the F_SENDDP blocks to send and F_RECVDP blocks to receive.

The options as to how a SINUMERIK 840D sl with F_DP communication can be integrated is shown in Fig. 7-21.

The F_DP communication is possible via PROFIBUS-DP (interface X126 or X136 of the NCU), as well as via PROFINET (PROFINET interfaces of the NCU7x0PN of the PLC319-3PN/DP) in the configurations PROFIBUS-DP master, PROFIBUS-DP slave, PROFIBUS-DP slave - peer-to-peer data transfer and PROFINET IO controller (via PN/PN coupler).

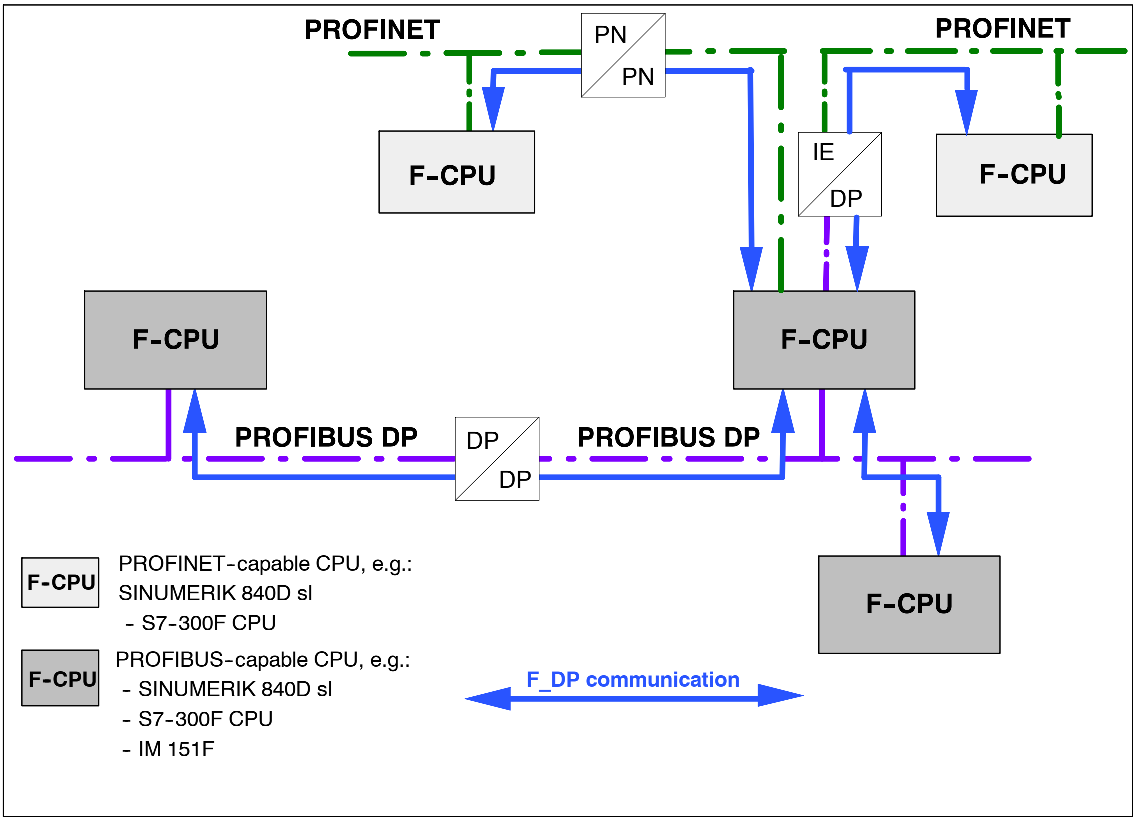


Fig. 7-21 F_DP communication options with SINUMERIK 840D sl

Presently, with SINUMERIK 840D sl, a maximum of three safety-relevant send connections and three safety-relevant receive connections can be configured for each NCU.

Note

The diagram 7-21 is an example, the PN/PN coupler can be eliminated.

Note

SIMATIC-F-CPUs that support the F_SENDDP/F_RCVDP blocks are suitable as communication partner, e.g. IM151F.

Note

The chapter only describes the SINUMERIK-specific safety-relevant CPU-CPU communication to couple plants and systems corresponding to the SIMATIC F_SENDDP / F_RCVDP protocol specifications. SINUMERIK does not support SIMATIC S7 communication with F_SENDS7 / F_RCVS7.

Description

When configuring F-DP communication between two F-CPUs, an input and output area must be defined via SIMATIC Step 7 via which the F telegrams are exchanged. The start address (logical basis address) can be freely selected. However, within an F-CPU it must be the same for the input and output areas. However, a different start address can be used in the two F-CPUs.

An F-DP communication always comprises a sender (F_SENDDP) and a receiver (F_RECVDP). Only the sender (in Fig. 7-22 F_SENDDP of the F-CPU1) transfers F net data - in the F net data telegram - to the receiver (in Fig. 7-22 F_RECVDP of F-CPU2). The receiver only acknowledges the receipt of the F net data telegram using an F acknowledgement telegram. The F acknowledgement telegram does not contain any F net data.

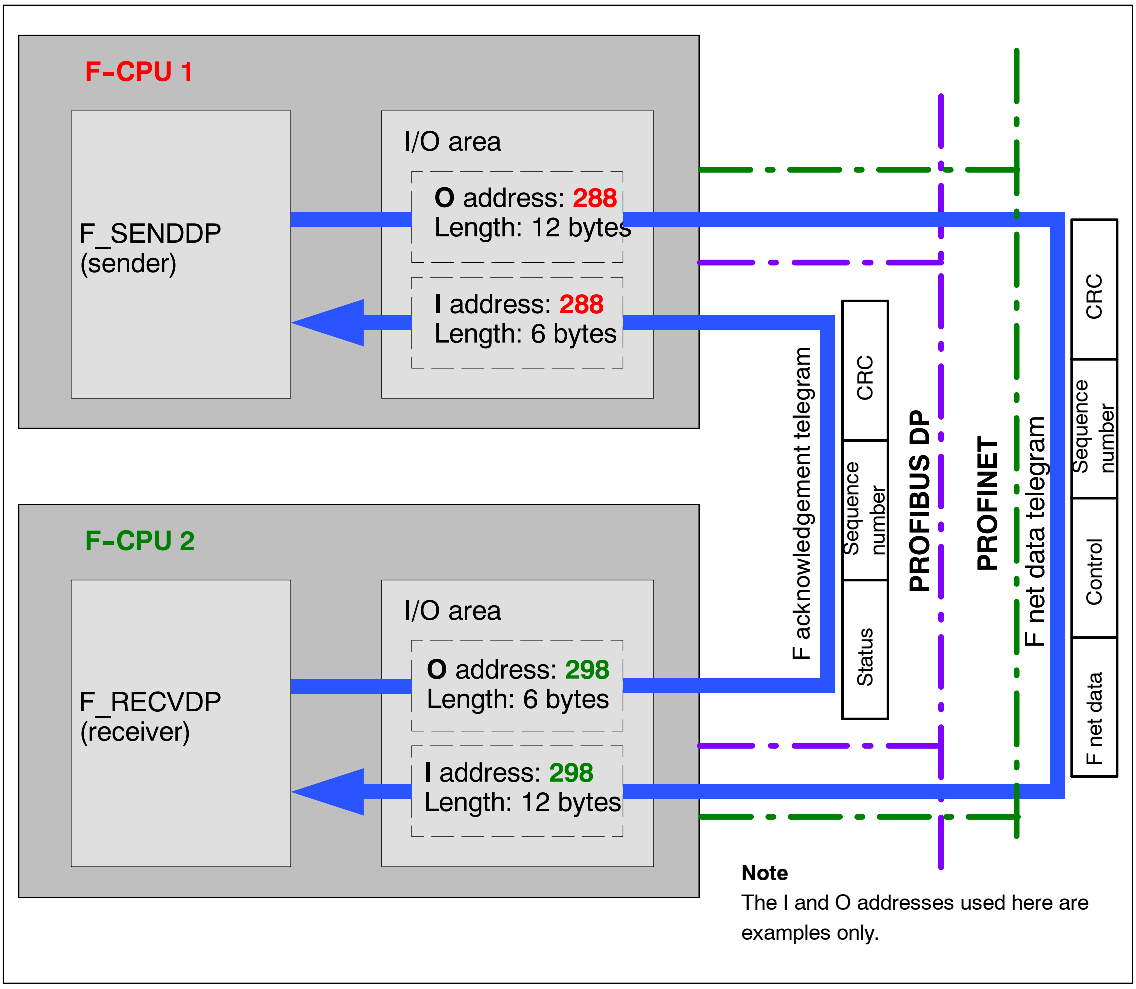


Fig. 7-22 Components of an F_DP communication relationship

F net data telegram

The F_SENDDP of the F-CPU1 (sender) cyclically generates an F net data telegram and writes it to the output data area of the F-CPU. The F net data telegram has the following structure that is compatible to SIMATIC:

- 6 bytes F net data
  - 2 bytes Bool
  - 2x2 bytes for 2 INT values
    (**Notice**: is not evaluated for SINUMERIK 840D sl)
- 2 bytes control
- 2 bytes sequence number
- 2 bytes CRC

As a result of the F_DP communication relationship – configured in SIMATIC Step 7 – the F net data telegram is transferred from the output area of the F-CPU1 into the input area of the F-CPU2.

F acknowledgement telegram

For an F net data telegram, which is identified as error-free, the F_RECVDP of the F-CPU2 (receiver) generates an F acknowledgement telegram and writes this to the output data area of the F-CPU. The F acknowledgement telegram has the following structure:

- 2 bytes status word
- 2 bytes sequence number
- 2 bytes CRC

Note

For the F_DP communication, F net data is only transferred from the F_SENDDP (CPU1: Sender) to F_RECVDP (CPU2: Receiver). If F net data also have to be transferred in the opposite direction, i.e. from CPU2 to CPU1, then an additional F_DP communication relationship must be configured.

7.4.1 Configuring and parameterizing the F_DP communication

The NCK machine data to parameterize F_DP communication are entered at the HMI. The NCK-F_DP layer transfers the machine data via the dual port RAM (DPR) to the PLC-F_DP layer. NCK and PLC-F_DP layer evaluate the particular NCK machine data and initialize the parameterized F_SENDDP and F_RECVDP drivers in this machine data for cyclic F_DP communication.

The machine data listed to parameterize F_DP communication are all taken into account in checksums (if not explicitly explained), so that if the MDs are accidentally changed, then an appropriate alarm is output.

The start addresses (logical basis addresses) of the input and output areas of the F_DP communication at the I/O bus lines of a SINUMERIK 840D sl on the PLC side are defined when configuring the hardware using SIMATIC Step7 HW Config.

The user must ensure that the starting addresses - assigned on the STEP 7 side - match the starting addresses parameterized in the NCK machine data. A check or automatic alignment is not made.

Parameterizing logical basis addresses in Step7

The parameterization of logical basis addresses for the F_DP communication of two NCUs via the X136 DP interface as PROFIBUS master-slave coupling is described as an example in this section.

If a DP/DP or PN/PN coupler is used then the coupling is directly configured by configuring these devices (see Simatic documentation).

PN/PN coupler
http://support.automation.siemens.com/WW/view/en/26993088/133300

DP/DP coupler
http://support.automation.siemens.com/WW/view/en/23641045/133300

Note

In order to couple the NCUs with one another, both NCUs must be configured in a Step7 project.

Step 1: Set the interface type
The properties of the interface are accessed by double clicking on interface X136. The interface type must be set to ”PROFIBUS” under the ”General” tab.

A window then opens with the PROFIBUS configuration. PROFIBUS must be configured in this window in the usual way.

Step 2: Setting the operating mode
Under the ”Mode” tab, an NCU must be set as ”DP slave”, the other NCU as ”DP master”.

The configurations can then be saved in both NCUs.

Step 3: Establish the coupling
In order that communication can be established between both NCUs, a coupling must be established between both of them. To do this, the already configured station must be selected from the hardware catalog in the ”PROFIBUS-DP” area for SINUMERIK, this is ”CPU31...” and this must then be dragged to the PROFIBUS line of the PROFIBUS master NCU. The ”Properties – DP slave” window is opened.
Under the ”Coupling” tab, the configured PROFIBUS master NCU must be selected and this connected by selecting ”Couple”. The window must then be exited with ”OK” and the project saved.

Step 4: Set the logical basis addresses

The addresses for the F_DP communication can now be set under ”Properties – DP slave”. Double click on the Profibus slave NCU to open the properties window in which the tab ”F Configuration” must be selected.

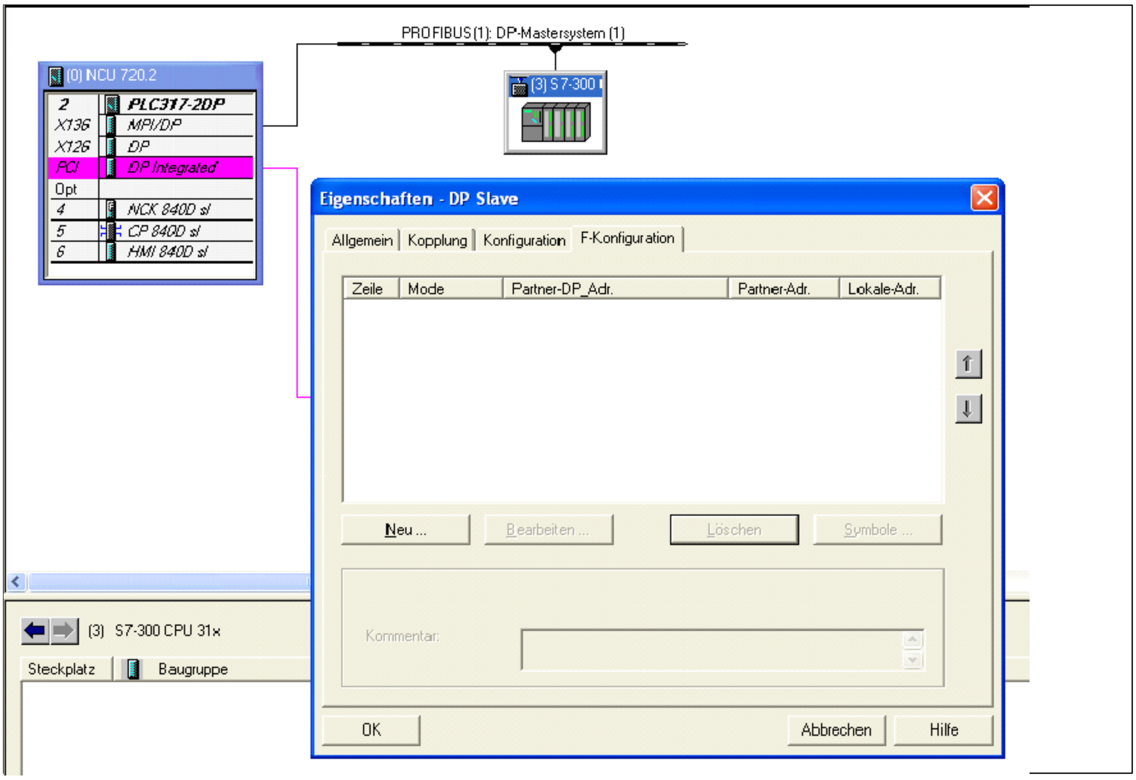


Fig. 7-23 Properties of the DP slave

The window to parameterize the logical basis addresses is opened by selecting ”New ...”. The mode (F master-slave send F-MS-S or F master-slave receive F-MS-R) and the addresses (LADDR) of the connection can now be set in this window.

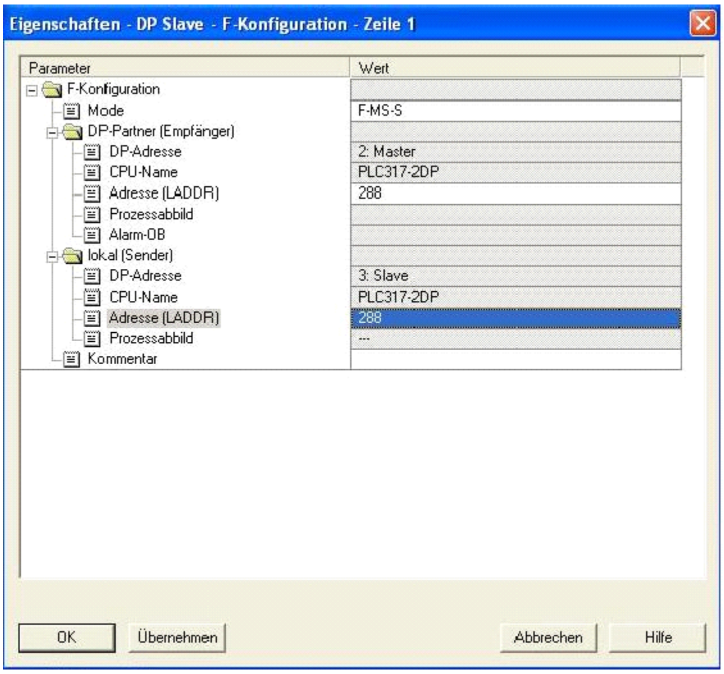


Fig. 7-24 Properties – DP slave – F configuration

By creating a new connection, the addresses for the net data and acknowledgement telegram are automatically parameterized. The parameterized addresses should then be entered into MD 13334/13344 $MN_SAFE_SDP/RDP_LADDR.

7.4.2 Sender F_SENDDP

In order to send SPL output data ($A_OUTSE) from one SINUMERIK 840D sl to another F–CPU using F_DP communication, an **SPL connection** must be parameterized. An SPL connection comprises the following:

- **F_DP communication relationship**
  The parameters of the F_DP communication are defined using the F_DP communication relationship:
  - Identifier (DP_DP_ID) and connection name
  - Communication parameters:
    - I/O start address (LADDR)
    - Monitoring time (TIMEOUT)
  - Error response (ERR_REAC)
- **SPL coupling**
  The SPL connection is used to define which SPL outputs ($A_OUTSE) are mapped to which net data signals of the F telegram.
  Note:
  The interpretation and processing of the F net data signals are realized via the PLC and NCK SPL and are the exclusive responsibility of the user or SPL programmer.

- **Connection number**
  A parameterizing data set is assigned to an SPL connection using the connection number.

An SPL connection is defined in a parameterizing data set. For SINUMERIK 840D sl, 12 parameterizing data sets are available for F_SENDDP. A maximum of three SPL connections, identified using three different identifiers (DP_DP_ID) may be simultaneously active. In case of an error, Alarm 27306 "F_DP: Max. number of active SPL connections (%1) for (%2) exceeded" is output

SPL output data ($A_OUTSE) can only be assigned to an SPL connection in the parameterizing data of the SPL coupling as contiguous area. If the SPL output data, which are required for an SPL connection, are not contiguous, but are distributed over several areas, then several SPL connections must be parameterized. These SPL connections are designated using identical F_DP communication relationships and connection numbers, but different SPL couplings. The parameterization of an SPL connection with several SPL couplings is designated as sub-slots within the scope of PROFIsafe (see Chapter 7.2.6 "Parameterizing the SPL-SGE interface").

The number of SPL couplings per SPL connection can be freely parameterized within the framework of the number of parameterizing data sets that are available. The following options are available to parameterize SPL connections and SPL couplings for each SPL connection:

- SPL connections: 1 to maximum 3
- SPL couplings per SPL connection: 1 up to a maximum of 12, whereby the sum of all SPL couplings of all SPL connections can be a maximum of 12

The following value range for system variables and machine data is obtained from this:

- System variable index: 1...n with n = 3
- Machine data index: 0...m with m = 11

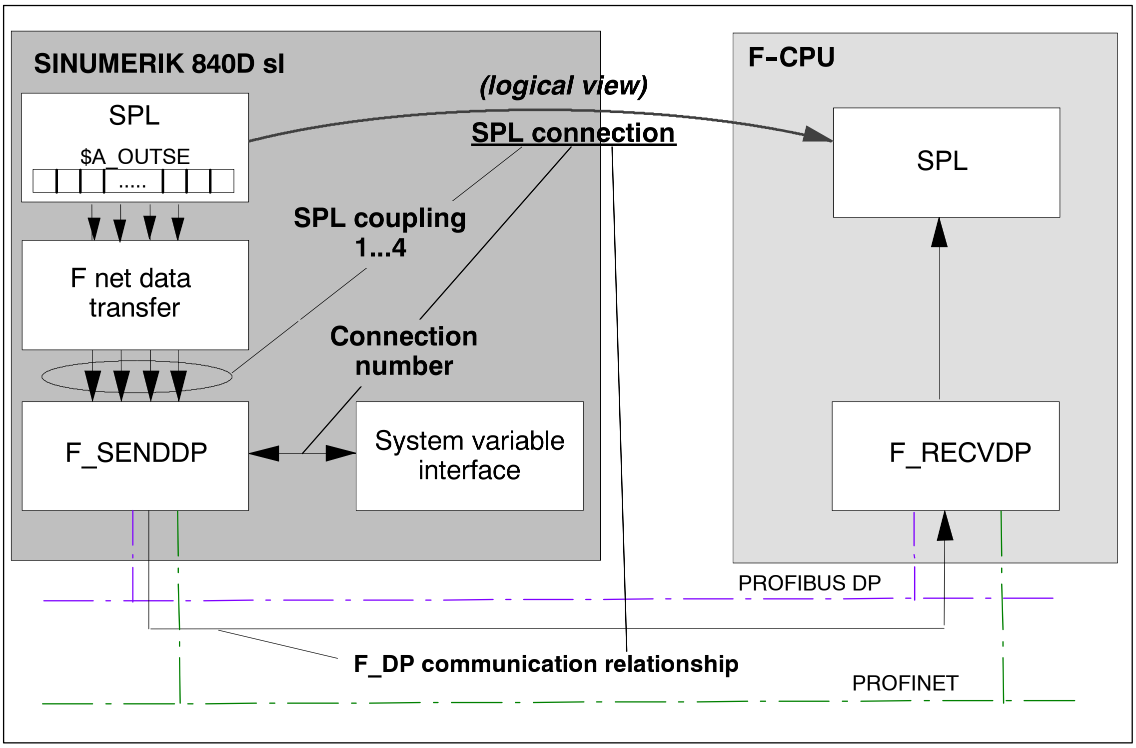


Fig. 7-25 Example of 1 SPL connection with 4 SPL couplings

Interface overview

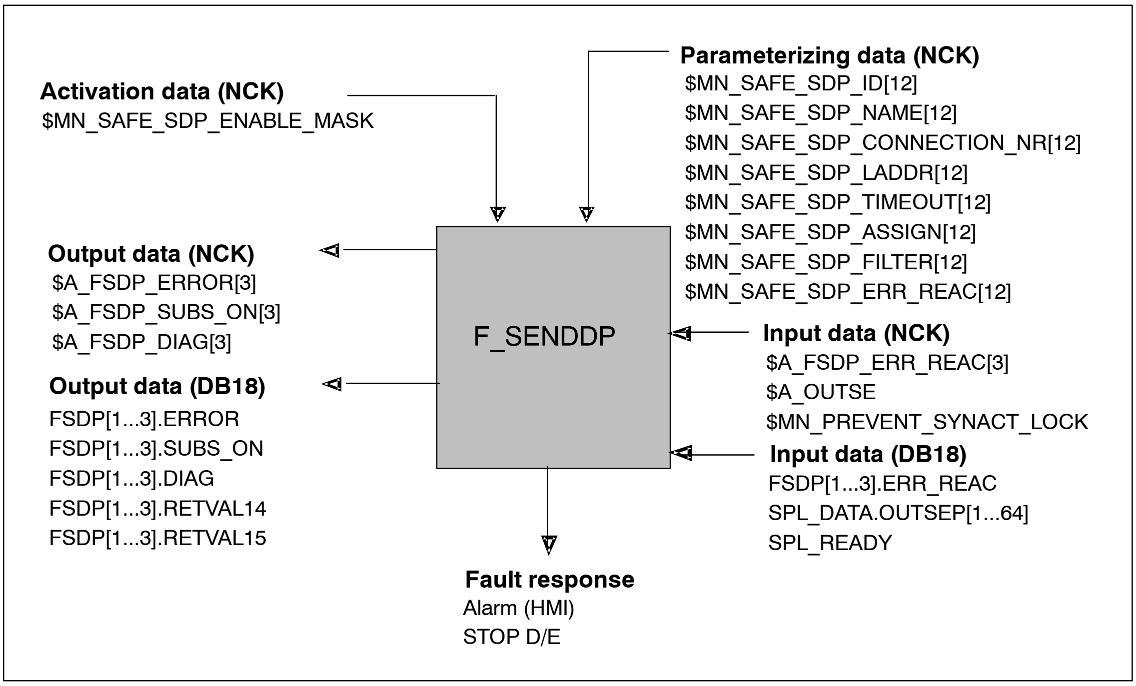


Fig. 7-26 Interface overview F_SENDDP

Activation data

Every parameterizing data set can be separately activated using the enable screen form.

Parameterizing data

The parameterizing data set of an SPL connection involves the following values:

- Identifier:
  - DP_DP_ID: MD 13331: $MN_SAFE_SDP_ID
  - Name: MD 13332: $MN_SAFE_SDP_NAME
- Connection number: MD 13333: $MN_SAFE_SDP_CONNECTION_NR #
- Communication parameters:
  - I/O start address: MD 13334: $MN_SAFE_SDP_LADDR #
  - Monitoring time: MD 13335: $MN_SAFE_SDP_TIMEOUT #
- Net data parameters:
  - SPL assignment: MD 13336: $MN_SAFE_SDP_ASSIGN
  - F net data filter: MD 13337: $MN_SAFE_SDP_FILTER
- Error response: MD 13338: $MN_SAFE_SDP_ERR_REAC #

For SPL connections with the same ID, all of the parameters designated with # must be identical. In case of an error, Alarm 27305 "F_DP: Parameter MD %1[%2] < > MD%3[%4]" is output.

Input/output data

The input and output data provide the user or SPL programmer an interface compatible to the SIMATIC F application blocks using system variables.

Fault response

The system responses when a communication error occurs can be influenced by the user by correspondingly setting the machine data $MN_SAFE_SDP_ERR_REAC or, at a later point in time by programming the system variables $A_FSDP_ERR_REAC in the SPL program.

SPL couplings (sub-slots)

Just the same as for PROFIsafe, also for F_SENDDP, only contiguous areas of SPL output data ($A_OUTSE[x] to $A_OUTSE[x+y]) can be assigned to an SPL connection. Several SPL connections must be parameterized if several non-contiguous pieces of SPL output data are to be transferred. These are characterized due to the fact that the parameters of the SPL couplings differ, but all other parameters of the SPL connection are identical. As part of the F_DP communication, these SPL connections are combined to form a single SPL connection communicating via PROFIBUS with several subordinate SPL couplings (sub-slots).

Example of an NCK parameterization

The following specifications are applied when it comes to further describing the NCK parameterization of an F_SENDDP communication relationship.

- Identifier
  - DP_DP_ID: 2000_D
  - Name: ”WZM1”
- Connection number: 1
- Communication parameters
  - I/O start address: 288_D
  - Monitoring time: 0.5 seconds
- Net data parameters
  - SPL outputs used: $A_OUTSE[1...4]
  - Filter data: 1111H
  - SPL outputs used: $A_OUTSE[33...36]
  - Filter data: 8888H
- Error response: 0_D

The following parameterizing data sets are obtained:

1. SPL connection (sub-slot 1)

$MN_SAFE_SDP_ID[0]	=	2000_D
$MN_SAFE_SDP_NAME[0]	=	WZM1
$MN_SAFE_SDP_CONNECTION_NR[0]	=	1
$MN_SAFE_SDP_LADDR[0]	=	288_D
$MN_SAFE_SDP_TIMEOUT[0]	=	0.5
$MN_SAFE_SDP_ASSIGN[0]	=	001004_D
$MN_SAFE_SDP_FILTER[0]	=	1111_H
$MN_SAFE_SDP_ERR_REAC[0]	=	0

2. SPL connection (sub-slot 2)

$MN_SAFE_SDP_ID[1]	=	2000_D
$MN_SAFE_SDP_NAME[1]	=	WZM1
$MN_SAFE_SDP_CONNECTION_NR[1]	=	1
$MN_SAFE_SDP_LADDR[1]	=	288_D
$MN_SAFE_SDP_TIMEOUT[1]	=	0.5
$MN_SAFE_SDP_ASSIGN[1]	=	033036_D
$MN_SAFE_SDP_FILTER[1]	=	8888_H
$MN_SAFE_SDP_ERR_REAC[1]	=	0

Note

All machine data of a parameterizing data set are linked with one another using the common machine data index.

MD 13331: $MN_SAFE_SDP_ID
Identifier of the SPL connection

Every SPL connection must be assigned a freely selectable, unique identifier (DP_DP_ID), however, this must be unique across all F-CPUs that are connected using F_DP communication.

MD 13332: $MN_SAFE_SDP_NAME
Connection name

An SPL connection can be given a freely selectable connection name with a maximum of 15 characters using MD $MN_SAFE_SDP_NAME. The connection name is displayed at the HMI and in the alarm display. If a connection name has been assigned, then for alarms 2735x, the name is displayed; if a name is not displayed, then the corresponding DP_DP_ID identifier is displayed.

The connection name does not have to be specified in all of the parameterizing data sets associated with an SPL connection. The connection name is always used that is specified in the first active parameterizing data set, i.e. the parameterizing data set with the lowest machine data index. All other data sets of an SPL connection are not evaluated with reference to connection names.

This MD is not incorporated in the checksum calculation; i.e. it can also be changed without aligning the checksum.

MD 13334: $MN_SAFE_SDP_LADDR
I/O start address

When generating the configuration in SIMATIC STEP7 HW Config, for each SPL connection a start address must be defined for the I/O area which is used for the F_SENDDP to exchange data with the associated F_RECVDP. The start address must be the same for the input and output data areas.

The user must enter the I/O start address of the SPL connection, defined in the configuration, in MD $MN_SAFE_SDP_LADDR[0...m].

Rules to define the start addresses and address areas of an SPL connection:

- The start address must be identical in the input <u>and</u> output data areas
- Slot length: Input data area = 6 bytes, output data area = 12 bytes
- Consistency of the slots in the input <u>and</u> output data areas - in both cases over the ”complete length”

The check is made on the PLC side within the scope of the cyclic F_DP communication by evaluating the SFC14/SFC15 return values. For an error, Alarm 27354 ”F_DP: %1 communication, connection %2 signals SFC%3 error %4”.

Parameterization of the F net data transfer

The transfer of the SPL outputs in the F net data is parameterized using the following NCK machine data:

- $MN_SAFE_SDP_ASSIGN[0...m]
- $MN_SAFE_SDP_FILTER[0...m]

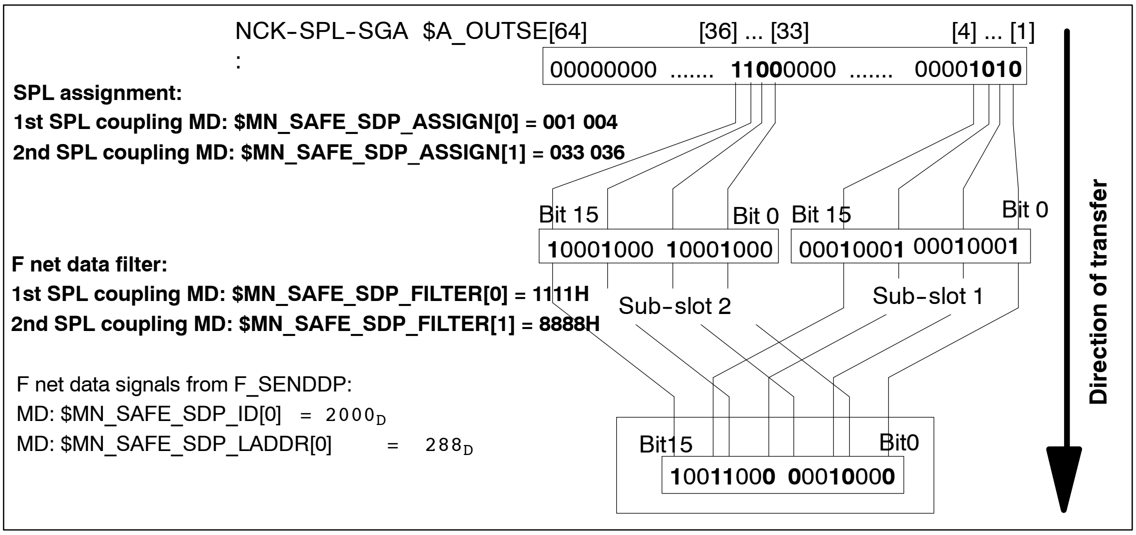


Fig. 7-27 F net data transfer F_SENDDP

MD 13336: $MN_SAFE_SDP_ASSIGN
SPL assignment

For the SPL assignment, the SPL outputs ($A_OUTSE) are selected, which are assigned to the F net data signals via the F net data filter. Only a contiguous area can be selected.

The SPL assignment is set using MD $MN_SAFE_SDP_ASSIGN[0...m].

The SPL output area data is specified in the decimal notation in the following format:

$MN_SAFE_SDP_ASSIGN[n] = aaa bbb with
aaa: Area limit 1, SPL-SGA $A_OUTSE[**aaa**]
bbb: Area limit 2, SPL-SGA $A_OUTSE[**bbb**]

The following conditions should be observed when specifying the area limits:

- All area data are valid: (aaa > bbb), (aaa < bbb), (aaa = bbb)
- |(aaa - bbb)| ≤ 16
  In case of an error, Alarm 27301 ”F_DP: MD %1[%2]: SPL coupling incorrect” is output.

- |(aaa - bbb)| = y
  With y = number of F net data signals selected in the MD F net data filter $MN_SAFE_SDP_FILTER.
  In case of an error, Alarm 27303 ”F_DP: Number of signals in MD %1[%2] < > MD %3[%4]” is output.

Example for NCK parameterization (see page 7-250)
The selected SPL outputs $A_OUTSE[1...4] and $A_OUTSE[33...36] are transferred in the F net data corresponding to the F net data filter of the particular SPL connection, refer to Fig. 7-27 ”F net data transfer F_SENDDP”.

MD 13337: $MN_SAFE_SDP_FILTER
F net data filter

The F net data filter allows the SPL outputs ($A_OUTSE), which are to be transferred, to be distributed across any F net data signals.

The F net data filter is set using MD $MN_SAFE_SDP_FILTER[0...m].

Example for NCK parameterization (see page 7-250)
The parameterized SPL outputs of the F_DP communication relationship (DP_DP_ID: 2000) are distributed via the F net data filter to bits 0, 4, 8 and 12 (1st sub-slot) and bits 3, 7, 11 and 15 (2nd sub-slot) in the F net data of the F telegram, see Fig. 7-27 ”F net data transfer F_SENDDP”.

Note

Within an SPL connection, an F net data signal of an F telegram may only be occupied by **one** SPL coupling via the F net data filter. When allocated a multiple number times, Alarm 27302 ”F_DP: Dual allocation MD %1 [%2] -MD %3 [%4]” is output

---

MD 13335: $MN_SAFE_SDP_TIMEOUT
Monitoring time

By specifying the monitoring time, the time is specified within which an F telegram from F_SENDDP must be acknowledged by F_RECVDP.

The monitoring time is set using MD $MN_SAFE_SDP_TIMEOUT[0...m].

When the monitoring time is exceeded, then depending on the system variables $A_FSDP_ERR_REAC, the selected alarm responses are initiated:

Alarm 27350 ”F_DP: %1 communication, DP_DP_ID = 52 signals error %3” and Alarm 27351 ”F_DP: %1 communication, DP_DP_ID = 52 signals error %3”.

Notes on commissioning
When commissioning F_DP communication for the first time, it is recommended that the monitoring time is initially kept at the default value in order to avoid alarms caused by the monitoring time being exceeded.
After the F_DP communication has been successfully commissioned, the monitoring time can then be changed to the required value, e.g. monitoring time $\geq$ 5 * F_DP clock cycle of the slower component of the SPL connection with F_DP clock cycle = MA_SAFE_SRDP_IPO_TIME_RATIO * IPO clock cycle.

For more complex PLC user programs, it is possible that the parameterized F DP clock cycle is either briefly or even permanently exceeded. This is the reason that for diagnostic purposes, the maximum value of the F_DP clock cycle since the last time the control booted (powered-up) is displayed in machine data $MA_INFO_SAFE_SRDP_CYCLE_TIME and in the diagnostics screen "SI communication".

Note

It can only be ensured that the level of an output signal is correctly detected on the sender side and transferred to the receiver if it is present for at least the monitoring time that has been parameterized (MN_SAFE_SDP_TIMEOUT).

MD 13330: $MN_SAFE_SDP_ENABLE_MASK
Enable screen form

The individual parameterizing data sets are enabled using the enable screen form. The enable screen form is bit orientated, i.e. bit **0** activates the 1st parameterizing data set with machine data index **0**.
If a parameterizing data set is not activated, then the machine data of the corresponding SPL connection are not evaluated.

MD 13333: $MN_SAFE_SDP_CONNECTION_NR
Connection number

A parameterizing data set is assigned to an SPL connection using the connection number. Presently, a max. of max. **3** SPL connections can be parameterized for F_SENDDP. As a result, the value range for the connection number obtained is: 1, 2, 3.

In the default setting, a parameterizing data set is not assigned to any SPL connection (connection number = 0). Each active parameterizing data set must be assigned to an SPL connection. In the case of an error, Alarm 27034 "Parameterization of MD %1[%2] invalid" is displayed.

The connection number is, at the same time, also the index to access system variables of the user interface of the SPL connection. The user interface involves the following system variables:

Input data
- $A_FSDP_ERR_REAC[1...n]

Output data
- $A_FSDP_ERROR[1...n]
- $A_FSDP_SUBS_ON[1...n]
- $A_FSDP_DIAG[1...n]

The connection number is set using MD $MN_SAFE_SDP_CONNECTION_NR.

<u>Example</u>

The parameterization data set x should be assigned to the **2nd** SPL connection.

- $MN_SAFE_SDP_CONNECTION_NR[x] = **2**

This means, that as user interface, the SPL connection x uses the above mentioned system variables with index **2**, e.g.: $A_FSDP_ERROR[**2**]

MD 13338: $MN_SAFE_SDP_ERR_REAC
Error response

The default value for the system variable $A_FSDP_ERR_REAC[1...n] (alarm response) is entered using machine data $MN_SAFE_SDP_ERR_REAC[1...n]. The alarm response can be dynamically changed by programming the system variable in the user programming.

After programming the error response using the system variable, the value saved in the machine data is no longer active until the control re-boots.

The significance of the values for the machine data correspond to the values for the system variable $A_FSDP_ERR_REAC[1...n].

Input data, F_SENDDP

System variable: Error response, $A_FSDP_ERR_REAC

The response when a communication error occurs is set using the system variable $A_FSDP_ERR_REAC[1...n]. This means, depending on the actual coupling or as a function of the plant/system components involved in the SPL connection, the response to a communication error, caused by an error in the communication path or by consciously switching off one of the plant/system components can be specifically entered. The following error responses can be set:

- Alarm 27350 and also STOP D/E
- Alarm 27350
- Alarm 27351 (display only, self-clearing)
- No alarm is displayed.

Supplementary conditions

1. For a communication error, the following system variables are always set independent of the error response set using the system variable $A_FSDP_ERR_REAC:
   - $A_FSDP_ERROR = 1
   - $A_FSDP_SUBS_ON = 1
2. When a communication error occurs, the currently programmed error response is realized. If the error response is changed, it only becomes effective when the next communication error occurs.
3. Whether STOP D or STOP E is initiated as error response can be parameterized using:
   - NCK: $MN_SAFE_SPL_STOP_MODE
   - PLC: DB18.DBX36.1
4. The system variable $A_FSDP_ERR_REAC[1...n] is a part of the crosswise data comparison SPL-CDC.

Note

Until the system variable is programmed for the first time, after the control boots, the value set using MD $MN_SAFE_SDP_ERR_REAC is active.

Output data, F_SENDDP

System variable: Error signal, $A_FSDP_ERROR

System variable $A_FSDP_ERR_REAC[1...n] is used to indicate that there is a communication error. The specific cause, determined by F_SENDDP, is communicated using the diagnostics data (system variable $A_FSDP_DIAG).

The system variable $A_FSDP_ERROR is cyclically compared with the corresponding PLC variables FSDP[1...3].ERROR. If the values are different, there is a system error and Alarm 27355 "F_DP: %1 communication, connection %2 reports system error %3 (%4)" is displayed.

System variable: Substitute value signal, $A_FSDP_SUBS_ON

System variable $A_FSDP_SUBS_ON[1...n] is used to signal that F_RECVDP has output substitute values to the application.

The system variable $A_FSDP_SUBS_ON is cyclically compared with the corresponding PLC variables FSDP[1...3].SUBS_ON. If the values are different, there is a system error and Alarm 27355 "F_DP: %1 communication, connection %2 reports system error %3 (%4)" is displayed.

System variable: diagnostics data, $A_FSDP_DIAG

System variable $A_FSDP_DIAG[1...n] is used to signal the cause of the communication error determined by F_SENDDP.

The system variable $A_FSDP_DIAG is <u>not</u> cyclically compared with the corresponding PLC variables FSDP[1...3].DIAG.

Comparison, NCK system variable / PLC variable

NCK system variable	PLC variable DB 18
Inputs	
$A_FSDP_ERR_REAC[1...n]	FSDP[1...3].ERR_REAC
$A_OUTSE	SPL_DATA_OUTSEP[1...64]
$MN_PREVENT_LOCK	SPL_READY
Outputs	
$A_FSDP_ERROR[1...n]	FSDP[1...n].ERROR
$A_FSDP_SUBS_ON[1...n]	FSDP[1...n].SUBS_ON
$A_FSDP_DIAG[1...n]	FSDP[1...n].DIAG
--	FSDP[1...n].RETVAL14
--	FSDP[1...n].RETVAL15

7.4.3 Receiver F_RECVDP

In order to transfer SPL output data from an F-CPU to a SINUMERIK 840D sl using F-DP communication, an **SPL connection** must be parameterized. This connection comprises the following:

- **F_DP communication relationship**
  The following F_DP communication parameters are defined using the F_DP communication relationship:
  - Identifier (DP_DP_ID) and connection name
  - Communication parameters:
    - I/O start addresses (LADDR)
    - Monitoring time (TIMEOUT)
  - Error response (ERR_REAC)
  - Substitute values in the case of an error (SUBS)
- **SPL coupling**
  The SPL coupling is used to define which F data signals of the F telegram are to be mapped to which SPL inputs ($A_INSE). Several SPL couplings can be parameterized for one SPL connection.

Note:
The interpretation and processing of the F net data signals are realized via the PLC and NCK SPL and are the exclusive responsibility of the user or SPL programmer.

- **Connection number**
  A parameterizing data set is assigned to an SPL connection using the connection number.

An SPL connection is defined in a parameterizing data set. For SINUMERIK 840D sl, 12 parameterizing data sets are available for F_RECVDP; as a maximum, three different SPL connections, designated using three different identifiers (DP_DP_ID) can be parameterized in the F DP communication relationships. In case of an error, Alarm 27306 "F_DP: Max. number of active SPL connections (%1) for (%2) exceeded" is output

SPL input data ($A_INSE) can only be assigned to an SPL connection in the parameterizing data of the SPL coupling as contiguous range. If the SPL input data, which are required for an SPL connection, are not contiguous, then several SPL connections must be parameterized in the parameterizing sets. These SPL connections are designated using identical F_DP communication relationships and connection numbers, but different SPL couplings. The parameterization of one SPL connection with several SPL couplings is designated as sub-slots within the framework of PROFIsafe (see Chapter 7.2.6 "Parameterizing the SPL-SGE interface").

The number of SPL couplings per SPL connection can be freely parameterized within the framework of the number of parameterizing data sets that are available. The following options are available to parameterize SPL connections and SPL couplings for each SPL connection:

- SPL connections: 1 to maximum 3
- SPL couplings per SPL connection: 1 up to a maximum of 12, whereby the sum of all SPL couplings of all SPL connections can be a maximum of 12

The following value range for system variables and machine data is obtained from this:

- System variable index: 1...n with n = 3
- Machine data index: 0...m with m = 11

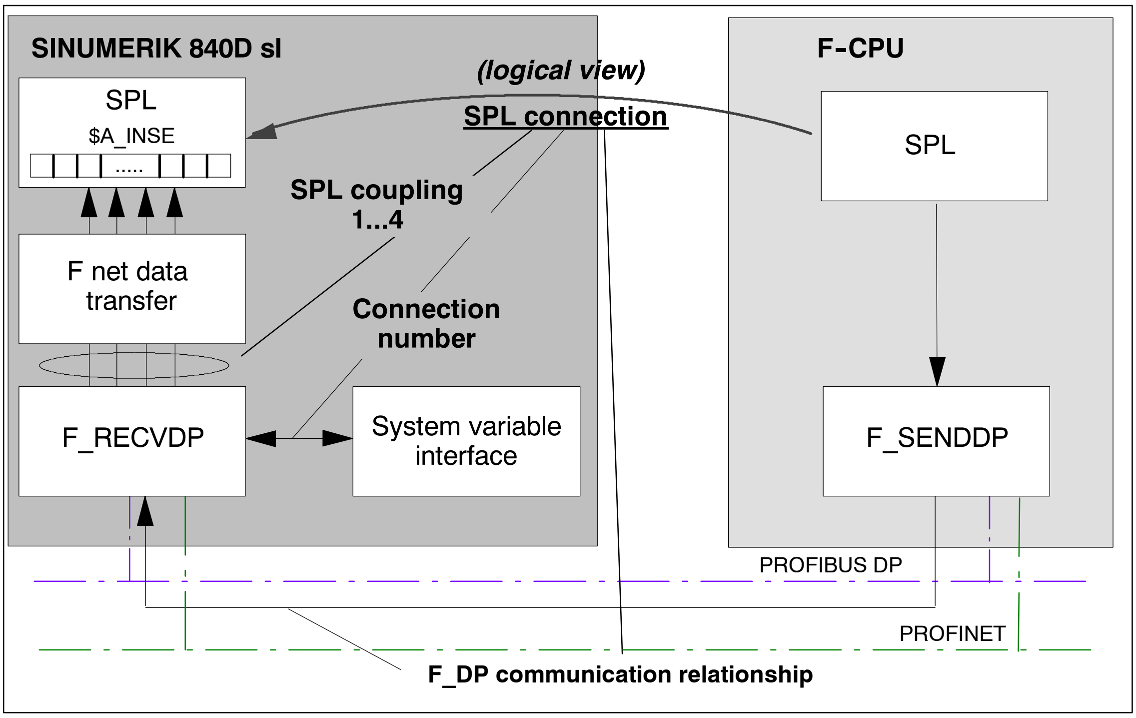


Fig. 7-28 Example of 1 SPL connection with 4 SPL couplings

Interface overview

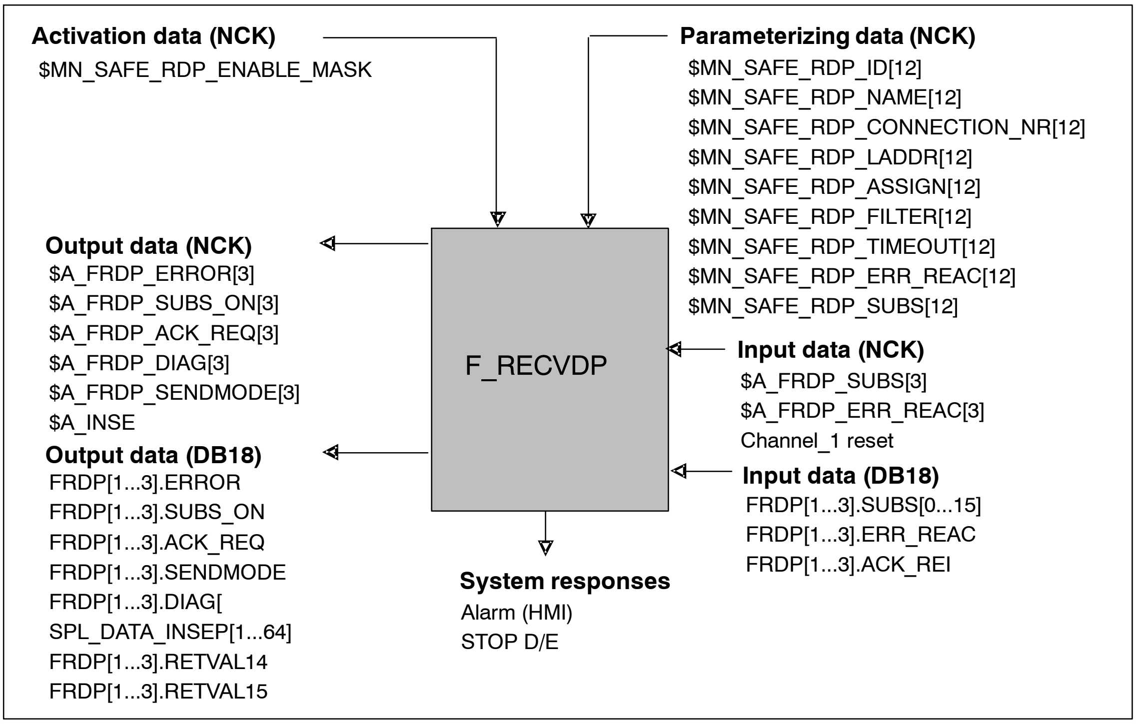


Fig. 7-29 Interface overview F_RECVDP

Activation data

Every parameterizing data set can be separately activated using the activation data.

Parameterizing data

The parameterizing data set of an SPL connection involves the following data areas:

- Identifier:
  - DP_DP_ID: MD 13341: $MN_SAFE_RDP_ID
  - Name: MD 13342: $MN_SAFE_RDP_NAME
- Connection number: MD 13343: $MN_SAFE_RDP_CONNECTION_NR #
- Communication parameters:
  - I/O start address: MD 13344: $MN_SAFE_RDP_LADDR #
  - Monitoring time: MD 13345: $MN_SAFE_RDP_TIMEOUT #
- Net data parameters:
  - SPL assignment: MD 13346: $MN_SAFE_RDP_ASSIGN
  - F net data filter: MD 13347: $MN_SAFE_RDP_FILTER
- Error reaction:
  - Error response MD 13348: $MN_SAFE_RDP_ERR_REAC #
  - Substitute values: MD 13349: $MN_SAFE_RDP_SUBS #

For SPL connections with the same identifier, all parameters identified with # must be identical. In case of an error, Alarm 27305 ”F_DP: Parameter MD %1[%2] < > MD%3[%4]” is output.

Input/output data

The input and output data provide the user or SPL programmer an interface compatible to the SIMATIC F application blocks using system variables.

Fault response

The system responses when a communication error occurs can be influenced by the user by appropriately setting the machine data $MN_SAFE_RDP_ERR_REAC and $MN_SAFE_RDP_SUBS or at a later time by programming the system variables $A_FRDP_ERR_REAC, $A_FRDP_SUBS in the SPL program.

SPL couplings (sub-slots)

Just the same as for PROFIsafe, also for F_RECVDP, only contiguous ranges of SPL input data ($A_INSE[x] up to $A_INSE[x+y]) can be assigned to an SPL connection. If the received F net data are to be transferred in several non-contiguous SPL input data areas, then several SPL connections must be parameterized. These are then designated using an identical identifier, communication parameter and connection number, but different SPL couplings. As part of the F_DP communication, these SPL connections are combined to form a single SPL connection communicating via PROFIBUS with several subordinate SPL couplings (sub-slots).

Example of an NCK parameterization

The following specifications are applied for the more detailed description of the NCK parameterization.

- Identifier
  - DP_DP_ID: 1000_D
  - Name: "WZM1"
- Connection number: 1
- Communication parameters
  - I/O start address: 298_D
  - Monitoring time: 0.5 seconds
- Net data parameters
  - SPL inputs used: $A_INSE[1...4]
  - Filter data : $000F_H$
  - SPL inputs used: $A_INSE[33...36]
  - Filter data: F000H
- Error reaction:
  - Error response: 0
  - Substitute values: 0

The following parameterizing data sets are obtained:

1. SPL connection (sub-slot 1)
   $MN_SAFE_RDP_ID[0] = 1000_D
   $MN_SAFE_RDP_NAME[0] = WZM1
   $MN_SAFE_RDP_CONNECTION_NR[0] = 1
   $MN_SAFE_RDP_LADDR[0] = 298_D
   $MN_SAFE_RDP_TIMEOUT[0] = 0.5
   $MN_SAFE_RDP_ASSIGN[0] = $001\ 004_D$
   $MN_SAFE_RDP_FILTER[0] = $000F_H$
   $MN_SAFE_RDP_ERR_REAC[0] = 0
   $MN_SAFE_RDP_SUBS[0] = 0
2. SPL connection (sub-slot 2)
   $MN_SAFE_RDP_ID[1] = 1000_D
   $MN_SAFE_RDP_NAME[1] = WZM1
   $MN_SAFE_RDP_CONNECTION_NR[1] = 1
   $MN_SAFE_RDP_LADDR[1] = 298_D
   $MN_SAFE_RDP_TIMEOUT[1] = 0.5
   $MN_SAFE_RDP_ASSIGN[1] = $033\ 036_D$
   $MN_SAFE_RDP_FILTER[1] = $F000_H$
   $MN_SAFE_RDP_ERR_REAC[1] = 0
   $MN_SAFE_RDP_SUBS[1] = 0

Note

All machine data of a parameterizing data set are linked with one another using the common machine data index.

MD 13341: $MN_SAFE_RDP_ID
Identifier of the F_DP communication relationship

The identifier must be assigned a freely selectable, unique identifier (DP_DP_ID), however, this must be unique across all F-CPUs that are connected using F_DP communication.

MD 13342: $MN_SAFE_RDP_NAME
Connection name

An SPL connection can be allocated a meaningful name using this machine data. The connection names can be freely selected and can be a maximum of 15 characters. The connection name is displayed at the HMI and in the alarm display. If a connection name is specified, then for Alarms 2735x, the name is displayed. If a connection name is not specified, then the corresponding identifier is displayed (DP_DP_ID).

The connection name does not have to be specified in all of the parameterizing data sets associated with an SPL connection. The connection name that is specified in the first active parameterizing data set is always used, i.e. the parameterizing data set with the lowest machine data index. All other data sets of an SPL connection are not evaluated with reference to connection names.

This MD is not incorporated in the checksum calculation; i.e. it can also be changed without aligning the checksum.

MD 13344: $MN_SAFE_RDP_LADDR
I/O start address

For each SPL connection, when generating the configuration in SIMATIC STEP 7 HW Config a start address must be defined for the I/O area via which the F_RECVDP exchanges data with the associated F_SENDDP The start address must be the same for the input and output data areas.

The user must enter the I/O start address of the SPL connection, defined in the configuration, in the MD $MN_SAFE_RDP_LADDR[0...m].

Rules to define the start addresses and address areas of an SPL connection:

- The start address must be identical in the input <u>and</u> output data areas
- Slot length: Input data area = 12 bytes, output data area: 6 bytes
- Consistency of the slots in the input <u>and</u> output data areas - in both cases over the ”complete length”

The check on the PLC side is made within the scope of the cyclic F_DP communication by evaluating the SFC14/SFC15 return values. For an error, Alarm 27354 ”F_DP: %1 communication, connection %2 signals SFC%3 error %4” is displayed.

Parameterization of the F net data transfer

The transfer of F net data in the SPL inputs is parameterized using the following NCK machine data:

- $MN_SAFE_RDP_ASSIGN[0...m]
- $MN_SAFE_RDP_FILTER[0...m]

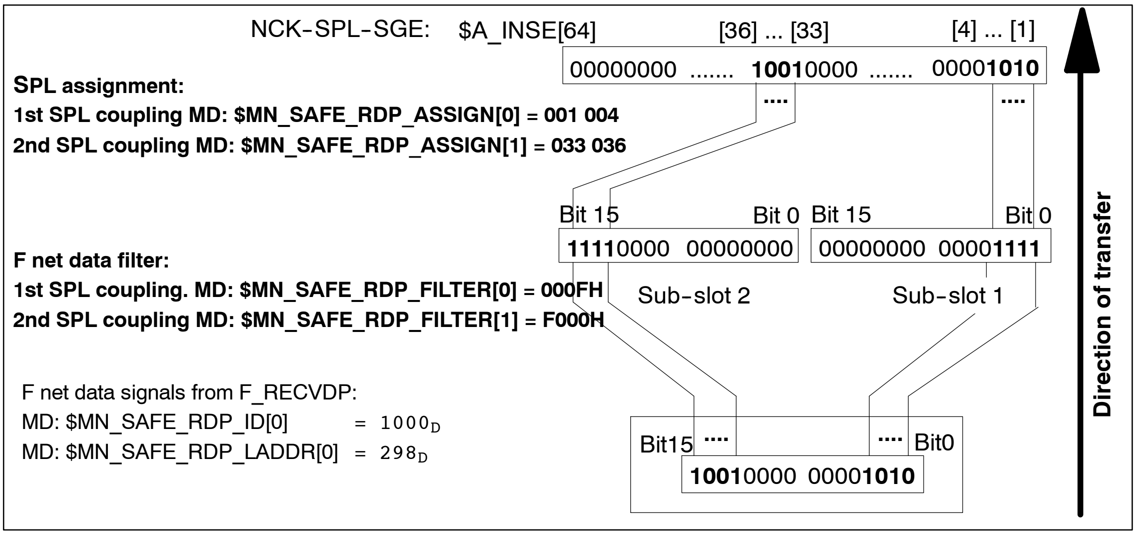


Fig. 7-30 F net data transfer F_RECVDP

MD 13347: $MN_SAFE_RDP_FILTER
F net data filter

If, on the receiver side, only individual F data signals of the F telegram - which are not located one after the other - are required within the SPL for further processing, then these can be selected using the F net data filter.

The F net data filter is set using machine data $MN_SAFE_RDP_FILTER[0...m].

Example for NCK parameterization (see page 7-261)

From the F net data signals of the F telegram, via the F net data filter of the 1st SPL connection (sub-slot 1), bits 0 to 3 are selected and via the F net data filter of the 2nd SPL connection (sub-slot 2), bits 12 to 15 are selected. The selected F net data signals are available as seamless bit field without any gaps (in the example, with length 4) at the output of the particular F net data filter.

MD 13346: $MN_SAFE_RDP_ASSIGN
SPL assignment

For the SPL assignment, the F net data signals selected using the F net data filter are assigned to the SPL inputs ($A_INSE) as seamless bit field (without any gaps).

The SPL assignment is set using MD $MN_SAFE_SDP_ASSIGN[0...m].

The SPL-SGE area is specified in the decimal notation in the format:

$MN_SAFE_RDP_ASSIGN[n] = aaa bbb with
aaa: Area limit 1, SPL-SGE $A_INSE[**aaa**]
bbb: Area limit 2, SPL-SGE $A_INSE[**bbb**]

The following conditions should be observed when specifying the area limit:

- All area data are valid: (aaa > bbb), (aaa < bbb), (aaa = bbb)
- |(aaa - bbb)| ≤ 16
  In case of an error, Alarm 27301 ”F_DP: MD %1[%2]: SPL coupling incorrect” is output.
- |(aaa - bbb)| = y
  With y = number of F net data signals selected in the MD F net data filter $MN_SAFE_RDP_FILTER.
  In case of an error, Alarm 27303 ”F_DP: Number of signals in MD %1[%2] < > MD %3[%4]” is output.

Example for NCK parameterization (see page 7-261)
The F net data signals, selected in each of the two SPL connections using the F net data filter, are available at the output of the particular F net data filter as seamless bit field (no gaps). The bit field of the 1st SPL connection is transferred in the SPL-SGE area $A_INSE[1] to $A_INSE[4] and the bit field of the 2nd SPL connection in the SPL-SGE area $A_INSE[33] to $A_INSE[36], refer to diagram 7-30 ”F net data transfer F_RECVDP.

An SPL input may only be occupied by one SPL connection. When allocated a multiple number times, Alarm 27302 ”F_DP: Dual allocation MD %1 [%2] -MD %3 [%4]” is output.

MD 13345: $MN_SAFE_RDP_TIMEOUT
Monitoring time

By specifying the monitoring time, the time is specified, within which a new F telegram, designated using the incremental sequence number, must be sent from the F_SENDDP (sender) to F_RECVDP (receiver).

The monitoring time is set using MD $MN_SAFE_RDP_TIMEOUT[0...m].

Notes on commissioning
When commissioning F_DP communication for the first time, it is recommended that the monitoring time is initially kept at the default value in order to avoid alarms caused by the monitoring time being exceeded. After the F_DP communication has been successfully commissioned, the monitoring time can then be changed to the required value, e.g. monitoring time ≥ 5 * F_DP clock cycle of the slower component of the SPL connection with F_DP clock cycle = $MA_SAFE_SRDP_IPO_TIME_RATIO * IPO clock cycle.

For more complex PLC user programs, it is possible that the parameterized F DP clock cycle is either briefly or even permanently exceeded. This is the reason that for diagnostic purposes, the maximum value of the F_DP clock cycle since the last time the control booted (powered-up) is displayed in machine data $MA_INFO_SAFE_SRDP_CYCLE_TIME and in the diagnostics screen "SI communication".

MD 13340: $MN_SAFE_RDP_ENABLE_MASK
Enable screen form

The individual parameterizing data sets are enabled using the enable screen form. The enable screen form is bit orientated, i.e. bit **0** activates the 1st parameterizing data set with machine data index **0**. If a parameterizing data set is not activated, then the machine data of the corresponding SPL connection are not evaluated.

The enable screen form is set using MD 13340:
$MN_SAFE_RDP_ENABLE_MASK.

MD 13343: $MN_SAFE_RDP_CONNECTION_NR
Connection number

A parameterizing data set is assigned to an SPL connection using the connection number. A max. of **3** SPL connections can be parameterized for F_RECVDP. As a result, the value range for the connection number obtained is: 1, 2, 3.

In the default setting, a parameterizing data set is not assigned to any SPL connection (connection number = 0). Each active parameterizing data set must be assigned to an SPL connection. In the case of an error, Alarm 27034 "Parameterization of MD %1[%2] invalid" is displayed.

The connection number is, at the same time, also the index to access system variables of the user interface of the SPL connection. The user interface involves the following system variables:

Input data

- $A_FRDP_SUBS[1...n]
- $A_FRDP_ERR_REAC[1...n]

Output data
- $A_FRDP_ERROR[1...n]
- $A_FRDP_SUBS_ON[1...n]
- $A_FRDP_ACK_REQ[1...n]
- $A_FRDP_DIAG[1...n]
- $A_FRDP_SENDMODE[1...n]

The connection number is set using MD $MN_SAFE_RDP_CONNECTION_NR.

Example:

The **3rd** SPL connection should be used.

- $MN_SAFE_RDP_CONNECTION_NR[x] = **3**

MD 13348: $MN_SAFE_RDP_ERR_REAC
Error response

Machine data $MN_SAFE_RDP_ERR_REAC[1...n] is used to set the default alarm response, which is initiated when an F_DP communication error occurs. The alarm response can be dynamically changed by the appropriate user programming via system variable $A_FRDP_ERR_REAC[1...n].

After programming the error response using the system variable, the value saved in the machine data is no longer active until the control re-boots.

The significance of the values for the machine data correspond to the values for the system variable $A_FRDP_ERR_REAC[1...n].

MD 13349: $MN_SAFE_RDP_SUBS
Substitute values

MD $MN_SAFE_RDP_SUBS[1...n] is used to set the default substitute values that are active after the control boots, which are output from an F_RECVDP driver to the SPL during an F_DP communication error.

In the SPL program, the user can dynamically enter other substitute values by writing to the system variable $A_FRDP_SUBS[1...n]. The substitute values set in the machine data are only active again when the control reboots the next time.

Input data F_RECVDP

System variable: Error response, $A_FRDP_ERR_REAC

The response when a communication error occurs is set using the system variable $A_FRDP_ERR_REAC[1...n]. This means, depending on the actual coupling or as a function of the plant/system components involved in the SPL connection, the response to a communication error, caused by an error in the communication path or by consciously switching one of the plant/system components, can be specified.

The following error responses can be set:

- Alarm 27350 and also STOP D/E
- Alarm 27350
- Alarm 27351 (display only, self-clearing)
- No alarm is displayed.

Supplementary conditions

1. For a communication error, the following system variables are always set independent of the error response set using the system variable $A_FRDP_ERR_REAC[1...n]:
   - $A_FRDP_ERROR[1...n] = 1
   - $A_FRDP_SUBS_ON[1...n] = 1
   - SPL input values $A_INSE[1...n] = $A_FRDP_SUBS[1...n]
2. When a communication error occurs, the currently programmed error response is realized. If the error response is changed, it only becomes effective when the next communication error occurs (in time).
3. Whether STOP D or STOP E is initiated as error response can be parameterized using:
   - NCK: $MN_SAFE_SPL_STOP_MODE
   - PLC: DB18.DBX36.1
4. The system variable $A_FRDP_ERR_REAC[1...n] is a part of the crosswise data comparison SPL-CDC.

Note

Until the system variable is programmed for the first time, after the control boots, the value set using MD $MN_SAFE_RDP_ERR_REAC is active.

System variable: Substitute values, $A_FRDP_SUBS

Using the system variable $A_FRDP_SUBS[1...n], substitute values are specified, which, in the case of an error, are output to the SPL input data parameterized using machine data $MN_SAFE_RDP_ASSIGN. A change to the substitute values only becomes effective in the next F_DP clock cycle - also during an error.

The system variable $A_FRDP_SUBS[1...n] is a part of the crosswise data comparison SPL-CDC.

Note

Until the system variables are programmed for the first time, after the control boots, the values defined using MD $MN_SAFE_RDP_SUBS[1...n] are active.

System variable: User acknowledgement, interface signal: DB18.FRDP_ACK_Rei and channel_1 reset

A user acknowledgement is always required after a communication error detected by F_RECVDP (system variable $A_FRDP_ERROR = 1). Once the cause of the error has been removed and F_SENDDP and F_RECVDP are again in cyclic communication, F_RECVDP sets the request for user acknowledgement via the system variable $A_FRDP_ACK_REI = 1.

A user acknowledgement can be realized as follows:

- PLC: Interface signal DB18.FRDP_ACK_REI
- NCK: Channel_1 reset

Driver-specific interface signal: DB18.FRDP_ACK_REI

The user acknowledgement is realized with a 0/1 change of the interface signal level. The interface signal must either be set or reset by the PLC user program. The applies to all F_RECVDP drivers.

The driver-specific interface signals are single-channel signals and are therefore not part of the crosswise data comparison SPL-CDC.

Note

The user acknowledgement via the interface signal only refers to acknowledging a communication error. If an alarm is initiated when a communication error is detected, this is not acknowledged, and neither the alarm nor the stop responses are reset.

Channel_1 reset

The user acknowledgement is internally realized in the system by initiating the channel_1 reset by pressing the reset key on the machine control panel

The interface signal is a single-channel signal and is therefore not part of the crosswise data comparison SPL-CDC.

Note

If an alarm is initiated when a communication error is detected, the alarm is acknowledged, and the alarm and stop responses are reset.

Output data F_RECVDP

System variable: Error signal, $A_FRDP_ERROR

System variable $A_FRDP_ERROR[1...n] is used to indicate that there is a communication error. The specific cause, determined by F_RECVDP, is communicated using the diagnostics data (system variable $A_FRDP_DIAG[1...n]).

System variable $A_FRDP_ERROR[1...n] is cyclically compared with the corresponding PLC variables FRDP[1...n].ERROR. If the values are different, there is a system error and Alarm 27355 ”F_DP: %1 communication, connection %2 reports system error %3 (%4)” is output.

System variable: Substitute value signal, $A_FRDP_SUBS_ON

System variable $A_FRDP_SUBS_ON[1...n] is used to signal that the substitute values, specified using the system variable $A_FRDP_SUBS[1...n] should be output to the SPL inputs $A_INSE[1...n].

System variable $A_FRDP_SUBS_ON[1...n] is cyclically compared with the corresponding PLC variables FRDP[1...n].SUBS_ON. If the values are different, there is a system error and Alarm 27355 "F_DP: %1 communication, connection %2 reports system error %3 (%4)" is displayed.

System variable: Request signal for user acknowledgement, $A_FRDP_ACK_REQ

System variable $A_FRDP_ACK_REQ[1...n] is used to signal that after a communication error, cyclic F telegrams are again being exchanged, but in order to acknowledge the error and to output the process values, a user acknowledgement is still required via the interface signal DB18.FRDP_ACK_REI or Channel_1 reset.

System variable $A_FRDP_ACK_REQ[1...n] is cyclically compared with the corresponding PLC variables FRDP[1...n].ACK_REQ. If the values are different, there is a system error and Alarm 27355 "F_DP: %1 communication, connection %2 reports system error %3 (%4)" is displayed.

System variable: Diagnostics data, $A_FRDP_DIAG

System variable $A_FRDP_DIAG[1...n] is used to signal the cause of the communication error determined by F_RECVDP.

System variable $A_FRDP_DIAG[1...n] is notcyclically compared with the corresponding PLC variables FRDP[1...n].DIAG.

System variable: Safety operation, $A_FRDP_SENDMODE

System variable $A_FRDP_SENDMODE[1...n] displays the actual operating mode of the F-CPU of the sender (F_SENDDP). If the F-CPU is in the deactivated safety mode, then this is signaled to the receiver in the F telegram. The receiver then sets $A_FRDP_SENDMODE[1...n] = 1.

For SINUMERIK 840D sl, the deactivated safety mode corresponds to the SPL-commissioning mode ($MN_PREVENT_SYNACT_LOCK = 0 or DB18DBX36.0 = 0).

System variable $A_FRDP_SENDMODE[1...n] is cyclically compared with the corresponding PLC variables FRDP[1...n].SENDMODE. If the values are different, there is a system error and Alarm 27355 "F_DP: %1 communication, connection %2 reports system error %3 (%4)" is displayed.

Comparison, NCK system variable / PLC variable

NCK system variable	PLC variable DB 18
Inputs	
$A_FRDP_SUBS[1...n]	FRDP[1...n].SUBS[0...15]
$A_FRDP_ERR_REAC[1...n]	FRDP[1...n].ERR_REAC
--	FRDP[1...n].ACK_REI
Outputs	
$A_FRDP_ERROR[1...n]	FRDP[1...n].ERROR
$A_FRDP_SUBS_ON[1...n]	FRDP[1...n].SUBS_ON
$A_FRDP_ACK_REQ[1...n]	FRDP[1...n].ACK_REQ
$A_FRDP_SENDMODE[1...n]	FRDP[1...n].SENDMODE
$A_FRDP_DIAG[1...n]	FRDP[1...n].DIAG
$A_INSE	SPL_DATA.INSEP[1...64]
--	FRDP[1...n].RETVAL14
--	FRDP[1...n].RETVAL15

7.4.4 Mapping the SIMATIC blocks

The parameters of the F_SENDDP and F_RCVDP blocks to be programmed in a SIMATIC-F-CPU and their corresponding mapping for SINUMERIK 840D sl are shown in the following:

F_SENDDP

Table 7-3 F_SENDDP

	SIMATIC block parameter F_SENDDP	SINUMERIK Parameters
Inputs	SD_BO_00 ... SD_BO_15	$A_OUTSE[x] 1) ... $A_OUTSE[y] 1)
	SD_I_00	- - - 2)
	SD_I_01	- - - 2)
	DP_DP_ID	$MN_SAFE_SDP_ID
	TIMEOUT	$MN_SAFE_SDP_TIMEOUT
	LADDR	$MN_SAFE_SDP_LADDR
Outputs	ERROR	$A_FSDP_ERROR
	SUBS_ON	$A_FSDP_SUBS_ON

Table 7-3 F_SENDDP

	SIMATIC block parameter F_SENDDP	SINUMERIK Parameters
	RETVAL 14	Alarm27354 3)
	RETVAL 15	Alarm27354 3)
	DIAG	$A_FSDP_DIAG

1) Assignment corresponding to the assign and filter machine data of the SPL coupling.
2) Transfer of integer values has not been implemented. Value in the F telegram always 0.
3) Description of the SFC(%3) under error code (%4), see Step7, online help

F_RECVDP

Table 7-4 F_RECVDP

	SIMATIC Block parameter F_RCVDP	SINUMERIK Parameters
	ACK_REI	DB18.FRDP_ACK_REI
Inputs	SUBBO_00 ... SUBBO_15	$MN_SAFE_RDP_SUBS/$A_FRDP_SUBS, bit 0 ... $MN_SAFE_RDP_SUBS/$A_FRDP_SUBS, bit 15
	SUBI_00	– – – 1)
	SUBI_01	– – – 1)
	DP_DP_ID	$MN_SAFE_SRP_ID
	TIMEOUT	$MN_SAFE_SRP_TIMEOUT
	LADDR	$MN_SAFE_SRP_LADDR
Outputs	ERROR	$A_FRDP_ERROR
	SUBS_ON	$A_FRDP_SUBS_ON
	ACK_REQ	$A_FRDP_ACK_REQ
	SENDMODE	$A_FRDP_SENDMODE
	RD_BO_00 ... RD_BO_15	$A_INSE[x] 2) ... $A_INSE[y] 2)
	RD_I_00	– – – 3)
	RD_I_0I	– – – 3)
	RETVAL 14	Alarm27354 4)
	RETVAL 15	Alarm27354 4)
	DIAG	$A_FRDP_DIAG

Table 7-4 F_RECVDP

	SIMATIC Block parameter F_RCVDP	SINUMERIK Parameters
[1] Transfer of integer values has not been implemented. Substitute values not required for integer values. [2] Assignment corresponding to the assign and filter machine data of the SPL coupling. 3) Transfer of integer values has not been implemented. The value possibly transferred from an F-CPU in the F telegram is not made available to the user. [4] Description of the SFC(%3) under error code (%4), see Step7, online help		

7.4.5 Parameterizing the PLC

Communication error when the control boots before SPL processing starts

When booting, user interface DB 18 is initialized with the boot substitute values and the boot error response from the NCK machine data. The values are valid and are effective when a communication error occurs as long as they are not overwritten with other values from the SPL (see also Chapter 7.4.10).

Initializing when booting:
FSDP[1..n].ERR_REAC = $MN_SAFE_SDP_ERR_REAC[0...n-1]

FRDP[1..n].SUBS[0..15] = $MN_SAFE_RDP_SUBS
FRDP[1..n].ERR_REAC = $MN_SAFE_RDP_ERR_REAC

7.4.6 Clock cycle setting of the F_DP communication

MD $MN_SAFE_SRDP_IPO_TIME_RATIO can be used to set a reduction ratio to the IPO clock cycle on the NCK side, this defines the time grid F_DP in which communication takes place between the NCK and PLC (F_DP clock cycle). This means that it is indirectly possible to optimize the utilization of the PLC using the F_DP communication.

The following supplementary conditions apply:

- The maximum value of the F_DP clock cycle exceeded
  The upper value of the F_DP clock cycle is actively limited. A parameterizing error (F_DP_clock cycle > **250** ms) results in Alarm 27300: "F_DP: Cycle time %1 [ms] is too long".

- Response when OB40 clock cycle is > F_DP clock cycle
  If the F_DP clock cycle is exceeded, then Alarm 27352 "F_DP: Communication error %1, error %2" is not immediately output, but up to a maximum limit value of **500** ms, an attempt is made to restart the OB40 coupling. In this case, the IPO clock cycle is used as call cycle and no longer the F_DP clock cycle.
  After the **500** ms limit has been exceeded, the alarm mentioned above is output and the configured stop response (STOP D or E) is initiated. F_DP communication processing is stopped. The F_RECVDP drivers output fail-safe values (0) as F net data.
- Displaying the maximum F_DP clock cycle
  The maximum F_DP clock cycle that occurs is displayed in MD $MN_INFO_SAFE_SRDP_CYCLE_TIME.
- Parameterizing error of the F_DP clock cycle
  The lower value of the F_DP clock cycle is not actively limited. When setting the F_DP clock cycle, the PLC-CPU performance should always be taken into consideration.
  When parameterizing an F_DP cycle that is too low, Alarm 27353: "F_DP: Actual cycle time %1 [ms] > parameterized cycle time" is output specifying the currently effective F_DP clock cycle.
  The criterion for an F_DP clock cycle that is set too low is that the parameterized F_DP clock cycle was exceeded **100** times one after the other.

7.4.7 Response times of the F_DP communication

The response times listed here refer exclusively to the internal processing of the signals by the F_DP communication layer. The following applies:

- **T(FRDP -> DB18) or T(FRDP -> SPL-INSE)**
  The transfer time from the input area of the F_RECVDP module to the input interface of the PLC-SPL or NCK-SPL
- **T(DB18 -> FSDP) or T(SPL-OUTSE -> FSDP)**
  The transfer time from the output interface of the PLC-SPL or NCK-SPL to the output area of the F_SENDDP.
- **T(FRDP -> FSDP)**
  Sum of the transfer times from:
  - T(FRDP -> DB18) or T(FRDP -> SPL-INSE)
  - Processing time by the user-specific SPL program.
  - T(DB18 -> FSDP) or T(SPL-OUTSE -> FSDP)

The following applies for the subsequent tables of the PLC and NCK processing times:

- Values in *italics* can increase by up to 500 ms due to delays in the communication path between the NCK and PLC.
- F_DP clock cycle: 500 ms is the permanently implemented maximum time to detect error-free communications between the NCK and PLC. A STOP response (STOP D/E) is initiated if this time is exceeded. The maximum F_DP clock cycle that has occurred is displayed in MD 10091: $MN_INFO_SAFE_SRDP_CYCLE_TIME.

- OB1 clock cycle: 150 ms is the maximum time set as standard in the PLC-CPU to monitor the user level. The PLC goes into the STOP state if this time is exceeded.
- IPO: IPO clock cycle is generated from MD 10050: Basic system clock cycle and MD 10070 interpolator clock cycle.
- 0...m * IPO clock cycle: This time component only becomes applicable if delays are incurred on the PLC side. In this case, in each subsequent IPO clock cycle, it is determined as to whether the PLC is ready to communicate again.
- OB40_INT is the maximum permissible time to initiate the interrupt on the NCK side up to execution of the PROFIsafe software and a ready signal to the NCK. The time is mainly determined by the run time (propagation time) of the F driver implementation on the PLC side and the PLC user program to be run-through in the OB40 context. These times typically lie in the vicinity of a few milliseconds.
- The error response for system errors (see Alarm 27355) and F_DP communication errors: Sequence number and CRC (see Alarms 27350 / 27351: SN and CRC) realized in the F_DP clock cycle in which the error is identified.
- The error response for F_DP communication error TIMEOUT (see Alarms 27350 and 27351: TO) is realized in the F_DP clock cycle in which the parameterized timeout time (FSDP: MD 13335: $MN_SAFE_SDP_TIMEOUT, FRDP: MD 13345 $MN_SAFE_RDP_TIMEOUT) is exceeded.
- The specified maximum times are theoretical values; it is extremely improbable that they actually occur in practice.

Reason:

- It is improbable that the run time of the PLC-F driver is delayed - in the OB40 context - by the maximum time of 500 ms. The reason for this is that the interrupting organizational blocks (OB8x) only have such long run times in extremely few cases.
- For the theoretical value, it would be necessary that two consecutive runs of the PLC-F_DP layer in the OB40 context are delayed by the permitted maximum of 500 ms - this is extremely improbable.
- The maximum time of 150 ms for the user program is not reached in any of the applications relevant in practice.

PLC processing times

Times::T(FRDP -> DB18)		
Formula	2 * *F_DP clock cycle* + 1 * OB1	
Max. times	2 * 500 ms + 1 * 150 ms	1150 ms
Typical times 1)	2 * 80 ms + 1 * 30 ms	190 ms
Times::T(DB18 -> FSDP)		
Formula	2 * *F_DP clock cycle* + 1 * OB1	
Max. times	2 * 500 ms + 1 * 150 ms	1150 ms
Typical times 1)	2 * 80 ms + 1 * 30 ms	190 ms
Times::T(FRDP -> FSDP)		
Formula	4 * *F_DP clock cycle* + 2 * OB1	
Max. times	4 * 500 ms + 2 * 150 ms	2300 ms
Typical times 1)	4 * 80 ms + 2 * 30 ms	380 ms

F_DP clock cycle = n * IPO; with n = 1, 2, 3, ...
1) Typical times: IPO = 8 ms; n = 10 => F_DP clock cycle = 80 ms; OB1 = 30 ms

NCK processing times (F_DP clock cycle <= 2 * IPO)

Times::T(FRDP -> SPL-INSE)		
Formula	2 * *F_DP clock cycle* + 1 * IPO	
Max. times	2 * 500 ms + 1 * 8 ms	1008 ms
Typical times 1)	2 * 16 ms + 1 * 8 ms	40 ms
Times::T(SPL-OUTSE -> FSDP)		
Formula	IPO + (0...m) * *IPO* + OB40_INT	
Max. times	8 ms + 500 ms + 50 ms	558 ms
Typical times 1)	8 ms + 2 ms	10 ms
Times::T(FRDP -> FSDP)		
Formula	2 * *F_DP clock cycle* + 2 * IPO + (0...m) * *IPO* + OB40_INT	
Max. times	2 * 500 ms + 2 * 8 ms + 500 ms + 50 ms	1566 ms
Typical times 1)	2 * 16 ms + 2 * 8 ms + 2 ms	50 ms

F_DP clock cycle = n * IPO; with n = 1, 2, 3, ...
1) Typical times: IPO = 8 ms; n = 10 => F_DP clock cycle = 80 ms; OB40_INT = 2 ms ... 50 ms (maximum)

NCK processing times (F_DP clock cycle > 2 * IPO)

Times::T(FRDP -> SPL-INSE)		
Formula	2 * *F_DP clock cycle* + 1 * IPO	
Max. times	2 * 500 ms + 1 * 8 ms	1008 ms
Typical times 1)	2 * 80 ms + 1 * 8 ms	168 ms
Times::T(SPL-OUTSE -> FSDP)		
Formula	IPO + (n - 2) * IPO + (0...m) * *IPO* + OB40_INT	
Max. times	8 ms + 8 * 8 ms + 500 ms + 50 ms	622 ms
Typical times 1)	8 ms + 8 * 8 ms + 2 ms	74 ms
Times::T(FRDP -> FSDP)		
Formula	2 * *F_DP clock cycle* + F_DP clock cycle + (0...m) * *IPO* + OB40_INT	
Max. times	2 * 500 ms + 80 ms + 500 ms + 50 ms	1630 ms
Typical times 1)	2 * 80 ms + 80 ms + 2 ms	242 ms

F_DP clock cycle = n * IPO; with n = 1, 2, 3, ...
1) Typical times: IPO = 8 ms; n = 10 => F_DP clock cycle = 80 ms; OB40_INT = 2 ms ... 50 ms (maximum)

7.4.8 Boot behavior of the F_DP communication

When the control boots, then the F_DP communication, i.e. the F_DP communication relationships of all parameterized SPL connections (F_SENDDP and F_RECVDP) automatically boot and establish cyclic F communication with their particular communication partner.

The boot state of the F_DP communication is represented in the output data of the user interface as follows:

- F_SENDDP (NCK)
  - $A_FSDP_ERROR = 0
  - $A_FSDP_DIAG = 0
  - $A_FSDP_SUBS_ON = 1
- F_SENDDP (PLC)
  - FSDP[1...n].ERROR = FALSE
  - FSDP[1...n].SUBS_ON = True
  - FSDP[1...n].DIAG = 0
  - FSDP[1...n].RETVAL14 = 0
  - FSDP[1...n].RETVAL15 = 0
- F_RECVDP (NCK)
  - $A_FRDP_ERROR[1...n] = 0
  - $A_FRDP_DIAG = 0
  - $A_FRDP_SUBS_ON = 1
  - $A_FRDP_ACK_REQ = 0
  - $A_FRDP_SENDMODE = 0

- F_RECVDP (PLC)
  - FRDP[1...n].ERROR = FALSE
  - FRDP[1..n].SUBS_ON = TRUE
  - FRDP[1...n].ACK_REQ = FALSE
  - FRDP[1...n].SENDMODE = FALSE
  - FRDP[1...n].DIAG = 0
  - FRDP[1...n].RETVAL14 = 0
  - FRDP[1...n].RETVAL15 = 0

As long as an F_DP communication relationship is still not in cyclic F communication, the substitute values $MN_SAFE_RDP_SUBS and FRDP[1...n].SUBS are output to the SPL inputs $A_INSE / SPL_DATA.INSEP:

- $A_INSE = $A_FRDP_SUBS / SPL_DATA.INSEP[x...y] = FRDP[1...n].SUBS[0...15]

Note

From the F_DP communication side, there is no time limit when waiting for the communication partner. Limiting the waiting time with a response when exceeded, must be implemented in the application itself.

After an error-free boot, the cyclic F communication is represented in the output data of the user interface as follows:

- F_SENDDP (NCK)
  - $A_FSDP_ERROR = 0
  - $A_FSDP_DIAG = 0
  - $A_FSDP_SUBS_ON = 0
- F_SENDDP (PLC)
  - FSDP[1...n].ERROR = FALSE
  - FSDP[1...n].SUBS_ON = FALSE
  - FSDP[1...n].DIAG = 0
  - FSDP[1...n].RETVAL14 = 0
  - FSDP[1...n].RETVAL15 = 0
- F_RECVDP (NCK)
  - $A_FSDP_ERROR = 0
  - $A_FRDP_DIAG = 0
  - $A_FRDP_SUBS_ON = 0
  - $A_FRDP_ACK_REQ = 0
  - $A_FRDP_SENDMODE = X (value corresponding to the received F telegram)
- F_RECVDP (PLC)
  - FRDP[1...n].ERROR = FALSE
  - FRDP[1...n].SUBS_ON = FALSE
  - FRDP[1...n].ACK_REQ = FALSE
  - FRDP[1...n].SENDMODE = X (value corresponding to the received F telegram)
  - FRDP[1...n].DIAG = 0
  - FRDP[1...n].RETVAL14 = 0
  - FRDP[1...n].RETVAL15 = 0

When cyclic F communication is established, the process values received by F_SENDDP are output at the SPL inputs SPL inputs $A_INSE / SPL_DATA.INSEP.

- $A_INSE / SPL_DATA.INSEP[x...y] = process values

Note

User acknowledgement is not required for the transition from booting into cyclic F communication.

7.4.9 Communication error after the control boots and active SPL processing

After a communication error has been detected, F_RECVDP outputs the substitute values $A_FRDP_SUBS / FRDP[1..n].SUBS, programmed in the user program, to SPL inputs ($A_INSE / SPL_DATA.INSEP).
F_SENDDP and F_RECVDP initiate the error response $A_FSDP/ FRDP_ERR_REAC (PLC: FSDP/FRDP[1..n].ERR_REAC) programmed in the user program. F_SENDDP and F_RECVDP immediately attempt to resume cyclic F_DP communication.

Note

There is no time limit when waiting for the communication partner.

The error state of the F_DP communication is represented as follows in the output data of the user interface:

- F_SENDDP (NCK)
  - $A_FSDP_ERROR = 1
  - $A_FSDP_DIAG = X (value corresponding to the detected communication error)
  - $A_FSDP_SUBS_ON = 1
- F_SENDDP (PLC)
  - FSDP[1...n].ERROR = TRUE
  - FSDP[1...n].SUBS_ON = TRUE
  - FSDP[1...n].DIAG = X (value corresponding to the detected communication error)
  - FSDP[1...n].RETVAL14 = X (value not equal to 0 if the error was detected by SFC)
  - FSDP[1...n].RETVAL15 = **X** (value not equal to 0 if the error was detected by SFC)
- F_RECVDP (NCK)
  - $A_FSDP_ERROR = 1

- $A_FRDP_DIAG = X (value corresponding to the detected communication error)
- $A_FRDP_SUBS_ON = 1
- $A_FRDP_ACK_REQ = 0
- $A_FRDP_SENDMODE = X (value corresponding to the last valid F telegram)
- $A_INSE = $A_FRDP_SUBS

- F_RECVDP (PLC)
  - FRDP[1...n].ERROR = TRUE
  - FRDP[1...n].SUBS_ON = TRUE
  - FRDP[1...n].ACK_REQ = FALSE
  - FRDP[1...n].SENDMODE = X (value corresponding to the last valid F telegram)
  - FRDP[1...n].DIAG = X (value corresponding to the detected communication error)
  - FRDP[1...n].RETVAL14 = X (value not equal to 0 if the error was detected by SFC)
  - FRDP[1...n].RETVAL15 = X (value not equal to 0 if the error was detected by SFC)
  - SPL_DATA.INSEP[x...y] = FRDP[1...n].SUBS

If the F_DP communication relationship resumes error-free cyclic operation, then it sets the request that the user explicitly acknowledges the communication error using $A_FRDP_ACK_REQ = 1 (PLC: FRDP[1...n].ACK_REQ = TRUE). Substitute values are still output as long as the user acknowledgement has not been given. The user acknowledges the request using DB18.FRDP_ACK_REI = 1 (PLC: FRDP[1...n].ACK_REI = TRUE) or Channel_1 reset.

The wait state for the user acknowledgement is represented in the output data of the user interface as follows:

- F_SENDDP (NCK)
  - $A_FSDP_ERROR = 1
  - $A_FSDP_DIAG = X (value corresponding to the detected communication error)
  - $A_FSDP_SUBS_ON = 1

- F_SENDDP (PLC)
  - FSDP[1...n].ERROR = TRUE
  - FSDP[1...n].SUBS_ON = TRUE
  - FSDP[1...n].DIAG = **X** (value corresponding to the detected communication error)
  - FSDP[1...n].RETVAL14 = 0
  - FSDP[1...n].RETVAL15 = 0

- F_RECVDP (NCK)
  - $A_FSDP_ERROR = 1
  - $A_FRDP_DIAG = X (value corresponding to the detected communication error)
  - $A_FRDP_SUBS_ON = 1
  - $A_FRDP_ACK_REQ = 1
  - $A_FRDP_SENDMODE = X (value corresponding to the last valid F telegram)
  - $A_INSE = $A_FRDP_SUBS

- F_RECVDP (PLC)
  - FRDP[1...n].ERROR = TRUE
  - FRDP[1...n].SUBS_ON = TRUE
  - FRDP[1...n].ACK_REQ = TRUE
  - FRDP[1...n].SENDMODE = X (value corresponding to the received F telegram)
  - FRDP[1...n].DIAG = X (value corresponding to the detected communication error)
  - FRDP[1...n].RETVAL14 = 0
  - FRDP[1...n].RETVAL15 = 0
  - SPL_DATA.INSEP[x...y] = FRDP[1...n].SUBS

Note

After an F_DP communication error, to enable F_DP communication, a user acknowledgement using the interface signal DB18.FRDP_ACK_REI is sufficient.

If, in addition to the F_DP communication, pending alarms with NCK responses - and possibly Stop D/E - are to be reset, then the user acknowledgement must be realized using a channel_1 reset.

After the user acknowledgement has been given, the F_DP communication is represented in the output data of the user interface as follows:

- F_SENDDP (NCK)
  - $A_FSDP_ERROR = 0
  - $A_FSDP_DIAG = 0
  - $A_FSDP_SUBS_ON = 0
- F_SENDDP (PLC)
  - FSDP[1...n].ERROR = FALSE
  - FSDP[1...n].SUBS_ON = FALSE
  - FSDP[1...n].DIAG = 0
  - FSDP[1...n].RETVAL14 = 0
  - FSDP[1...n].RETVAL15 = 0
- F_RECVDP (NCK)
  - $A_FSDP_ERROR = 0
  - $A_FRDP_DIAG = 0
  - $A_FRDP_SUBS_ON = 0
  - $A_FRDP_ACK_REQ = 0
  - $A_FRDP_SENDMODE = X (value corresponding to the F telegram)
  - $A_INSE = process values
- F_RECVDP (PLC)
  - FRDP[1...n].ERROR = FALSE
  - FRDP[1...n].SUBS_ON = FALSE
  - FRDP[1...n].ACK_REQ = FALSE
  - FRDP[1...n].SENDMODE = X (value corresponding to the received F telegram)
  - FRDP[1...n].DIAG = 0
  - FRDP[1...n].RETVAL14 = 0
  - FRDP[1...n].RETVAL15 = 0
  - SPL_DATA.INSEP[x...y] = process values

Note

If a DP slave is switched off using F_SENDDP / F_RECVDP with communication active, then among other things, the PLC signals the Alarms 400551/400552 ”MPI/DP bus error”. The alarms are not issued if, before the DP slave is switched off, this is specifically deactivated by calling SFC12 [D_ACT_DP].

7.4.10 Communication error when the control boots before SPL processing starts

When booting, the user interface (DB18) is initialized with the boot substitute values and the boot error response from the NCK machine data. The values are valid and are effective for communication error as long as they are not overwritten with values from the SPL.

Initializing when booting:
FRDP[1...n].ERR_REAC = $MN_SAFE_SDP_ERR_REAC

FRDP[1...n].SUBS[0..15] = $MN_SAFE_RDP_SUBS
FRDP[1...n].ERR_REAC = $MN_SAFE_RDP_ERR_REAC

7.4.11 Acknowledging a communication error with Channel_1 reset

If, due to a communication error, an alarm with NCK responses and possibly a STOP D/E initiated, then the user acknowledgement must be realized using a channel_1 reset in order that the alarms are cleared and the alarm responses reset. If the channel_1 reset is initiated before setting the request for the user acknowledgement $A_FRDP_ACK_REQ, then the NCK responses are reset within the scope of the reset processing. As a result of the communication error that is still present, the alarm is again initiated in the next F_DP clock cycle and the NCK responses are reactivated.

If the error response (STOP D/E), programmed when a communication error occurs, prevents e.g. moving plant/systems into a suitable position required to continue operation in a production plant or system, then the error response must be re-programmed <u>before</u> acknowledging the NCK responses using a channel_1 reset.

Example

1. The currently programmed error response is $A_FRDP_ERR_REAC = 0 (Alarm 27350 + STOP D/E).
2. A communication error is identified and the responses Alarm 27350 + STOP D/E initiated.
3. In order that the plant can continue to produce, the component involved should be manually moved into a suitable position. To do this, error response $A_FRDP_ERR_REAC must be set to 3 (no Alarm) in the user program and then a channel_1 reset must be initiated. The alarms are then cleared and the NCK responses reset.
4. The error response is initiated again as the communication error is still present after the channel_1 reset. Due to the fact that the error response was re-programmed, an alarm is not initiated and no NCK interlocks due to STOP D/E are effective. This means that the plant components can be moved.

7.4.12 F_DP communication for a system error

There is a system error, if incorrect behavior (inappropriate response) is detected, which is not caused by a communication error described in the F_DP protocol, but was only the result of incorrect behavior (malfunction) of the system software or hardware.

Driver-specific system errors:

- Asynchronous fault state (StateFault)
  The NCK or PLC-F_DP driver is in the fault/error state while the F_DP of the 2nd channel is not in a fault/error state.
  => Alarm 27355
- Sign-of-life monitoring (LifeSign)
  The NCK or PLC-F_DP driver has not updated its sign-of-life.
  => Alarm 27355
- Discrepancies in the F telegram data (TelegramDiscrepancy)
  NCK and PLC-F_DP drivers cyclically generate an F telegram with diversity through 2 channels. The two F telegrams are compared before compiling the F telegram to be sent. A discrepancy in the telegram data was identified in this comparison.
  => Alarm 27355
- Discrepancies in the output data (OutputdataDiscrepancy)
  The F_DP drivers indicate their particular state using various output data. At the end of each F_DP clock cycle, the NCK and PLC status data are compared and they must match.
  => Alarm 27355
  The following output data are compared:
  F_SENDDP (NCK)
  - $A_FSDP_ERROR
  - $A_FSDP_SUBS_ON

F_SENDDP (PLC)
- FSDP[1..n].ERROR
- FSDP[1..n].SUBS_ON

F_RECVDP (NCK)
- $A_FRDP_ERROR
- $A_FRDP_SUBS_ON
- $A_FRDP_ACK_REQ
- $A_FRDP_SENDMODE

F_RECVDP (NCK)
- FRDP[1..n].ERROR
- FRDP[1..n].SUBS_ON
- FRDP[1..n].ACK_REQ
- FRDP[1..n].SENDMODE

F_DP communication-specific system error

- The SPL input/output data are not updated (SPL I/O-communication)
  Data exchange between the SPL and the F_DP drivers is interrupted.
  => Alarm 27355
- No longer any communications between the NCK and PLC
  The PLC was not able to process the OB40 request for F_DP communication within the maximum monitoring time of 500 ms.
  => Alarm 27355

Depending on the particular error, the cyclic processing of the F_DP driver (driver-specific system error) or the complete F_DP communication (F_DP communication-specific system error) is stopped and the relevant alarm is displayed. With the alarm, the NC start is locked and Stop D/E initiated.

Behavior regarding SPL:
Stopped F_RECVDP drivers output fail-safe values (0) as F net data towards the SPL.

Behavior regarding communication partners:
Stopped F_DP drivers no longer generate any F telegrams. At the latest after the configured timeout time, the communication partners detect the F_DP communication failure and go into the safe state corresponding to the specified profile.

7.4.13 NCK/PLC data exchange

Cyclic F_DP data transfer

After evaluating the machine data of the F_DP communication through the NCK and PLC-F_DP layer and initializing the parameterized F_SENDDP and F_RECVDP drivers, cyclic operation of both F_DP layers is started.

From this instant in time onwards, the NCK initiates an OB40 alarm on the PLC in the set F_DP clock cycle (multiple of the IPO clock cycle, set via MD $MN_SAFE_SRDP_IPO_TIME_RATIO). The basic program software on the PLC side for F_DP communication is then run.

If, when attempting to issue an OB40 request to the PLC, it is identified that the previous request has still not been executed, then no new request is issued in this F_DP clock cycle. An OB40 request is only issued to the PLC, if the PLC has enabled the interface, i.e. after acknowledging the previous request.

From the first unsuccessful attempt, attempts to issue a new OB40 request to the PLC are no longer realized in the F_DP clock cycle but in the IPO clock cycle, so that a communication error (timeout) does not occur as a result of the delay on the side of the external F-CPU.

If an OB40 request from the PLC is not acknowledged up to a max. limit value of **500** ms limit, Alarm 27352 "F_DP: Communication error %1, Error %2" is output and the configured stop response (Stop D/E) initiated. F_DP communication processing is stopped. The F_RECVDP drivers output fail-safe values (0) as F net data.

After the OB40 has been exited, the PLC returns to the level that was interrupted. The input image on the PLC side is updated in DB18 after the end of the actual OB1 cycle. This therefore ensures that the PLC-SPL always processes contiguous input information from a time perspective.

7.4.14 Effects on the SPL

Using the F_DP communication has no effect on existing SPL programs with reference to the interlocking logic in them. However, a conflict can occur when assigning SPL inputs, if an SPL input is to be written to from several applications, e.g. F_RECVDP and PROFIsafe.

The multiple assignment of an SPL input is identified, when booting - across applications - and is displayed using Alarm 27099 "Double assignment in SPL assignment MD %1[%2] - MD %3[%4]".

The evaluation of the status signals of the SPL connections and changing the system responses in the case of an error must, if necessary, be additionally programmed in the SPL.

Warning

Depending on the application, the user must invert the status signals of an F_SENDDP-/F_RECVDP connection (e.g. $A_FSDP_ERROR[1...n], $A_FSDP_SUBS_ON[1...n], $A_FRDP_ERROR[1...n], $A_FRDP_SUBS_ON[1...n], $A_FRDP_SENDMODE) when further processing in the SPL. This is done in order to ensure a safe state in the case of incorrect behavior/response of the PLC or NCK.

Example:
If $A_FRDP_SENDMODE is to be output as safety-related signal from the SPL to PROFIsafe, then this signal must first be inverted. This is done in order that the fail-safe value ”0” also corresponds to the safe state, i.e. it has the significance ”deactivated safety mode”.

7.4.15 Functionality of the SPL input/output data

Only the user (machinery construction OEM) defines the functionality of the SPL input/output data within the scope of the F_DP communication.

The SPL programs of NCK-SPL and PLC-SPL are not executed synchronously (from a time perspective). As a result of runtime differences in the SPL programs, brief differences can occur in the output data of both SPL programs (NCK: $A_OUTSE, PLC: $A_OUTSEP).

In order that PLC and NCK-F_SENDDP use identical F net data for the two-channel generation of an F telegram, the SPL output data are exchanged between the two channels (PLC: $A_OUTSEP and NCK: $A_OUTSE) in each F_DP clock cycle alternating, and are ANDed with one another before the sender. For safety reasons, the user (machinery construction OEM) must select the functionality of an SPL input/output data so that the value ”0” corresponds to the safe state of the functionality represented by this data. Only then can it be absolutely ensured that the appropriate function is only activated on CPU2 (F_RECVDP) if the function is activated in both SPL programs (PLC-SPL and NCK-SPL) of CPU1 (F_SENDDP).

Warning

For safety reasons, this is the reason that the functionality of an SPL input or output data is selected so that the value ”0” corresponds to the safe state of the functionality represented by this data.

The synchronization of the SPL output data described above ensures that if it is intended to simultaneously change several SPL output data in the SPL program, then these are also consistently transferred (in time) in the F net data telegram of the F_SENDDP. If, in a user application, several SPL output data are interpreted as a contiguous bit pattern, it must therefore be taken into account that intermediate values can briefly occur.

Example:
Three SPL output data are considered to be contiguous. The value is changed from 101 to 110 in both SPL programs (NCK-SPL and PLC-SPL).
Values transferred from the F_SENDDP in the F net data telegram:

	NCK-SPL	**AND**	PLC-SPL	=	F net data telegram
Output value	101	&	101	=	101
Possible intermediate value	*110*	&	*101*	=	*100*
End value	110	&	110	=	110

Warning

Due to runtime differences in the NCK-SPL and PLC-SPL, it cannot be guaranteed that when several SPL output data are simultaneously changed (NCK: $A_OUTSE, PLC: $A_OUTSEP) that these are consistently transferred (in time) from the F_SENDDP in the F net data telegram.

7.4.16 Supplementary conditions

For SINUMERIK 840D sl, the following restrictions apply for the safety-related CPU-CPU communication to couple plants and systems:

- The 2 integer values, defined in the F net data area of the F telegram, are not used or not evaluated by the F_SENDDP and F_RECVDP realized for SINUMERIK.
- Axial SGE/SGA cannot be directly coupled to F_SENDDP and F_RECVDP.
- A maximum of 250 ms can be set for the F_DP clock cycle.
- The F net data are automatically coupled to the SPL interface in data block DB 18 by the basic PLC program. It is not possible to couple them in a PLC user program.

7.5 Safe programmable logic (SPL)

7.5.1 Fundamentals

Function

These signals must be logically combined (interlocked) in a safety-related, freely programmable form in order to be able to flexibly process safety-related external process signals and safety-related internal input and output signals. The "Safe Programmable Logic" (SPL) handles this task as an integral system component.

Characteristics:

- Logic operations implemented by the user are cyclically processed.
- Instructions are effective in all operating modes.
- The PLC program immediately starts to execute the instructions after the control has booted.
- The SGE/SGA must be supplied by the machine manufacturer - both in the drive monitoring channel as well as in the NCK monitoring channel.
- The NCK-SPL is written as ASUB using the CNC function synchronous actions. The PLC-SPL is written as PLC user program.

In order to check that the two SPLs (PLC and NCK) are functioning, the system program arranges cyclic data comparison between the PLC and NCK.

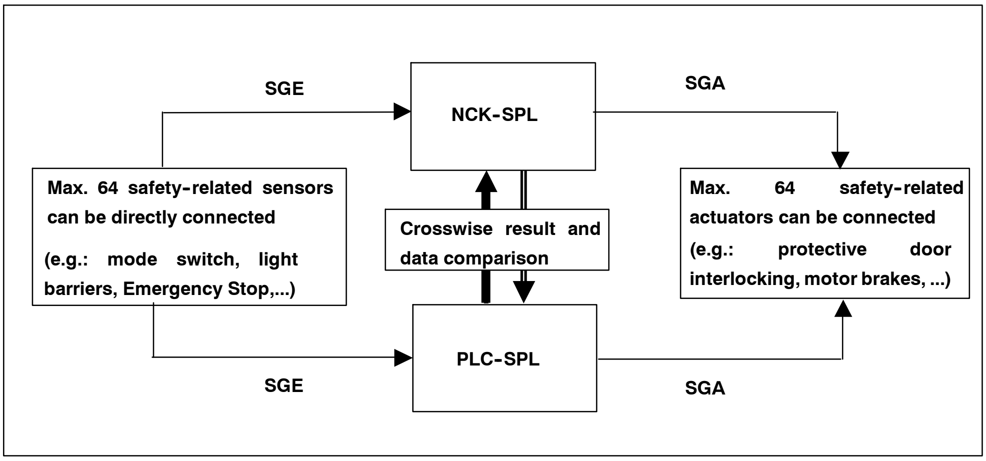


Fig. 7-31 Safe programmable logic

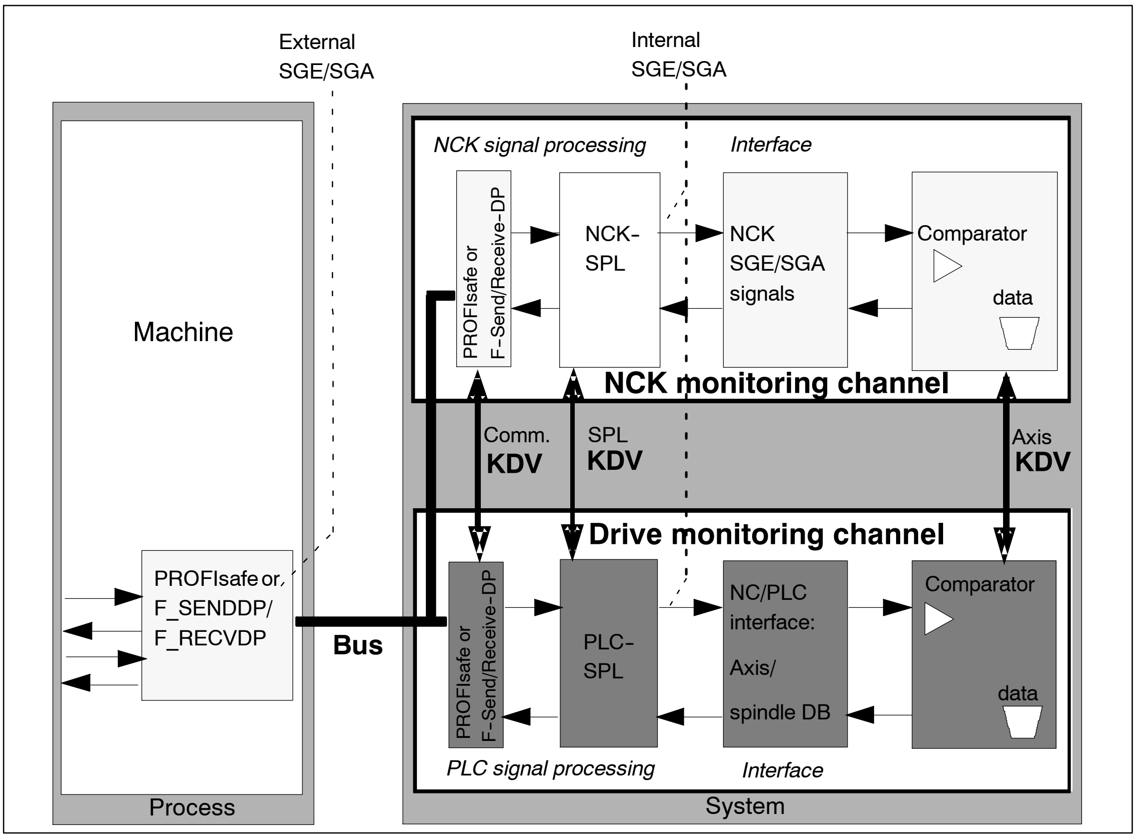


Fig. 7-32 Integrating the SPL into the complete system

Crosswise data comparison

Data is cyclically exchanged between the PLC and NCK to check the correct functioning of the two SPLs (PLC and NCK). Just the same as the comparison between the NCK and the drive, it cross-checks the signals that arrive at the SPL, the safety-related signals generated by the SPL as well as internal markers.

The discrepancy time for the crosswise data comparison of SPL variables is permanently set to 1 s (or 10 s $A_CMDSI).

The following signals are included in the crosswise data comparison between the NCK and the PLC:

Table 7-5 Signals for crosswise data comparison

NCK-SPL data	Signal image of the PLC data	PLC-SPL data (DB18)
$A_INSE[1 ... 64]	$A_INSEP[1...64]	DBX38.0 ... DBX45.7
$A_OUTSE[1 ... 64]	$A_OUTSEP[1...64]	DBX46.0 ... DBX53.7
$A_INSI[1 ... 64]	$A_INSIP[1...64]	DBX54.0 ... DBX61.7
$A_OUTSI[1 ... 64]	$A_OUTSIP[1...64]	DBX62.0 ... DBX69.7

Table 7-5 Signals for crosswise data comparison

NCK-SPL data	Signal image of the PLC data	PLC-SPL data (DB18)
$A_MARKERSI[1 ... 64]	$A_MARKERSIP[1...64]	DBX70.0 ... DBX77.7
$A_FSDP_ERR_REAC[1...3]	–	DBX190, DBX200, DBX210
$A_FRDP_SUBS[1...3]	–	DBX220, DBX232, DBX244
$A_FRDP_ERR_REAC[1...3]	–	DBX222, DBX234, DBX246
$MN_PREVENT_SYN-ACT_LOCK	–	
$MN_SAFE_SPL_STOP_MODE	–	
$MN_SAFE_SPL_USER_DATA	–	DBD256, DBD260, DBD264, DBD268

If a difference is detected between the signals of both channels, this is indicated using Alarm 27090 and the configured stop response (STOP D/E) is initiated if the SPL commissioning phase has been defined to have been completed.

If the user attempts to acknowledge the initiated alarms and stop responses, without having resolved the cause of the CDC error, then the stop response as well as the alarm are initiated again.

The criterion ”commissioning phase completed” is derived from the NCK-MD $MN_PREVENT_SYNACT_LOCK[0,1] in the NCK. If one of the two field entries is not equal to 0, ”commissioning phase completed” is set by CDC internally. On the PLC side, this criterion is entered using DB18.DBX36.0. If this bit is set to ”1”, then the commissioning phase is considered to have been completed. An SPL-CDC error results in a stop response only after the SPL commissioning phase has been completed.

The stop response for an SPL-CDC error is set in the NCK using NCK-MD $MN_SPL_STOP_MODE. If the MD value is 3, for an SPL-CDC error, a STOP D is initiated – for an MD value of 4, a STOP E is initiated. On the PLC side, this stop response is entered using DB18.DBX36.1. If this bit is set to ”1”, for an SPL-CDC error, a STOP E is initiated – otherwise a STOP D.

Any changes to data on the NCK and PLC side do not take effect until after power on.

Clearing the external SPL outputs for SPL system errors

If communication between NCK and PLC is interrupted with reference to the SPL-CDC, then all external SPL output signals ($A_OUTSE/$A_OUTSEP) are cleared with a 5 s delay.

This state occurs if data for crosswise data comparison is not exchanged between the NCK and PLC for one second. This is due to the fact that

- the one second limit of the user cycle limit in the PLC (OB1 cycle) was exceeded.
- a system error has occurred. The NCK or PLC system software no longer runs due to a system error – therefore interrupting communications.

Behavior of the NCK

The specified timer of 5 s is started if Alarm 27092 ”Communication interrupted for crosswise data comparison NCK-SPL, error detected by %1” is initiated. This is independent of which component (NCK or PLC) interrupted the alarm.

The system variable $A_STATSID, bit 29 = 1 is used to indicate to the SPL user that this timer has been started. This means that he has a possibility of initiating plant/system-specific actions before the system deletes (clears) the output.

After this time has expired, the system deletes the external SPL outputs. The status variable $A_STATSID, bit 29 remains set. When reading-back the external outputs in the NCK-SPL via the system variable $A_OUTSE, ”0” is read corresponding to the actual output status.

Behavior of the PLC

If, on the PLC side, it is detected that the communication timeout has been exceeded, then a timer is started with 5 s.

After this time has expired, the PLC goes into Stop (by calling an SFC46). This state can only be exited using a power on.

After the 5 s timer has expired, for diagnostics purposes, the PLC outputs Alarm 400253 ”PLC-STOP due to SPL system error”. At the same time, an entry with the same significance is located in the diagnostics buffer.

Using the status signal DB18.DBX119.5, the SPL programmer and the NCK is provided with the information that the timer was started. This means that he has the possibility of initiating system-specific actions before the PLC goes into the stop condition.

Note

In order to achieve the shortest possible response time, the system variable $A_STATSID, bit 29 and the status signal DB18.DBX119.5 must be evaluated in the SPL in order to bring, as far as possible, the SPL-SGA into a safe state (cleared SPL-SGA).

Supplementary conditions

The user must take into consideration the following points regarding the functioning of the crosswise data comparison:

- Both channels (NCK/PLC) must execute the same logic.

- Do not implement any response sequences or sequence controllers that are externally controlled using short input pulses. This is because short pulses of this type may only be sent and processed in one channel because of sampling effects.
- Unused inputs/outputs/markers of the SPL must be assigned the default value = 0; single-channel use of individual bits for non-safety relevant purposes is not permissible.
- External STOPs must be enabled (they are also used internally) and can be extracted from the SPL if required. The ”external STOP A” must be parameterized at the SPL interface for all safety axes using MD $MA_SAFE_EXT_STOP_INPUT[0]. If this condition is not fulfilled, then Alarm 27033 is output.
- Crosswise data comparison checks whether the ”commissioning phase” has been completed. If errors are detected in the crosswise data comparison, a ”STOP D/E” is triggered on the NCK and drive depending on this criterion. If the commissioning phase has not been completed after booting, Alarm 27095 ”SPL protection not activated” is repeatedly displayed (every 3 hours).
- In the case of a crosswise data comparison error, no system response is initiated regarding the SGE/SGA processed by the SPL. Users must implement this themselves. The only exception is when a system error is detected as was described above.

7.5.2 Synchronized actions for Safety Integrated

Motion-synchronizing actions (or ”synchronizing actions” for short) are instructions programmed by the user, which are evaluated in the interpolation cycle of the NCK in synchronization with the execution of the part program. If the condition programmed in the synchronized action is fulfilled (logical expression) or if none is specified, then actions assigned to the instruction are activated in synchronism with the remainder of the part program run.

Description

The number of programmable synchronized action blocks depends entirely on the configurable number of synchronized action elements. The number of storage elements for general motion-synchronizing actions (synchronizing action elements) is defined in machine data MD 28250: MM_NUM_SYNC_ELEMENTS.

The memory management is listed separately in order to be able to handle synchronized actions for SAFE.SPF independently.
Using MD 28251: $MC_MM_NUM_SAFE_SYNC_ELEMENTS is used to configure the memory for the safety synchronized action elements.
All modal synchronized actions that are programmed in the sub-program /_N_CST_DIR/_N_SAFE_SPF retrieve their elements from this memory area.

In order to determine the required for synchronized action elements, at the start and at the end of SAFE.SPF, system variables $AC_SAFE_SYNA_MEM can be read. The difference between these values is then the number of synchronized action elements required. This value plus a possible reserve must be entered into MD 28251: $MC_MM_NUM_SAFE_SYNC_ELEMENTS.

Reference: /FBSY/ Description of Functions, Synchronized Actions

7.5.3 User configurations

In order to provide users (machinery construction OEMs, SPL programmers), the option of being able to save various machine configurations in a protected way (e.g. regarding the I/O structure or the number of safety-related axes), data are defined in the NCK (MD) and PLC (DB 18) in which users can save such information. These data can be interrogated in order to execute different SPL instructions e.g. corresponding to the meaning.

These data have no function for the NCK and PLC (they are not interpreted any further by the NCK and PLC).

In this case, for the NCK, a general machine data field applies

MD 13312: $MN_SAFE_SPL_USER_DATA[0...3]

Users can save information in this MD that must be set the same as the corresponding data in DB 18 (DBD256, 260, 264, 268), e.g.

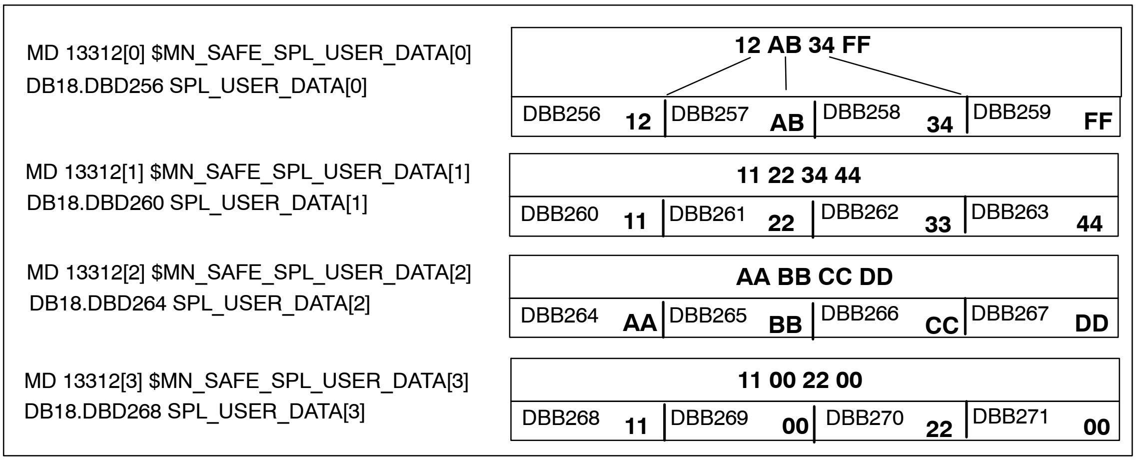


Fig. 7-33 Assignment between MD 13312 and data block DB18

Differences between the NCK and PLC data are identified using the SPL-CDC and result, corresponding to the parameterized stop response, in a STOP D/E on all safety-related axes. Alarm 27090 ”Error for crosswise Data comparison NCK-PLC” is output with a reference to the machine data.

Further, system variable $A_STATSID, bit 27 = 1 is used to indicate to the SPL user that there is an SPL-CDC error.

Changes to the machine data or DB 18 data are only effective after power on.

Changes to data are indicated using a corresponding alarm after restart.

7.5.4 NCK-SPL program

Description

The NCK-SPL program is written as an NC program (ASUB) with synchronized actions.

Characteristics

The NCK-SPL program has the following features:

- The program can be started manually with NC START during commissioning.
- The following applies once the program has been started:
  - The synchronous actions assigned an ID No. are cyclically executed in the IPO clock cycles (modal)
  - The synchronous actions assigned the keyword IDS remain active even after the operating mode has been changed or NC-STOP/NC RESET
  - In order to check the program, the status of the active synchronous actions (operating area "Machine", soft key "Synchronous actions") can be displayed.
  - The program can be modified during commissioning. It must then be restarted.
  - The NCK-SPL program is saved in the NCK path_N_CST_DIR as sub-routine "_N_SAFE_SPF" (HMI view: standard cycles/SAFE.SPF).
    Other sub-routine names are not permitted.
- The images of the PLC safety variables ($A_INSIP(D), $A_OUTSIP(D), $A_INSEP(D), $A_OUTSEP(D), $A_MARKERSIP(D)) are required for the simulation (on the NC side) of an SPL. These can be used to develop the SPL step-by-step. They can only be read by the NCK.

Protective mechanisms

- The synchronous action IDs used for the NCK-SPL are protected from being influenced by the PLC or other programs using MD $MN_PREVENT_SYNACT_LOCK. To activate the protection, the number range of the synchronous action IDs used in the SPL program must be entered into the two fields of machine data $MN_PREVENT_SYNACT_LOCK. It is then no longer possible to change these synchronous actions (CANCEL, LOCK have no effect) once _N_SAFE_SPF has been started.
- When changing the machine data $MN_PREVENT_SYNACT_LOCK[0,1] from zero to values not equal to zero, an option set for the SPL inputs and outputs and an SPL file under /_N_CST_DIR/_N_SAFE_SPF, then Alarm 27098 "SPL commissioning phase complete" is initiated. This can only be acknowledged with a power on and should be used as information for the user, that
  a) the SPL protective mechanisms (see Table 7-6) are activated
  b) a restart is necessary in order to activate these protective mechanisms.
- System variables $A_OUTSI, $A_OUTSID, $A_OUTSE, $A_OUTSED, $A_MARKERSI, $A_TIMERSI, $A_CMDSI, $A_FSDP_ERR_REAC, $A_FRDP_ERR_REAC and $A_FRDP_SUBS are protected from being written to by programs other than the NCK-SPL (/_N_CST_DIR/_N_SAFE_SPF). If an error occurs, Alarm 17070 "Channel %1 block %2 data item write-protected" is output.
- A reference checksum is calculated when booting by the NCK-SPL (/_N_CST_DIR/_N_SAFE_SPF) - it is entered into the program as a comment:

  Example: ; SAFE_CHECKSUM = 000476bbH
  The checksum is then cyclically re-calculated and compared with the reference checksum. If a deviation is detected, Alarm 27093 "Checksum error NCK-SPL, %1, %2, %3" is output.
- The system variables $A_INSIP(D), $A_OUTSIP(D), $A_INSEP(D), $A_OUTSEP(D) and $A_MARKERSIP(D) are only accessible during the commissioning phase.

If NCK-SPL execution is interrupted for any reason or the SI system variables are changed by another program, then this is detected by the cyclic crosswise data comparison with the PLC.

Table 7-6 Response to SPL errors

Event	MD 11500 $MN_PREVENT_ SYNACT_LOCK[m,n] equal to 0	MD 11500 $MN_PREVENT_ SYNACT_LOCK[m,n] not equal to 0
Crosswise data comparison NCK-PLC identifies an error	Alarm 27090 is triggered	Alarm 27090 is triggered and in addition, STOP D/E is triggered
SPL program file is to be changed (written, deleted, re-named, edited)	No response	Alarm 27093 is triggered

Warning

The protective mechanisms that prevent changes to the NCK-SPL file and the NCK-SPL instructions (statements) are only effective if MD $MN_PREVENT_SYNACT_LOCK[0,1] is not equal to 0.

The machine construction OEM must ensure that the protective mechanisms are activated no later than after the completion of the acceptance test and the values, set in MD $MN_PREVENT_SYNACT_LOCK[0,1] are documented in the acceptance report.

After commissioning has been completed, the access rights to the SAFE.SPF file must be set to the correct access level for writing/reading/deleting access operations (manufacturer or service).

As long as the protective mechanisms for the NCK-SPL have not been activated (MN_PREVENT_SYNACT_LOCK[0.1] equal to 0), Alarm 27095 is displayed when the crosswise data comparison between the NCK and the PLC starts. This alarm can be acknowledged with the NCK key so that the SPL can be commissioned.

Note

The SPL program must be addressed using upper case letters. Alarm 27097 is output if this is not observed.

7.5.5 Starting the SPL

The NCK-SPL is active after the control has booted, if at least

1. The functions SBH/SG and ”external STOPs” have been enabled for at least one axis using $MA_/$MD_SAFE_FUNCTION_ENABLE,
2. One of the NCK-SPL interfaces is used.
   This means that an axial SGE/SGA was parameterized at one of the SPL interfaces using its assignment MD.

In this case, the ”external STOP A” must be parameterized at the SPL interface for **all** of the axes that use Safety Integrated.

NCK-SPL (SAFE.SPF) can be started in three different ways:

- Start via Safety-PowerOn
- Start via PROG_EVENT
- Start via the PLC program

SPL start without axial safety enable

When the machine is being commissioned, it may be necessary to start SPL without enabling axis-specific safety-relevant functions.

It is therefore possible to handle general machine functions (hydraulics, Emergency Stop) before the axis is commissioned.
This is only possible in the commissioning state of the SPL ($MN_PREVENT_SYNACT_LOCK[0,1]==0 and DB18.DBX36.0==0).
This state is displayed when the SPL starts using Alarm 27095 "%1 SPL protection not activated".

If an attempt is made to start the SPL in the protective state (after commissioning has been completed) without the axial safety function having been activated, then Alarm 27096 is output. The SPL is started if the SPL-CDC is not activated.

Start via Safety-PowerOn

When the "Safety-PowerOn" function is activated, SAFE.SPF is automatically started when booting. The system starts even if alarms are present.
The function is activated by setting **Bit 5** (**Safety-PowerOn**) in machine data 20108: **$MC_PROG_EVENT_MASK**. A possible SAFE.SPF call in the PROG_EVENT.SPF can be removed.

It is only possible to work with a restricted language scope in order that SAFE.SPF can be started in spite of the fact that alarms are present. Access operations to the PLC or drives are not possible.
For commands, which are not included in the language scope, Alarm 15420 "Channel %1 %2 Instruction in the current mode not allowed" is output.

If it is required to change over an existing SAFE.SPF to the restricted language scope, then it is possible to proceed as follows:

- MD 20108: $MC_PROG_EVENT_MASK, Bit 5=0
- MD 10095: $MN_SAFE_MODE_MASK, Bit 2=1 (as a result, for SAFE.SPF, the reduced language scope is activated - also as result of the CALL call)
- Call SAFE.SPF in MDI (CALL "/_N_CST_DIR/_N_SAFE_SPF")
- SAFE.SPF is edited until the program can be executed without any alarms with the restricted language scope.
- MD $MC_PROG_EVENT_MASK, Bit 5=1; SAFE.SPF is called when booting and is executed error-free with the restricted language scope.

Example for SAFE.SPF

A simple example for SAFE.SPF will now be shown that is started using PROG_EVENT when the system boots and includes steady-state synchronous actions.

```
; File: SAFE.SPF
=============
```

```
; Definitions
DEFINE STOP_A_DISABLE AS $A_OUTSI[1]
DEFINE STOP_C_DISABLE AS $A_OUTSI[2]
DEFINE STOP_D_DISABLE AS $A_OUTSI[3]
;
DEFINE STOP_A_EXT AS $A_INSE[6]
DEFINE STOP_C_EXT AS $A_INSE[7]
DEFINE STOP_D_EXT AS $A_INSE[8]

DEFINE STOP_A_XT AS $A_INSE[9]
;
; Program section
N10 IDS=01 DO STOP_A_DISABLE=STOP_A_EXT
N20 IDS=02 DO $A_OUTSE[1]=NOT $A_OUTSE[1]
N30 M17
```

Starting the NCK-SPL from the PLC user program

Program start

The NCK-SPL can also be started from the PLC user program. As soon as the NCK-SPL has been started, the crosswise data comparison is activated in the system program (NCK and PLC basic program).
The NCK-SPL program must be started as an ASUB. To do this, the interrupt number and channel must first be assigned via FB4 using the ASUB (asynchronous sub-routine) function via parameter PIService=”PI.ASUB”.
As soon as FB4 has been successfully run (output parameter ”Done”=TRUE) the program is executed via FC9 ”ASUB” [asynchronous sub-routine].
In this case, MD 11602 **$MN_ASUP_START_MASK** is taken into account, which can be used to set that stop reasons for the sequence are ignored.
Deviating from the recommended setting 7H, the following settings are also possible:

- Bit 1 can be deleted, if MD 20700 $MN_REFP_NC_START_LOCK (in the channel in which the SPL is started) is deleted, or, if at the instant that the ASUB starts, the axes (in the channel, in which the SPL is started) must not be safely referenced, e.g. in the park state.
- Bit 2 can be deleted if no read-in disable is present when booting.

Further, MD 11604 $MN_ASUP_START_PRIO_LEVEL (interrupt priority from which the MD $MN_ASUP_START_MASK is active) must be observed.

Starting the PLC-SPL

The PLC-SPL in conjunction with FB4/FC9 has started if the FC9 has signaled successful execution and has displayed that the end of SAFE.SPF has been reached. This is displayed using a signal in SAFE.SPF (e.g. $A_PLCSIOUT variable, M function) or SPL status bit 13 (DB18.DBX137.5). Only then may the PLC-SPL be started to ensure that both SPLs run in synchronism and therefore the axial monitoring channels are synchronously supplied.

Parameterizing FB 4

FB4 may only be started in the cyclic mode (OB 1).

Table 7-7 Parameterizing FB 4

Signal	Type	Range of values	Meaning
Reg			
PIService	ANY	PI.ASUB	Assign interrupt
Unit	INT	1 to 10 [1]	Channel
WVar1	INT	[1]	Interrupt number
WVar2	INT	[1]	Priority
WVar3	INT	0/1 [0]	LIFTFAST
WVar4	INT	0/1 [0]	BLSYNC
Addr1	STRING	'/_N_CST_DIR/'	NCK-SPL path name
Addr2	STRING	'_N_SAFE_SPF'	NCK-SPL program name

[values in brackets are standard values required for the call]

Parameterizing FC 9

Table 7-8 Parameterizing FC9

Signal	Type	Type	Range of values	Remark
Start	I	Bool		
ChanNo	I	Int	1 to 10 [1]	No. of the NC channel
IntNo	I	Int	1 – 8 [1]	Interrupt No.
Active	O	Bool		1 = Active
Done	O	Bool		1 = ASUB completed
Error	O	Bool		

[values in brackets are standard values required for the call]

7.5.6 Language scope for SAFE.SPF

In order that no NC alarms are output when the SINUMERIK control boots, which prevent a started SAFE.SPF being completely executed, it is necessary to define a restricted language scope for SAFE.SPF. It is not permissible that commands are programmed which access the PLC or drives.

If a SAFE.SPF is tested or commissioned with a restricted language scope, then every Alarm 15189 ”Channel %1 Block %2 Error when executing SAFE.SPF” requires a power on. In order to prevent this, MD 10095: $MN_SAFE_MODE_MASK, bit 2 can be set to 1.

Now, the restricted language scope is active each time that SAFE.SPF is called using the command CALL<path name>. For instance, the call can be made from MDI or PROG_EVENT.SPF at reset. For commands, which are not included in the language scope, only Alarm 15420 ”Channel %1 Channel %2 Instruction in current mode not allowed” is output and not Alarm 15189. Alarm 15420 can be deleted with a reset.

In order to change over an existing SAFE.SPF to a restricted language scope, it is possible to proceed as follows for example:

- MD 20108: $MC_PROG_EVENT_MASK, Bit 5=0
- In the PROG_EVENT.SPF, remove the SAFE.SPF call from the PowerOn section or the SAFE.SPF call from the ASUB.
- MD 10095: $MN_SAFE_MODE_MASK, Bit 2=1
- SAFE.SPF is not called when the system boots
- SAFE.SPF is now called with CALL ”_N_CMA_DIR_/_N_SAFE_SPF” e.g. from MDI or PROG_EVENT at RESET. The restricted language scope is now active, alarms that occur can be deleted with RESET.
- SAFE.SPF is edited until the program can be executed without any alarms with the restricted language scope.
- MD $MC_PROG_EVENT_MASK, Bit 5=1
- MD 10095: $MN_SAFE_MODE_MASK, Bit 2=0
- SAFE.SPF is called when the system boots and with the restricted language scope is executed error-free.

Configuration

The function is activated using machine data 20108 $MC_PROG_EVENT_MASK, Bit 5=1. An existing SAFE.SPF call in a PROG_EVENT.SPF power on section or in an ASUB can be removed. If the function is active, then only the restricted language scope is possible in a SAFE.SPF. If the function is not active, then the complete language scope is permitted in a SAFE.SPF. If MD $MC_PROG_EVENT_MASK, Bit 5=0, then SAFE.SPF is not executed when the system boots and errors are present.

Table 7-9 Permissible language commands for SAFE.SPF

Block format	
Nxxx	;Block number
XYZ:	;Labels
/	;Skip, block skip
;	;Comment characters
	;Empty line
Beginning of the program	
PROC SAFE	;First operation in the program
Attributes, which are programmed in the PROC line	
SBLOF	;Single block skip
DISPLOF	;Skip, block display
ACTBLOCNO	;For DISPLOF, for an alarm output the number of the actual block
DISPLON	;Activate block display
SBLOF is always active, even if SBLOF is not programmed	
Variable definition	
DEF	;Creating DUDs
DEFINE	;Creating macros
Assignments	
Values are assigned to variables with an = character. The value being assigned can either be a constant or an algorithm If the value is a constant, the binary, hexadecimal or exponential notation is possible.	
'B0000001'	;Binary notation
'H3C7F'	;Hexadecimal notation
4.1EX-3	;Exponential notation
Fields can be assigned with	
REP	:Initialization with the same values
SET	;Initialization with value list
SETA	;Copying fields
Writing, i.e. the lefthand part of an assignment, is possible with these variables:	
LUD	
GUD	
R parameters	
$AC_PARAM[ ]	
$AC_MARKER[ ]	
$AA_ESR_TRIGGER	;Single axis, trigger ESR
$AC_ESR_TRIGGER	;Trigger ESR
$AN_ESR_TRIGGER	;Trigger ESR

Table 7-9 Permissible language commands for SAFE.SPF

all Synact GUDs	
Safety system variables that can be written to:	
$A_OUTSE[ ]	
$A_OUTSED[ ]	
$A_OUTSI[ ]	
$A_OUTSDI[ ]	
$A_MARKERSI[ ]	
$A_MARKERSID[ ]	
$A_TIMERSI[ ]	
$A_CMDSI[ ]	
$A_PLCSIOUT[ ]	
$A_FSDP_ERR_REAC[ ]	
$A_FRDP_SUBS[ ]	
$A_FRDP_ERR_REAC[ ]	
Reading the righthand part of an assignment is possible with all variables – i.e. also with all safety system variables.	
Arithmetic function	
+	;Addition
–	;Subtraction
*	;Multiplication
/	;Division
DIV	;Division, for variable type INT and REAL
MOD	;Modulo division
SIN( )	;Sine
COS( )	;Cosine
Tan( )	;Tangent
ASIN( )	;Arcsine
ACOS( )	;Arccosine
ATAN2( )	;Arctangent2
SQRT( )	;Square root
ABS( )	;Absolute value
POT( )	;2. power (square)
TRUNC( )	;Integral number part (truncate to integer)
ROUND( )	;Round to integer number
ROUNDUP( )	;Round up
LN( )	;Natural logarithm
EXP( )	;Exponential function
MINVAL( )	;Lower value of two variables

Table 7-9 Permissible language commands for SAFE.SPF

MAXVAL( )	;Larger value of two variables
BOUND( )	;Variable value within the defined value range
Predefined safety functions	
SIRELIN( )	;Assign input quantities
SIRELOUT( )	;Assign output quantities
SIRELTIME( )	;Assign times for timer
SIRELAY	;
Predefined functions and procedures	
ITOR( )	;Conversion, integer to real
ITOB( )	;Conversion, integer to Bool
RTOI( )	;Conversion, real to integer
RTOB( )	;Conversion, real to Bool
BTOI( )	;Conversion, Bool to integer
BTOR( )	;Conversion, Bool to real
SETAL( )	;Set alarm
MSG(<<)	;Output message with contents of variables
Program jumps	
GOTOB	;Jump instruction with jump destination towards ;the beginning of program
GOTOF( )	;Jump instruction with jump destination towards ;the end of program
GOTO	;Jump instruction with jump destination search. The ;search is first made towards the end of the program, then ;towards the beginning of the program.
GOTOC	;Same effect as for GOTO with the difference that Alarm ;14080 ”Jump designation not found” is suppressed.
An IF condition can be programmed in the block in front of the jump instruction.	
Program branch	
CASE(<expression>)	
OF <constant_1>	
GOTOF <jump designation_1> <constant_2>	
GOTOF<jump destination_2...>	
DEFAULT GOTOF <jump designation n>	
Program repetition	
REPEAT LableA P=n	;Repeat program section
REPEAT LableA LableB P=n	;Repeat program section
REPEATB LableA P=n	;Repeat block

Table 7-9 Permissible language commands for SAFE.SPF

Control structures	
IF, ELSE, ENDIF	;Program loop with alternative
LOOP, ENDLOOP	;Endless program loop
FOR, TO, ENDFOR	;Count loop
WHILE; ENDWHILE	;Program loop with condition at start of loop
REPEAT, UNTIL	;Program loop with condition at end of loop
Program flow	
STOPRE	; preprocessing stop
DELAYSTON	;Start of a stop delay area
DELAYSTOF	;End of a stop delay area
Relational operators	
<>, ==, >=, <, >, <=	
Bit-by-bit logic operator	
B_AND	
B_OR	
B_NOT	
B_XOR	
Logic operator	
AND	
OR	
EMERGENCY	
XOR	
For the logic operations, the following applies to the BOOL, CHAR, INT and REAL data types: 0 corresponds to FALSE; not equal to 0, corresponds to TRUE	
Synchronized action	
CANCEL	;Delete synchronized actions
IDS	;Static synchronized action ;A number range is not monitored
WHENEVER	;The action is cyclically executed in each ipo clock cycle ;as long as the condition is fulfilled.
WHEN	;As soon as the condition has been fulfilled, the ;action is executed once.
EVERY	;The action is activated once, if the condition is fulfilled. ;The action is executed again if the condition ;changes from the false state into the true state.
FROM	;If the condition has been fulfilled once, the action is ;executed cyclically in every interpolation clock cycle for ;as long as the synchronized action remains active.
DO	;Start of the action section

Table 7-9 Permissible language commands for SAFE.SPF

No subprograms, i.e. technology cycles can be called in the action section. No axes can be traversed and no auxiliary functions can be output. The following value assignments are possible: – R parameters – $AC_PARAM[ ] – $AC_MARKER[ ] – all Synact GUDs – all safety system variables that can be written to and G functions	
G function	
G70	;Metric dimensions (group 13)
G71	;Inch dimensions (group 13)
G700	;Metric dimensions also F (group 13)
G710	;Inch dimensions also F (group 13)
G04 F	;Dwell time (group 2)
End of program	
ENDPROC	;End line of program with start line PROC
RET	;without output to the PLC ;The RET command can now also be programmed ;without parameter in a main program.
M17	;No output to the PLC
M02	;No output to the PLC
M30	;No output to the PLC

Note

All language commands, which are not listed in this table, result in NC alarms 15189 ”Channel %1 Block %2 Error when executing SAFE.SPF” and 15420 ”Channel %1 Block %2 Instruction in current mode not allowed”.

Additional information on the complete NCK language scope can be found under:

References: Programming Manual Fundamentals, Chapter 16 ”Tables”.

7.5.7 Diagnostics/commissioning

The system variables $A_INSIP(D), $A_OUTSIP(D), $A_INSEP(D) and $A_OUTSEP(D), and $A_MARKERSIP(D) are only used for diagnostics and commissioning the NCK–SPL. These system variables represent the input data for crosswise data comparison on the PLC side. They are updated every IPO cycle. They can also be used to access the CDC on the PLC side from the NC. This helps when commissioning the SPL:

- Crosswise data comparison function can be temporarily bypassed
- NCK-SPL can be simulated to the process and to the NCK monitoring channel To do this, the relevant PLC images are written to the variables $A_OUTSED and $A_OUTSID as long as there is no NCK-SPL. This means that the NCK-SPL can be commissioned step-by-step. This data may only be accessed during the commissioning phase.

In order to allow the SPL to be commissioned without the crosswise data comparison function constantly responding, the following "minimum NCK-SPL" can be installed in this phase:

```
; Simulate external SPL interface
IDS = 03 DO $A_OUTSED[1]     =  $A_OUTSEPD[1]
IDS = 04 DO $A_OUTSED[2]     =  $A_OUTSEPD[2]
; Simulate internal SPL interface
IDS = 07 DO $A_OUTSID[1]     =  $A_OUTSIPD[1]
IDS = 08 DO $A_OUTSID[2]     =  $A_OUTSIPD[2]
; Emulate PLC markers (for all markers used in the PLC)
IDS = 09 DO $A_MARKERSID[1]  =  $A_MARKERSIPD[1]
IDS = 10 DO $A_MARKERSID[2]  =  $A_MARKERSIPD[2]
; End of program
M17
```

These instructions simulate the output interfaces of the NCK-SPL and therefore "short-circuit" the crosswise data comparison.

Warning

The logic used in this phase has a single channel structure and is therefore not safe!

The described minimum NCK-SPL must be replaced by a full NCK-SPL without any access to $A_INSIP(D), ..., $A_MARKERSIP(D) when the PLC side is completed!

Additional diagnostic support:

- $A_STATSID: A value not equal to 0 means that an error has occurred in the crosswise data comparison. The error numbers are selected in the same way as on the PLC side (see Chapter 7.5.11).
- $A_CMDSI[n]: n=1: 10x change timer value for long forced checking procedure pulses and/or single-channel test stop logic.
- $A_LEVELSID: Indicates how many signals have different signal levels on the NCK and PLC sides that can be presently detected.
- In addition, other NC variables or free R parameters can be written to monitor internal states of the SPL.

The following applies to all system variables of the NCK-SPL outputs:
They can be written from and read back to the SPL program.

7.5.8 Safe software relay

The standard SPL block ”safety software relay” is designed to meet the requirements of an Emergency Stop function with safe programmable logic. However, it can also be used to implement other similar safety functions, e.g. to control a protective door.

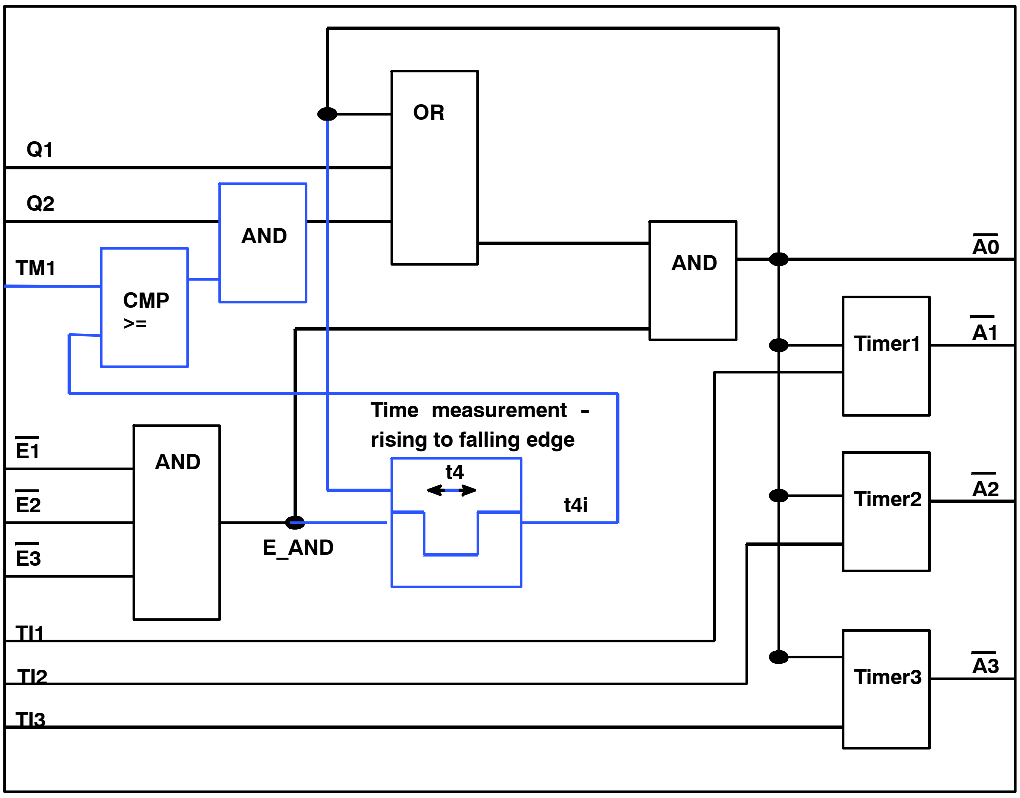


Fig. 7-34 Function diagram of the ”safety relay”

The description is provided in the following:

Three shutdown inputs E1 to E3	If one of these inputs is set to 0, direct output A0 is set to 0. Outputs A1 toA3 switch with the delay of timer 1–3. If one of these inputs is not used, then it is internally set to ”1” as static signal. One of these inputs must also be used to initiate test operation of the safety relay (forced checking procedure).

Two acknowledge inputs Q1 and Q2	Q1 must be supplied with the signal from the real acknowledge button. Q2 is only used for the forced checking procedure. The software relay itself does not have to be subject to a forced checking procedure. However, if the Emergency Stop function is executed and if external actuators have to be subject to a forced checking procedure, if the relay drops-out during the Emergency Stop test, then it can be acknowledged using Q2 (in a defined time window, refer to TM1). This input must also be connected with a safety system variable (even if the signal is not used) – preferably with a $A_MARKERSI – in order to detect that this acknowledge signal is available as steady-state signal in the crosswise data comparison with the PLC. The associated comparison data in the PLC must have a steady-state 0 signal level (error detection using different states of the particular SPL marker for the PLC and NCK).
Three timer initialization values TI1 to TI3	The times after which outputs A1 to A3 are switched to 0 at a negative edge in output signal A0 are defined here.
One timer limit value TM1	Defines the maximum time that the shutdown inputs E1 to E3 may have been at a 0 signal level so that they can still be acknowledged using Q2. Q2 should only be used for the internal safety relay test. It is not permissible that Q2 is used to acknowledge a ”real” shutdown.
Four output values A0 to A3	A0 supplies the result of ANDing E1 to E3 without any delay. Outputs A1 to A3 supply the same result for positive edges of A0; for negative edges, the results are delayed by the timer initialization TI1 to TI3 (switch-out delay). A0 to A3 do not produce a result after booting until an acknowledgment has been received via Q1.

Initialization in the part program

The connections for the function block are defined when initialized. The input and output quantities of the function block are assigned to the required system variables ($A_MARKERSI, $A_INSE, $A_OUTSE,...). The following functions must be called:

SIRELIN: This language command assigns the input quantities Q1, Q2, E1, E2 and E3 to the safety relay x (x = 1..4). The return value contains the number of the first incorrect parameter; a value of 0 indicates that the parameter assignment is correct.

Syntax: SIRELIN(x,status,”Q1”,”Q2”,”E1”,”E2”,”E3”)

The transfer parameters Q1 to E3 are strings and must therefore be entered in quotation marks (” ”). The following system variables are permissible as input quantities:
$A_MARKERSI[ ]
$A_INSE[ ]
$A_INSI[ ]
$A_OUTSE[ ]
$A_OUTSI[ ]

E2 and E3 are optional. If these parameters are not entered, the relevant inputs are set to ”1” (static signal).

SIRELOUT: This language command assigns the output quantities A0, A1, A2 and A3 to safety relay x (x = 1..4). The return value ”status” contains the number of the first incorrect parameter; a value of 0 indicates that the parameter assignment is correct.

Syntax: SIRELOUT(x,status,”A0”,”A1”,”A2”,A3”)

The transfer parameters A0 to A3 are strings and must therefore be entered in quotation marks (” ”). The following system variables are permissible as output quantities:
$A_MARKERSI[ ]
$A_OUTSE[ ]
$A_OUTSI[ ]
$A_PLCSIOUT[ ]

A1 to A3 are optional. If these parameters are not specified, then the corresponding outputs are not supplied. However, if A1 is specified, the initialization value for timer 1 (TI1) must also be parameterized via SIRELTIME. The same applies for A2 and timer 2 (TI2) and A3 and timer 3 (T!3).

SIRELTIME: This language command assigns the times – for the timers required – to safety relay x (x = 1..4). These include the timer limit value TM1 and the timer initialization values TI1, TI2 and TI3. The return value contains the number of the first incorrect parameter; a value of 0 indicates that the parameter assignment is correct.

Syntax: SIRELTIME(x,status,TM1,TI1,TI2,TI3)

Transfer parameters TM1 to TI3 are REAL numbers (timers in seconds). TI1 to TI3 are optional. If these parameters are not specified, the corresponding outputs A1 to A3 are not supplied. However, if TI1 is specified, output A1 must also be parameterized via SIRELOUT. The same applies for TI2 and A2 and TI3 and A3.

Note

- The initialization language commands must be directly included in the part program (e.g. SAFE.SPF); they may not be used in synchronized actions! If this condition is violated, Alarm 12571, "Channel 1 Block %2 %3 not permitted in motion synchronizing action" is triggered.
- As described above, there is an interdependency between the number of the optional parameters for the language commands SIRELTIME and SIRELOUT. This interdependency is checked in the language command that comes later in the part program sequence. If, for example, A2 is no longer parameterized in SIRELOUT, but TI2 is specified in SIRELTIME, then this parameter is identified as being incorrect!

Cyclic sequence

The correctly timed call in the SPL is made using the language command SIRELAY. A calling parameter is not required in the cyclic section except to select the desired relay x (x = 1..4). Initialization must be carried out beforehand. If this is not correctly done, then this is indicated in the return value of the language command SIRELAY. The cyclic section must be integrated in the synchronized actions of the SPL.

Syntax: status = SIRELAY(x)

The "status" variable must be defined as integer to correctly map the possible return values of the function block.

The following values are possible for status:

Return value status	Meaning
1	The input quantity of the safety relay is either not parameterized or not correctly parameterized. Remedy: Call SIRELIN with the correct parameterization
2	The output quantities of the safety relay are either not parameterized or not correctly parameterized. Remedy: Call SIRELOUT with the correct parameterization
3	The input and output quantities of the safety relay are either not parameterized or not correctly parameterized. Remedy: Call SIRELIN and SIRELOUT with the correct parameterization
4	The timers of the safety relay are either not parameterized or not correctly parameterized. Remedy: Call SIRELTIME with the correct parameterization
5	The input quantities and timers of the safety relay are either not parameterized or not correctly parameterized. Remedy: Call SIRELIN and SIRELTIME with the correct parameterization

Return value status	Meaning
6	The output quantities of the safety relay are either not parameterized or not correctly parameterized. Remedy: Call SIRELOUT and SIRELTIME with the correct paramete-rization
7	The initialization of the safety relay was either not carried out or not correctly carried out. Remedy: Call SIRELIN, SIRELOUT and SIRELTIME with the correct parameterization

Note

1. The SIRELAY call must be made in the NCK-SPL (program SAFE.SPF), since the allocation of the output quantities corresponds to the write access operations to safety system variables. If the call comes from a different program, Alarm 17070 "Channel %1 Block %2 Data write-protected" is output.
2. The SIRELAY call must be included in a synchronized action. If this condition is violated, Alarm 14091, "Channel %1 Block %2 function not permitted, Index: 6" is output.
3. If parameter x contains a value that lies outside the range 1 to 4, Alarm 20149 "Channel %1 Block %2 Motion synchronous action: Invalid index" is output.

Forced checking procedure

When the safety relay is tested, acknowledge input Q2 and one of the three disable inputs (E1, E2 or E3) must be used. Q2 must be connected to a safety marker ($A_MARKERSI[ ]) and may only be briefly set (< 1s) to 1.

One of the three inputs E1 to E3 can be used (e.g. from the PLC) with a short falling edge to check that the safety relay has dropped out. The 0 signal level may not be present for longer than the time parameterized in TM1. The maximum value for TM1 is 1s, as otherwise the crosswise data comparison between NCK and PLC-SPL would detect an error.

Acknowledge input Q2 can only be used if the measured time t4 is shorter than TM1. This prevents a queued shutdown operation being acknowledged externally via the test acknowledge input. If A0 is 1 at the time of the falling edge of E_AND (= ANDing of E1, E2 and E3), time t4i (see Fig. 7-34) is allocated the measured time t4. For additional measurements, while A0 remains at 0, t4i is only re-saved if the measured time t4 is greater than the old value of t4i.

Supplementary conditions

The language commands SIRELIN, SIRELOUT and SIRELTIME may not be used in synchronized actions.

The language command SIRELAY may only be used in synchronized actions of the SPL (SAFE.SPF). The connection must be specified beforehand using the language commands SIRELIN, SIRELOUT and SIRELTIME.

Example

Example of an Emergency Stop implemented using NCK-SPL in SAFE.SPF:

```
DEF          INT RESULT_IN, RESULT_OUT, RESULT_TIME

N10 DEFINE IE_NH_E            AS $A_INSE[1]
N20 DEFINE IE_NH_Q            AS $A_INSE[2]
N30 DEFINE MI_NH_Q            AS $A_MARKERSI[1]
N40 DEFINE MI_C_ABW           AS $A_MARKERSI[2]
N50 DEFINE MI_A_ABW_A         AS $A_MARKERSI[3]
N60 DEFINE MI_A_ABW_S         AS $A_MARKERSI[4]
N70 DEFINE M_STATUS_1         AS $AC_MARKER[1]
;-------------------------------------------------------------------
N200 SIRELIN(1,RESULT_IN,"IE_NH_Q","MI_NH_Q","IE_NH_E")
N210 SIRELOUT(1,RESULT_OUT,"MI_C_ABW","MI_A_ABW_A","MI_A_ABW_S")
N220 SIRELTIME(1,RESULT_TIME,0.4, 2.2, 3.5)
;-------------------------------------------------------------------
N300 IDS=10 DO M_STATUS_1 = SIRELAY(1)
--------------------Error handling-----------------------------
N310 IDS=11 EVERY M_STATUS_1 < > DO . . . . . .
```

FUNCTION_BLOCK FB 10

Declaration of the function

```
VAR_INPUT
    In1 : BOOL := True ;              //   Input 1
    In2 : BOOL := True ;              //   Input 2
    In3 : BOOL := True ;              //   Input 3
    Ackn1 : BOOL;                     //   Ackn1 signal
    Ackn2 : BOOL;                     //   Ackn2 signal
    TimeValue1 : TIME := T#0ms ;      //   TimeValue for Output 1
    TimeValue2 : TIME := T#0ms ;      //   TimeValue for Output 2
    TimeValue3 : TIME := T#0ms ;      //   TimeValue for Output 3
END_VAR

VAR_OUTPUT
    Out0 : BOOL;                      //   Output without Delay
    Out1 : BOOL;                      //   Delayed Output to False by Timer 1
    Out2 : BOOL;                      //   Delayed Output to False by Timer 2
    Out3 : BOOL;                      //   Delayed Output to False by Timer 3
```

```
END_VAR

VAR_INOUT
      FirstRun: BOOL;                    //    True by User after 1st start of SPL
END_VAR
```

The following table shows all formal parameters of the SI relay function:

Signal	Type	Type	Remark
In1	I	BOOL	Input 1
In2	I	BOOL	Input 2
In3	I	BOOL	Input 3
Ackn1	I	BOOL	Acknowledge input 1
Ackn2	I	BOOL	Acknowledge input 2
TimeValue1	I	TIME	Value 1 for switch-off delay
TimeValue2	I	TIME	Value 2 for switch-off delay
TimeValue3	I	TIME	Value 3 for switch-off delay
Out0	O	BOOL	Output, instantaneous (no delay)
Out1	O	BOOL	Output, delayed by TimeValue1
Out2	O	BOOL	Output, delayed by TimeValue2
Out3	O	BOOL	Output, delayed by TimeValue3
FirstRun	I/O	BOOL	Activation of the basic setting

Parameter FirstRun must be switched to the value TRUE via a retentive data (memory bit, bit in the data block) at the first run-through after the control has booted. This data can be preset, e.g. in OB 100. The parameter is reset to FALSE when FB 10 is executed for the first time. Separate data must be used for parameter FirstRun for each call with separate instance.

Note

The block must be called once by the user program (per SI relay) cyclically in the OB1 cycle from when the SPL program starts. The user must provide an instance DB with any number for this purpose. The call is multi-instance-capable.

7.5.9 System variables for SINUMERIK 840D sl

The following system variables can only be used in combination with SINUMERIK Safety Integrated. They are used when programming the safe programmable logic (SPL).

Also see Chapter 8.7.2 ”Description of the system variables” for a detailed description of the system variables.

Table 7-10 Overview of system variables

System variables	Meaning	Range of values	Data type	Possible access for			
				Part program		Synchr. action	
				r	w	r	w
Actual position							
$VA_IS[axis]	Safe actual position for Safety Integrated		DOUBLE	x		x	
$AA_IM[axis]	Actual position of the closed-loop control		DOUBLE	x		x	
$VA_IM[axis]	Encoder actual value in the machine coordinate system		DOUBLE	x		x	
Error status							
$A_XFAULTSI	In the crosswise data comparison between NCK and drive of any axis, an actual-value error has been detected		INT	x		x	
$VA_XFAULTSI [axis name]	The crosswise data comparison for this axis between NCK and drive has detected an actual value error		INT	x		x	
$VA_STOPSI	Current Safety Integrated stop of the relevant axis		INT	x		x	
$A_STOPESI	Current Safety Integrated STOP E for any axis		INT	x		x	
Internal SPL inputs/outputs							
$A_INSI[n]	NCK input	n = 1, 2, ... 64 stand for the No. of the input	BOOL	x		x	
$A_INSID[n]	NCK inputs	n = 1,2	INT	x		x	
$A_INSIP[n]	Image, PLC input	n = 1,2, ...64	BOOL	x		x	
$A_INSIPD[n]	Image of the PLC inputs	n = 1,2	INT	x		x	

Table 7-10 Overview of system variables

				r	w	r	w
$A_OUTSI[n]	NCK output	n = 1, 2, ... 64 stand for the No. of the output	BOOL	x	x	x	x
$A_OUTSID[n]	NCK outputs	n = 1,2	INT	x	x	x	x
$A_OUTSIP[n]	Image, PLC output	n = 1, 2, ... 64	BOOL	x		x	
$A_OUTSIPD[n]	Image of the PLC outputs	n = 1,2	INT	x		x	
External SPL inputs/outputs							
$A_INSE[n]	NCK input	n = 1, 2, ... 64 stand for the No. of the input	BOOL	x		x	
$A_INSED[n]	NCK inputs	n = 1,2	INT	x		x	
$A_INSEP[n]	Image of PLC input	n = 1, 2, ... 64 stand for the No. of the input	BOOL	x		x	
$A_INSEPD[n]	Image of the PLC inputs	n = 1,2	INT	x		x	
$A_OUTSE[n]	NCK output	n = 1, 2, ... 64 stand for the No. of the output	BOOL	x	x	x	x
$A_OUTSED[n]	NCK outputs	n = 1,2	INT	x	x	x	x
$A_OUTSEP[n]	Image of a PLC output	n = 1, 2, ... 64 stand for the No. of the output	BOOL	x		x	
$A_OUTSEPD[n]	Image of the PLC outputs	n = 1,2	INT	x		x	
SPL markers and timers							
$A_MARKERSI[n]	Markers	n = 1, 2, ... 64 stands for the No. of the marker	BOOL	x	x	x	x
$A_MARKERSID[n]	Markers	n = 1, 2	INT	x	x	x	x
$A_MARKERSIP[n]	Image of the PLC markers	n = 1,2, ...64	BOOL	x		x	
$A_MARKERSIPD[n]	Image of the PLC markers	n = 1, 2	INT	x		x	
$A_TIMERSI[n]	Timer	n = 1, 2...16 stand for the No. of the timer	REAL	x	x	x	x
F_SENDDP							
$A_FSDP_ERR_REAC[n]	Response when a communication error occurs	n = 1, 2, 3	INT	x	x	x	x

Table 7-10 Overview of system variables

				r	w	r	w
$A_FSDP_ERROR[n]	There is a communication error	n = 1, 2, 3	BOOL	x		x	
$A_FSDP_SUBS_ON[n]	Substitute values are output to the application at F_RECVDP (receiver)	n = 1, 2, 3	BOOL	x		x	
$A_FSDP_DIAG[n]	The cause of the communication error determined by F_SENDDP is communicated	n = 1, 2, 3	INT	x		x	
F_RECVDP							
$A_FRDP_SUBS[n]	The substitute values, which are output to the SPL in certain states, are entered	n = 1, 2, 3	INT	x	x	x	x
$A_FRDP_ERR_REAC[n]	Response when a communication error occurs	n = 1, 2, 3	INT	x	x	x	x
$A_FRDP_ERROR[n]	There is a communication error	n = 1, 2, 3	BOOL	x		x	
$A_FRDP_SUBS_ON[n]	Substitute values are output to the application	n = 1, 2, 3	BOOL	x		x	
$A_FRDP_ACK_REQ[n]	Error-free F telegrams are again cyclically exchanged after a communication error	n = 1, 2, 3	BOOL	x		x	
$A_FRDP_DIAG[n]	The cause of the communication error determined by F_RECVDP is communicated	n = 1, 2, 3	INT	x		x	
$A_FRDP_SENDMODE[n]	Actual operating mode of the F-CPU of the F_SENDDP communication partner	n = 1, 2, 3	BOOL	x		x	
Miscellaneous							
$A_STATSID	Crosswise data comparison error triggered if the value is not equal to 0	Bits 0...27 CDC error in the I/O signals or markers Bit 28 CDC error ”SPL protection status” Bit 29 timeout in the communications between NCK and SPL Bit 30 PLC signals a stop to the NCK	INT	x		x	

Table 7-10 Overview of system variables

				r	w	r	w
$A_CMDSI	10x change timer value for long forced checking procedure pulses and/or single-channel test stop logic	Bit 0 = 1 10x time active	BOOL	x	x	x	x
$A_LEVELSID	CDC stack level display: Number of signals for which NCK and PLC detect different signal levels	0...320	INT	x		x	
$A_PLCSIIN	Single-channel communication between NCK and PLC SPL		BOOL	x		x	
$A_PLCSIOUT	Single-channel communication between NCK and PLC SPL		BOOL	x	x	x	x
$AC_SAFE_SYNA_MEM	Free safety synchronizing elements	[0,MAX_INT]		x		x	
Note: r –> read, w -> write							

7.5.10 Behavior after power on / mode change / reset

1. After the system has booted, the following Safety Integrated system variables are assigned the value zero:

   $A_INSE(D), not for F_DP communication
   $A_OUTSE(D),
   $A_OUTSI(D),
   $A_MARKERSI(D),
   $A_INSEP(D), not for F_DP communication
   $A_OUTSEP(D),
   $A_OUTSIP(D),
   $A_MARKERSIP(D)
   $A_INSI(D).

2. Pre-assignment of other variables before cyclic processing of the NCK-SPL starts can be programmed in the same part program as the NCK-SPL itself. To ensure that the pre-assignment instructions are only performed once, they must use the following syntax:

   IDS=<No.> WHEN TRUE DO<Boot instructions>

   As a result of the identifier IDS, the events "operating mode change" and "reset" have no effect on the processing of the NCK-SPL.

3. Several boot instructions can be programmed in one block.

4. For the relevant FDP system variables, see Chapter 7.4.8 "Boot behavior of the F_DP communication" and the following.

7.5.11 SPL data on the PLC side

The safe programmable logic of the PLC (PLC–SPL) is a sub–function of the safety functions integrated in the SINUMERIK.

Signals

The PLC–SPL signals are in DB18 and are sub–divided into

1. Parameterization part, and
2. Data area/status.

Parameterization part

SPL_READY:
The SPL_READY = TRUE signal indicates that the commissioning phase has been completed, i.e. if a CDC error has occurred, the basic program sends a ”STOP D/E” to all the axes.

STOP_MODE:
For crosswise comparison error:
0 = external STOP D
1 = external STOP E
to the drive

Data area/status

SPL_DATA
The useful (net) data for the PLC–SPL is contained in the SPL_DATA structure. The useful data area is sub–divided into internal inputs/outputs and marker areas and external inputs/outputs that correspond to the hardware I/Os.
With the appropriate parameterization for external inputs/outputs, the basic program transfers the input image of the I/Os to the external inputs in DB 18 and from the external outputs in DB 18 to the output.

SPL_DELTA
The SPL_DELTA area is used for diagnostics. A signal with the status TRUE in this area means that the signal is different in the NCK and PLC at this bit position.

CMDSI
Signal CMDSI can be used to extend the timeout value in the crosswise SPL data comparison by a factor of 10. This extension is used for long forced checking procedure pulses or single–channel test stop logic functions.

STATSI
A CDC error is indicated in STATSI. STATSI contains the number of the signal whose signal difference caused this CDC error. The error number (1…320) refers to SPL_DATA as an array with 5x64=320 signals.

LEVELSI
The signal LEVELSI is used for diagnostics and indicates how many signals with different signal levels are present.

COMM_TO
If communication between NCK and PLC regarding the SPL-CDC is interrupted, then the PLC is switched into the STOP state with a delay of 5 s. Status signal DB18.DBB119, bit 5 is used to inform the SPL programmer that the 5 s timer was started. This means that it is possible to initiate system-specific actions before the PLC goes into the stop condition.

SPL status signals for SPL_STATUS (DB18.DBB136)
For a detailed description, see Chapter 8.6.3 ”PLC data bock (DB 18)”.

INSEP_PROFISAFE (DB18.DBB138)
Bit array INSEP_PROFISAFE[1...8] is used to indicate which INSEP bytes are only assigned to PROFIsafe components.
0 = no PROFIsafe components are assigned to INSEP[1...8]
1 = PROFIsafe component transferred to INSEP[1...8] by the basic program

OUTSEP_PROFISAFE (DB18.DBB140)
Bit array OUTSEP_PROFISAFE[1...8] is used to indicate which OUTSEP bytes are only assigned to PROFIsafe components.
0 = no PROFIsafe components are assigned to OUTSEP[1...8]
1 = transfer from OUTSEP [1..8] to PROFIsafe components using the basic program

7.5.12 Direct communications between NCK and PLC-SPL

In SPL applications, a certain degree of single-channel communications between the two SPLs (NCK and PLC) is always required in addition to safety-related switching elements being connected through two channels. Testing external stops and the Emergency Stop acknowledgment are typical applications.

In order to be able to exchange single-channel SI-specific signals between the NCK and PLC in a dedicated data area, a corresponding communication interface exists between these components. The meaning of the individual bits in this interface are defined by the user.

NCK	PLC	
$A_PLCSIOUT[1...32]	DB18.DBD128	32 bits from the NCK to PLC
$A_PLCSIIN[1...32]	DB18.DBD132	32 bits from the PLC to NCK

Supplementary conditions

System variables $A_PLCSIOUT[1...32] and $A_PLCSIIN[1...32] are protected so that they cannot be accessed from other programs, except the NCK-SPL program (SAFE.SPF). A corresponding programming command is rejected with the alarm 17070 "Channel %1 block %2 Data write-protected".

7.6 Safe Brake Test (SBT)

7.6.1 Applications

When the drives are powered-down axes and mechanical systems can drop as a result of gravity. The mechanical braking system test should be used for all axes which must be prevented from moving in an uncontrolled manner by a holding brake. This test function is primarily intended for so-called ”vertical axes”.

The functionality is based on ”travel to fixed stop” (FXS). The travel to fixed stop can be individually parameterized to test the function of the mechanical braking system. It is activated and deselected from the PLC. For further details on travel to fixed stop, see /FB1/, F1.

The machine manufacturer can use his PLC user program to close the brake at a suitable instant in time (nominal value every 8h, see Chapter 1.6.1 ”Information Sheets of the Employer's Liability Insurance Association”) and to initiate that the drive produces an additional force in addition to the weight of the axis. In an error/ faultfree state, the brake can produce the necessary braking torque / the necessary braking force, i.e. the axis hardly moves.
When an error/fault occurs, the actual position value exits the parameterizable monitoring window. This prevents an axis from possibly sagging. The function test of the brake mechanical system is negatively acknowledged.

The brake test must always be started when the axis is at a standstill. The direction in which the drive produces its torque / its force is specified by the PLC using a ”traversing motion” via FC 18. The direction of travel should be selected so that the motor applies force in the direction of the already existing force due to weight as a result of the load. The target of this motion must be able to be reached without any danger (no collision, sufficient distance to the end stops), if the brake cannot provide the necessary torque / force.

7.6.2 Parameterization

The user can use the following axial NCK machine data to parameterize the function test of the mechanical braking system:

Machine data	Description
MD 37000: $MA_FIXED_STOP_MODE	Enable brake test
MD 37030: $MA_FIXED_STOP_THRESHOLD	Threshold for fixed stop detection
MD 36966 $MA_SAFE_BRAKETEST_TORQUE	Enters the test torque

Machine data	Description
MD 36967: $MA_SAFE_BRAKETEST_POS_TOL	Position tolerance, brake test
MD 36968: $MA_SAFE_BRAKETEST_CONTROL	**Bit 0 = 0:** As average value of the torque limiting, drive parameter p1532: ”Torque limit offset” is used **Bit 0 = 1:** The measured torque at the instant in time that the brake test is selected is used as the average value of the torque limit

MD 37000 $MA_FIXED_STOP_MODE: Travel to fixed stop mode

The function test of the mechanical braking system is enabled by setting bit 1 in MD 37000 $MA_FIXED_STOP_MODE. If the user needs to travel to a fixed stop with this axis from the part program, bit 0 can also be set. It is internally monitored to check that only one type of travel to fixed stop is active at a time. In the case of an error, Alarm 20092, ”Axis % Travel to fixed stop still active” is issued.

MD 37030 $MA_FIXED_STOP_THRESHOLD: Threshold for fixed stop reached

The contour deviation that is determined is always used in the brake test to detect that the fixed stop has been reached. The parameterization in MD 37040 $MA_FIXED_STOP_BY_SENSOR is therefore irrelevant. The required threshold value must be set in MD 37030 $MA_FIXED_STOP_THRESHOLD. This means that the traversing distance from the PLC via FC 18 must be greater than this threshold value.

If the travel distance that is entered is too short, after the end position is reached on the setpoint side, Alarm 20096 ”Axis %1 brake test aborted, additional information %2” is output. The supplementary info contains the value 2 ”End position reached, motion stopped”.

MD 36966 $MA_SAFE_BRAKETEST_TORQUE: Holding torque, brake test

The machine manufacturer must parameterize the required brake test torque as percentage in the axial MD 36966 $MA_SAFE_BRAKETEST_TORQUE. The magnitude of the torque to be configured is orientated to the maximum holding force of the brake, according to the data sheet, that should be checked. Internally, this is used to calculate the drive torque that is required in addition to the weight of the axis to load the brake. The drive torque to load the holding brake is limited to the maximum motor torque if the desired test torque would require a higher drive torque.
Value for MD 36966 = (test torque of the brake / p2003) * 100
The value from $MA_SAFE_BRAKETEST_TORQUE refers to the reference torque or the reference force from drive parameter p2003, whose image is saved in $MA_SAFE_BRAKETEST_TORQUE_NORM.
The magnitude of the torque to be configured is orientated to the maximum holding force of the brake to be tested.

Incorrect parameterization in MD $MA_SAFE_BRAKETEST_TORQUE could mean that the drive with reduced torque cannot even apply the required holding torque. These parameter assignments are detected when the brake test is selected and results in Alarm 20095 ”Axis %1 inadmissible holding torque %2”.

MD 36967 $MA_SAFE_BRAKETEST_POS_TOL: Position tolerance, brake test

The monitoring window for the maximum permissible movement during the brake test is defined in the axial MD 36967 $MA_SAFE_BRAKETEST_POS_TOL. The PLC actively monitors this position window – from the start of the brake test and not only when it has been detected that the fixed stop has been reached. This is a difference when compared to activating the traversing to the fixed stop function from the part program.

MD 36968 $MA_SAFE_BRAKETEST_CONTROL: Sequence check for the brake test

Principally, the automatic determination of the load torque available using MD 36998 $MA_SAFE_BRAKETEST_CONTROL, bit 0 = 1 is preferred. This is because over the complete traversing path of a suspended axis the torque situation continually changes to some extent or the other. The torque situation is, e.g. dependent on the different tools/workpieces being used and can vary significantly. Using the automatic torque determination function, the instantaneous holding torque available at standstill is automatically determined (mAct from Fig. 7-35) and is temporarily used as average value for the torque limiting in the drive. In this case, it must be ensured that at the start of the test, the brake is open, otherwise an incorrect reference value will be determined. With the automatic torque determination function, the plausibility of the load torque is not checked. The currently available holding torque is displayed in r1509 ”Force setpoint before force limiting”.

If the automatic torque determination function is not used (MD 36998 $MA_SAFE_BRAKETEST_CONTROL=0), then p1532 ”Torque limit offset” should be parameterized. Also in this case, when selecting the brake test, the holding torque required for the force due to the weight is internally measured and the effective brake test torque adapted. Contrary to the automatic torque determination function, the plausibility of the load torque is checked.

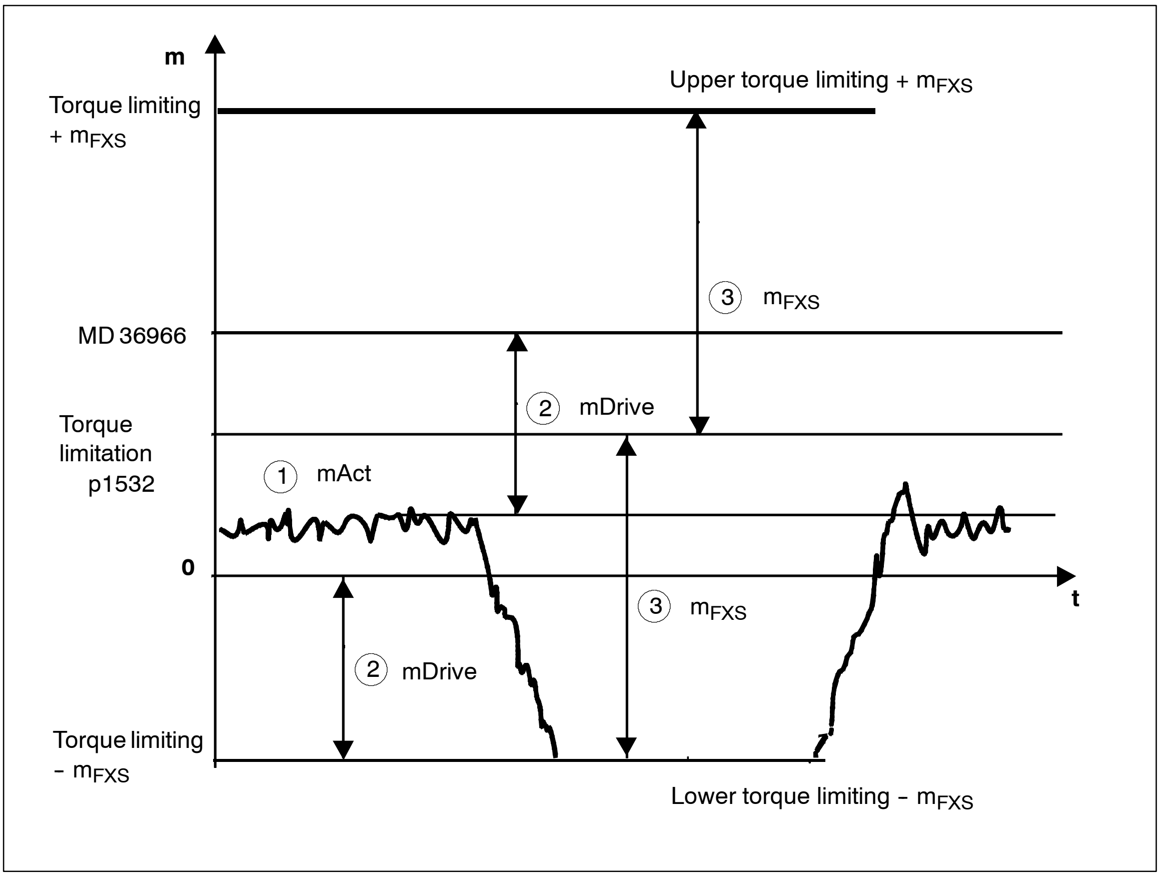


Fig. 7-35 Torque limiting for SINAMICS S120

1

When selecting the brake test, the holding torque required for the force due to the weight of the axis is internally measured (m_{Act}).

2

The drive must only additionally provide the difference between this torque and the braking torque from MD 36966 $MA_SAFE_BRAKETEST_TORQUE. In the diagram 7-35, this torque is designated with m_{Drive}.

3

For the non automatic torque determination function, the following applies: The torque limiting of SINAMICS is symmetrical around the torque from drive parameter p1532. In the diagram 7-35 the measured torque m_Act is however less than p1532.
This is the reason that m_{FXS} from Fig. 7-35 is entered as torque limiting.
m_{FXS} is the sum from m_{drive} and the drive parameter p1532. If the measured torque m_{act} matches that parameterized in drive parameter p1532, m_{FXS} becomes the value from the MD $MA_SAFE_BRAKETEST_TORQUE.

7.6.3 Torque limits

The torque limits p1520[0] and p1521[0] and the reference torque p2003 are pre-assigned when commissioning the motor. The torque limits and the reference torque are pre-assigned differently depending on the technological application p0500 and dependent on the hardware components being used.

Further, the torque limits p1522[0] and p1523[0] are pre-assigned as follows:
p1522[0] 63:2902:5 reference to +100% referred to p2003 in the same Motor Module
p1523[0] 63:2902:12 reference to -100% referred to p2003 in the same Motor Module

When using the safe brake test, these pre-assignments for p1522[0] / p1523[0] may not be changed.
However, when upgrading the software, the following setting, which is also permissible, can be present:
p1522[0] 0:1.0 100% of p2003
p1523[0] 63:2900.0 reference to p2900 in the same Motor Module
p2900[0] -100% -100% from p2003

To ensure that the brake test functions without any errors, it should be checked as to whether the required test torque in MD 36966 $MA_SAFE_BRAKETEST_TORQUE is not prevented from being generated due to the fact that torque limits are effective in the drive. For details on this, please see SINAMICS List Manual, e.g. function charts 5610 and 5620.
For instance, the selectable torque limits from p1520/p1521 and p1522/p1523 may not be set so low that the required torque cannot be established for the brake test. When required, p1520/p1521 or p2003 should be adapted. When making a change to p2003, machine data 36966 should be re-determined.
Further, e.g. the following parameters can also have a limiting effect:
p1530/p1531 (power limit, motoring/regenerating)
p0640 (current limit)
p0326 (motor stall torque correction factor)

7.6.4 Traversing direction for the brake test

The brake test must always be started when the axis is at a standstill. The direction in which the drive produces its force is specified by the PLC using the direction specified by the traversing motion of FC 18. For a brake test, the motor should apply a force to the brake that is applied in addition to the force due to weight. The target of this traversing motion must be able to be reached without incurring any potential hazard (sufficient clearance to end stops) for the case that the brake cannot provide the necessary force. As part of the application, the position can be interrogated using conventional cams (not safety cams, as this is not a safety-related function) that then define the traversing direction of the axis via FC18 during the braking test.
If a brake test is executed against the force due to weight, in spite of the closed brake, the motor must generate a torque corresponding to the force due to weight and the test torque.
Note when using MD36968 $MA_SAFE_BRAKETEST_CONTROL, bit 0 = 0:
If a traversing direction is selected that opposes the force due to the weight, Alarm "20097 axis %1 incorrect direction braking test" is initiated, if the actual torque, when selecting the brake test deviates by more than 7.5% of MD 36966 $$MA_SAFE_BRAKETEST_TORQUE from drive parameter p1532. This alarm indicates that the brake test was executed with a torque that was incorrect by more than 15%. Principally, the automatic determination of the available load torque using MD 36968 $MA_SAFE_BRAKETEST_CONTROL, Bit 0 = 1 is the preferred solution (see Chapter 7.6.2, Section MD 36968 $MA_SAFE_BRAKETEST_CONTROL: Sequence control for the brake test).

7.6.5 Brake control for SINUMERIK 840D sl

If Safety Integrated is activated for an axis, then the brake can be closed using the interface signal "Close brake", DB31-61, DBX23.5. The feedback signal is realized using the interface bit "Motor holding brake open", DB31-61, DBX92.5. In this case, it involves a single-channel control. If the brake is to be safely controlled, then the SBC function integrated in the drive must also be activated. The interface bits for the brake, only activated in conjunction with Safety Integrated, have a higher priority than the standard interface signal DB31-61, DBX20.5 "Open motor holding brake". The "Extended brake control" function of the S120 is used independently of SBT.

7.6.6 Sequence

Warning

The brake test must be carried out before carrying out the test stop. If the brake test was not successful (i.e. the brake cannot hold the axis), then it is not permissible that the test stop is carried out. Users must carefully take this into consideration when configuring the brake test and test stop. The brake may only be tested when the axis is in an absolutely safe position.

The brake test must always be started when the axis is at a standstill. For the entire duration of the brake test, the enable signals of the parameterized axis must be set to enable (e.g. the controller inhibit, feed enable signals). It must be ensured that the feed override of 100% is effective.

Monitoring limits of the PLC sequence signals

Step	Status/expected feedback	Monitoring time value
Activate brake test	DBX 11.0 = 1	TV_BTactiv
Brake test active	DBX 71.0 = 1	TV_BTactiv
Close brake	DBX 23.5 = 1	TV_Bclose
Brake closed	DBX 92.5 = 0	TV_Bclose
Output traversing command	DBX 64.6 or DBX 64.7	TV_FeedCommand
Check, output traversing command	DBX62.5 = 1	TV_FXSreached
Wait for the holding time	DBX62.5 = 1	TV_FXShold
De-select brake test/open brake	DBX71.0 = 0	TV_BTactiv

The PLC signals described here are used in or as parameters in the basic program blocks FB 11 and FC 18.

For a PLC-monitored/controlled axis, also see:
References: /FB2/, P2 ”Autonomous single-axis processes”

Note

The signals shown here are only intended for diagnostics and providing an understanding. The signals should not be influenced by the user program elsewhere.

Sequence to test the mechanical braking

Before the brake test can be started via FB 11 (from the basic program), the NC axis to be tested must be transferred to the PLC as ”PLC-controlled axis” During the complete test, the axis must remain a PLC-controlled axis. Start via FB 11 can be made after the transfer to the PLC.

The start parameter of the FB 11 must be continuously at 1 during the complete test. With MD 36968 $MA_SAFE_BRAKETEST_CONTROL Bit 0 =1, shortly before the brake is closed, the actual holding torque is determined and is temporarily used in the drive as average value for the torque limiting. After the brake is closed, the PLC-controlled axis is traversed in the specified direction against the brake using FC 18. If the fixed stop is detected (”Fixed stop reached” DB31-DB61, DBX62.5), the PLC interrupts the traversing motion (FC 18 is exited with error 30). The reduced torque limits are withdrawn and the brake is re-opened.

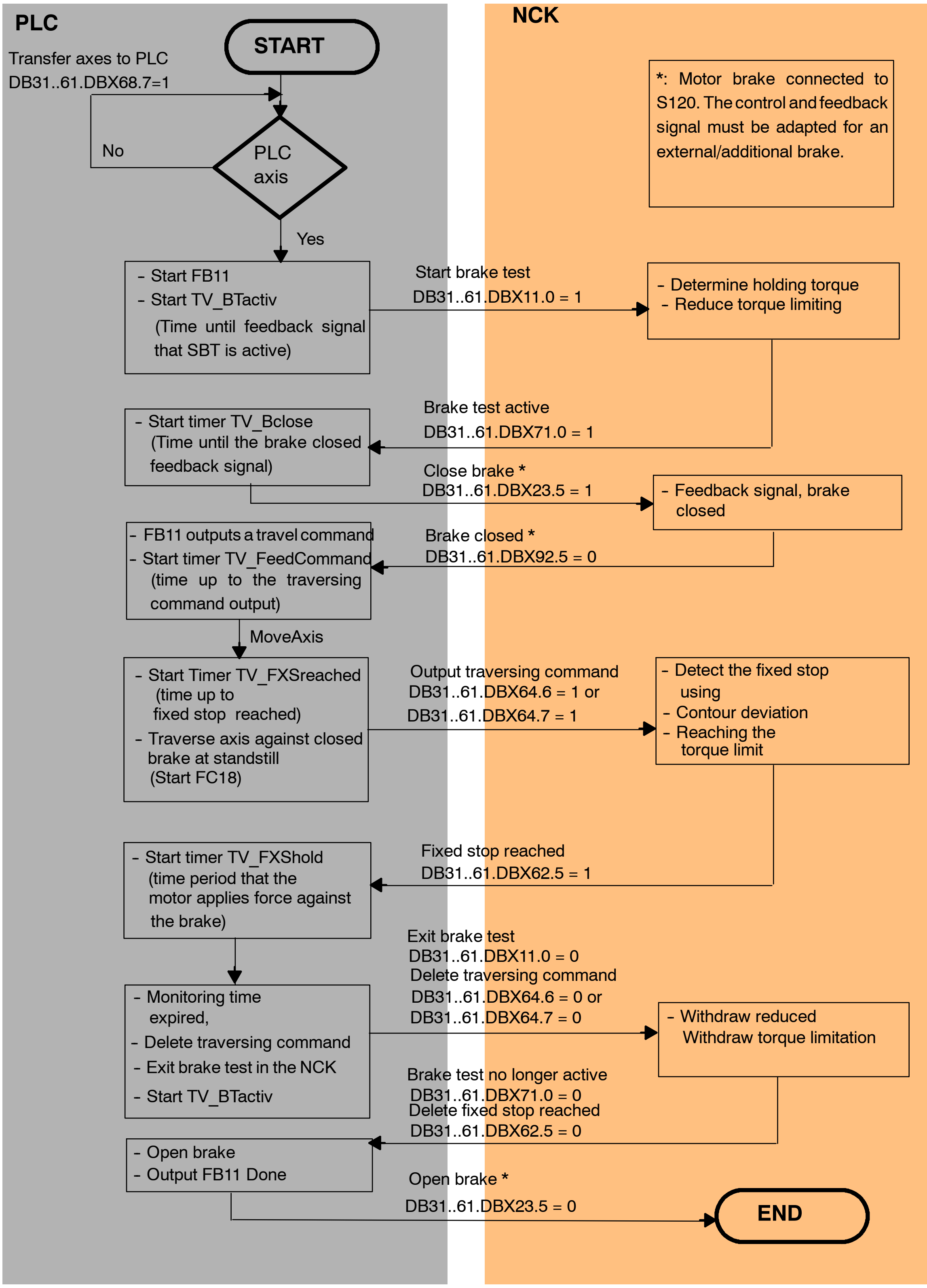


Fig. 7-36 Sequence, function test of the mechanical brake system

7.6.7 Description, FB 11

Declaration of the function:

```
VAR_INPUT
   Start : BOOL ;                     //Start of the brake test
   Quit : BOOL ;                      //Acknowledge fault
   Bclosed : BOOL ;                   //Brake closed input (single channel – PLC)
   Axis : INT ;                       //Testing axis No.
   TimerNo : TIMER ;                  //Timer from user
   TV_BTactiv : S5TIME ;              //TimeValue -> brake test active
   TV_Bclose : S5TIME ;               //TimeValue -> close brake
   TV_FeedCommand : S5TIME ;          //TimeValue -> force FeedCommand
   TV_FXSreached : S5TIME ;           //TimeValue -> Fixed stop reached
   TV_FXShold : S5TIME ;              //TimeValue -> test brake
END_VAR

VAR_OUTPUT
         CloseBrake : BOOL ;          //Signal close brake
         MoveAxis : BOOL ;            //do move axis
         Done : BOOL;
         Error : BOOL;
         State : BYTE ;               //Error byte
END_VAR
```

The following table lists all of the formal parameters of the brake test function:

Signal	Type	Type	Remark
Start	I	BOOL	Starts the brake test
Ackn	I	BOOL	Acknowledge fault
Bclosed	I	BOOL	Feedback input whether a control signal has been issued to close the brake (single-channel PLC)
Axis	I	INT	**Axis number of axis to be tested**
TimerNo	I	TIMER	Timer from user program
TV_Btactiv	I	S5TIME	Monitoring time value -> brake test active. Check the axis signal DBX71.0
TV_Bclose	I	S5TIME	Monitoring time value -> close brake. Check the input signal Bclosed after the CloseBrake output was set.
TV_FeedCommand	I	S5TIME	Monitoring time value -> output traversing command. Check traversing commands after MoveAxis has been set.
TV_FXSreached	I	S5TIME	Monitoring time value -> fixed stop reached
TV_FXShold	I	S5TIME	Monitoring time value -> test brake
CloseBrake	O	BOOL	Request, close brake
MoveAxis	O	BOOL	Request, initiate traversing motion
Done	O	BOOL	Test successfully completed

Signal	Type	Type	Remark
Error	O	BOOL	Error occurred
State	O	BYTE	Error status

Error identifiers of the FB 11

State	Meaning
0	No fault
1	Start conditions not fulfilled, e.g., axis not under closedloop control/brake closed/ axis disabled
2	No NC checkback in ”Brake test active” signal on selection of brake test
3	No ”Brake applied” checkback by input signal Bclosed
4	No traversing command output (e.g. axis motion has not been started)
5	Fixed stop is not reached -> axis RESET was initiated
6	Traversing inhibit/approach too slow -> fixed stop cannot be reached. Monitoring time TV_FXSreached has expired.
7	Brake is not holding at all (the end position is reached)/approach speed is too high
8	Brake opens during the holding time
9	Error when deselecting the brake test
10	Internal error
11	”PLC-controlled axis” signal not enabled in the user program

Note

The block must be called by the user program. The user must provide an instance DB with any number for this purpose. The call is multi-instance-capable.

Additional alarm support

To support the commissioning of the brake test Alarm 20096, ”Axis %1 brake test aborted, additional information %2” can be enabled with MD 11411 $MN_ENABLE_ALARM_MASK, bit 5 = 1. This alarm supplies more detailed information if the brake test is interrupted.

7.6.8 Application example

Information and notes for typical applications are provided as example in the following description.

Parameterization of the machine data

Machine data	Value	Description
MD 37000 $MA_FIXED_STOP_MODE	2H	FXS only possible via PLC
MD 37030 $MA_FIXED_STOP_THRESHOLD	2 mm	Threshold for fixed stop detection. The value must be less than the traversing distance of the FC 18
MD 36966 $MA_SAFE_BRAKETEST_TORQUE	%	Enter test torque referred to p2003
MD 36967 $MA_SAFE_BRAKETEST_POS_TOL	1 mm	Position tolerance, brake test
MD 36968 $MA_SAFE_BRAKETEST_CONTROL	1	Bit 0 = 1: The measured torque at the instant in time that the brake test is selected is used as the average value of the reduced torque limit.

MD 37000 $MA_FIXED_STOP_MODE, bit1 = 1 is the prerequisite for the SBT; only then does the NCK evaluate the PLC signal ”Start brake test” If this is not the case, a timeout after the brake test has started ensures that the SBT (FB 11) is aborted (see Fig. 7-36 ”Sequence function test of the mechanical braking system”).

If MD 37000 $MA_FIXED_STOP_MODE bit 1 = 1, without at least MD 36901 $MA_SAFE_FUNCTION_ENABLE, bit 0 = 1, then MD 37000 $MA_FIXED_STOP_MODE, bit 1 = 1 is deleted when booting. Alarm 27033, ”Axis %1 parameterization of MD MA_FIXED_STOP_MODE invalid” is displayed.

If the ”travel to fixed stop” function is used elsewhere, then the parameterization of the fixed stop alarms should be adapted. The fixed stop alarms should be parameterized as follows for the brake test:

MD 37050 $MA_FIXED_STOP_ALARM_MASK	2H	Enable fixed stop alarms
MD 37052 $MA_FIXED_STOP_ALARM_REACTION	Bit 0 –4 =1	Response, fixed stop alarms

Example of calling FB11

```
AUF  DB37              //Brake test, Z axis
UN   DBX  92.5         //Feedback signal, brake open
=    M    111.5        //Brake Z axis is closed
O    E    7.5;         //Initiates the brake test, Z axis
O    M    110.7        //Brake test already started
```

```
    FP   M   110.0        //Edge marker
    UN   M   111.4        //Fault has occurred
    S    M   110.7        //Brake test running
    S    M   110.6        //Start
    SPBN m001             //Conditional jump
    L    DBB 68           //Load channel state
    UW   W#16#F           //Mask bits
    T    MB  115          //Note channel state
    L    B#16#10          //Load fixed value
    T    DBB 8            //Request neutral axis
m001: NOP 0               //Jump mark
    U    DBX 68.6         //Feedback signal, axis is neutral
    U    M   110.6        //Start
    FP   M   110.1        //Edge marker
    R    M   110.6        //Start
    S    M   110.5        //Step 1
    S    DBX 28.7         //Request PLC monitored axis

    U    DBX 63.1         //Feedback signal, the PLC is monitoring the axis
    U    M   110.5        //Step 1
    FP   M   110.2        //Edge marker
    R    M   110.5        //Step 1
    S    M   111.0        //Start FB 11

  CALL FB 11 , DB211      //Brake test module
    Start    := M111.0    //Start brake test
    Quit     := E3.7      //Acknowledge error with reset key
    Bclosed  :=M111.5     //Feedback signal brake not open
    Axis     :=7 //Axis number of axis to be tested, Z axis
    TimerNo  :=T 110      //Timer number
    TV_BTactiv  :=S5T#200MS   //Monitoring time value: Brake test active
                              DBX71.0
    TV_Bclosed :=S5T#1S,  //Monitoring time value: Brake closed
    TV_FeedCommand :=S5T#1S   //Monitoring time value: Travel command
    are output
    TV_FXSreached :=S5T#1S  //Monitoring time value: Fixed stop reached
    TV_FXShold := S5T#2S,  //Monitoring time value: Brake test time
    CloseBrake := DB37.DBX23.5   //Request, close brake
    MoveAxis :=M111.2        //Request, initiate traversing motion
    Done     := M111.3,      //Test successfully completed
    Error    := M111.4,      //Error occurred
    State    := MB112        //Error status
    AUF  DB  37              //Brake test, Z axis
    U    M   111.2           //Move axis
    FP   M   111.5           //FC18 start
    S    M   111.7           //Start FC18
    O    M   111.3           //Test successfully completed
    O    M   111.4           //Error has occurred
    FP   M   110.3           //Edge marker
    R    DBX 28.7            //Request, PLC monitored axis
```

```
    UN   DBX 63.1              //Feedback signal, the PLC is monitoring the axis
    U    M    111.0            //Start the brake test for FB
    U    M    110.7            //Brake test running
    SPBN m002                  //Conditional jump
    L    MB   115              //Load noted channel state
    OW   W#16#10               //Mark bits
    T    DBB  8                //Request channel axis
m002: NOP 0;
  CALL   FC  18                //Traverse Z axis
    Start   :=M   111.7        //Start of traversing motion
    Stop    := FALSE           //Not used
    Funct   := B#16#5          //Mode: Axis mode
    Mode    := B#16#1          //Traverse: Incremental
    AxisNo :=7                 //Axis number of the axis to be traversed, Z axis
    Pos     := -5.000000e+000, // Distance travelled: Minus 5 mm
    FRate   := 1.000000e+003,  //Feed rate: 1000 mm/min
    InPos   := M   113.0,      //Position reached
    Error   := M   113.1       //Error has occurred
    State   := MB  114         //Error status
AUF  DB  37                    //Open axis DB
    U    M    113.0            //Position reached
    O    M    113.1            //Error has occurred
    FP   M    113.2            //Edge marker
    R    M    111.7            //Start FC18
    U    E    3.7              //Reset MCP
    SPBN end                   //Conditional jump
    U    M    111.4            //Error has occurred
    =    DBX  28.1             //Acknowledge error with axis reset
    R    M    111.0            //Start FB 11
    R    M    110.7            //Brake test running
end: NOP 0
```

Determining the test torque, MD 36966 $MA_SAFE_BRAKETEST_TORQUE

When determining the test torque MD 36966 $MA_SAFE_BRAKE-TEST_TORQUE, the maximum holding torque that occurs must first be determined. The maximum occurring holding torque can be determined in r1509 by traversing the axis to various positions with different forces / torques due to weight (tools or workpieces).

Examples to determine MD 36966 $MA_SAFE_BRAKETEST_TORQUE, p2003=100Nm:

Max. holding torque M_{0max} r1509	**Test torque M_T=M_{0max} + 30%**	**Limit value of the actual torque before SBT M_T*0.85**
20Nm = 20%	26%	22.1%
30Nm = 30%	39%	33.15%

Max. holding torque M_{0max} r1509	Test torque M_T=M_{0max} + 30%	Limit value of the actual torque before SBT M_T*0.85
40Nm = 40%	52%	34%
50Nm = 50%	65%	42.5%
60Nm = 60%	78%	51%
70Nm = 70%	91%	59.5%

The ”limit value of the actual torque before SBT” shown here, indicates that the actual torque, automatically determined before the SBT, must not be lower, as otherwise Alarm 20095 ”Axis %1 inadmissible holding torque” is output.

The test results are evaluated

Analysis using servo trace

The signal characteristics must be viewed in order to evaluate the brake test. The behavior during the brake test can be recorded using the servo trace:

Signal selection
System deviation
Following error
Torque limit
Torque-generating current actual value i(q)

Measuring parameters
Measurement time: 4000 ms
Trigger: No trigger

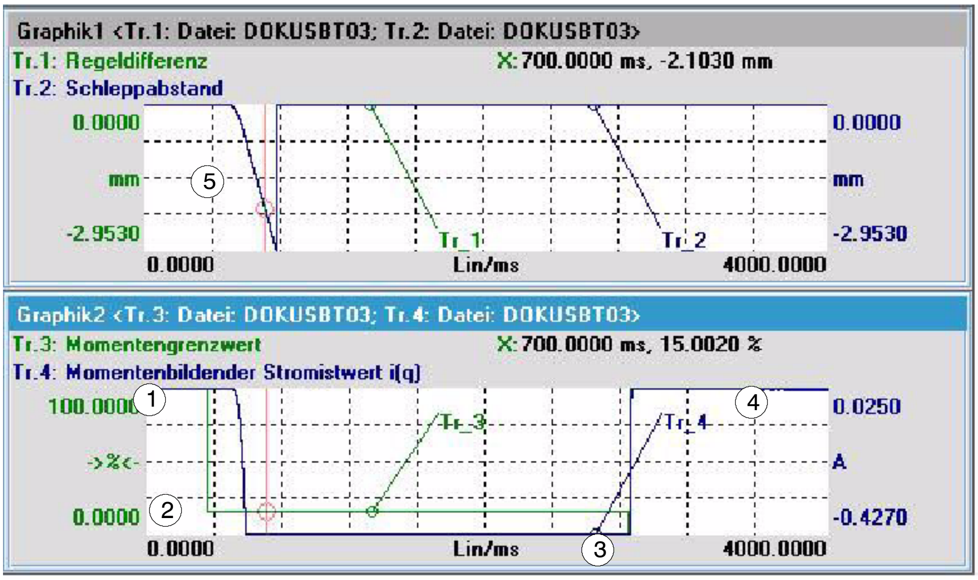


Fig. 7-37 Servo trace, brake test for a positive test result

1 Current actual value that is required to hold the axis in this position

2 Start of the brake test

3 End of the brake test

4 The holding current re-establishes itself

5 Setpoint is output, following error built up

Analysis with SinuCom NC ATW

In conjunction with the acceptance test, SinuCom NC is part of the automatic acceptance test ATW for SBT.

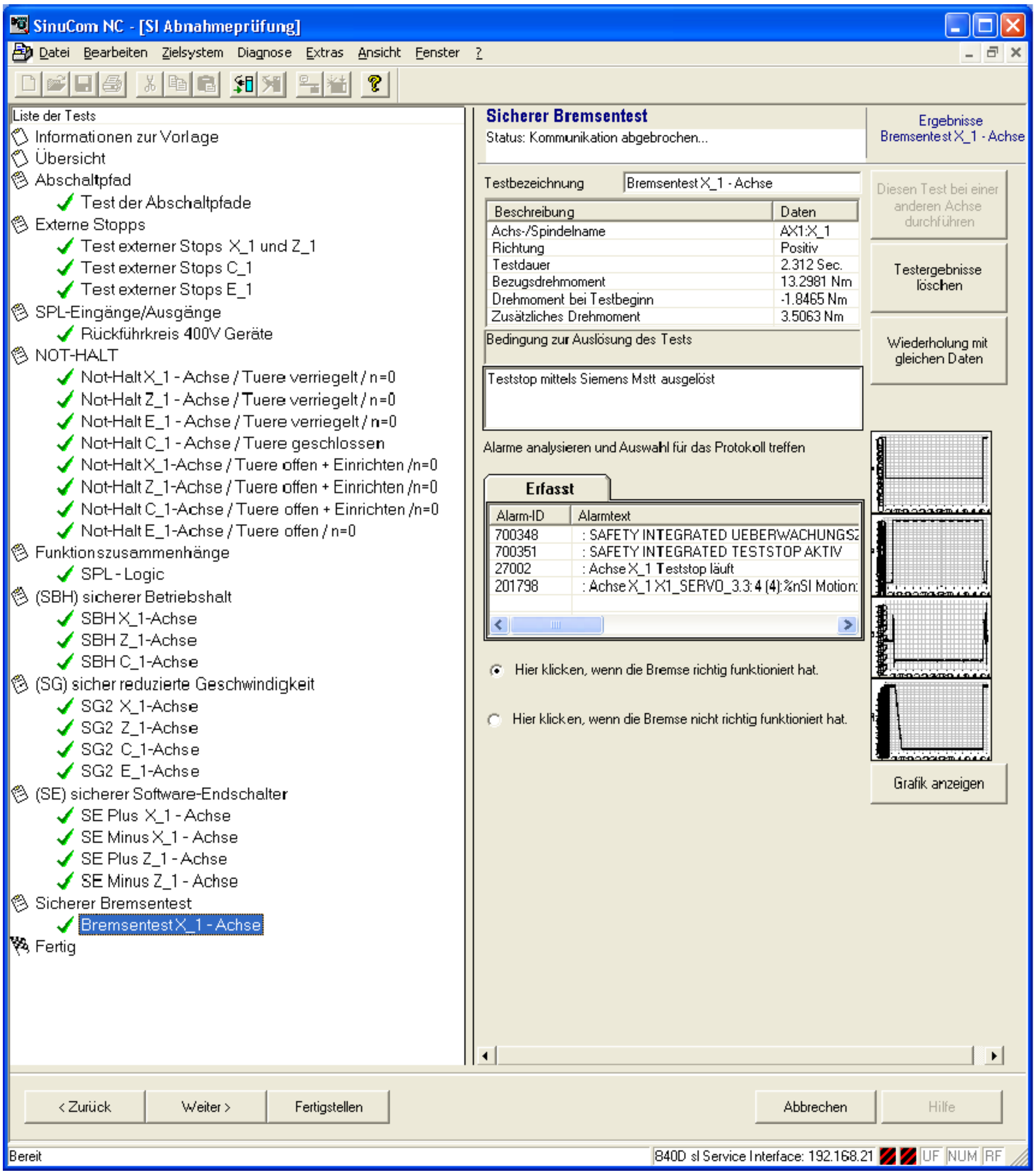
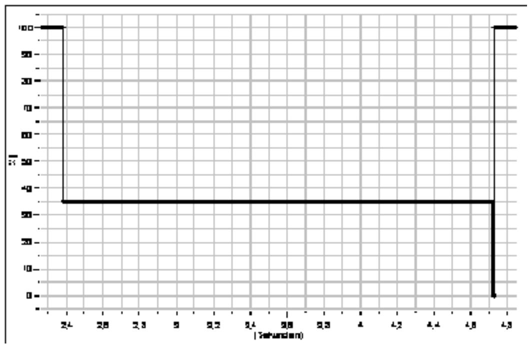
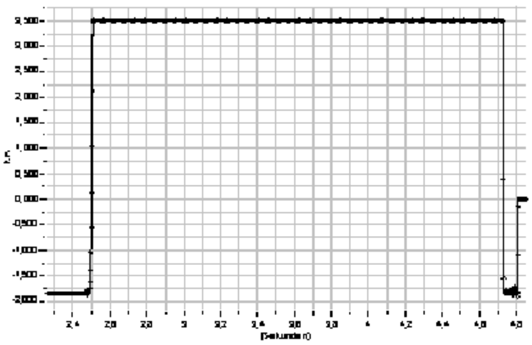
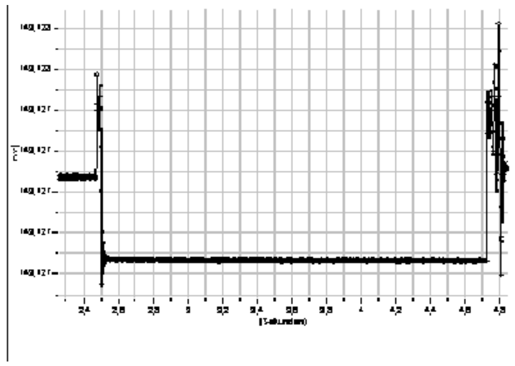
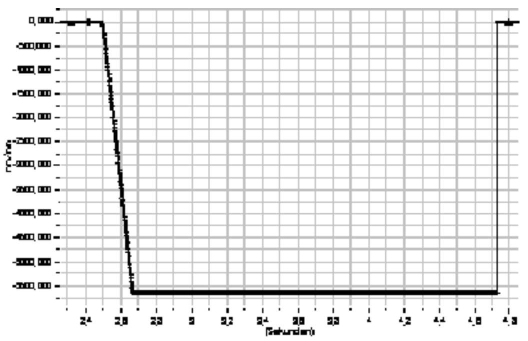


Fig. 7-38 Safe brake test with Sinucom NC ATW

	**Torque limit when testing the SBT** Reducing the torque limit, at the end of the test, the limit is set to 0 in order to re-establish the additional torque to be generated.
	**Required torque when testing the SBT** During the test, an additional torque is established, and at the end is withdrawn again.
	**Actual position when testing the SBT** Axis motion is minimal if the brake was successfully tested. The holding current re-establishes itself at the end of the SBT and opening the brake. Here, a slight sag can be seen.
	**Setpoint of the axis-specific feed** Setpoint is output and the following error built-up.

7.6.9 Supplementary conditions

- When testing the mechanical braking system, it is not permissible that traverse to fixed stop (FXS) or traversing with a limited torque, FOC are simultaneously active. In this case, Alarm 20092, ”Axis %1 travel to fixed stop still active” is triggered.
- During the brake test, contour monitoring is not active. After the PLC has started traversing motion then there is also no standstill monitoring.
- The function test/check of the brake mechanical system cannot be used for gantry axes.
- For other ”travel to fixed stop” applications, machine data MD 37050 $MA_FIXED_STOP_ALARM_MASK and MD 37052 $MA_FIXED_STOP_ALARM_REACTION should be adapted.
- If FC18 is called for the same axis in the remainder of the user program, the calls must be mutually interlocked. For example, this can be achieved via a common call of this function with an interlocked common data interface for the FC 18 parameters. An additional option is to call the FC 18 a multiple number of times, in which case the inactive FC 18 must be skipped. An interlock against being used a multiple number of times must be provided.
- The feed override should be set to 100% so that the required velocity can be reached during the test. If this is realized via the interface, then it should be carefully noted that if the brake test is not successful, then the override does not statically remain at 100%. As an alternative to directly writing to the interface, a message can be generated.
- The torque limits change when a parameter set is changed over.
- Changing the reference torque p2003 means that the use of a referred torque quantity results in a different dynamic behavior. If p2003 is changed then this alters the system behavior when the brake test is performed. In order to avoid this, when booting, the NCK system software reads out the value from p2003 and saves it in MD $MA_SAFE_BRAKETEST_TORQUE_NORM. For each additional control boot, MD 36969 $MA_SAFE_BRAKETEST_TORQUE_NORM is checked for changes and where relevant, Alarm 27039 ”Axis %1 parameterization MD %2[%3] changed, confirmation and functional test required!” is displayed. MD 36969 $MA_SAFE_BRAKETEST_TORQUE_NORM, is included in the axial checksum $MA_SAFE_ACT_CHECKSUM[0].
- With simultaneous use of the extended brake control (r0108.14=1) and dynamic stiffness control control (MD 32640 $MA_STIFFNESS_CONTROL_ENABLE=1), the factory setting p1152=r0899.15 must be changed (”disconnected”), and p1152 must be set to 1.

- **Master-slave:** The automatic test of the mechanical braking system has not been released for master-slave couplings, as mechanical damage cannot be fully excluded if the brake is defective due to the wide range of different couplings available. When using a master-slave configuration, it must be decided as to whether a temporary or a permanent coupling is involved. A temporary coupling can be disconnected (released) before testing the mechanical brake system so that the individual brakes are tested.
- **Gantry group:** The automatic test of the mechanical braking system is not released for gantry groups, as mechanical damage cannot be fully excluded if the brake is defective due to the wide range of different couplings.

Space for your notes

8 Data Description

8.1 Machine data for SINUMERIK 840D sl

8.1.1 Overview of the machine data

The checksum data have the following meanings:

Axial checksums

CRC	Functionality	Change results in an alarm
AX[**0**]	Monitoring functionality	**27032** "Axis %1 checksum error of safe monitoring. Confirmation and acceptance test are required!"
AX[**1**]	SINAMICS HW dependent data	**27035** "Axis %1 new HW component, acknowledgement and function test required"
AX[**2**]	SINAMICS coupling	**27060** "Axis %1 checksum error of drive assignment. Confirmation and acceptance test required"

NCK checksums

CRC	Functionality	Change results in an alarm
NCK[**0**]	Safe communication; SPL I/O connection; SPL functionality	**27070** "Checksum error, SPL parameter assignment, and SPL interfaces. Confirmation and acceptance test are required!"
NCK[**1**]	User SPL configuration	**27071** "Checksum error, safe SPL parameterization. Confirmation and acceptance test are required"
NCK[**2**]	Enable I/O connection	**27072** "Checksum error, enabling safe communication. Confirmation and acceptance test required"
NCK[**3**]	PROFIsafe–CRC1	**27073** "Checksum error, S7 PROFIsafe configuration. Confirmation and acceptance test required.

–– means: This data is not calculated into any checksum.

Table 8-1 Overview of machine data for SINUMERIK 840D sl

Number	Identifier	Name	Checksums MD
General ($MN_ ...)			
10050	SYSCLOCK_CYCLE_TIME	Basic system clock cycle, see /FB1/, G2	--
10060	POSCTRL_SYSCLOCK_TIME_RATIO	Factor, position controller clock cycle, see /FB1/, G2	--
10070	IPO_SYSCLOCK_TIME_RATIO	Factor, interpolator clock cycle	--
10071	IPO_CYCLE_TIME	Interpolator cycle	NCK[0]
10089	$MN_SAFE_PULSE_DIS_TIME_BUSFAIL	Wait time pulse cancellation when the bus fails	AX[0]
10090	SAFETY_SYSCLOCK_TIME_RATIO	Factor for the monitoring clock cycle	--
10091	INFO_SAFETY_CYCLE_TIME	Display, monitoring clock cycle time	AX[0]
10092	INFO_CROSSCHECK_CYCLE_TIME	Displays the clock cycle time for a cross-wise data comparison	--
10093	INFO_NUM_SAFE_FILE_ACCESS	Number of SPL file access operations	--
10094	SAFE_ALARM_SUPPRESS_LEVEL	Alarm suppression level	--
10095	SAFE_MODE_MASK, Bit 1	Safety Integrated operating modes	NCK[2] NCK[0]
10096	SAFE_DIAGNOSIS_MASK	Safety Integrated diagnostic functions	--
10097	SAFE_SPL_STOP_MODE	Stop response for SPL errors	NCK[0]
10098	PROFISAFE_IPO_TIME_RATIO	Factor PROFIsafe communications clock cycle time	NCK[0]
10099	INFO_PROFISAFE_CYCLE_TIME	PROFIsafe communications clock cycle time	--
10200	INT_INCR_PER_MM	Computational resolution for linear positions see /FB1/, G2	--
10210	INT_INCR_PER_DEG	Computational resolution for angular positions see /FB1/, G2	--
10385	PROFISAFE_MASTER_ADRESS	PROFIsafe address of the PROFIsafe master module	NCK[0]
10386	PROFISAFE_IN_ADRESS	PROFIsafe address of an input module	NCK[0]
10387	PROFISAFE_OUT_ADRESS	PROFIsafe address of a PROFIsafe output module	NCK[0]
10388	PROFISAFE_IN_ASSIGN	Input assignment, $A_INSE to PROFIsafe input module	NCK[0]
10389	PROFISAFE_OUT_ASSIGN	Output assignment, $A_OUTSE to PROFIsafe module	NCK[0]
10393	SAFE_DRIVE_LOGIC_ADDRESS	Logical drive addresses, SI	AX[2]
11500	PREVENT_SYNACT_LOCK	Protected synchronized actions	--
11602	ASUP_START_MASK	Ignore stop conditions for ASUB	--
11604	ASUP_START_PRIO_LEVEL	Priorities as of which ASUP_START_MASK takes effect	--
11411	ENABLE_ALARM_MASK	Activation of alarms	--
11415	SUPPRESS_ALARM_MASK_2	Suppress alarm outputs	--
13300	PROFISAFE_IN_FILTER	F useful (net) data filter IN	NCK[0]

Table 8-1 Overview of machine data for SINUMERIK 840D sl

Number	Identifier	Name	Checksums MD
13301	PROFISAFE_OUT_FILTER	F net (useful) data filter OUT	NCK[0]
13302	PROFISAFE_IN_ENABLE_MASK	Enable screen of the connections to PROFI-safe input modules	NCK[2]
13303	PROFISAFE_OUT_ENABLE_MASK	Enable screen form of the connections to PROFIsafe outputs modules	NCK[2]
13304	PROFISAFE_IN_SUBS_ENAB_MASK	Activation of the substitute value output for PROFIsafe input modules	NCK[2]
13305	PROFISAFE_IN_SUBS	Substitute values for passive connections to PROFIsafe input modules	NCK[0]
13308	PROFISAFE_IN_NAME	Name of the PROFIsafe input module	--
13309	PROFISAFE_OUT_NAME	Name of the PROFIsafe output module	--
13310	SAFE_SPL_START_TIMEOUT	Delay, display Alarm 27097	--
13312	SAFE_SPL_USER_DATA	User SPL data is changed	NCK[1]
13316	SAFE_GLOB_CONFIG_CHANGE_DATA	Date/time of the last change SI-NCK-MD	--
13317	SAFE_GLOB_PREV_CONFIG	Data, previous safety configuration	--
13318	SAFE_GLOB_ACT_CHECKSUM	Actual checksum NCK	--
13319	SAFE_GLOB_DES_CHECKSUM	Reference checksum	--
13320	SAFE_SRDP_IPO_TIME_RATIO	Factor F_DP communication clock cycle	NCK[0]
13322	INFO_SAFE_SRDP_CYCLE_TIME	Maximum F_DP communication clock cycle	--
13330	SAFE_SDP_ENABLE_MASK	Enable screen form F_SENDDP communication relationships	NCK[2]
13331	SAFE_SDP_ID	Identifier of the F_SENDDP communication relationship	NCK[0]
13332	SAFE_SDP_NAME	Name of the SPL connection	--
13333	SAFE_SDP_CONNECTION_NR	Number of the SPL connection	NCK[0]
13334	SAFE_SDP_LADDR	Basis address of the input/output data area F_SENDDP	NCK[0]
13335	SAFE_SDP_TIMEOUT	Monitoring time F_SENDDP	NCK[0]
13336	SAFE_SDP_ASSIGN	Output assignment.$A_OUTSE to F_SENDDP net data	NCK[0]
13337	SAFE_SDP_FILTER	F net data filter between $A_OUTSE and F_SENDDP	NCK[0]
13338	SAFE_SDP_ERR_REAC	Error response	NCK[0]
13340	SAFE_RDP_ENABLE_MASK	Enable screen form F_RECVDP communication relationship	NCK[2]
13341	SAFE_RDP_ID	Identifier of the F_RECVDP communication relationship	NCK[0]
13342	SAFE_RDP_NAME	Name of the SPL connection	--
13343	SAFE_RDP_CONNECTION_NR	Assignment, SPL connection to system variables	NCK[0]
13344	SAFE_RDP_LADDR	Basis address of the input/output data area, F_RECVDP	NCK[0]

Table 8-1 Overview of machine data for SINUMERIK 840D sl

Number	Identifier	Name	Checksums MD
13345	SAFE_RDP_TIMEOUT	Monitoring time F_RECVDP	NCK[0]
13346	SAFE_RDP_ASSIGN	Input assignment F_RECVDP net data to $A_INSE	NCK[0]
13347	SAFE_RDP_FILTER	F net data filter between F_RECVDP and $A_INSE	NCK[0]
13348	SAFE_RDP_ERR_REAC	Error response	NCK[0]
13349	SAFE_RDP_SUBS	Substitute values in the case of an error	NCK[0]
Channelspecific ($MC_ ...)			
20106	PROG_EVENT_IGN_SINGLEBLOCK	PROG_EVENTs ignore the single block	--
20107	PROG_EVENT_IGN_INHIBIT	PROG_EVENTs ignore the read-in inhibit	--
20108	PROG_EVENT_MASK	Event-controlled program call	--
20192	PROG_EVENT_IGN_PROG_STATE	Do not display the execution of the prog events on the OPI	--
20700	REFP_NC_START_LOCK	NC-Start disable without reference point	--
28251	MM_NUM_SAFE_SYNC_ELEMENTS	Number of elements for expressions in safety synchronized actions	--
Axis/spindlespecific ($MA_ ...)			
30130	CTRLOUT_TYPE	Setpoint output type	--
30240	ENC_TYPE	Encoder type of the actual value sensing (position actual value) see /FB1/, G2	--
30300	IS_ROT_AX	Rotary axis/spindle see /FB1/, R2	--
30320	DISPLAY_IS_MODULO	Modulo 360 degrees display for rotary axis or spindle see /FB1/, R2	--
30330	MODULO_RANGE	Size of the modulo range see /FB1/, R2	--
32300	MA_AX_ACCEL	Axis acceleration see /FB1/, B2	--
35200	GEAR_STEP_SPEEDCTRL_ACCEL	Acceleration in the open-loop speed controlled mode see /FB1/, S1	--
35210	GEAR_STEP_POSCTRL_ACCEL	Acceleration in the closed-loop position controlled mode see /FB1/, S1	--
35410	SPIND_OSCILL_ACCEL	Acceleration when oscillating see /FB1/, S1	--
36060	STANDSTILL_VELO_TOL	Threshold velocity/speed "axis/spindle stationary" see /FB1/, A2	--
36620	SERVO_DISABLE_DELAY_TIME	Shutdown delay controller enable see /FB1/, A2	--
36901	SAFE_FUNCTION_ENABLE	Enable safety-related functions	AX[0]
36902	SAFE_IS_ROT_AX	Rotary axis	AX[0]
36903	SAFE_CAM_ENABLE	Enable safe cam track	AX[0]
36905	SAFE_MODULO_RANGE	Modulo value, safe cams	AX[0]
36906	SAFE_CTRLOUT_MODULE_NR	SI drive assignment	AX[2]
36907	SAFE_DRIVE_PS_ADDRESS	PROFIsafe address of the drive	AX[2]

Table 8-1 Overview of machine data for SINUMERIK 840D sl

Number	Identifier	Name	Checksums MD
36912	SAFE_ENC_INPUT_NR	Actual value assignment: Drive encoder number	AX[2]
36914	SAFE_SINGLE_ENC	SI single-encoder system	AX[0]
36916	SAFE_ENC_IS_LINEAR	Linear scale	AX[0]
36917	SAFE_ENC_GRID_POINT_DIST	Grid spacing, linear scale	AX[0]
36918	SAFE_ENC_RESOL	Encoder pulses per revolution	AX[0]
36919	SAFE_ENC_PULSE_SHIFT	Shift factor of the encoder multiplication	AX[0]
36920	SAFE_ENC_GEAR_PITCH	Spindle pitch	AX[0]
36921	SAFE_ENC_GEAR_DENOM[n]	Denominator, gearbox ratio encoder/load	AX[0]
36922	SAFE_ENC_GEAR_NUMERA[n]	Numerator, gearbox ratio encoder/load	AX[0]
36923	SAFE_INFO_ENC_RESOL	safety-relevant encoder resolution	--
36924	SAFE_ENC_NUM_BITS[0] SAFE_ENC_NUM_BITS[1] SAFE_ENC_NUM_BITS[2] SAFE_ENC_NUM_BITS[3]	Bit information of the redundant actual value	AX[1] AX[1] AX[0] AX[0]
36925	SAFE_ENC_POLARITY	Direction reversal actual value	AX[0]
36927	SAFE_ENC_MOD_TYPE	Encoder evaluation type	AX[1]
36928	SAFE_ENC_IDENT	Encoder identification	AX[1]
36929	SAFE_ENC_CONF	Configuration of the redundant actual value	AX[1]
36930	SAFE_STANDSTILL_TOL	Standstill tolerance	AX[0]
36931	SAFE_VELO_LIMIT[n]	Limit value for safely-reduced speed	AX[0]
36932	SAFE_VELO_OVR_FACTOR[n]	SG selection values	AX[0]
36933	SAFE_DES_VELO_LIMIT	SG setpoint speed limiting	--
36934	SAFE_POS_LIMIT_PLUS[n]	Upper limit value for safe limit position	AX[0]
36935	SAFE_POS_LIMIT_MINUS[n]]	Lower limit value for safe limit position	AX[0]
36936	SAFE_CAM_POS_PLUS[n]	Plus cams position for safe cams	AX[0]
36937	SAFE_CAM_POS_MINUS[n]	Minus cams position for safe cams	AX[0]
36938	SAFE_CAM_TRACK_ASSIGN[n]	Cam track assignment	AX[0]
36940	SAFE_CAM_TOL	Tolerance for safe cams	AX[0]
36942	SAFE_POS_TOL	Tolerance, actual value comparison (crosswise)	AX[0]
36944	SAFE_REFP_POS_TOL	Tolerance, actual value comparison (referencing)	AX[0]
36945	SAFE_VELO_X_FILTER_TIME	Filter time n< n_x	AX[0]
36946	SAFE_VELO_X	Velocity limit n<n_x	AX[0]
36947	SAFE_VELO_X_HYSTERESIS	Velocity hysteresis n<n_x	AX[0]
36948	SAFE_STOP_VELO_TOL	Speed tolerance for safe acceleration monitoring	AX[0]
36949	SAFE_SLIP_VELO_TOL	Speed tolerance, slip	AX[0]
36950	SAFE_MODE_SWITCH_TIME	Tolerance time for SGE changeover	AX[0]
36951	SAFE_VELO_SWITCH_DELAY	Delay time, speed changeover	AX[0]

Table 8-1 Overview of machine data for SINUMERIK 840D sl

Number	Identifier	Name	Checksums MD
36952	SAFE_STOP_SWITCH_TIME_C	Transition time, STOP C to safe Standstill	AX[0]
36953	SAFE_STOP_SWITCH_TIME_D	Transition time, STOP D to safe Standstill	AX[0]
36954	SAFE_STOP_SWITCH_TIME_E	Transition time, STOP E to safe Standstill	AX[0]
36955	SAFE_STOP_SWITCH_TIME_F	Transition time STOP F to STOP B	AX[0]
36956	SAFE_PULSE_DISABLE_DELAY	Delay time, pulse cancellation	AX[0]
36957	SAFE_PULSE_DIS_CHECK_TIME	Time to check pulse cancellation	AX[0]
36958	SAFE_ACCEPTANCE_TST_TIMEOUT	Time limit for the acceptance test duration	AX[0]
36960	SAFE_STANDSTILL_VELO_TOL	Shutdown speed, pulse cancellation	AX[0]
36961	SAFE_VELO_STOP_MODE	Stop response, safely-reduced speed	AX[0]
36962	SAFE_POS_STOP_MODE	Stop response, safe limit position	AX[0]
36963	SAFE_VELO_STOP_REACTION[n]	Stop response, safely-reduced speed	AX[0]
36964	SAFE_IPO_STOP_GROUP	Grouping, safety IPO response	--
36965	SAFE_PARK_ALARM_SUPPRESS	Alarm suppression for parking axes	AX[0]
36966	SAFE_BRAKETEST_TORQUE	Holding torque, brake test	AX[0]
36967	SAFE_BRAKETEST_POS_TOL	Position tolerance, brake test	AX[0]
36968	SAFE_BRAKETEST_CONTROL	Extended settings for the brake test	AX[0]
36969	SAFE_BRAKETEST_TORQUE_NORM	Reference quantity for the holding torque, brake test	AX[0]
36970	SAFE_SVSS_DISABLE_INPUT	Input assignment, SBH/SG deselection	AX[0]
36971	SAFE_SS_DISABLE_INPUT	Input assignment, SBH deselection	AX[0]
36972	SAFE_VELO_SELECT_INPUT[n]	Input assignment, SG selection	AX[0]
36973	SAFE_POS_SELECT_INPUT	Input assignment, SE selection	AX[0]
36974	SAFE_GEAR_SELECT_INPUT[n]	Input assignment, gearbox ratio selection	AX[0]
36977	SAFE_EXT_STOP_INPUT[n]	Input assignment, external brake request	AX[0]
36978	SAFE_OVR_INPUT[n]	Input assignment, SG override	AX[0]
36980	SAFE_SVSS_STATUS_OUTPUT	Output assignment, SBH/SG active	AX[0]
36981	SAFE_SS_STATUS_OUTPUT	Output assignment for SBH active	AX[0]
36982	SAFE_VELO_STATUS_OUTPUT[n]	Output assignment active SG selection	AX[0]
36985	SAFE_VELO_X_STATUS_OUTPUT	Output assignment for $n < n_x$	AX[0]
36987	SAFE_REFP_STATUS_OUTPUT	Output assignment, axis safely referenced	AX[0]
36988	SAFE_CAM_PLUS_OUTPUT[n]	Output assignment, SN1+ to SN4+	AX[0]
36989	SAFE_CAM_MINUS_OUTPUT[n]	Output assignment, SN1- to SN4-	AX[0]
36990	SAFE_ACT_STOP_OUTPUT[n]	Output assignment, active STOP	AX[0]
36992	SAFE_CROSSCHECK_CYCLE	Displays the axial crosswise comparison clock cycle	--
36993	SAFE_CONFIG_CHANGE_DATE[n]	Date/time of the last change SI-NCK-MD	--
36994	SAFE_PREV_CONFIG[n]	Data, previous safety function	--

Table 8-1 Overview of machine data for SINUMERIK 840D sl

Number	Identifier	Name	Checksums MD
36995	SAFE_STANDSTILL_POS	Standstill position	--
36997	SAFE_ACKN	User acknowledgement	--
36998	SAFE_ACT_CHECKSUM	Actual checksum	--
36999	SAFE_DES_CHECKSUM	Reference checksum	--
37000	FIXED_STOP_MODE	Travel to fixed stop mode	--
37900	SAFE_CAM_TRACK_OUTPUT	Output assignment cam tracks 1 to 4	AX[0]
37901	SAFE_CAM_RANGE_OUTPUT_1	Output assignment, cam range for cam track 1	AX[0]
37902	SAFE_CAM_RANGE_OUTPUT_2	Output assignment, cam range for cam track 2	AX[0]
37903	SAFE_CAM_RANGE_OUTPUT_3	Output assignment, cam range for cam track 3	AX[0]
37904	SAFE_CAM_RANGE_OUTPUT_4	Output assignment, cam range for cam track 4	AX[0]
37906	SAFE_CAM_RANGE_BIN_OUTPUT_1	Output assignment, cam range bit for cam track 1	AX[0]
37907	SAFE_CAM_RANGE_BIN_OUTPUT_2	Output assignment, cam range bit for cam track 2	AX[0]
37908	SAFE_CAM_RANGE_BIN_OUTPUT_3	Output assignment, cam range bit for cam track 3	AX[0]
37909	SAFE_CAM_RANGE_BIN_OUTPUT_4	Output assignment, cam range bit for cam track 4	AX[0]

8.1.2 Description of machine data

General information

General information about machine data and an explanation of their contents such as units, data type, protective stage, effectiveness, etc. can be found in the following references:

References: /LIS/, Lists, SINUMERIK 840D/840D sl

10050 MD number	**$MN_SYSCLOCK_CYCLE_TIME** Basic system cycle		
Default value: 0.004	Min. input limit: 0.000125	Max. input limit: 0.031	
Change becomes effective after: POWER ON	Protection level: 7/2	Unit: s	
Data type: Double			
Significance:	Basic clock cycle time of the system software The clock cycle times of cyclic tasks (position controller/IPO) are set in a multiple of this basic clock cycle. Apart from special applications in which POSCTRL_SYSCLOCK_TIME_RATIO is set to a value greater than 1, the basic clock cycle corresponds to the position controller clock cycle. For systems with PROFIBUS-DP connection, this MD corresponds to the PROFIBUS-DP cycle time. When booting, this time is read out of the configuring file (SDP type 2000) and written into the MD. This MD can only be changed using the configuring file. Note: If this MD is reduced, then this can result in an automatic correction of POSCTRL_CYCLE_DELAY, that cannot be undone at the next increase! Details: The basic clock cycle is an integer multiple (SYSCLOCK_SAMPL_TIME_RATIO) of units of the clock cycle of the measured value sampling. When the system boots, the entered value is automatically rounded to a multiple of this incrementing. Note: After a POWER OFF/ON, discrete timer division ratios may produce a value that is not an integer of the input value. E.g.: Entry =0.005s after power OFF/ON =0.00499840 or Entry =0.006s after power OFF/ON =0.0060032		
Special cases, errors,...			
corresponds with..			

10060 MD number	**$MN_POSCTRL_SYSCLOCK_TIME_RATIO** Factor for position-control cycle			
Default value: 1		Min. input limit: 1		Max. input limit: 31
Change becomes effective after: POWER ON			Protection level: 7/2	Unit: -
Data type: DWORD				
Significance:	The position control clock cycle is entered as a multiple of the time units of the basic system clock cycle SYSCLOCK_CYCLE_TIME. 1 is the standard setting. This means that the position control clock cycle corresponds to the basic system clock cycle SYSCLOCK_CYCLE_TIME. Setting values > 1 involves computation time for processing the additional timer interrupts by the operating system and should only be used in cases where a task exists in the system that should run faster than the position controller clock cycle. For systems with PROFIBUS-DP connection, this MD represents ratio between the PROFIBUS-DP clock cycle and position controller clock cycle.			
Special cases, errors,...				
corresponds with..				

10070 MD number	**$MN_IPO_SYSCLOCK_TIME_RATIO** Factor for interpolator clock cycle			
Default value: 4		Min. input limit: 1		Max. input limit: 100
Change becomes effective after: POWER ON			Protection level: 7/2	Unit: -
Data type: DWORD				
Significance:	The interpolator clock cycle is entered as a multiple of the time units of the basic system clock cycle SYSCLOCK_CYCLE_TIME. It is only permissible to set integer multiples of the position controller clock cycle (set using POSCTRL_SYSCLOCK_TIME_RATIO). Values, that do not represent an integer multiple of the position controller clock cycle are automatically increased to the next integer multiple of the position controller clock cycle before they become effective (at the next boot). In this case, Alarm 4102 ”IPO cycle increase to [ ] ms” is output.			
Special cases, errors,...				
corresponds with..	MD 10060: POSCTRL_SYSCLOCK_TIME_RATIO			

10071 MD number	**$MN_IPO_CYCLE_TIME** Interpolator cycle			
Default value: 0.0		Min. input limit: -		Max. input limit: -
Change becomes effective after: POWER ON			Protection level: 7/2	Unit: -
Data type: DWORD				
Significance:	Interpolation time Displays the interpolator clock cycle time (this cannot be modified !). Internally, this is formed from the machine data SYSCLOCK_CYCLE_TIME and IPO_SYSCLOCK_TIME_RATIO.			
Special cases, errors,...				
corresponds with..	MD 10050: SYSCLOCK_CYCLE_TIME MD 10070: IPOL_SYSCLOCK_TIME_RATIO			

10089 MD number	**$MN_SAFE_PULSE_DIS_TIME_BUSFALL** Wait time pulse cancellation when the bus fails			
Default value: 0.0		Min. input limit: 0.0		Max. input limit: 0.8
Change becomes effective after: POWER ON			Protection level: 7/2	Unit: s
Data type: DOUBLE				
Significance:	Time after which a communication failure to the drive occurs the pulses are safely canceled. During this time it is still possible to implement a response that is executed independently in the drive (refer to extended stop and retract). In the following cases, the system does not wait for this time up to pulse cancellation to expire: • When selecting an external STOP A, a test stop or a test stop of an external shutdown • When SBH is active or SBH is selected • For an active SG stage or when selecting an SG stage for which immediate pulse cancellation is parameterized in $MA_SAFE_VELO_STOP_MODE or $MA_SAFE_VELO_STOP_REACTION. Note: $MN_SAFE_PULSE_DIS_TIME_BUSFAIL is transferred to drive parameter p9580 using the copy function of SI-MD and compared in a crosswise data comparison. This general machine data is included in the axial checksum calculation of the safety-related machine data ($MA_SAFE_ACT_CHECKSUM, $MA_SAFE_DES_CHECKSUM).			
Special cases, errors,...				
corresponds with..				

10090 MD number	**$MN_SAFETY_SYSCLOCK_TIME_RATIO** Factor for the monitoring clock cycle			
Default value: 3		Min. input limit: 1		Max. input limit: 50
Change becomes effective after: POWER ON			Protection level: 7/1	Unit: -
Data type: DWORD				
Significance:	Ratio between the monitoring and system basic clock cycle. The monitoring clock cycle is the product of this data and $MN_SYSCLOCK_CYCLE_TIME.			
Special cases, errors,...	The monitoring clock cycle is checked during run-up: • It must be an integral multiple of the position control clock cycle • It must be < 25 ms If these conditions are not fulfilled, the factor is rounded-off to the next possible value. The monitoring cycle that is actually set is displayed using $MN_INFO_SAFETY_CYCLE_TIME. Further, the value for the crosswise data comparison clock cycle that is displayed using $MN_INFO_CROSSCHECK_CYCLE_TIME also changes. Note: The monitoring clock cycle defines the response time of the monitoring functions. It should be noted that a short monitoring clock cycle time increases the load on the CPU.			
corresponds with..	MD 10050: $MN_SYSCLOCK_CYCLE_TIME MD 10091: $MN_INFO_SAFETY_CYCLE_TIME MD 10092: $MN_INFO_CROSSCHECK_CYCLE_TIME			

10091 MD number	**$MN_INFO_SAFETY_CYCLE_TIME** Displays the monitoring clock cycle time			
Default value: 0		Min. input limit: -		Max. input limit:
Change becomes effective after: POWER ON			Protection level: 7/0	Unit: s
Data type: DOUBLE				
Significance:	Display data: Displays the actually effective monitoring clock cycle. This data cannot be written to. The data value is always re-calculated as soon as one of the following data is changed: SAFETY_SYSCLOCK_TIME_RATIO POSCTRL_SYSCLOCK_TIME_RATIO SYSCLOCK_CYCLE_TIME The new value only becomes effective after power on.			
corresponds with:	MD 10090: $MN_SAFETY_SYSCLOCK_TIME_RATIO			
Additional references	/FBSI/ see Chapter 5.1, ”Monitoring clock cycle”, Chapter 5.2 ”Crosswise data comparison”			

10092 MD number	**$MN_INFO_CROSSCHECK_CYCLE_TIME** Displays the clock cycle time for a crosswise data comparison			
Default value: 0.0		Min. input limit: -		Max. input limit:
Change becomes effective after: POWER ON			Protection level: 7/0	Unit: s
Data type: DOUBLE				
Significance:	Display data: Maximum crosswise data comparison in seconds. This is obtained from the INFO_SAFETY_CYCLE_TIME and the number of data to be compared crosswise (depending on the drive type being used, this can differ for the individual axes). The data value is always re-calculated as soon as one of the following data is changed: SAFETY_SYSCLOCK_TIME_RATIO POSCTRL_SYSCLOCK_TIME_RATIO SYSCLOCK_CYCLE_TIME The new value only becomes effective after power on.			
corresponds with ...	MD 10090: $MN_SAFETY_SYSCLOCK_TIME_RATIO MD 36992: $MA_SAFE_CROSSCHECK_CYCLE			
Additional references	/FBSI/ see Chapter 5.1, ”Monitoring clock cycle”, Chapter 5.2 ”Crosswise data comparison”			

10093 MD number	**$MN_INFO_NUM_SAFE_FILE_ACCESS** Number of SPL file access operations			
Default value: 0		Min. input limit: 0		Max. input limit: -
Change becomes effective after: POWER ON			Protection level: 0/0	Unit: -
Data type: DWORD				
Significance:	Display data: SPL file /_N_CST_DIR/_N_SAFE_SPF has been accessed n-times in the protected state. This MD is only used for service purposes. The value of the MD can only be 0 or 1. The value cannot be changed.			
Special cases, errors,...				

10094 MD number	$MN_SAFE_ALARM_SUPPRESS_LEVEL Alarm suppression level	
Default value: 2	Min. input limit: 0	Max. input limit: 113
Change becomes effective after: POWER ON	Protection level: 7/2	Unit: -
Data type: BYTE		

Significance:

The monitoring channels NCK and drive or NCK and PLC display alarms with the same significance in several situations.
In order to reduce the size of the alarm screen, this MD is used to specify whether safety alarms with the same significance are to be suppressed. The two-channel stop response is not influenced by the setting.
0 = alarms triggered in two channels are displayed to the full extent
- Two-channel display of all axial safety alarms
- Alarm 27001, fault code 0 is displayed
- Alarms 27090, 27091, 27092, 27093 and 27095 are displayed through two channels and a multiple number of times.

1 = alarms with the same meaning are only displayed once.
This involves the following alarms and messages:
27010 = C01707
27011 = C01714
27012 = C01715
27013 = C01706
27020 = C01710
27021 = C01709
27022 = C01708
27023 = C01701
27024 = C01700
For these alarms, only one of the specified alarms (270xx or C01xxx) is initiated. The alarm of the monitoring channel that then subsequently initiates the alarm with the same significance, is no longer displayed.
Furthermore, Alarm 27001 with fault code 0 is suppressed. This alarm occurs as a result of drive Alarm C01711. In this particular case, drive parameters r9710[0,1], r9711[0,1], r9735[0,1], r9736[0,1], r9737[0,1], r9738[0,1], r9739[0,1] provide information regarding the cause of the error.
2= default
Going beyond the functionality with MD value=1, the alarms from the SPL processing (27090, 27091, 27092, 27093 and 27095) are only displayed through one channel and only once. This also applies to alarms of the PROFIsafe communications (27250 and following).
3= axial Alarms 27000 and A01797 are replaced by Alarm message 27100 for all axes/drives. Alarm 27040 is replaced by Alarm 27140 for all axes/drives.
12= going beyond the functionality with MD value = 2, the alarms are assigned priorities. What appears to be apparent follow-on alarms are no longer displayed or are automatically cleared from the display.
The following alarms may be involved:
27001, 27004, 27020, 27021, 27022, 27023, 27024, 27091, 27101, 27102, 27103, 27104, 27105, 27106, 27107
13= going beyond the functionality with MD value = 3, the alarms are assigned priorities as for MD value 12.
This machine data must be set to 0 to generate an acceptance report. This allows the system to document all of the alarms that have been initiated.
xx (100 position set) = axial acceptance test alarms of the NCK (27032, 27035, 27060) are replaced in the SPL commissioning mode by Alarm 27135 for all axes.

This machine data must be set to 0 to generate an acceptance report. This allows the system to document all of the alarms that have been initiated.

Special cases, errors,...

10095 MD number	$MN_SAFE_MODE_MASK ’Safety Integrated’ operating modes	
Default value: 0	Min. input limit: 0	Max. input limit: 0x0001
Change becomes effective after: POWER ON	Protection level: 7/2	Unit: –
Data type: DWORD		
Significance:	Bit 1=0: The ”Modular PROFIsafe I/O interface” function is not active. Bit 1=1: The ”Modular PROFIsafe I/O interface” function is active. Bit 2=0: The reduced language scope for SAFE.SPF is only activated for an automatic state when booting ($MC_PROG_EVENT_MASK Bit 5) Bit 2=1: The reduced language scope for SAFE.SPF is also activated if SAFE.SPF is called using the CALL command	

10096 MD number	$MN_SAFE_DIAGNOSIS_MASK ’Safety Integrated’ diagnostic functions	
Default value: 1	Min. input limit: 0	Max. input limit: 0x0007
Change becomes effective after: NewConf	Protection level: 7/2	Unit: –
Data type: DWORD		
Significance:	Bit 0=0 SGE differences between NCK and the drive monitoring channels are not displayed Bit 0=1 Default: SGE differences between NCK and the drive monitoring channels are displayed Differences between the following SGEs are detected (the listed bit numbers refer to the axial mapping of the SGEs – these correspond to the assignment of the axial VDI interface): Bit 0: SBH/SG deselection = DB3<x>.DBX22.0 Bit 1: SBH deselection = DB3<x>.DBX22.1 Bit 3: SG selection, bit 0 = DB3<x>.DBX22.3 Bit 4: SG selection, bit 1 = DB3<x>.DBX22.4 Bit 12: SE selection = DB3<x>.DBX23.4 Bit 28: SG correction, bit 0 = DB3<x>.DBX33.4 Bit 29: SG correction, bit 1 = DB3<x>.DBX33.5 Bit 30: SG correction, bit 2 = DB3<x>.DBX33.6 Bit 31: SG correction, bit 3 = DB3<x>.DBX33.7 The differences are indicated using message Alarm 27004. Bit 1 = 0: Default: Displays an unsuccessful SPL start after the timer defined in MD SAFE_SPL_START_TIMEOUT has expired with Alarm 27097 Bit 1 = 1: Display of Alarm 27097 is suppressed. Alarm 27097 indicates, that in spite of the SPL configuration, SPL was not started after the time set in MD SAFE_SPL_START_TIMEOUT expired. For the cause, refer to the description of Alarm 27097. Bit 2 = 0: Default: Communication errors with SFC error codes are displayed using Alarm 27354 bit 2 = 1: Display of Alarm 27354 is suppressed	
Special cases, errors,...		

10097 MD number	**$MN_SAFE_SPL_STOP_MODE** Stop response for SPL errors	
Default value: 3	Min. input limit: 3	Max. input limit: 4
Change becomes effective after: POWER ON	Protection level: 7/2	Unit: -
Data type: BYTE		
Significance:	Selects the stop response when errors are detected in the crosswise data comparison of NCK and PLC-SPL 3: Stop D 4 Stop E When the value 4 is entered in this MD (Stop E) without enabling the external Stop E in all axes with SI function enable signals ($MA_SAFE_FUNCTION_ENABLE not equal to 0) results in Alarm 27033, ”Axis %1 Invalid parameterization of MD MN_SAFE_SPL_STOP_MODE”. To remedy this, either parameterize Stop D or set bit 4 and bit 6 in $MA_SAFE_FUNCTION_ENABLE for all of the axes involved. If this MD is set to 4, then DB18.DBX36.1 (Stop E) must also be set to 1 in order to communicate this parameterization to the PLC. For a different parameter assignment, Alarm 27090 is output, ”Error for crosswise data comparison NCK-PLC”.	
Special cases, errors,...		

10098 MD number	**$MN_PROFISAFE_IPO_TIME_RATIO** Factor PROFIsafe communications clock cycle time	
Default value: 1	Min. input limit: 1	Max. input limit: 25
Change becomes effective after: POWER ON	Protection level: 7/1	Unit: -
Data type: DWORD		
Significance:	Ratio between PROFIsafe communication and interpolation clock cycle. The actual PROFIsafe communication clock cycle is the product from this data and IPO_CYCLE_TIME and is displayed in MD INFO_PROFISAFE_CYCLE_TIME. In this clock cycle, OB40 on the PLC side is initiated from the NCK to enable communication between the F master and F slaves. The PROFIsafe communications clock cycle may not be greater than 25 ms.	
Special cases, errors,...		

10099 MD number	**$MN_INFO_PROFISAFE_CYCLE_TIME** PROFIsafe communications clock cycle time	
Default value: 0.0	Min. input limit: -	Max. input limit: -
Change becomes effective after: Power On	Protection level: 7/0	Unit: s
Data type: DOUBLE		
Significance:	Display data: Time grid for communications between an F master and F slave. The value is obtained from the interpolator clock cycle and MD $MN_PROFISAFE_IPO_TIME_RATIO. The value cannot be changed. PROFIsafe communications via the OB40 in the PLC use this time grid.	
Special cases, errors,...		

10385 MD number	$MN_PROFISAFE_MASTER_ADDRESS[n] 0 ... 15 PROFIsafe address of the PROFIsafe master module	
Default value: 0	Min. input limit: 0	Max. input limit: 0x0500FA7DH
Change becomes effective after: POWER ON	Protection level: 7/2	Unit: -
Data type: DWORD		
Significance:	Defines the PROFIsafe address for the F master NCK/PLC. This is used to uniquely assign an F master to an F slave. This parameter must be entered in accordance with the "F_source_address" parameter set in S7-ES for the F slaves. An attempt to establish communications is only made for F slaves that have entered this address. Format: 0s 00 aaaa s: Bus segment (5 = I/O connection on the PLC side) aaaa: Hexadecimal PROFIsafe address of the F master	
Special cases, errors,...		

10386 MD number	$MN_PROFISAFE_IN_ADDRESS[n]: 0 ... 15 PROFIsafe address of an input module	
Default value: 0	Min. input limit: 0	Max. input limit: 0x0501FFFF
Change becomes effective after: POWER ON	Protection level: 7/2	Unit: -
Data type: DWORD		
Significance:	Definition of the PROFIsafe target address of a PROFIsafe input module Format: 0s 0x aaaa s: Bus segment (5 = I/O connection on the PLC side) x: Sub-slot address Range of values: 0...1 x = 0 addresses the F net data signals 1 ...32 x = 1 addresses the F net data signals 33 ...64 aaaa: Hexadecimal PROFIsafe address of the F module	
Special cases, errors,...		

10387 MD number	$MN_PROFISAFE_OUT_ADDRESS[n]: 0 ... 15 PROFIsafe address of a PROFIsafe output module	
Default value: 0	Min. input limit: 0	Max. input limit: 0x0501FFFFH
Change becomes effective after: POWER ON	Protection level: 7/2	Unit: -
Data type: DWORD		
Significance:	PROFIsafe target address of a PROFIsafe output module Format: 0s 0x aaaa s: Bus segment (5 = I/O connection on the PLC side) x: Sub-slot address Range of values: 0...1 x = 0 addresses the F net data signals 1 ...32 x = 1 addresses the F net data signals 33 ...64 aaaa: Hexadecimal PROFIsafe address of the F module	
Special cases, errors,...		

10388 MD number	**$MN_PROFISAFE_IN_ASSIGN[n]: 0 ... 15** Input assignment $A_INSE to PROFIsafe module	
Default value: 0	Min. input limit: 0	Max. input limit: 64064
Change becomes effective after: POWER ON	Protection level: 7/2	Unit: –
Data type: DWORD		
Significance:	The SPL area data is specified in the decimal notation in the following format: **aaa bbb** with aaa = area limit 1, SPL signal $A_INSE[**aaa**] bbb = area limit 2, SPL signal $A_INSE[**bbb**] Example: PROFISAFE_IN_ASSIGN[0] = **4001** or alternatively **1004**: The system variable area $A_INSE[**1**] to $A_INSE[**4**] is supplied with the state of the input terminals of the PROFIsafe module, which were parameterized using MD PROFISAFE_IN_ADDRESS[0] and were selected using MD PROFISAFE_IN_FILTER[0].	
Special cases, errors,...		

10389 MD number	**$MN_PROFISAFE_OUT_ASSIGN[n]: 0 ... 15** Output assignment, $A_OUTSE to PROFIsafe module	
Default value: 0	Min. input limit: 0	Max. input limit: 64064
Change becomes effective after: POWER ON	Protection level: 7/2	Unit: –
Data type: DWORD		
Significance:	The SPL area data is specified in the decimal notation in the following format: **aaa bbb** with aaa = area limit 1, SPL signal $A_OUTSE[**aaa**] bbb = area limit 2, SPL signal $A_OUTSE[**bbb**] Example: PROFISAFE_OUT_ASSIGN[0] = **4001** or alternatively **1004**: The output terminals of the PROFIsafe module, selected using MD PROFISAFE_IN_FILTER[0] are supplied with the states of the system variables $A_OUTSE[**1**] to $A_OUTSE[**4**].	
Special cases, errors,...		

10393 MD number	**$MN_SAFE_DRIVE_LOGIC_ADDRESS** Logical drive addresses, SI	
Default value: 6700, 6724, 6748, 6772, 6796, 6820, 6844, 6868, 6892, 6916, 6940, 6964, 6988, 7012, 7036, 7060, 7084, 7108, 7132, 7156, 7180, 7204, 7228, 7252, 7276, 7300, 7324, 7348, 7372, 7396, 7420, 7444, 7468, 7492, 7516, 7540, 7564	Min. input limit: 258	Max. input limit: 8191
Change becomes effective after: POWER ON	Protection level: 7/2	Unit: –
Data type: DWORD		
Significance:	Logical I/O addresses of the SI telegram of drives connected to PROFIBUS. An address is assigned to a drive.	
Special cases, errors,...		

11411 MD number	**$MN_ENABLE_ALARM_MASK** Activation of alarms		
Default value: 0	Min. input limit: -	Max. input limit: -	
Change becomes effective after: RESET	Protection level: 7/2	Unit: -	
Data type: DWORD			
Significance:	Screen form to generate alarms, which are normally suppressed. Bit set: Alarms of this alarm group are output. Bit not set: Alarms of this alarm group are not output. Bit hex. value, Meaning == 0: 0x1 Alarms are output, which have as alarm response SHOWALARMAUTO. 1: 0x2 Alarms are output, which have as alarm response SHOWWARNING. 2: 0x4 Alarm 22280 ”Thread power-up path too short” is output. 3: 0x8 Alarms, which are triggered by the NCU LINK MODULE, are switched-in. 4: 0x10 Alarm 10883 ”Chamfer or rounding must be shortened” permitted. 5: 0x20 Alarm 20096 ”Brake test interrupted” is output. 6: 0x40 Alarm 16956 ”Program cannot be started because of global start inhibit” is output. Alarm 14005 ”Program cannot be started because of program-specific start inhibit” is output. Alarm can only be switched-in in the RESET channel state, in all other channel states, it is output without any associated conditions. 7: 0x80 Alarm 16957 ”Stop-delay range is suppressed” is output. 8: 0x100 Alarm 1011 Fine coding 150019 or 150020 ”Incorrect axis number in the LINK” 9: 0x200 Alarm 22033 Diagnostics 1 to 6 for ”Track synchronous operation” (couplings) 10: 0x400 Alarm 15122 ”Power on after power failure: %1 data were restored, of which %2 machine data, %3 error” is output. 11: 0x800 Alarms 10722, 10723, 10732 or 10733 are output instead of alarms 10720, 10721, 10730 or 10731. 12: 0x1000 Alarm 22033 Diagnostics greater than or equal to 7 for ”Track synchronous operation” (couplings)		
Special cases, errors,...			

11415 MD number	**$MN_SUPPRESS_ALARM_MASK_2** Suppress alarm outputs				
Default value: 0x8		Min. input limit: -		Max. input limit: -	
Change becomes effective after: Power On			Protection level: 7/2		Unit: -
Data type: DWORD					
Significance:	Screen form for suppressing special alarm outputs. Bit set: The corresponding alarm (warning) is **not** triggered. Bit hex. Meaning Value === 0: 0x1 16773 ”Channel %1 Axis %3 is following axis. The axis/spindle locks of the leading axes are different” 1: 0x2 2100 ”NCK battery warning level reached” 2101 ”NCK battery alarm” 2102 ”NCK battery alarm” 2: 0x4 2120 ”NCK fan alarm” (ineffective on modules which do not require a fan by design) 3: 0x8 15120 ”PowerFail: Show buffer overflow” 4: 0x10 15187 ”Error during execution of PROGEVENT file” 5: 0x20 15188 ”Error during execution of ASUB file” 6: 0x40 26120 ”$AA_ESR_ENABLE = 1 and axis is to become neutral” 26121 ”Axis is neutral and $AA_ESR_ENABLE =1 is to be set” 26123 ”$AA_ESR_ENABLE = 1 is to be set, but $MA_ESR_REACTION is not set” 26124 ”$AC_TRIGGER triggered, but axis is neutral, ESR ignores this axis” 7: 0x80 10724 ”Software limit violated at start of block” 10734 ”Operating range limit violated at start of block” 10737 ”Work (WCS) operating range limit violated at start of block” 8: 0x100 14008 ”WRITE command in /_N_EXT_DIR” 10734 ”Operating range limit violated at start of block” 10737 ”Work (WCS) operating range limit violated at start of block” 9: 0x200 14006 ”Invalid program name” 10: 0x400 4006 ”Maximum number of axes that can be activated exceeded” 11: 0x800 16017 ”LIFTFAST ignores this axis, as it cannot be used for the current axis type” 12: 0x1000 22025 ”Channel %1 Block %2 Following axis/spindle %3 Synchronism (2): Fine tolerance exceeded” - Exception: The alarm is generated if for the following axis/spindle involved, CPMALARM[FAx] Bit 8 = 0 is programmed. 22026 ”Channel %1 Block %2 Following axis/spindle %3 Synchronism (2): Coarse tolerance exceeded” - Exception: The alarm is generated if for the following axis/spindle involved, CPMALARM[FAx] Bit 9 = 0 is programmed. 13: 0x2000 22001 ”Braking ramp longer than Stop D time.” 22002 ”Braking ramp longer than Stop D time with gear stage %3 Reason %4.” 14: 0x4000 16963 ”ASUB start refused.” 15: 0x8000 21751,”Limit velocity %2 deg/min on modulo axis %1 exceeded (defective cam output)” 21752,”Axis %1 minimum cam width cam %3 undershot at curr. velocity %2” 16: 0x10000 17212 ”Channel %1 tool management: Load manual tool %3, duplo no. %2 into the spindle/toolholder” 17214 ”Channel %1 tool management: Remove manual tool %3 from spindle/toolholder %2” 17215 ”Channel %1 tool management: Unload manual tool %3 from buffer location %2” 17216 ”Channel %1 unload manual tool from toolholder %4 and load manual tool %3 %2” 17: 0x20000 16771 ”Channel %1 Block %3 Following axis %2 overlaid movement not enabled”					
Special cases, errors,...					

11500 MD number	**$MN_PREVENT_SYNACT_LOCK** Protected synchronized actions			
Default value: 0.0		Min. input limit: 0		Max. input limit: 255
Change becomes effective after: Power On			Protection level: 7/2	Unit: -
Data type: DWORD				
Significance:	Fist and last ID of a protected synchronized action area. Synchronized actions with ID numbers that are located in the protected range, can no longer be: - overwritten - deleted (CANCEL) - disabled (lock) once they have been defined. Protected synchronized actions cannot be disabled via the PLC either. They are indicated to the PLC as non-lockable in the interface. Note: Protection for synchronized actions must be cancelled while generating the synchronized actions as otherwise, at each change, a POWER ON would be necessary in order to redefine the logic. With 0.0, there is no area of protected synchronized actions. The function is switched-out. The values are read as absolute values and the upper and lower values can be specified in any sequence.			
Special cases, errors,...				

11602 MD number	**$MN_ASUP_START_MASK** Ignore stop conditions for ASUB			
Default value: 0		Min. input limit: 0		Max. input limit: 0xf
Change becomes effective after: POWER ON			Protection level: 7/2	Unit: -
Data type: DWORD				
Significance:	The machine data specifies which stop reasons are to be ignored for an ASUB start. The ASUB is started or the following stop reasons are ignored: **Bit 0:** Stop reason: Stop key, M0 or M01 If the NCK is in the reset state or JOG mode), an ASUB is immediately started (without this bit, an ASUB cannot be started in RESET/JOG). NOTICE This bit is implicitly set if, in $MN_PROG_EVENT_MASK if there is a deviation from zero in one channel! This bit is implicitly set, if bit 1 is set in $MN_SEARCH_RUN_MODE! **Bit 1:** Starting also permitted even if not all of the axes are referenced. Bit 2: Starting permitted even if a read-in inhibit is active, i.e. the blocks of the ASUB program are immediately switched-in and executed. This means that the machine data IGNORE_INHIBIT_ASUP becomes ineffective. The NCK behavior corresponds to that of the machine data allocation IGNORE_INHI-BIT_ASUP= FFFFFFFF. When the bit is not set: The ASUB is selected internally, but processed only when the read-in disable is cancelled. The assignment of machine data IGNORE_INHIBIT_ASUP is evaluated. If the following also applies: IGNORE_INHIBIT_ASUP = 0, then although an ASUB is internally initiated, the blocks of the ASUB program are only changed in when the read-in inhibit is withdrawn. When the ASUB is triggered, the path is immediately braked (except with the BLSYNC option). The read-in disable is set again in the ASUB program. **Bit 3:** Notice: The following function can always be activated in single-channel systems. Multi-channel systems required, in addition, bit 1 in machine data $MN_BAG_MASK. The function is only effective for ASUBs, that were activated from the interrupted program state (channel status reset). The function does not work in multi-channel systems without $MN_BAG_MASK bit 1. If an ASUB is automatically started from the JOG mode, then the user may stop in the middle of the ASUB program. The JOG operating mode is continuously displayed to the user. In this situation, the user can jog as BIT 3 is set. Without bit 3, this is not possible. In this situation, the mode change is interlocked with Alarm 16927. The user can continue the ASUB program using the ”start” key. It goes without saying that the user cannot jog as long as the ASUB program is running. The user may jog again once the ASUB program has ended. Bit 4...15: reserved			
corresponds with ...	MD 11604: ASUP_START_PRIO_LEVEL			
Special cases, errors,...				

11604 MD number	**$MN_ASUP_START_PRIO_LEVEL** Priorities as of which ASUP_START_MASK takes effect			
Default value: 0		Min. input limit: 0		Max. input limit: 128
Change becomes effective after: POWER ON			Protection level: 7/2	Unit: –
Data type: DWORD				
Significance:	This machine data specifies from which ASUB priority the machine data ASUP_START_MASK is to be applied. MD ASUP_START_MASK is applied from the level specified here up to the highest ASUB priority level 1.			
corresponds with ...	MD 11602 ASUP_START_MASK			
Additional references				

13300 MD number	**$MN_PROFISAFE_IN_FILTER** F useful (net) data filter IN			
Default value: 0xFFFFFFFF		Min. input limit: –		Max. input limit: –
Change becomes effective after: POWER ON			Protection level: 7/2	Unit: –
Data type: DWORD				
Significance:	Filter between F net (useful) data and $A_INSE variables The machine data: $MN_PROFISAFE_IN_FILTER is used to define which F net data bits of the PROFIsafe module are accepted for further processing from the F net data interface of the PROFIsafe module in the NCK. The filtered F net data bits are pushed together inside the NCK to form a bit array without any gaps (consecutive bit array). The machine data: $MN_PROFISAFE_IN_ASSIGN is then used to define in which $INSE variables, the filtered F net data bits are transferred. Example: Note: For reasons of simplicity, only 16 bits are taken into consideration. Parameter assignment: PROFISAFE_IN_FILTER = 1010100101000100 PROFISAFE_IN_ASSIGN = 011006 n = 16 11 6 1 1010 1000 0000 0100 value at the F net data interface of the PROFIsafe module 1010 1001 0100 0100 $MN_PROFISAFE_IN_FILTER 0000 0000 0011 1001 internal NCK F net data image xxxx x111 001x xxxx $INSE[n], x = not relevant			
corresponds with ...				
Additional references				

13301 MD number	**$MN_PROFISAFE_OUT_FILTER** F net (useful) data filter OUT	
Default value 0xFFFFFFFF	Min. input limit: -	Max. input limit: -
Change becomes effective after: POWER ON	Protection level: 7/2	Unit: -
Data type: DWORD		
Significance:	Filter between $A_OUTSE variables and F net (useful) data The machine data: PROFISAFE_OUT_ASSIGN is used to define which $A_OUTSE[n] variables are transferred into the F net data bits of the PROFIsafe module. The machine data: PROFISAFE_OUT_FILTER is used to define which F net data bit is transferred to the particular $A_OUTSE[n] variable. Example: Note: For reasons of simplicity, only 16 bits are taken into consideration. Parameter assignment: $MN_PROFISAFE_OUT_FILTER = 1010100101000100 $MN_PROFISAFE_OUT_ASSIGN = 011006 n = 16 11 6 1 xxxx x111 111x xxxx example value in the $OUTSE variables, x not relevant 0000 0000 0011 1111 internal NCK F net data image 1010 1001 0100 0100 $MN_PROFISAFE_OUT_FILTER 1010 1001 0100 0100 F net data of the PROFIsafe module	
corresponds with ...		
Additional references		

13302 MD number	**$MN_PROFISAFE_IN_ENABLE_MASK** Enable screen form of the connections to PROFIsafe input modules	
Default value 0	Min. input limit: 0	Max. input limit: FFFFH
Change becomes effective after: Restart	Protection level: 7/2	Unit: -
Data type: DWORD		
Significance:	The machine data sets of the PROFIsafe connections to PROFIsafe input modules are enabled using the enable screen forms. A machine data set includes the following data: - $MN_PROFISAFE_IN_ADDRESS[n] - $MN_PROFISAFE_IN_ASSIGN[n] - $MN_PROFISAFE_IN_FILTER[n] - $MN_PROFISAFE_IN_SUBS[n] Bit n = 0 The machine data set [n] is checked for consistency, but is however not active. The PROFIsafe connection [n] or the slot [n] is inactive. Bit n = 1 The machine data set [n] is active. The PROFIsafe connection [n] or the slot [n] is active.	
corresponds with ...		
Additional references		

13303 MD number	**$MN_PROFISAFE_OUT_ENABLE_MASK** Enable screen form of the connections to PROFIsafe outputs modules			
Default value 0		Min. input limit: 0		Max. input limit: FFFFH
Change becomes effective after: Restart			Protection level: 7/2	Unit: –
Data type: DWORD				
Significance:	The machine data sets of the PROFIsafe connections to PROFIsafe output modules are enabled using the enable screen forms. A machine data set includes the following data: – $MN_PROFISAFE_OUT_ADDRESS[n] – $MN_PROFISAFE_OUT_ASSIGN[n] – $MN_PROFISAFE_OUT_FILTER[n] Bit n = 0 The machine data set [n] is checked for consistency, but is however not active. The PROFIsafe connection [n] or the slot [n] is inactive. Bit n = 1 The machine data set [n] is active. The PROFIsafe connection [n] or the slot [n] is active.			
corresponds with ...				
Additional references				

13304 MD number	**$MN_PROFISAFE_IN_SUBS_ENAB_MASK** Activation of the substitute value output for PROFIsafe input modules			
Default value 0		Min. input limit: 0		Max. input limit: FFFFH
Change becomes effective after: Restart			Protection level: 7/2	Unit: –
Data type: DWORD				
Significance:	The substitute value output for connections to PROFIsafe input modules is enabled using the enable screen form. Bit n = 0 For the connection parameterized in machine data set [n], the process data of the PROFI-safe input module are transferred into the SPL input data. The PROFIsafe connection [n] or the slot [n] is active. Bit n = 1 For the connection parameterized in machine data set [n], the substitute values from $MN_PROFISAFE_IN_SUBS[n] are transferred into the SPL input data. The PROFIsafe connection [n] or the slot [n] is passive.			
corresponds with ...				
Additional references				

13305 MD number	**$MN_PROFISAFE_IN_SUBS** Substitute values for passive connections to PROFIsafe input modules			
Default value 0		Min. input limit: 0		Max. input limit: FFFFFFFFH
Change becomes effective after: Restart			Protection level: 7/2	Unit: -
Data type: DWORD				
Significance:	For passive connections to PROFIsafe input modules, substitute values parameterized in the machine data are transferred to SPL inputs ($A_INSE) parameterized using $MN_PROFISAFE_IN_ASSIGN[n]. If the SPL inputs parameterized using $MN_PROFISAFE_IN_ASSIGN[n] overlap with the SPL inputs of an active slot, then the substitute values of the passive slot are adapted by the control so that SPL inputs are not allocated twice. The states of the signals from the active slots have priority.			
corresponds with ...				
Additional references				

13308 MD number	**$MN_PROFISAFE_IN_NAME** Name of the PROFIsafe input module			
Default value -		Min. input limit: -		Max. input limit: -
Change becomes effective after: Restart			Protection level: 7/2	Unit: -
Data type: STRING				
Significance:	Every PROFIsafe input module can be assigned a symbolic name. If a name is assigned, this is displayed in the alarm text instead of the PROFIsafe address.			
corresponds with ...				
Additional references				

13309 MD number	**$MN_PROFISAFE_OUT_NAME** Name of the PROFIsafe output module			
Default value -		Min. input limit: -		Max. input limit: -
Change becomes effective after: Restart			Protection level: 7/2	Unit: -
Data type: STRING				
Significance:	Every PROFIsafe output module can be assigned a symbolic name. If a name is assigned, this is displayed in the alarm text instead of the PROFIsafe address.			
corresponds with ...				
Additional references				

13310 MD number	**$MN_SAFE_SPL_START_TIMEOUT** Delay, display Alarm 27097			
Default value 20.		Min. input limit: 1.		Max. input limit: 60.
Change becomes effective after: POWER ON			Protection level: 7/2	Unit: s
Data type: DOUBLE				
Significance:	After the control has booted, after the time has expired, Alarm 27097 is displayed if there was no SPL start.			
corresponds with ...				
Additional references				

13312 MD number	**$MN_SAFE_SPL_USER_DATA[0...3]** User data			
Default value 0		Min. input limit: 0x0		Max. input limit: 0xFFFFFFFF
Change becomes effective after: POWER ON			Protection level: 7/2	Unit: –
Data type: DWORD				
Significance:	User data is used to save user-specific information. Using crosswise data comparison between the NCK and PLC, this data is monitored for changes. Changes to this data are identified by the checksum calculation and signaled with alarm 27070. The data must match the corresponding PLC data (DB18, DBD 256 – 268). Discrepancies between the NCK and PLC lead to the parameterized Stops (STOP D or STOP E) being initiated and are displayed using Alarm 27090.			
corresponds with ...				
Additional references				

13316 MD number	**$MN_SAFE_GLOB_CONFIG_CHANGE_DATA[0...6]** Date/time of the last change SI-NCK-MD			
Default value –		Min. input limit: –		Max. input limit: –
Change becomes effective after: POWER ON			Protection level: 7/–	Unit: –
Data type: DWORD				
Significance:	Safety system, display data: Date and time of the last configuration change of safety-related NCK machine data. Changes made to the machine data that are calculated into the checksums SAFE_GLOB_ACT_CHECKSUM are recorded.			
corresponds with ...				
Additional references				

13317 MD number	**$MN_SAFE_GLOB_PREV_CONFIG[0...10]** Data, previous safety configuration		
Default value 0H	Min. input limit: 0H	Max. input limit: FFFFFFFFH	
Change becomes effective after: POWER ON	Protection level: Siemens	Unit: –	
Data type: DWORD			
Significance:	Safety system, display data: Buffer memory to save previous safety configuration data Index 0: Status flag bit of the change history Index 1: Previous value, option data Index 2: Previous value, reference checksum SAFE_GLOB_DES_CHECKSUM[0] Index 3: Last value, option data before loading default data Index 4: Last value, reference checksum SAFE_GLOB_DES_CHECKSUM[0] before loading default data Index 5: Previous value, reference checksum SAFE_GLOB_DES_CHECKSUM[1] Index 6: Last value, reference checksum SAFE_GLOB_DES_CHECKSUM[1] before loading default data Index 7: Previous value, reference checksum SAFE_GLOB_DES_CHECKSUM[2] Index 8: Last value, reference checksum SAFE_GLOB_DES_CHECKSUM[2] before loading default data Index 9: Previous value, reference checksum SAFE_GLOB_DES_CHECKSUM[3] Index 10: Last value, reference checksum SAFE_GLOB_DES_CHECKSUM[3] before loading default data.		
corresponds with ...			
Additional references			

13318 MD number	**$MN_SAFE_GLOB_ACT_CHECKSUM[0...3]** Actual checksum NCK		
Default value 0H	Min. input limit: 0H	Max. input limit: FFFFFFFFH	
Change becomes effective after: POWER ON	Protection level: 7/–	Unit: –	
Data type: DWORD			
Significance:	Safety system, display data: The actual checksum – calculated after POWER ON or a RESET – over the actual values of safety-related machine data is entered here. Assignment of the field indices: Index 0: General safety parameterization, parameterization of the SPL I/O coupling Index 1: SPL user data Index 2: Enable I/O connection (PROFIsafe and F_SEND/F_RECV) Index 3: PROFIsafe parameters from the S7 configuring		
corresponds with ...			
Additional references			

13319 MD number	**$MN_SAFE_GLOB_DES_CHECKSUM[0...3]** Reference checksum		
Default value 0H	Min. input limit: 0H	Max. input limit: FFFFFFFFH	
Change becomes effective after: POWER ON	Protection level: 7/-	Unit: -	
Data type: DWORD			
Significance:	This machine data contains the reference checksum over the actual values of safety-related machine data that was saved during the last machine acceptance test. Assigning the indices: Index 0: General safety parameterization, parameterization of the SPL I/O coupling Index 1: SPL user data Index 2: Enable I/O connection (PROFIsafe and F_SEND/F_RECV) Index 3: PROFIsafe parameters from the S7 configuring		
corresponds with ...			
Additional references			

13320 MD number	**$MN_SAFE_SRDP_IPO_TIME_RATIO** Factor F_DP communication clock cycle		
Default value 10	Min. input limit: 1	Max. input limit: 65535	
Change becomes effective after: Restart	Protection level: 7/2	Unit: -	
Data type: DWORD			
Significance:	Ratio between the interpolator clock cycle and the F_DP clock cycle in which F_DP communication takes place. In the resulting time grid, OB40 on the PLC side is initiated from the NCK to enable F_DP communication. The value obtained for the communication clock cycle from this MD and the set IPO clock cycle may not be greater than 250 ms.		
corresponds with ...			
Additional references			

13322 MD number	**$MN_INFO_SAFE_SRDP_CYCLE_TIME** Maximum F_DP communication clock cycle		
Default value 0.0	Min. input limit: -	Max. input limit: -	
Change becomes effective after: Restart	Protection level: 7/0	Unit: s	
Data type: DOUBLE			
Significance:	Indicates the maximum time grid in which F_DP communication takes place for plant/system coupling. The value is obtained from the interpolator clock cycle and MD $MN_SAFE_SRDP_IPO_TIME_RATIO. When the set communication clock cycle is exceeded, this is also displayed here. It involves a pure display data. The value cannot be changed.		
corresponds with ...			
Additional references			

13330 MD number	**$MN_SAFE_SDP_ENABLE_MASK** Enable screen form of the SPL connections		
Default value 0	Min. input limit: 0	Max. input limit: 0xFFF	
Change becomes effective after: Restart	Protection level: 7/2	Unit: –	
Data type: DWORD			
Significance:	The particular SPL connection is activated using the individual bits of the enable screen form.		
corresponds with ...			
Additional references			

13331 MD number	**$MN_SAFE_SDP_ID[0...11]** Identifier of the F_DP communication relationship		
Default value 0	Min. input limit: –32768	Max. input limit: +32767	
Change becomes effective after: POWER ON	Protection level: 7/2	Unit: –	
Data type: DWORD			
Significance:	Any value that is unique throughout the network as identifier of the F_DP communication relationship. SIMATIC block parameters: DP_DP_ID		
corresponds with ...			
Additional references			

13332 MD number	**$MN_SAFE_SDP_NAME[0...11]** Name of the SPL connection		
Default value –	Min. input limit: –	Max. input limit: –	
Change becomes effective after: POWER ON	Protection level: 7/2	Unit: –	
Data type: STRING			
Significance:	Every SPL connection can be assigned a name. If a name is assigned, this is displayed in the alarm text instead of DP_DP_ID.		
corresponds with ...			
Additional references			

13333 MD number	**$MN_SAFE_SDP_CONNECTION_NR[0...11]** Number of the SPL connection			
Default value 0		Min. input limit: 0	Max. input limit: 3	
Change becomes effective after: POWER ON		Protection level: 7/2	Unit: –	
Data type: BYTE				
Significance:	The number of the SPL connection, which is parameterized with this data set, is set using the machine data. The SPL connection number is, at the same time, also the index to access the system variables of the user interface of this SPL connection. This following applies to the following system variables: - $A_FSDP_ERR_REAC - $A_FSDP_ERROR - $A_FSDP_SUBS_ON - $A_FSDP_DIAG Example: $MN_SAFE_SDP_CONNECTION_NR[2] = 3 means that the control and status information of the SPL connection, which is parameterized via data set 2, can be found in the system variables with the field index 3.			
corresponds with ...				
Additional references				

13334 MD number	**$MN_SAFE_SDP_LADDR[0...11]** Start address of the input and output data area of this F_DP communication relationship			
Default value 288		Min. input limit: 288	Max. input limit: 32767	
Change becomes effective after: Restart		Protection level: 7/2	Unit: –	
Data type: DWORD				
Significance:	The start address of the input and output data area, parameterized in SIMATIC STEP 7, via which the F_SENDDP of this SPL connection communicates. SIMATIC block parameters: LADDR			
corresponds with ...				
Additional references				

13335 MD number	**$MN_SAFE_SDP_TIMEOUT[0...11]** Monitoring time of the F_SENDDP			
Default value 0.5		Min. input limit: 0.0	Max. input limit: 60	
Change becomes effective after: Restart		Protection level: 7/2	Unit: s	
Data type: DOUBLE				
Significance:	The monitoring time is the time within which the F_SENDDP sends a new F telegram to F_RECVDP or F_RECVDP must have acknowledged a new F telegram. When the monitoring time is exceeded, F_RECVDP outputs substitute values to the SPL. SIMATIC block parameters: TIMEOUT			
corresponds with ...				
Additional references				

13336 MD number	**$MN_SAFE_SDP_ASSIGN[0...11]** Selects the SPL signals $A_OUTSE to transfer in the F_SENDDP net data				
Default value 0		Min. input limit: 0		Max. input limit: 64064	
Change becomes effective after: Restart			Protection level: 7/2		Unit: –
Data type: DWORD					
Significance:	The selection of the SPL signals $A_OUTSE to be transferred can only be done area for area. Format: 00 **aaa bbb** (decimal) with aaa = area limit 1, SPL signal $A_OUTSE[**aaa**] bbb = area limit 2, SPL signal $A_OUTSE**[bbb]** Example: $MN_SAFE_SDP_ASSIGN[0] = **001 004** or alternatively **004 001** The SPL signals $A_OUTSE[1] to $A_OUTSE[4] are transferred in the F_SENDDP net data selected using MD ...F_SENDDP_FILTER[0].				
corresponds with ...					
Additional references					

13337 MD number	**$MN_SAFE_SDP_FILTER[0...11]** F net data filter between the SPL interface $A_OUTSE and F_SENDDP				
Default value 0xFFFF		Min. input limit: 0		Max. input limit: 0xFFFF	
Change becomes effective after: Restart			Protection level: 7/2		Unit: –
Data type: DWORD					
Significance:	The SPL signals, selected using MD $MN_SAFE_SDP_ASSIGN are transferred in the F_SENDDP net data signals in the sequence of the filter bits set to 1. The least significant SPL signal at the least significant filter bit of the F_SENDDP set to 1 etc. – for all selected SPL signals. **Bit x = 1** An SPL signal is transferred at the bit position x of the F_SENDDP net data. **Bit x = 0** No SPL signal is transferred at the bit position x of the F_SENDDP net data.				
corresponds with ...					
Additional references					

13338 MD number	**$MN_SAFE_SDP_ERR_REAC[0...11]** Error response				
Default value 0		Min. input limit: 0		Max. input limit: 3	
Change becomes effective after: Restart			Protection level: 7/2		Unit: –
Data type: DWORD					
Significance:	The error response defined here is initiated in the case of a communication error. This value is valid as long as no other value is entered from the SPL via the system variable $A_FSDP_ERR_REAC. Meaning of values: 0 = Alarm **27350** + Stop D/E 1 = Alarm **27350** 2 = Alarm **27351** (only display, self-clearing) 3 = No system response				
corresponds with ...					
Additional references					

13340 MD number	**$MN_SAFE_RDP_ENABLE_MASK** Enable screen form of the SPL connections		
Default value 0	Min. input limit: 0	Max. input limit: 0xFFF	
Change becomes effective after: Restart	Protection level: 7/2	Unit: –	
Data type: DWORD			
Significance:	The particular SPL connection is activated using the individual bits of the enable screen form.		
corresponds with ...			
Additional references			

13341 MD number	**$MN_SAFE_RDP_ID[0...11]** Identifier of the F_RECVDP communication relationship		
Default value 0	Min. input limit: –32768	Max. input limit: +32767	
Change becomes effective after: Restart	Protection level: 7/2	Unit: –	
Data type: DWORD			
Significance:	Any value that is unique throughout the network as identifier of the F_DP communication relationship. SIMATIC block parameters: DP_DP_ID		
corresponds with ...			
Additional references			

13342 MD number	**$MN_SAFE_RDP_NAME[0...11]** Name of the SPL connection		
Default value –	Min. input limit: –	Max. input limit: –	
Change becomes effective after: Restart	Protection level: 7/2	Unit: –	
Data type: STRING			
Significance:	Every SPL connection can be assigned a name. If a name is assigned, this is displayed in the alarm text instead of DP_DP_ID.		
corresponds with ...			
Additional references			

13343 MD number	**$MN_SAFE_RDP_CONNECTION_NR[0...11]** Number of the SPL connection		
Default value 0	Min. input limit: 0		Max. input limit: 3
Change becomes effective after: POWER ON		Protection level: 7/2	Unit: –
Data type: BYTE			
Significance:	The number of the SPL connection, which is parameterized with this data set, is set using the machine data. The SPL connection number is, at the same time, also the index to access the system variables of the user interface of this SPL connection. This following applies to the following system variables: - $A_FRDP_SUBS - $A_FRDP_ERR_REAC - $A_FRDP_ERROR - $A_FRDP_SUBS_ON - $A_FRDP_ACK_REQ - $A_FRDP_DIAG - $A_FRDP_SENDMODE Example: $MN_SAFE_SDP_CONNECTION_NR[2] = 3 means that the control and status information of the SPL connection, which is parameterized via data set 2, can be found in the system variables with the field index 3.		
corresponds with ...			
Additional references			

13344 MD number	**$MN_SAFE_RDP_LADDR[0..11]** Basis address of the input/output data area, F_RECVDP		
Default value 288	Min. input limit: 288		Max. input limit: 32767
Change becomes effective after: Restart		Protection level: 7/2	Unit: –
Data type: DWORD			
Significance:	The start address of the input and output data area, parameterized in SIMATIC STEP 7, via which the F_SENDDP and F_RECVDP of this SPL connection communicate. SIMATIC block parameters: LADDR		
corresponds with ...			
Additional references			

13345 MD number	**$MN_SAFE_RDP_TIMEOUT[0...11]** Monitoring time of the F_DP communication relationship		
Default value 0.5	Min. input limit: 0.0		Max. input limit: 60
Change becomes effective after: Restart		Protection level: 7/2	Unit: s
Data type: DOUBLE			
Significance:	The monitoring time is the time within which the F_SENDDP sends a new F telegram to F_RECVDP or F_RECVDP must have acknowledged a new F telegram. When the monitoring time is exceeded, F_RECVDP outputs substitute values to the SPL. SIMATIC block parameters: TIMEOUT		
corresponds with ...			
Additional references			

13346 MD number	**$MN_SAFE_RDP_ASSIGN[0...11]** Input assignment F_RECVDP net data to $A_INSE	
Default value 0	Min. input limit: 0	Max. input limit: 64064
Change becomes effective after: Restart	Protection level: 7/2	Unit: -
Data type: DWORD		
Significance:	The selection of the SPL signals $A_INSE to be supplied can only be done area for area. Format: 00 **aaa bbb** (decimal) with aaa = area limit 1, SPL signal $A_INSE**[aaa]** bbb = area limit 2, SPL signal $A_INSE**[bbb]** Example: $MN_SAFE_RDP_ASSIGN[0] = **001 004** or alternatively **004 001** The F_RECVDP net data, selected using MD F_RDP_FILTER[0] are transferred in the SPL signals $A_INSE[1] to $A_INSE[4].	
corresponds with ...		
Additional references		

13347 MD number	**$MN_SAFE_RDP_FILTER[0...11]** F net data filter between F_RECVDP and SPL interface $A_INSE	
Default value 0xFFFF	Min. input limit: 0x0	Max. input limit: 0xFFFF
Change becomes effective after: Restart	Protection level: 7/2	Unit: -
Data type: DWORD		
Significance:	The F_RECVDP net data signals, whose filter bit is set to 1 are transferred in the SPL signals selected using MD $MN_SAFE_RDP_ASSIGN. The least significant F_RECVDP net data signal in the least significant SPL signal, etc. for all selected F_RECVDP net data signals. **Bit x = 1** The F_RECVDP net data signal of bit position x is transferred as SPL signal. **Bit x = 0** The F_RECVDP net data signal of bit position x is not transferred as SPL signal.	
corresponds with ...		
Additional references		

13348 MD number	**$MN_SAFE_RDP_ERR_REAC[0...11]** Error response	
Default value 0	Min. input limit: 0	Max. input limit: 3
Change becomes effective after: Restart	Protection level: 7/2	Unit: -
Data type: DWORD		
Significance:	The error response defined here is initiated in the case of a communication error. This value is valid as long as no other value is entered from the SPL via the system variable $A_FRDP_ERR_REAC. Meaning of values: - 0 = Alarm **27350** + Stop D/E - 1 = Alarm **27350** - 2 = Alarm **27351** (display only, self clearing) - 3 = No system response	
corresponds with ...		
Additional references		

13349 MD number	**$MN_SAFE_RDP_SUBS[0...11]** Substitute values in the case of an error			
Default value 0		Min. input limit: 0		Max. input limit: 0xFFFF
Change becomes effective after: Restart			Protection level: 7/2	Unit: –
Data type: DWORD				
Significance:	In the case of a communication error, the substitute values defined here are activated in the system variables $A_INSE assigned in this SPL connection. This value is valid as long as no other value is entered from the SPL via the system variable $A_FRDP_SUBS.			
corresponds with ...				
Additional references				

20106 MD number	**$MC_PROG_EVENT_IGN_SINGLEBLOCK** Prog events ignore the single block			
Default value (0x0, 0x0,...)		Min. input limit: 0		Max. input limit: 0x3F
Change becomes effective after: POWER ON			Protection level: 7/2	Unit: –
Data type: DWORD				
Significance:	Event-controlled program calls (prog events) can be set regarding their behavior for a read-in disable Bit 0 = 1: Prog event after a part program start makes a block change without another start Bit 1 = 1: Prog event after a part program end makes a block change without another start Bit 2 = 1: Prog event after a control panel reset makes a block change without another start Bit 3 = 1: Prog event after power up a block change without another start Bit 4 = 1: Prog-event after 1st start after block search makes a block change without another start. Bit 5 = 1: Safety prog event when booting makes a block change without another start			
corresponds with ...				

20107 MD number	**$MC_PROG_EVENT_IGN_INHIBIT** Prog events ignore the read-in disable		
Default value (0x0, 0x0,...)	Min. input limit: 0	Max. input limit: 0x3F	
Change becomes effective after: POWER ON	Protection level: 7/2	Unit: -	
Data type: DWORD			
Significance:	Event-controlled program calls (prog events) can be set regarding their behavior for a read-in disable Bit 0 = 1: Prog event after a part program start makes a block change despite the read-in disable Bit 1 = 1: Prog event after a part program end makes a block change despite the read-in disable Bit 2 = 1: Prog event after a control panel reset makes a block change despite the read-in disable Bit 3 = 1: Prog event after booting makes a block change despite the read-in disable Bit 4 = 1: Prog event after 1st start after block search makes block change despite the read-in disable Bit 5 = 1: Safety prog event when booting makes a block change despite the read-in disable		
corresponds with ...			
Additional references			

20108 MD number	**$MC_PROG_EVENT_MASK** Event-controlled program call		
Default value (0x0, 0x0,...)	Min. input limit: 0	Max. input limit: 0x3F	
Change becomes effective after: POWER ON	Protection level: 7/2	Unit: -	
Data type: DWORD			
Significance:	Parameterizes the event where the user program, set with $MN_PROG_EVENT_NAME (default: _N_PROG_EVENT_SPF) is implicitly called: Bit 0 = 1: Part program start Bit 1 = 1: Part program end Bit 2 = 1: Operator panel reset Bit 3 = 1: Boot Bit 4 = 1 Reserved Bit 5 =1: Safety program when booting The user program is called using the following search path: 1. /_N_CUS_DIR/_NPROG_EVENT_SPF 2. /_N_CMA_DIR/_NPROG_EVENT_SPF 3. /_N_CST_DIR/_NPROG_EVENT_SPF The safety program must be available at the following location: 1. _N_CST_DIR/_N_SAFE_SPF In addition, after the action blocks, the user program set using MD11620 $MN_PROG_EVENT_NAME is automatically started via MD11450 $MN_SEARCH_RUN_MODE bit 1, independent of the settings in this machine data.		
corresponds with ...			
Additional references			

20192 MD number	**$MC_PROG_EVENT_IGN_PROG_STATE** Do not display the execution of the prog events on the OPI		
Default value (0x0, 0x0,...)	Min. input limit: 0	Max. input limit: 0x3F	
Change becomes effective after: POWER ON	Protection level: 7/2	Unit: -	
Data type: DWORD			
Significance:	Event-controlled program calls (prog events) can be influenced regarding their behavior at the OPI interface. The variables progStatus and chanStatus remain uninfluenced in spite of the active prog event processing - and stay at the old value. As a consequence, the prog event processing can be hidden from the HMI. Bit 0 = 1: Reserved bit with effect Bit 1 = 1: Prog event after part program end does not change progStatus and chanStatus Bit 2 = 1: Prog event after operator panel reset does not change progStatus and chanStatus Bit 3 = 1: Prog event after booting does not change progStatus and chanStatus Bit 4 = 1: Reserved Bit 5 = 1: Safety prog event when booting does not change progStatus and chanStatus		
corresponds with ...			
Additional references			

20700 MD number	**$MC_REFP_NC_START_LOCK** NC start disable without reference point		
Default value TRUE	Min. input limit: -	Max. input limit: -	
Change becomes effective after: Reset	Protection level: 7/2	Unit: -	
Data type: BOOLEAN			
Significance:	0: The NC/PLC interface signal (NC start) to start part programs or part program blocks (MDA and save/overwrite) is effective, even if one or all axes of the channel have still not been referenced. In order that the still reach the correct position after the NC start, the workpiece coordinate system (WCS) must be set to a correct value using other methods (scratching, automatic work offset determination, etc.). 1: Those axes, that were specified (in the application) as requiring to be referenced in the axial MD $MA_REFP_CYCLE_NR (value > -1), must be referenced, before an NC start is permitted.		
corresponds with ...			
Additional references			

28251 MD number	**$MC_MM_NUM_SAFE_SYNC_ELEMENTS** Number of elements for expressions in safety synchronized actions			
Default value 0	Min. input limit: 0		Max. input limit: 32000	
Change becomes effective after: POWER ON		Protection level: 7/2		Unit: –
Data type: DWORD				
Significance:	The expressions of motion synchronizing actions are saved in storage elements in the control system. A motion synchronizing action requires a minimum of 4 elements. The assignments are as follows: each operand in the condition: 1 element each action: >= 1 element each assignment: 2 elements each additional operand in complex expressions: 1 element See also: MD 28250: $MC_MM_NUM_SYNC_ELEMENTS			
corresponds with ...				
Additional references				

36901 MD number	**$MA_SAFE_FUNCTION_ENABLE** Enables safety-related functions	
Default value: 0H	Min. input limit: 0H	Max. input limit: 0x1FFFB
Change becomes effective after: POWER ON	Protection level: 7/2	Unit: -
Data type: DWORD		
Significance:	The functions for safe operation can be enabled for one axis/spindle using this machine data. It is only possible to enable - on an axis-specific basis - as many axes/spindles for safe operation as have been enabled by the global option. The more partial functions that are set then the more computing time the safe functions require. Bit 0: Enable safely-reduced speed, safe operating stop Bit 1: Enable safe limit switch Bit 2: Reserved for functions with absolute reference (such as SE/SN) Bit 3: Enable actual value synchronization, 2-encoder system Bit 4: Enable external ESR activation (STOP E) Bit 5: Enable SG correction Bit 6: Enable the external stop requests / external STOPs Bit 7: Enable cam synchronization Bit 8: Enable safe cam, pair 1, cam+ Bit 9: Enable safe cam, pair 1, cam- Bit 10: Enable safe cam, pair 2, cam+ Bit 11: Enable safe cam, pair 2, cam- Bit 12: Enable safe cam, pair 3, cam+ Bit 13: Enable safe cam, pair 3, cam- Bit 14: Enable safe cam, pair 4, cam+ Bit 15: Enable safe cam, pair 4, cam- Bit 16: Enable synchronization (hysteresis and filtering ”$n<n_x$”	
Special cases, errors,...	- If bit 1 or a higher bit is set, then bit 0 must also be set since the control system switches to a safe operational stop in response to STOP C, D or E (a parameterizing alarm 27033 is displayed if an error is detected). - If an insufficient number of axes/spindles have been enabled for safe operation using the global option, then this data may be overwritten with the value 0000 when booting.	
corresponds with ...	Global option	
Additional references	/FBSI/ see Chapter: 5.5, ”Enabling safety-related functions”	

36902 MD number	**$MA_SAFE_IS_ROT_AX** Rotary axis	
Default value: FALSE	Min. input limit: -	Max. input limit: -
Change becomes effective after: POWER ON	Protection level: 7/2	Unit: -
Data type: BOOLEAN		
Significance:	This data specifies whether the axis for safe operation is a rotary axis/spindle or linear axis. = 0: Linear axis = 1: Rotary axis/spindle The value set in this MD must be the same as the value set in MD $MA_IS_ROT_AX. If they are not identical a parameterizing error is displayed.	
corresponds with ...		

36903 MD number	**$MA_SAFE_CAM_ENABLE** Enable safe cam track	
Default value: 0	Min. input limit: 0	Max. input limit: 0x3FFFFFFF
Change becomes effective after: POWER ON	Protection level: 7/2	Unit: –
Data type: DWORD		
Significance:	30 safe cams can be enabled for one axis/spindle for the ”safe cam track” function using this machine data. The enable signals may only be issued if the cam enable is not used in $MA_SAFE_FUNCTION_ENABLE. The cam synchronization is automatically activated if the ”safe cam track” function is enabled. Bit 0: Enable safe cam track, cam 1 Bit 1: Enable safe cam track, cam 2 Bit 2: Enable safe cam track, cam 3 Bit 3: Enable safe cam track, cam 4 Bit 4: Enable safe cam track, cam 5 Bit 5: Enable safe cam track, cam 6 Bit 6: Enable safe cam track, cam 7 Bit 7: Enable safe cam track, cam 8 Bit 8: Enable safe cam track, cam 9 Bit 9: Enable safe cam track, cam 10 Bit 10: Enable safe cam track, cam 11 Bit 11: Enable safe cam track, cam 12 Bit 12: Enable safe cam track, cam 13 Bit 13: Enable safe cam track, cam 14 Bit 14: Enable safe cam track, cam 15 Bit 15: Enable safe cam track, cam 16 Bit 16: Enable safe cam track, cam 17 Bit 17: Enable safe cam track, cam 18 Bit 18: Enable safe cam track, cam 19 Bit 19: Enable safe cam track, cam 20 Bit 20: Enable safe cam track, cam 21 Bit 21: Enable safe cam track, cam 22 Bit 22: Enable safe cam track, cam 23 Bit 23: Enable safe cam track, cam 24 Bit 24: Enable safe cam track, cam 25 Bit 25: Enable safe cam track, cam 26 Bit 26: Enable safe cam track, cam 27 Bit 27: Enable safe cam track, cam 28 Bit 28: Enable safe cam track, cam 29 Bit 29: Enable safe cam track, cam 30	
corresponds with ...	/FBSI/ see Chapter 6.8 ”Safe software cams, safe cam track (SN)”	

36905 MD number	**$MA_SAFE_MODULO_RANGE** Modulo value, safe cams			
Default value: 0.0		Min. input limit: 0.0		Max. input limit: 737280.0
Change becomes effective after: POWER ON			Protection level: 7/2	Unit: Degrees
Data type: DOUBLE				
Significance:	Actual value range within which safe cams for rotary axes are calculated. The axis must be a rotary axis ($MA_SAFE_IS_ROT_AX = 1). 0: Modulo correction after +/– 2048 revolutions (i.e. after 737 280 degrees) > 0 and multiples of 360 Degrees: Modulo correction after this value e.g. value = 360 degrees –> the actual value range is between 0 and 359.999 degrees, i.e. a modulo correction is carried out after every revolution.			
Special cases, errors,...	– If the value set in this data is not 0 or a multiple of 360 degrees, then an appropriate alarm is output when the system boots. – The cam positions are also checked with respect to the parameterized actual value when the system boots. An appropriate alarm is output if parameterization errors are detected. – Actual value ranges set in $MA_SAFE_MODULO_RANGE and $MA_MODULO_RANGE must be a multiple integer.			
corresponds with ...	MD 30330: $MA_MODULO_RANGE MD 36935: $MA_SAFE_CAM_POS_PLUS[n] MD 36937: $MA_SAFE_CAM_POS_MINUS[n]			
Additional references	/FBSI/ see Chapter 6.8: "Safe software cams, safe cam track (SN)"			

36906 MD number	**$MA_SAFE_CTRLOUT_MODULE_NR** SI drive assignment			
Default value: 1, 2, 3..		Min. input limit: 1		Max. input limit: 31
Change becomes effective after: POWER ON			Protection level: 7/2	Unit: –
Data type: BYTE				
Significance:	Index in the data array $MN_SAFE_DRIVE_LOGIC_ADDRESS to assign the drive for SI motion monitoring functions. The same drive must be assigned that was also selected using CTRLOUT_MODULE_NR and DRIVE_LOGIC_ADDRESS.			
Special cases, errors,...				
corresponds with ...				

36907 MD number	**$MA_SAFE_DRIVE_PS_ADDRESS** PROFIsafe address of the drive			
Default value: 0		Min. input limit: 0		Max. input limit: 65534
Change becomes effective after: POWER ON		Protection level: 7/0		Unit: –
Data type: DWORD				
Significance:	This NCK-MD contains the PROFIsafe address of the drive assigned to this axis. When booting, the drive reads out this MD (via drive parameter p9810). The address must be unique across all of the axes. This MD cannot be written to; the PROFIsafe address must be parameterized in the drive.			
Special cases, errors,...				
corresponds with ...				

36912 MD number	**$MA_SAFE_ENC_INPUT_NR** Actual value assignment: Input on drive module/measuring circuit card			
Default value: 1		Min. input limit: 1		Max. input limit: 3
Change becomes effective after: POWER ON		Protection level: 7/2		Unit: –
Data type: BYTE				
Significance:	Number of the actual value input of a module via which the SI encoder is addressed. 1: SI encoder is connected to the upper input (motor encoder) 2: SI encoder is connected to the lower input (2nd encoder)			
Special cases, errors,...				
corresponds with ...	p9526, p0189,			

36914 MD number	**$MA_SAFE_SINGLE_ENC** SI single-encoder system			
Default value: TRUE		Min. input limit: –		Max. input limit: –
Change becomes effective after: POWER ON		Protection level: 7/2		Unit: –
Data type: BOOLEAN				
Significance:	ID that SI is carried out with an encoder. If different encoders are used for the Safety Integrated monitoring functions in the drive and in the NCK, then this MD must be parameterized to be 0.			
Special cases, errors,...				
corresponds with ...				

36916 MD number	$MA_SAFE_ENC_IS_LINEAR Linear scale	
Default value: 0	Min. input limit: 0	Max. input limit: 1
Change becomes effective after: POWER ON	Protection level: 7/2	Unit: –
Data type: BOOLEAN		
Significance:	This MD specifies whether a linear or a rotary encoder is connected. = **0**: A rotary encoder is connected, $MA_SAFE_ENC_RESOL is used to specify its resolution and $MA_SAFE_ENC_GEAR_PITCH, $MA_SAFE_ENC_GEAR_DENOM[n] and $MA_SAFE_ENC_GEAR_NUMERA[n] are used to convert it to the load side. The MD: $MA_SAFE_ENC_GRID_POINT_DIST has no significance. = **1**: Linear encoder is connected, $MA_SAFE_ENC_GRID_POINT_DIST is used to specify its resolution. The MDs: $MA_SAFE_ENC_RESOL, $MA_SAFE_ENC_GEAR_PITCH, $MA_SAFE_ENC_GEAR_DENOM[n] and $MA_SAFE_ENC_GEAR_NUMERA[n] have no significance. This MD cannot be written to, the encoder type must be parameterized in the drive. If the value changes then Alarm 27036 is output.	
corresponds with ...	For 0: $MA_SAFE_ENC_RESOL $MA_SAFE_ENC_GEAR_PITCH $MA_SAFE_ENC_GEAR_DENOM[n] $MA_SAFE_ENC_GEAR_NUMERA[n] For 1: $MA_SAFE_ENC_GRID_POINT_DIST	

36917 MD number	$MA_SAFE_ENC_GRID_POINT_DIST Grid spacing, linear scale	
Default value: 0.01	Min. input limit: 0.000 01	Max. input limit: 250
Change becomes effective after: POWER ON	Protection level: 7/2	Unit: mm
Data type: DOUBLE		
Significance:	This MD specifies the grid spacing of the linear scale used here. Not relevant for rotary encoders.	
corresponds with ...		

36918 MD number	$MA_SAFE_ENC_RESOL Encoder pulses per revolution	
Default value: 2 048	Min. input limit: 1	Max. input limit: 100 000 000
Change becomes effective after: POWER ON	Protection level: 7/2	Unit: –
Data type: DWORD		
Significance:	This MD specifies the number of pulses per revolution for a rotary encoder. Not relevant for a linear encoder.	
corresponds with ...		

36919 MD number	**$MA_SAFE_ENC_PULSE_SHIFT** Shift factor of the encoder multiplication	
Default value: 11	Min. input limit: 2	Max. input limit: 18
Change becomes effective after: POWER ON	Protection level: 7/2	Unit: –
Data type: BYTE		
Significance:	Shift factor of the multiplication (resolution) of the encoder, that is used for the Safety Integrated monitoring functions in the NCK. The encoder value must be divided by 2 so many times in order to obtain the number of encoder pulses. A shift factor of 11 corresponds to an encoder multiplication by a factor of 2048. If the drive provides this information (r0979[3,13,23]), then this MD is automatically internally assigned a value after the drive has run up. If the value changes then Alarm 27036 is output.	
corresponds with ...		

36920 MD number	**$MA_SAFE_ENC_GEAR_PITCH** Spindle pitch	
Default value: 10.0	Min. input limit: 0.1	Max. input limit: 10000.
Change becomes effective after: POWER ON	Protection level: 7/2	Unit: mm
Data type: DOUBLE		
Significance:	Gear ratio of the gearbox (gear) between the encoder and load for a linear axis with rotary encoder.	
corresponds with ...		

36921 MD number	**$MA_SAFE_ENC_GEAR_DENOM[n]: 0 ... 7** Denominator, gearbox ratio encoder/load	
Default value: 1	Min. input limit: 1	Max. input limit: 2 147 000 000
Change becomes effective after: POWER ON	Protection level: 7/2	Unit: –
Data type: DWORD		
Significance:	Denominator of the gear between encoder and load, i.e. the denominator of the fraction number of encoder revolutions / number of load revolutions n= 0, 1, ... ,7 stands for gearbox stages 1, 2, ... 8 The actual value is selected using safety-related input signals (SGE).	
corresponds with ...	MD 36922: $MA_SAFE_ENC_GEAR_NUMERA[n]	

36922 MD number	**$MA_SAFE_ENC_GEAR_NUMERA[n]: 0 ... 7** Numerator, gearbox ratio encoder/load	
Default value: 1	Min. input limit: 1	Max. input limit: 2 147 000 000
Change becomes effective after: POWER ON	Protection level: 7/2	Unit: –
Data type: DWORD		
Significance:	Numerator of the gear between encoder and load, i.e. the numerator of the fraction number of encoder revolutions / number of load revolutions” n= 0, 1, ... 7 stands for gearbox stages 1, 2, ... 8 The actual value is selected using safety-related input signals (SGE).	
corresponds with ...	MD 36921: $MA_SAFE_ENC_GEAR_DENOM[n]	

36923 MD number	**$MA_SAFE_INFO_ENC_RESOL** Safety-relevant encoder resolution		
Default value: 0.0	Min. input limit: -	Max. input limit: -	
Change becomes effective after: POWER ON	Protection level: 7/0	Unit: mm, degrees	
Data type: DOUBLE			
Significance:	Display data: Resolution of the encoder being used in the particular gear stage for the Safety Integrated monitoring functions. With this accuracy, for a single-encoder system, safety-related positions can be monitored. If different encoders are used for the Safety Integrated monitoring functions in the drive and in the NCK, then this MD is 0.		
corresponds with ...			

36924 MD number	**$MA_SAFE_ENC_NUM_BITS[0...3]** Bit information of the redundant actual value		
Default value: 16,2,16,16	Min. input limit: -16	Max. input limit: 32	
Change becomes effective after: Restart	Protection level: 7/-	Unit: -	
Data type: DWORD			
Significance:	Information about the redundant actual value: - Field index 0: Number of valid bits of the redundant actual value - Field index 1: Number of bits of the fine resolution of the redundant actual value - Field index 2: Number of relevant bits of the redundant actual value - Field index 3: Most significant bit of the redundant coarse position This information is read-out when booting (for DRIVE-CLiQ encoders, from the drive parameters r0470, r0471, r0472 and r0475, for SMI/SMC/SME encoders, the default values apply) and compared with the values that were last saved. This MD is then overwritten. Alarm 27035 or 27036 is output if they are not equal. The values of this MD flow into the checksum calculation: - Index 0, 1 -> MD $MA_SAFE_ACT_CHECKSUM[1] - Index 2, 3 -> MD $MA_SAFE_ACT_CHECKSUM[0]		
corresponds with ...			

36925 MD number	**$MA_SAFE_ENC_POLARITY** Direction reversal actual value		
Default value: 1	Min. input limit: -1	Max. input limit: 1	
Change becomes effective after: POWER ON	Protection level: 7/2	Unit: -	
Data type: DWORD			
Significance:	Using this data, the direction of the actual value can be reversed. = -1: Direction reversal = 0 or = 1: no direction reversal		
corresponds with ...			

36927 MD number	$MA_SAFE_ENC_MOD_TYPE Encoder evaluation type	
Default value: 1	Min. input limit: 0	Max. input limit: 255
Change becomes effective after: Restart	Protection level: 7/-	Unit: -
Data type: BYTE		
Significance:	Type of the encoder evaluation of this axis used for Safety Integrated. This type is read out of drive parameter r9527 when booting. If a valid value has not been entered, alarm 27038 is output. If the drive parameter contains a valid value, then this is compared with the last value saved in this MD. This MD is then overwritten. Alarm 27035 is output if they are not equal. The value of this MD is incorporated in the calculation of MD36998 $MA_SAFE_ACT_CHECKSUM[1]. Valid values in drive parameter r9527: = 1: Sensor Module (SMI, SMC, SME) = 2: DRIVE-CLiQ encoder All other values result in Alarm 27038. In this case, the value from r9527 is not accepted in the MD.	
corresponds with ...		

36928 MD number	$MA_SAFE_ENC_IDENT[n] Encoder identification	
Default value: 0	Min. input limit: -	Max. input limit: -
Change becomes effective after: POWER ON	Protection level: 7/0	Unit: -
Data type: DWORD		
Significance:	Identification of the encoder evaluation of this axis used for Safety Integrated. When booting, the encoder evaluation reads out this identification and compares with the last value saved here. This MD is then overwritten. The value of this MD is incorporated in the calculation of MD $MA_SAFE_ACT_CHECKSUM[1].	
corresponds with ...	r9881: SI motion Sensor Module Node Identifier control	

36929 MD number	$MA_SAFE_ENC_CONF Configuration of the redundant actual value	
Default value: 0	Min. input limit: -	Max. input limit: -
Change becomes effective after: Restart	Protection level: 7/-	Unit: -
Data type: DWORD		
Significance:	Configuration of the redundant actual value: Bit 0: Up-down counter Bit 1: Encoder CRC: LSB/MSB of the redundant coarse position first Bit 2: Redundant coarse position MSB/LSB justified When booting - for DRIVE-CLiQ encoders - this information is read-out of drive parameter r0474 (the default values apply for SMI/SMC/SME encoders) and is then compared with the last value saved here. This MD is then overwritten. Alarm 27035 is output if they are not equal. The value of this MD is incorporated in the calculation of MD $MA_SAFE_ACT_CHECKSUM[1].	
corresponds with ...		

36930 MD number	**$MA_SAFE_STANDSTILL_TOL** Standstill tolerance		
Default value: 1.	Min. input limit: 0.	Max. input limit: 100.	
Change becomes effective after: POWER ON	Protection level: 7/2	Unit: mm, degrees	
Data type: DOUBLE			
Significance:	This MD specifies the tolerance for a safe operating stop. If the difference between the position limit value and position actual value is greater than the tolerance set here when a safe operating stop is selected, then the control system outputs Alarm 27010 with STOP B. The position limit value is the position actual value at the instant that a safe operating stop is selected.		
corresponds with ...	MD 36956: $MA_SAFE_PULSE_DISABLE_DELAY		

36931 MD number	**$MA_SAFE_VELO_LIMIT[n]: 0 ... 3** Limit value for safely-reduced speed		
Default value: 2000.	Min. input limit: -	Max. input limit: -	
Change becomes effective after: POWER ON	Protection level: 7/2	Unit: mm/min, rev/min	
Data type: DOUBLE			
Significance:	This MD defines the limit values for safely-reduced speeds 1, 2, 3 and 4. When SG1, SG2, SG3 or SG4 is selected and the actual speed exceeds this limit value, then the control system outputs Alarm 27011 with the stop response configured in $MA_SAFE_VELO_STOP_MODE or $MA_SAFE_VELO_STOP_REACTION. n = 0, 1, 2, 3 stands for the limit value of SG1, SG2, SG3, SG4		
Special cases, errors,...	When SBH/SG is active in a 1-encoder system, the speed is monitored corresponding to the encoder limit frequency set in MD $MA_SAFE_ENC_FREQ_LIMIT. An appropriate alarm is output if this limit is exceeded.		
corresponds with ...	MD 36961: $MA_SAFE_VELO_STOP_MODE MD 36963: $MA_SAFE_VELO_STOP_REACTION		

36932 MD number	**$MA_SAFE_VELO_OVR_FACTOR[n]: 0 ... 15** SG selection values		
Default value: 100.0	Min. input limit: 1.0	Max. input limit: 100.0	
Change becomes effective after: POWER ON	Protection level: 7/2	Unit: %	
Data type: DOUBLE			
Significance:	Limit value corrections for the safely-reduced speeds 2 and 4 can be selected using SGEs and the associated correction value (percentage value) set using this MD. n = 0, 1, ... , 15 stands for correction 0, 1, ... 15		
Special cases, errors,...	• The ”Correction for safely reduced speed” function is enabled using MD 36901 $MA_SAFE_FUNCTION_ENABLE. • This correction has no effect for the limit values associated with safely-reduced speeds 1 and 3.		
Additional references	MD 36978: $MA_SAFE_OVR_INPUT[n] MD 36931: $MA_SAFE_VELO_LIMIT[n]		
Additional references	Refer to Chapter 6.5.4: ”Override for safely-reduced speed”		

36933 MD number	**$MA_SAFE_DES_VELO_LIMIT** SG setpoint speed limiting	
Default value: 0.0	Min. input limit: 0	Max. input limit: 100
Change becomes effective after: RESET	Protection level: 7/2	Unit: %
Data type: DOUBLE		
Significance:	This is an evaluation factor to define the setpoint limit from the actual speed limit. The active SG limit value is evaluated using this factor and is entered into the interpolator as setpoint limit. When SBH is selected, a setpoint of 0 is entered. When 100% is entered, the setpoint is limited to the active SG stage When 0% is entered the setpoint speed limiting is not active.	
Special cases, errors,...	- This MD may have to be altered several times before an optimum setting for the dynamic response of the drives is found. In order that this operation is not made unnecessarily complex, "reset" has been defined as the criterion for being effective. - This data is not included in the crosswise data comparison with the drive. - This data is not included in the axial checksum $MA_SAFE_ACT_CHECKSUM, as it is a single-channel function.	
corresponds with ...		
Additional references	Refer to Chapter : 11.1"Limiting the setpoint speed"	

36934 MD number	**$MA_SAFE_POS_LIMIT_PLUS[n]: 0 ... 1** Upper limit value for safe limit position	
Default value: 100 000	Min. input limit: -2 147 000	Max. input limit: 2 147 000
Change becomes effective after: POWER ON	Protection level: 7/2	Unit: Degrees, mm
Data type: DOUBLE		
Significance:	This MD specifies the upper limit value for safe end positions 1 and 2. When SE1 or SE2 is selected and the actual position exceeds this limit, then the control system outputs Alarm 27012 with the stop response configured in $MA_SAFE_POS_STOP_MODE and changes over into the SBH mode. If SBH is violated, STOP B and A are initiated as stop response. n = 0, 1 stand for the upper limit value of SE1, SE2	
Special cases, errors,...	If a lower or identical value is entered in MD $MD_SAFE_POS_LIMIT_PLUS[n] than in MD $MA_SAFE_POS_LIMIT_MINUS[n], then a parameterizing error is displayed.	
corresponds with ...	MD 36962: $MA_SAFE_POS_STOP_MODE MD 36935: $MA_SAFE_POS_LIMIT_MINUS[n] MD 36901: $MA_SAFE_FUNCTION_ENABLE	
Additional references	/FBSI/ see Chapter 6.7: "Safe software limit switches (SE)"	

36935 MD number	**$MA_SAFE_POS_LIMIT_MINUS[n]: 0 ... 1** Lower limit value for safe limit position		
Default value: -100 000	Min. input limit: -2 147 000	Max. input limit: 2 147 000	
Change becomes effective after: POWER ON	Protection level: 7/2	Unit: Degrees, mm	
Data type: DOUBLE			
Significance:	This MD specifies the lower limit value for safe end positions 1 and 2. When SE1 or SE2 is selected and the actual position is less than this limit value, then the control system outputs Alarm 27012 with the stop response configured in $MA_SAFE_POS_STOP_MODE and changes over into the SBH mode. If SBH is violated, STOP B and A are initiated as stop response. n = 0, 1 stand for the lower limit value of SE1, SE2		
Special cases, errors,...	If a lower or identical value is entered in MD $MD_SAFE_POS_LIMIT_PLUS[n] than in MD $MA_SAFE_POS_LIMIT_MINUS[n], then a parameterizing error is displayed.		
corresponds with ...	MD 36962: $MA_SAFE_POS_STOP_MODE MD 36934: $MA_SAFE_POS_LIMIT_PLUS[n]		
Additional references	/FBSI/ see Chapter 6.7: "Safe software limit switches (SE)"		

36936 MD number	**$MA_SAFE_CAM_POS_PLUS[n]: 0 ... 29** Plus cams position for safe cams		
Default value: 10	Min. input limit: -2 147 000	Max. input limit: 2 147 000	
Change becomes effective after: POWER ON	Protection level: 7/2	Unit: mm, inches, degrees	
Data type: DOUBLE			
Significance:	This MD specifies the plus cam position for safe cams SN1+, SN2+, SN3+, ... For the "safe cams" function, the following applies: If the actual position is greater than this value when the safe cam function is active ($MA_SAFE_FUNCTION_ENABLE), then the appropriate safety-relevant output signal (SGA) is set to 1. If the actual position falls below this value, SGA is set to 0. n = 0, 1, 2, 3 stand for the plus cam position of SN1+, SN2+, SN3+, SN4+		
	For the "safe cam track" function, the following applies: If the "safe cam track" function is enabled ($MA_SAFE_CAM_ENABLE), then the safety-related output signals "cam track" and "cam range" are set corresponding to the parameterization in MD $MA_SAFE_CAM_TRACK_ASSIGN[n]. n = 0 ... 29 stand for the plus cam position of SN1+, ..., SN30+		
corresponds with ...	MD 36901: $MA_SAFE_FUNCTION_ENABLE MD 36903: $MA_SAFE_CAM_ENABLE MD 36937: $MA_SAFE_CAM_POS_MINUS[n] MD 36938: $MA_SAFE_CAM_TRACK_ASSIGN[n] MD 36988: $MA_SAFE_CAM_PLUS_OUTPUT[n] MD 37900: $MA_SAFE_CAM_TRACK_OUTPUT[n] MD 37901/37902/37903/37904: $MA_SAFE_CAM_RANGE_OUTPUT_1/2/3/4[n] MD 37906/37907/37908/37909: $MA_SAFE_CAM_RANGE_BIN_OUTPUT_1/2/3/4[m]		
Additional references	/FBSI/ see Chapter 6.8: "Safe software cams, safe cam track (SN)"		

36937 MD number	**$MA_SAFE_CAM_POS_MINUS[n]: 0 ... 29** Minus cams position for safe cams		
Default value: -10	Min. input limit: -2 147 000	Max. input limit: 2 147 000	
Change becomes effective after: Power On	Protection level: 7/2	Unit: mm, degrees	
Data type: DOUBLE			
Significance:	This MD specifies the minus cam position for safe cams SN1-, SN2-, SN3-, ... For the "safe cams" function, the following applies: If the actual position is greater than this value when the safe cam function is active ($MA_SAFE_FUNCTION_ENABLE), then the appropriate safety-relevant output signal (SGA) is set to 1. If the actual position falls below this value, SGA is set to 0. n = 0, 1, 2, 3 stand for the minus cam position of SN1 -, SN2 -, SN3 -, SN4 -		
	For the "safe cam track" function, the following applies: If the "safe cam track" function is enabled ($MA_SAFE_CAM_ENABLE), then the safety-related output signals "cam track" and "cam range" are set corresponding to the paramete-rization in MD $MA_SAFE_CAM_TRACK_ASSIGN[n]. n = 0 ... 29 stand for the plus cam position of SN1-, ..., SN30-		
corresponds with ...	MD 36901: $MA_SAFE_FUNCTION_ENABLE MD 36903: $MA_SAFE_CAM_ENABLE MD 36937: $MA_SAFE_CAM_POS_PLUS[n] MD 36938: $MA_SAFE_CAM_TRACK_ASSIGN[n] MD 36988: $MA_SAFE_CAM_PLUS_OUTPUT[n] MD 37900: $MA_SAFE_CAM_TRACK_OUTPUT[n] MD 37901/37902/37903/37904: $MA_SAFE_CAM_RANGE_OUTPUT_1/2/3/4[n] MD 37906/37907/37908/37909: $MA_SAFE_CAM_RANGE_BIN_OUTPUT_1/2/3/4[m]		
Additional references	Refer to Chapter 6.8: "Safe software cams, safe cam track (SN)"		

36938 MD number	**$MA_SAFE_CAM_TRACK_ASSIGN[n]: 0 ... 29** Cam track assignment		
Default value: 100, 101, ... , 114; 200, 201, ..., 214	Min. input limit: 100	Max. input limit: 414	
Change becomes effective after: Power On	Protection level: 7/2	Unit: –	
Data type: DWORD			
Significance:	Assigns the individual cams to a maximum of 4 cam tracks including defining the numerical value for the SGA ”cam range”. The ”hundreds” position defines which cam track is assigned to the cams. Valid values are 1, 2 or 3 or 4. The ”tens” and ”ones” positions contain the numerical value that should be signaled to the safe logic as SGA ”cam range” and processed there. Valid values are 0 to 14, whereby each numerical value may only be used once for each cam. Therefore the valid value range of this machine data is: 100...114, 200...214, 300...314, 400...414 Examples: MD 36938[0] = 207: Cam 1 (index 0) is assigned to cam track 2. If the position is in the range of this cam, then 7 is entered in the SGA ”cam range” of the 2nd cam track. MD 36938[5] = 100: Cam 6 (index 5) is assigned to cam track 1. If the position is in the range of this cam, then 0 is entered in the SGA ”cam range” of the 1st cam track.		
corresponds with ...	MD 36903: $MA_SAFE_CAM_ENABLE MD 36936: $MA_SAFE_CAM_POS_PLUS[n] MD 36937: $MA_SAFE_CAM_POS_MINUS[n] MD 37900: $MA_SAFE_CAM_TRACK_OUTPUT[n] MD 37901/37902/37903/37904: $MA_SAFE_CAM_RANGE_OUTPUT_1/2/3/4[n] MD 37906/37907/37908/37909: $MA_SAFE_CAM_RANGE_BIN_OUTPUT_1/2/3/4[m]		
Additional references	Refer to Chapter 6.8: ”Safe software cams, safe cam track (SN)”		

36940 MD number	**$MA_SAFE_CAM_TOL** Tolerance for safe cams		
Default value: 0.1	Min. input limit: 0.001	Max. input limit: 10	
Change becomes effective after: POWER ON	Protection level: 7/2	Unit: mm, degrees	
Data type: DOUBLE			
Significance:	Due to the different mounting locations of the encoders and variations in clock cycle and signal transit (propagation times), the cam signals of the two monitoring channels never switch at precisely the same position and never simultaneously. This data specifies the tolerances for all cams as a load-side distance. The monitoring channels may have different signal states for the same cam within this tolerance bandwidth without initiating Alarm 27001 or 27104/27105. Recommendation: Enter an identical or slightly higher value than that set in MD 36942.		
Special cases, errors,...			
Additional references	Refer to Chapter 6.8: ”Safe software cams, safe cam track (SN)”		

36942 MD number	**$MA_SAFE_POS_TOL** Tolerance, actual value comparison (crosswise)	
Default value: 0.1	Min. input limit: 0.001	Max. input limit: 360
Change becomes effective after: POWER ON	Protection level: 7/2	Unit: mm, degrees
Data type: DOUBLE		
Significance:	Due to the fact that encoders are not mounted at identical locations and the effect of backlash, torsion, leadscrew errors etc. the actual positions sensed simultaneously by the NCK and drive may differ from one another. The tolerance bandwidth for the crosswise comparison of the actual positions in the two monitoring channels is specified in this machine data.	
Special cases, errors,...	• When defining this tolerance value, primarily the values from the machine-specific risk analysis must be taken into account. • Stop response STOP F is activated when the tolerance bandwidth is violated.	

36944 MD number	**$MA_SAFE_REFP_POS_TOL** Tolerance, actual value comparison (referencing)	
Default value: 0.01	Min. input limit: 0	Max. input limit: 36
Change becomes effective after: POWER ON	Protection level: 7/2	Unit: mm, degrees
Data type: DOUBLE		
Significance:	This machine data specifies the tolerance for checking the actual values after referencing (for incremental encoders) or when powering-up (for absolute encoders). An absolute actual axis position is determined by referencing. A second absolute actual position is calculated from the last stop position that was saved prior to the control being powered-down and the distance traversed since power-on. The control system checks the actual values after referencing on the basis of the two actual positions, the traversed distance and this machine data. The following factors must be taken into consideration when calculating tolerance values: Backlash, leadscrew errors, compensation (max. compensation values for SSFK, sag and temperature compensation), temperature errors, torsion (2-encoder system), gearbox play for control gears, coarser resolution (2-encoder system), oscillating distance/range for control gears.	
Special cases, errors,...	If these two absolute actual positions deviate from one another by more than the value set in this data - with a valid user agreement - then Alarm 27001 is output with Fault code 1003 and a new user agreement is required for referencing.	

36945 MD number	**$MA_SAFE_VELO_X_FILTER_TIME** Filter time $n< n_x$		
Default value: 0.0	Min. input limit: 0.0	Max. input limit: 100.	
Change becomes effective after: POWER ON	Protection level: 7/2	Unit: ms	
Data type: DOUBLE			
Significance:	Setting the filter time for generating the SGA $n<n_x$ of safe motion monitoring functions. The filtering must be activated by setting bit 16 in $MA_SAFE_FUNCTION_ENABLE to 1. With default value 0, filtering is not active. By parameterizing a filter time not equal to 0, the response time of the SGA $n<n_x$ increases.		
corresponds with ...			
Additional references	Documentation (see Chapter 6.6) ”SGA ”$n < n_x$” and ”SG active””		

36946 MD number	**$MA_SAFE_VELO_X** Velocity limit $n<n_x$		
Default value: 20.	Min. input limit: 0.	Max. input limit: 6 000.	
Change becomes effective after: POWER ON	Protection level: 7/2	Unit: mm/min, rev/min	
Data type: DOUBLE			
Significance:	This machine data defines the limit speed n_x for the SGA ”$n < n_x$”. If this velocity limit is fallen below, SGA ”$n < n_x$” is set. If the function ”synchronization, hysteresis and filtering $n<nx$” in $MA_SAFE_FUNCTION_ENABLE, bit 16 is enabled, then a value greater than 0 must be parameterized here, otherwise a parameterizing alarm is issued.		
corresponds with ...			
Additional references	Documentation (see Chapter 6.6) ”SGA ”$n < n_x$” and ”SG active””		

36947 MD number	**$MA_SAFE_VELO_X_HYSTERESIS** Velocity hysteresis $n<n_x$:		
Default value: 10.	Min. input limit: 0.001	Max. input limit: 500.	
Change becomes effective after: POWER ON	Protection level: 7/2	Unit: mm/min, inch/min, rev/min	
Data type: DOUBLE			
Significance:	Setting the hysteresis threshold for generating the SGA $n<n_x$ of safe motion monitoring functions. This MD is only effective if the function ”synchronization, hysteresis and filtering $n<n_x$” has been enabled in $MA_SAFE_FUNCTION_ENABLE, bit 16. In addition to the hysteresis, this machine data is also used to check the velocities in the two monitoring channels at the threshold. The maximum difference that is permitted between the two values is the value of this machine data, otherwise, a Stop F is initiated. The following must apply: $MA_SAFE_VELO_X_HYSTERESIS ≤ 1/2 $MA_SAFE_VELO_X		
corresponds with ...			
Additional references	Documentation (see Chapter 6.6) ”SGA ”$n < n_x$” and ”SG active””		

36948 MD number	$MA_SAFE_STOP_VELO_TOL Speed tolerance for safe acceleration monitoring		
Default value: 300.	Min. input limit: 0.	Max. input limit: 120000.	
Change becomes effective after: POWER ON	Protection level: 7/2	Unit: mm/min, rpm, inch/ min	
Data type: DOUBLE			
Significance:	Actual speed tolerance for safe acceleration monitoring (SBR). After the safe acceleration monitoring has been activated (by initiating a Stop B or C), then this tolerance is applied to the actual speed. It is not permissible that the actual velocity is greater than the limit that is therefore specified. Otherwise, a Stop A will be initiated. This means that if the drive accelerates, this will be identified very quickly.		
corresponds with ...			
Additional references	/FBSIsl/ see Chapter 6.4: "Safe acceleration monitoring (SBR)" (a recommended setting and setting formula are specified in this Chapter).		

36949 MD number	$MA_SAFE_SLIP_VELO_TOL Speed tolerance, slip		
Default value: 6.	Min. input limit: 0.	Max. input limit: 6000.	
Change becomes effective after: POWER ON	Protection level: 7/2	Unit: mm/min, rev/min	
Data type: DOUBLE			
Significance:	Speed difference that, for a 2-encoder system, is tolerated between the motor and load sides without the crosswise data comparison between the drive and NCK signaling an error. MD 36949 is only evaluated if MD $MA_SAFE_FUNCTION_ENABLE, bit 3 is set.		
corresponds with ...			
Additional references	Refer to Chapter 5.4.6: Actual value synchronization		

36950 MD number	$MA_SAFE_MODE_SWITCH_TIME Tolerance time for SGE changeover	
Default value: 0.5	Min. input limit: 0	Max. input limit: 10.
Change becomes effective after: POWER ON	Protection level: 7/2	Unit: s
Data type: DOUBLE		
Significance:	SGE changeover operations do not take effect simultaneously owing to variations in run times (propagation times) for SGE data transmission in the two monitoring channels. A crosswise data comparison would, in this case, output an error message. This data is used to specify the period of time after SGE changeover operations during which no crosswise comparison of actual values and monitoring results is carried out (machine data is still compared!). The selected monitoring functions continue to operate unhindered in both monitoring channels. A safety-related function is immediately activated in a monitoring channel if selection or changeover is detected in this channel. The different run time (propagation time) is mainly caused by the PLC cycle time. System-related minimum tolerance time 2 x PLC cycle time (maximum cycle) + 1 x IPO cycle time. The variations in the run times in the external circuitry (e.g. relay operating times) must also be taken into account.	
Special cases, errors,...		
Additional references	Refer to Chapter 7.1: ”safety-related input/output signals (SGE/SGA)”	

36951 MD number	$MA_SAFE_VELO_SWITCH_DELAY Delay time, speed changeover	
Default value: 0.1	Min. input limit: 0	Max. input limit: 600.
Change becomes effective after: POWER ON	Protection level: 7/2	Unit: s
Data type: DOUBLE		
Significance:	A timer with this value is started when changing from a higher to a lower safely-reduced speed - or when a safe operating stop is selected when the safely-reduced speed function is active. The parameterized value must be selected as low as possible. While the timer is running, the speed continues to be monitored against the last selected speed limit value. During this period, the axis/spindle can be braked, for example, from the PLC user program, without the monitoring function signaling an error and initiating a stop response.	
Special cases, errors,...	1. The timer is immediately interrupted as soon as a higher or identical SG limit (i.e. to that which was previously active) is selected. 2. The timer is immediately interrupted if ”non-safe operation” (SGE ”deselect SBH/SG=1) is selected. 3. The timer is re-triggered (restarted) if, while the timer is running, a changeover is made to a lower SG limit than was previously active or to SBH.	
corresponds with ...		

36952 MD number	**$MA_SAFE_STOP_SWITCH_TIME_C** Transition time, STOP C to safe standstill		
Default value: 0.1	Min. input limit: 0	Max. input limit: 600.	
Change becomes effective after: POWER ON	Protection level: 7/2	Unit: s	
Data type: DOUBLE			
Significance:	This machine data defines the time period between the initiation of a STOP C and the activation of a safe operating stop. The parameterized value must be selected as low as possible. After the time has expired, the drive is monitored for a safe operating stop. If the axis/spindle was still not able to be stopped, STOP B is initiated.		
corresponds with ...			

36953 MD number	**$MA_SAFE_STOP_SWITCH_TIME_D** Transition time, STOP D to safe standstill		
Default value: 0.1	Min. input limit: 0	Max. input limit: 600.	
Change becomes effective after: POWER ON	Protection level: 7/2	Unit: s	
Data type: DOUBLE			
Significance:	This machine data defines the time period between the initiation of a STOP D and the activation of a safe operating stop. The parameterized value must be selected as low as possible. After the time has expired, the drive is monitored for a safe operating stop. If the axis/spindle was still not able to be stopped, STOP B is initiated.		
corresponds with ...			

36954 MD number	**$MA_SAFE_STOP_SWITCH_TIME_E** Transition time, STOP E to safe standstill		
Default value: 0.1	Min. input limit: 0	Max. input limit: 600.	
Change becomes effective after: POWER ON	Protection level: 7/2	Unit: s	
Data type: DOUBLE			
Significance:	Time after which a changeover is made from STOP E to a safe operating stop. The parameterized value must be selected as low as possible.		
Special cases, errors,...			
corresponds with ...			

36955 MD number	**$MA_SAFE_STOP_SWITCH_TIME_F** Transition time STOP F to STOP B		
Default value: 0.0	Min. input limit: 0	Max. input limit: 600.	
Change becomes effective after: POWER ON	Protection level: 7/2	Unit: s	
Data type: DOUBLE			
Significance:	Time after which, for a STOP F with active monitoring functions, a change is made to STOP B. The parameterized value must be selected as low as possible. During this time, e.g., another braking response can be activated using synchronous actions. The changeover is also made if a STOP C/D/E occurs during this time.		
Special cases, errors,...			
corresponds with ...			

36956 MD number	**$MA_SAFE_PULSE_DISABLE_DELAY** Delay time, pulse cancellation		
Default value: 0.1	Min. input limit: 0	Max. input limit: 600	
Change becomes effective after: POWER ON	Protection level: 7/2	Unit: s	
Data type: DOUBLE			
Significance:	For a STOP B, the axis is braked along the current limit with speed setpoint 0. After the delay time defined in this data, the braking mode changes to STOP A for pulse cancellation. The parameterized value must be selected as low as possible.		
Special cases, errors,...	The pulses are cancelled earlier than defined in this machine data if the condition for the pulse cancellation is available via MD 36960: $MA_SAFE_STANDSTILL_VELO_TOL or MD 36620: $MA_SERVO_DISABLE_DELAY_TIME the condition for pulse cancellation is available. If the timer in this machine data is set to zero, then an immediate transition is made from STOP B to a STOP A (immediate pulse cancellation).		
corresponds with ...	MD 36960: $MA_SAFE_STANDSTILL_VELO_TOL MD 36620: $MA_SERVO_DISABLE_DELAY_TIME MD 36060: $MA_STANDSTILL_VELO_TOL		

36957 MD number	**$MA_SAFE_PULSE_DIS_CHECK_TIME** Time to check pulse cancellation		
Default value: 0.1	Min. input limit: 0	Max. input limit: 10	
Change becomes effective after: POWER ON	Protection level: 7/2	Unit: s	
Data type: DOUBLE			
Significance:	This machine data specifies the time when, after pulse cancellation has been requested, the pulses must be actually cancelled. The time that elapses between setting the SGA ”enable pulses” and detecting the SGE ”pulses cancelled status” may not exceed the time limit set in this data.		
Special cases, errors,...	If this time is exceeded, a STOP A is initiated.		

36958 MD number	$MA_SAFE_ACCEPTANCE_TST_TIMEOUT Time limit for the acceptance test duration	
Default value: 40.0	Min. input limit: 5	Max. input limit: 100
Change becomes effective after: POWER ON	Protection level: 7/2	Unit: s
Data type: DOUBLE		
Significance:	On the NCK side, a time limit can be entered for the duration of an acceptance test. If an acceptance test takes longer than the time specified in MD 36958, then the NCK terminates the test. The acceptance test status is set to zero on the NCK side. If the acceptance test has been reset, then on the NCK and drive sides, SI power on alarms are again changed over from being able to be acknowledged with a reset to being able to be acknowledged with power on. NCK clears Alarm 27007 and the drive clears Alarm 300952. This MD is also used to limit the duration of an acceptance test SE (safe limit positions). After the programmed time has expired, the acceptance test SE is interrupted and Alarm 27008 is cleared. The software limit positions are then again effective – the same as they are entered in the machine data.	
corresponds with ...		

36960 MD number	$MA_SAFE_STANDSTILL_VELO_TOL Shutdown speed, pulse cancellation	
Default value: 0.0	Min. input limit: 0.0	Max. input limit: 6 000.
Change becomes effective after: POWER ON	Protection level: 7/2	Unit: mm/min, rev/min
Data type: DOUBLE		
Significance:	When the axis/spindle speed drops below this limit, it is considered to be at a ”standstill”. In the STOP B mode the pulses are then cancelled (as a result of the transition to STOP A).	
corresponds with ...	MD 36956: $MA_SAFE_PULSE_DISABLE_DELAY	

36961 MD number	**$MA_SAFE_VELO_STOP_MODE** Stop response, safely-reduced speed	
Default value: 5	Min. input limit: 0	Max. input limit: 14
Change becomes effective after: POWER ON	Protection level: 7/2	Unit: -
Data type: BYTE		
Significance:	The stop response programmed in this machine data is initiated if a limit value for safely-reduced speed 1, 2, 3 or 4 is exceeded. = 0, 1, 2, 3 correspond to STOP A, B, C, D - common for each SG level = 5 means that the stop response can be configured for specific SGs in MD 36963. The ones position defines the selection of the stop response when the safely-reduced speed is exceeded. The tens position defines the behavior when the communication fails if a time greater than 0 was parameterized in $MN_SAFE_PULSE_DIS_TIME_BUSFAIL. 0: Stop A 1: Stop B 2: Stop C 3: Stop D 4: Stop E 5: SAFE_VELO_STOP_MODE not valid - the stop response is parameterized using MD SAFE_VELO_STOP_REACTION 10: Stop A, in addition when the communication fails to the drive and SG is active, the pulses are not immediately cancelled 11: Stop B, in addition when the communication fails to the drive and SG is active, the pulses are not immediately cancelled 12: Stop C, in addition when the communication fails to the drive and SG is active, the pulses are not immediately cancelled 13: Stop D, in addition when the communication fails to the drive and SG is active, the pulses are not immediately cancelled 14: Stop E, in addition when the communication fails to the drive and SG is active, the pulses are not immediately cancelled	
Special cases, errors,...	For a value of 5 in this MD, the stop response for each SG stage is selectively defined $MA_SAFE_VELO_STOP_REACTION.	
corresponds with ...	MD 36931: $MA_SAFE_VELO_LIMIT[n] MD 36963: $MA_SAFE_VELO_STOP_REACTION[n]	

36962 MD number	**$MA_SAFE_POS_STOP_MODE** Stop response, safe limit position	
Default value: 2	Min. input limit: 2	Max. input limit: 4
Change becomes effective after: POWER ON	Protection level: 7/2	Unit: -
Data type: BYTE		
Significance:	When passing a safe limit position 1 or 2, then the stop response specified in this machine data is initiated. 2: STOP C 3 STOP D 4 STOP E	
corresponds with ...	MD 36934: $MA_SAFE_POS_LIMIT_PLUS[n] MD 36935: $MA_SAFE_POS_LIMIT_MINUS[n]	

36963 MD number	**$MA_SAFE_VELO_STOP_REACTION[n]: 0 ... 3** Stop response, safely-reduced speed			
Default value: 2		Min. input limit: 0		Max. input limit: 14
Change becomes effective after: POWER ON			Protection level: 7/2	Unit: –
Data type: BYTE				
Significance:	The stop response programmed in this machine data is initiated if a limit value for safely-reduced speed 1, 2, 3 or 4 is exceeded. n = 0, 1, 2, 3 stands for SG1, SG2, SG3, SG4 The ones position defines the SG-specific selection of the stop response when the safely-reduced speed is exceeded. The tens position defines the behavior when the communication to the drive fails on an SG-specific basis if a time greater than 0 was parameterized in $MN_SAFE_PULSE_DIS_TIME_BUSFAIL. Value means: 0: Stop A 1: Stop B 2: Stop C 3: Stop D 4: Stop E 10: Stop A, in addition when the communication fails to the drive, the pulses are not immediately cancelled if this SG stage active 11: Stop B, in addition when the communication fails to the drive, the pulses are not immediately cancelled if this SG stage active 12: Stop C, in addition when the communication fails to the drive, the pulses are not immediately cancelled if this SG stage active 13: Stop D, in addition when the communication fails to the drive, the pulses are not immediately cancelled if this SG stage active 14: Stop E, in addition when the communication fails to the drive, the pulses are not immediately cancelled if this SG stage active			
Special cases, errors,...	This function is only active when MD 36961 has the value 5.			
corresponds with ...	MD 10089: $MA_SAFE_PULSE_DIS_TIME_BUSFAIL MD 36961: $MA_SAFE_VELO_STOP_MODE			

36964 MD number	**$MA_SAFE_IPO_STOP_GROUP** Grouping, safety IPO response		
Default value: 0	Min. input limit: 0	Max. input limit: 1	
Change becomes effective after: RESET	Protection level: 7/2	Unit: –	
Data type: BYTE			
Significance:	This MD is only effective for Safety Integrated axes/spindles. It influences the channel-wide IPO response distribution of Safety Integrated. 0 = default: All other axes/spindles in the channel are notified of the IPO stop response of this axis. 1 = For internal stops, the axes and machining spindles, interpolating with the axis involved, are also additionally influenced via the initiated safety alarms. On the other hand, other axes/ spindles in the channel continue to operate without any disturbance. For external stops (without alarm) all of the other axes/spindles remain unaffected by the safety axis/spindle stop. This allows, for example, the pulses of the spindle to be safely cancelled (using an external Stop A). This means that the spindle can be manually rotated and the axes can still be safely monitored while it is moving. If, in some machining situations, the other axes/spindles should stop together with the safety axis/spindle, then the user is responsible in implementing this using PLC or synchronous action logic combinations.		
corresponds with ...			

36965 MD number	**$MA_SAFE_PARK_ALARM_SUPPRESS** Alarm suppression for parking axis		
Default value: FALSE	Min. input limit: –	Max. input limit: –	
Change becomes effective after: POWER ON	Protection level: 7/2	Unit: –	
Data type: BOOLEAN			
Significance:	This MD is only effective for Safety Integrated axes/spindles. 0: Default: Alarms 27000/A01797 are displayed when selecting parking. 1: Alarms 27000/A01797 are not displayed when selecting parking. This is necessary for axes that are disconnected from one another on the encoder side during the machining process (e.g. dressing axes). Alarms are displayed when parking operation is subsequently deselected.		
corresponds with ...			

36966 MD number	**$MA_SAFE_BRAKETEST_TORQUE** Holding torque, brake test		
Default value: 5.0	Min. input limit: 0.0		Max. input limit: 100.0
Change becomes effective after: POWER ON		Protection level: 7/2	Unit: %
Data type: REAL			
Significance:	This MD specifies the torque or force when testing the mechanical brake system. This torque or this force is generated during the test against the closed brake and it is not permissible that the axis moves. The percentage value entered here refers to drive parameter p2003 of the axis. When selecting the brake test (i.e. with the brake open), if the actual torque is more than 85% of the test torque, the brake test is interrupted with Alarm 20095. This therefore ensures that the motor can hold the axis even if the brake is defective. If the brake test is performed using drive parameter p1532 (MD 36968 $MA_SAFE_BRAKETEST_CONTROL bit 0 = 0), the required safety margin is increased by twice the difference between the actual holding torque and the value in parameter p1532. The corresponding test function is enabled using MD $MA_FIXED_STOP_MODE bit 1.		
corresponds with ...	MD 36969: $MN_SAFE_BRAKETEST_TORQUE_NORM		
Additional references	Refer to Chapter 7.6: ”Safe brake test (SBT)”		

36967 MD number	**$MA_SAFE_BRAKETEST_POS_TOL** Position tolerance, brake test		
Default value: 1.0	Min. input limit: –		Max. input limit: –
Change becomes effective after: POWER ON		Protection level: 7/2	Unit: mm/degr.
Data type: DOUBLE			
Significance:	Maximum position tolerance when testing the mechanical brake system. If the axis position deviates from the position by more than this tolerance, when the brake test is selected, then the brake test is aborted. The corresponding test function is enabled using MD $MA_FIXED_STOP_MODE bit 1.		
corresponds with ...			
Additional references	Refer to Chapter 7.6: ”Safe brake test (SBT)”		

36968 MD number	**$MA_SAFE_BRAKETEST_CONTROL** Extended settings for the brake test		
Default value: 0	Min. input limit: 0		Max. input limit: 1
Change becomes effective after: POWER ON		Protection level: 7/2	Unit: –
Data type: DWORD			
Significance:	Bit 0: Select the average value for the torque limiting 0: Drive parameter p1532 is used as the average value of the torque limiting. 1: The measured torque at the instant in time that the brake test is selected is used as the average value of the torque limit.		
corresponds with ...			
Additional references	Refer to Chapter 7.6: ”Safe brake test (SBT)”		

36969 MD number	$MA_SAFE_BRAKETEST_TORQUE_NORM Reference quantity for the holding torque, brake test	
Default value: 0.0	Min. input limit: –	Max. input limit: –
Change becomes effective after: POWER ON	Protection level: 7/0	Unit: Nm
Data type: DOUBLE		
Significance:	Setting the reference quantity for torques. All of the torques specified as relative value refer to this reference quantity. This MD involves an image of drive parameter p2003.	
corresponds with ...		
Additional references		

Description of the parameterization of the SGE machine data MD 36970 to MD 36978

This machine data involves eight-digit hexadecimal numbers, where each digit has a different significance that is now explained:

Coding of the input assignment

is	mm	xx	nn	Permissible values	Explanation
i	Inversion			0, 8	0: No inversion 8: Inversion before processing
s	Segment No.			0, 4	4: Internal image in the system memory (system variable)
mm	Module No.			01–02	01: Addressing the internal SPL interface $A_OUTSI 02: Addressing the external SPL interface (only for input signals, $A_INSE)
xx	Submodule No.			01–02	Index of the system variable word (each 32 bit)
nn	I/O No.			01–20	Bit number in the system variable word $A_OUTSID[xx], $A_INSED[xx]

If several output signals are set, then the signal involved is first inverted. The (in some cases inverted) output signals are then AND'ed and the result is output at the terminal.

Note

The maximum input value for all axial NCK_SGE configured machine data is 84020220
An incorrect entry will be detected the next time the system boots and flagged using Alarm 27033.

36970 MD number	**$MA_SAFE_SVSS_DISABLE_INPUT** Input assignment, SBH/SG deselection		
Default value: 0	Min. input limit: -	Max. input limit: -	
Change becomes effective after: POWER ON	Protection level: 7/2	Unit: -	
Data type: DWORD			
Significance: Configuration:	This machine data defines the NCK input to select/deselect the SBH and SG functions Signal means = 0, SG or SBH is selected = 1, SG and SBH are deselected Configuration: Refer to the coding of the input assignment		
Special cases, errors,...	• Input value of 0 means: There is no assignment, the input remains fixed at 0, SG and SBH cannot be deselected • Input value of 80 00 00 00 means: There is no assignment, the input remains fixed at 1 • If MD bit 31 is set, then the signal is processed inverted (i = 8).		
corresponds with ...			
References:			

36971 MD number	**$MA_SAFE_SS_DISABLE_INPUT** Input assignment, SBH deselection		
Default value: 0	Min. input limit: -	Max. input limit: -	
Change becomes effective after: POWER ON	Protection level: 7/2	Unit: -	
Data type: DWORD			
Significance:	Assignment of the NCK input to de-select the safe operating stop function. Configuration: Refer to the coding of the input assignment Assignment of the terminal signal level to the safe functions if safely-reduced speed or safe operating stop has been activated. Signal means = 0, safe operating stop is selected = 1, safe operating stop is deselected (only if STOP C, D or E has not been activated by other functions)		
Special cases, errors,...	• If MD bit 31 is set, then the signal is processed inverted (i = 8). • This input is of no significance if SG and SBH have been deselected (refer to $MA_SAFE_SVSS_DISABLE_INPUT).		
corresponds with ...	MD 36970: $MA_SAFE_SVSS_DISABLE_INPUT		

36972 MD number	**$MA_SAFE_VELO_SELECT_INPUT[n]: 0 ... 1** Input assignment, SG selection		
Default value: 0	Min. input limit: -		Max. input limit: -
Change becomes effective after: POWER ON		Protection level: 7/2	Unit: -
Data type: DWORD			
Significance:	This machine data defines the two inputs to select SG1, SG2, SG3 or SG4. Configuration: Refer to the coding of the input assignment n = 1, 0 stand for bit 1, 0 to select from SG1 to SG4 Assignment of the input bits to the safely-reduced speeds: Bit 1 Bit 0 Selected SG 0 0 SG1 0 1 SG2 1 0 SG3 1 1 SG4		
Special cases, errors,...	If the MD bits 31 are set, then the signal is processed inverted (i = 8).		
corresponds with ...	MD 36970: $MA_SAFE_SVSS_DISABLE_INPUT		

36973 MD number	**$MA_SAFE_POS_SELECT_INPUT** Input assignment, SE selection		
Default value: 0	Min. input limit: -		Max. input limit: -
Change becomes effective after: POWER ON		Protection level: 7/2	Unit: -
Data type: DWORD			
Significance:	This machine data defines the input to select the safe limit position 1 or 2. Configuration: Refer to the coding of the input assignment Signal means = 0, SE1 is active = 1, SE2 is active		
Special cases, errors,...	If MD bit 31 is set, then the signal is processed inverted (i = 8).		
corresponds with ...	MD 36970: $MA_SAFE_SVSS_DISABLE_INPUT		

36974 MD number	**$MA_SAFE_GEAR_SELECT_INPUT[n]: 0 ... 2** Input assignment, gearbox ratio selection		
Default value: 0	Min. input limit: -		Max. input limit: -
Change becomes effective after: POWER ON		Protection level: 7/2	Unit: -
Data type: DWORD			
Significance:	Assignment of the input terminals for selecting the gear ratio (gear stage). Configuration: Refer to the coding of the input assignment n= 2, 1, 0 stand for bit 2, 1, 0 to select gearbox stages 1 to 8 Bit 2 Bit 1 Bit 0 active gearbox stage 0 0 0 Stage 1 0 0 1 Stage 2 0 1 0 Stage 3 ... ... 1 1 1 Stage 8		
Special cases, errors,...	If the MD bits 31 are set, then the signal is processed inverted (i = 8).		
corresponds with ...	MD 36970: $MA_SAFE_SVSS_DISABLE_INPUT		

36977 MD number	**$MA_SAFE_EXT_STOP_INPUT[n]: 0 ... 3** Input assignment, external brake request			
Default value: 0, 0, 0, 0		Min. input limit: -		Max. input limit: -
Change becomes effective after: POWER ON			Protection level: 7/2	Unit: -
Data type: DWORD				
Significance:	This data defines the NCK inputs to select/deselect the external brake requests. n = 0, 1, 2, 3 stands for various braking types n = 0: Assignment for ”deselect external STOP A” (SH, pulse cancellation) n = 1: Assignment for ”deselect external STOP C” (braking at the current limit) n = 2: Assignment for ”deselect external STOP D” (braking along a path) n = 3: Assignment for ”deselect external STOP E” (ESR, braking along a path)			
Special cases, errors,...	If the MD bits 31 are set, then the signal is processed inverted (i = 8). The signal ”deselect external STOP A” can not be parameterized inverted. In the case of an error, a parameterizing error is signaled			
corresponds with ...	MD 36970: $MA_SAFE_SVSS_DISABLE_INPUT			
Additional references				

36978 MD number	**$MA_SAFE_OVR_INPUT[n]: 0 ... 3** Input assignment, SG override			
Default value: 0, 0, 0, 0		Min. input limit: -		Max. input limit: -
Change becomes effective after: POWER ON			Protection level: 7/2	Unit: -
Data type: DWORD				
Significance:	Assigns the NCK inputs for the correction of the limit value of the safely-reduced speeds 2 and 4. Configuration: Refer to the coding of the input assignment n = 3, 2, 1, 0 stand for correction selection bits 3, 2, 1, 0 Assigns the input bits to the SG correction values: Bit 3 Bit 2 Bit 1 Bit 0 0 0 0 0 Correction 0 is selected 0 0 0 1 Correction 1 is selected to 1 1 1 1 Correction 15 is selected The correction factor itself (percentage) is defined using the following machine data: MD 36932: $MA_SAFE_VELO_OVR_FACTOR[n]			
Special cases, errors,...	- The function ”correction, safely-reduced speed” is enabled using MD 36901: $MA_SAFE_FUNCTION_ENABLE, bit 5. - If the MD bits 31 are set, then the signal is processed inverted (i = 8).			
corresponds with ...	MD 36932: $MA_SAFE_VELO_OVR_FACTOR[n]			
Additional references	Refer to Chapter 6.5.4: ”Override for safely-reduced speed”, see MD 36970: $MA_SAFE_SVSS_DISABLE_INPUT			

Description of the parameterization of the SGA machine data MD 36980 to MD 36990

Coding of the output assignment

is	mm	xx	nn	Permissible values	Explanation
i	Inversion			0, 8	0: No inversion 8: Inversion before processing
s	Segment No.			0, 4	4: Internal image in the system memory (system variable)
mm	Module No.			01	01: Addressing the internal SPL interface $A_INSI
xx	Submodule No.			01 - 02	Index of the system variable word (each 32 bit)
nn	I/O No.			01 - 20	Bit number in the system variable word $A_INSID[xx]

Note

The maximum input value for all axial NCK_SGA configuring machine data is 84010220
An incorrect entry will be detected the next time the system boots and flagged using Alarm 27033.

36980 MD number	**$MA_SAFE_SVSS_STATUS_OUTPUT** Output assignment, SBH/SG active	
Default value: 0	Min. input limit: -	Max. input limit: -
Change becomes effective after: POWER ON	Protection level: 7/2	Unit: -
Data type: DWORD		
Significance:	Assigns the output to signal the status of the functions safely-reduced speed and safe operating stop. Signal means: = 0, SG and SBH are not active = 1, SG or SBH is active	
Special cases, errors,...	- Input value of 0 means: There is no assignment, the output remains unaffected - Input value of 80 00 00 00 means: There is no assignment, the output remains fixed at 1 - If a single output signal is connected to a terminal, the following applies: If MD bit 31 is set, then the signal is processed inverted (i = 8). - If several output signals are connected to the same terminal, the following applies: If MD bit 31 is set (i = 8), then the relevant signal is initially inverted. The (in some cases inverted) output signals are then AND'ed and the result is output at the terminal.	
corresponds with ...		
Additional references	see MD 36970: $MA_SAFE_SVSS_DISABLE_INPUT	

36981 MD number	**$MA_SAFE_SS_STATUS_OUTPUT** Output assignment for SBH active	
Default value: 0	Min. input limit: -	Max. input limit: -
Change becomes effective after: POWER ON	Protection level: 7/2	Unit: -
Data type: DWORD		
Significance:	This machine data defines the output or the system variable for the "SBH active" signal. Configuration: Refer to the coding of the output assignment Signal means = 0, SBH is not active = 1, SBH is active	
Special cases, errors,...	If MD bit 31 is set, then the signal is processed inverted.	
Additional references	see MD 36980: $MA_SAFE_SVSS_DISABLE_OUTPUT	

36982 MD number	**$MA_SAFE_VELO_STATUS_OUTPUT[n]: 0 ... 1** Output assignment active SG selection		
Default value: 0	Min. input limit: -	Max. input limit: -	
Change becomes effective after: POWER ON	Protection level: 7/2	Unit: -	
Data type: DWORD			
Significance:	This machine data defines the outputs or the system variables for the signals ”SG active bit 0” and ”SG active bit 1”. Configuration: Refer to the coding of the output assignment n = 1, 0 stands for SG active, bits 1, 0 SG active Bit 1 Bit 0 means = 0 = 0 SG1 active, if SBH/SG is active and SBH is not active SBH active, if SBH/SG are active and SBH is active = 1 = 0 SG2 active = 0 = 1 SG3 active = 1 = 1 SG4 active		
Special cases, errors,...	If MD bit 31 is set, then the signal is processed inverted.		
Additional references	see MD 36980: $MA_SAFE_SVSS_DISABLE_OUTPUT		

36985 MD number	**$MA_SAFE_VELO_X_STATUS_OUTPUT** Output assignment for n < n_x		
Default value: 0	Min. input limit: -	Max. input limit:	
Change becomes effective after: POWER ON	Protection level: 7/2	Unit:	
Data type: DWORD			
Significance:	This machine data defines the output or the system variable for the signal ”n < n_x”. Configuration: Refer to the coding of the output assignment Signal means = 0, actual speed is higher than the limit speed in $MA_SAFE_VELO_X = 1, actual speed is lower or equal to the limit speed		
Special cases, errors,...	If MD bit 31 is set, then the signal is processed inverted.		
corresponds with ...	MD 36946: $MA_SAFE_VELO_X		
Additional references	see MD 36980: $MA_SAFE_SVSS_DISABLE_OUTPUT		

36987 MD number	**$MA_SAFE_REFP_STATUS_OUTPUT** Output assignment, axis safely referenced		
Default value: 0	Min. input limit: 0	Max. input limit: -	
Change becomes effective after: POWER ON	Protection level: 7/2	Unit: -	
Data type: DWORD			
Significance:	This machine data specifies the output for the ”axis safely referenced” signal. Signal = 0 Axis is not safely referenced (i.e. the safety-relevant end position monitoring is inactive!) = 1 Axis is safely referenced		
Special cases, errors,...	If MD bit 31 is set, then the signal is processed inverted.		
Additional references	see MD 36980: $MA_SAFE_SVSS_DISABLE_OUTPUT		

36988 MD number	**$MA_SAFE_CAM_PLUS_OUTPUT[n]: 0 ... 3** Output assignment, SN1+ to SN4+		
Default value: 0, 0, 0, 0	Min. input limit: -	Max. input limit: -	
Change becomes effective after: POWER ON	Protection level: 7/2	Unit: -	
Data type: DWORD			
Significance:	This machine data specifies the outputs for the cam signals SN1+ to SN4+. n = 0, 1, 2, 3 stands for the assignment of plus cams SN1+, SN2+, SN3+, SN4+ Signal means = 0 Axis is located to the left of the cam (actual value < cam position) = 1 Axis is located to the right of the cam (actual value > cam position)		
Special cases, errors,...	If MD bit 31 is set, then the signal is processed inverted.		
Additional references	see MD 36980: $MA_SAFE_SVSS_DISABLE_OUTPUT see also Chapter 6.8: Safe software cams, output assignment)		

36989 MD number	**$MA_SAFE_CAM_MINUS_OUTPUT[n]: 0 ... 3** Output assignment, SN1- to SN4-		
Default value: 0	Min. input limit: -	Max. input limit: -	
Change becomes effective after: POWER ON	Protection level: 7/2	Unit:	
Data type: DWORD			
Significance:	This machine data defines the outputs for the minus cams SN1- to SN4-. = 0, 1, 2, 3 corresponds to the assignment for minus cams SN1-, SN2-, SN3-, SN4- Signal means = 0 Axis is located to the left of the cam (actual value < cam position) = 1 Axis is located to the right of the cam (actual value > cam position)		
Special cases, errors,...	- In order to generate a cam signal to identify the range, a cam must be negated and must be parameterized with another cam at the same output.		
Additional references	see MD 36980: $MA_SAFE_SVSS_DISABLE_OUTPUT see also Chapter 6.8: Safe software cams, output assignment		

36990 MD number	**$MA_SAFE_ ACT_STOP_OUTPUT[n]: 0...3** Output assignment of the active stop		
Default value: 0	Min. input limit: -	Max. input limit: -	
Change becomes effective after: POWER ON	Protection level: 7/2	Unit: -	
Data type: DWORD			
Significance:	Assignment of the output terminals to display the stops that are presently active. Index = 0: Assignment for "STOP A/B is active" Index = 1: Assignment for "STOP C is active" Index = 2: Assignment for "STOP D is active" Index = 3: Assignment for "STOP E is active"		
Special cases, errors,...			
corresponds with ...			
Additional references	see MD 36980: $MA_SAFE_SVSS_DISABLE_OUTPUT		

36992 MD number	**$MA_SAFE_CROSSCHECK_CYCLE** Displays the axial crosswise comparison clock cycle		
Default value: 0.0	Min. input limit: 0	Max. input limit: -	
Change becomes effective after: POWER ON	Protection level: 7/0	Unit: s	
Data type: DOUBLE			
Significance:	Safety system, display data: Indicates the effective axial comparison clock cycle in seconds. The clock cycle is obtained from INFO_SAFETY_CYCLE_TIME and the number of data to be compared crosswise. The axial value displayed depends on the associated drive module, as the length of the crosswise comparison list differs between performance-1/Standard-2 and Performance-2 modules.		
Special cases, errors,...			

36993 MD number	**$MA_SAFE_CONFIG_CHANGE_DATE[n]: n = 0...6** Date/time of the last change SI axis MD		
Default value: -	Min. input limit: -	Max. input limit: -	
Change becomes effective after: POWER ON	Protection level: 7/-	Unit: -	
Data type: STRING			
Significance:	Safety system, display data: Date and time of the last configuration change of safety-related NCK axis machine data. Changes made to the machine data that are calculated into the axial checksums SAFE_ACT_CHECKSUM are recorded.		
Special cases, errors,...			

36994 MD number	**$MA_SAFE_PREV_CONFIG[n]: n = 0...8** Data, previous safety axis configuration		
Default value: 0H	Min. input limit: 0H	Max. input limit: FFFFFFFFH	
Change becomes effective after: POWER ON	Protection level: Siemens	Unit: -	
Data type: DWORD			
Significance:	Buffer memory to save previous safety configuration data Index[0]: Status flag bit of the change history Index[1]: Previous value, function enable Index[2]: Previous value, reference checksum SAFE_DES_CHECKSUM[0] Index[3]: Last value, function enable before loading standard data Index[4]: Last value, reference checksum SAFE_DES_CHECKSUM[0] before loading default data Index[5]: Previous value, reference checksum SAFE_DES_CHECKSUM[1] Index[6]: Last value, reference checksum SAFE_DES_CHECKSUM[1] before loading default data Index[7]: Previous value, reference checksum SAFE_DES_CHECKSUM[2] Index[8]: Last value, reference checksum SAFE_DES_CHECKSUM[2] before loading default data		
Special cases, errors,...			

36995 MD number	**$MA_SAFE_STANDSTILL_POS** Standstill position	
Default value: 0	Min. input limit: -	Max. input limit: -
Change becomes effective after: POWER ON	Protection level: 0/0	Unit: -
Data type: DWORD		
Significance:	The position at which the axis has currently stopped is displayed in this MD. To be able to perform a plausibility check on the axis referencing when the control system is powered-up the next time, the current axis position is permanently saved (in a non-volatile fashion) when the following events take place: - When safe operating stop (SBH) is selected - Cyclically when SE/SN is active	
Special cases, errors,...	Any manual changes to the MD are detected the next time that the control is powered-up (plausibility check). A new user agreement is required after referencing.	

36997 MD number	**$MA_SAFE_ACKN** User acknowledgement	
Default value: 0	Min. input limit: -	Max. input limit: -
Change becomes effective after: POWER ON	Protection level: 7/2	Unit: -
Data type: DWORD		
Significance:	The status of the user agreement is displayed in this machine data. The user can confirm or cancel his ”user agreement” using an appropriate screen. If it is internally detected in the software that the reference to the machine has been lost, then it is automatically cancelled (e.g. when changing over gear ratios or when referencing, the plausibility check when comparing with the saved stop position fails).	
Special cases, errors,...	Any manual changes to the MD are detected the next time that the control is powered-up (plausibility check). A new user agreement is required after referencing.	

36998 MD number	**$MA_SAFE_ACT_CHECKSUM[0,1,2]** Actual checksum	
Default value: 0H	Min. input limit: 0H	Max. input limit: FFFFFFFFH
Change becomes effective after: POWER ON	Protection level: 7/0	Unit: -
Data type: DWORD		
Significance:	The actual checksum - calculated after power on or a reset - over the actual values of safety-related machine data is entered here. Assigning the indices: Index 0: Axial monitoring functions Index 1: HW component IDs Index 2: Drive assignment	

36999 MD number	**$MA_SAFE_DES_CHECKSUM[0,1,2]** Reference checksum		
Default value: 0H	Min. input limit: 0H	Max. input limit: FFFFFFFFH	
Change becomes effective after: POWER ON	Protection level: 7/1	Unit: –	
Data type: DWORD			
Significance:	This machine data contains the reference checksum over the actual values of safety-related machine data that was saved during the last machine acceptance test. Assigning the indices: Index 0: Axial monitoring functions Index 1: HW component IDs Index 2: Drive assignment		

37000 MD number	**$MA_FIXED_STOP_MODE** Travel to fixed stop mode		
Default value: 0	Min. input limit: 0	Max. input limit: 3	
Change becomes effective after: POWER ON	Protection level: 7/2	Unit: –	
Data type: BYTE			
Significance:	This machine data defines how the ”Travel to fixed stop” function can be started. 0: Travel to fixed stop not available. 1: Travel to fixed stop can be started from the NC program with command FXS[0,1] =1. 2: The function is only controlled from the PLC 3: NCK and PLC are peers [same priority] (user ensures synchronization)		

37900 MD number	**$MA_SAFE_CAM_TRACK_OUTPUT[0...3]** Output assignment cam tracks 1 to 4		
Default value: 0, 0, 0, 0	Min. input limit: –	Max. input limit: –	
Change becomes effective after: POWER ON	Protection level: 7/2	Unit: –	
Data type: DWORD			
Significance:	This machine data specifies the outputs for cam tracks 1 to 4. Configuration: see $MA_SAFE_SVSS_STATUS_OUTPUT n = 0, 1, 2, 3 corresponds to the assignment for cam tracks 1 to 4 Signal means = 0, axis is not located on a cam of cam track n = 1, axis is located on a cam of cam track n		
Special cases, errors,...	The ”safe cam track” function is enabled using MD 36903 $MA_SAFE_CAM_ENABLE. If MD bit 31 is set, then the signal is processed inverted.		

37901 MD number	$MA_SAFE_CAM_RANGE_OUTPUT_1[0...3] Output assignment, cam range for cam track 1	
Default value: 0, 0, 0, 0	Min. input limit: -	Max. input limit: -
Change becomes effective after: POWER ON	Protection level: 7/2	Unit: -
Data type: DWORD		
Significance:	This machine data specifies the outputs for the cam range of cam track 1. Configuration: see $MA_SAFE_SVSS_STATUS_OUTPUT n = 0, 1, 2, 3 corresponds to the 4 bits to specify the range on cam track 1 Bit 3 Bit 2 Bit 1 Bit 0 0 0 0 0 Cam range 0 is active 0 0 0 1 Cam range 1 is active up to ... 1 1 1 1 Cam range 15 is active The cam range is defined using the following machine data: MD 36938: $MA_SAFE_CAM_TRACK_ASSIGN[n] Signal means = 0...14, axis is located in the range of the cam that was assigned to range ID 0...14 on cam track 1. = 15 axis is located in the range to the right of the outermost cam of cam track 1	
Special cases, errors,...	The "safe cam track" function is enabled using MD 36903 $MA_SAFE_CAM_ENABLE. If the MD bits 31 are set, then the signal is processed inverted. If not all of the 4 bits are assigned, then under certain circumstances, it cannot be uniquely and clearly identified as to which cam range is active.	
corresponds with ...	MD 37900: $MA_SAFE_CAM_TRACK_OUTPUT	

37902 MD number	$MA_SAFE_CAM_RANGE_OUTPUT_2[0...3] Output assignment, cam range for cam track 2	
Default value: 0, 0, 0, 0	Min. input limit: -	Max. input limit: -
Change becomes effective after: POWER ON	Protection level: 7/2	Unit: -
Data type: DWORD		
Significance:	This machine data specifies the outputs for the cam range of cam track 2. Configuration: see $MA_SAFE_SVSS_STATUS_OUTPUT n = 0, 1, 2, 3 corresponds to the 4 bits to specify the range on cam track 2 Bit 3 Bit 2 Bit 1 Bit 0 0 0 0 0 Cam range 0 is active 0 0 0 1 Cam range 1 is active up to ... 1 1 1 1 Cam range 15 is active The cam range is defined using the following machine data: MD 36938: $MA_SAFE_CAM_TRACK_ASSIGN[n] Signal means = 0...14, axis is located in the range of the cam that was assigned to range ID 0...14 on cam track 2. = 15 axis is located in the range to the right of the outermost cam of cam track 2	
Special cases, errors,...	The "safe cam track" function is enabled using MD 36903 $MA_SAFE_CAM_ENABLE. If the MD bits 31 are set, then the signal is processed inverted. If not all of the 4 bits are assigned, then under certain circumstances, it cannot be uniquely and clearly identified as to which cam range is active.	
corresponds with ...	MD 37900: $MA_SAFE_CAM_TRACK_OUTPUT	

37903 MD number	**$MA_SAFE_CAM_RANGE_OUTPUT_3[0...3]** Output assignment, cam range for cam track 3		
Default value: 0, 0, 0, 0	Min. input limit: -	Max. input limit: -	
Change becomes effective after: POWER ON	Protection level: 7/2	Unit: -	
Data type: DWORD			
Significance:	This machine data specifies the outputs for the cam range of cam track 3. Configuration: see $MA_SAFE_SVSS_STATUS_OUTPUT n = 0, 1, 2, 3 corresponds to the 4 bits to specify the range on cam track 3 Bit 3 Bit 2 Bit 1 Bit 0 0 0 0 0 Cam range 0 is active 0 0 0 1 Cam range 1 is active up to ... 1 1 1 1 Cam range 15 is active The cam range is defined using the following machine data: MD 36938: $MA_SAFE_CAM_TRACK_ASSIGN[n] Signal means = 0...14, axis is located in the range of the cam that was assigned to range ID 0...14 on cam track 3. = 15 axis is located in the range to the right of the outermost cam of cam track 3		
Special cases, errors,...	The ”safe cam track” function is enabled using MD 36903 $MA_SAFE_CAM_ENABLE. If the MD bits 31 are set, then the signal is processed inverted. If not all of the 4 bits are assigned, then under certain circumstances, it cannot be uniquely and clearly identified as to which cam range is active.		
corresponds with ...	MD 37900: $MA_SAFE_CAM_TRACK_OUTPUT		

37904 MD number	**$MA_SAFE_CAM_RANGE_OUTPUT_4[0...3]** Output assignment, cam range for cam track 4		
Default value: 0, 0, 0, 0	Min. input limit: -	Max. input limit: -	
Change becomes effective after: POWER ON	Protection level: 7/2	Unit: -	
Data type: DWORD			
Significance:	This machine data specifies the outputs for the cam range of cam track 4. Configuration: see $MA_SAFE_SVSS_STATUS_OUTPUT n = 0, 1, 2, 3 corresponds to the 4 bits to specify the range on cam track 4 Bit 3 Bit 2 Bit 1 Bit 0 0 0 0 0 Cam range 0 is active 0 0 0 1 Cam range 1 is active up to ... 1 1 1 1 Cam range 15 is active The cam range is defined using the following machine data: MD 36938: $MA_SAFE_CAM_TRACK_ASSIGN[n] Signal means = 0...14, axis is located in the range of the cam that was assigned to range ID 0...14 on cam track 4. = 15 axis is located in the range to the right of the outermost cam of cam track 4		
Special cases, errors,...	The ”safe cam track” function is enabled using MD 36903 $MA_SAFE_CAM_ENABLE. If the MD bits 31 are set, then the signal is processed inverted. If not all of the 4 bits are assigned, then under certain circumstances, it cannot be uniquely and clearly identified as to which cam range is active.		
corresponds with ...	MD 37900: $MA_SAFE_CAM_TRACK_OUTPUT		

37906 MD number	**$MA_SAFE_CAM_RANGE_BIN_OUTPUT_1[0...14]** Output assignment, cam range bit for cam track 1			
Default value: 0, 0, 0, 0		Min. input limit: 0		Max. input limit: -
Change becomes effective after: POWER ON			Protection level: 7/2	Unit: -
Data type: DWORD				
Significance:	This machine data specifies the outputs for the cam range bits of cam track 1. Configuration: see $MA_SAFE_SVSS_STATUS_OUTPUT Field index n corresponds to the parameterizable cam range numbers on cam track 1. The cam range number is defined using the following machine data: MD 36938: $MA_SAFE_CAM_TRACK_ASSIGN[0...29] Signal means = 0, axis is not located on the cam with cam range number n = 1, axis is located on the cam with cam range number n Example: The signal that is addressed using field index 5 goes to 1 if the axis is located at the cam that is assigned to cam track 1 by parameterizing the cam range number 5.			
Special cases, errors,...	The "safe cam track" function is enabled using MD 36903 $MA_SAFE_CAM_ENABLE. If the MD bits 31 are set, then the signal is processed inverted. If the cam range number n is not parameterized on cam track 1 then the signal of field index n can never go to 1. The output MD with field index n must in this case not be parameterized.			

37907 MD number	**$MA_SAFE_CAM_RANGE_BIN_OUTPUT_2[0...14]** Output assignment, cam range bit for cam track 2			
Default value: 0, 0, 0, 0		Min. input limit: 0		Max. input limit: -
Change becomes effective after: POWER ON			Protection level: 7/2	Unit: -
Data type: DWORD				
Significance:	This machine data specifies the outputs for the cam range bits of cam track 2. Configuration: see $MA_SAFE_SVSS_STATUS_OUTPUT Field index n corresponds to the parameterizable cam range numbers on cam track 2. The cam range number is defined using the following machine data: MD 36938: $MA_SAFE_CAM_TRACK_ASSIGN[0...29] Signal means = 0, axis is not located on the cam with cam range number n = 1, axis is located on the cam with cam range number n Example: The signal that is addressed using field index 5 goes to 1 if the axis is located at the cam that is assigned to cam track 2 by parameterizing the cam range number 5.			
Special cases, errors,...	The "safe cam track" function is enabled using MD 36903 $MA_SAFE_CAM_ENABLE. If the MD bits 31 are set, then the signal is processed inverted. If the cam range number n is not parameterized on cam track 2 then the signal of field index n can never go to 1. The output MD with field index n must in this case not be parameterized.			

37908 MD number	$MA_SAFE_CAM_RANGE_BIN_OUTPUT_3[0...14] Output assignment, cam range bit for cam track 3	
Default value: 0, 0, 0, 0	Min. input limit: -	Max. input limit: -
Change becomes effective after: POWER ON	Protection level: 7/2	Unit: -
Data type: DWORD		
Significance:	This machine data specifies the outputs for the cam range bits of cam track 3. Configuration: see $MA_SAFE_SVSS_STATUS_OUTPUT Field index n corresponds to the parameterizable cam range numbers on cam track 3. The cam range number is defined using the following machine data: MD 36938: $MA_SAFE_CAM_TRACK_ASSIGN[0...29] Signal means = 0, axis is not located on the cam with cam range number n = 1, axis is located on the cam with cam range number n Example: The signal that is addressed using field index 5 goes to 1 if the axis is located at the cam that is assigned to cam track 3 by parameterizing the cam range number 5.	
Special cases, errors,...	The "safe cam track" function is enabled using MD 36903 $MA_SAFE_CAM_ENABLE. If the MD bits 31 are set, then the signal is processed inverted. If the cam range number n is not parameterized on cam track 3 then the signal of field index n can never go to 1. The output MD with field index n must in this case not be parameterized.	

37909 MD number	$MA_SAFE_CAM_RANGE_BIN_OUTPUT_4[0...14] Output assignment, cam range bit for cam track 3	
Default value: 0, 0, 0, 0	Min. input limit: -	Max. input limit: -
Change becomes effective after: POWER ON	Protection level: 7/2	Unit: -
Data type: DWORD		
Significance:	This machine data specifies the outputs for the cam range bits of cam track 4. Configuration: see $MA_SAFE_SVSS_STATUS_OUTPUT Field index n corresponds to the parameterizable cam range numbers on cam track 4. The cam range number is defined using the following machine data: MD 36938: $MA_SAFE_CAM_TRACK_ASSIGN[0...29] Signal means = 0, axis is not located on the cam with cam range number n = 1, axis is located on the cam with cam range number n Example: The signal that is addressed using field index 5 goes to 1 if the axis is located at the cam that is assigned to cam track 4 by parameterizing the cam range number 5.	
Special cases, errors,...	The "safe cam track" function is enabled using MD 36903 $MA_SAFE_CAM_ENABLE. If the MD bits 31 are set, then the signal is processed inverted. If the cam range number n is not parameterized on cam track 4 then the signal of field index n can never go to 1. The output MD with field index n must in this case not be parameterized.	

8.2 Parameters for SINAMICS S120

Note

Some safety parameters for the motion monitoring functions on the CU are protected with access level 4 (manufacturer access) which means that as standard, they are not visible in the expert list of the STARTER drive commissioning tool. However, the access stage is reduced as a result of a user-specific view for SINUMERIK 840D sl to 3 (expert access) so that the safety parameters for the motion monitoring functions are visible on the HMI without having to enter a password for the access stage.
This comment must be taken into account for all safety parameters for the motion monitoring functions (name ”SI Motion...”) that are listed in the following Chapters: There, standard access level 4 is sometimes specified, while in operation with SINUMERIK 840D sl, access level 3 is actually effective.

The following parameters are available:

- Safety parameters for the Control Unit
- Safety parameters for the Motor Module

Parameter number

The parameter number consists of a leading ”p” or ”r”, followed by the parameter number and the index (optional).

Examples of the representation in the parameter list:

- p... Setting parameters (can be read and written to)
- r... Visualization parameters (read-only)
- p0918 Setting parameter 918
- p0099[0...3] Setting parameter 99, indices 0 to 3
- p1001[0...n] Setting parameter 1001, indices 0 to n (n = configurable)
- r0944 Visualization parameter 944

Other examples of the notation used in the documentation:

- p1070[1] Setting parameter 1070, index 1
- p2098[1].3 Setting parameter 2098, index 1, bit 3
- r0945[2](3) Visualization parameter 945, index 2 of drive object 3
- p0795.4 Setting parameter 795, bit 4
- r2129.0...15 display parameter 2129 with bit field (maximum 16 bit)

The possible data types of parameter values are as follows:

I8	Integer8	8 Bit integer number
I16	Integer16	16 Bit integer number
I32	Integer32	32 Bit integer number
U8	Unsigned8	8 Bit without sign

U16	Unsigned16	16 Bit without sign
U32	Unsigned32	32 Bit without sign
REAL32	REAL32	Floating-point number (32 bits)

For a complete list of the parameters in the SINAMICS S120 drive system, refer to:

References: /LH1/ SINAMICS S List Manual

8.2.1 Parameter overview

When copying, the parameters with grey background are not taken into consideration. The machine manufacturer must manually enter this data.

Table 8-2 Parameters for SINAMICS S120

No.	Designators for SINAMICS S120	Check-sum	Equivalent MD for 840D sl	
	Name		No.	Name
p2003	Reference torque		36969	$MN_SAFE_BRAKETEST_TORQUE_NORM
Parameters for motion monitoring functions				
p9500	SI motion monitoring clock cycle (Control Unit)	0	10090	$MN_SAFETY_SYSCLOCK_TIME_RATIO
p9501	SI motion enable safety functions (Control Unit)	0	36901	$MA_SAFE_FUNCTION_ENABLE
p9502	SI motion axis type (Control Unit)	0	36902	$MA_SAFE_IS_ROT_AX
p9503	SI motion SCA (SN) enable (Control Unit)	0	36903	$MA_SAFE_CAM_ENABLE
p9505	SI motion SCA (SN) enable (Control Unit)	0	36905	$MA_SAFE_MODULO_RANGE
p9515	SI motion coarse position value configuration (CU)	2	--	--
p9516	SI motion, motor encoder configuration, safety-related functions (CU)	1	36916	$MA_SAFE_ENC_IS_LINEAR
p9517	SI motion linear scale, grid division (Control Unit)	1	36917	$MA_SAFE_ENC_GRID_POINT_DIST
p9518	SI motion encoder pulses per revolution (Control Unit)	1	36918	$MA_SAFE_ENC_RESOL
p9519	SI motion fine resolution G1_XIST1 (Control Unit)	1	36919	$MA_SAFE_ENC_PULSE_SHIFT
p9520	SI motion spindle pitch (Control Unit)	1	36920	$MA_SAFE_ENC_GEAR_PITCH
p9521	SI motion, gearbox, encoder/load, denominator (Control Unit)	1	36921	$MA_SAFE_ENC_GEAR_DENOM[n]
p9522	SI motion, gearbox, encoder/load, numerator (Control Unit)	1	36922	$MA_SAFE_ENC_GEAR_NUMERA[n]
p9523	SI motion redundant coarse position value valid bits (CU)	2	--	--
p9524	SI motion fine resolution coarse position value (Control Unit)	2	--	--
p9525	SI motion redundant coarse position relevant bits (Control Unit)	1	--	--

Table 8-2 Parameters for SINAMICS S120

	Name		No.	Name
p9526	SI motion encoder assignment control (Control Unit)	1	--	--
r9527	SI motion Sensor Module type 2. channel (Control Unit)		--	--
r9529	SI motion Gx_XIST1 coarse position safety most significant bit (Control Unit)	1	--	--
p9530	SI motion standstill tolerance (Control Unit)	0	36930	$MA_SAFE_STANDSTILL_TOL
p9531	SI motion SLS (SG) limit values (Control Unit)	0	36931	$MA_SAFE_VELO_LIMIT[n]
p9532	SI motion SLS (SG) override factor (Control Unit)	0	36932	SAFE_VELO_OVR_FACTOR[n]
p9534	SI motion SLP (SE) upper limit values (Control Unit)	0	36934	$MA_SAFE_POS_LIMIT_PLUS[n]
p9535	SI motion SLP (SE) lower limit values (Control Unit)	0	36935	$MA_SAFE_POS_LIMIT_MINUS[n]
p9536	SI motion SCA (SN) plus cam position (Control Unit)	0	36936	$MA_SAFE_CAM_POS_PLUS[n]
p9537	SI motion, SCA (SN) minus cam position	0	36937	$MA_SAFE_CAM_POS_MINUS[n]
p9538	SI motion SCA (SN) cam track assignment (Control Unit)	0	36938	$MA_SAFE_CAM_TRACK_ASSIGN
p9540	SI motion SCA (SN) tolerance (Control Unit)	0	36940	$MA_SAFE_CAM_TOL
p9542	SI motion actual value comparison tolerance (crosswise) (Control Unit)	0	36942	$MA_SAFE_POS_TOL
p9544	SI motion actual value comparison tolerance (referencing) (CU)	0	36944	$MA_SAFE_REFP_POS_TOL
p9545	SI Motion SSM (SGA n < nx) filter time (Control Unit)	0	36945	$MA_SAFE_VELO_X_FILTER_TIME
p9546	SI Motion SSM (SGA n < nx) velocity limit n_x (CU)	0	36946	$MA_SAFE_VELO_X
p9547	SI motion SSM (SGA n < nx) velocity hysteresis (CU)	0	36947	$MA_SAFE_VELO_X_HYSTERESIS
p9548	SI motion SBR actual speed tolerance (Control Unit)	0	36948	$MA_SAFE_STOP_VELO_TOL
p9549	SI motion slip speed tolerance (Control Unit)	0	36949	$MA_SAFE_SLIP_VELO_TOL
p9550	SI motion SGE changeover tolerance time (Control Unit)	0	36950	$MA_SAFE_MODE_SWITCH_TIME
p9551	SI motion SGE changeover delay time (Control Unit)	0	36951	$MA_SAFE_VELO_SWITCH_DELAY
p9552	SI motion transition time STOP C to SOS (SBH) (Control Unit)	0	36952	$MA_SAFE_STOP_SWITCH_TIME_C
p9553	SI motion transition time STOP D to SOS (SBH) (Control Unit)	0	36953	$MA_SAFE_STOP_SWITCH_TIME_D
p9554	SI motion transition time STOP E to SOS (SBH) (Control Unit)	0	36954	$MA_SAFE_STOP_SWITCH_TIME_E
p9555	SI motion transition time STOP F to STOP B (Control Unit)	0	36955	$MA_SAFE_STOP_SWITCH_TIME_F
p9556	SI motion pulse cancelation delay time (Control Unit)	0	36956	$MA_SAFE_PULSE_DISABLE_DELAY
p9557	SI motion pulse cancellation checking time (Control Unit)	0	36957	$MA_SAFE_PULSE_DIS_CHECK_TIME

Table 8-2 Parameters for SINAMICS S120

	Name		No.	Name
p9558	SI motion acceptance test time limit (Control Unit)	0	36958	$MA_SAFE_ACCEPTANCE_TST_TIME-OUT
p9560	SI motion pulse cancelation shutdown speed (Control Unit)	0	36960	$MA_SAFE_STANDSTILL_VELO_TOL
p9561	SI motion SLS (SG) stop response (Control Unit)	0	36961	$MA_SAFE_VELO_STOP_MODE
p9562	SI motion SLP (SE) stop response (Control Unit)	0	36962	$MA_SAFE_POS_STOP_MODE
p9563	SI motion SLS (SG)-specific stop response (Control Unit)	0	36963	$MA_SAFE_VELO_STOP_REAC-TION[n]
p9570	SI motion acceptance test mode (Control Unit)			Corresponds to OPI variables for NCK
p9571	SI motion acceptance test status (Control Unit)			Corresponds to OPI variables for NCK
r9590	SI motion version safe motion monitoring functions (Control Unit)		--	--
Parameters for basic safety functions integrated in the drive				
p9601	SI enable functions integrated in the drive (Control Unit)		--	--
p9602	SI enable safe brake control (Control Unit)		--	--
p9620	BI: SI signal source for STO (SH)/SBC/SS1 (Control Unit)		--	--
p9621	BI: SI Safe Brake Adapter signal source (Control Unit)		--	--
p9622	SI SBA relay wait times (Control Unit)		--	--
p9650	SI SGE changeover tolerance time (Control Unit)		--	--
p9651	SI STO/SBC/SS1 debounce time (Control Unit)		--	--
p9652	SI Safe Stop 1 delay time (Control Unit)		--	--
p9658	SI transition time STOP F to STOP A (Control Unit)		--	--
p9659	SI forced checking procedure, timer		--	--
p9697	SI motion, pulse cancellation failsafe delay time (CU)		--	--
General diagnostic parameters on the CU				
r9710	SI motion, diagnostics result list 1		--	--
r9711	SI motion, diagnostics result list 2		--	--
r9712	SI motion diagnostics position actual value motor side		--	--
r9713	SI motion diagnostics position actual value load side		--	--
r9714	SI motion diagnostics speed actual value load side		--	--
r9718	CO/BO: SI motion, control signals 1		--	--
r9719	CO/BO: SI motion, control signals 2		--	--
r9721	SI motion, status signals		--	--
r9724	SI motion, crosswise comparison clock cycle			
r9725	SI motion, diagnostics STOP F		--	For 840D, integrated into the alarm text
p9726	SI motion, user agreement, select/deselect		--	Corresponds to OPI variables for NCK
r9727	SI motion, internal drive user agreement		36997	$MA_SAFE_ACKN

Table 8-2 Parameters for SINAMICS S120

	Name		No.	Name
r9728	SI motion, actual checksum, SI parameters		36998	$MA_SAFE_ACT_CHECKSUM
p9729	SI motion, reference checksum, SI parameters		36999	$MA_SAFE_DES_CHECKSUM
r9730	SI motion safe maximum speed		--	--
r9731	SI safe position accuracy		--	--
r9733	SI CO: SI motion effective speed setpoint limiting		--	--
p9735	SI motion, diagnostics result list 3		--	--
p9736	SI motion, diagnostics result list 4		--	--
p9737	SI motion, diagnostics result list 5		--	--
p9738	SI motion, diagnostics result list 6		--	--
p9739	SI motion, diagnostics result list 7		--	--
r9744	SI message buffer changes, counter		--	--
r9747	SI message code		--	--
r9748	SI message time received in milliseconds		--	--
r9749	SI message value		--	--
p9752	SI message cases, counter		--	--
r9753	SI message value for float values		--	--
r9754	SI message time received in days		--	--
r9755	SI message time removed in milliseconds		--	--
r9756	SI message time removed in days		--	--
p9759	SI acknowledge messages, drive object		--	--
p9761	SI password input		--	--
p9762	SI password, new		--	--
p9763	SI password acknowledgment		--	--
r9770	SI version, safety functions integrated in the drive (Control Unit)		--	--
r9771	SI common functions (Control Unit)		--	--
r9772	CO/BO: SI status (Control Unit)		--	--
r9773	CO/BO: SI status (Control Unit+Motor Module)		--	--
r9774	CO/BO: SI status (safe standstill group)		--	--
r9780	SI monitoring clock cycle (Control Unit)		--	--
r9794	SI crosswise comparison list (Control Unit)		--	--
r9795	SI diagnostics, STOP F (Control Unit)		--	--
r9798	SI actual checksum SI parameters (Control Unit)		--	--
p9799	SI reference checksum SI parameters (Control Unit)		--	--
Parameters for functions integrated in the drive MM				
p9801	SI enable safety functions (Motor Module)		--	--
p9802	SI enable safe brake control (Motor Module)		--	--
p9810	SI PROFIsafe address (Motor Module)		--	--
p9821	BI: SI Safe Brake Adapter signal source (Motor Module)			
p9822	SI SBA relay wait times (Motor Module)			
p9850	SI SGE changeover, tolerance time (Motor Module)		--	--

Table 8-2 Parameters for SINAMICS S120

	Name		No.	Name
p9851	SI STO/SBC/SS1 debounce time (Motor Module)			
p9852	SI Safe Stop 1 delay time (Motor Module)		--	--
p9858	SI transition time STOP F to STOP A (Motor Module)		--	--
r9870	SI version (Motor Module)		--	--
r9871	SI common functions (Motor Module)		--	--
r9872	CO/BO: SI status (Motor Module)		--	--
r9880	SI monitoring clock cycle (Motor Module)		--	--
r9881	SI Sensor Module Node Identifier control		--	--
r9890	SI version (Sensor Module)		--	--
r9894	SI crosswise comparison list (Motor Module)		--	--
r9895	SI diagnostics, STOP F (Motor Module)		--	--
p9897	SI motion, pulse cancellation failsafe delay time (MM)		--	--
r9898	SI actual checksum SI parameters (Motor Module)		--	--
p9899	SI reference checksum SI parameters (Motor Module)		--	--

Downloading standard motor data

When standard motor data is downloaded some drive parameters are overwritten. If another type of motor is installed (e.g. after repairs have been carried out) and the associated motor default data is downloaded, then the encoder data must be changed back to its original value.

8.2.2 Description of parameters

r0470[0....2]	Redundant coarse position value valid bits				
Displays the valid bits of the redundant coarse position value. [0] = Encoder 1 [1] = Encoder 2 [2] = Encoder 3 See also: p9523				Checksum:	Protection level: 3
Unit: -	Default value: -	Minimum value:	Maximum value: –	Data type: U16	Effectiveness: POWER ON

r0471[0....2]	Redundant coarse position value fine resolution bits				
Displays the number of bits for the fine resolution of the redundant coarse position value. [0] = Encoder 1 [1] = Encoder 2 [2] = Encoder 3 See also: p9524				Checksum:	Protection level: 3
Unit: -	Default value: -	Minimum value:	Maximum value: –	Data type: Integer16	Effectiveness: POWER ON

r0472[0....2]	Redundant coarse position value relevant bits				
Displays the number of relevant bits for the redundant coarse position value. [0] = Encoder 1 [1] = Encoder 2 [2] = Encoder 3				Checksum:	Protection level: 3
Unit: -	Default value: -	Minimum value:	Maximum value: –	Data type: U16	Effectiveness: POWER ON

r0474[0....2]	Redundant coarse position value configuration				
Displays the encoder configuration for the redundant coarse position value. [0] = Encoder 1 [1] = Encoder 2 [2] = Encoder 3 Bit array 00 up-counter 1 signal yes, 0 signal no 01 encoder CRC, least significant byte first 1 signal yes, 0 signal no 02 redundant coarse position value most significant bit left-justified 1 signal yes, 0 signal no See also p9515				Checksum:	Protection level: 3
Unit: -	Default value: -	Minimum value:	Maximum value: –	Data type: U16	Effectiveness: POWER ON

r0475[0....2]	Gx_XIST1 coarse position safety most significant bit				
Displays the bit number for the safety most significant bit (MSB) of the Gx_XIST1 coarse position. [0] = Encoder 1 [1] = Encoder 2 [2] = Encoder 3 See also: p9529				Checksum:	Protection level: 3
Unit: -	Default value: -	Minimum value:	Maximum value: –	Data type: U16	Effectiveness: POWER ON

r0979[0....30]	PROFIdrive encoder format / PD encoder format				
Displays the position actual value encoder that is being used according to PROFIdrive. [0] = header [1] = type, encoder 1 [2] = resolution, encoder 1 [3] = shift factor G1_XIST1 [4] = shift factor G1_XIST2 [5] = revolutions that can be distinguished, encoder 1 [6] = reserved [7] = reserved [8] = reserved [9] = reserved [10] = reserved [11] = type, encoder 2 [12] = resolution, encoder 2 [13] = shift factor G2_XIST1 [14] = shift factor G2_XIST2 [15] = revolutions that can be distinguished, encoder 2 [16] = reserved [17] = reserved [18] = reserved [19] = reserved [20] = reserved [21] = type, encoder 3 [22] = resolution, encoder 3 [23] = shift factor G3_XIST1 [24] = shift factor G3_XIST2 [25] = revolutions that can be distinguished, encoder 3 [26] = reserved [27] = reserved [28] = reserved [29] = reserved [30] = reserved				Checksum:	Protection level: 3
Unit: -	Default value: -	Minimum value:	Maximum value: –	Data type: U32	Effectiveness: POWER ON

p1532[0...n]	CO: Torque limit, offset / CO: Force offset, force limit				
Sets the torque offset for the torque limit. Sets the force offset for the force limit.				Checksum:	Protection level: 3
Unit: -	Default value: -	Minimum value: –100000.00 [Nm] –100000.00 [N]	Maximum value: 100000.00 [Nm] 100000.00 [N]	Data type: Floating point	Effectiveness: POWER ON

p2003	Reference force / reference torque				
Setting the reference quantity for torques/forces. All of the torques specified as relative value refer to this reference quantity. The reference quantity in this parameter corresponds to 100% or 4000 hex or 4000 0000 hex. Note For the automatic calculation (p0340 = 1, p3900 > 0) the corresponding pre-assignment is only made if the parameter is not inhibited from being overwritten using p0573 = 1 (i.e. is not write protected). If a BICO interconnection is established between different physical quantities, then the particular reference quantities are used as internal conversion factor. Example: The actual value of the total torque (r0079) is interconnected to a test socket (e.g. p0771[0]). The actual torque value is cyclically converted into a percentage of the reference torque (p2003) and is output corresponding to the selected scaling. The actual value of the total force (r0079[0]) is interconnected at a test socket (e.g. p0771[0]). The actual force value is cyclically converted into a percentage of the reference force (p2003) and output corresponding to the selected scaling.				Checksum:	Protection level: 3
Unit: Nm	Default value: 1.0	Minimum value: 0.01	Maximum value: 20000000.0	Data type: Floating Point32	Effectiveness: POWER ON

Parameters for motion monitoring functions

p9500	**SI motion monitoring clock cycle (Control Unit)**				
Sets the monitoring clock cycle for safety motion monitoring functions.				Checksum: Yes	Protection level: 3
Unit: ms	Default value: 12	Minimum value: 0.5	Maximum value: 25	Data type: Floating Point32	Effectiveness: POWER ON

Using p9500, the monitoring clock cycle for safety-related operation with a higher-level control is defined. p9500 must be an integer multiple of the position controller clock cycle. If a value is entered into p9500 that is not an integer multiple of the position controller clock cycle, then the value entered is rounded-off to the next multiple (integer multiple) of the position controller clock cycle and Fault F01652 ("SI CU:Monitoring clock cycle not permissible") is output with fault value 101.

Each time that a new connection is established for the clock-cycle synchronous PROFIBUS, the PROFIBUS master can specify a new position controller clock cycle; this is the reason that the check "p9500 multiple integer of the position controller clock cycle" is repeated. Fault F01652 is output if an error occurs.

The Safety Integrated monitoring clock cycle is, just like all other SI drive parameters, a drive-specific monitoring clock cycle. However, different SI monitoring clock cycles within a drive system are not supported.

p9501	SI motion enable safety functions (Control Unit)				
Sets the enable signals for the safety-related motion monitoring functions Bit signal name 00 enable SOS/SLS (SBH/SG) 01 enable SLP (SE) 03 enable actual value synchronization 04 enable external ESR activation 05 enable override SLS (SG) 06 enable external STOPs 07 enable cam synchronization 08 enable SCA1+ (SN1+) 09 enable SCA1- (SN1-) 10 enable SCA2+ (SN2+) 11 enable SCA2- (SN2-) 12 enable SCA3+ (SN3+) 13 enable SCA3- (SN3-) 14 enable SCA4+ (SN4+) 15 enable SCA4- (SN4-) 16 enable NX hys FII				Checksum: Yes	Protection level: 3
Unit: -	Default value: 0	Minimum value: 0	Maximum value: 0xFFFF FFFF	Data type: Unsigned32	Effectiveness: POWER ON

The individual SI monitoring functions for a drive are enabled using p9501.

If one of the bits from bit 1 is set, then bit 0 must also be set. This is because for a STOP C/D/E, the system changes into a safe operating stop. If this is not the case, Fault F01683 ("SI motion: SBH/SG enable missing") is output.

p9502	SI motion axis type (Control Unit)				
Sets the axis type (linear axis or rotary axis/spindle) 0 = linear axis 1 = rotary axis/spindle				Checksum: Yes	Protection level: 4
Unit: -	Default value: 0	Minimum value: 0	Maximum value: 1	Data type: Integer16	Effectiveness: POWER ON

For the commissioning software, after the axis type has been changed over, the units that are dependent on the axis type are only updated after a project upload.

p9503	**SI motion SCA (SN) enable (Control Unit)**				
Setting to enable the "Safe cam" function (SCA). Bit signal name 00 enable SCA1 (SN1) 01 enable SCA2 (SN2) 02 enable SCA3 (SN3) 03 enable SCA4 (SN4) 04 enable SCA5 (SN5) 05 enable SCA6 (SN6) 06 enable SCA7 (SN7) 07 enable SCA8 (SN8) 08 enable SCA9 (SN9) 09 enable SCA10 (SN10) 10 enable SCA11 (SN11) 11 enable SCA12 (SN12) 12 enable SCA13 (SN13) 13 enable SCA14 (SN14) 14 enable SCA15 (SN15) 15 enable SCA16 (SN16) 16 enable SCA17 (SN17) 17 enable SCA18 (SN18) 18 enable SCA19 (SN19) 19 enable SCA20 (SN20) 20 enable SCA21 (SN21) 21 enable SCA22 (SN22) 22 enable SCA23 (SN23) 23 enable SCA24 (SN24) 24 enable SCA25 (SN25) 25 enable SCA26 (SN26) 26 enable SCA27 (SN27) 27 enable SCA28 (SN28) 28 enable SCA29 (SN29) 29 enable SCA30 (SN30)				Checksum: Yes	Protection level: 4
Unit: –	Default value: 0	Minimum value: –	Maximum value: –	Data type: Unsigned32	Effectiveness: POWER ON

The cam pairs 1 to 4 can also be enabled in p9501, bits 8–15. In this case, a 0 must be in p9503. Vice versa, a 0 must be in p9501, bits 8–15 if cams are enabled in p9503. This is checked during booting and where relevant C01681 ("SI Motion: Monitoring function not supported") is output with fault value 2.

p9505	**SI motion SCA (SN) modulo value (Control Unit)**				
Sets the modulo range of the safety position actual value in degrees for the function "Safe cams" (SCA) for rotary axes.				Checksum: Yes	Protection level: 4
Unit: Degrees	Default value: 0	Minimum value: 0	Maximum value: 737280	Data type: Floating Point32	Effectiveness: POWER ON

p9515	SI motion coarse position value configuration (CU)				
Sets the encoder configuration for the redundant coarse position value **Bit 00:** Up-counter 1 signal: Yes, 0 signal: No **Bit 01:** Encoder CRC, least significant byte at first 1 signal: Yes, 0 signal: No **Bit 02:** Redundant coarse position value most significant bit left-justified 1 signal: Yes, 0 signal: No **Bit 16:** DRIVE-CLiQ encoder 1 signal: Yes, 0 signal: No				Checksum: Yes	Protection level: 3
Unit: -	Default value: 0	Minimum value: -	Maximum value: -	Data type: Unsigned32	Effectiveness: POWER ON

See also: r0474
The following applies to safety-related functions that have not been enabled (p9501 = 0):
- when booting p9515 is automatically set the same as p0474.
The following applies to safety-related functions that have been enabled (p9501 > 0):
- p9515 is checked to ensure that it coincides with p0474.
Parameterizing a DQI encoder: p9515 = 10001H / p0474 = 2H

p9516	SI motion, motor encoder configuration, safety-related functions (CU)				
Sets the configuration for motor encoders and position actual value **Bit 00**: Motor encoder, rotary/linear 1 signal: Linear, 0 signal: Rotary **Bit 01**: Position actual value, sign change 1 signal: Yes , 0 signal: No				Checksum: Yes	Protection level: 3
Unit: -	Default value: 0	Minimum value: -	Maximum value: -	Data type: Unsigned16	Effectiveness: POWER ON

The information whether a 1-encoder system or 2-encoder system is not included in this parameter. This is derived from the parameter p9526 ”SI motion encoder assignment control”.
The following applies to safety-related functions that have not been enabled (p9501 = 0):
- when booting p9516.0 is automatically set the same as p0404.0. When booting p9516.1 is automatically set the same as p0410.1.
The following applies to safety-related functions that have been enabled (p9501 > 0):
- p9516.1 is checked to ensure that it coincides with p0404.1.

p9517	SI motion linear scale, grid division (Control Unit)				
Sets the grid division for a linear motor encoder The encoder, which is used for safe motion monitoring on the Control Unit must be parameterized in this parameter.				Checksum: Yes	Protection level: 3
Unit: nm	Default value: 10 000	Minimum value: 0	Maximum value: 250 000 000	Data type: FloatingPoint32	Effectiveness: POWER ON

See also: p0407, p9516
See also: F01671
Note: A change only becomes effective after POWER ON.
The following applies to safety-related functions that have not been enabled (p9501 = 0):
- when booting p9517 is automatically set the same as p0407.
The following applies to safety-related functions that have been enabled (p9501 > 0):
- p9517 is checked to ensure that it coincides with p0407.

p9518	SI motion encoder pulses per revolution (Control Unit)				
Sets the number of encoder pulses per revolution for rotary motor encoders				Checksum: Yes	Protection level: 3
Unit: –	Default value: 2048	Minimum value: 0	Maximum value: 16777215	Data type: Unsigned32	Effectiveness: POWER ON

The encoder, which is used for safe motion monitoring on the Control Unit must be parameterized in this parameter.
The following applies to safety-related functions that have not been enabled (p9501 = 0): p9518 is automatically set the same as p0408 during booting.
The following applies to safety-related functions that have been enabled (p9501 > 0): p9518 is checked to ensure that it coincides with p0408.

p9519	SI motion fine resolution G1_XIST1 (Control Unit)				
Sets the fine resolution for G1_XIST1 in bits The encoder, which is used for safe motion monitoring on the Control Unit must be parameterized in this parameter. The following applies to safety-related functions that have not been enabled (p9501 = 0): when booting, p9519 is automatically set the same as p0418. The following applies to safety-related functions that have been enabled (p9501 > 0): p9519 is checked to ensure that it coincides with p0418. G1_XIST1: Encoder 1 position actual value 1 (PROFIdrive)				Checksum: Yes	Protection level: 3
Unit: –	Default value: 11	Minimum value: 2	Maximum value: 18	Data type: Unsigned32	Effectiveness: POWER ON

Sets the fine resolution in bits of incremental position actual values for the PROFIBUS encoder interface. Corresponds to p0418.

p9520	SI motion spindle pitch (Control Unit)				
Sets the ratio between the encoder and load in mm/revolutions for a linear axis with rotary encoder				Checksum: Yes	Protection level: 3
Unit: mm	Default value: 10	Minimum value: 0.1	Maximum value: 8388	Data type: REAL32	Effectiveness: POWER ON

p9521[0...7]	SI motion, gearbox, encoder/load, denominator (Control Unit)				
Sets the denominator for the gearbox between the encoder (or motor for encoderless monitoring functions) and load. [0] = gear 1 [1] = gear 2 [2] = gear 3 [3] = gear 4 [4] = gear 5 [5] = gear 6 [6] = gear 7 [7] = gear 8				Checksum: Yes	Protection level: 3
Unit: -	Default value: 1	Minimum value: 1	Maximum value: 2 147 000 000	Data type: Unsigned32	Effectiveness: POWER ON

See also: p9522
It is not possible to changeover the gear stage. Gear 1 (index 0) is always active.

p9522[0...7]	SI motion, gearbox, encoder/load, numerator (Control Unit)				
Sets the numerator for the gear between the encoder (or motor for encoderless monitoring functions) and load. [0] = gear 1 [1] = gear 2 [2] = gear 3 [3] = gear 4 [4] = gear 5 [5] = gear 6 [6] = gear 7 [7] = gear 8				Checksum: Yes	Protection level: 3
Unit: -	Default value: 1	Minimum value: 1	Maximum value: 2 147 000 000	Data type: Unsigned32	Effectiveness: POWER ON

See also: p9521
It is not possible to changeover the gear stage. Gear 1 (index 0) is always active.
The numerator of the gear ratio must be multiplied by the number of pole pairs for the encoderless monitoring functions.
Example:
Gear ratio 1:4, number of pole pairs (r0313) = 2 --> p9521 = 1, p9522 = 8 (4 x 2)

p9523	SI motion redundant coarse position value valid bits (CU)				
Sets number of valid bits of the redundant coarse position value. The encoder, which is used for safe motion monitoring on the Control Unit must be parameterized in this parameter.				Checksum: Yes	Protection level: 3
Unit: -	Default value: 9	Minimum value: 0	Maximum value: 16	Data type: Unsigned32	Effectiveness: POWER ON

Note: A change only becomes effective after POWER ON.
The following applies to safety-related functions that have not been enabled (p9501 = 0):
- when booting p9523 is automatically set the same as r0470.
The following applies to safety-related functions that have been enabled (p9501 > 0):
- p9523 is checked to ensure that it coincides with r0470.

p9524	SI motion redundant coarse position value fine resolution bits (CU)				
Sets the number of bits for the fine resolution of the redundant coarse position value. The encoder, which is used for safe motion monitoring on the Control Unit must be parameterized in this parameter.				Checksum: Yes	Protection level: 3
Unit: -	Default value: -2	Minimum value: -16	Maximum value: 16	Data type: Integer16	Effectiveness: POWER ON

Note: A change only becomes effective after POWER ON.
The following applies to safety-related functions that have not been enabled (p9501 = 0):
- when booting p9524 is automatically set the same as r0471.
The following applies to safety-related functions that have been enabled (p9501 > 0):
- p9524 is checked to ensure that it coincides with r0471.

p9525	SI motion redundant coarse position value relevant bits (CU)				
Sets the number of relevant bits for the redundant coarse position value.				Checksum: Yes	Protection level: 3
Unit: -	Default value: 9	Minimum value: 0	Maximum value: 16	Data type: Unsigned16	Effectiveness: POWER ON

Note: A change only becomes effective after POWER ON.
The following applies to safety-related functions that have not been enabled (p9501 = 0):
- when booting p9525 is automatically set the same as r0470
The following applies to safety-related functions that have been enabled (p9501 > 0):
- p9525 is checked to ensure that it coincides with r0470.

p9526	SI motion encoder assignment second channel				
Sets the number of the encoder that is used in the second channel (control, Motor Module) for safe motion monitoring functions. Note: For safety-related motion monitoring functions the redundant safety position actual value sensing must be activated in the appropriate encoder data set (p0430.19 = 1). For p9526 = 1, the encoder for the closed-loop speed control is used for the second channel of the motion monitoring functions (1-encoder system). A change only becomes effective after POWER ON.				Checksum: Yes	Protection level: 3
Unit: -	Default value: 1	Minimum value: 1	Maximum value: 3	Data type: Unsigned32	Effectiveness: POWER ON

p9529	SI motion Gx_XIST1 coarse position safety most significant bit (Control Unit)				
Sets the bit number for the safety most significant bit (MSB) of the Gx_XIST1 coarse position. The encoder, which is used for safe motion monitoring on the Control Unit must be parameterized in this parameter.				Checksum: Yes	Protection level: 3
Unit: Degrees	Default value: 11	Minimum value: 0	Maximum value: 31	Data type: Unsigned16	Effectiveness: POWER ON

The following applies to safety-related functions that have not been enabled (p9501 = 0):
- when booting p9529 is automatically set the same as r0475.
The following applies to safety-related functions that have been enabled (p9501 > 0):
- p9529 is checked to ensure that it coincides with r0475.

p9530	SI motion standstill tolerance (Control Unit)				
Sets the tolerance for the "safe operating stop" function (SOS).				Checksum: Yes	Protection level: 3
Unit: mm	Default value: 1	Minimum value: 0	Maximum value: 100	Data type: FloatingPoint32	Effectiveness: POWER ON

p9531[0...3]	SI motion SLS (SG) limit values (Control Unit)				
Sets the limit values for the "safely limited speed" function (SLS). Index: [0] = limit value SLS1 [1] = limit value SLS2 [2] = limit value SLS3 [3] = limit value SLS4				Checksum: Yes	Protection level: 3
Unit: mm/min	Default value: 2000	Minimum value: 0	Maximum value: 1 000 000	Data type: FloatingPoint32	Effectiveness: POWER ON

p9532[0...15]	SI motion SLS (SG) override factor (Control Unit)				
Sets the override factor for the limit value for SLS2 and SLS4 of the function "safely limited speed" (SLS). [0] = SLS (SG) override factor 0 [1] = SLS (SG) override factor 1 [2] = SLS (SG) override factor 2 [3] = SLS (SG) override factor 3 [4] = SLS (SG) override factor 4 [5] = SLS (SG) override factor 5 [6] = SLS (SG) override factor 6 [7] = SLS (SG) override factor 7 [8] = SLS (SG) override factor 8 [9] = SLS (SG) override factor 9 [10] = SLS (SG) override factor 10 [11] = SLS (SG) override factor 11 [12] = SLS (SG) override factor 12 [13] = SLS (SG) override factor 13 [14] = SLS (SG) override factor 14 [15] = SLS (SG) override factor 15				Checksum: Yes	Protection level: 4

Unit: %	Default value: 100	Minimum value: 0	Maximum value: 100	Data type: Floating Point32	Effectiveness: POWER ON

p9534[0...1]	**SI motion SLP (SE) upper limit values (Control Unit)**				
Sets the upper limit values for the "safely limited position" function (SLP). Index: [0] = limit value SLP1 (SE1) [1] = limit value SLP2 (SE2)				Checksum: Yes	Protection level: 4
Unit: mm, degrees	Default value: 100 000	Minimum value: -2 147 000	Maximum value: 2 147 000	Data type: FloatingPoint32	Effectiveness: POWER ON

The following applies when setting the SLP limit values: p9534 > p9535. A change only becomes effective after POWER ON.

See also: p9501, p9535, p9562

p9535[0...1]	**SI motion SLP (SE) lower limit values (Control Unit)**				
Sets the lower limit values for the "safely limited position" function (SLP). Index: [0] = limit value SLP1 (SE1) [1] = limit value SLP2 (SE2)				Checksum: Yes	Protection level: 4
Unit: mm, degrees	Default value: -100 000	Minimum value: -2 147 000	Maximum value: 2 147 000	Data type: FloatingPoint32	Effectiveness: POWER ON

The following applies when setting the SLP limit values: p9534 > p9535. A change only becomes effective after POWER ON.

See also: p9501, p9534, p9562

p9536[0...29]	SI motion SCA (SN) plus cam position (Control Unit)				
Sets the plus cam position for the ”safe cam” function (SCA). Index: [0] = cam position SCA1 (SN1) [1] = cam position SCA2 (SN2) [2] = cam position SCA3 (SN3) [3] = cam position SCA4 (SN4) [4] = cam position SCA5 (SN5) [5] = cam position SCA6 (SN6) [6] = cam position SCA7 (SN7) [7] = cam position SCA8 (SN8) [8] = cam position SCA9 (SN9) [9] = cam position SCA10 (SN10) [10] = cam position SCA11 (SN11) [11] = cam position SCA12 (SN12) [12] = cam position SCA13 (SN13) [13] = cam position SCA14 (SN14) [14] = cam position SCA15 (SN15) [15] = cam position SCA16 (SN16) [16] = cam position SCA17 (SN17) [17] = cam position SCA18 (SN18) [18] = cam position SCA19 (SN19) [19] = cam position SCA20 (SN20) [20] = cam position SCA21 (SN21) [21] = cam position SCA22 (SN22) [22] = cam position SCA23 (SN23) [23] = cam position SCA24 (SN24) [24] = cam position SCA25 (SN25) [25] = cam position SCA26 (SN26) [26] = cam position SCA27 (SN27) [27] = cam position SCA28 (SN28) [28] = cam position SCA29 (SN29) [29] = cam position SCA30 (SN30)				Checksum: Yes	Protection level: 4
Unit: mm, degrees	Default value: 10	Minimum value: -2 147 000	Maximum value: 2 147 000	Data type: Floating Point32	Effectiveness: POWER ON

See also: p9501, p9503, p9537
A change only becomes effective after POWER ON.

<table>
<tr><th>p9537[0...29]</th><th colspan="5">SI motion SCA (SN) minus cam position (Control Unit)</th></tr>
<tr><td colspan="4">Sets the minus cam position for the ”Safe cam” function (SCA).
Index:
[0] = cam position SCA1 (SN1)
[1] = cam position SCA2 (SN2)
[2] = cam position SCA3 (SN3)
[3] = cam position SCA4 (SN4)
[4] = cam position SCA5 (SN5)
[5] = cam position SCA6 (SN6)
[6] = cam position SCA7 (SN7)
[7] = cam position SCA8 (SN8)
[8] = cam position SCA9 (SN9)
[9] = cam position SCA10 (SN10)
[10] = cam position SCA11 (SN11)
[11] = cam position SCA12 (SN12)
[12] = cam position SCA13 (SN13)
[13] = cam position SCA14 (SN14)
[14] = cam position SCA15 (SN15)
[15] = cam position SCA16 (SN16)
[16] = cam position SCA17 (SN17)
[17] = cam position SCA18 (SN18)
[18] = cam position SCA19 (SN19)
[19] = cam position SCA20 (SN20)
[20] = cam position SCA21 (SN21)
[21] = cam position SCA22 (SN22)
[22] = cam position SCA23 (SN23)
[23] = cam position SCA24 (SN24)
[24] = cam position SCA25 (SN25)
[25] = cam position SCA26 (SN26)
[26] = cam position SCA27 (SN27)
[27] = cam position SCA28 (SN28)
[28] = cam position SCA29 (SN29)
[29] = cam position SCA30 (SN30)</td><td>Checksum:
Yes</td><td>Protection level:
4</td></tr>
<tr><td>Unit:
mm, degrees</td><td>Default value:
-10</td><td>Minimum value:
-2 147 000</td><td>Maximum value:
2 147 000</td><td>Data type:
Floating Point32</td><td>Effectiveness:
POWER ON</td></tr>
</table>

See also: p9501, p9503, p9537
A change only becomes effective after POWER ON.

p9538[0...29]	SI motion SCA (SN) cam track assignment (Control Unit)	
Assigns the individual cams to a maximum of 4 cam tracks and defines the numerical value for the SGA ”cam range”. p9538[0...29] = CBA dec C = assigns the cam to the cam track. Valid values are 1, 2, 3, 4. BA = numerical value for the SGA ”cam range”. If the position is in the range of this cam, value BA is signaled to the safety logic via SGA ”cam range” of the cam track that is set using C. Valid values are 0 ... 14. Every numerical value can only be used once for each cam track. Examples: p9538[0] = 207 Cam 1 (index 0) is assigned to cam track 2. If the position is in the range of this cam, then a value of 7 is entered into SGA ”cam range” of the second cam track. p9538[5] = 100 Cam 6 (index 5) is assigned to cam track 1. If the position is in the range of this cam, then a value of 0 is entered into SGA ”cam range” of the first cam track. Index: [0] = track assignment SCA1 [1] = track assignment SCA2 [2] = track assignment SCA3 [3] = track assignment SCA4 [4] = track assignment SCA5 [5] = track assignment SCA6 [6] = track assignment SCA7 [7] = track assignment SCA8 [8] = track assignment SCA9 [9] = track assignment SCA10 [10] = track assignment SCA11 [11] = track assignment SCA12 [12] = track assignment SCA13 [13] = track assignment SCA14 [14] = track assignment SCA15 [15] = track assignment SCA16 [16] = track assignment SCA17 [17] = track assignment SCA18 [18] = track assignment SCA19 [19] = track assignment SCA20 [20] = track assignment SCA21 [21] = track assignment SCA22 [22] = track assignment SCA23 [23] = track assignment SCA24 [24] = track assignment SCA25 [25] = track assignment SCA26 [26] = track assignment SCA27 [27] = track assignment SCA28 [28] = track assignment SCA29 [29] = track assignment SCA30	Checksum: Yes	Protection level: 4

Unit:	Default value:	Minimum value:	Maximum value:	Data type:	Effectiveness:
	[0] 100 [1] 101 [2] 102 [3] 103 [4] 104 [5] 105 [6] 106 [7] 107 [8] 108 [9] 109 [10] 110 [11] 111 [12] 112 [13] 113 [14] 114 [15] 200 [16] 201 [17] 202 [18] 203 [19] 204 [20] 205 [21] 206 [22] 207 [23] 208 [24] 209 [25] 210 [26] 211 [27] 212 [28] 213 [29] 214	100	414	Unsigned32	POWER ON

See also: F01681
A change only becomes effective after POWER ON.

p9540	**SI motion SCA (SN) tolerance (Control Unit)**				
Sets the tolerance for the "Safe cam" function (SCA). Within this tolerance, both monitoring channels may signal different signal states of the same safe cam.				Checksum: Yes	Protection level: 4
Unit: mm, degrees	Default value: 0.1	Minimum value: 0.001	Maximum value: 10 mm or 10 degrees	Data type: Floating Point32	Effectiveness: POWER ON

See also: F01681
A change only becomes effective after POWER ON.

p9542	SI motion actual value comparison tolerance (crosswise) (Control Unit)				
Sets the tolerance in mm or Degrees for the crosswise comparison of the actual position between the two monitoring channels				Checksum: Yes	Protection level: 3
Unit: mm	Default value: 0.1	Minimum value: 0.001	Maximum value: 10 mm or 360 degrees	Data type: Floating Point32	Effectiveness: POWER ON

See also: C01711 ”SI motion: Defect in a monitoring channel”.

p9544	SI motion actual value comparison tolerance (referencing) (Control Unit)				
Sets the tolerance in mm or Degrees to check the actual values after referencing (incremental encoder) or when powering-up (absolute encoder).				Checksum: Yes	Protection level: 4
Unit: mm, degrees	Default value: 0.01	Minimum value: 0	Maximum value: 36 mm or 36 degrees	Data type: Floating Point32	Effectiveness: POWER ON

See also: C01711 ”SI motion: Defect in a monitoring channel”.
A change only becomes effective after POWER ON.

p9545	SI Motion SSM (SGA $n<n_x$) filter time) (Control Unit)				
Setting of the filter time for the SSM feedback signal to detect standstill ($n < n_x$). Note: The filter time is only effective when the function has been enabled (p9501.16 = 1). The parameter is contained in the crosswise data comparison of the two monitoring channels.				Checksum: Yes	Protection level: 3
Unit: ms	Default value: 0.00	Minimum value: 0.00	Maximum value: 100.00	Data type: Floating Point32	Effectiveness: POWER ON

p9546	SI Motion SSM (SGA $n < n_x$) velocity limit n_x (CU)				
Setting of the velocity limit for the SSM feedback signal to detect standstill ($n < n_x$). If this limit value is fallen below, the signal ”SSM feedback signal active” (SGA n < n_x) is set. For p9568 = 0, the value in p9546 is also valid for the function ”SAM”. For p9506 = 3, the following applies: If the value falls below the set threshold, the ”SAM” function is switched off. If the value falls below the set threshold, the ”SAM” function is switched off.				Checksum: Yes	Protection level: 3
Unit: mm/min rpm	Default value: 20	Minimum value: 0	Maximum value: 1000 000	Data type: Floating Point32	Effectiveness: POWER ON

p9547	SI Motion SSM (SGA n < n_x) velocity hysteresis (CU)				
Setting of the velocity hysteresis for the SSM feedback signal to detect standstill (n < n_x). The velocity hysteresis is only effective when the function has been enabled (p9501.16 = 1). The parameter is contained in the crosswise data comparison of the two monitoring channels.				Checksum: Yes	Protection level: 3
Unit: mm/min rpm	Default value: 10.0000	Minimum value: 0.0010	Maximum value: 500.0000	Data type: Floating Point32	Effectiveness: POWER ON

See also: C01711

p9548	SI motion SBR actual speed tolerance (Control Unit)				
Sets the velocity tolerance for the ”safe acceleration monitoring” (SAM)				Checksum: Yes	Protection level: 3
Unit: mm/min rpm	Default value: 300	Minimum value: 0	Maximum value: 120 000	Data type: Floating Point32	Effectiveness: POWER ON

See also: C01706 ”SI motion: Safe acceleration monitoring limit exceeded”.

p9549	SI motion slip speed tolerance (Control Unit)				
Sets the velocity tolerance, which is applied for a 2-encoder system in a crosswise comparison between the two monitoring channels. If the actual value synchronization is not enabled (p9501.3 = 0), then the value parameterized in p9542 is used as tolerance in the crosswise data comparison.				Checksum: Yes	Protection level: 3
Unit: mm/min rpm	Default value: 6	Minimum value: 0	Maximum value: 6000	Data type: Floating Point32	Effectiveness: POWER ON

p9550	SI motion SGE changeover tolerance time (Control Unit)				
Sets the tolerance time to change over the safety-related inputs (SGE)				Checksum: Yes	Protection level: 4
Unit: ms	Default value: 500	Minimum value: 0	Maximum value: 10 000	Data type: Floating Point32	Effectiveness: POWER ON

p9551	SI motion SLS(SG) changeover delay time (Control Unit)				
Sets the delay time for the SLS changeover or for the changeover from SLS to SOS for the ”safely limited speed” function (SLS). At the transition from a higher to a lower safely limited speed stage or to a safe operating stop (SOS), the ”old” speed stage remains active for this delay time. Also from non safety-related operation, when SLS or SOS is activated, this delay still applies.				Checksum: Yes	Protection level: 4
Unit: ms	Default value: 100	Minimum value: 0	Maximum value: 600 000	Data type: Floating Point32	Effectiveness: POWER ON

p9552	SI motion transition time STOP C to SOS (SBH) (Control Unit)				
Sets the transition time from STOP C to ”Safe Operating Stop” (SOS).				Checksum: Yes	Protection level: 3
Unit: ms	Default value: 100	Minimum value: 0	Maximum value: 600 000	Data type: Floating Point32	Effectiveness: POWER ON

p9553	SI motion transition time STOP D to SOS (SBH) (Control Unit)				
Sets the transition time from STOP D to ”Safe Operating Stop” (SOS)				Checksum: Yes	Protection level: 3
Unit: ms	Default value: 100	Minimum value: 0	Maximum value: 600 000	Data type: Floating Point32	Effectiveness: POWER ON

p9554	SI motion transition time STOP E to SOS (SBH) (Control Unit)				
Sets the transition time from STOP E to ”Safe Operating Stop” (SOS)				Checksum: Yes	Protection level: 4
Unit: ms	Default value: 100	Minimum value: 0	Maximum value: 600 000	Data type: Floating Point32	Effectiveness: POWER ON

p9555	SI motion transition time STOP F to STOP B (Control Unit)				
Sets the transition time from STOP F to STOP B				Checksum: Yes	Protection level: 3
Unit: ms	Default value: 0	Minimum value: 0	Maximum value: 600 000	Data type: Floating Point32	Effectiveness: POWER ON

See also: C01711 ”SI motion defect in a monitoring channel”

p9556	SI motion pulse cancelation delay time (Control Unit)				
Sets the delay time for the safe pulse cancellation after STOP B This parameter has no effect for encoderless motion monitoring functions with safe braking ramp monitoring (p9506 = 1).				Checksum: Yes	Protection level: 3
Unit: ms	Default value: 100	Minimum value: 0	Maximum value: 600 000	Data type: Floating Point32	Effectiveness: POWER ON

See also: p9560 and: C01701, also see: C01701 ”SI motion, STOP B initiated”.

p9557	SI motion pulse cancellation checking time (Control Unit)				
Sets the time after which the pulses must have been cancelled after initiating the test stop. Setting is only effective after power on.				Checksum: Yes	Protection level: 3
Unit: ms	Default value: 100	Minimum value: 0	Maximum value: 10 000	Data type: Floating Point32	Effectiveness: POWER ON

See also: C01798 ”SI motion: ”Test stop running”.

p9558	SI motion acceptance test mode time limit (Control Unit)				
Sets the maximum time for the acceptance test mode. If the acceptance test mode lasts longer than the selected time limit, then the mode is automatically exited.				Checksum: Yes	Protection level: 3
Unit: ms	Default value: 40 000	Minimum value: 5 000	Maximum value: 100 000	Data type: Floating Point32	Effectiveness: POWER ON

See also: C01799 ”SI motion: Acceptance test mode is active”.

p9560	SI motion pulse cancelation shutdown speed (Control Unit)				
Sets the shutdown speed for pulse cancellation. ”Standstill” (zero speed) is assumed below this speed and for STOP B / SS1, the pulses are cancelled (as a result of a transition to STOP A).				Checksum: Yes	Protection level: 3
Unit: mm/min, rpm	Default value: 0	Minimum value: 0	Maximum value: 6000	Data type: Floating Point32	Effectiveness: POWER ON

p9561	SI motion SLS (SG) stop response (Control Unit)				
Sets the stop response for the ”safely limited speed” function (SLS). This setting applies to all SLS limit values. An input value of less than 5 signifies protection for personnel, from 10 and onwards, machine protection. 0: STOP A 1: STOP B 2: STOP C 3: STOP D 4: STOP E 5: Set the stop response using p9563 (SG-specific) 10: STOP A with delayed pulse cancellation when the bus fails 11: STOP B with delayed pulse cancellation when the bus fails 12: STOP C with delayed pulse cancellation when the bus fails 13: STOP D with delayed pulse cancellation when the bus fails 14: STOP E with delayed pulse cancellation when the bus fails				Checksum: Yes	Protection level: 4
Unit: -	Default value: 5	Minimum value: 0	Maximum value: 14	Data type: Integer16	Effectiveness: POWER ON

See also: p9531, p9563

p9562	SI motion SLP (SE) stop response (Control Unit)				
Sets the stop response for the ”safely limited position” function (SLP). 2: STOP C 3: STOP D 4: STOP E				Checksum: Yes	Protection level: 4
Unit: -	Default value: 2	Minimum value: 2	Maximum value: 4	Data type: Integer16	Effectiveness: POWER ON

See also: p9534, p9535

p9563[0...3]	**SI motion SLS (SG)-specific stop response (Control Unit)**				
Sets the SLS-specific stop response for the ”safely limited speed” function (SLS). These settings apply to the individual limit values for SLS. 0: STOP A 1: STOP B 2: STOP C 3: STOP D 4: STOP E 10: STOP A with delayed pulse cancellation when the bus fails 11: STOP B with delayed pulse cancellation when the bus fails 12: STOP C with delayed pulse cancellation when the bus fails 13: STOP D with delayed pulse cancellation when the bus fails 14: STOP E with delayed pulse cancellation when the bus fails Index: [0] = limit value SLS1 [1] = limit value SLS2 [2] = limit value SLS3 [3] = limit value SLS4				Checksum: Yes	Protection level: 3
Unit: -	Default value: 2	Minimum value: 0	Maximum value: 14	Data type: Integer16	Effectiveness: POWER ON

See also: p9531, p9561, p9580

p9570	**SI motion acceptance test mode (Control Unit)**				
Setting to select/deselect the acceptance test mode 0: [00 hex] Deselect acceptance test mode 172: [AC hex] Select acceptance test mode				Checksum: No	Protection level: 3
Unit: -	Default value: 0	Minimum value: 0	Maximum value: 00AC hex	Data type: Integer16	Effectiveness: immediately

See also: p9558, r9571, C01799

r9571	**SI motion acceptance test status (Control Unit)**				
Displays the status of the acceptance test mode 0: [00 hex] accept_mode inactive 12: [0C hex] accept_mode not possible due to power on fault 13: [0D hex] accept_mode not possible due to incorrect ID in p9570 15: [0F hex] accept_mode not possible due to expired accept_timer 172: [AC hex] accept_mode active				Checksum: No	Protection level: 3
Unit: -	Default value: 0	Minimum value: 0	Maximum value: 0xAC	Data type: Integer16	Effectiveness: -

See also: p9558, p9570
See also: C01799 ”SI motion, acceptance test mode active”

p9580	**SI motion pulse cancelation delay time after bus failure (Control Unit)**				
Sets the delay time after which the pulses are safely cancelled after a bus failure.				Checksum: Yes	Protection level: 3
Unit: ms	Default value: 0	Minimum value: 0	Maximum value: 800	Data type: Real32	Effectiveness: -

r9590[0...3]	SI motion version safe motion monitoring functions (Control Unit)				
Displays the Safety Integrated version for safe motion monitoring functions on the Control Unit. [0] = Safety Version (major release) [1] = Safety Version (minor release) [2] = Safety Version (baselevel or patch) [3] = Safety Version (hotfix) Example: r9590[0] = 2, r9590[1] = 3, r9590[2] = 1 --> SI motion version V02.03.01				Checksum: No	Protection level: 3
Unit: –	Default value: –	Minimum value: –	Maximum value: –	Data type: Unsigned16	Effectiveness:

See also: r9770, r9870, r9890

Parameters for basic safety functions integrated in the drive

These parameters are also relevant for the motion monitoring functions as the safe standstill is carried out by monitoring functions integrated in the drive. See Chapter 6.1 ”Safe standstill (SH)”.

p9601	SI enable functions integrated in the drive (Control Unit)				
Sets the enable signals for safety functions integrated in the drive on the Control Unit Bit Signal name 00 STO (SH) enable via terminals (Control Unit)				Checksum: Yes	Protection level: 3
Unit: -	Default value: 0000 bin	Minimum value: -	Maximum value: -	Data type: Unsigned32	Effectiveness: When exiting the SI commissioning mode

It is permissible to simultaneously enable the safety functions integrated in the drive (p9601/p9801 < > 0) and the motion monitoring functions (p9501 < > 0).
See also: p9801

p9602	**SI enable safe brake control (Control Unit)**				
Sets the enable signal for the function safe brake control (SBC) on the Control Unit. 0: SBC is not enabled 1: Close the holding brake when SH is selected or when SI errors occur The safe brake control function only becomes active if at least one safety monitoring function is enabled (i.e. p9501 not equal to 0 and/or p9601/p9801 not equal to 0). If a motor holding brake is not being used then it does not make any sense to enable the parameterization ”no motor holding brake available” and ”safe brake control” (p1215 = 0, p9602 = p9802 = 1). The parameterization ”motor holding brake the same as sequence control, connection via BICO” and ”safe brake control” enabled (p1215 = 3, p9602 = 1, p9802 = 1) does not make sense. The parameterization ”motor holding brake without feedback signals” and ”safe brake control” enabled (p1278 = 1, p9602 = 1, p9802 = 1) is not permissible.				Checksum: Yes	Protection level: 3
Unit: -	Default value: 0	Minimum value: 0	Maximum value: 1	Data type: Integer16	Effectiveness: When exiting the SI commissioning mode

See also: p9802

p9620	**BI: SI signal source for STO (SH)/SBC/SS1 (Control Unit)**				
Sets the signal source for the following functions on the Control Unit: STO: Safe Torque Off / SH: Safe standstill SBC: Safe Brake Control SS1: Safe Stop 1 (SS1, time monitored) See also: p9601 Note: The following signal sources are permitted: - fixed zero (default setting) - digital inputs (DI 0 to DI 7 on the Control Unit NCU7xx. - digital inputs DI 0 to DI 3 on the Controller Extensions (CX32, NX10, NX15). - digital inputs (DI 0 to DI 3 on the Control Unit 310 (CU310). It is not permitted to interconnect to a digital input is in simulation mode. When connecting n power sections in parallel, the following applies: p9620[0] = signal source for power unit 1 ... p9620[n-1] = signal source for power unit				Checksum: No	Protection level: 3
Unit: -	Default value: 0	Minimum value: -	Maximum value: -	Data type: Unsigned32	Effectiveness:

p9621	BI: SI Safe Brake Adapter signal source (Control Unit)				
Setting of the signal source for the Safe Brake Adapter (SBA). This therefore defines via which digital input the Safe Brake Adapter checkback signal (SBA_DIAG) is read in. p9621/p9821 = 0: No Safe Brake Control (SBC) available with Safe Brake Adapter (SBA). p9621/p9821 = r0722.x (x = 0, 1 ... 7) Safe Brake Adapter and booksize unit (no Communication Interface Module (CIM)). p9621/p9821 = r9872.3 Safe Brake Adapter and chassis unit(CIM). For a crosswise data comparison between p9621 and p9821, no difference is tolerated. The following must apply when using the ”Safe Brake Adapter” function: p9601 = p9801 <> 0 and p9602 = p9802 = 1				Checksum: No	Protection level: 3
Unit: -	Default value: 0	Minimum value: -	Maximum value: -	Data type: Unsigned32	Effectiveness:

See also: p9601, p9602, p9821

p9622[0...1]	SI SBA relay wait times (Control Unit)				
Setting the wait times for switching on and switching off the Safe Brake Adapter relay. The relay-specific minimum wait times to evaluate the feedback signal contacts must be set. For a relay, these differ when switching on and switching off. [0] = wait time, switching on [1] = wait time, switching off For a crosswise data comparison between p9622 and p9822, a difference of one safety monitoring clock cycle is tolerated. The parameterized time is internally rounded-off to an integer multiple of the monitoring clock cycle. The relay-specific minimum wait times (ms) to evaluate the feedback signal contacts are entered.				Checksum: No	Protection level: 3
Unit: ms	Default value: 0	Minimum value: -	Maximum value: -	Data type: FloatingPoint32	Effectiveness:

See also: p9822

p9650	SI SGE changeover tolerance time (Control Unit)				
Sets the tolerance time to change over the safety-relevant inputs (SGE) on the Control Unit. Because of the different runtimes of the two monitoring channels, an SIS switchover is not effective at the same time. After an SIS switchover, a cross-comparison of the dynamic data is not carried out during this tolerance time. For a crosswise data comparison between p9650 and p9850, a difference of one safety monitoring clock cycle is tolerated. The parameterized time is internally rounded-off to an integer multiple of the monitoring clock cycle.				Checksum: Yes	Protection level: 3
Unit: ms	Default value: 500	Minimum value: 0	Maximum value: 2 000.00	Data type: FloatingPoint32	Effectiveness: When exiting the SI commissioning mode

See also: p9850

p9651	SI STO/SBC/SS1 debounce time (Control Unit)				
Setting the debounce time of the CU DI, which are used to control the SH terminal (see p9620). The debounce time is accepted, rounded-off to whole milliseconds. The debounce time specifies the maximum duration of an interference pulse at the F-DIs so that it does not generate any reaction for the SGEs. Example: Debounce time = 1 ms: Interference pulses of 1 ms are filtered, only pulses longer than 2 ms are processed. Debounce time = 3 ms: Interference pulses of 3 ms are filtered, only pulses longer than 4 ms are processed.				Checksum:	Protection level: 3
Unit: ms	Default value: 0.00	Minimum value: 0.00	Maximum value: 100.00	Data type: FloatingPoint32	Effectiveness:

p9652	SI Safe Stop 1 delay time (Control Unit)				
Sets the delay time of the pulse cancellation for the function ”Safe Stop 1” (SS1) on the Control Unit to brake along the OFF3 down ramp (p1135). So that the drive is able to travel along the OFF3 ramp completely and any motor holding brake being used can be applied, the delay time should be set as follows: Motor holding brake parameterized: Delay time >= p1135 + p1228 + p1217 Motor holding brake not parameterized: Delay time >= p1135 + p1228 For a crosswise data comparison between p9652 and p9852, a difference of one safety monitoring clock cycle is tolerated. The parameterized time is internally rounded-off to an integer multiple of the monitoring clock cycle.				Checksum: Yes	Protection level: 3
Unit: s	Default value: 0.00	Minimum value: 0.00	Maximum value: 300.00	Data type: Floating Point32	Effectiveness:

See also: p1135, p9852

p9658	SI transition time STOP F to STOP A (Control Unit)				
Sets the transition time from STOP F to STOP A on the Control Unit. For a crosswise data comparison between p9658 and p9858, a difference of one safety monitoring clock cycle is tolerated. The parameterized time is internally rounded-off to an integer multiple of the monitoring clock cycle. STOP F: Defect in a monitoring channel (error in the CDC) STOP A: Pulse deletion via safety shutdown path				Checksum: Yes	Protection level: 3
Unit: ms	Default value: 0	Minimum value: 0	Maximum value: 30 000.00	Data type: Floating Point32	Effectiveness: When exiting the SI commissioning mode

See also: F01611

p9659	SI forced checking procedure, timer				
Sets the time interval to carry out the dynamic update and to test the safety shutdown paths (forced checking procedure). Within the parameterized time, STO must have been deselected at least once. The monitoring time is reset at every STO deselection.				Checksum: Yes	Protection level: 3
Unit: h	Default value: 8	Minimum value: 0	Maximum value: 9 000	Data type: Floating Point32	Effectiveness: immediately

p9697	SI delay time, pulse cancellation after communication failure (CU)				
Setting the delay time for the pulse cancellation after bus failure via failsafe values on the Control Unit (e.g. for ESR (extended stop and retract)).				Checksum: Yes	Protection level: 3
Unit: ms	Default value: 0	Minimum value: 0	Maximum value: 800	Data type: Real32	Effectiveness: immediately

General diagnostic parameters on the CU

r9710[0...1]	SI motion, diagnostics result list 1				
Display of result list 1 which led to an error for a crosswise data comparison between the two monitoring channels. [0]: Result list second channel [1]: Result list drive Bit 00: Actual value > Upper limit SOS Bit 01: Actual value > Lower limit SOS Bit 02: Actual value> Upper limit SE1 Bit 03: Actual value > Lower limit SE1 Bit 04: Actual value> Upper limit SE2 Bit 05: Actual value > Lower limit SE2 Bit 06: Actual value> Upper limit SG1 Bit 07: Actual value > Lower limit SG1 Bit 08: Actual value > Upper limit SG2 Bit 09: Actual value > Lower limit SG2 Bit 10: Actual value > Upper limit SG3 Bit 11: Actual value > Lower limit SG3 Bit 12: Actual value > Upper limit SG4 Bit 13: Actual value > Lower limit SG4 Bit 16: Actual value> Upper limit SBR Bit 17: Actual value > Lower limit SBR				Checksum: No	Protection level: 3
Unit: -	Default value: -	Minimum value: -	Maximum value: -	Data type: Unsigned32	Effectiveness: -

See also: C01711 ”SI motion: Defect in a monitoring channel”.

r9711[0...1]	SI motion, diagnostics result list 2				
Display of result list 2, which led to an error between the two monitoring channels for a crosswise data comparison. [0]: Result list second channel [1]: Result list drive Bit 00 Actual value > Upper limit SN1+ Bit 01 Actual value > Lower limit SN1+ Bit 02 Actual value > Upper limit SN1– Bit 03 Actual value > Lower limit SN1– Bit 04 Actual value > Upper limit SN2+ Bit 05 Actual value > Lower limit SN2+ Bit 06 Actual value > Upper limit SN2– Bit 07 Actual value > Lower limit SN2– Bit 08 Actual value > Upper limit SN3+ Bit 09 Actual value > Lower limit SN3+ Bit 10 Actual value > Upper limit SN3– Bit 11 Actual value > Lower limit SN3– Bit 12 Actual value > Upper limit SN4+ Bit 13 Actual value > Lower limit SN4+ Bit 14 Actual value > Upper limit SN4– Bit 15 Actual value > Lower limit SN4– Bit 16 Actual value > Upper limit n_x+ Bit 17 Actual value > Lower limit n_x + Bit 18 Actual value > Upper limit n_x – Bit 19 Actual value > Lower limit n_x – Bit 20 Actual value > Upper limit modulo Bit 21 Actual value > Lower limit modulo				Checksum: No	Protection level: 3
Unit: -	Default value: -	Minimum value: -	Maximum value: -	Data type: Unsigned32	Effectiveness: -

See also: C01711 ”SI motion: Defect in a monitoring channel”

r9712	SI motion diagnostics position actual value motor side				
Display of the actual position actual value on the motor side for the motion monitoring functions on the Control Unit.				Checksum: No	Protection level: 3
Unit: -	Default value: -	Minimum value: -	Maximum value: -	Data type: Unsigned32	Effectiveness: -

r9713	SI motion diagnostics position actual value load side				
Displays the actual position actual value on the load side of the two monitoring channels and their difference. [0] = load side actual value on the Control Unit [1] = load side actual value on the second channel [2] = load side actual value difference Control Unit – second channel re r9713[0]: The display of the load side position actual value on the Control Unit is updated in the monitoring clock cycle. re r9713[0]: The display of the load side position actual value on the second channel is updated in the crosswise data comparison clock cycle (r9724) and is realized, delayed by one crosswise data comparison clock cycle. re r9713[2]: The difference between the load side position actual value on the Control Unit and the load side position actual value on the second channel is updated in the crosswise data comparison clock cycle (r9724) and is realized, delayed by one crosswise data comparison clock cycle. re r9713[3]: The maximum difference between the load side position actual value on the Control Unit and the load side position actual value on the second channel.				Checksum: No	Protection level: 3
Unit: –	Default value: –	Minimum value: –	Maximum value: –	Data type: Unsigned32	Effectiveness: –

r9714	SI motion diagnostics speed actual value load side				
Displays the actual load side speed value for the motion monitoring functions on the Control Unit. [0] = load side actual velocity value on the Control Unit [1] = actual SAM/SBR velocity limit on the Control Unit For linear axes, the following units apply: Micrometers per monitoring clock cycle (p9500). For rotary axes, the following units apply: Millidegrees per monitoring clock cycle (p9500).				Checksum: No	Protection level: 3
Unit: –	Default value: –	Minimum value: –	Maximum value: –	Data type: Integer32	Effectiveness: –

r9718.23	CO/BO: SI motion, control signals 1				
Control signals 1 for the safe motion monitoring functions. Bit 23: Set the offset for travel to fixed endstop to the actual torque 1 signal: Set, 0 signal: Reset				Checksum: No	Protection level: 4
Unit: –	Default value: –	Minimum value: –	Maximum value: –	Data type: Unsigned32	Effectiveness: –

r9719.0...31	CO/BO: SI motion, control signals 2				
Control signals 2 for the safe motion monitoring functions. Bit signal name 00 deselect SOS/SLS (SBH/SG) 1 signal: Yes, 0 signal: No 01 deselect SOS (SBH) 1 signal: Yes, 0 signal: No 03 select SLS (SG) bit 0, 1 signal: Set, 0 signal: Not set 04 select SLS (SG) bit 1, 1 signal: Set, 0 signal: Not set 08 gear selection bit 0, 1 signal: Set, 0 signal: Not set 09 gear selection bit 1, 1 signal: Set, 0 signal: Not set 10 gear selection bit 2, 1 signal: Set, 0 signal: Not set 12 select SLP (SE) 1 signal: SLP2 (SE2), 0 signal: SLP1 (SE1) 13 close brake from control 1 signal: Yes, 0 signal: No 15 select test stop 1 signal: Yes, 0 signal: No 16 SGE valid 1 signal: Yes, 0 signal: No 18 deselect external STOP A, 1 signal: Yes, 0 signal: No 19 deselect external STOP C, 1 signal: Yes, 0 signal: No 20 deselect external STOP D, 1 signal: Yes, 0 signal: No 21 deselect external STOP E, 1 signal: Yes, 0 signal: No 28 SLS (SG) override bit 0, 1 signal: Set, 0 signal: Not set 29 SLS (SG) override bit 1, 1 signal: Set, 0 signal: Not set 30 SLS (SG) override bit 2, 1 signal: Set, 0 signal: Not set 31 SLS (SG) override bit 3, 1 signal: Set, 0 signal: Not set re r9719.0 and r9719.1: These two bits must be considered together. If SOS/SLS (SBH/SG) is deselected using bit 0, then the assignment of bit 1 is irrelevant. If SOS/SLS (SBH/SG) is selected using bit 0, then bit 1 is used to change over between SOS (SBH) and SLS (SG).				Checksum: No	Protection level: 3
Unit: -	Default value: -	Minimum value: -	Maximum value: -	Data type: Unsigned32	Effectiveness: -

r9721.0...15	CO/BO: SI status signals				
Status signals for the safety motion monitoring functions. Bit signal name 00 SOS or SLS active, 1 signal: Yes, 0 signal: No 01 SOS active, 1 signal: Yes, 0 signal: No 02 pulse enable, 1signal: Deleted, 0 signal: released 03 active SLS stage bit 0, 1 signal: Set, 0 signal: Not set 04 active SLS stage bit 1, 1 signal: Set, 0 signal: Not set 05 speed below limit value n_x 1 signal: Yes, 0 signal: No 06 status signals valid, 1 signal: Yes, 0 signal: No 07 safely-referenced 1 signal: Yes, 0 signal: No 12 STOP A or B active, 1 signal: Yes, 0 signal: No 13 STOP C active, 1 signal: Yes, 0 signal: No 14 STOP D active, 1 signal: Yes, 0 signal: No 15 STOP E active, 1 signal: Yes, 0 signal: No For Safety Integrated Basic Functions (STO, SBC, SS1), the value is equal to zero.				Checksum: No	Protection level: 3
Unit: -	Default value: -	Minimum value: -	Maximum value: -	Data type: Unsigned32	Effectiveness: -

r9724	SI motion, crosswise comparison clock cycle				
Displays the crosswise comparison clock cycle (clock cycle time with which each individual CDC value is compared between the two monitoring channels. See also: p9500				Checksum: No	Protection level: 3
Unit: ms	Default value: -	Minimum value: -	Maximum value: -	Data type: FloatingPoint32	Effectiveness: -

r9725[0..2]	SI motion, diagnostics STOP F				
Displays the message value that resulted to a STOP F on the drive. A value of 0 means: STOP F was signaled from the Control Unit. A value of 1 ... 999 means: Number of the incorrect crosswise compared data between the drive and control. A value >of 1000 means: Additional diagnostic values of the drive. Re: Index 1: Display of the value of the Control Unit, which resulted in the STOP F. Re: Index 2: Display of the value of the second channel, which resulted in the STOP F. Index: [0] = message value for a crosswise data comparison [1] = Control Unit crosswise data comparison actual value [2] = Component crosswise data comparison actual value Note: The significance of the individual values is described in Alarm 27001 of the higher-level control.				Checksum: No	Protection level: 3
Unit: -	Default value: -	Minimum value: -	Maximum value: -	Data type: Unsigned32	Effectiveness: -

See also: C01711

p9726	SI motion, user agreement, select/deselect				
Setting to select/deselect the user agreement 0: [00 hex] Deselect user agreement 172: [AC hex] Select user agreement See also: r9727				Checksum: No	Protection level: 4
Unit: -	Default value: 0000 hex	Minimum value: 0000 hex	Maximum value: 00AC hex	Data type: Integer16	Effectiveness: POWER ON

r9727	SI motion, internal drive user agreement				
Displays the internal status of the user agreement Value = 0: User agreement is not set Value = AC hex: User agreement is set See also: p9726				Checksum: No	Protection level: 4
Unit: -	Default value: -	Minimum value: -	Maximum value: -	Data type: Integer16	Effectiveness:

r9728[0...2]	SI motion, actual checksum, SI parameters				
Displays the checksum over the checked Safety Integrated parameters of the motion monitoring functions (actual checksum). [0]: Checksum over SI parameters for motion monitoring [1]: Checksum over SI parameters for actual values [2] = Checksum over SI parameters for HW				Checksum: No	Protection level: 3
Unit: -	Default value: -	Minimum value: -	Maximum value: -	Data type: Unsigned32	Effectiveness:

See also: F01680 ”SI motion: Checksum error safe monitoring functions”.

r9729[0...2]	**SI motion, reference checksum, SI parameters**				
Sets the checksum over the checked Safety Integrated parameters of the motion monitoring functions (reference checksum). [0]: Checksum over SI parameters for motion monitoring [1]: Checksum over SI parameters for actual values [2] = Checksum over SI parameters for HW See also: r9728				Checksum: No	Protection level: 3
Unit: -	Default value: 0000 hex	Minimum value: 0000 hex	Maximum value: 0xFFFF FFFF	Data type: Unsigned32	Effectiveness: POWER ON

See also: F01680 ”SI motion: Checksum error safe monitoring functions”.

r9730	**SI motion safe maximum speed**				
Displays the maximum safe speed (load side) permissible due to the acquisition of actual values for safe motion monitoring functions. Message C01711 is output with the corresponding follow-on errors after the displayed value has been exceeded.				Checksum: No	Protection level: 3
Unit: rpm mm/min	Default value: -	Minimum value: -	Maximum value: -	Data type: FloatingPoint32	Effectiveness: POWER ON

r9731	**SI motion safe position accuracy**				
Displays the maximum position accuracy (load side) that can be achieved due to the acquisition of the actual value for the safe motion monitoring functions.				Checksum: No	Protection level: 3
Unit: Degrees, mm	Default value: -	Minimum value: -	Maximum value: -	Data type: FloatingPoint32	Effectiveness: POWER ON

r9735[0...1]	**SI motion, diagnostics result list 3**				
Displays result list 3 where for a crosswise data comparison with the control, led to an error. [0]: Result list second channel [1]: Result list drive Bit array Bit 00 Actual value > Upper limit SN1+ Bit 01 Actual value > Lower limit SN1+ Bit 02 Actual value > Upper limit SN1- Bit 03 Actual value > Lower limit SN1- Bit 04 Actual value > Upper limit SN2+ Bit 05 Actual value > Lower limit SN2+ Bit 06 Actual value > Upper limit SN2- Bit 07 Actual value > Lower limit SN2- Bit 08 Actual value > Upper limit SN3+ Bit 09 Actual value > Lower limit SN3+ Bit 10 Actual value > Upper limit SN3- Bit 11 Actual value > Lower limit SN3- Bit 12 Actual value > Upper limit SN4+ Bit 13 Actual value > Lower limit SN4+ Bit 14 Actual value > Upper limit SN4- Bit 15 Actual value > Lower limit SN4- Bit 16 Actual value > Upper limit SN5+ Bit 17 Actual value > Lower limit SN5+ Bit 18 Actual value > Upper limit SN5- Bit 19 Actual value > Lower limit SN5- Bit 20 Actual value > Upper limit SN6+ Bit 21 Actual value > Lower limit SN6+ Bit22 Actual value > Upper limit SN6- Bit23 Actual value > Lower limit SN6- See also: C01711				Checksum: No	Protection level: 3
Unit: -	Default value: -	Minimum value: -	Maximum value: -	Data type: Unsigned32	Effectiveness: POWER ON

r9736[0...1]	**SI motion, diagnostics result list 4**				
Displays result list 4 where for a crosswise data comparison with the control, led to an error. [0]: Result list second channel [1]: Result list drive Bit array Bit 00 Actual value > Upper limit SN7+ Bit 01 Actual value > Lower limit SN7+ Bit 02 Actual value > Upper limit SN7- Bit 03 Actual value > Lower limit SN7- Bit 04 Actual value > Upper limit SN8+ Bit 05 Actual value > Lower limit SN8+ Bit 06 Actual value > Upper limit SN8- Bit 07 Actual value > Lower limit SN8- Bit 08 Actual value > Upper limit SN9+ Bit 09 Actual value > Lower limit SN9+ Bit 10 Actual value > Upper limit SN9- Bit 11 Actual value > Lower limit SN9- Bit 12 Actual value > Upper limit SN10+ Bit 13 Actual value > Lower limit SN10+ Bit 14 Actual value > Upper limit SN10- Bit 15 Actual value > Lower limit SN10- Bit 16 Actual value > Upper limit SN11+ Bit 17 Actual value > Lower limit SN11+ Bit 18 Actual value > Upper limit SN11- Bit 19 Actual value > Lower limit SN11- Bit 20 Actual value > Upper limit SN12+ Bit 21 Actual value > Lower limit SN12+ Bit22 Actual value > Upper limit SN12- Bit23 Actual value > Lower limit SN12- See also: C01711				Checksum: No	Protection level: 3
Unit: -	Default value: -	Minimum value: -	Maximum value: -	Data type: Unsigned32	Effectiveness: POWER ON

r9737[0...1]	**SI motion, diagnostics result list 5**				
Displays result list 5 where for a crosswise data comparison with the control, led to an error. [0]: Result list second channel [1]: Result list drive Bit array Bit 00 Actual value > Upper limit SN13+ Bit 01 Actual value > Lower limit SN13+ Bit 02 Actual value > Upper limit SN13- Bit 03 Actual value > Lower limit SN13- Bit 04 Actual value > Upper limit SN14+ Bit 05 Actual value > Lower limit SN14+ Bit 06 Actual value > Upper limit SN14- Bit 07 Actual value > Lower limit SN14- Bit 08 Actual value > Upper limit SN15+ Bit 09 Actual value > Lower limit SN15+ Bit 10 Actual value > Upper limit SN15- Bit 11 Actual value > Lower limit SN15- Bit 12 Actual value > Upper limit SN16+ Bit 13 Actual value > Lower limit SN16+ Bit 14 Actual value > Upper limit SN16- Bit 15 Actual value > Lower limit SN16- Bit 16 Actual value > Upper limit SN17+ Bit 17 Actual value > Lower limit SN17+ Bit 18 Actual value > Upper limit SN17- Bit 19 Actual value > Lower limit SN17- Bit 20 Actual value > Upper limit SN18+ Bit 21 Actual value > Lower limit SN18+ Bit22 Actual value > Upper limit SN18- Bit23 Actual value > Lower limit SN18- See also: C01711				Checksum: No	Protection level: 3
Unit: -	Default value: -	Minimum value: -	Maximum value: -	Data type: Unsigned32	Effectiveness: POWER ON

r9738[0...1]	**SI motion, diagnostics result list 6**				
Displays result list 6 where for a crosswise data comparison with the control, led to an error. [0]: Result list second channel [1]: Result list drive Bit array Bit 00 Actual value > Upper limit SN19+ Bit 01 Actual value > Lower limit SN19+ Bit 02 Actual value > Upper limit SN19- Bit 03 Actual value > Lower limit SN19- Bit 04 Actual value > Upper limit SN20+ Bit 05 Actual value > Lower limit SN20+ Bit 06 Actual value > Upper limit SN20- Bit 07 Actual value > Lower limit SN20- Bit 08 Actual value > Upper limit SN21+ Bit 09 Actual value > Lower limit SN21+ Bit 10 Actual value > Upper limit SN21- Bit 11 Actual value > Lower limit SN21- Bit 12 Actual value > Upper limit SN22+ Bit 13 Actual value > Lower limit SN22+ Bit 14 Actual value > Upper limit SN22- Bit 15 Actual value > Lower limit SN22- Bit 16 Actual value > Upper limit SN23+ Bit 17 Actual value > Lower limit SN23+ Bit 18 Actual value > Upper limit SN23- Bit 19 Actual value > Lower limit SN23- Bit 20 Actual value > Upper limit SN24+ Bit 21 Actual value > Lower limit SN24+ Bit22 Actual value > Upper limit SN24- Bit23 Actual value > Lower limit SN24- See also: C01711				Checksum: No	Protection level: 3
Unit: -	Default value: -	Minimum value: -	Maximum value: -	Data type: Unsigned32	Effectiveness: POWER ON

r9739[0...1]	**SI motion, diagnostics result list 7**				
Displays result list 7 where for a crosswise data comparison with the control, led to an error. [0]: Result list second channel [1]: Result list drive Bit array Bit 00 Actual value > Upper limit SN25+ Bit 01 Actual value > Lower limit SN25+ Bit 02 Actual value > Upper limit SN25- Bit 03 Actual value > Lower limit SN25- Bit 04 Actual value > Upper limit SN26+ Bit 05 Actual value > Lower limit SN26+ Bit 06 Actual value > Upper limit SN26- Bit 07 Actual value > Lower limit SN26- Bit 08 Actual value > Upper limit SN27+ Bit 09 Actual value > Lower limit SN27+ Bit 10 Actual value > Upper limit SN27- Bit 11 Actual value > Lower limit SN27- Bit 12 Actual value > Upper limit SN28+ Bit 13 Actual value > Lower limit SN28+ Bit 14 Actual value > Upper limit SN28- Bit 15 Actual value > Lower limit SN28- Bit 16 Actual value > Upper limit SN29+ Bit 17 Actual value > Lower limit SN29+ Bit 18 Actual value > Upper limit SN29- Bit 19 Actual value > Lower limit SN29- Bit 20 Actual value > Upper limit SN30+ Bit 21 Actual value > Lower limit SN30+ Bit22 Actual value > Upper limit SN30- Bit23 Actual value > Lower limit SN30- See also: C01711				Checksum: No	Protection level: 3
Unit: -	Default value: -	Minimum value: -	Maximum value: -	Data type: Unsigned32	Effectiveness: POWER ON

r9744	**SI message buffer changes, counter**				
Displays the changes of the safety message buffer. This counter is incremented every time that the safety message buffer changes. This is used to check whether the safety message buffer has been read out consistently. See also r9747, r9748, r9749, p9752, r9754, r9755, r9756, r9759				Checksum: –	Protection level: 3
Unit: -	Default value: -	Minimum value: -	Maximum value: -	Data type: Unsigned16	Effectiveness: -

r9747[0...63]	SI message code				
Displays the number of the safety messages that have occurred. See also r9744, r9748, r9749, r9754, p9752, r9753, r9754, r9755, r9756, r9759 "Safety message" (Cxxxxx) type messages are entered in the safety message buffer. Message buffer structure (principle): r9747[0], r9748[0], r9749[0], r9753[0], r9754[0], r9755[0], r9756[0] --> Actual message case, safety message 1 ... r9747[7], r9748[7], r9749[7], r9753[7], r9754[7], r9755[7], r9756[7] --> Actual message case, safety message 8 r9747[8], r9748[8], r9749[8], r9753[8], r9754[8], r9755[8], r9756[8] --> 1st acknowledged message case, safety message 1 ... r9747[15], r9748[15], r9749[15], r9753[15], r9754[15], r9755[15], r9756[15] --> 1st acknowledged message case, safety message 8 ... r9747[56], r9748[56], r9749[56], r9753[56], r9754[56], r9755[56], r9756[56] --> 7th acknowledged message case, safety message 1 ... r9747[63], r9748[63], r9749[63], r9753[63], r9754[63], r9755[63], r9756[63] --> 7th acknowledged message case, safety message 8				Checksum: –	Protection level: 3
Unit: –	Default value: –	Minimum value: –	Maximum value: –	Data type: Unsigned16	Effectiveness: –

r9748[0...63]	SI message time received in milliseconds				
Displays the relative system runtime in milliseconds when the safety message occurred. See also r9744, r9747, r9749, p9752, r9753, r9754, r9755, r9756, p9759				Checksum: –	Protection level: 3
Unit: ms	Default value: –	Minimum value: –	Maximum value: –	Data type: Unsigned32	Effectiveness: –

r9749[0...63]	SI message value				
Displays the additional information about the safety message that occurred (as integer number). See also r9744, r9747, r9748, p9752, r9753, r9754, r9755, r9756, p9759				Checksum: –	Protection level: 3
Unit: –	Default value: –	Minimum value: –	Maximum value: –	Data type: Integer32	Effectiveness: –

p9752	SI message cases, counter				
Number of safety message cases that have occurred since the last reset. The safety message buffer is cleared by resetting the parameter to 0. See also r9745, r9748, r9749, r9754, r9755, r9756				Checksum: –	Protection level: 3
Unit: –	Default value: 0	Minimum value: 0	Maximum value: 65535	Data type: Unsigned16	Effectiveness: POWER ON

r9753[0...63]	**SI message value for float values**				
Displays additional information about the safety message that has occurred for float values. See also r9744, r9747, r9748, p9752, r9754, r9755, r9756, p9759				Checksum: –	Protection level: 3
Unit: –	Default value: –	Minimum value: –	Maximum value: –	Data type: Floating point	Effectiveness: –

r9754[0...63]	**SI message time received in days**				
Displays the relative system runtime in days when the safety message occurred. See also r9744, r9747, r9748, r7949, p9752, r9753, r9755, r9756, p9759				Checksum: –	Protection level: 3
Unit: days	Default value: –	Minimum value: –	Maximum value: –	Data type: Unsigned16	Effectiveness: –

r9755[0...63]	**SI message time removed in milliseconds**				
Displays the relative system runtime in milliseconds when the safety message was removed. See also r9744, r9747, r9748, r7949, p9752, r9753, r9754, r9756, p9759				Checksum: –	Protection level: 3
Unit: ms	Default value: –	Minimum value: –	Maximum value: –	Data type: Unsigned32	Effectiveness: –

r9756[0...63]	**SI message time removed in days**				
Displays the relative system runtime in days when the safety message was removed. See also r9744, r9747, r9748, r7949, p9752, r9753,r9754, r9755, p9759				Checksum: –	Protection level: 3
Unit: days	Default value: –	Minimum value: –	Maximum value: –	Data type: Unsigned16	Effectiveness: –

p9761	**SI password input**				
Enters the Safety Integrated password. It is not permissible to change Safety Integrated parameter settings until the Safety Integrated password has been entered.				Checksum: No	Protection level: 3
Unit: –	Default value: 0000 hex	Minimum value: 0000 hex	Maximum value: FFFF FFFF hex	Data type: Unsigned32	Effectiveness: immediately

See also: F01659 ”SI CU: Write task for parameter rejected”

p9762	**SI password, new**				
Enters a new Safety Integrated password. If the Safety Integrated password is changed it must be acknowledged in the following parameter: See also: p9763				Checksum: No	Protection level: 3
Unit: –	Default value: 0000 hex	Minimum value: 0000 hex	Maximum value: FFFF FFFF hex	Data type: Unsigned32	Effectiveness: immediately

p9763	**SI password acknowledgment**				
Acknowledges the new Safety Integrated password. The new password entered into p9762 must be re-entered in order to acknowledge. After successfully acknowledged, the new Safety Integrated password is set with p9762=p9763=0. See also: p9762				Checksum: No	Protection level: 3
Unit: -	Default value: 0000 hex	Minimum value: 0000 hex	Maximum value: FFFF FFFF hex	Data type: Unsigned32	Effectiveness: immediately

r9770[0...3]	**SI version, safety-relevant functions integrated in the drive (Control Unit)**				
Displays the Safety Integrated version on the Control Unit. Index 0: Safety Version (major release) Index 1: Safety Version (minor release) Index 2: Safety Version (baselevel or patch) Index 3 = Safety Version (hotfix) See also: r9870, r9890 Example: r9770[0]=2, r9770[1]=3, r9770[2]=1--> Safety Version V02.03.01				Checksum: No	Protection level: 3
Unit: -	Default value: -	Minimum value: -	Maximum value: -	Data type: Unsigned16	Effectiveness: –

r9771	**SI common functions (Control Unit)**				
Displays the Safety Integrated monitoring functions supported on the Control Unit and Motor Module. The Control Unit determines this display. **Bit 00**: STO via terminals is supported 1 signal: Yes, 0 signal: No **Bit 01**: SBC supported 1 signal: Yes, 0 signal: No **Bit 02**: SI motion supported 1 signal: Yes, 0 signal: No **Bit 03**: SS1 supported 1 signal: Yes, 0 signal: No				Checksum: No	Protection level: 3
Unit: -	Default value: -	Minimum value: -	Maximum value: -	Data type: Unsigned32	Effectiveness: –

r9772	**CO/BO: SI status (Control Unit)**				
Displays the Safety Integrated status on the Control Unit. **Bit 00**: STO selected on the Control Unit 1 signal: Yes, 0 signal: No **Bit 01**: STO active on the Control Unit 1 signal: Yes, 0 signal: No **Bit 02**: SS1 active on the Control Unit 1 signal: Yes, 0 signal: No **Bit 04**: SBC requested 1 signal: Yes, 0 signal: No **Bit 05**: SS1 selected on CU 1 signal: Yes, 0 signal: No **Bit 06**: SS1 active on the Control Unit 1 signal: Yes, 0 signal: No **Bit 09**: STOP A cannot be acknowledged, active 1 signal: Yes, 0 signal: No **Bit 10**: STOP A active 1 signal: Yes, 0 signal: No **Bit 15**: STOP F active 1 signal: Yes, 0 signal: No **Bit 16**: STO cause, Safety commissioning mode 1 signal: Yes, 0 signal: No **Bit 17**: STO cause, selection via terminals 1 signal: Yes, 0 signal: No **Bit 18**: STO cause, selection via SMM 1 signal: Yes, 0 signal: No **Bit 19**: STO cause, actual value missing 1 signal: Yes, 0 signal: No **Bit 22**: SS1 cause, selection terminal 1 signal: Yes, 0 signal: No				Checksum: No	Protection level: 2
Unit: -	Default value: -	Minimum value: -	Maximum value: -	Data type: Unsigned32	Effectiveness: –

r9773	**CO/BO: SI status (Control Unit + Motor Module)**				
Displays the Safety Integrated status on the drive (Control Unit + Motor Module). **Bit 00**: STO selected in the drive 1 signal: Yes, 0 signal: No **Bit 01**: STO active in the drive 1 signal: Yes, 0 signal: No **Bit 02**: SS1 active in the drive 1 signal: Yes, 0 signal: No **Bit 04**: SBC requested 1 signal: Yes, 0 signal: No **Bit 05**: SS1 selected in the drive 1 signal: Yes, 0 signal: No **Bit 06**: SS1 active in the drive 1 signal: Yes, 0 signal: No **Bit 31**: Shutdown path test required 1 signal: Yes, 0 signal: No This status is formed from the AND operation of the relevant status of the two monitoring channels.				Checksum: No	Protection level: 2
Unit: -	Default value: -	Minimum value: -	Maximum value: -	Data type: Unsigned32	Effectiveness: –

r9774	**CO/BO: SI status (STO group)**				
Displays the status for Safety Integ rated of the group to which this drive belongs. This signals are an AND logic operation of the individual status signals of the drives included in this group **Bit 00**: STO selected in the group 1 signal: Yes, 0 signal: No **Bit 01**: STO active in the group 1 signal: Yes, 0 signal: No **Bit 02**: SS1 active in the group 1 signal: Yes, 0 signal: No **Bit 04**: SBC requested in the group 1 signal: Yes, 0 signal: No **Bit 05**: SS1 selected in group 1 signal: Yes, 0 signal: No **Bit 06**: SS1 active in the group 1 signal: Yes, 0 signal: No **Bit 31**: Shutdown paths of the group must be tested 1 signal: Yes, 0 signal: No If a drive belonging to a group is deactivated using p0105, then the signals in r9774 can no longer be correctly displayed (countermeasure: Before deactivating, remove this drive from the group). A group is formed by appropriately grouping the terminals for ”safe standstill”. The status of a group of n drives is, for drives 1 to n–1 displayed with a delay of one monitoring clock cycle; this is a system–related effect.				Checksum: No	Protection level: 2
Unit: -	Default value: -	Minimum value: -	Maximum value: -	Data type: Unsigned32	Effectiveness: –

r9780	SI monitoring clock cycle (Control Unit)				
Displays the clock cycle time for the Safety Integrated Basic Functions on the Control Unit. See also: r9880				Checksum: No	Protection level: 3
Unit: ms	Default value: –	Minimum value: –	Maximum value: –	Data type: Floating Point32	Effectiveness: –

The SI monitoring clock cycle cannot be parameterized for STO/SBC/SS1. It is permanently specified in the software and displayed in r9780.

r9781[0...1]	SI change monitoring checksum (Control Unit)				
Displays the checksum for change tracking for Safety Integrated. These are additional parameters, which are generated and used to track changes (fingerprints for the function "Safety Logbook") to Safety parameters (that are relevant for checksums). [0] = SI change tracking, checksum functional [1] = SI change tracking checksum, hardware dependent				Checksum:	Protection level: 3
Unit:	Default value: –	Minimum value: –	Maximum value: –	Data type: Unsigned32	Effectiveness: –

See also: p9601, p9729, p9799 and F01690

r9794[0...19]	SI crosswise comparison list (Control Unit)				
Displays the number of the data that are being presently compared crosswise on the Control Unit. r9794[0] = 1 (monitoring clock cycle) r9794[1] = 2 (enable safety-related functions) r9794[2] = 3 (SGE changeover, tolerance time) r9794[3] = 4 (transition time, STOP F to STOP A) ... The list of crosswise compared data depends on the particular application. See also: r9894 The complete list of numbers for the crosswise compared data is listed in fault F01611.				Checksum: No	Protection level: 3
Unit: -	Default value: -	Minimum value: -	Maximum value: -	Data type: Unsigned16	Effectiveness: –

r9795	SI diagnostics, STOP F (Control Unit)				
Displays the number of the cross-checked data which has caused STOP F on the Control Unit.				Checksum: No	Protection level: 2
Unit: -	Default value: -	Minimum value: -	Maximum value: -	Data type: Unsigned32	Effectiveness: –

Crosswise data comparison ID	Crosswise comparison data	Associated parameters
1	SI monitoring clock cycle, integrated in the drive	r9780
2	SI enable parameters (CU/MM)	p9601/p9801

Cross-wise data com-parison ID	Crosswise comparison data	Associated parameters
3	Tolerance time changeover, safety-related input signals (CU/MM)	p9650/p9850
4	Transition time from STOP F to STOP A (CU/MM)	p9658/p9858
5	Safe brake control (CU/MM)	p9602/p9802
6	Correct parameter information	p9501/p29822
7	SI delay time of the pulse cancellation for Safe Stop 1	p9652, p9852
9	SI debounce time for STO/SBC/SS1 (MM)	p9651, p9851
10	SI delay time for pulse suppression for ESR	p9697, p9897

Additional diagnostic values (from 1000 onwards):

Value	Description of error(s)	Description
1000	Check (watchdog) timer has expired	Change timer in the MM has been active too long
1001	Change timer initialization error	When starting the change timer, MM has not set the "timer running bit"
1002	Check (watchdog) timer initialization error	The CU had not started the check (watchdog) timer although in MM the change timer is presently running
2000	Error when comparing the SH terminals	Status of the SH terminals on the Control Unit and Motor Module are different.
2001	Error when comparing the feedback signals DIAG_U and DIAG_L	Status of the feedback signals of the safety shut-down paths on the Control Unit and Motor Module are different.
2002	Error for delay timer SS1	Status of the delay timer SS1 on the Control Unit and Motor Module are different

r9798	**SI actual checksum SI parameters (Control Unit)**				
Displays the checksum over the checked Safety Integrated parameters on the Control Unit (actual checksum).				Checksum: No	Protection level: 3
Unit: -	Default value: -	Minimum value: -	Maximum value: -	Data type: Unsigned32	Effectiveness: –

r9799	**SI reference checksum SI parameters (Control Unit)**				
Sets the checksum for the checked Safety Integrated parameters on the Control Unit (reference checksum).				Checksum: No	Protection level: 3
Unit: -	Default value: 0000 hex	Minimum value: 0000 hex	Maximum value: FFFF FFFF hex	Data type: Unsigned32	Effectiveness:

The actual checksum (r9798) calculated by the CU must be entered into the reference checksum p9799. This therefore acknowledges the safety commissioning on the Control Unit for the basis functions integrated in the drive.

Parameters for functions integrated in the drive MM

p9801	**SI enable, functions integrated in the drive (Motor Module)**				
Sets the enable signals for safety functions on the Motor Module **Bit 00**: STO enabled via terminals (Motor Module) 1 signal: Enabled, 0 signal: Locks				Checksum: Yes	Protection level: 3
Unit: -	Default value: 0	Minimum value: 0	Maximum value: 1h	Data type: Unsigned16	Effectiveness:

It is permissible to simultaneously enable the safety functions integrated in the drive (p9601/p9801 < > 0) and the motion monitoring functions (p9501 < > 0).

p9802	**SI enable safe brake control (Motor Module)**				
Sets the enable signal for the ”Safe brake control” function (SBC) on the Motor Module. 0: Inhibit SBC 1: Enable SBC The ”safe brake control” function only becomes active if at least one safety monitoring function is enabled (i.e. p9501 not equal to 0 and/or p9801 not equal to 0). If a motor holding brake is not being used then it does not make any sense to enable the parameterization ”no motor holding brake available” and ”safe brake control” (p1215 = 0, p9602 = p9802 = 1). The parameterization ”motor holding brake the same as sequence control, connection via BICO” and ”safe brake control” enabled (p1215 = 3, p9602 = 1, p9802 = 1) does not make sense. The parameterization ”motor holding brake without feedback signals” and ”safe brake control” enabled (p1278 = 1, p9602 = 1, p9802 = 1) is not permissible.				Checksum: Yes	Protection level: 3
Unit: -	Default value: 0	Minimum value: 0	Maximum value: 1	Data type: Integer32	Effectiveness:

If p9802 = 1, the holding braking is closed when SH is selected or SI errors occur. p9602 has priority over p1215.

p9810	**SI PROFIsafe address (Motor Module)**				
Sets the PROFIsafe address of the Motor Module.				Checksum: Yes	Protection level: 3
Unit: -	Default value: 0000 hex	Minimum value: 0000 hex	Maximum value: FFFE hex	Data type: Unsigned16	Effectiveness:

p9821	BI: SI Safe Brake Adapter signal source (Motor Module)				
Setting of the signal source for the Safe Brake Adapter (SBA). This therefore defines via which digital input the Safe Brake Adapter checkback signal (SBA_DIAG) is read in. p9621/p9821 = 0: No Safe Brake Control (SBC) available with Safe Brake Adapter (SBA). p9621/p9821 = r0722.x (x = 0, 1 ... 7) Safe Brake Adapter and booksize unit (no Communication Interface Module (CIM)). p9621/p9821 = r9872.3 Safe Brake Adapter and chassis unit(CIM). For a crosswise data comparison between p9621 and p9821, no difference is tolerated. The following must apply when using the ”Safe Brake Adapter” function: p9601 = p9801 <> 0 and p9602 = p9802 = 1				Checksum: No	Protection level: 3
Unit: -	Default value: 0	Minimum value: -	Maximum value: -	Data type: Unsigned32	Effectiveness:

See also: p9601, p9602, p9821

p9822[0...1]	SI SBA relay wait times (Motor Module)				
Setting the wait times for switching on and switching off the Safe Brake Adapter relay. The relay-specific minimum wait times to evaluate the feedback signal contacts must be set. For a relay, these differ when switching on and switching off. [0] = wait time, switching on [1] = wait time, switching off For a crosswise data comparison between p9622 and p9822, a difference of one safety monitoring clock cycle is tolerated. The parameterized time is internally rounded-off to an integer multiple of the monitoring clock cycle. The relay-specific minimum wait times (ms) to evaluate the feedback signal contacts are entered.				Checksum: No	Protection level: 3
Unit: ms	Default value: 0	Minimum value: -	Maximum value: -	Data type: FloatingPoint32	Effectiveness:

p9850	SI SGE changeover, tolerance time (Motor Module)				
Sets the tolerance time to changeover the safety-related inputs (SGE) on the Motor Module. Because of the different runtimes of the two monitoring channels, an SIS switchover is not effective at the same time. After an SIS switchover, a cross-comparison of the dynamic data is not carried out during this tolerance time. For a crosswise data comparison between p9650 and p9850, a difference of one safety monitoring clock cycle is tolerated. The parameterized time is internally rounded-off to an integer multiple of the monitoring clock cycle.				Checksum: Yes	Protection level: 3
Unit: µs	Default value: 500 000	Minimum value: 0	Maximum value: 2 000 000	Data type: Floating Point32	Effectiveness:

p9851	SI STO/SBC/SS1 debounce time (Motor Module)				
Setting of the debounce time for the EP terminal of the Motor Module. The debounce time is rounded-off to whole milliseconds. The debounce time specifies the maximum duration of an interference pulse at the F-DIs so that it does not generate any reaction for the SGEs. Notice: This parameter is overwritten by the copy function of the safety functions integrated in the drive. Example: Debounce time = 1 ms: Interference pulses of 1 ms are filtered, only pulses longer than 2 ms are processed. Debounce time = 3 ms: Interference pulses of 3 ms are filtered, only pulses longer than 4 ms are processed.				Checksum: Yes	Protection level: 3
Unit: µs	Default value: 0.00	Minimum value: 0.00	Maximum value: 1 000 0.00	Data type: Floating Point32	Effectiveness:

p9852	SI Safe Stop 1 delay time (Motor Module)				
Sets the delay time of the pulse cancellation for the function "Safe Stop 1" (SS1) on the Motor Module to brake along the OFF3 down ramp (p1135). Also refer to: p1135, p9652 For a crosswise data comparison between p9652 and p9852, a difference of one safety monitoring clock cycle is tolerated. The parameterized time is internally rounded-off to an integer multiple of the monitoring clock cycle.				Checksum: Yes	Protection level: 3
Unit: ms	Default value: 0	Minimum value: 0	Maximum value: 300000.00	Data type: Floating Point32	Effectiveness:

p9858	SI transition time STOP F to STOP A (Motor Module)				
Sets the transition time from STOP F to STOP A on the Motor Module. For a crosswise data comparison between p9658 and p9858, a difference of one safety monitoring clock cycle is tolerated. The parameterized time is internally rounded-off to an integer multiple of the monitoring clock cycle. STOP F: Defect in a monitoring channel (error in the CDC) STOP A: Pulse deletion via safety shutdown path				Checksum: Yes	Protection level: 3
Unit: µs	Default value: 0	Minimum value: 0	Maximum value: 30 000 000.00	Data type: Floating Point32	Effectiveness:

r9870[0...3]	SI version, safety functions integrated in the drive (Motor Module)				
Displays the Safety Integrated version on the Motor Module. [0]: Safety Version (major release) [1]: Safety Version (minor release) [2]: Safety Version (baselevel or patch) [3] = Safety Version (hotfix) Example: r9870[0]=2, r9870[1]=3, r9870[2]=1--> Safety Version V02.03.01				Checksum: No	Protection level: 3
Unit: -	Default value: -	Minimum value: -	Maximum value: -	Data type: Unsigned16	Effectiveness: -

r9871	**SI common functions (Motor Module)**				
Displays the Safety Integrated monitoring functions supported on the Control Unit and Motor Module. The Motor Module determines this display. **Bit 00**: STO via terminals is supported 1 signal: Yes, 0 signal: No **Bit 01**: SBC is supported 1 signal: Yes, 0 signal: No **Bit 02**: SI motion supported 1 signal: Yes, 0 signal: No **Bit 03**: SS1 supported 1 signal: Yes, 0 signal: No				Checksum: No	Protection level: 3
Unit: -	Default value: -	Minimum value: -	Maximum value: -	Data type: Unsigned32	Effectiveness: –

r9872.0...24	CO/BO: SI status (Motor Module)				
Displays the Safety Integrated status on the Motor Module. **Bit 00**: STO selected on the Motor Module 1 signal: Yes, 0 signal: No **Bit 01**: STO active on the Motor Module 1 signal: Yes, 0 signal: No **Bit 02**: SS1 delay time active on the Motor Module 1 signal: Yes, 0 signal: No **Bit 03**: Safe Brake Adapter feedback signal 1 signal: High, 0 signal: Low **Bit 04**: SBC requested 1 signal: Yes, 0 signal: No **Bit 05**: SS1 selected on Motor Module 1 signal: Yes, 0 signal: No **Bit 06**: SS1 active on Motor Module 1 signal: Yes, 0 signal: No **Bit 09**: STOP A cannot be acknowledged, active 1 signal: Yes, 0 signal: No **Bit 10**: STOP A active 1 signal: Yes, 0 signal: No **Bit 15**: STOP F active 1 signal: Yes, 0 signal: No **Bit 16:** STO cause, Safety commissioning mode 1 signal: Yes, 0 signal: No **Bit 17:** STO cause, selection via terminal 1 signal: Yes, 0 signal: No **Bit 18**: STO cause, selection via SSM 1 signal: Yes, 0 signal: No **Bit 20**: STO cause, selection PROFIsafe 1 signal: Yes, 0 signal: No **Bit 22**: SS1 cause, selection terminal 1 signal: Yes, 0 signal: No **Bit 23**: SS1 cause, selection PROFIsafe 1 signal: Yes, 0 signal: No **Bit 24:**Slave Motor Module ready for communication 1 signal: Yes, 0 signal: No If communication is interrupted between the Control Unit and Motor Module (e.g. by switching-off the Motor Module), then this display parameter is no longer updated. The last transferred status of the Motor Module is displayed. Note: Re bit 00: When STO is selected, the cause is displayed in bits 16 ... 18 and in bit 20. Re: bit 05: When SS1 is selected, the cause is displayed in bits 22 and 23. Re: bit 18: When the bit is set, STO is selected via PROFIsafe. Re: bits 22, 23: These bits indicate via which path SS1 was initiated, i.e. who started the SS1 delay time. If the SS1 delay time is not started (e.g. because an STO is simultaneously initiated), then neither of the two bits are set. Re: bit 24: Only for a parallel connection and active motion monitoring functions: Slave Motor Module ready for communication.				Checksum: No	Protection level: 2
Unit: -	Default value: -	Minimum value: -	Maximum value: -	Data type: Unsigned32	Effectiveness: –

r9880	SI monitoring clock cycle (Motor Module)				
Displays the clock cycle time for the Safety Integrated Basic Functions on the Motor Module.				Checksum: No	Protection level: 3
Unit: ms	Default value: -	Minimum value: -	Maximum value: -	Data type: Floating Point32	Effectiveness: –

r9881[0...11]	SI motion Sensor Module Node Identifier, second channel				
Displays the Node Identifier of the Sensor Module that is used by the second channel for the motion monitoring functions.				Checksum: No	Protection level: 3
Unit: –	Default value: –	Minimum value: –	Maximum value: –	Data type: Unsigned8	Effectiveness: –

r9890[0...2]	SI version (Sensor Module)				
Displays the Safety Integrated version on the Sensor Module. [0]: Safety Version (major release) [1]: Safety Version (minor release) [2]: Safety Version (baselevel or patch) Example: r9890[0]=2, r9890[1]=3, r9890[2]=1--> Safety Version V02.03.01				Checksum: No	Protection level: 3
Unit: –	Default value: –	Minimum value: –	Maximum value: –	Data type: Unsigned16	Effectiveness: –

r9894[0...19]	SI crosswise comparison list (Motor Module)				
Displays the number of the data that are being presently compared crosswise on the Motor Module. Example: r9894[0] = 1 (monitoring clock cycle) r9894[1] = 2 (enable safety-related functions) r9894[2] = 3 (SGE changeover, tolerance time) r9894[3] = 4 (transition time, STOP F to STOP A) ... The list of crosswise compared data depends on the particular application.				Checksum: No	Protection level: 2
Unit: –	Default value: –	Minimum value: –	Maximum value: –	Data type: Unsigned16	Effectiveness: –

r9895	SI diagnostics, STOP F (Motor Module)				
Displays the number of the cross-checked data which has caused STOP F on the Motor Module.				Checksum: No	Protection level: 2
Unit: –	Default value: –	Minimum value: –	Maximum value: –	Data type: Unsigned32	Effectiveness: –

Diagnostics data that provides more information on Fault F30611 ("SI MM: Defect in a monitoring channel").

Crosswise data comparison ID	Crosswise comparison data	Associated parameters
1	SI monitoring clock cycle	r9780, r9880
2	SI enable safety functions	p9601, p9801
3	SI SGE changeover, tolerance time	p9650, p9850
4	SI transition time from STOP F to STOP A	p9658, p9858
5	SI enable safe brake control	p9602, p9802

Cross-wise data com-parison ID	Crosswise comparison data	Associated parameters
6	Correct parameter information	p9501, p2982
7	SI delay time of the pulse cancellation for Safe Stop 1	p9652, p9852
9	SI debounce time for STO/SBC/SS1 (MM)	p9651, p9851
10	SI delay time for pulse suppression for ESR	p9697, p9897

Additional diagnostic values (from 1000 onwards):

Value	Description of error(s)	Description
1000	Check (watchdog) timer has expired	Change timer in the CU has been active too long
1001	Change timer initialization error	When starting the change timer, the CU had not set the ”timer running bit”
1002	Check (watchdog) timer initialization error	The MM had not started the check (watchdog) timer although the change timer is currently running in the CU
2000	Error when comparing the SH terminals	Status of the SH terminals on the Control Unit and Motor Module are different.
2001	Error when comparing the feedback signals DIAG_U and DIAG_L	Status of the feedback signals of the safety shutdown paths on the Control Unit and Motor Module are different.
2002	Error when comparing the feedback signals	Status of the delay timer SS1 on the Control Unit and Motor Module are different

r9897	SI delay time, pulse cancellation after communication failure (Motor Module)				
Setting the delay time for the pulse cancellation after bus failure via failsafe values on the Motor Module (e.g. for ESR (extended stop and retract)). Notice: This parameter is overwritten by the copy function of the safety functions integrated in the drive.				Checksum: Yes	Protection level: 3
Unit: µs	Default value: 0	Minimum value: 0	Maximum value: 800 000	Data type: Real32	Effectiveness: –

r9898	SI actual checksum SI parameters (Motor Module)				
Displays the checksum for the checked Safety Integrated parameters on the Motor Module (actual checksum).				Checksum: No	Protection level: 3
Unit: -	Default value: -	Minimum value: -	Maximum value: -	Data type: Unsigned32	Effectiveness: –

r9899	SI reference checksum SI parameters (Motor Module)				
Sets the checksum for the checked Safety Integrated parameters on the Motor Module (reference checksum).				Checksum: No	Protection level: 3
Unit: –	Default value: 0000 hex	Minimum value: 0000 hex	Maximum value: FFFF FFFF hex	Data type: Unsigned32	Effectiveness: When exiting the SI commissioning mode

The actual checksum (r9898) calculated by the MM must be entered into the reference checksum p9899. This therefore acknowledges the safety commissioning on the Motor Module.

8.3 NCK-MD, that are read from Safety Integrated

The safety software reads the following NCK machine data. To a large extent, these machine data are not calculated into the checksums, as they do not have any direct safety-relevant significance, or as a consequence of changing this data, the safety-relevant data is changed, which in turn, is calculated into the checksum.

MD number	MD identifier	Use
10050	SYSCLOCK_CYCLE_TIME	to determine the monitoring clock cycle; as time basis for position controller based monitoring times
10060	POSCTRL_SYSCLOCK_TIME_RATIO	to distribute the SI monitoring channels to various position control clock cycles
10070	IPO_SYSCLOCK_TIME_RATIO	as time basis for IPO-based monitoring times
30100	CTRLOUT_SEGMENT_NR	Defines as to whether a PROFIdrive drive is involved.
36906	CTRLOUT_MODULE_NR	to determine access to the interface to the DRV; to determine the drive module type
30130	CTRLOUT_TYPE	to protect against parameterizing errors
10200	INT_INCR_PER_MM	to convert the reference position from the NCK into the SI computation format (linear axes)
10210	INT_INCR_PER_DEG	to convert the reference position from the NCK into the SI computation format (rotary axes/spindles)
30300	IS_ROT_AX	for a plausibility check, rotary axis setting
36912	ENC_INPUT_NR	from which encoder data is read using drive parameter r0979
30240	ENC_TYPE	to protect against inadmissible measuring functions
34210	ENC_REFP_STATE	to protect against inadmissible measuring functions
30330	MODULO_RANGE	for plausibility check, modulo values
10360	FASTIO_DIG_NUM_OUTPUTS	Determines double assignment of IO modules
10071	IPO_CYCLE_TIME	Time basis for IPO-based monitoring times
11500	PREVENT_SYNACT_LOCK	SPL protection

8.4 Drive parameters that are read from the NCK-SI

The following drive parameters are read when the control boots to protect the drive parameterization, relevant for the safety functions, from being changed.

Parameter No.	Meaning	Stored in the NCK-MD	Alarm when changing the MD value
p2003	Reference torque	SAFE_BRAKETEST_TORQUE_NORM	27039
r0979[1, 11, 21] [1)]	Type encoder	SAFE_ENC_IS_LINEAR	27036
r0979[2, 12, 22] [1)]	Encoder resolution	SAFE_ENC_GRID_POINT_DIST SAFE_ENC_RESOL [2)]	27036
r0979[3, 13, 23] [1)]	Shift factor XIST1	SAFE_ENC_PULSE_SHIFT	27036
r9744	Message buffer changes counter	– [3)]	–
r9747[0]	Message code	– [3)]	–
r9748[0]	Message time, received	– [3)]	–
r9749[0]	Message value	– [3)]	–
p9810	PROFIsafe address	SAFE_DRIVE_PS_ADDRESS	27035
r9881[0...11]	Sensor Module Node Identifier	SAFE_ENC_IDENT	27035
r0470[0,1,2] [1)]	Valid bits of the redundant coarse position value	SAFE_ENC_NUM_BITS[0]	27035
r0471[0,1,2] [1)]	Fine resolution of the redundant coarse position value	SAFE_ENC_NUM_BITS[1]	27035
r0472[0,1,2] [1)]	Relevant bits of the redundant coarse position value	SAFE_ENC_NUM_BITS[2]	27036
r0474[0,1,2] [1)]	Configuration of the redundant coarse position value Bit 0: Count direction, up/down Bit 1: CRC 16: LSB/ MSB first Bit 2: MSB/LSB justified	SAFE_ENC_CONF	27035
r0475[0,1,2] [1)]	Safety MSB of the redundant coarse position value	SAFE_ENC_NUM_BITS[3]	27036

Parameter No.	Meaning	Stored in the NCK-MD	Alarm when changing the MD value
r9527	Encoder evaluation type	SAFE_ENC_MOD_TYPE	27035

1) Which parameter indices are read depends on which encoder was selected using MD $MA_SAFE_ENC_INPUT_NR.

2) The selected encoder type defines in which MD the value is saved. Setting is made using MD $MC_SAFE_ENC_IS_LINEAR.

3) These parameters are not mapped in NCK-MD, but in Alarm 27900 and correspondingly alarm parameters changed over.

8.5 Protecting checksum

Checksums are generated using this MD in order to detect falsification of the SI-relevant machine data checked in the acceptance test.

In order to provide users with the most accurate information as possible about the area of the safety relevant parameterization in which a discrepancy has occurred between the reference and actual checksum, the machine data and the associated checksums are subdivided into:

- Machine data that are parameterized using the axis-specific SI functionality (refer to Chapter. 8.1.1)

  => $MA_SAFE_ACT_CHECKSUM[0...2]
- Machine data that are parameterized using the general and NCK-specific SI functionality (refer to Chapter. 8.1.1)

  => $MN_SAFE_GLOB_ACT_CHECKSUM[0...3]

There are machine data fields, which are independent of one another, for these two machine data groups, in which the checksums are saved.

These two groups are subdivided into various machine data, which in turn are used to calculate independent checksums. Each checksum change is displayed with its own alarm message. This means that using the alarm number alone, the user can identify which function area should be especially carefully assessed in the subsequently required function or acceptance test.

Modular machine concepts are supported by this distribution.

The value of the checksums $MN_SAFE_GLOB_ACT_CHECKSUM[0...3] and $MA_SAFE_ACT_CHECKSUM[0...2] is re-calculated for various events:

- When the control boots
- Machine control panel reset
- PI service ”_N_CRCSMD”

A comparison between the MD values $MN_SAFE_GLOB_ACT_CHECK-SUM[0...3] / $MA_SAFE_ACT_CHECKSUM[0...2] and the expected values for the checksums in MD $MN_SAFE_GLOB_DES_CHECKSUM[0...3] / $MA_SAFE_DES_CHECKSUM[0...2] is only performed when the control boots, a discrepancy between the values is displayed using one of the alarms mentioned below.

In this case, it is necessary to confirm the actual checksum by copying this value into MD $MN_SAFE_GLOB_DES_CHECKSUM[0...3] / $MA_SAFE_DES_CHECKSUM[0...2] and rebooting the control.

8.6 Interface signals

General information

The safety-related input and output signals (SGE and SGA) are signals that are sent to and received from the system through two channels.

Warning

A STOP F (displayed using Alarms 27001, 27101 and onwards or F01711) only results in a subsequent STOP B/A response, if at least one of the safety-related functions SBH, SG, SE, SN or $n<n_x$ synchronization is active or selected. If only the function ”$n < n_x$” is active, then a STOP F does not result in a subsequent STOP B/A response.
This means that if ”$n < n_x$” is used as a safety function, then at least one of the SBH, SG, SE or SN functions must be active or selected (e.g. by selecting a high SG level).

Note

The SGE/SGA in the drive monitoring channel are mapped in an area of the NC/PLC interface (signals to/from the drive) and must be supplied in the PLC user program.
As a result of the two-channel structure of Safety Integrated, the machine manufacturer must supply the SGE and SGA in both the NCK monitoring channel and the drive monitoring channel.
Unused SGEs must be set to a defined state.

8.6.1 Interface signals for SINUMERIK 840D sl

Table 8-3 Interface signals for 840D sl

DB 31...	Signals from/to the drive							
Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
...	...							
...	...							
...	...							
DBB 22				SG selection Bit 1	Bit 0	Acknowledgem., communic. failure	SBH Deselection	SBH/SG Deselection
DBB 23	Test stop Selection		Close brake	SE Selection		Gear ratio selection Bit 2	Bit 1	Bit 0
SGE (signals to the drive)								
DBB 32			Deselect ext. STOP_E	Deselect ext. STOP_D	Deselect ext. STOP_C	Deselect ext. STOP_A		
DBB 33	SG correction select/override Bit 3	Bit 2	Bit 1	Bit 0				
...	...							
...	...							
...	...							
DBB 108	Axis safely referenced			Communication failure not acknowl.	Fault data transfer	"Pulses cancelled" status	Communication failure	SBH/SG active
DBB 109	SN4–	SN4+	SN3–	SN3+	SN2–	SN2+	SN1–	SN1+
Cam signals of the plus and minus cams Cam position								
DBB 110			$n < n_x$	SG active Bit 1	Bit 0		SBH active	
DBB 111	STOP_E active	STOP_D active	STOP_C Active	STOP_A/B Active				
DBB 112	Cam range for cam track 1							
DBB 113	Cam range for cam track 2							
DBB 114	Cam range for cam track 3							
DBB 115	Cam range for cam track 4							
DBB 116								
DBB 117					Cam track 4	Cam track 3	Cam track 2	Cam track 1
	Cam track 1							
DBB 118	Cam 8	Cam 7	Cam 6	Cam 5	Cam 4	Cam 3	Cam 2	Cam 1
	Cam track 1							
DBB 119		Cam 15	Cam 14	Cam 13	Cam 12	Cam 11	Cam 10	Cam 9
	Cam track 2							
DBB 120	Cam 8	Cam 7	Cam 6	Cam 5	Cam 4	Cam 3	Cam 2	Cam 1
	Cam track 2							
DBB 121		Cam 15	Cam 14	Cam 13	Cam 12	Cam 11	Cam 10	Cam 9

	Cam track 3							
DBB 122	Cam 8	Cam 7	Cam 6	Cam 5	Cam 4	Cam 3	Cam 2	Cam 1
	Cam track 3							
DBB 123		Cam 15	Cam 14	Cam 13	Cam 12	Cam 11	Cam 10	Cam 9
	Cam track 4							
DBB 124	Cam 8	Cam 7	Cam 6	Cam 5	Cam 4	Cam 3	Cam 2	Cam 1
	Cam track 4							
DBB 125		Cam 15	Cam 14	Cam 13	Cam 12	Cam 11	Cam 10	Cam 9

Note:
DB 31 / 32 / 33 ... contains the interface signals for axis/spindle 1 / 2 / 3 ...

8.6.2 Description of the interface signal

Description of the signals sent to the monitoring channel

SGE, SBH/SG deselection, SBH deselection

The SBH and SG functions are selected/deselected using these signals.

Table 8-4 Selecting/deselecting SBH and SG

SGE		
SBH/SG deselection	**SBH deselection**	**Meaning**
= 1	x	SBH and SG are deselected
= 0	= 0	SBH is selected
= 0	= 1	SG is selected
x: Signal state is optional		

SGE – SG selection, bits 1, 0

By combining these signals when the SG function is activated it is possible to select the speed limit value for SG1, 2, 3 or 4.

Table 8-5 Selecting speed limit values for SGs

SGE		
SG selection Bit 1	**SG selection Bit 0**	**Meaning**
= 0	=0	Speed limit value for SG1 is selected
= 0	=1	Speed limit value for SG2 is selected
= 1	=0	Speed limit value for SG3 is selected
=1	=1	Speed limit value for SG4 is selected

SGE gearbox ratio selection, bits 2, 1, 0

The combination of these signals determines the selected gearbox ratio 1, 2, ... ,8.

Table 8-6 Ratio selection

SGE gearbox ratio selection			
Bit 2	**Bit 1**	**Bit 0**	**Meaning**
0	0	0	Gearbox stage 1 is selected
0	0	1	Gearbox stage 2 is selected
0	1	0	Gearbox stage 3 is selected
...			...
1	1	1	Gearbox stage 8 is selected

SGE SE selection

When this signal is appropriately activated, and the SE function is activated, either SE1 or SE2 is selected.

0 signal: SE1 is selected

1 signal: SE2 is selected

SGE SG correction selection/override, bits 3, 2, 1, 0

16 overrides for the limit value of safely reduced speeds 2 and 4 can be defined using the SGEs. This means that the limit values for SG2 and SG4 can be more finely graduated.
An override factor of between 1 and 100% can be assigned to the selected override using the following machine data:

for 840D sl:
MD 36932: $MA_SAFE_VELO_OVR_FACTOR[n]

for SINAMICS S120:
p9532[n]: SI motion, override factor

SGE test stop selection

This signal is used to initiate the shutdown path test for the drive monitoring channel (see Chapter 6.1.1 ”Shutdown paths”).

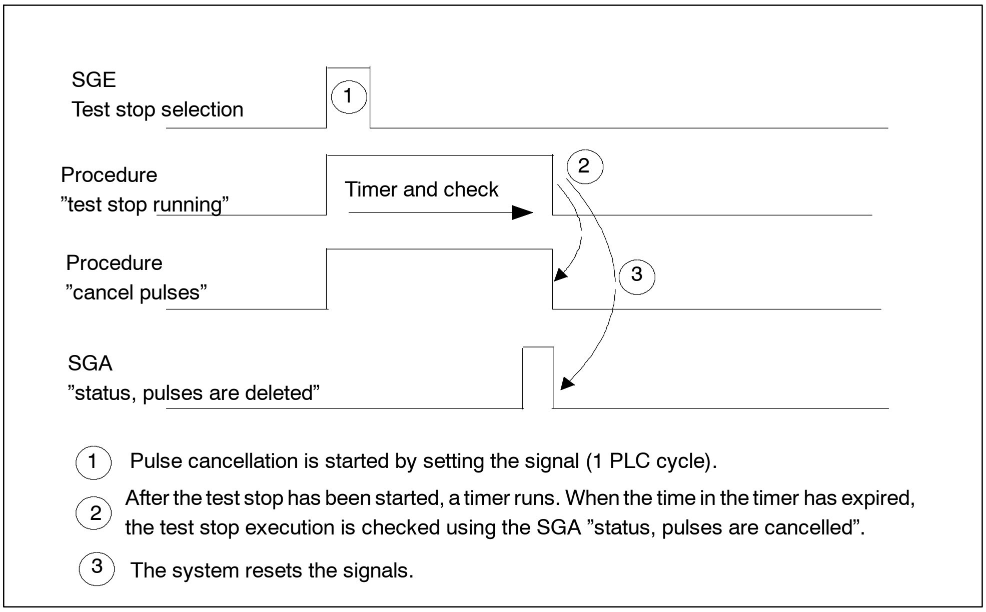


Fig. 8-1 Signal timing for SGE test stop selection

The test stop is also carried out at the same time in the NCK monitoring channel (see Chapter 6.1.2 ”Testing the shutdown paths”).

Test stop for external STOPs

See Chapter 6.3.8 ”Forced checking procedure of the external STOPs”.

SGE deselect ext. STOP A

”Pulse cancellation” can be requested and executed using this SGE.
The safe functions currently active (SG/SBH/SN/SE) are not influenced by this SGE.
If one of the currently active limits is violated, an appropriate alarm is initiated. The associated shutdown response cannot be activated because the pulses have already been cancelled. As soon as the stop request is cancelled via the SGE ”deselect ext. STOP A” any queued shutdown responses become active.

If a stop request is active, SGA ”STOP A/B is active” is set in the same way as it would be for an internally triggered STOP A.

0 signal: ”Pulse cancellation” is requested
1 signal: ”Pulse cancellation” is not requested

SGE deselect ext. STOP C

This SGE requests ”braking with n_{set} = 0” (braking along the OFF3 ramp).
When this stopping type is initiated, the safe acceleration monitoring (SBR) is activated. In addition, the timer set in MD36952/p9552:
$MA_SAFE_STOP_SWITCH_TIME_C / ”SI motion transition time STOP C to SBH” is started.
After this time has elapsed, the system automatically changes over to SBH.

If a stop request is active, SGA ”STOP C is active” is set in the same way as it would be for an internally triggered STOP C.

0 signal: ”Braking with n_{set} = 0” is requested
1 signal: No request for ”braking with n_{set} = 0”

Note

Stopping with an external STOP A (pulse cancellation) has a higher priority and can interrupt an external STOP C (braking along the OFF3 down ramp).

SGE deselect ext. STOP D

”Braking along a path” can be requested using this SGE.
When ext. STOP D is triggered, the timer set using MD 36953/p9553
$MA_SAFE_STOP_SWITCH_TIME_D / ”SI motion transition time STOP D to SBH” is started.
After this time has elapsed, the system automatically changes over to SBH.

If a stop request is active, SGA ”STOP D is active” is set in the same way as it would be for an internally triggered STOP D.

0 signal: ”Braking along a path” is requested
1 signal: ”Braking along the path” is not requested

Note

Stopping with an external STOP A (pulse cancellation) and external STOP C (braking along the OFF 3 down ramp) have a higher priority and can interrupt an external STOP D (braking along a path).

SGE deselect ext. STOP E

This SGE can be used to request a stop via the function ”extended stopping and retraction” (ESR). When an external STOP E is initiated the timer set using MD 36954: $MA_SAFE_STOP_SWITCH_TIME_E / p9554: ”SI motion transition time STOP E to SBH” is started.
After this time has elapsed, the system automatically changes over to SBH.

If a stop request is active, SGA ”STOP E is active” is set in the same way as it would be for an internally triggered STOP E.
0 signal: ”Stop/retraction” is requested
1 signal: ”Stop/retraction” is not requested

Note

Stopping with an ext. STOP A (pulse cancellation), ext. STOP C (braking along the OFF3 down ramp) and ext. STOP D (braking along a path) have a higher priority and can interrupt an ext. STOP E.

STOP E only produces a different response than STOP D if the user has configured the ESR function – extended stop and retract – and initiation of the ESR is programmed depending on $VA_STOPSI or $A_STOPESI. If no ESR is active, the STOP E behaves like a STOP D. However, if the ESR was incorrectly configured, there is a delay up to the time $MC_ESR_DELAY_TIME1 and $MC_ESR_DELAY_TIME2 compared to STOP D until the braking operation is initiated.

After these times have expired, braking is initiated at the current limit.

Close SGE brake (only the drive)

Using this SGE, a mechanical brake, that is controlled from the drive brake control, is closed. It is used to check brake closing while testing the mechanical brake system.

- If this SGE is set, the brake is closed.
- If this SGE is deleted, then the brake assumes the status of the drive brake control – i.e. it is not forcibly opened (no positive opening).

Note

This SGE must be connected to the brake control using a BiCo interconnection in the drive (p0858 to source r9719, bit 13). This connection is parameterized as standard.

Description of signals from the monitoring channel

SGA SBH/SG active

This signal is used to signal the drive monitoring channel the status of the SBH and SG functions as follows:

0 signal: SBH/SG is not active
1 signal: SBH/SG is active

SGA status, pulses are cancelled (drive only)

After the shutdown path test has been initiated using the SGE test stop selection or if a limit value is violated with a resulting STOP A response, this signal is output to indicate that the drive pulses have been internally cancelled (refer to Chapter 6.1.1, "Shutdown paths").

0 signal: Pulses are enabled
1 signal: Pulses are cancelled

SGA axis safely referenced

This indicates as to whether the relevant axis/spindle has been safely referenced (see Chapter 5.4.3, "Axis states").

0 signal: Axis is not safely referenced
1 signal: Axis is safely referenced

SGA SN1+, SN1-, SN2+, SN2-, SN3+, SN3-, SN4+, SN4-

These signals are used to indicate which of the plus or minus cams of cam pair 1, 2, 3 or 4 is "actuated".

0 signal:
Axis/spindle is located to the left of the cam (actual value < cam position)
1 signal:
Axis/spindle is located to the right of the cam (actual value > cam position)

SGA safe cam track

These signals are used to display whether the axis is located on a cam that is assigned to this cam track (this only applies to the "safe cam track" function).

0 signal:
The axis is not located on a cam of the cam track
1 signal:
The axis is located on a cam of this cam track

SGA safe cam range

The bits (4 bits per cam track) display in which cam range the axis is presently located (this is only valid for the ”safe cam track” function).

SGA safe cam range bits

This signal displays at which cam the axis is presently located (this is only valid for the ”safe cam track” function).

0 signal: The axis is not located at this cam
1 signal: The axis is located at this cam

SGA SBH active

The signal indicates the status of the safe operating stop (SBH).

0 signal: SBH is not active
1 signal: SBH is active

SGA STOP A/B is active

This signal indicates that STOP A/B is active.
The signal must be used for the forced checking procedure for external STOPs.

0 signal: STOP A/B is not active
1 signal: STOP A/B is active

SGA STOP C is active

This signal indicates that STOP C is active.
The signal must be used for the forced checking procedure for external STOPs.

0 signal: STOP C is not active
1 signal: STOP C is active

SGA STOP D is active

This signal indicates that STOP D is active.
The signal must be used for the forced checking procedure for external STOPs.

0 signal: STOP D is not active
1 signal: STOP D is active

SGA STOP E is active

This signal indicates that STOP E is active.
The signal must be used for the forced checking procedure for external STOPs.

0 signal: STOP E is not active
1 signal: STOP E is active

SGA ”n < n_x

This SGA indicates whether the absolute value of the actual speed is above or below a speed specified in the machine data.

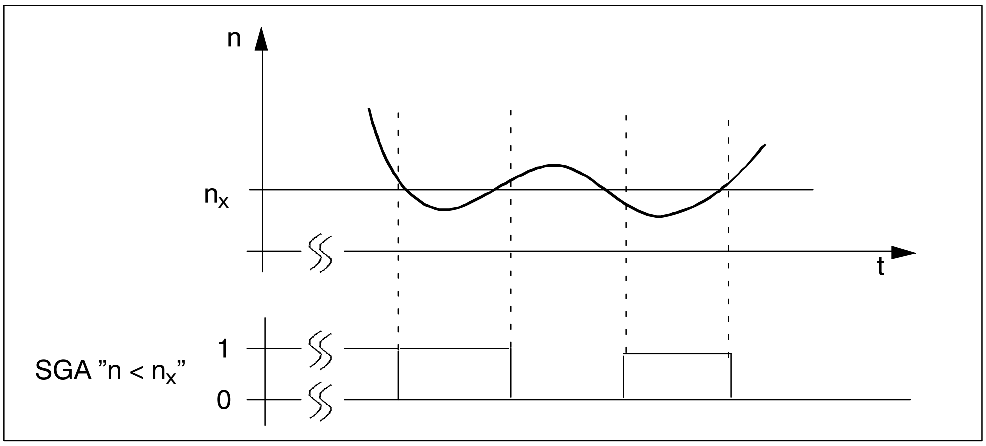


Fig. 8-2 Signal n < n_x, dependent on the speed characteristic

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Warning

A STOP F (displayed using Alarms 27001, 27101 and onwards or F01711) only results in a subsequent STOP B/A response, if at least one of the safety-related functions SBH, SG, SE, SN or n<n_x synchronization” is active or selected. If only the function ”n < n_x” is active, then a STOP F does not result in a subsequent STOP B/A response.
This means that if ”n < n_x” is used as a safety function, then at least one of the SBH, SG, SE or SN functions must be active or selected (e.g. by selecting a high SG level).

Note

If the axis/spindle runs at a speed n_x, then as a result of actual differences in the two monitoring channels, the SGA ”n < n_x” can have different states.
This must be taken into account in the safe processing of the SGAs.

SG active, bits 0, 1

The SGAs ”SG active bits 1, 0” display which safely-reduced speed and therefore which speed limit value is actively monitored. The SGAs are only updated if the function ”SBH/SG” is enabled and SG is active (SGE ”SBH/SG deselection” = 0 and ”SBH deselection” = 1).

Table 8-7 Display of the active safely reduced speed

SGA				Meaning
SG active Bit 1	SG active Bit 0	SBH/ SG active	SBH active	
=0	=0	1	1	SBH is active (safely reduced speed is not active)
=0	=0	1	0	Speed limit value for SG1 active
=0	=1	1	0	Speed limit value for SG2 active
=1	=0	1	0	Speed limit value for SG3 active
=1	=1	1	0	Speed limit value for SG4 active
=0	=0	0	0	Neither SBH nor SG is active
Note: The state ”SG active bits 1, 0” = ”0” has different meanings. A clear interpretation can be obtained by additionally evaluating the SGAs ”SBH active” and ”SBH/SG active”.				

Communication failure

For a sign-of-life error or CRC error, this signal is set to TRUE. The PLC-SPL remains functional in so much that the drive monitoring channel is not required. SGE to the drive are not effective. The SGA from the drive are frozen at the state before communications failed.
Response time of the PLC when the sign of life character from the drive fails: 3 s
Response time of the PLC for CRC errors from the drive: 1 PLC cycle
Ongoing behavior depends on the bit ”Acknowledgement communication failure”.
The fault situation can only be executed with power on.

Fault, data transfer

This signal is used to diagnose the cause for the set signal ”communication error”.

1 signal: There is a CRC error
0 signal: There is no CRC error

Acknowledgement, communication failure

It is possible to acknowledge faults that are displayed via the ”communication failure” bit using the ”acknowledgement communication failure” signal. This acknowledgement must be made in the same OB1 cycle as when the ”communication failure” signal occurred as 0/1 edge.

Warning

When setting the acknowledgement, the user assumes the responsibility of providing suitable substitute values for the SGA of the drive, as these are no longer valid. The user must bring the machine into a safe state.

If the acknowledgement is not made after an OB1 cycle, then the frozen SGA are changed over from the drive to deleted SGA and the diagnostics bit ”Communication failure was not acknowledged” is set. If the acknowledgement is made within an OB1 cycle, the SGA of the drive remain frozen and the diagnostics bit ”Communication failure was not acknowledged” is not set. There is no further response. The fault situation can only be executed with power on.

Communication failure was not acknowledged

Indicates whether a fault displayed using bit ”Communication failure” was acknowledged using the bit ”Acknowledge communication failure”:

0: Communication has not failed or a communication failure was acknowledged.

1: Communication has failed and this was not acknowledged.

8.6.3 PLC data block (DB 18)

Parameterization part

DB 18		Signals for safety SPL						
Data block		Interface PLC ---> PLC						
Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	INSEP Valid (valid bit)							
DBB 0	8th input byte	7th input byte	6th input byte	5th input byte	4th input byte	3rd input byte	2nd input byte	1st input byte
DBB1								
	OUTSEPValid (valid bit)							
DBB 2	8th output byte	7th output byte	6th output byte	5th output byte	4th output byte	3rd output byte	2nd output byte	1st output byte
DBB 3								
DBW4	INSEP_ADDR (address 1st input byte)							
DBW6	INSEP_ADDR (address 2nd input byte)							
DBW8	INSEP_ADDR (address 3rd input byte)							
DBW10	INSEP_ADDR (address 4th input byte)							
DBW12	INSEP_ADDR (address 5th input byte)							
DBW14	INSEP_ADDR (address 6th input byte)							
DBW16	INSEP_ADDR (address 7th input byte)							
DBW18	INSEP_ADDR (address 8th input byte)							
DBW20	OUTSEP_ADDR (address 1st output byte)							
DBW22	OUTSEP_ADDR (address 2nd output byte)							

DB 18	Signals for safety SPL							
DBW24	OUTSEP_ADDR (address 3rd output byte)							
DBW26	OUTSEP_ADDR (address 4th output byte)							
DBW28	OUTSEP_ADDR (address 5th output byte)							
DBW30	OUTSEP_ADDR (address 6th output byte)							
DBW32	OUTSEP_ADDR (address 7th output byte)							
DBW34	OUTSEP_ADDR (address 8th output byte)							
DBB36							STOP_MODE	SPL_READY
DBB37								

Note

DBB 0–35 is not relevant for SINUMERIK 840D sl.

Data area/errors

DB 18	Signals for safety SPL							
Data block	Interface PLC ---> NCK							
Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	Data area of SPL inputs/outputs							
DBD 38	SPL_DATA.INSEP[1 ...32]							
DBD 42	SPL_DATA.INSEP[33 ...64]							
DBD 46	SPL_DATA.OUTSEP[1 ...32]							
DBD 50	SPL_DATA.OUTSEP[33 ...64]							
	Data area for user SPL							
	SPL_DATA.INSIP[1 ...32]							

DB 18		Signals for safety SPL						
DBD 54								
DBD 58	SPL_DATA.INSIP[33 ...64]							
DBD 62	SPL_DATA.OUTSIP[1 ...32]							
DBD 66	SPL_DATA.OUTSIP[33 ...64]							
DBD 70	SPL_DATA.MARKERSIP[1 ...32]							
DBD 74	SPL_DATA.MARKERSIP[33 ...64]							
	Difference in signal level NCK - PLC for diagnostics							
DBD 78	SPL_DELTA.INSEP[1 ...32]							
DBD 82	SPL_DELTA.INSEP[33 ...64]							
DBD 86	SPL_DELTA.OUTSEP[1 ...32]							
DBD 90	SPL_DELTA.OUTSEP[33 ...64]							
DBD 94	SPL_DELTA.INSIP[1 ...32]							
DBD 98	SPL_DELTA.INSIP[33 ...64]							
DBD 102	SPL_DELTA.OUTSIP[1 ...32]							
DBD 106	SPL_DELTA.OUTSIP[33 ...64]							
DBD 110	SPL_DELTA.MARKERSIP[1 ...32]							
DBD 114	SPL_DELTA.MARKERSIP[33 ...64]							
DBB 118								CMDSI
DBB 119		STOP_ FROM_ NC	COMM_TO	IBN_ FAULT		PS_ FEHL		

DB 18	Signals for safety SPL
DBD 120	STATSI Error number 0 = no error 1 – 320 = signal number starting from SPL_DATA.INSEP[1]
DBD 124	LEVELSI CDC stack level display (diagnostics capability: How many SPL signals currently have different levels)

Additional data areas

DB 18		Signals for safety SPL						
Data block		Interface PLC –––> NCK						
Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	Data area of single-channel inputs/outputs							
DBB128	PLCSIOUT[1 ...8]							
DBB129	PLCSIOUT[9 ...16]							
DBB130	PLCSIOUT[17 ..24]							
DBB131	PLCSIOUT[25 ...32]							
DBB132	PLCSIIN[1 ...8]							
DBB133	PLCSIIN[9 ...16]							
DBB134	PLCSIIN[17 ...24]							
DBB135	PLCSIIN[25 ...32]							
DBW136	SPL status[1 ...16]							
DBB138	INSEP_PROFISAFE[1 ...8] PROFIsafe module(s) for 8th input byte	7th input byte	6th input byte	5th input byte	4th input byte	3rd input byte	2nd input byte	1st input byte
DBB139								

DB 18	Signals for safety SPL							
	OUTSEP_PROFISAFE[1 ...8] PROFIsafe module(s) for							
DBB140	8th output byte	7th output byte	6th output byte	5th output byte	4th output byte	3rd output byte	2nd output byte	1st output byte
DBB141								
DBB142 to DBB149								
DBB150 to DBB157								
DBB158 to DBB188								

F_SENDDP

DB 18	Signals for safety SPL							
Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
DBW190	FSDP[1].ERR_REAC							
DBB192							FSDP[1]. SUBS_ON	FSDP[1]. ERROR
DBB193								
DBW194	FSDP[1].DIAG							
DBW196	FSDP[1].RETVAL14							
DBW198	FSDP[1].RETVAL15							
DBW200	FSDP[2].ERR_REAC							
DBB202							FSDP[2]. SUBS_ON	FSDP[2]. ERROR

DB 18	Signals for safety SPL							
DBB203								
DBW204	FSDP[2].DIAG							
DBW206	FSDP[2].RETVAL14							
DBW208	FSDP[2].RETVAL15							
DBW210	FSDP[3].ERR_REAC							
DBB212							FSDP[3]. SUBS_ON	FSDP[3]. ERROR
DBB213								
DBW214	FSDP[3].DIAG							
DBW216	FSDP[3].RETVAL14							
DBW218	FSDP[3].RETVAL15							

F_RECVDP

DB 18		Signals for safety SPL						
Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
DBB220	FRDP[1]. SUBS[7]	FRDP[1]. SUBS[6]	FRDP[1]. SUBS[5]	FRDP[1]. SUBS[4]	FRDP[1]. SUBS[3]	FRDP[1]. SUBS[2]	FRDP[1]. SUBS[1]	FRDP[1]. SUBS[0]
DBB221	FRDP[1]. SUBS[15]	FRDP[1]. SUBS[14]	FRDP[1]. SUBS[13]	FRDP[1]. SUBS[12]	FRDP[1]. SUBS[11]	FRDP[1]. SUBS[10]	FRDP[1]. SUBS[9]	FRDP[1]. SUBS[8]
DBW222	FRDP[1].ERR_REAC							
DBB224								FRDP[1]. ACK_REI
DBB225					FRDP[1]. SEND- MODE	FRDP[1]. ACK_REQ	FRDP[1]. SUBS_ON	FRDP[1]. ERROR
DBW226	FRDP[1].DIAG							

DB 18	Signals for safety SPL							
DBW228	FRDP[1].RETVAL14							
DBW230	FRDP[1].RETVAL15							
DBB232	FRDP[2]. SUBS[7]	FRDP[2]. SUBS[6]	FRDP[2]. SUBS[5]	FRDP[2]. SUBS[4]	FRDP[2]. SUBS[3]	FRDP[2]. SUBS[2]	FRDP[2]. SUBS[1]	FRDP[2]. SUBS[0]
DBB233	FRDP[2]. SUBS[15]	FRDP[2]. SUBS[14]	FRDP[2]. SUBS[13]	FRDP[2]. SUBS[12]	FRDP[2]. SUBS[11]	FRDP[2]. SUBS[10]	FRDP[2]. SUBS[9]	FRDP[2]. SUBS[8]
DBW234	FRDP[2].ERR_REAC							
DBB236								FRDP[2]. ACK_REI
DBB237					FRDP[2]. SEND-MODE	FRDP[2]. ACK_REQ	FRDP[2]. SUBS_ON	FRDP[2]. ERROR
DBW238	FRDP[2].DIAG							
DBW240	FRDP[2].RETVAL14							
DBW242	FRDP[2].RETVAL15							
DBB244	FRDP[3]. SUBS[7]	FRDP[3]. SUBS[6]	FRDP[3]. SUBS[5]	FRDP[3]. SUBS[4]	FRDP[3]. SUBS[3]	FRDP[3]. SUBS[2]	FRDP[3]. SUBS[1]	FRDP[3]. SUBS[0]
DBB245	FRDP[3]. SUBS[15]	FRDP[3]. SUBS[14]	FRDP[3]. SUBS[13]	FRDP[3]. SUBS[12]	FRDP[3]. SUBS[11]	FRDP[3]. SUBS[10]	FRDP[3]. SUBS[9]	FRDP[3]. SUBS[8]
DBW246	FRDP[3].ERR_REAC							
DBB248								FRDP[3]. ACK_REI
DBB249					FRDP[3]. SEND-MODE	FRDP[3]. ACK_REQ	FRDP[3]. SUBS_ON	FRDP[3]. ERROR
DBW250	FRDP[3].DIAG							
DBW252	FRDP[3].RETVAL14							
DBW254	FRDP[3].RETVAL15							
DBD256	SPL_USER_DATA[0]							
DBD260	SPL_USER_DATA[1]							

DB 18	Signals for safety SPL
DBD264	SPL_USER_DATA[2]
DBD268	SPL_USER_DATA[3]

SPL status signals for DB18.DBW136

DB18.DBX136.0	SPL_STATUS[1]	NCK-SPL interfaces parameterized
DB18.DBX136.1	SPL_STATUS[2]	NCK-SPL program file exists
DB18.DBX136.2	SPL_STATUS[3]	NCK waits for the PLC to boot
DB18.DBX136.3	SPL_STATUS[4]	NCK and PLC in cyclic operation
DB18.DBX136.4	SPL_STATUS[5]	Call FB4 processing for SPL
DB18.DBX136.5	SPL_STATUS[6]	Exit FB4 processing for SPL
DB18.DBX136.6	SPL_STATUS[7]	Call FC9 processing for SPL
DB18.DBX136.7	SPL_STATUS[8]	Exit FC9 processing for SPL
DB18.DBX137.0	SPL_STATUS[9]	SPL start implemented using PROG_EVENT mechanism
DB18.DBX137.1	SPL_STATUS[10]	Crosswise data comparison started, NCK
DB18.DBX137.2	SPL_STATUS[11]	Crosswise data comparison started, PLC
DB18.DBX137.3	SPL_STATUS[12]	NCK-SPL checksum checking active
DB18.DBX137.4	SPL_STATUS[13]	All SPL protective mechanisms active
DB18.DBX137.5	SPL_STATUS[14]	End of SPL program reached
DB18.DBX137.6	SPL_STATUS[15]	SPL start via Safety-PowerOn
DB18.DBX137.7	SPL_STATUS[16]	Not assigned

Table 8-8 Overview of DB 18 signals

DB18				
Signal	**r - read w - write**	**Type**	**Range of values**	**Remark**
Parameterization part				
INSEP_VALID[1..8] (no significance)	r/w	Bool		0 = INSEP[1..8] No automatic transfer, can be supplied from the user program (AWP) 1 = Transfer of input byte, specified in INSEP_ADDR[1..8] to INSEP[1..8] by the basic program

Table 8-8 Overview of DB 18 signals

Signal	r - read w - write	Type	Range of values	Remark
OUTSEP_VA-LID[1..8] (no significance)	r/w	Bool		0 = OUTSEP[1..8] No automatic transfer, can be retrieved from the user program (AWP) 1 = Transfer to the output byte, specified in OUTSEP[1..8] from OUT-SEP_ADDR[1..8] by the basic program
INSEP_ADDR[1..8] (no significance)	r/w	Int	1..EB max	Address, input byte
OUT-SEP_ADDR[1..8] (no significance)	r/w	Int	1..AB max	Address, output byte
SPL_READY	r/w	Bool		0 = commissioning phase (for a crosswise data comparison error, a STOP D is not initiated) 1 = commissioning completed (for a crosswise data comparison error, STOP D is initiated)
STOP_MODE	r/w	Bool		If DB18, DBX36.1 was set to 1, for a crosswise data comparison error, instead of an external STOP D, an external STOP E is transferred to the drive
Data area/status				
SPL_DATA				Net (useful) data:
INSEP[1..64]	r	Bool		External PLC input for the SPL
OUTSEP[1..64]	r/w	Bool		External PLC output for the SPL
INSIP[1..64]	r	Bool		Internal PLC input for the SPL
OUTSIP[1..64]	r/w	Bool		Internal PLC output for the SPL
MARKERSIP[1..64]	r/w	Bool		Marker for SPL
SPL_DELTA				Signal differences for diagnostics:
INSEP[1..64]	r	Bool		External PLC input for the SPL
OUTSEP[1..64]	r	Bool		External PLC output for the SPL
INSIP[1..64]	r	Bool		Internal PLC input for the SPL
OUTSIP[1..64]	r	Bool		Internal PLC output for the SPL
MARKERSIP[1..64]	r	Bool		Marker for SPL
CMDSI	r/w	Bool		The timeout value in the crosswise data comparison is extended by a factor of 10
PS_FEHL	r	Bool		PS-communication error, in conjunction with PROFIsafe, an error is signaled

Table 8-8 Overview of DB 18 signals

Signal	r - read w - write	Type	Range of values	Remark
IBN_FAULT	r	Bool		CDC error ”SPL protection status” (Status NC: $MN_PREVENT_SYN-ACT_LOCK not equal to PLC: SPL_READY)
COMM_TO	r	Bool		0 –> 1 communications timeout detected, PLC will go to STOP in 5 s
STOP_FROM_NC	r	Bool		NCK signals a stop to the PLC.
STATSID	r	Dint	1 – 320	Status: 0 □no error 1 □320 error No. corresponds to signal from SPL_DATA, whose signal level difference resulted in a CDC error
LEVELSI	r	Dint		CDC stack level display (diagnostics capability: How many SPL signals currently have different levels)
PLCSIIN[1 ..32]	r/w	Bool		Single-channel signals from the PLC to NCK
PLCSIOUT[1 ..32]	r	Bool		Single-channel signals from the NCK to the PLC
SPL_STATUS	r	Bool		Status signals from NCK to PLC
INSEP_PROFI-SAFE	r	Bool		0 = no assignment from PROFIsafe F modules to INSEP [1..8] 1 = transfer from PROFIsafe F module to INSEP [1..8] using the basic program
OUTSEP_PROFI-SAFE	r	Bool		0 = no assignment from PROFIsafe F modules to OUTSEP [1..8] 1 = transfer from OUTSEP [1..8] to PROFIsafe F module using the basic program
F_SENDDP				
Inputs				
FSDP[..3].ERR_REAC	r/w	Int	0, 1, 2, 3	0 = Alarm27350 + STOP D/E 1 = Alarm 27350 2 = Alarm 27351 (only display, self-clearing) 3 = No system response
Outputs				
FSDP[..3].ERROR	r	Bool	TRUE, FALSE	0 = Normal operation 1 = Communication error
FSDP[..3].SUBS_ON	r	Bool	TRUE, FALSE	0 = output of process values 1 = output of substitute values

Table 8-8 Overview of DB 18 signals

Signal	r - read w - write	Type	Range of values	Remark
FSDP[..3].DIAG	r	Word	2#0000_0000_0000_0000 – 2#1110_0000_0111_0000	Bit 0–3: Reserved Bit 4: 1 = Timeout detected Bit 5: 1 = Sequence number error detected Bit 6: 1 = CRC error detected Bit 7–12: Reserved Bit 13: 1 = Discrepancies in the F telegram data (Telegram Discrepancy) Bit 14: 1 = Sign-of-life monitoring (LifeSign) Bit 15: 1 = Asynchronous fault state (StateFault)
FSDP[..3].RETVAL14	r	Word		Error code of the SFC 14 (description of the error codes in the online help for SFC 14)
FSDP[..3].RETVAL15	r	Word		Error code of the SFC 15 (description of the error codes in the online help for SFC 15)
F_RECVDP				
Inputs				
FRDP[..3].SUBS_ON[0..15]	r/w	Bool	TRUE/FALSE	Substitute values for SPL input data
FRDP[..3].ERR_REAC	r/w	Int	0, 1, 2, 3	0 = Alarm 27350 + STOP D/E 1 = Alarm 27350 2 = Alarm 27351 (only display, self-clearing) 3 = No system response
FRDP[..3].ACK_REI	r/w	Bool	TRUE/FALSE	1 = User acknowledgement
Outputs				
FRDP[..3].ERROR	r	Bool	TRUE/FALSE	0 = Normal operation 1 = Communication error
FRDP[..3].SUBS_ON	r	Bool	TRUE/FALSE	0 = output of process values 1 = output of substitute values
FRDP[..3].ACK_REQ	r	Bool	TRUE/FALSE	1 = User acknowledgement required
FRDP[..3].SENDMODE	r	Bool	TRUE/FALSE	1 = F_CPU of the sender in deactivated safety operation

Table 8-8 Overview of DB 18 signals

Signal	r - read w - write	Type	Range of values	Remark
FRDP[..3].DIAG	r	Word	2#0000_0000_0000_0000 – 2#1110_0000_0111_0000	Bit 0–3: Reserved Bit 4: 1 = Timeout detected Bit 5: 1 = Sequence number error detected Bit 6: 1 = CRC error detected Bit 7–12: Reserved Bit 13: 1 = Discrepancies in the F telegram data (Telegram Discrepancy) Bit 14: 1 = Sign–of–life monitoring (LifeSign) Bit 15: 1 = Asynchronous fault state (StateFault)
FRDP[..3].RET-VAL14	r	Word		Error code of the SFC 14 (description of the error codes in the online help for SFC 14)
FRDP[..3].RET-VAL15	r	Word		Error code of the SFC 15 (description of the error codes in the online help for SFC 15)
User data				
MD 13312: $MN_SAFE_SPL_USER_DATA[0]=1h corresponds to DB18.DBX259.0 = 1 MD 13312: $MN_SAFE_SPL_USER_DATA[1]=2702H corresponds to DB18.DBX263.1 = 1 DB18.DBX262.0 = 1 DB18.DBX262.1 = 1 DB18.DBX262.2 = 1 DB18.DBX262.5 = 1				

8.7 System variables

8.7.1 System variables for SINUMERIK 840D sl

System variables

Table 8-9 Overview of system variables

System variables	Meaning	Range of values	Data type	Possible access for Part program r	Part program w	Synchronized action r	Synchronized action w
Actual position							
$VA_IS[axis]	Safe actual position for Safety Integrated	Axis identifier GEOAX CHANAX MACHAX SPINDLE	DOUBLE	x		x	
$AA_IM[axis]	Actual position of the closed-loop control	Axis identifier GEOAX CHANAX MACHAX SPINDLE	DOUBLE	x		x	
$VA_IM[axis]	Encoder actual value in the machine coordinate system	Axis identifier GEOAX CHANAX MACHAX SPINDLE	DOUBLE	x		x	
Internal inputs/outputs							
$A_INSI[n]	NCK input	n = 1, 2, ... 64 stand for the No. of the input	BOOL	x		x	
$A_INSID[n]	NCK inputs	n = 1,2	INT	x		x	
$A_INSIP[n]	Image, PLC input	n = 1,2, ...64	BOOL	x		x	
$A_INSIPD[n]	Image of the PLC - SPL inputs from the drive monitoring channel	n = 1,2	INT	x		x	
$A_OUTSI[n]	NCK output	n = 1, 2, ... 64 stand for the No. of the output	BOOL	x	x	x	x
$A_OUTSID[n]	NCK outputs	n = 1,2	INT	x	x	x	x
$A_OUTSIP[n]	Image, PLC output	n = 1, 2, ... 64	BOOL	x		x	
$A_OUTSIPD[n]	Image of the PLC - SPL outputs from the drive monitoring channel	n = 1,2	INT	x		x	
External inputs/outputs							
$A_INSE[n]	NCK input	n = 1, 2, ... 64 stands for the No. of the input 1)	BOOL	x		x	
$A_INSED[n]	NCK inputs	n = 1,2 1)	INT	x		x	

Table 8-9 Overview of system variables

				r	w	r	w
$A_INSEP[n]	Image of a PLC-SPL input from the PLC HW I/O	n = 1, 2, ... 64 stand for the No. of the input	BOOL	x		x	
$A_INSEPD[n]	Image of the PLC - SPL inputs from PLC HW I/O	n = 1,2	INT	x		x	
$A_OUTSE[n]	NCK output	n = 1, 2, ... 64 stands for the No. of the output 1)	BOOL	x	x	x	x
$A_OUTSED[n]	NCK outputs	n = 1,2 1)	INT	x	x	x	x
$A_OUTSEP[n]	Image of a PLC - SPL output from the PLC HW I/O	n = 1, 2, ... 64 stand for the No. of the output	BOOL	x		x	
$A_OUTSEPD[n]	Image of PLC - SPL outputs from PLC HW I/O	n = 1,2	INT	x		x	
Markers and timers							
$A_MARKERSI[n]	Markers	n = 1, 2, ... 64 stands for the No. of the marker	BOOL	x	x	x	x
$A_MARKERSID[n]	Markers	n = 1, 2	INT	x	x	x	x
$A_MARKERSIP[n]	Image of the PLC markers	n = 1,2, ...64	BOOL	x		x	
$A_MARKERSIPD[n]	Image of the PLC markers	n = 1, 2	INT	x		x	
$A_TIMERSI[n]	Timer	n = 1, 2...16 stand for the No. of the timer	REAL	x	x	x	x
F_SENDDP							
Inputs							
$A_FSDP_ERR_REAC[n]	Response when a communication error occurs	n = 1, 2, 3	INT	x	x	x	x
Outputs							
$A_FSDP_ERROR[n]	There is a communication error	n = 1, 2, 3	BOOL	x		x	
$A_FSDP_SUBS_ON[n]	Substitute values are output to the application at the F_RECVDP (receiver)	n = 1, 2, 3	BOOL	x		x	
$A_FSDP_DIAG[n]	The cause of the communication error determined by F_SENDDP is communicated	n = 1, 2, 3	INT	x		x	
$A_FSDP_RETVAL14	Error code of the SFC 14 (see online help for SFC14)	n = 1, 2, 3	WORD	x		x	
$A_FSDP_RETVAL15	Error code of the SFC 15 (see online help for SFC15)	n = 1, 2, 3	WORD	x		x	
F_RECVDP							
Inputs							
$A_FRDP_SUBS[n]	The substitute values that are output to the SPL in certain states are entered	n = 1, 2, 3	INT	x	x	x	x

Table 8-9 Overview of system variables

				r	w	r	w
$A_FRDP_ERR_REAC[n]	Response when a communication error occurs	n = 1, 2, 3	INT	x	x	x	x
$A_FRDP_ACK_REI[n]	Error-free F telegrams are again cyclically exchanged after a communication error	n = 1, 2, 3	BOOL	x	x	x	x
Outputs							
$A_FRDP_ERROR[n]	There is a communication error	n = 1, 2, 3	BOOL	x		x	
$A_FRDP_SUBS_ON[n]	Substitute values are output to the application	n = 1, 2, 3	BOOL	x		x	
$A_FRDP_ACK_REQ[n]	Error-free F telegrams are again cyclically exchanged after a communication error	n = 1, 2, 3	BOOL	x		x	
$A_FRDP_SENDMODE[n]	Actual operating mode of the F-CPU of the F_SENDDP communication partner	n = 1, 2, 3	BOOL	x		x	
$A_FRDP_DIAG[n]	The cause of the communication error determined by F_RECVDP is communicated	n = 1, 2, 3	INT	x		x	
$A_FRDP_RETVAL14	Error code of the SFC 14 (see online help for SFC14)		WORD	x		x	
$A_FRDP_RETVAL15	Error code of the SFC 15 (see online help for SFC15)		WORD	x		x	
Miscellaneous							
$A_STATSID	Crosswise data comparison error triggered if the value is not equal to 0	Bits 0...27 CDC error in the I/O signals or markers Bit 28 CDC error ”SPL protection status” Bit 29 timeout in the communications between NCK and SPL Bit 30 PLC signals a stop to the NCK	INT	x		x	
$A_CMDSI	10x change timer timeout value for long forced checking procedure pulses and/or single-channel test stop logic	Bit 0 = 1 10x time active	BOOL	x	x	x	x
$A_LEVELSID	CDC stack level display: Number of signals for which NCK and PLC detect different signal levels	0...320	INT	x		x	

Table 8-9 Overview of system variables

				r	w	r	w
$A_XFAULTSI	Bit 0=1: In a crosswise data comparison between NCK and drive of any particular safety axis, an actual value error was detected. Bit 1=1: In the crosswise data comparison between NCK and drive of any axis, an error was detected and the delay time (<>0) until STOP B is initiated for this axis is either running or has already expired.	[0,3]	INT	x		x	
$VA_XFAULTSI[axis]	Bit 0=1: The crosswise data comparison for this axis between NCK and drive has detected an actual value error Bit 1=1: In the crosswise data comparison between NCK and drive of this axis, an error was detected and the delay time (<>0) until STOP B is initiated for this axis is either running or has already expired.	[0,3]	INT	x		x	
$VA_STOPSI[axis]	Current Safety Integrated stop of the relevant axis -1: No stop 0: Stop A 1: Stop B 2: Stop C 3: Stop D 4: Stop E 5: Stop F 10: Test stop 11: Test, external pulse cancellation	[-1,11]	INT	x		x	
$A_STOPESI	Current Safety Integrated STOP E for any axis 0: No stop otherwise: For one of the axes, a Stop E is present	[0,MAX_INT]	INT	x		x	
$A_PLCSIIN[1...32]	Single-channel direct communication between NCK and PLC-SPL. Signals can be written by the PLC and read by the NCK.	[FALSE, TRUE]	BOOL	x		x	
$A_PLCSIOUT[1...32]	Single-channel direct communication between NCK and PLC-SPL. Signals can be read by the PLC, written and read by the NCK.	[FALSE, TRUE]	BOOL	x		x	

Table 8-9 Overview of system variables

				r	w	r	w
$AC_SAFE_SYNA_MEM	Free safety synchronized action elements	[0,MAX_INT]		x		x	

Note:

r -> read, w -> write
An implicit preliminary stop is generated
Only permitted in the commissioning phase

1) The number of these system variables depends on the option SI Basic or SI Comfort. For SI Basic, the following applies:
4 INSE[1..4]
4 OUTSE[1..4]
4 INSED[1]
4 OUTSED[1]

8.7.2 Description of the system variables

System variable $VA_IS

The safe actual value, used by SI, can be read and further processed by the NC part program for every axis/spindle.

Example:
When an NC part program is started, Safety Integrated checks whether axis X would move into the vicinity of shutdown limits as a result of the zero offsets when a program is processed. The part program can be programmed as follows, for example:

```
IF ($VA_IS[X] < 10000) GOTOF POS_OK           ; if the actual value is too high,
MESG (”Axis has nearly reached limit switch!”) ; then the following message,
POS_OK:                                        ; otherwise, continue here
...
```

The variable can also be used in synchronous actions in order to reduce the override when the axis is nearly at the limit switch.

Difference between $VA_IS and $AA_IM

Both variable $VA_IS and variable $AA_IM can be used to read actual values.

Table 8-10 Difference between $VA_IS and $AA_IM

Variable	Meaning
$VA_IS	Reading the actual value used by SI
$AA_IM	Reading the actual value used by the closed-loop control (setpoint for the closed-loop position control)

Reference: /PGA/, Programming Manual Job Planning

System variables $A_XFAULTSI and $VA_XFAULTSI

For crosswise data comparison errors between the NCK and SINAMICS S120, the response depends on the actual operating state:

- SBH, SG, SE, SN or $n<n_x$ synchronization active: A crosswise data comparison error causes a transition from Stop F to Stop B – which in turn initiates the fastest possible braking of the axis. A Stop A is then initiated and the pulse enable is cancelled.
- SBH, SG and $n<n_x$-synchronization not active and SE/SN is not used or Stop C/D/E already active: In this case, a Stop F due to a crosswise data comparison error does not result in any further action – only Alarm 27001 or 2710x is output that provides information. Processing then continues.

This chain of responses is not altered to ensure the appropriate level of safety for personnel.

To allow responses to a crosswise data comparison error, system variable $A_XFAULTSI is used to display that a crosswise data comparison error has occurred on a particular SI axis. Retraction can then be initiated as a response to this system variable.

Further, an axis-specific system variable $VA_XFAULTSI[<axis name>] has been introduced so that, if necessary, axis-specific responses can be applied.

The system variables are updated independent of whether SI monitoring functions are active or inactive.

$A_XFAULTSI

Information about Stop F for a safety axis:

Bit 0 = 1: In a crosswise data comparison between NCK and drive of any particular safety axis, an actual value error was detected.

Bit 1 = 1: In the crosswise data comparison between NCK and drive of any axis, an error was detected and the delay time until Stop B is initiated ($MA_SAFE_STOP_SWITCH_TIME_F) for this axis is either running or has already expired.

Note: The bit is only set if a delay not equal to 0 is configured.

$VA_XFAULTSI[X] (X = axis identifier)

Information about Safety Integrated Stop F for this axis

Bit 0 set: In the crosswise data comparison between NCK and drive an actual value error was detected.

Bit 1 set: In the crosswise data comparison between NCK and drive – an error was detected and the delay time □ up until a STOP B ($MA_SAFE_STOP_SWITCH_TIME_F) is initiated □ is either running or has expired.

Note: The bit is only set if a delay not equal to 0 is configured.

System variable $VA_STOPSI

Axial system variable that contains the present stop. For a value of 4, a Stop E is active for this axis.

System variable $A_STOPESI

Global system variable that with a value not equal to 0 indicates that a Stop E is active for one particular axis.

System variables $A_INSI[1...64]

The status signals of the NCK monitoring channel can be used in the NCK-SPL using these system variables. Each of the system variables $A_INSI[1...64] can be assigned any safety-related output signal or the AND logic operation of several signals using axial MD $MA_SAFE_xxx_OUTPUT. These system variables can only be read by the user program.

Parameterizing example:
- $MA_SAFE_CAM_PLUS_OUTPUT[0] = 04010101H
=> the SGA "SN1+" can be evaluated in the SPL using the system variable $A_INSI[1].

Programming example:

```
; Copying an SGA from the internal SPL interface into the external
SPL interface

N1010 IDS = 01 DO $A_OUTSE[1] = $A_INSI[1]
```

These system variables can only be read by the user program.

System variable $A_INSE[1...64]

The system variables $A_INSE contain the input circuit of the NCK-SPL.

System variables $A_INSED[1,2]

Image of the safety input signals (external NCK interface).

System variables $A_INSID[1,2]

The status signals of the NCK monitoring channel can be evaluated in the NCK-SPL in a double-word-serial fashion using this system variable:

$A_INSID[1] corresponds to $A_INSI[1...32]
$A_INSID[2] corresponds to $A_INSI[33...64]

These system variables can only be read by the user program.

System variables $A_OUTSE[1...64]

The system variables $A_OUTSE contain the outputs of the NCK-SPL.

System variables $A_OUTSI[1...64]

The control signals of the NCK monitoring channel can be addressed from the NCK-SPL using these system variables. Each of the system variables $A_OUTSI[1...64] can be simultaneously assigned any one or several safety-related input signals by using the axial MD $MA_SAFE_xxx_INPUT.

Parameterizing example:
- $MA_SAFE_VELO_SELECT_INPUT[0] = 04010204H
=> The SGE "SG selection, bit 0" is controlled in the SPL using the system variable $A_OUTSI[36].

Programming example:

```
; SGA ”cam 1+” (refer above) controls the SG selection
;
N1020 IDS = 02 DO $A_OUTSI[36] = $A_INSI[1]
```

These system variables can be read by the user program and written into by SAFE.SPF.

System variables $A_OUTSID[1,2]

The control signals of the NCK monitoring channel can be addressed in the NCK-SPL in a double-word-serial fashion using these system variables:

$A_OUTSID[1] corresponds to $A_OUTSI[1...32]
$A_OUTSID[2] corresponds to $A_OUTSI[33...64]

These system variables can be read by the user program and written into by SAFE.SPF.

System variables $A_OUTSED[1,2]

The external status signals can be addressed by the NCK-SPL in a double-word-serial fashion using these system variables:

$A_OUTSED[1] corresponds to $A_OUTSE[1...32]
$A_OUTSED[2] corresponds to $A_OUTSE[33...64]

These system variables can be read by the user program and written into by SAFE.SPF.

System variables $A_MARKERSI[1...64]

Up to 64 status bits of the SPL can be flagged using these system variables. The markers are read and written directly into the NCK-SPL.

Programming example:

```
N1030   IDS = 03 DO $A_MARKERSI[2] = $A_OUTSI[1] AND $A_INSE[2]
N1040   IDS = 04 DO $A_OUTSE[1] = $A_MARKERSI[2]
```

System variables $A_MARKERSID[1,2]

The SPL status bits can be addressed in a word-serial fashion using these system variables.

$A_MARKERSID[1] corresponds to $A_MARKERSI[1...32]
$A_MARKERSID[2] corresponds to $A_MARKERSI[33...64]

System variables $A_TIMERSI[1...16]

Up to sixteen timers can be programmed using these system variables.

Programming example:

```
; Set marker once after two seconds, reset the timer value and stop
the timer.
N1050 IDS = 05 WHENEVER $A_TIMERSI[1] > 2.0 DO
              $A_TIMERSI[1] = 0.0 $A_TIMERSI[1] = -1.0
              $A_MARKERSI[2] = 1
```

System variable $A_STATSID

This system variable can be using in the NCK-SPL to evaluate whether, in the crosswise data comparison between NCK and PLC, an error was detected in the two-channel control/processing of the control and status signals. This gives the user the opportunity to respond to this error with specific synchronous actions.

Bit 0... 27:	Crosswise data comparison error in the input/output signals or markers.
Bit 28:	Crosswise data comparison error "SPL protection status" (status $MN_PREVENT_SYNACT_LOCK not equal to DB18.DBX36.0).
Bit 29:	Time error in the communications between NCK and PLC (in 5 s, all ext. NCK-SPL outputs are set to zero, the PLC goes to stop).
Bit 30:	PLC signals a stop to the NCK.

Programming example:

```
; For a crosswise data comparison error, set ext. output
N1060 IDS = 06 WHENEVER $A_STATSID <> 0 DO $A_OUTSE[1] = 1
```

These system variables can only be read by the user program.

System variable $A_CMDSI[1]

This system variable can be used to increase the time up to 10 s monitoring the signal changes in the crosswise data comparison between NCK and PLC.

This means that signal differences between the NCK and PLC system variables can be tolerated for up to 10s without Alarm 27090 being output.

This system variable can be read and written into by the user program.

System variable $A_LEVELSID

This system variable is used to display the stack level of the signal change monitoring in the crosswise data comparison between NCK and PLC. This variable indicates the current number of signals to be checked by the crosswise data comparison function.

System variables $A_xxxP(D)

Images (mapping) of the PLC-SPL interface and markers are provided to make it easier to commission the SPL. The system variables are updated in the same clock cycle as the crosswise data comparison between the NCK and the PLC. These system variables can only be accessed reading.
These system variables may only be used in the commissioning phase.
As soon as commissioning has been signaled as completed, access to these system variables is blocked. If these program commands are processed, Alarm 17210 is output to indicate an error condition.

System variables $A_INSIP[1...64]

Images of the PLC-side internal SPL input signals (status signals from the drive monitoring channel) can be read using these system variables.

Associated DB18 values: DB18.DBX54.0 ... DBX61.7

System variables $A_INSIPD[1,2]

Images of the PLC-side internal SPL input signals (status signals from the drive monitoring channel) can be read in a double-word-serial fashion (32 bit) using these system variables.

Associated DB18 values: DB18.DBD54, DBD58

System variables $A_OUTSIP[1...64]

Images of the PLC-side internal SPL output signals (control signals to the drive monitoring channel) can be read using these system variables.

Associated DB18 values: DB18.DBX62.0 ... DBX69.7

System variables $A_OUTSIPD[1,2]

Images of the PLC-side internal SPL output signals (control signals to the drive monitoring channel) can be read in a double-word-serial fashion (32 bit) using these system variables.

Associated DB18 values: DB18.DBD62, DBD66

System variables $A_INSEP[1...64]

Images of the PLC-side external SPL input signals (control signals to the PLC-SPL) can be read using these system variables.

Associated DB18 values: DB18.DBX38.0 ... DBX45.7

System variables $A_INSEPD[1,2]

Images of the PLC-side external SPL input signals (control signals to the PLC-SPL) can be read in a double-word-serial fashion (32 bit) using these system variables.

Associated DB18 values: DB18.DBD38, DBD42

System variables $A_OUTSEP[1...64]

Images of the PLC-side external SPL output signals (status signals from the PLC-SPL) can be read using these system variables.

Associated DB18 values: DB18.DBX46.0 ... DBX53.7

System variables $A_OUTSEPD[1,2]

Images of the PLC-side external SPL output signals (status signals from the PLC-SPL) can be read in a double-word-serial fashion (32 bit) using these system variables.

Associated DB18 values: DB18.DBD46, DBD50

System variables $A_MARKERSIP[1..64]

Images of the PLC-side SPL markers can be read using these system variables.

Associated DB18 values: DB18.DBX70.0 ... DBX77.7

System variables $A_MARKERSIPD[1,2]

Images of the PLC-side SPL markers can be read in a double-word-serial fashion (32 bit) using these system variables.

Associated DB18 values: DB18.DBD70, DBD74

System variable $A_PLCSIIN[1..32]

Single-channel direct communication between NCK and PLC-SPL. Signals can be written by the PLC and read by the NCK.

System variable $A_PLCSIOUT[1..32]

Single-channel direct communication between NCK and PLC-SPL. Signals can be read by the PLC and read and written by the NCK.

System variable $AC_SAFE_SYNA_MEM

Variable $AC_SAFE_SYNA_MEM contains the number of free synchronizing action elements Safety Integrated. The number before and after SAFE.SPF has run is read in order to determine the value of the required elements. The difference between the two values is then the number that (with a safety margin) must be entered into machine data $MC_MM_NUM_SAFE_SYNC_ELEMENTS.

System variable $A_FSDP_ERR_REAC

The response when a communication error occurs is set using the system variable. Depending on the actual interdependency of the two plant/system components involved, the response to a communication error, caused by a communication path error or by consciously switching off one the plant/system components can be specifically entered.

0 = Alarm 27350 + Stop D/E
1 = Alarm 27350
2 = Alarm 27351 (only display, self-clearing)
3 = No system response

Note
The user interface is set in all cases:
$A_FSDP_ERROR = 1
$A_FSDP_SUBS_ON = 1
$A_FSDP_DIAG corresponding to the detected communication error

Whether initiated as fault response Stop D or Stop E, can be parameterized using:
NCK: $MN_SAFE_SPL_STOP_MODE
PLC: DB18.DBX36.1

Default value: After the control boots, initially, the values saved in MD $MN_SAFE_SDP_ERR_REAC become active.

System variable $A_FSDP_ERROR

The system variable is used to indicate that there is a communication error. The error cause determined by F_SENDDP is contained in the diagnostics data $A_FSDP_DIAG.
0 = Normal operation
1 = Communication error

System variable $A_FSDP_SUBS_ON

The system variable is used to indicate that substitute values are output to the application at F_RECVDP (receiver).
0 = output of process values
1 = output of substitute values

System variable $A_FSDP_DIAG

The system variable is used to indicate the cause of the communication error determined by F_SENDDP.
Bit 0 – 3: Reserved
Bit 4: 1 = Timeout detected
Bit 5: 1 = Sequence number error detected
Bit 6: 1 = CRC error detected
Bit 7 – 12: Reserved
Bit 13: 1 = Discrepancy in the F telegram data (TelegramDiscrepancy)
Bit 14: 1 = Sign-of-life monitoring (LifeSign)
Bit 15: 1 = Asynchronous fault state (StateFault)

System variable $A_FRDP_SUBS

Substitute values that are output to the SPL in the following states are entered using the system variable:
– start of cyclic communication
– communication error
Changes to the substitute values always become effective in the next F_DP clock cycle, even during a fault situation.

Default value: After the control boots, initially, the values saved in MD $MN_SAFE_RDP_SUBS become active.

System variable $A_FRDP_ERR_REAC

The response when a communication error occurs is set using the system variable. Depending on the actual interdependently of the two plant/system components involved, the response to a communication error, caused by a communication path error or by consciously switching off one the plant/system components can be specifically entered.

0 = Alarm 27350 + Stop D/E
1 = Alarm 27350
2 = Alarm 27351 (only display, self-clearing)
3 = No system response

Note
The user interface is set in all cases:
$A_FSDP_ERROR = 1
$A_FRDP_SUBS_ON = 1
$A_FRDP_DIAG corresponding to the detected communication error

SPL inputs $A_INSE correspondingly to $A_FRDP_SUBS

Whether initiated as fault response Stop D or Stop E, can be parameterized using:
NCK: $MN_SAFE_SPL_STOP_MODE
PLC: DB18.DBX36.1

Default value: After the control boots, initially, the values saved in MD $MN_SAFE_SDP_ERR_REAC become active.

System variable $A_FRDP_ERROR

The system variable is used to indicate that there is a communication error. The error cause determined by F_RECVDP is contained in the diagnostics data $A_FRDP_DIAG.
0 = Normal operation
1 = Communication error

System variable $A_FRDP_SUBS_ON

The system variable is used to indicate that substitute values are output to the application.
0 = output of process values
1 = output of substitute values

System variable $A_FRDP_ACK_REQ

The system variable is used to signal that after a communication error, cyclic F telegrams are again cyclically exchanged error-free - and to acknowledge the error and to output the process values, a user acknowledgement is still required via the interface signal DB18.FRDP_ACK_REI or a channel_1 reset.

System variable $A_FRDP_DIAG

The system variable is used to indicate the cause of the communication error determined by F_RECVDP.
Bit 0 - 3: Reserved
Bit 4: 1 = Timeout detected
Bit 5: 1 = Sequence number error detected
Bit 6: 1 = CRC error detected
Bit 7 - 12: Reserved
Bit 13: 1 = Discrepancies in the F telegram data (TelegramDiscrepancy)
Bit 14: 1 = Sign-of-life monitoring (LifeSign)
Bit 15: 1 = Asynchronous fault state (StateFault)

System variable $A_FRDP_SENDMODE

The system variable is used to indicate the actual operating mode of the F-CPU of the F_SENDDP communication partner:
1: The F-CPU is in the deactivated safety mode
0: The F-CPU is in the safety mode

Note
For SINUMERIK 840D sl, the deactivated safety mode corresponds to the SPL commissioning mode ($MN_PREVENT_SYNACT_LOCK == 0 or DB18.DBX36.0 == 0).

Note

Write access operations to all named system variables are only possible from the program saved in program file /_N_CST_DIR/_N_SAFE_SPF reserved for the SPL. Access operations from other programs are flagged as an error with Alarm 17070.

Space for your notes

Commissioning 9

Note

Not all of the HMI functions shown are available in all of the HMI versions (HMI Embedded, SINUMERIK Operate, HMI Advanced).

Warning

After hardware and/or software components have been changed or replaced, it is only permissible to boot the system and activate the drives when the protective devices are closed. Personnel must not be present in the danger zone.

Depending on the change or replacement, it may be necessary to carry out a new, partial or complete acceptance test (refer to Chapter 9.5 Acceptance report).
Before persons may re-enter the hazardous area, the drives should be tested to ensure that they exhibit stable behavior by briefly moving them in both the plus and minus directions (+/-).
This is especially important specifically for high-speed linear or torque motors.

Note

The function ”safe software limit switch” (SE) is also called ”safe limit positions” and the function ”safe software cams” (SN) is also called ”safe cams”.

Warning

If SI functions SH, SBH or SG have been enabled, then they become operational after the control system has booted (basic display on screen). For the SE and SN functions safety-related position evaluation is only possible after safety-related referencing has been successfully completed.

Warning

Protection of operating personnel must be the primary consideration when configuring machine data for SINUMERIK Safety Integrated. This is this reason that the parameterizable tolerances, limit values and delay times should be determined and optimized during the commissioning phase dependent on the machine design and arrangement.

9.1 HMI screens and softkeys

Configuring safety-related functions

When selecting ”Commissioning/NC/Safety-Integrated” you reach the starting screen for the Safety Integrated commissioning support. The following screen 9-1 is displayed:

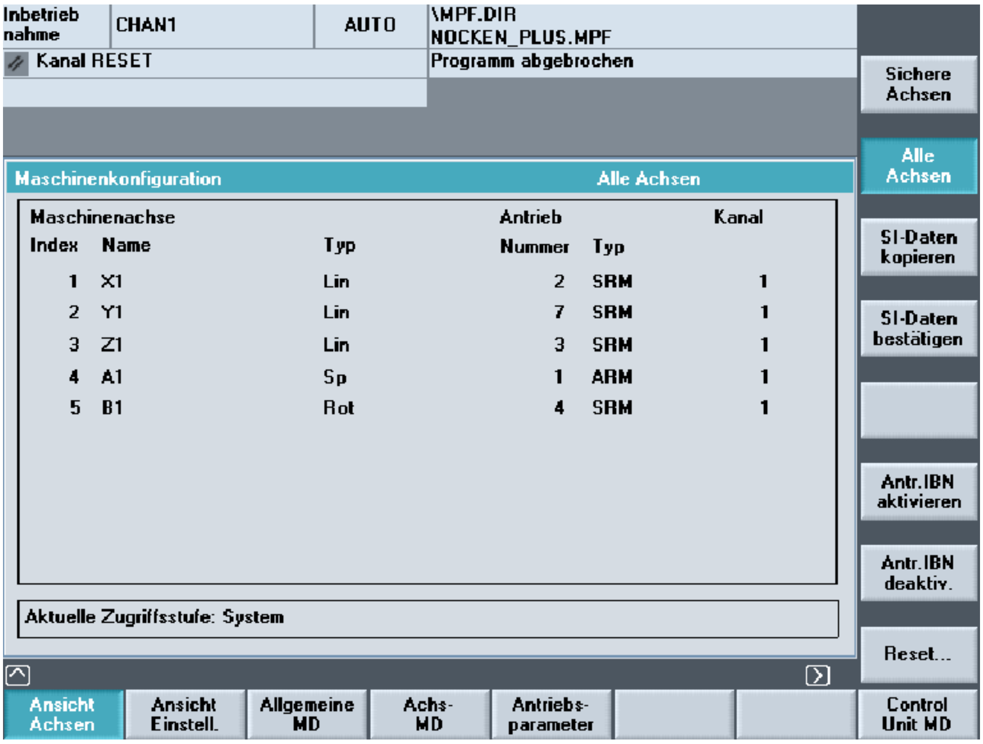

Fig. 9-1 Example for ”Commissioning/NC/Safety-Integrated” for 840D sl

View of the axes (horizontal softkey)

Softkey ”safe axes”

All of the axes are listed in this screen that were activated for Safety Integrated.

Softkey ”All axes”

Here, defined axes are listed independent of whether it involves a safety axis or not.

Softkey ”Copy SI data”

When the softkey is pressed, all NC machine data, relevant for the SI functions, is transferred into the corresponding drive parameters.

The SI machine data/parameters to define the encoder mounting arrangement must be separately entered for the NCK and drive by the commissioning engineer. The copy function has no effect for the drive parameters marked in the Table 8-2 ”Parameters for SINAMICS S120”.
Drive data is automatically saved after data has been copied. The data is saved for all safety axes.

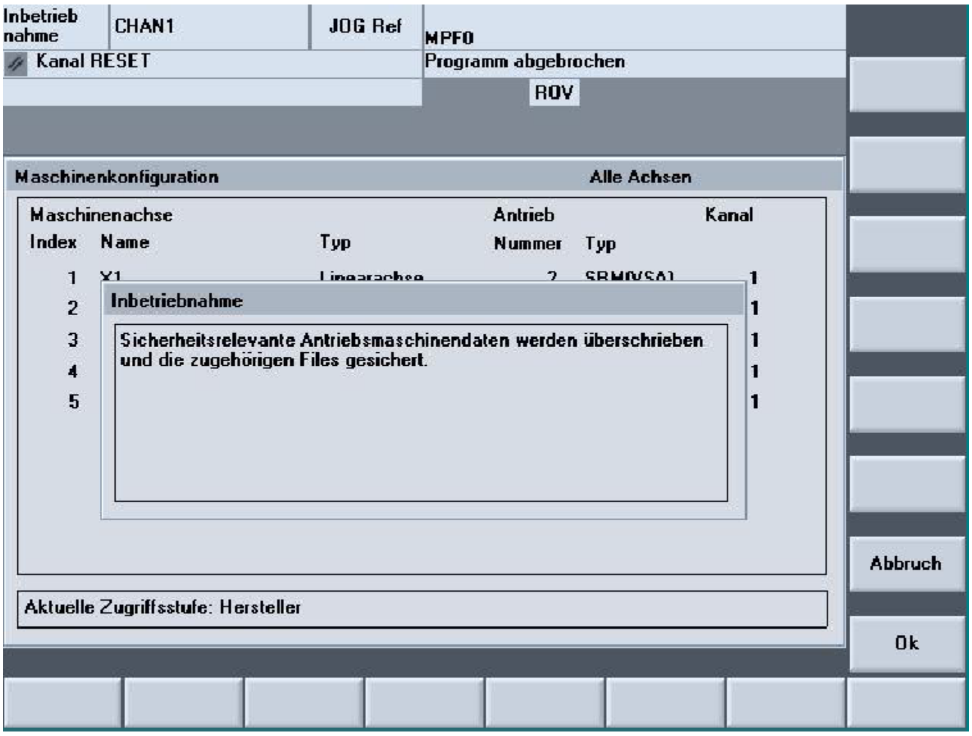

Fig. 9-2 Softkey Copy SI data for 840D sl

<u>Softkey ”Confirm SI data”</u>

After an drive/NCK RESET, the actual checksum is saved by pressing the softkey Confirm SI data in the ”Commissioning/NC/Safety-Integrated” screen and acknowledging the following dialog box with ”OK”. From now on, SI data will be monitored for any changes. Drive data is automatically saved after data has been acknowledged.

Note

If the copy or confirm process is initiated in the screen form ”Axis MD”, the particular operation is only carried out for the currently selected axis.

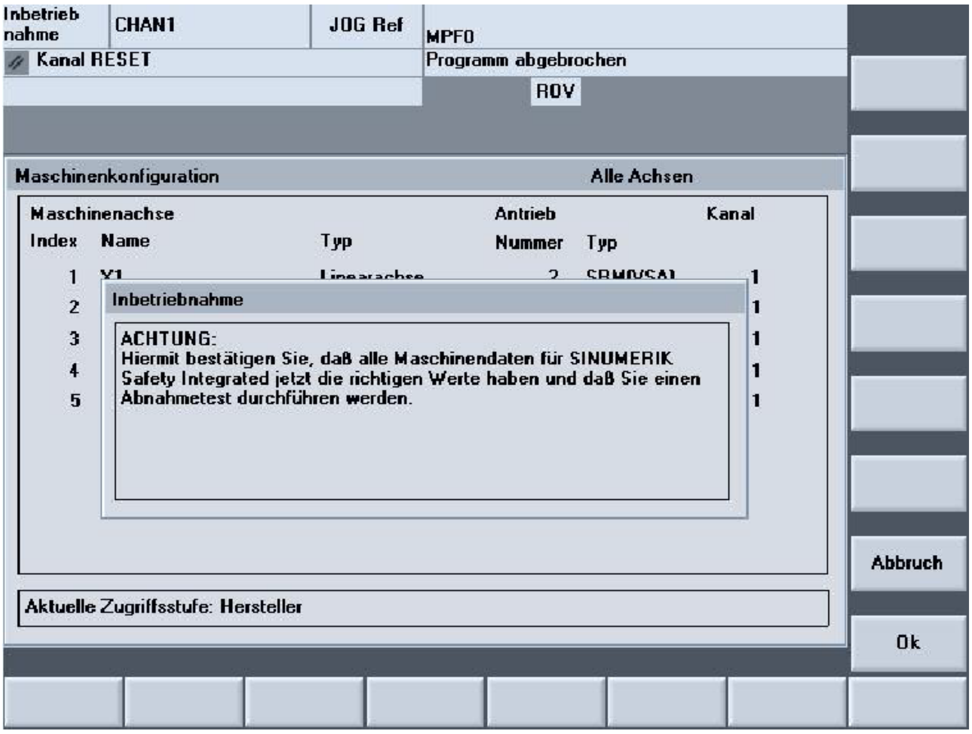

Fig. 9-3 Softkey ”Confirm SI data” for 840D sl

Softkey ”Activate drive commissioning”

Value ”95” is entered in drive parameter p0010 to commission the SI drives. Further, the dialog box to pre-assign the drive PROFIsafe address is started.

Pre-assigning the drive PROFIsafe address

The pre-assignment of the SI PROFIsafe addresses is activated if the user presses the "Activate drive commissioning" softkey.

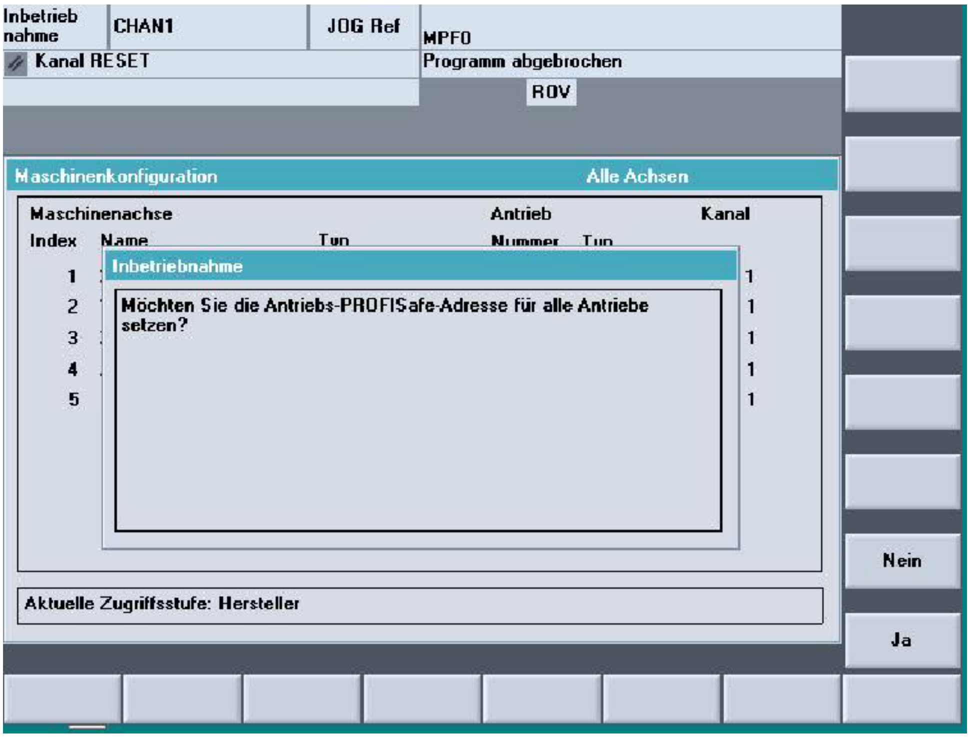

Fig. 9-4 Pre-assigning a drive PROFIsafe address for 840D sl

The operation can be rejected or accepted using the "Yes", "No" softkeys. When agreeing, already existing settings of parameter p9810 are overwritten. When rejected, the existing setting are kept. After this, the system switches to the SI commissioning mode (p0010=95).

Softkey "De-activate drive commissioning"

A value of "0" is entered into drive parameter p0010 to commission SI drives; this exits the drive commissioning state. Using softkeys, the user can select as to whether the drive data should be saved.

Softkey "Drive / Reset..."

The drives are RESET and then a power on is carried out for the NCK.

Safety-Integrated settings (horizontal softkey: ”View settings”)

Softkey ”Display SBH/SG (starting screen)

The configured values for SBH and the SG stages are displayed in the Fig. 9-5. You can scroll between the SI axes using the softkeys ”Axis+” and ”Axis–”. The configured values for SE and SN positions can be displayed using the softkeys ”Display safe end positions” and ”Display safe cams”.

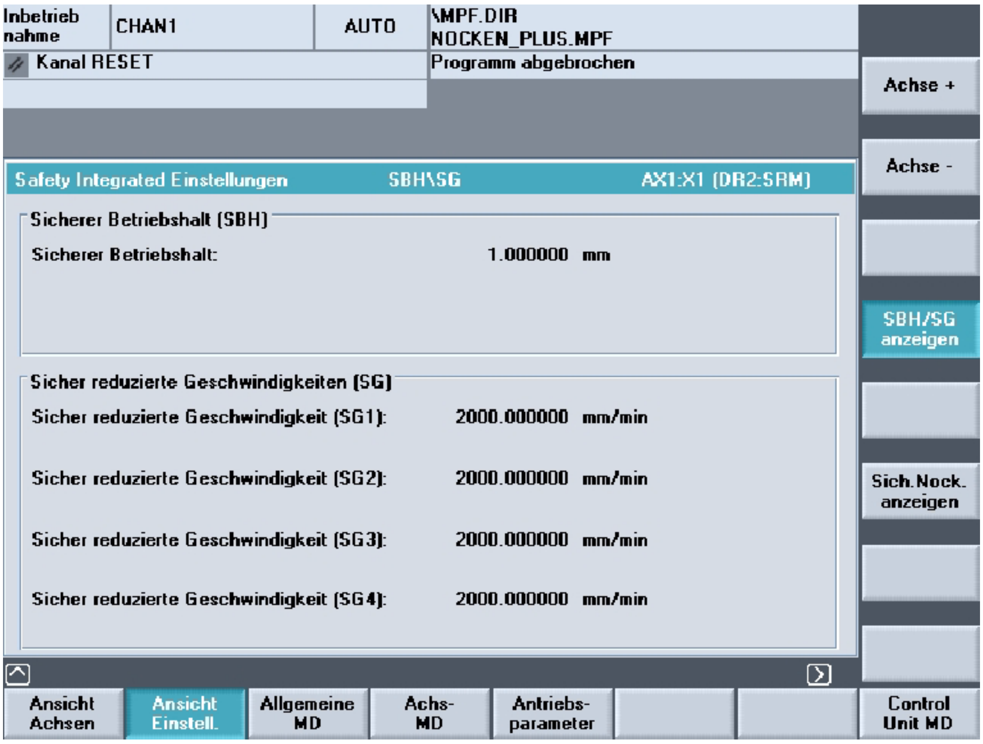

Fig. 9-5 Softkey Display SBH/SG for 840D sl

Safe software cams / safe cam track (SN)

"Display safe cam" softkey

For the safe software cams function (SN) this softkey is used to display the safe cams as well as the cam track.

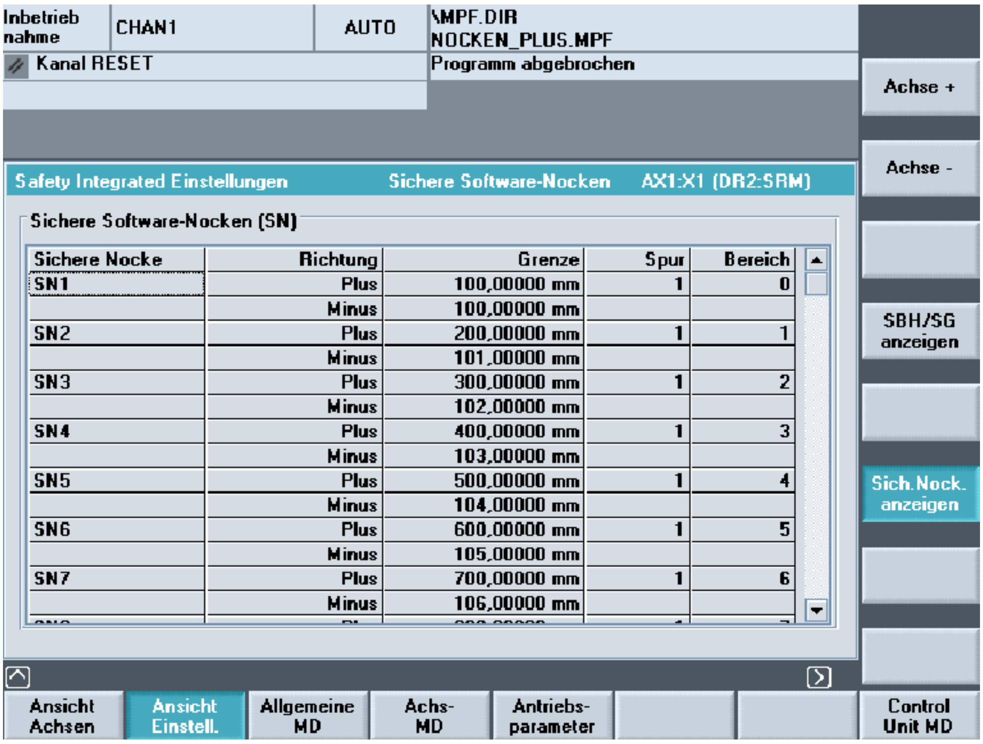

Fig. 9-6 "Display safe cams" softkey for 840D sl

Displaying the Safety MD and selected MD on a split screen

Using the softkey ”MD selection”, ”SI-MD” and ”SI + MD selection”, it is possible to toggle between selected machine data relevant to SI, SI machine data, and a window split in two – in which both SI data as well as also selected machine data can be displayed.

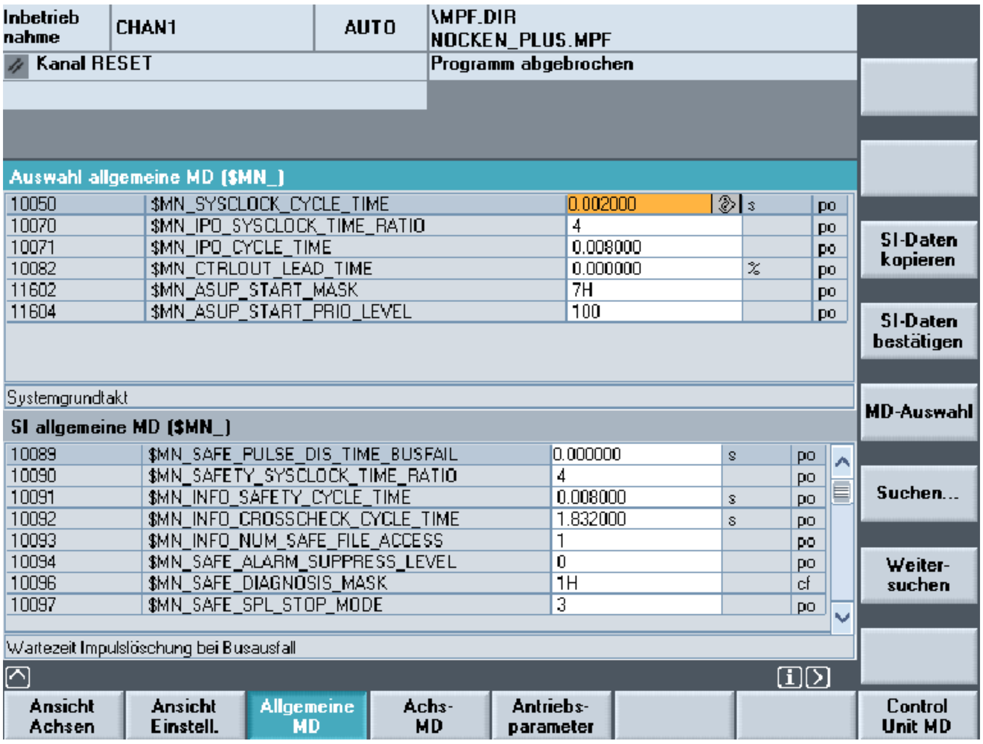

Fig. 9-7 Softkey ”General MD” for 840D sl

<u>General MD</u>

The general machine data is listed here and can be changed.

<u>Axis MD</u>

The axis machine data are listed here and can be changed.

<u>Drive parameters</u>

The drive parameters are listed here and can be changed.

<u>Control Unit MD</u>

The Control Unit parameters are listed here and can be changed.

Creating Safety Integrated machine data

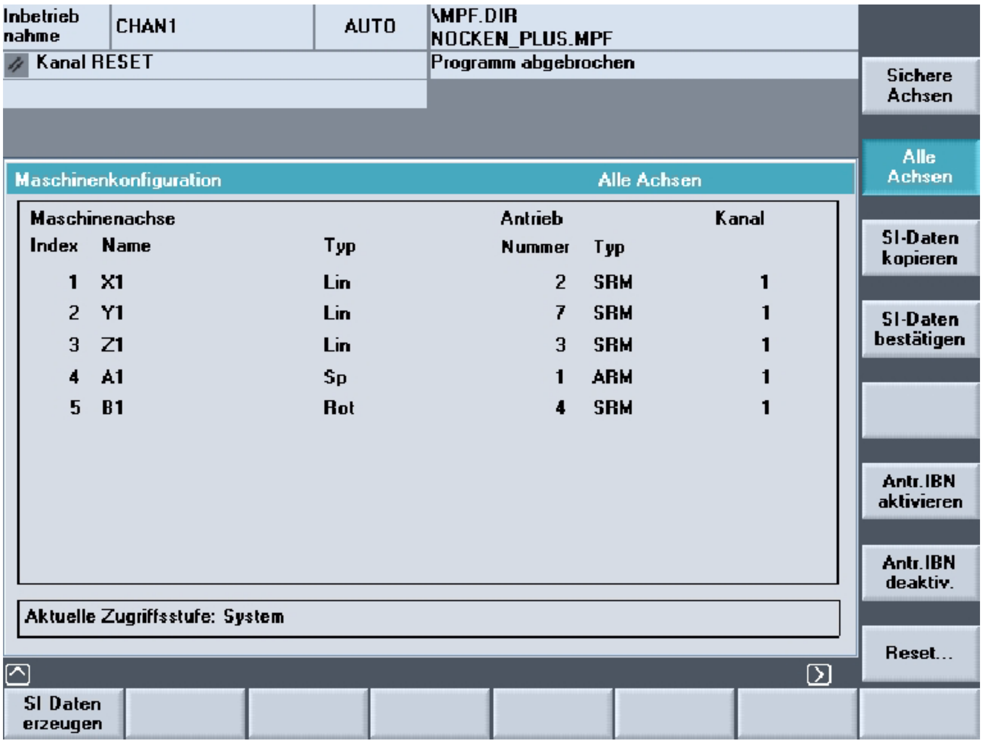

Fig. 9-8 Softkey ”Creating SI data” for 840D sl

Using the softkey ”Create SI data” it is possible to carry out the following parameterization:

- SI encoder adaptation
- Calculate safe acceleration monitoring (SBR)

SI encoder adaptation

A list is created comparing the actual values of the relevant MD and Safety MD. Using the softkey ”SI drive parameters”, the display can be changed over to the corresponding drive parameters.

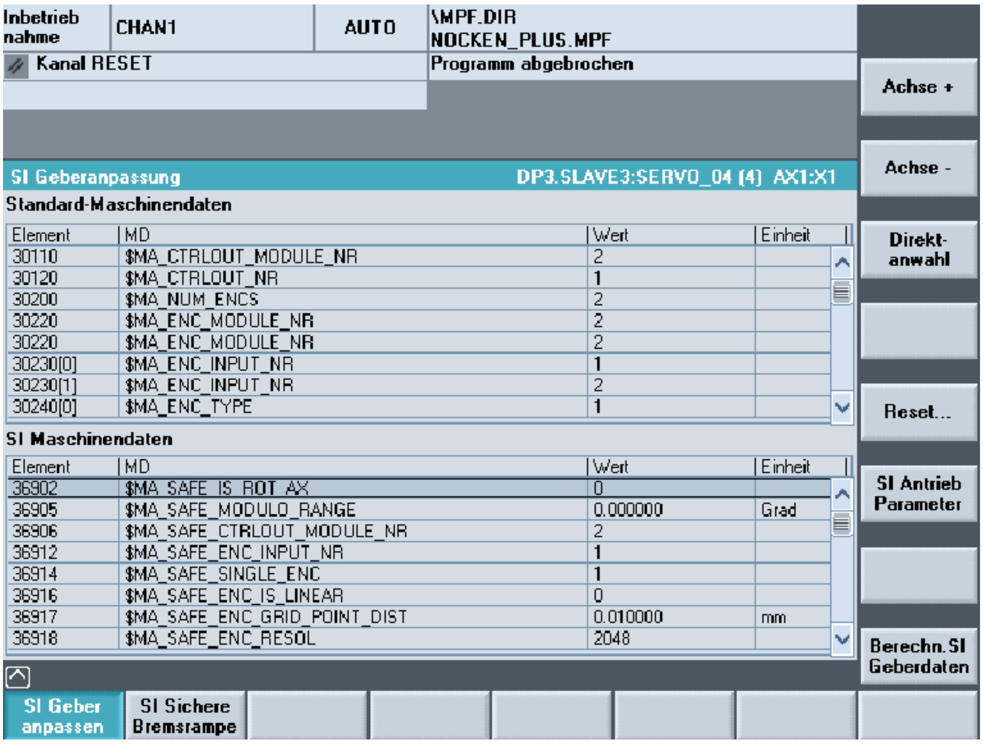

Fig. 9-9 Softkey ”SI encoder adaptation” for 840D sl

By pressing the softkey ”Calculate SI encoder data”, a parameterizing recommendation for the Safety MD and parameters is determined and displayed. Further, a list that shows the actual values of the corresponding machine data is created.

When configuring two encoders, the following rules apply:

- The first encoder is always the encoder for the drive
- The second encoder is always the encoder for the NCK
- $MA_ENC_INPUT_NR[0]=1
- $MA_ENC_INPUT_NR[1]=2

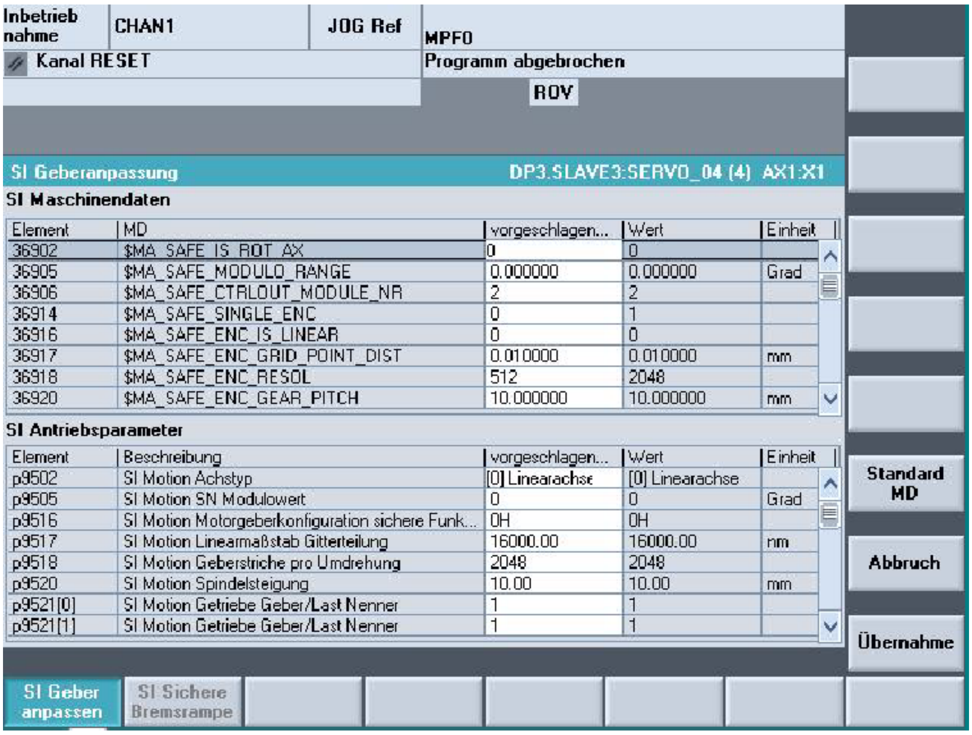

Fig. 9-10 Defining ”SI encoder adaptation” for 840D sl

The list is transferred into the corresponding SI machine data and SINAMICS parameters using the softkey ”Accept”. They are rejected with ”Abort”. The user can also adapt the values that have been determined.

The settings must be saved using the softkey ”Confirm SI data” (see e.g. Fig.9-8).

The axis assignment is described in Chapter 9.2 ”Procedure when commissioning the system for the first time” under Step 3.

SI safe acceleration monitoring (SBR)

Using the softkey ”SI safe acceleration monitoring”, a window is displayed with the actual settings for the axis and the associated drive.

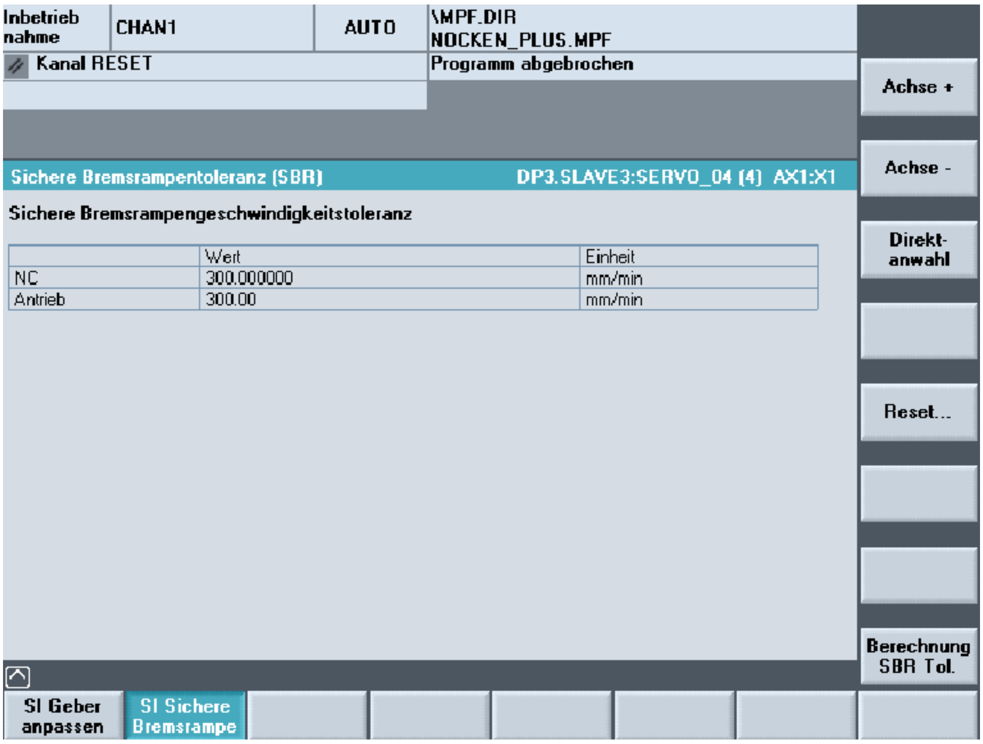

Fig. 9-11 SI safe acceleration monitoring for 840D sl

The softkey ”Calculate SBR tol.” leads to the window where a decision can be made whether the calculation of the tolerance of the safe acceleration monitoring can be agreed (”Accept” softkey) or the operation is cancelled (”Abort” softkey). Also here, the user can adapt the recommendation.

The settings must be saved using the softkey ”Confirm SI data” (see e.g. Fig.9-8).

The equations from Chapter 6.4 ”Safe acceleration monitoring (SBR)” are used as basis to calculate the SBR tolerance. A tolerance of 20% is added to the value determined in this fashion.

With ”Accept”, the calculated value for the safe acceleration monitoring is accepted in machine data 36948: $MA_SAFE_STOP_VELO_TOL and Parameter p9548: SI Motion SBR.

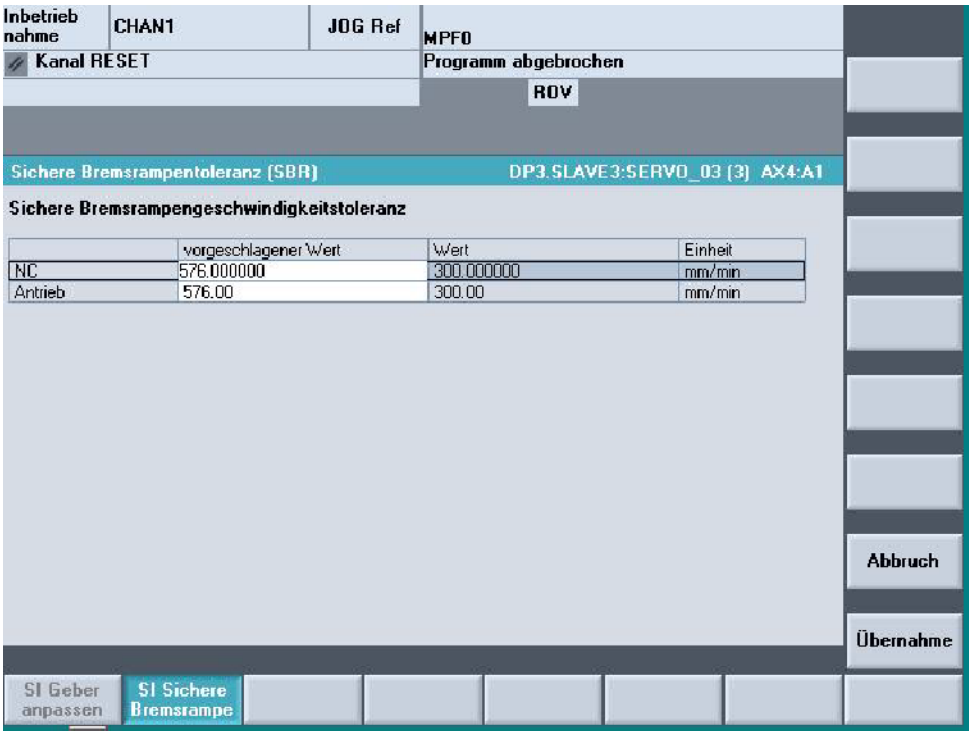

Fig. 9-12 SI safe acceleration monitoring for 840D sl

9.2 Procedure when commissioning the drive for the first time

This Chapter describes the steps that are necessary to commission the safety functions integrated in the system. For the safety functions integrated in the system, the ”safe standstill” (SH) safety function integrated in the drive can also be used. This is the reason that a minimum configuration of the safety functions integrated in the drive is always necessary. The SH function itself does not have to be enabled, but possibly a required brake control (SBC) must be parameterized.

Commissioning SH/SBC/SS1 via the terminal control is described in detail in Chapter 4 ”Safety Functions Integrated in the Drive”.

It is advisable to commission the machine so that at least the axes can be moved. The safety monitoring functions can then be immediately tested after SI data has been entered. This type of test is absolutely essential in order to detect any data entry errors.

The following steps must be taken in the specified sequence to commission SI functions:

Note

If only the SH, SBC and SS1 functions are used, then commissioning is carried out as described in the Chapter 4.7 ”Commissioning the SH, SBC and SS1 functions”.

Warning

From SINAMICS SW2.5 and higher, the following applies:
In a system configuration, the firmware versions of the DRIVE-CLiQ components can only differ from the versions on the CF card, if either

a) the automatic upgrade/downgrade (parameter p7826) is deactivated, or
b) components with a new firmware version can no longer be downgraded to the status of the version available on the CF card.

Case a) is not permitted when Safety Integrated is used. The automatic upgrade/downgrade must never be disabled when Safety Integrated is used. (automatic firmware update (p7826) must be equal to 1)

Case b) is only permissible if this combination has been explicitly approved by the manufacturer.

Step 1:

Enable option

- Starting screen ”Commissioning/NC/Safety-Integrated”: Set the password (at least the machine manufacturer password)
- ”General machine data” screen:
  Set the options

Step 2:

Commissioning PROFIsafe (Chapter 7.2.5 ”Parameterizing PROFIsafe communications (NCK)”) and the associated PROFIsafe I/O.

Commissioning safety-related CPU-CPU communication (F_DP communication) (Chapter 7.4.1 ”Configuring and parameterizing F_DP communication”)

Commissioning the safety programmable logic (Chapter 7.5.5 ”Starting the SPL”).

Step 3:

In the screen ”Axis-specific machine data” set the function enable bits (MD 36901: $MA_SAFE_FUNCTION_ENABLE and MD 36902: $MA_SAFE_IS_ROT_AX) of all axes for which the safety-related motion monitoring functions are to be used. Enter the monitoring clock cycle and check.

- ”General machine data” screen:
  Enter the factor for the monitoring clock cycle in data $MN_SAFETY_SYSCLOCK_TIME_RATIO (see Chapter 5.1”Monitoring clock cycle” and Chapter 5.2 ”Crosswise data comparison”).
- The actual monitoring time is immediately displayed in data $MN_INFO_SAFETY_CYCLE_TIME.

Note

Before the next NCK RESET is initiated, you must copy the actual monitoring clock cycle to parameter p9500 ”SI motion monitoring clock cycle” of the drive using softkey ”Copy SI data” in the ”Drive configuration” screen.

Notes the axis assignment

Note

The drives must be assigned to the axis due to the degrees of freedom that exist for the PROFIdrive telegram configuring - also in the SI machine data.
This is the reason that the recommendations when configuring the drive configuration also apply when configuring Safety Integrated:

- Using the standard configuration and the recommended logical basis addresses in STEP7.
- No re-parameterization of the selected list of drive objects in drive parameter p0978.

Under these prerequisites, the following cases can occur:

a) If the drive assignment using machine data MD 30110: $MA_CTRLOUT_MODULE_NR, MD 30220: $MA_ENC_MODULE_NR[0/1] and MD 13050: $MN_DRIVE_LOGIC_ADDRESS was left at the standard value, then also the drive assignment in MD 36906: $MA_SAFE_CTRLOUT_MODULE_NR and MD 10393: $MN_SAFE_DRIVE_LOGIC_ADDRESS must not changed.

b) If the drive assignment was changed using the machine data MD 30110: $MA_CTRLOUT_MODULE_NR and MD 30220: $MA_ENC_MODULE_NR[0/1], then MD 36906: $MA_SAFE_CTRLOUT_MODULE_NR should be parameterized to the same value as for MD 30110: $MA_CTRLOUT_MODULE_NR

c) If the drive assignment was realized by interchanging the logical drive addresses in MD 13050: $MN_DRIVE_LOGIC_ADDRESS, then the same marshalling should also be made in MD 10393: $MN_SAFE_DRIVE_LOGIC_ADDRESS.
Example: Drive 1 and 2 were exchanged by interchanging index 0 and 1 of MD 13050. MD 13050[0] was parameterized to 4140 and MD 13050[1] was parameterized to 4100. Then, Index 0 and 1 of MD 10393 must also be interchanged, i.e. 10393[0] must be set to 6724 and MD 10393[1] must be set to 6700.

The user is provided with support when assigning axes under the HMI path "Commissioning/Drive system/Drive units/PROFIBUS connection".

Step 4:

Commissioning the SH/SBC/SS1 functions integrated in the drive.

Note

The parameters of the safety functions integrated in the drive have their own password protection that is however de-activated before commissioning.
In the SINUMERIK environment we recommend that this password protection is not activated as the complete commissioning area is password protected.
The procedure to change the SI password is described in Chapter 4.7.2 ”Procedure when commissioning SH, SBC and SS1”

- In the drive, the SI commissioning mode must be selected. If an attempt is made to change the SI parameters integrated in the drive without being in the commissioning mode, then the drive rejects this with a message. A prerequisite for the commissioning mode is that the pulses have been cancelled for all of the drives. For all drives, the commissioning mode is selected using the softkey ”Activate drive commissioning” in the screen ”Safety Integrated”. When pressing this softkey, from the HMI, 95 is written into every drive parameter p0010, if:
  - in the associated NC axis in MD 36901: $MA_SAFE_FUNCTION_ENABLE has a value not equal to 0, or
  - in drive parameter p9501: ”SI enable safety-related functions” there is a value not equal to 0.
- Using the softkey ”Activate drive commissioning”, the user can also preset the PROFIsafe addresses using parameter p9810: SI PROFIsafe address (Motor Module).
- Parameterize the functions integrated in the drive in the ”Drive machine data” screen. These especially include:
  - Function enable SBC (p9602/p9802)
  - Forced checking procedure timer p9659 = 9000 when using Safety Sinumerik

  also possibly
  - PROFIsafe address, if it hasn’t already been set using the softkey ”Activate drive commissioning”
  - CRC via the parameters integrated in the drive (this is also realized using the softkey ”Deactivate drive commissioning”, see the next point)
- Setting the CRC and saving the parameterization that was just made is simultaneously carried-out for all drives using the softkey ”Deactivate drive commissioning”.

Step 5:

Set the monitoring function for all of the axes to be safely monitored.

Enter the following in the specified sequence in the ”axis-specific machine data” screen:

1. Axis characteristics (rotary or linear axis)
2. Measuring-circuit assignment, i.e. which encoder will supply the safety actual value, what are the characteristics of this encoder and how it is mechanically mounted.
3. Monitoring limit values and tolerances
4. Changeover and monitoring times
5. Stop responses after a monitoring function has responded
6. Assignment of safety-relevant inputs and outputs, i.e. which sources are supplying the control signals for the NC monitoring channel and where do the feedback signals go (for the drive monitoring channel, this logical assignment must be programmed in the PLC, i.e. there are no corresponding drive parameters).

Step 6:

Set the monitoring and save the data for all of the associated drives.
Here, almost all data entered under Step 6 are again entered in the ”Drive machine data” screen. When the softkey ”Copy SI data” in the ”Safety Integrated” screen is pressed, the settings from Step 5 are automatically entered, with the exception of Points 2 and 6. Point 2 cannot be copied because the drive always operates with the motor encoder and for a two-encoder system, has other characteristic data than the encoder evaluated from the NC. The 6th point is not applicable on the drive side. The following operating steps are therefore involved:

1. Press the softkey ”Copy SI data” in the screen ”Safety Integrated”.
2. For each drive, enter the encoder configuration using the softkey ”Adapt SI encoder”. At the same time, the data, copied under Point 1 in Step 6 can be subject to a visual check.
3. Initiate an NCK and drive reset using the appropriate softkey. In this case, component IDs are also transferred from the drive to the NCK.
4. Press the softkey ”Acknowledge SI data” in the ”Drive configuration” screen.
   A dialog box describing the function of the softkey then appears: After acknowledging with ”OK”, the actual checksum of the safety-related data is then saved in both monitoring channels and monitored for changes from this point onwards. Further, drive data is automatically saved in a non-volatile fashion.
5. A dialog box is displayed on the screen requesting you to perform an acceptance test. You must acknowledge this dialog box. Now carry out the NCK reset and drive reset that are listed.
6. Activate SPL protection.

Step 7:

Issue a user agreement (see Chapter 5.4.4, ”User agreement”)

- The safe limit positions and safe cams are now activated (provided that they have been enabled, refer to Chapter 5.5, ”Enabling safety-related functions”). This step can be omitted if you do not wish to use either of these functions.
- The key-operated switch must be set to position 3 in order to issue a user agreement.

Step 8:

Carry out the acceptance test and enter in the logbook.

- All of the safety functions that have been enabled must be tested. For suggestions on how to test activated SI functions, please refer to Chapter 9.5.2, ”Acceptance test” and 9.5 ”Acceptance report”.
- The parameterization of all PROFIsafe I/O components should be checked using a function test and checking the printout of the hardware configuration from SIMATIC Step 7.

Step 9:

- Save all machine data using the ”Services” area. This data can be used to commission series equipment.
- Save (back-up) the complete SIMATIC Step 7 project.

Warning

After the acceptance test has been completed, all illegal (old) MD files must be removed from the Flashcard (to avoid confusion between old and new data). Data that corresponds to the acceptance test data must be backed-up (archived).

Step 10:

Delete (clear) the password in order to prevent the unauthorized change of machine data.

9.3 Standard commissioning

The setting for the safety monitoring functions is automatically transferred with other data in the course of a normal series commissioning process. The following steps need to be taken in addition to the normal commissioning procedure:

1. Enter a user agreement
2. Carry out an acceptance test

Sequence of operations for series commissioning

The following sequence of operations is recommended when commissioning series equipment:

- Download the data set for the series machine into the control.
- Adjust the absolute encoder.
- Carry out a POWER ON.
  This ensures that any errors – i.e. deviations in the data content that may exist between the NCK and drive – will be detected by the checksum check and crosswise data comparison.
  Data must be checked if an error is detected. Cross check errors on the hardware-related cross checksums (Alarm 27035, message F01680 with ID 2) or Alarm 27032 are normal if the series commissioning data come from another machine. These errors can be removed using the ”Confirm SI-HW” softkey (see Chapter 9.6 ”Motor replacement or encoder replacement”).
  If an error no longer occurs, then data has not been changed and is identical to the acceptance test data. The copy function may be used if data is subsequently altered.
- Carry out random function tests.
  The tests are required for acceptance of the new machine.

Software/hardware upgrade

Warning

Please carefully read the instructions in the relevant Update Manual before updating the software.

Warning

From SINAMICS SW2.5 and higher, the following applies:
In a system configuration, the firmware versions of the DRIVE-CLiQ components can only differ from the versions on the CF card, if either

a) the automatic upgrade/downgrade (parameter p7826) is deactivated, or
b) components with a new firmware version can no longer be downgraded to the status of the version available on the CF card.

Case a) is not permitted when Safety Integrated is used. The automatic upgrade/downgrade must never be disabled when Safety Integrated is used. (automatic firmware update (p7826) must be equal to 1)

Case b) is only permissible if this combination has been explicitly approved by the manufacturer.

9.4 Changing machine data

The user must enter the correct password before he can change the machine data for SI functions to the system. After data for SI functions has been altered, a new acceptance test must be carried out on the SI function(s) involved and then recorded and confirmed in the acceptance report.

Change report

Changes made to NCK machine data important for Safety Integrated are recorded in a display data. The time that the change is made is displayed in

an axis MD 36996: $MA_SAFE_CONFIG_CHANGE_DATE[0...6] and

an NCK-MD 13316: $MN_SAFE_GLOB_CFG_CHANGE_DATE[0...6].

This MD can neither be overwritten by manual entry nor by loading an MD archive. The only way to delete this MD is to boot the control from the general reset mode (service switch position 1).

This data is updated when the following changes are made to the NCK machine data:

- A modified safety MD configuration is activated
  (NCK-Safety-MD have been changed and acknowledged by correction of $MA_SAFE_DES_CHECKSUM or $MN_SAFE_GLOB_DES_CHECKSUM).
  Changes, depending on the modified MD context (axial MD or NCK-MD), are listed in MD $MN_SAFE_GLOB_CONFIG_CHANGE_DATE or in MD $MA_SAFE_CONFIG_CHANGE_DATE.

- Changes in the S7 configuration regarding PROFIsafe-relevant parameters. These are all of the values that go into the PROFIsafe CRC1 (e.g. PROFIsafe source and target address, PROFIsafe monitoring time). Changes are listed in MD $MN_SAFE_GLOB_CONFIG_CHANGE_DATE.
- When MD $MA_SAFE_FUNCTION_ENABLE is changed from values not equal to zero to zero, or from zero to values not equal to zero. These changes mean that the safety functionality of an axis is completely enabled/disabled. Changes are listed in MD $MN_SAFE_CONFIG_CHANGE_DATE.

  Other changes to MD $MA_SAFE_FUNCTION_ENABLE (selecting/deselecting individual safety functions) always change MD $MA_SAFE_ACT_CHECKSUM, which themselves have to be acknowledged by changes to MD $MA_SAFE_DES_CHECKSUM. Changes are listed in MD $MA_SAFE_CONFIG_CHANGE_DATE.
- When MD $MA_SAFE_FUNCTION_ENABLE is changed by reducing the safety option. If the scope of axial safety functions is enabled for more axes than are set in the safety option data, the function enable for the excess number of axes is automatically cancelled again when the control boots. This deletion is noted in MD $MA_SAFE_CONFIG_CHANGE_DATE. This procedure is associated with the initiation of alarm 8041 "Axis %1: MD %2 reset, the associated option is not sufficient" This alarm disappears at the next power on, however the entry in MD $MA_SAFE_CONFIG_CHANGE_DATE is kept.
- Loading an MD archive that is different to the currently active NCK-MD set.
- When upgrading (corresponds to downloading an MD archive)
- Series commissioning (corresponds to downloading an MD archive)

Supplementary conditions

Changes to the MD configuration are only noted when the change becomes active, i.e. after altering MD $MA_SAFE_DES_CHECKSUM / $MN_SAFE_GLOB_DES_CHECKSUM and a subsequent power on.

When a commissioning archive is downloaded, then in a first step, a change is noted in the change history. If the currently active safety configuration is saved in this commissioning archive (=> effectively no change to the safety configuration), then the change that was previously entered is withdrawn. This is realized by copying the data $MA_SAFE_CONFIG_CHANGE_DATE[1] to [0], [2] to [1], [3] to [2], [4] to [3], [5] to [4], [6] to [5]. Is entered into $MA_SAFE_CONFIG_CHANGE_DATE[6] as date "00/00/0000 00:00:00". The same is true for the entries in MD $MN_SAFE_GLOB_CONFIG_CHANGE_DATE.

9.5 Acceptance test

9.5.1 General information

The requirements associated with an acceptance test can be derived from the EU Machinery Directive. Accordingly, the machine manufacturer (OEM) is responsible for the following:

- to carry out an acceptance test for safety-related functions and machine parts, and
- to issue an "Acceptance certificate" that includes the results of the test.

When using the Safety Integrated function, the acceptance test is used to check the correct configuring of the SI monitoring functions used in the NCK, PLC and drive. The test objective is to verify proper implementation of the defined safety functions, to check test mechanisms (forced checking procedure measures) and to examine the response of individual monitoring functions by specifically violating tolerance limits. This should be carried out for all safety functions, i.e. for the axial monitoring functions, the SPL, the safety-related communication relationships, the safety-related I/O etc.

Warning

The acceptance test is used to check that the safety functions have been correctly parameterized. Using the acceptance test, potential configuring errors are to be identified and the correct configuring documented.
The measured values (e.g. distance, time) and the system behavior determined (e.g. initiating a specific stop) when carrying out the acceptance test are used to check the plausibility of the configured safety functions. The measured values that are determined are typical and are not worst-case values. They represent the behavior of the machine at the time of measurement. The measurements cannot be used to derive maximum distances for over-travel.

Warning

If machine data for SI functions is changed, a new acceptance test must be carried out for the modified SI function and recorded in the acceptance report.

Note

The acceptance test should also be carried out for the PROFIsafe I/O.

Information regarding carrying out the acceptance test

- Some of the standard NC monitoring functions, such as zero speed monitoring, software limit switches, etc. must be de-activated (monitoring limits must be made less sensitive) before the acceptance test is carried out.
  The function sequences can be acquired and listed using the servo trace function or using the D/A converter output.
- After the SPL has been commissioned the access authorization for the NCK-SPL (SAFE.SPF) via the HMI interface must be reduced to the manufacturer or service level and documented in the acceptance report.
- Please refer to the information in Chapter 9.2, "Procedure when commissioning for the first time".
- The acceptance report comprises checking the alarm displays and including the alarm reports in the overall acceptance report. In order to obtain reproducible and comparable alarm displays, during the acceptance test, MD 10094: $MN_SAFE_ALARM_SUPPRESS_LEVEL must be set to 0 in order to avoid suppressing alarm outputs.
- For SINUMERIK 840D sl, to document a test stop that has been carried out, it is sufficient to just log the test stop alarms of the NCK (27002); it is not absolutely necessary to log the test stop alarms of the SINAMICS S120 (C01798).

SINAMICS firmware versions

For SINUMERIK software releases 1.3 and 1.4/2.4, different firmware versions of the components involved in the safety functions (NCU, NX, Motor Modules, Sensor Modules, DRIVE-CLiQ motor) can be combined without having to adapt the firmware versions.
From SINUMERIK software release 1.5/2.5 and higher, the following applies:
The firmware versions of the Motor Modules, Sensor Modules and DRIVE-CLiQ motors involved in the safety functions (these include integrated Sensor Modules) must be adapted to the SINAMICS firmware version of the NCU. This is performed automatically when booting if parameter p7826 (firmware, automatic) is set to 1 (default setting). When Safety Integrated is used, parameter p7826 (firmware, automatic) must be set to 1 and must not be re-parameterized. During the acceptance test for Safety Integrated, the safety firmware versions of **<u>all</u>** of the Motor Modules, Sensors Modules and DRIVE-CLiQ motors involved in the safety functions should be read out, logged and checked against the following list.
http://support.automation.siemens.com/WW/view/en/28554461

Every line in the table represents a permissible combination of safety firmware versions.

Authorized person, acceptance report

The test of each SI function must be carried out by an authorized person and logged in the acceptance report. The report must be signed by the person who carried out the acceptance tests. The acceptance test report must be kept in the logbook of the particular machine.

An authorized person in the above sense is a person authorized by the machine manufacturer who on account of his or her technical qualifications and knowledge of the safety functions has the necessary skill sets to perform the acceptance test in the correct manner.

Documentation, data archiving

The results of the acceptance test as well as all hardware and software changes as shown in the table 9-1 should be documented in a suitable form.

In addition to the acceptance report, the following SI relevant data must be archived:
NC machine data
Drive parameters
PLC/NCK-SPL program
PLC project

Necessity of an acceptance test

A full acceptance test (as described in this Chapter) must always be carried out when the functionality of Safety Integrated is commissioned for the first time on a machine.

Extended safety-related functionality, transferring the commissioned software to additional series machines, modifications to the hardware, software upgrades, changes within the scope of modular machine concepts etc. make it necessary to carry out the acceptance test - possibly with a reduced test scope.

In order to define a partial acceptance test it is first necessary to describe the individual parts of the acceptance test and then define logical groups that represent the components of the acceptance test. The assignment of the safety-relevant machine data and parameters to difference CRCs support this grouping (e.g. to support modular machine concepts).

Content of the complete acceptance test

1) DOCUMENTATION

Documentation of the machine and of safety functions

1.1 Machine description (with overview)

1.2 Details about the control system

1.3 Configuration diagram

1.4 Function table
Active monitoring functions depending on the operating mode, the protective doors and other sensors/CPU-CPU communication
Ideally, this table should be the objective and result of the configuring work.

1.5 SI functions per axis

1.6 Information about safety equipment

2) FUNCTION TEST PART 1
General function check incl. checking the wiring/programming/configuring

2.1 Test of the shutdown paths
(check the forced checking procedure of the shutdown paths)

2.2 Test of the external stop

2.3 Test of the brake control

2.4 Test the forced dormant error detection procedure of the inputs and outputs

2.5 Test of the emergency stop function and of safety circuits

2.6 Test all SPL switching states and associated input/output signals

2.7 Test the PROFIsafe input/output signals

3) FUNCTION TEST PART 2
Detailed function test incl. checking the values of the individual SI functions used

3.1 Test the SI function safe operating stop □SBH
(in each case with evaluated measurement diagram and measured values)

3.2 Test the SI function safely reduced speed □SG
(in each case with evaluated measurement diagram and measured values)

3.3 Test the SI function safety-related output $n < n_x$
(in each case with evaluated measurement diagram and measured values)

3.4 Test the SI function safe limit positions □SE
(in each case with evaluated measurement diagram and measured values)

3.5 Test the SI function safe cams □SN
(check using the diagnostics display or assigned SGAs or with the evaluated measuring diagrams and measured values)

3.6 If necessary, test the SI function external stops
(in each case with evaluated measurement diagram and measured values)

3.7 Test the SI function SBC/SBT
(in each case with evaluated measurement diagram or measured values/PROFIsafe I/O)

4) Additional measures

4.1 Function test actual value acquisition
  a. General check of the actual value acquisition
    - After the replacement, first switch on and brief operation with traversing in both directions.

Warning

During this process, all personnel must keep out of the danger area.

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  b. Checking the safety actual value acquisition
    - When the motion monitoring functions are activated, briefly move the drive in both directions.

4.2 Check the SGE/SGA signals of the relevant module

4.3 When changing the acceleration behavior/jerk axis-specific tests of the Function test Part 2

4.4 Test the new safety functionality

4.5 Check the checksums and software versions, compare whether check sums and software versions are identical, with the reference machine. Hardware checksum 36998[1] is always different from that of the reference machine.

5) COMPLETING THE REPORT

A report of the commissioning status that was checked is generated with the appropriate counter-signatures

5.1 Check the SI machine data

5.2 Check the hardware configuration of the PROFIsafe I/O

5.3 Check the NCK and SINAMICS software releases

5.4 Log of the checksums (axis MD / SPL / PROFIsafe I/O)

5.5 Completing the NCK commissioning (protect synchronous actions)

5.6 Completion of the PLC commissioning

5.7 Verify the data backup

5.8 Countersignature

APPENDIX

- Reports/measurement records for FUNCTION TEST PART 1/2
- Alarm logs/servotrace measurements (only for a conventional acceptance test)
- Archive the following SI-relevant data:
  - NC machine data
  - Drive parameters
  - PLC/NCK-SPL program
  - PLC project

Note

The template in the toolbox is only a recommendation.

An electronic template for the acceptance report is available:

- in the toolbox for SINUMERIK 840D sl
- on DOConCD for SINUMERIK 840D sl
- on the service CD for SINUMERIK 840D sl

The acceptance report is divided into the following sections:

- Plant/system description
- Description of the safety functions
- Test of safety functions

Effect of the acceptance test for specific measures

Table 9-1 Scope of the acceptance test depending on specific measures

Measure	Documentation	Function test Part 1	Function test Part 2	Supplementary measures	Report completion
Replacement of the encoder system (refer to Chap. 9.6)	Supplement, hardware data	No	No	Item 4.1	Supplement, possibly new checksums and counter-signature
Replace an SMC, SME module (refer to Chap. 9.6)	Supplement, hardware data/ software version data	No	No	Item 4.1	Supplement to the new checksums and countersignature
Replace a motor with DRIVE-CLiQ (refer to Chap. 9.6)	Supplement, hardware data/ software version data	No	No	Item 4.1	Supplement to the new checksums and countersignature
Replacing the Motor Module	Supplement, hardware data/ software version data	Yes, only point 2.1 and 2.2	No	Item 4.1	Countersignature
Replacing the NCU hardware	Supplement, hardware data/ software version data	Yes	No	Item 4.1	Countersignature
Replacing the NX Hardware	Supplement, hardware data/ software version data	Yes, only points 2.1, 2.2 and 2.3	No	Point 4.1, only for axes controlled by the NX	Countersignature
Hardware replacement, PROFIsafe I/O	Possibly supplement hardware data	No	No	Item 4.2	Countersignature

Table 9-1 Scope of the acceptance test depending on specific measures

Measure	Documentation	Function test Part 1	Function test Part 2	Supplementary measures	Report completion
Change system clock cycle (SI clock cycle changes)	Supplement configuration data	No	Yes	No	Supplement to the new checksum and countersignature
Changed system clock cycle (SI clock cycle, IPO remains the same)	Supplement configuration data	No	Yes	No	Countersignature
Changed IPO clock cycle (checksum NCK 0 changes)	Supplement configuration data	No	Yes	No	Supplement to the new checksum and countersignature
Changed monitoring clock cycle	Supplement configuration data	No	Yes	No	Supplement to the new checksum and countersignature
Changed PROFIsafe clock cycle	Supplement configuration data	Yes, only Point 2.7	No	No	Supplement to the new checksum and countersignature
Changed drive assignment	Adapt configuration diagram	Yes, only Point 2.6	No	Item 4.1	Supplement to the new checksum and countersignature
Changed SAFE_USER_DATA	Supplement, SI function per axis, function table	Yes, only for the tests influenced by the function expansion	Yes, only for the tests influenced by the function expansion	No	Supplement to the new checksum and countersignature
Reconfigured PROFIsafe I/O in S7	Supplement configuration data	No	No	Item 4.2	Point 2.1, supplement the new checksum and countersignature
Changed within the scope of "modular PROFIsafe"	Supplement configuration diagram and function table	Yes, only point 2.6 and 2.7	No	No	Supplement to the new checksum and countersignature
Changed within the scope of "F_SEND/ F_RECEIVE	Supplement configuration diagram and function table	Yes, only point 2.6 and 2.7	No	No	Supplement to the new checksum and countersignature
Software upgrade Update [2] (NCU/drive/ PLC)	Supplement software version	No [1)]	No [1)]	Item 4.3	Supplement, possibly new checksums and counter-signature

Table 9-1 Scope of the acceptance test depending on specific measures

Measure	Documentation	Function test Part 1	Function test Part 2	Supplementary measures	Report completion
Software upgrade Upgrade [3] (NCU/drive/PLC)	Supplement software version	No [1)]	Yes, for axes with modified drive checksum [1, 4]	Points 4.3 and 4.4	Supplement, possibly new checksums and counter-signature
Software upgrade (HMI)	Supplement software version	No	No	No	No
An individual limit value has been changed (e.g. SG limit)	Supplement, SI function per axis	No	Yes, only test the corresponding function	No	Supplement to the new checksum and countersignature
Function expanded (e.g. additional actuator, additional SG stage)	Supplement, SI function per axis, function table	Yes, only for the tests influenced by the function expansion	Yes, only for the tests influenced by the function expansion	No	Supplement to the new checksum and countersignature
SPL change	Supplement, SI function per axis, function table	Yes, only Point 2.6	No	No	Supplement to the new checksum and countersignature
Data transferred to additional machines with series commissioning	Possibly supplement, machine description (check the SW version)	Yes	No	Points 4.1, 4.3 and 4.5	Supplement to the new checksum and countersignature

[1] Regarding the acceptance test, the notes in the documentation of the SW upgrade must be carefully observed.

[2] An update involves an update to a new Service Pack (SP) or a new Hotfix (HF) within a software line, e.g. 02.05.01.03 (01 = Service Pack; 03 = Hotfix) to 02.05.02.03 (does not take into account any change of the Safety functionality).

[3] An upgrade involves an upgrade to a new software release, e.g. 02.05.xx.xx to 02.06.xx.xx or 02.xx.xx.xx. to 03.xx.xx.xx (does not take into account any change of the Safety functionality).

[4] If **no** drive checksums have changed, then a complete function test, Part 2 does not have to be performed. However, a test should be performed with reduced testing scope.

Test with reduced test scope

Test of Safety Integrated functions at any axis (each NCU and each NX) and a comparison with the test results before the upgrade.

Note:

If the results of function test, Part 2 are taken from another identical machine, then this is the sole responsibility of the machine manufacturer and should be appropriately commented in the acceptance report.

9.5.2 Conventional acceptance test

Procedure of the conventional acceptance test

Safety function	Test initiated by	Function checked using	Represented using
Forced dormant error detection of the switch-off signal paths	Test stop initiated e.g. by reducing the test stop time or separate key	Alarm log	27002 axis Test stop running C01798 test stop running (this is not absolutely required)
	Switching operations at the SGE/SGA	Diagnosis view	Diagnostics screen SI status
		Servo trace SGE/SGA	Decoded using servo trace bit graphics
Sequence of the test stop routine for external stops	Test stop initiated e.g. by reducing the test stop time or separate key	Servo trace SGE/SGA	De-coded using servo trace bit graphics
		Diagnosis view	Diagnostics screen SI status
		Drive interface PLC	Trace Sinucom NC trace
Forced checking procedure of the input/output peripherals (e.g. Emergency Stop)	Test stop initiated e.g. by reducing the test stop time or separate key	Disconnect the feedback signal contacts or jumper an SPL input	User error message Stop D is initiated
Configuring/hardware configuration of the PROFIsafe I/O	SPL	Diagnostic displays, behavior of the SPL and I/O terminals, printout of the hardware configuration from SIMATIC Step 7	Printout of the hardware configuration from SIMATIC Step 7
Test the safety-related functions (according to the function table)	Use the safety-related sensors	Diagnosis view	Diagnostics screen SI status
Safe operating stop (SBH)	Exceed the SBH limit by setting MD 36933 to 0% operating mode, JOG traversing keys	Servo trace: (actual speed, active encoder / and actual value, active encoder)	the marker functionality of the servo trace
Safely reduced speed (SG)	Exceed the SG limit by setting MD 36933 to 0% operating mode, JOG traversing keys	Servo trace: (actual speed, active encoder / and actual value, active encoder)	the marker functionality of the servo trace

Safety function	Test initiated by	Function checked using	Represented using
SGA ”n < n_x”	Exceed the speed n_x	Servo trace: (SGE/SGA and actual speed, active encoder)	the marker functionality of the servo trace De-coded using bit graphics Trace Sinucom NC trace
Safe software limit switches (SE)	Pass the positive and negative limit switches Change the SW limit switch	Servo trace: (actual speed, active encoder / and actual value, active encoder)	the marker functionality of the servo trace
Safe software cams (SN)	Pass individual cam positions	Servo trace (SGE/SGA) Diagnosis view Drive interface PLC	the marker functionality of the servo trace De-coding using bit graphics Trace Sinucom NC trace
SBC / SBT	Test stop initiated e.g. by reducing the test stop time or separate key	Servo trace: (actual value active encoder, torque)	
F_DP communication	F_DP communication interrupted e.g. by withdrawing the PROFIBUS/ PROFINET connector Switching operations at the SGE/SGA	Diagnosis view	

Recommendation to measure the stopping distance/speed increase for the acceptance test

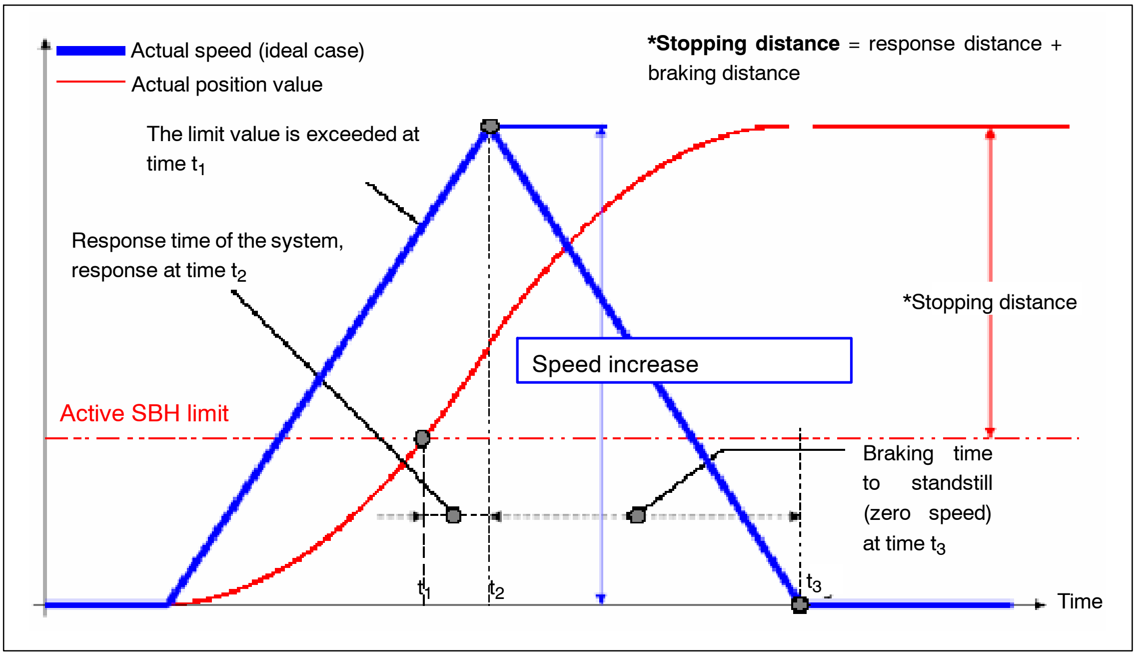

Fig. 9-13 Exceeding SBH

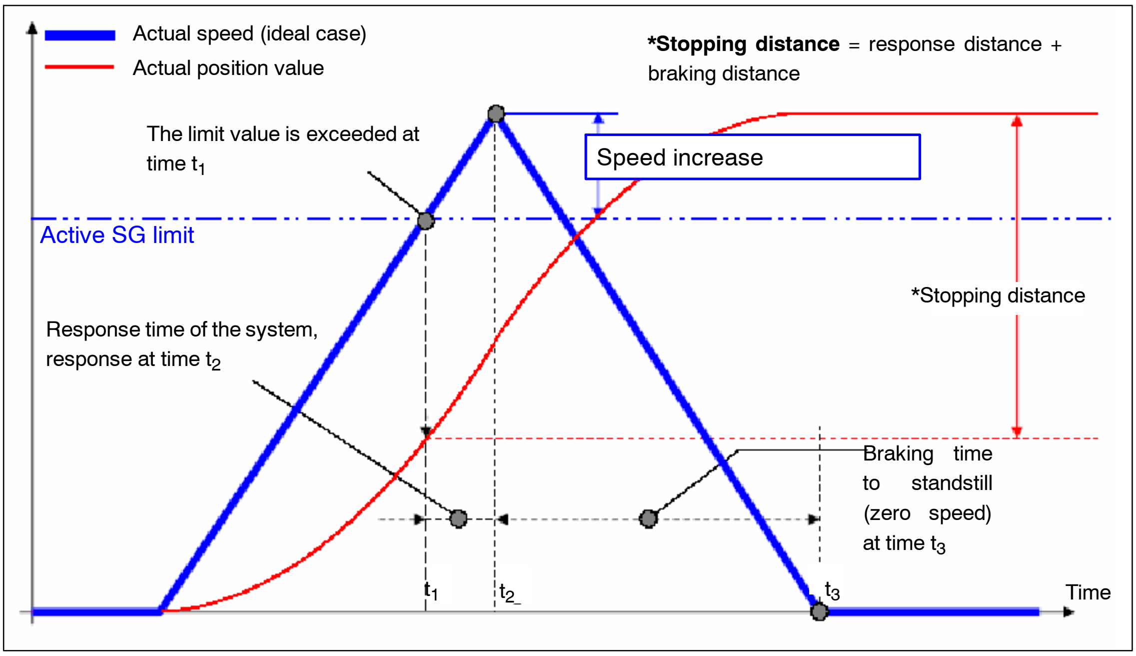

Fig. 9-14 Exceeding SG

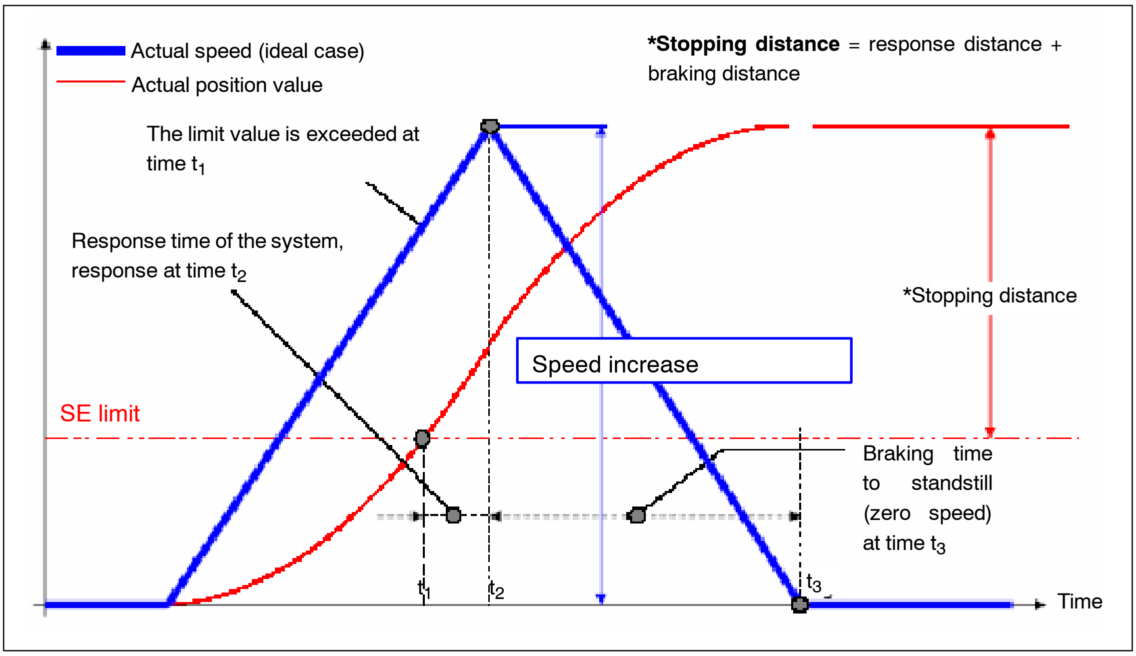

Fig. 9-15 Exceeding SE

9.5.3 Acceptance test support

In order to make it easier to carry out the acceptance test and standardize this, there is the function "Acceptance test support" in the SinuCom NC commissioning tool".

The objective of this acceptance support is to control the creation and administration of an acceptance report and prepare and carry out the required test steps using the appropriate operator actions via the operator interface. The test steps that are required as part of the acceptance test are not completely automatically executed but are controlled by a skilled operator. This operator must carry out the measures, associated with the test step, at the system being tested. The acceptance test support provides the following:

- Support when documenting the active monitoring functions and monitoring limit values by reading out the appropriate machine data.
- Support when documenting the checksum values.
- Standardization of the procedure when carrying out the test, following a pre-defined test list.
- The time and resources required for testing are reduced by preparing test procedures within the system, automatic trace and evaluation techniques and it takes less time to acknowledge SI alarms that are output.

Software prerequisites

The acceptance test report function is based on the interaction between the NCK/ drive and the SinuCom NC operator interface. This means that if this function is used, these components must have a certain minimum software version.

SinuCom NC software	Version 7.2 SP1
NCU system software	Version 1.3

The basic functionality of the SinuCom NC software is explained within the scope of its own documentation. This documentation also provides information about the steps when handling the acceptance test support function, a description of the screen forms and the menu prompting. This is the reason that this is not handled in this documentation.

Reference: Commissioning/Service Tool SINUMERIK SinuCom NC (INC)

Scope of the test list

The test steps of the SI acceptance test, supported by the system, is based on the previous test execution and comprises the following steps:

Designation	Purpose of the test step
General information	
Overview	Document the machine details (e.g. manufacturer, machine type,…)
Check the forced checking procedure measures	
Switch-off signal paths	Test the forced checking procedure of the shutdown paths for the NCK and drive. (logging NCK Alarm 27002 is sufficient.)
External stops	Test the forced checking procedure of the (that are being used) external stop responses.
Qualitative function checks	
Emergency stop	Test the internal Emergency Stop functionality when executed via external stop responses and the response to the external SPL I/O.
Function inter-relationships	Test all of the states relevant for the safety functions that should be first documented within the scope of a function table or similar (interdependency of sensor signals, positions, modes). In this case, the following should be taken into account – the active monitoring function for SI-monitored axes (internal safety functions) and the switching state of safety-related external SPL output peripherals (I/O).
Quantitative function checks	
SBH (safe operating stop)	Test the response when provoking that the SBH limit values are violated and define associated characteristic quantities/parameters.
SG (Safely-reduced speed)	Test the response when provoking that the SG limit values are violated and define associated characteristic quantities/parameters.
SE (safe software limit switches)	Test the response when provoking that the SE limit value is violated and define associated characteristic quantities/parameters.
SBT	When the brake is closed, the drive generates an additional torque that must not result in any axis motion.

Designation	Purpose of the test step
Completion	
Ready	The test results are saved and downloaded. The acceptance report is generated based on the test results that have been determined.

SI acceptance test

The following rule applies with the start of the SI acceptance test:

- The alarm suppression possibly set in MD 10094 $MN_SAFE_ALARM_SUPPRESS_LEVEL is not taken into account.

Test step, motion monitoring

With the start of a test step of the motion monitoring (e.g. SBH, SG) the following conditions apply:

- Alarm "Acceptance test mode active" NCK (Alarm No. 27007) and drive (Fault No. C01799) are output.
- The setpoint velocity limiting set using MD 36933 $MA_SAFE_DES_VELO_LIMIT is de-activated. This allows the axis to be traversed in spite of the fact that the SBH monitoring is active or a traversing speed greater than the actual SG monitoring without having to change the selected reference (setpoint) speed limiting.
- SI power on alarms can be temporarily acknowledged with a reset so that after an SBH response has been tested for an axis, an NCK reset does not have to be initiated for the fault acknowledgement. This involves the acknowledgment criteria for the following alarms:

Alarm No. NCK	Fault No. drive	Alarm text
27010	C01707	Tolerance for safe operating stop exceeded
27023	C01701	STOP B initiated
27024	C01700	STOP A initiated

- Traversing motion is possible in spite of the external Stop C/D. This means that it is also possible to test the active SBH monitoring state that results from an external Stop.
- An active stop in another axis does <u>not</u> result in a traversing inhibit for the axis being tested – also for the setting MD 36964 $MA_SAFE_IPO_STOP_GROUP = 0 for this axis.
- When traversing the axes using the JOG buttons, then the set speed limits are ignored – such as e.g. MD 32020 $MA_JOG_VELO – and the G0 value is activated as effective limit value (maximum axis speed).

- The single-channel software limit switches (set positions, refer to MD 36100 to MD 36130) are de-activated when testing SE. This means that an axis can pass these software limit switches without having to change the associated machine data.

Prerequisites for the test step motion monitoring

A test step of the motion monitoring becomes active under the following conditions:

- There is no active SI power on alarm for the axis to be tested.
- The pulses of the axis to be tested are enabled.
- JOG is active as NC operating mode.
- The SI monitoring function selected when carrying out the test step is active, i.e. if for example the SG2 test is selected as test, then if SG1 is active, the acceptance test mode is not active.
- Both monitoring channels (NCK, drive) allow the mode to be activated. The state that is assumed is subject to a crosswise data comparison between the NCK and drive.

A test step is cancelled by the following conditions:

- As a result of an NCK Reset
- When an internal timer value expires, that defines the maximum time that the state can be active.
  This timer value is set in the following machine data
  MD 36958 $MA_SAFE_ACCEPTANCE_TST_TIMEOUT (NCK) and parameter p9558: SI motion, acceptance test mode, time limit.

Trace techniques

A test is carried out prompted step-by-step using the SinuCom NC operator interface. There are various trace techniques, which can be used to confirm and log as to whether the test was successfully completed.

Text entry by the operator
A table or cell for the user documentation is provided for the test. This should then be completed corresponding to the specifications. In addition to how the test is initiated, the text entry includes, e.g. a description of test situations and responses or similar.

Alarms that occur are automatically logged
Specific system and user alarms expected for the test step that are automatically logged after the data trace function has been started. After the appropriate data has been traced, the selection of alarms to be logged can be reduced to those alarms that are relevant for the specific test step.

Internal signal trace function

The SinuCom NC internal trace function is started when the data trace is started and the signals, relevant for the specific test step, recorded. The trace is either automatically ended or the user ends it for some tests (external stops, Emergency Stop).

Specific NC machine data must be set in order that the trace function can be used. This prepares the appropriate resources for the function. The values to be set should be taken from the SINUMERIK SinuCom NC start-up tool.

Basic operating information and instructions

- The operator is prompted, step-by-step when carrying out a test. The following limitations/constraints must be observed, especially for those tests that use the internal trace function:

  If a traversing direction has been selected, then this must also be taken into account for the subsequent task. The reason for this is that the trigger condition for the automatic data acquisition and evaluation is based on this direction data

  A procedure is initiated to activate the trace function using the button <start data acquisition>. This can take several seconds. The signal is only acquired <u>after</u> the appropriate feedback has been received in a message box.

  If the trace has to be manually terminated, then this step should, if at all possible, be made directly after the last expected signal change that is relevant for the trace. This ensures that the relevant area is optimally displayed in the subsequent trace display.
- For each test step, the operator must decide as to whether the test was successfully carried out. He should make this decision based on traced and determined data and test situations that have been carried out and documented. This can be confirmed after the test has been carried out by selecting the appropriate results.
- The test list, provided and supported by SinuCom NC includes the basic test steps to be carried out. Depending on the machine configuration, several tests may not be necessary for the particular machine. This can be selected in the basic screen of the test step. Further, there are test cases, that are required for the machine but are not (or still not) included within the scope of the test list, e.g. measuring the braking travel when a light barrier is obstructed, or similar. These tests should still be manually executed.
- When generating the acceptance certificate, for documentation purposes, data is automatically retrieved from some machine data (SI limit values, checksums, hardware information).
  Further, the results of the tests that were carried out are incorporated in the document. The report is structured the same as the document that was previously manually created. Some sections, such as for example, the machine overview, function table of the configured safety functions etc., that are not standardized, are still manually incorporated in the document at a later date.

9.6 Replacing a motor or encoder

Warning

After hardware and/or software components have been changed or replaced, it is only permissible to boot the system and activate the drives when the protective devices are closed. Personnel must not be present in the danger zone.

Depending on the change or replacement, it may be necessary to carry out a new, partial or complete acceptance test (see Chapter 9.5 Acceptance test).
Before persons may re-enter the hazardous area, the drives should be tested to ensure that they exhibit stable behavior by briefly moving them in both the plus and minus directions (+/-).
It is especially important to carefully observe this for high-dynamic linear and torque motors.

Warning

After the measuring system has been replaced - regardless of whether it is a direct or an indirect system - the relevant axis must be re-calibrated.

Description

The following information essentially refers to replacing a motor encoder. The limitations that apply as well as the procedures are essentially the same when replacing a direct measuring system.

When service is required (motor defective or encoder defective), it might be necessary to completely replace the motor or just the motor encoder.

In this case, the motor encoder must be re-calibrated. This influences the behavior of Safety Integrated if the functionality ”safe limit positions” or ”safe cams” have been activated for the axis in question, i.e. the axis has the status ”safely referenced”. Depending on which motor measuring system is used, it might be necessary to select a different procedure.

The procedure for replacing a motor with absolute value encoder and to replace a motor with incremental encoder are described in the following text. The end of the Chapter discusses 2-encoder systems and encoder modules.

Supplementary conditions

As mentioned above, the functionality ”safe limit positions” or ”safe cams” is active for the axis in question.

The user agreement is set for the axis, i.e. the axis has had the status ”safely referenced” at least once – the actual position value of the NC and the SI actual values (axis/drive) have been appropriately calibrated.

”Safe limit positions” or ”Safe cams” have been able to be used.
A motor or motor encoder has to be replaced under these general conditions.

Replacing a motor with absolute value encoder

In order to set-up the encoder, the offset between the machine zero and the zero of the absolute encoder was determined.

The calibrated state is identified by the control using
MD 34210: ENC_REFP_STATE = 2.

The important factor when replacing a motor (also without Safety Integrated) is that a defined position reference can be established with respect to the mechanical parts of the machine. For example, by mounting and removing the motor at a defined mechanical position or appropriately re-calibrating the system after the motor has been replaced.

After the old motor has been removed and the new motor installed, another actual position value is read by the new absolute value encoder (there is no longer a defined reference to the correctly calibrated actual position value).

Therefore the following error profile appears when the control boots:

Alarm 27001 Axis <name of the axis> fault in a monitoring channel, Code **1003**, values: NCK x, drive y.

The comparison between the saved stop position and the actual position indicates a larger deviation than that specified in MD 36944: $MA_SAFE_REFP_POS_TOL or parameter p9544: ”SI motion, actual value comparison tolerance (referencing)”

The alarm results in a STOP B followed by a STOP A (safe pulse cancellation) for the axis involved.

The user agreement is also cancelled. This means that the axis loses the status ”safely referenced” in connection with the Alarms 27000/C01797 axis <name of the axis> not safely referenced.

The actual position value supplied by the new motor encoder has no reference to the mechanical system. This means that the absolute value encoder must be re-aligned and set-up at this point.

Note

A safety acceptance report is generally not required after a motor has been replaced.

Re-calibration procedure

1. Carry out an NCK reset

Note

After the NCK-Reset, the axis can be traversed again. Alarms 27000/C01797 ”Axis not safely referenced” are still present and indicate that the functions ”safe limit positions” and ”safe cams” are not active in this state. For example, if ”safe limit positions” is being used as a substitute for hardware limit switches, then it is important to note that at this time, the safe limit positions are not functional!

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2. Traverse the axis to the reference position, previously enter MD 34010 REFP_CAM_DIR_IS_MINUS corresponding to the approach direction. (34010 should be set to 1 if the axis is moved in the negative (minus) direction to the reference position.)
3. MD 34100: Set REFP_SET_POS to the actual value of the reference position.
4. MD 34210: Set ENC_REFP_STATE = 1 to activate the calibration.
5. Select the axis that is to be calibrated on the machine control panel and press the RESET key on the machine control panel.
6. Select the JOG/REF mode, enable the axis feed.
7. The calibration process must be initiated with traversing key + or - according to MD 34010: REFP_CAM_DIR_IS_MINUS and the approach direction to the reference position. (Backlash has been moved through).
8. The axis does not traverse. Instead, the offset between the correct actual value (reference position) and the actual value - supplied by the encoder - is entered in MD 34090: REFP_MOVE_DIST_CORR. The actual value appears in the basic screen and the axis signals ”referenced”. The value 2 is entered in MD 34210 as result.
   Example:
   MD 34010=1 (minus) and the reference position was approached in the negative (minus) direction. This means that the ”-” key must also be pressed on the machine control panel.
9. When the absolute value encoder has been re-calibrated (MD 34210 from 1 -> 2), the axis changes over into the ”referenced” state. At this time, the new valid actual position is accepted as the safe actual values (axis and drive).
10. Finally, with the JOG/REF machine mode active, on the HMI the ”user agreement” softkey must be pressed and the user agreement for the axis involved must be reset. Alarms 27000/C01797 disappear and the functions ”safe limit position” and ”safe cams” are safely active again.

Replacing a motor with incremental encoder

The same conditions apply as when replacing a motor with absolute encoder.

To calibrate the encoder, a reference point approach has been set up, e.g. with reference point cams. This means that after the zero mark has been passed when leaving the cam, the reference point is approached according to the offsets in 34080 REFP_MOVE_DIST and 34090 REFP_MOVE_DIST_CORR – and the value of the reference point is set in MD 34100: REFP_SET_POS. After the referencing operation, Alarm messages 27000/C01797 "axis not safely referenced" disappear and the functions "safe limit positions" and "safe cams" are safely active.

The important factor when replacing a motor (also without Safety Integrated) is that a defined position reference can be established with respect to the mechanical parts of the machine. For example, by mounting and removing the motor at a defined mechanical position or appropriately re-calibrating the system after the motor has been replaced. At this instant in time, Alarms 27000/C01797 still do not disappear; they only disappear after the user agreement has been set.

After the old motor has been removed and the new motor installed, the following procedure is recommended:

Re-calibration procedure

1. Boot the control or carry out an NCK reset
2. If the JOG/REF machine mode is active on the HMI, the "user agreement" softkey must be pressed and the user agreement for the axis involved is withdrawn to avoid **Alarm 27001** Axis <name of the axis> fault in a monitoring channel, Code **1003**, values: NCK x, drive y
3. After the system has booted, the JOG/REF mode is selected and the feed enable for the axis is issued. Carry out a reference point approach for the axis involved.

Note

The error at a reference point approach is no more than one revolution of the motor (difference between two zero marks). This offset is usually not critical for the mechanical parts of the machine. If problems arise with the traversing limits because of the type of reference point approach, then for example, set the offset values in MD 34080 /34090 to non-critical values.

Alarms 27000/C01797 ”Axis not safely referenced” are still present and indicate that the functions ”safe limit positions” and ”safe cams” are not active in this state. **For example, if ”safe limit positions” is being used as a substitute for hardware limit switches, then it is important to note that at this time, the safe limit positions are not functional!**

After completion of the reference point approach, the axis goes into the ”referenced” status. However, because of the zero mark offset between the encoders, the reference position still has to be calibrated, i.e. the position reference with respect to the mechanical system must be re-established. The system is calibrated after measuring the difference - usually in MD 34080 REFP_MOVE_DIST or 34090 REFP_MOVE_DIST_CORR.

4. After the reference point has been re-calibrated, the reference point approach must be re-initiated. The axis changes over into the ”referenced”' state. At this time, the reference point value is taken over as the safe actual value for the axis and drive.
5. Finally, with the JOG/REF machine mode active, on the HMI the ”user agreement” softkey must be pressed and the user agreement for the axis involved must be reset. Alarms 27000/C01797 disappear and the functions ”safe limit position” and ”safe cams” are safely active again.

Comments about 2-encoder systems

Case A

1st measuring system: Incremental motor measuring system
2nd measuring system: Absolute direct measuring system
As active measuring system via the axis interface, the 2nd position measuring system (DBAx 1.5 = 0, DBAx 1.6 =1) is statically selected

In this case, motor replacement is straightforward because the NC reference point position is only supplied with values from the 2nd measuring system (DMS).

Case B

1st measuring system: Absolute motor measuring system
2nd measuring system: Incremental direct measuring system
As active measuring system via the axis interface, when booting, for monitoring purposes the 1st position measuring system (DBAx1.5 = 1, DBX 1.6 =0) is selected and then subsequently the 2nd position measuring system is selected (DBAx 1.5 = 0, DBX 1.6 =1).

In this case, the motor must be replaced carefully observing the **Description, motor with absolute value encoder**. This is because it is necessary to re-calibrate the absolute value encoder. When re-calibrating the system, we recommend that you permanently select the 1st position measuring system and the axis is only traversed using the motor measuring system.

Replacing the encoder modules

When replacing the encoder modules (SMC, SME, DRIVE-CLiQ encoders) or when replacing motors with integrated encoders (motor with DRIVE-CLiQ), a change to the configuration of the safety-related components is detected, and a request is made that a service person acknowledges this.

After at least one of these encoder components has been replaced, Alarm 27035 ”Axis %1 new HW component, acknowledgement and function test required” is output (changed CRC in index 1 of $MA_SAFE_ACT_CHECKSUM[ ] and possibly Alarm F01680 with ID 2, i.e. hardware IDs have changed).

When replacing motors with integrated encoders, Alarm F01680 ”SI Motion CU: Checksum error safe monitoring functions” is output with fault value 2 (changed CRC of parameter p9728[2]), i.e. changed hardware identifiers). Also in this case, an acknowledgement is required and a function test must be performed.

The term ”function test” designates a partial acceptance test that is described in detail in the alarm description.

If Alarm 27035 or F01680 with ID 2 is output, a new softkey ”Acknowledge SI HW” is displayed in the alarm screen. This can only be actually selected with key switch setting 3 (the same as for the user agreement).

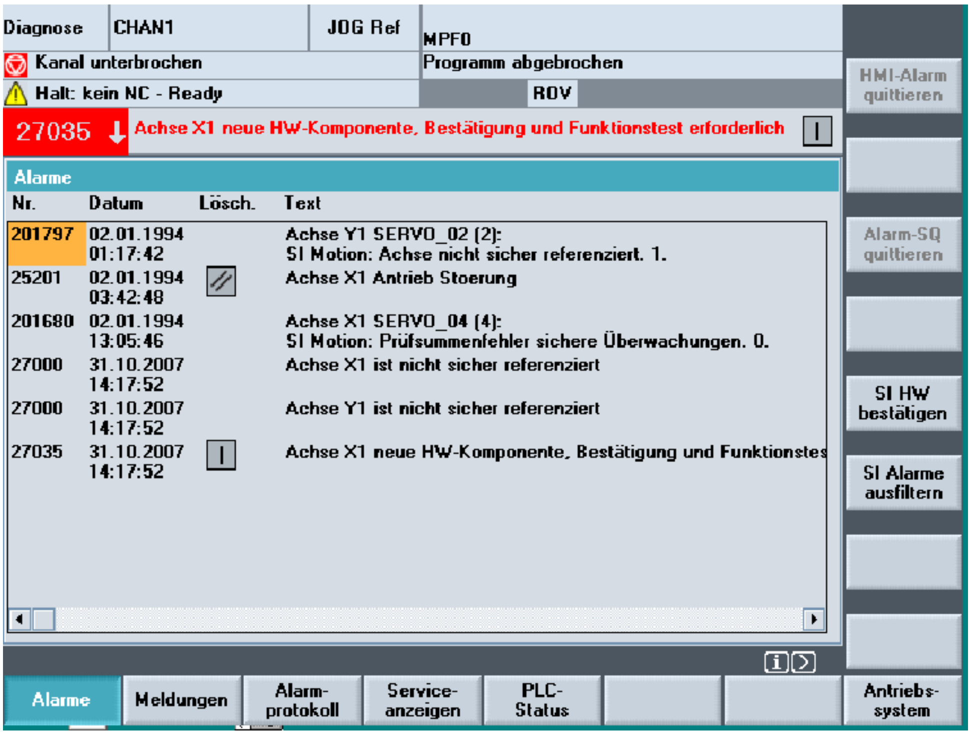


Fig. 9-16 Acknowledging SI HW

After the softkey is selected, the following message is displayed on the HMI:

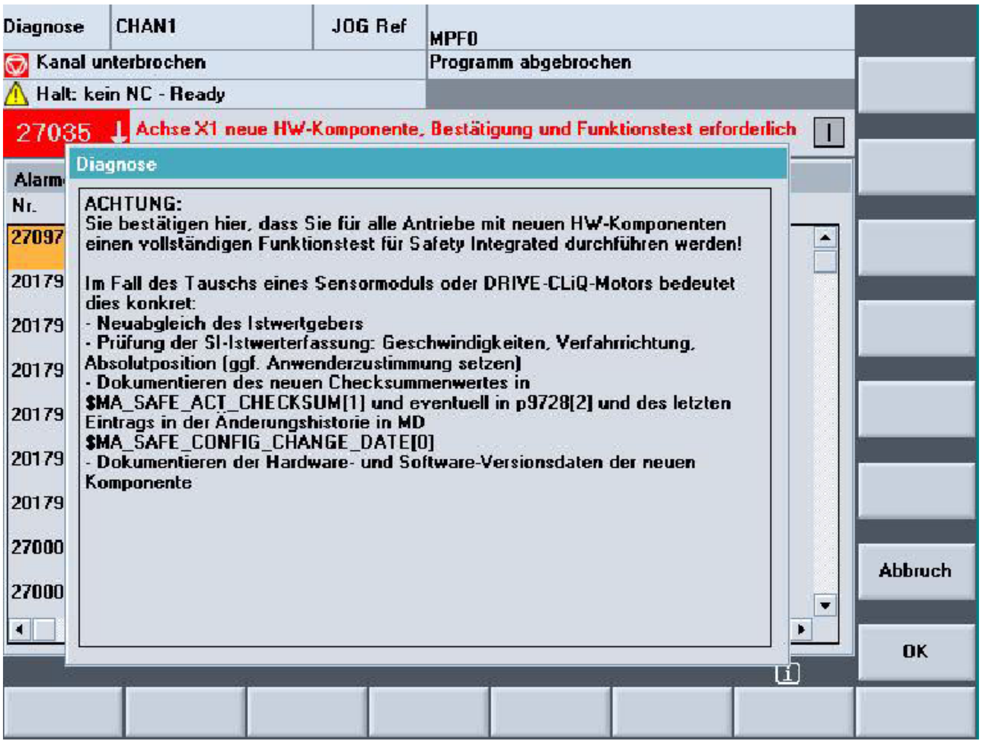


Fig. 9-17 Acknowledging SI HW, step 2

After acknowledging with OK, the actual checksums SAFE_ACT_CHECKSUM[1] / r9728[2] for all of the axes are copied to the reference checksum SAFE_DES_CHECKSUM[1] / p9729[2] and a recommendation is given to power on the control. This is carried out by pressing OK.

After the system has successfully booted, the user must carry out the measures of the function test just acknowledged in the HMI messages or in Alarm 27035 / F01680, i.e.

- Re-calibration of the actual value encoder
- Check the SI actual value acquisition: Speeds, traversing direction, absolute position (if required, set the user agreement)
- Document the new checksum value in SAFE_ACT_CHECKSUM[1] or r9728[2] and the last entry in the change history in MD SAFE_CONFIG_CHANGE_DATE[0]
- Document the hardware and software version data of the new component

Alternatively, Alarm 27035 / F01680 can be acknowledged using the softkey "Acknowledge SI data" and the softkey "Reset drive/NCK".

The user can suppress the automated internal actual value check by resetting the "user agreement" – therefore requesting that the axis is re-calibrated with the appropriate user agreement.

Space for your notes

Diagnostics 10

Note

Not all of the HMI functions shown are available in all of the HMI versions (HMI Embedded, SINUMERIK Operate, HMI Advanced).

10.1 Troubleshooting procedure

- The alarms that have been activated in response to an error are output in the "DIAGNOSIS – ALARMS" display. When required, the safety alarms can be suppressed in the diagnostics display using the "Filter out SI alarms" softkey.
- For Alarm 27090 "Error for crosswise data comparison NCK–PLC", the cause of the error (the incorrect SPL variable) is displayed in the alarm output.
- For Alarm 27254 "PROFIsafe: F module, error on channel", the input/output channel with error for modules belonging to the ET 200 series, is displayed in the alarm output.
- For Alarm 27001 "Defect in a monitoring channel", the fine error code is also displayed in the alarm output.
- For Alarm C01711 "SI motion defect in a monitoring channel" the fine error code is displayed in the alarm output. In the screen "Commissioning – machine data – drive MD", using parameter r9725: "SI motion diagnostics STOP F", the cause of the alarm can be read out.
- The current crosswise data comparison error code of the drive monitoring channel is displayed in the diagnostics screen "Status SI" in line "Stop F code value".
- For Alarms F01611/F30611 "Defect in a monitoring channel", the fine error code is displayed in the alarm output. The current error search of this alarm is additionally displayed in parameters r9795/r9895.

Note

Different error codes may be displayed for the NCK and drive monitoring channels.

10.1.1 Service displays

SINUMERIK Operate

If safety functions are configured both in the NCK and drive, two softkeys (SI NCK status and drive status) are listed to display the screen signals.

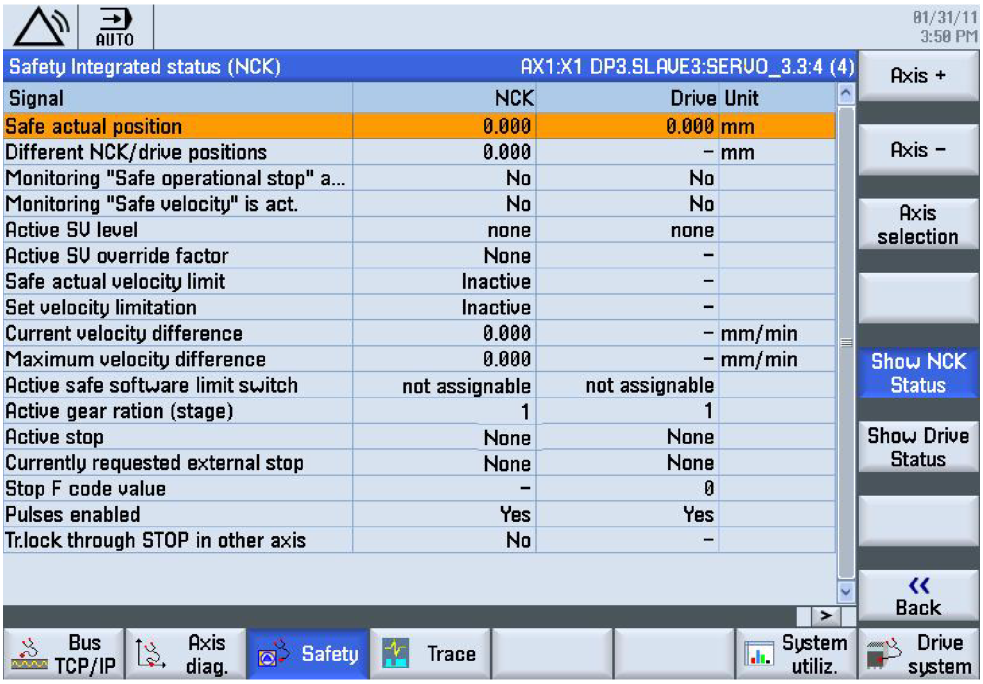
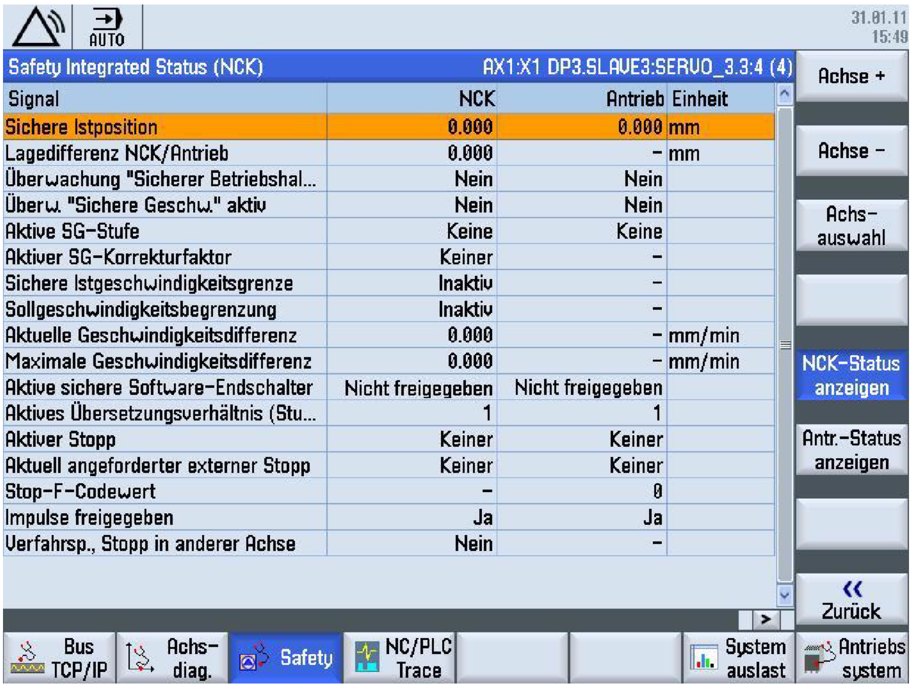


Fig. 10-1 New softkeys to select the display for SI status

Information about the status SI Header is also displayed in this function, which shows whether you are in the NCK or in the drive.

Fig. 10-2 SI header status

Display of the diagnostic signals of the NCK



Signal	NCK	Antrieb	Einheit
Sichere Istposition	0.000	0.000	mm
Lagedifferenz NCK/Antrieb	0.000	–	mm
Überwachung "Sicherer Betriebshal...	Nein	Nein	
Überw. "Sichere Geschw." aktiv	Nein	Nein	
Aktive SG-Stufe	Keine	Keine	
Aktiver SG-Korrekturfaktor	Keiner	–	
Sichere Istgeschwindigkeitsgrenze	Inaktiv	–	
Sollgeschwindigkeitsbegrenzung	Inaktiv	–	
Aktuelle Geschwindigkeitsdifferenz	0.000	–	mm/min
Maximale Geschwindigkeitsdifferenz	0.000	–	mm/min
Aktive sichere Software-Endschalter	Nicht freigegeben	Nicht freigegeben	
Aktives Übersetzungsverhältnis (Stu...	1	1	
Aktiver Stopp	Keiner	Keiner	
Aktuell angeforderter externer Stopp	Keiner	Keiner	
Stop-F-Codewert	–	0	
Impulse freigegeben	Ja	Ja	
Verfahrsp., Stopp in anderer Achse	Nein	–	

Fig. 10-3 Status display NCK

The axis +, axis – vertical softkeys or direct selection are used to set the desired axis. The current axis is displayed in the top right half of the table.

Various states for both channels are displayed separately in the diagnostics screen.

Display of the diagnostic signals of the drive

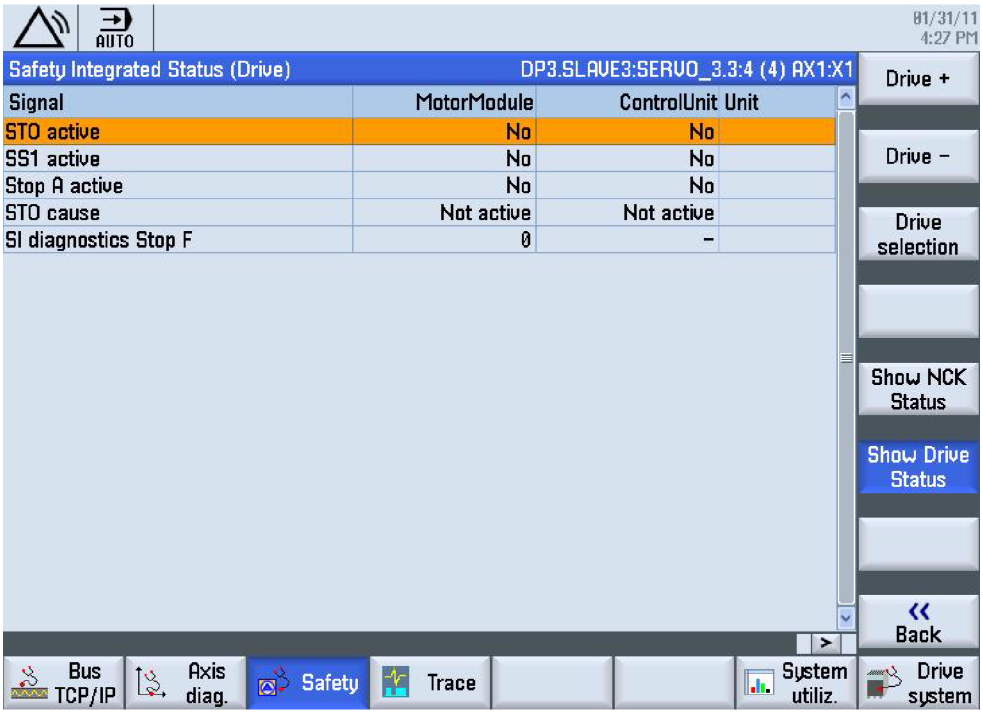


Fig. 10-4 Status signals, drive

The following table shows the list of signals of the drive for the status SI screen.

Signal	Motor Module	Control Unit
STO active	r9872.1	r9772.1
SS1 active	r9872.2	r9772.2
STOP A active	r9872.10	r9772.10
STOP F active	r9872.15	r9772.15
STO cause, Safety commissioning mode	r9872.16	r9772.16
STO cause, selection via terminal	r9872.17	r9772.17
STO cause, actual value is missing	r9872.19	r9772.19

Display of the checksum

The screen for checksum SI is divided into three areas:

- Safety options
- Safety checksum status
- Details, Safety checksums

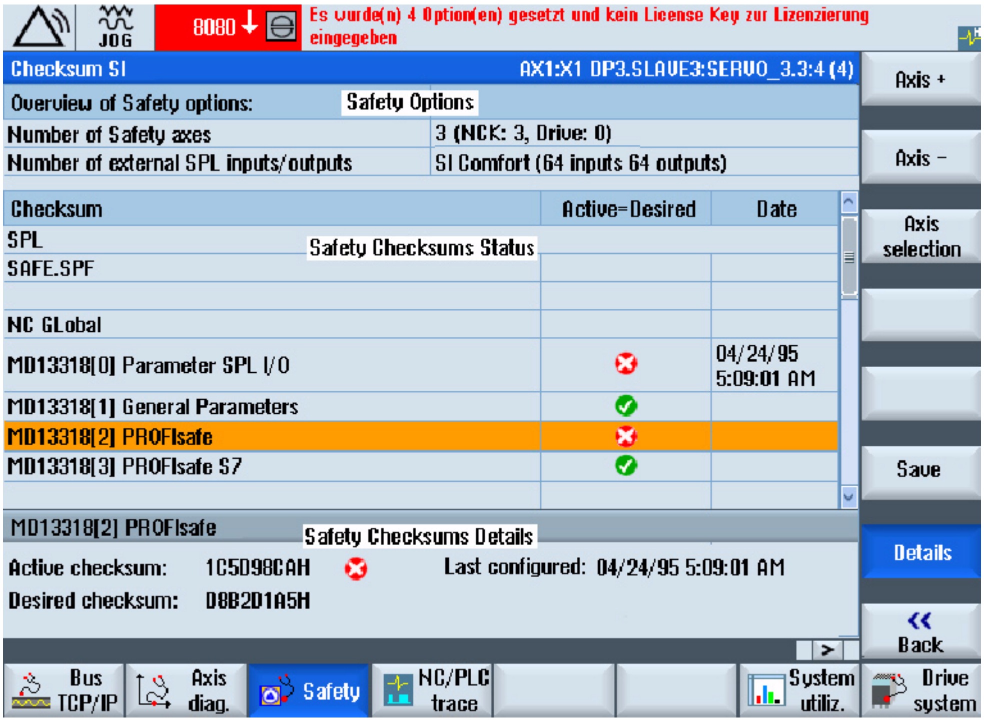


Fig. 10-5 Display checksums

Softkey

- Save
  With this softkey, the values of the checksum for all drives and axes are saved in an XML file, which is selected by the user.
- Details
  This softkey is used to select detailed information concerning the selected checksum.

HMI-Advanced

- Upon activation of the ”Service SI” softkey, the following information blocks about Safety Integrated related data are displayed on the HMI for the selected axis:
  - Status SI (selected per default)
  - SI configuration
  - Cam SGA
  - SGE/SGA
  - SPL
  - SI communication

Status SI

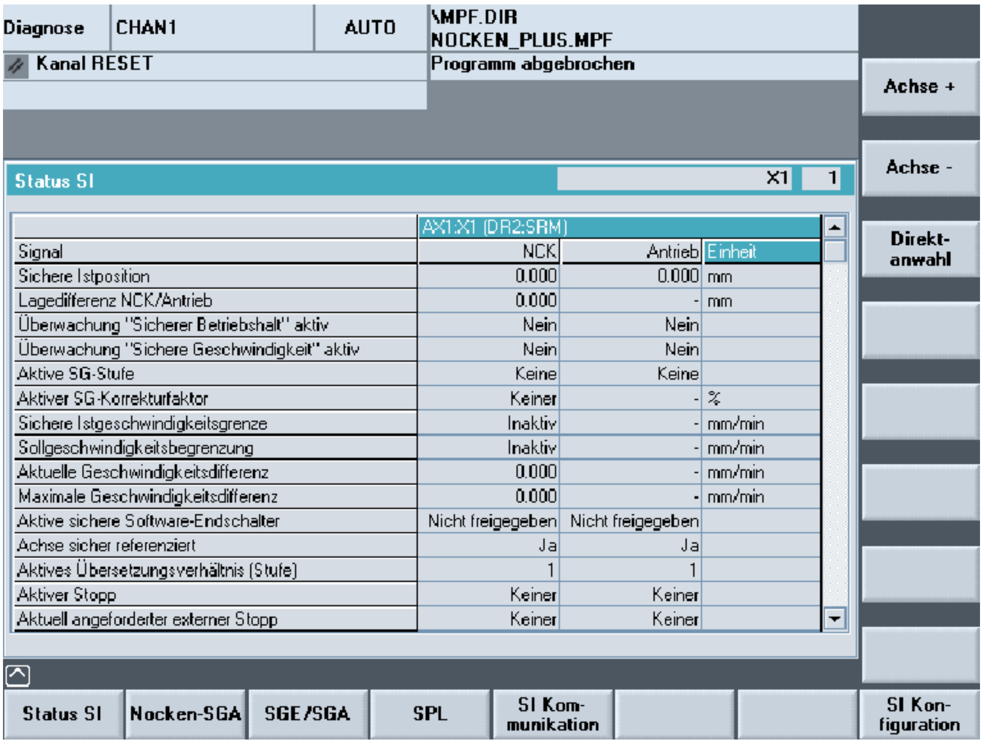


Fig. 10-6 Status SI

The axis +, axis – vertical softkeys or direct selection are used to set the desired axis. The current axis is displayed in the top right half of the table.

Various states for both channels are displayed separately in the diagnostics screen.

SI configuration

You can go to the SI configuration window by pressing the softkey ”SI configuration”.

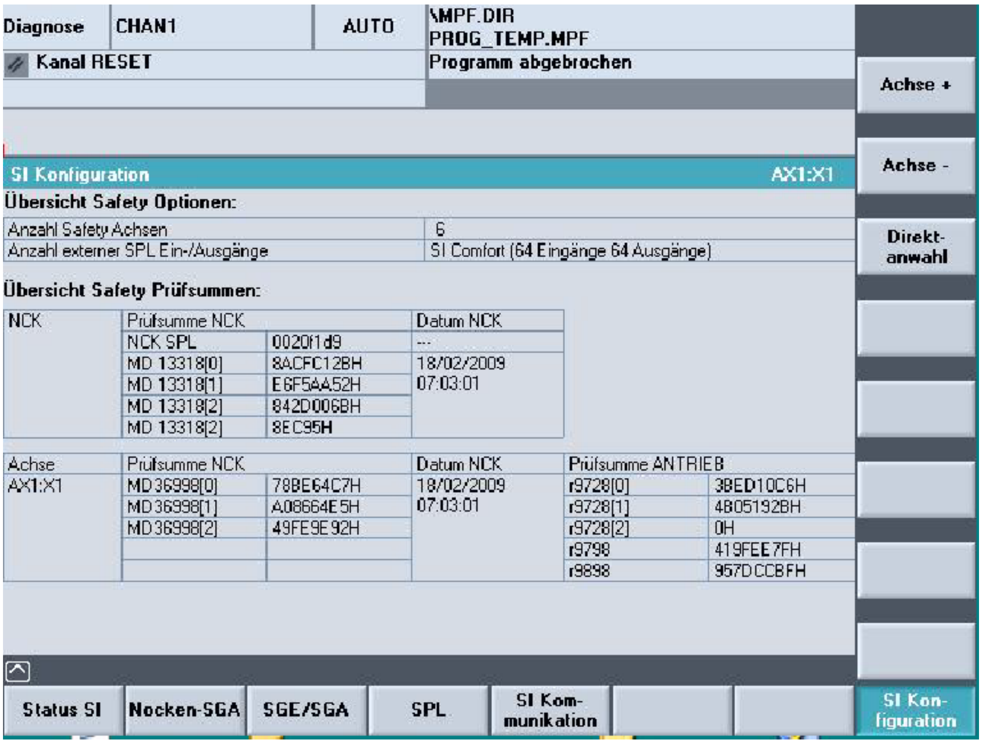


Fig. 10-7 SI configuration

An overview of the safety options that have been set is displayed in the upper section of this diagnostics screen.

The Safety checksums for the NCK, the axis and the drive are shown in the lower window section.

SGE/SGA

The SGE/SGA window is reached by pressing the softkey SGE/SGA".

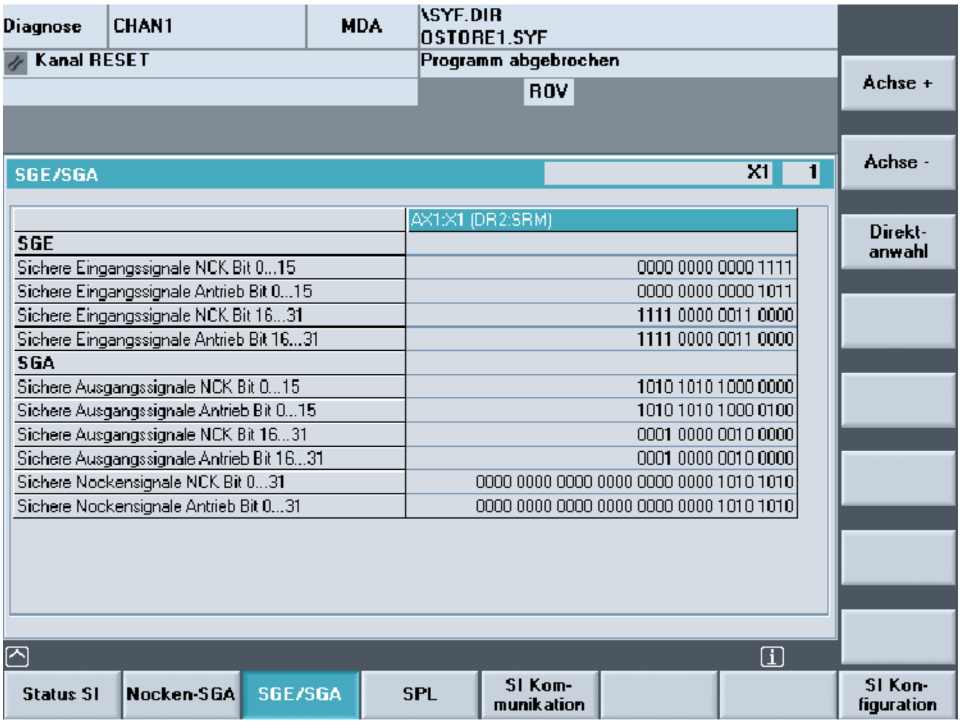


Fig. 10-8   Status display of SGE/SGA

The available signals are shown in the diagram above.

Fig. 10-9 shows the detailed status display of the safety input/output signals.

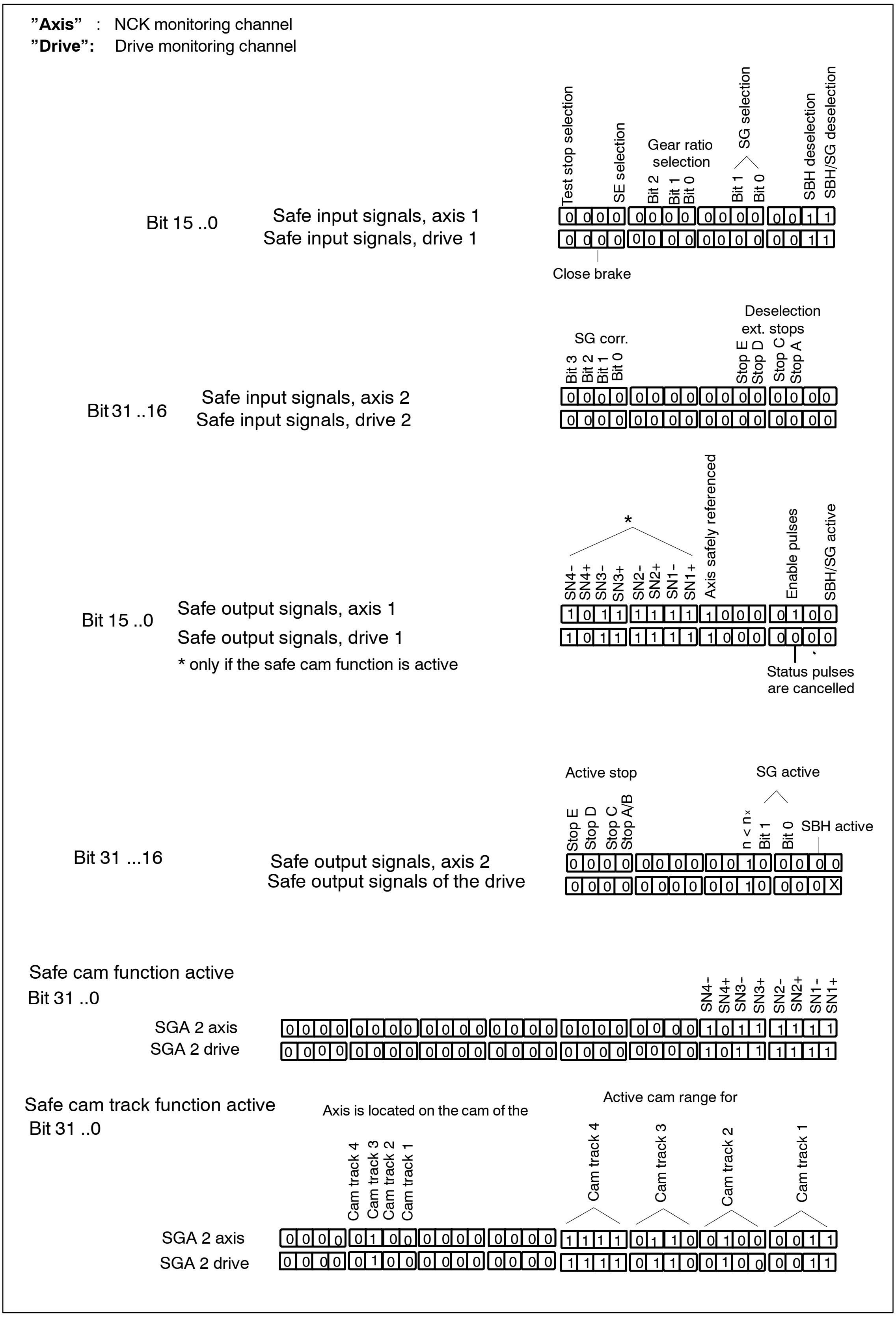


Fig. 10-9 Significance of the status display of the safety-related input and output signals

Cam SGA

You can reach the corresponding windows for safe cam (Fig. 10-10) or safe cam track (Fig. 10-11) using the ”Cam SGA” softkey.

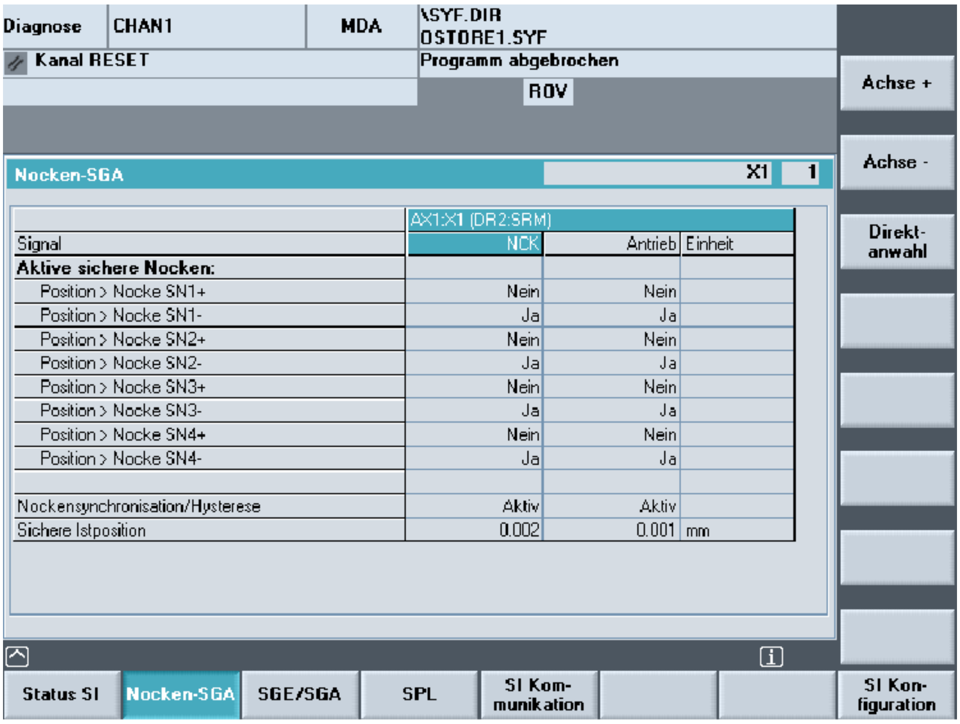


Fig. 10-10 Cam SGA

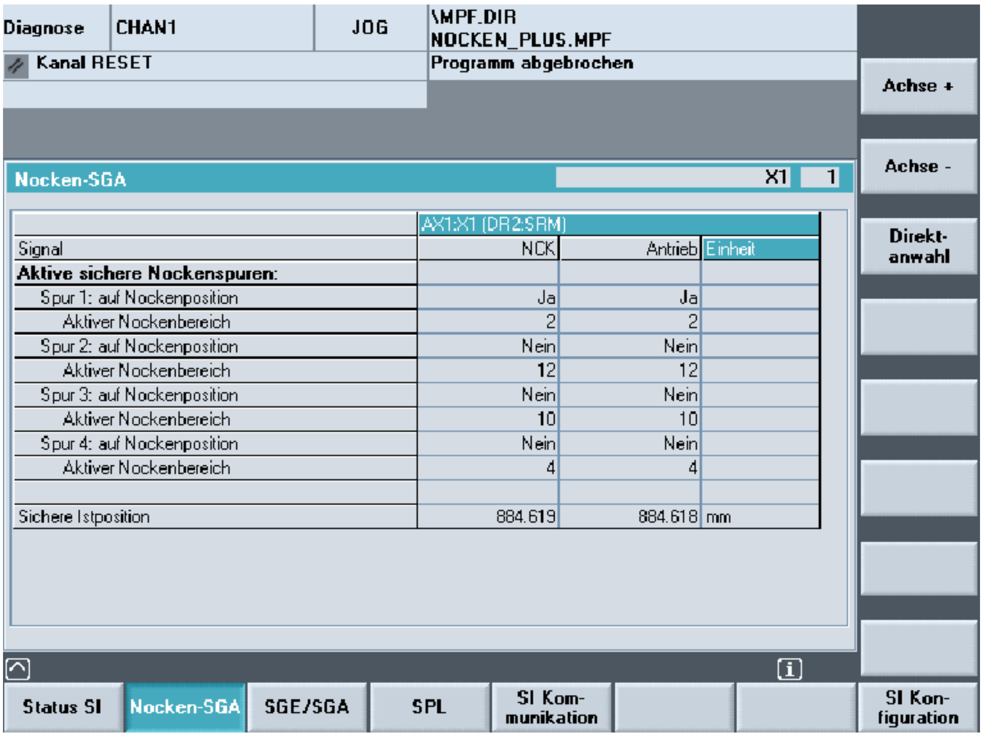


Fig. 10-11 Cam SGA

SPL

The SPL window is reached by pressing the softkey ”SPL”.

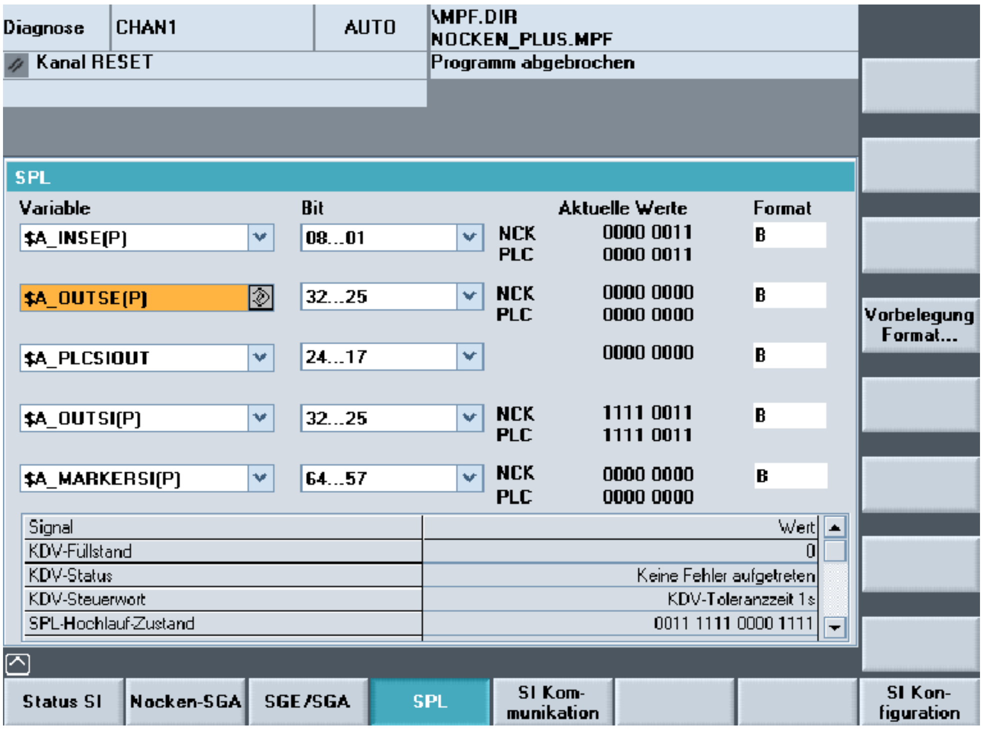


Fig. 10-12 Status display SPL

In the ”Variable” selection box, you can select:
$A_INSE(P) corresponds to simultaneous selection of
$A_INSE upper line, origin of the NCK and
$A_INSEP lower line, origin of the PLC
and effectively the same for the other variables:
$A_OUTSE (P)
$A_INSI (P)
$A_OUTSI (P)
$A_MARKERSI (P)
$A_PLCSIIN
$A_PLCSIOUT

The variables that have been selected and the associated bit areas are saved and are taken into account when subsequently selecting the screen.

Using the select key, the following formats can be selected in the variable rows

B	Binary
H	Hexadecimal
D	Decimal, can be selected.

The selected format is applicable for the particular variable, as each variable can be assigned an individual display format.
Further, various SPL states are displayed.

SI communication

You can go to the general SI communication window by pressing the softkey ”SI communication”.

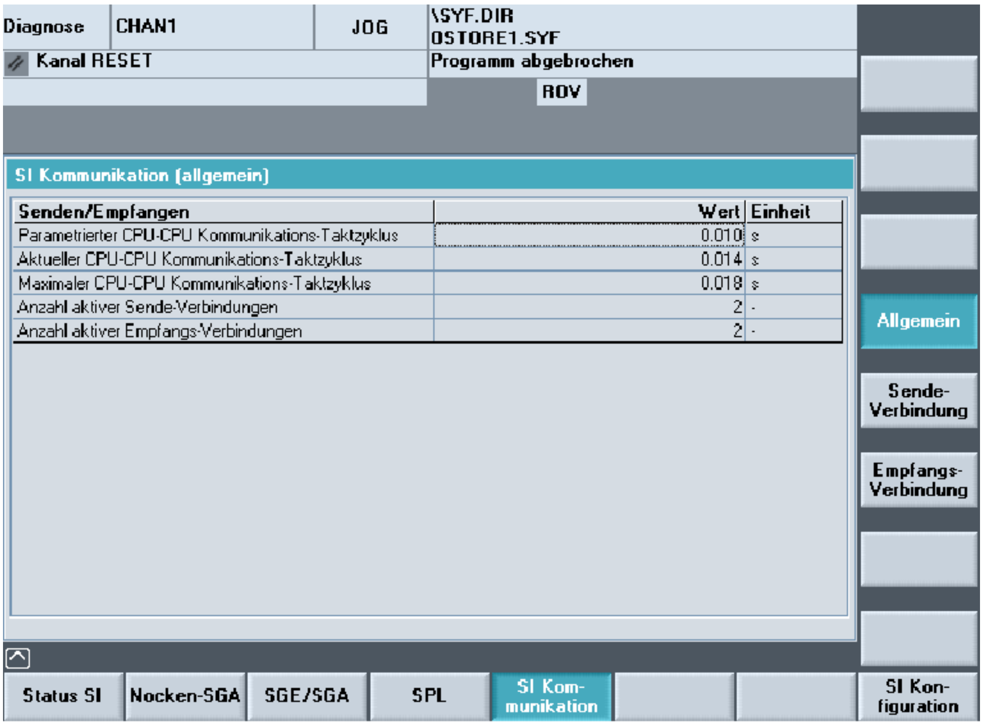


Fig. 10-13 Status display, SI communication

The send and receive connections can be selected using the vertical softkeys.

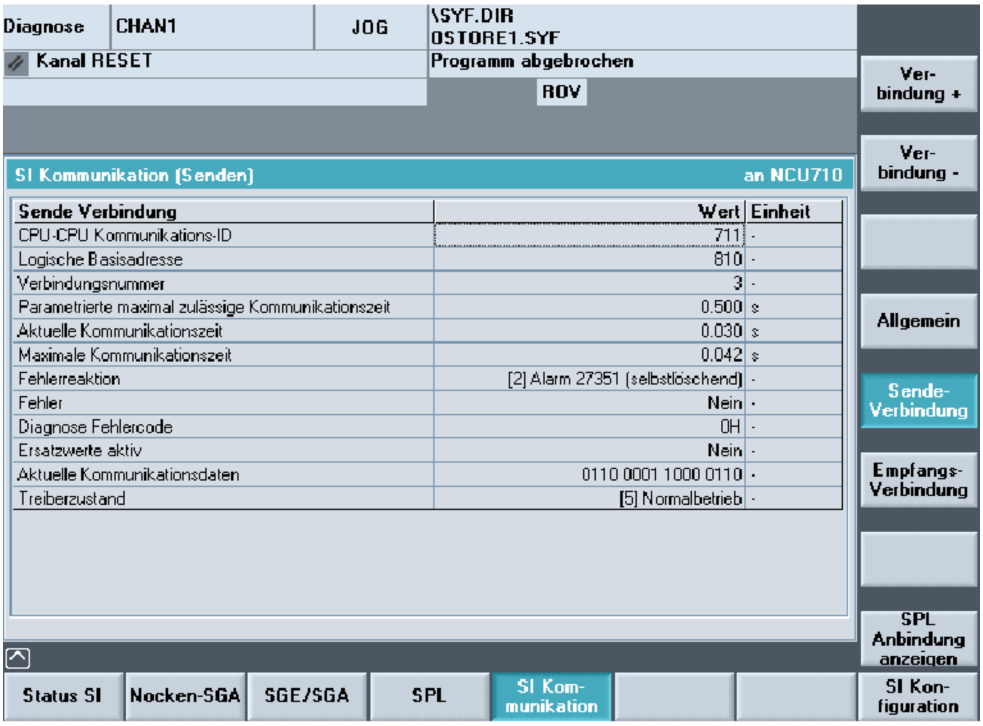


Fig. 10-14 SI communication [sending]

The SI communication [send] screen contains a list of the configuration in tabular form and the status of F_SENDDP. Additional details, e.g. the comparison of the $A_OUTSE variables and F_SENDDP are displayed using the softkey ”Display SPL couplings”.

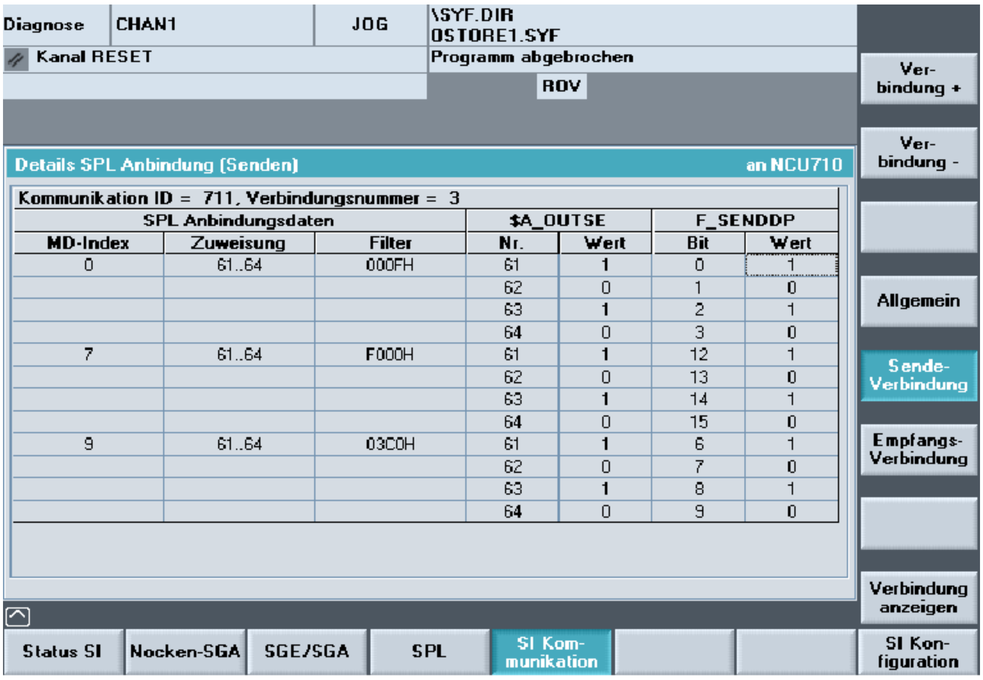


Fig. 10-15 SPL coupling (sending)

Data for F_RECVDP are displayed using the ”Receive connection” softkey and ”Display SPL couplings”.

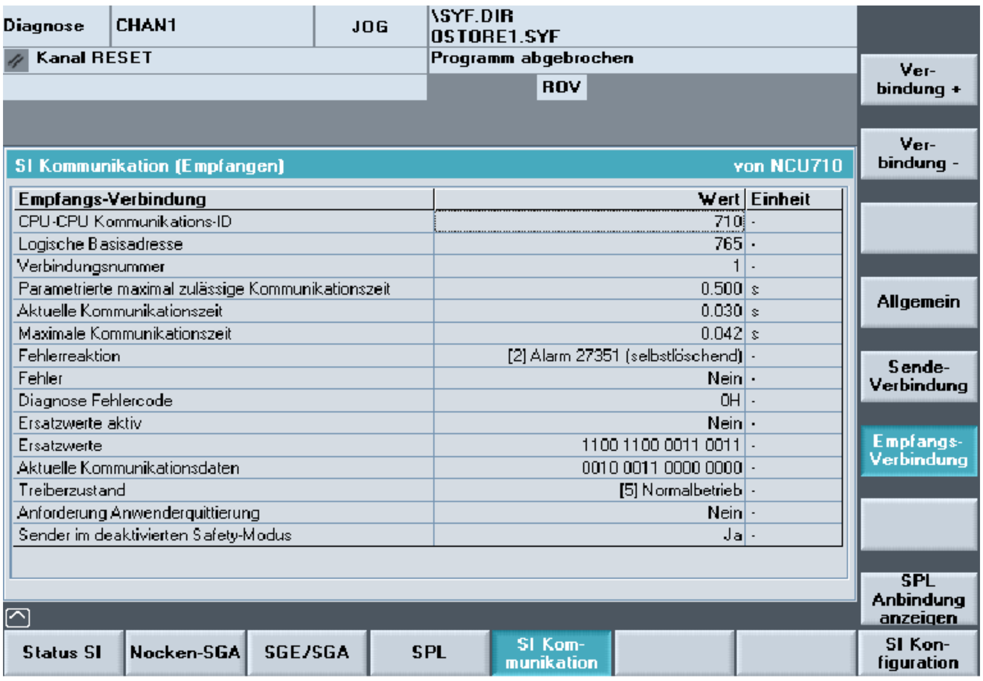


Fig. 10-16 SI communication [receiving]

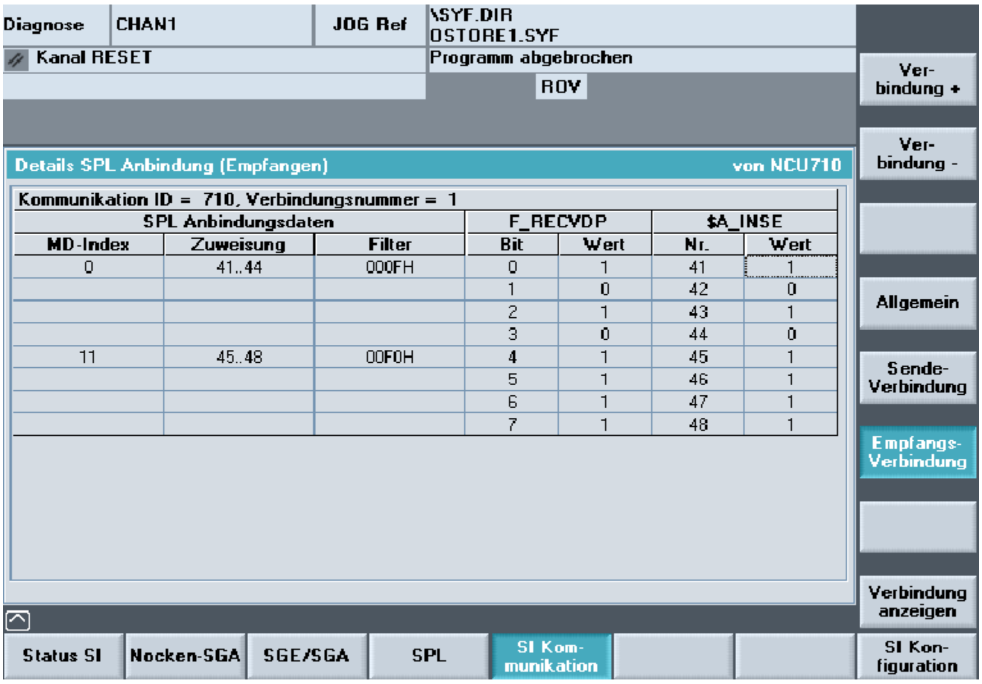


Fig. 10-17 SPL coupling (receiving)

10.1.2 Diagnostics support by configuring your own extended alarm text (HMI Advanced)

In order to upgrade the level of diagnostics information when an error occurs, certain Safety Integrated system alarms can be supplemented by a freely-definable user text. For instance, for hardware-related faults, supplementary information such as input designation, circuit diagram identification number or similar can be included in the system alarm that is output.

This extended alarm text is based on the interaction between the NCK system software (that specifies the parameter that addresses the supplementary information for the alarm text) and the HMI software (that has to appropriately process this parameter).

Dedicated extended alarm texts can be defined for the following Safety Integrated system alarms:

- General SPL crosswise data comparison errors (different status of the SPL variables) Alarm 27090, error for crosswise data comparison, NCK-PLC
- Channel-related errors on the PROFIsafe module (only when using the ET 200 PROFIsafe I/O)
  Alarm 27254 PROFIsafe: F module, error on channel

Prerequisites, HMI Advanced

The following entry is in the configuration file for the alarm server (file MBDDE.INI) in the section [Text files]:

File excerpt: mbdde.ini

```
[Textfiles]

NCK=f:dhmb.diraln_          ; Example : Standard entry
```

This means that all of the NCK alarms are defined in the file referenced after the NCK entry. The processing of an extended alarm text for the above specified alarms is prepared as part of this definition.

File excerpt: aln_gr.com

```
027090 0 0 ”Error for crosswise data comparison NCK-PLC, %1[%2], NCK:
%3; %4<ALSI>”

027254 0 0 ”PROFIsafe: F module %1, error in channel %2; %3<ALSI>”
```

Using the supplement **%4<ALSI>** (Alarm 27090) and **%3<ALSI>** (Alarm 27254), the possibility of providing an alarm text extension is defined for the alarm.

Principle of operation – extended alarm text

If Alarm 27090 or Alarm 27254 occurs, the NCK transfers an additional parameter value to the HMI software (27090: %4; 27254: %3). This parameter has a defined value range. Each value can be uniquely assigned an extended alarm text.

Value range of the transfer parameter

000
Parameterizing error detected when booting (different state active)
Crosswise data comparison error, SPL protective mechanism: MD 11500 □ DB18.DBX36.0
Crosswise data comparison error, stop response for SPL error: MD 10097 □ DB18.DBX36.1

001...064
Error in system variables $A_INSE(P)[01...64] (Alarm 27090/Alarm 27254)
The index value then results from a channel error signaled from the PROFIsafe module
(Alarm 27254), that is assigned the appropriate $A_INSE(P) variable (e.g. discrepancy error)

065...128
Error in the system variables $A_OUTSE(P)[01...64] (Alarm 27090/Alarm 27254). This means, Alarm 27090 signals an internal logic error ($A_OUTSE(P) variables differ) and Alarm 27254 signals a channel error signaled from the PROFIsafe module that is assigned to the appropriate $A_OUTSE(P) variable (e.g. short-circuit fault).

129...192
Error in system variables $A_INSI(P)[01...64] (only alarm 27090)

193...256
Error in system variables $A_OUTSI(P)[01...64] (only alarm 27090)

257...320
Error in system variables $A_MARKERSI(P)[01...64] (only alarm 27090)

Definition of the extended text

The file, in which the extended texts are defined, is also declared in the configuration file for the alarm server (file MBDDE.INI) in the section [IndexTextFiles].

File excerpt: mbdde.ini

```
[IndexTextfiles]

ALSI=f:dhmb.diralsi_       ; Example : Standard entry
```

We recommend that this file for the extended text is located in the HMI user directory.

Every parameter can be assigned a dedicated text in this file, whereby the text entry is located in front of the associated parameter value (refer to the following file excerpt).

File excerpt: alsi_gr.com

```
000000 0 0   "Parameterizing error MD11500/DB18.DBX36.0 or
                                   MD10097/DB18.DBX36.1"

000001 0 0   "User text $A_INSE(P)[01]"

..

000064 0 0   "User text $A_INSE(P)[64]"

000065 0 0   "User text $A_OUTSE(P)[01]"

..

000128 0 0   "User text $A_OUTSE(P)[64]"

000129 0 0   "User text $A_INSI(P)[01]"


000192 0 0   "User text $A_INSI(P)[64]"

000193 0 0   "User text $A_OUTSI(P)[01]"


000256 0 0   "User text $A_OUTSI(P)[64]"

000257 0 0   "User text $A_MARKERSI(P)[01]"

000320 0 0   "User text $A_MARKERSI(P)[64]"
```

The assigned user text is then displayed when Alarms 27090 or 27254 occur, referred to the associated SPL variable.

10.1.3 Integrating safety SPL user alarms (SINUMERIK Operate)

Preconditions

In order to integrate the alarm text extension for SINUMERIK Operate, the ”HMI Solutionline Alarm Text Converter” is used. Using this converter, it is possible to convert alarm text extensions, which were already generated on an HMI Advanced or a self-generated alarm text extension (in *.com format) into the *.ts format required for SINUMERIK Operate, and to integrate this using WINSCP.

The alarm text converter is included in the scope of delivery of the software (setup_alarmtextconverter.exe).

Converting SINUMERIK Operate Safety user alarms from PCU50

Start the alarm text converter and allocate a filename under ”Output File Prefix” (e.g. user_alsi).

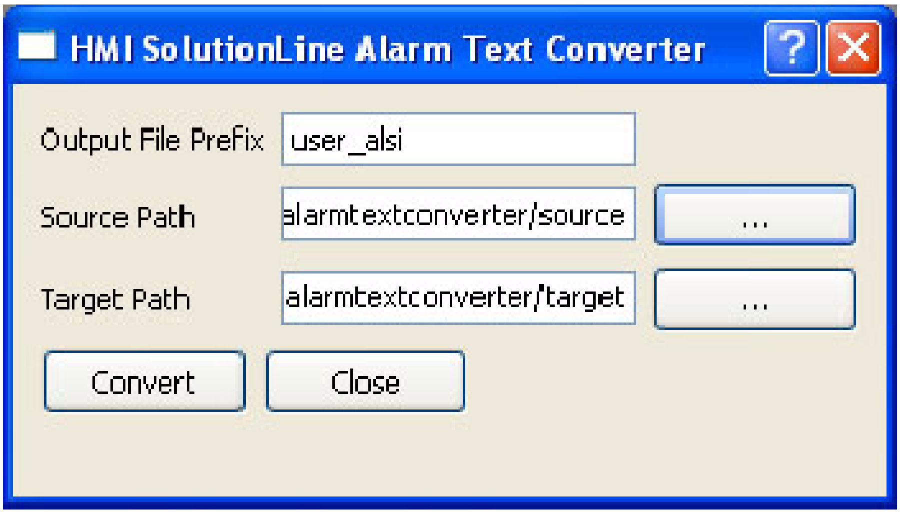


Fig. 10-18 Allocating the file name

The source directory is specified in ”Source Path”.

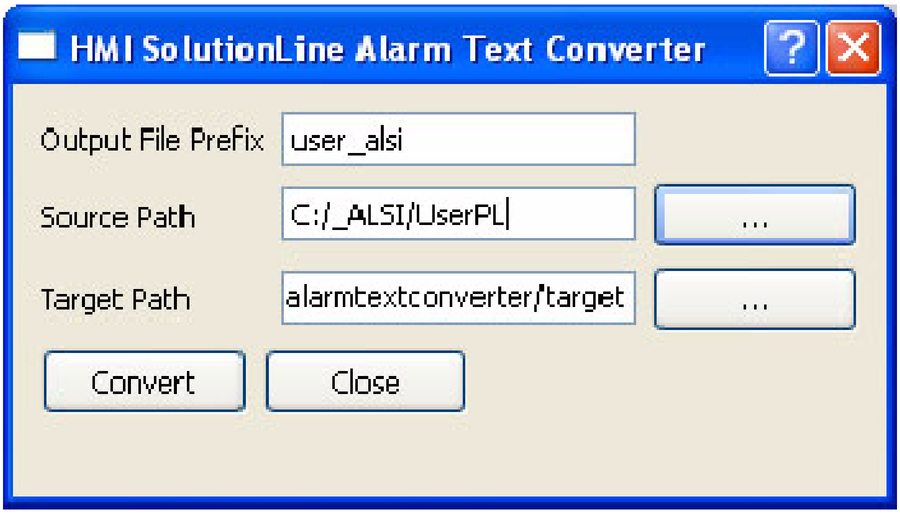


Fig. 10-19 Selecting the source directory

As the SPL user text files are index text files (pro rata alarm text), for correct conversion in the specified ”Source Path”, a subdirectory with the name */ALSI must be created. The alarm text extension file *.com to be converted must be saved in this subdirectory.

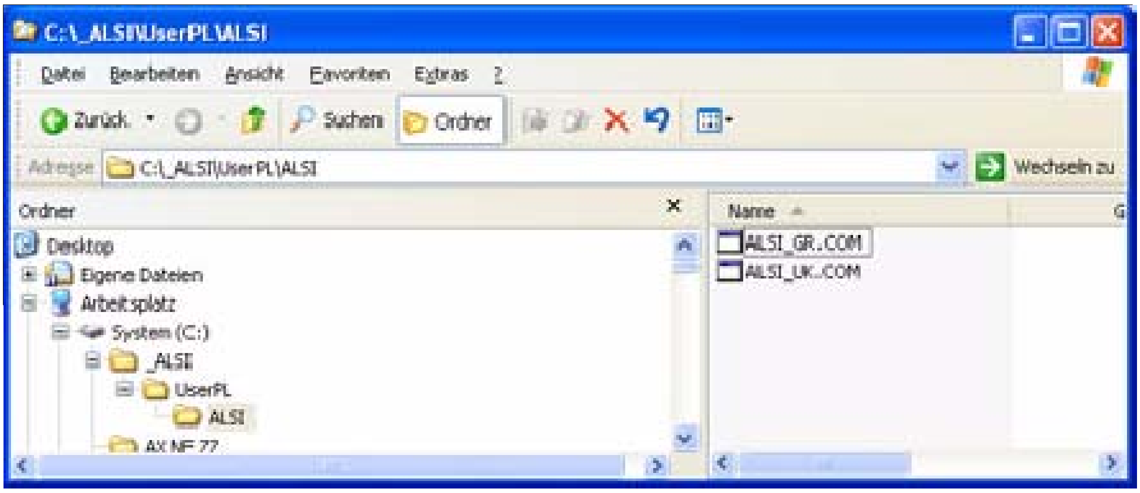


Fig. 10-20 Creating a subdirectory

In ”Target Path”, the target directory is specified in which the converted safety user alarm text files for SINUMERIK Operate should be stored.

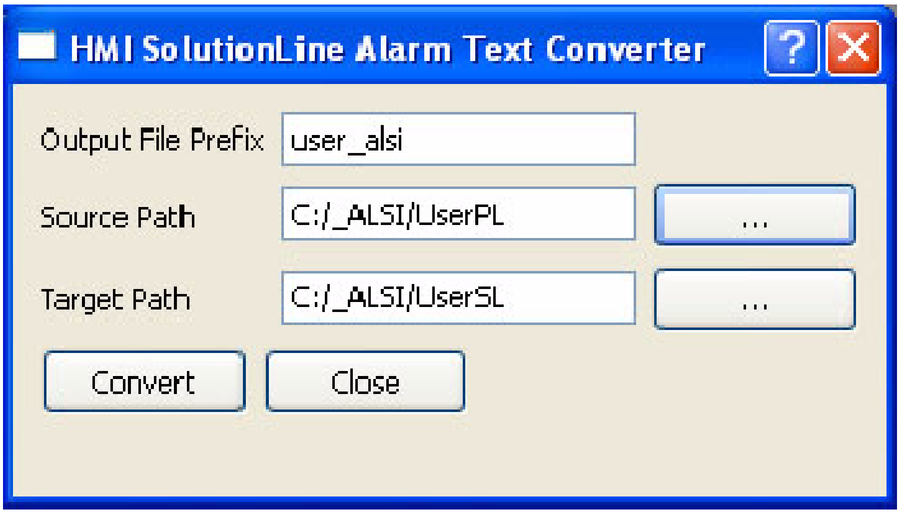


Fig. 10-21 Determining the target directory

A ”cfg” and an ”lng” folder are created in the ”Target Path” with ”Convert”.

The following files are generated in ”cfg”:

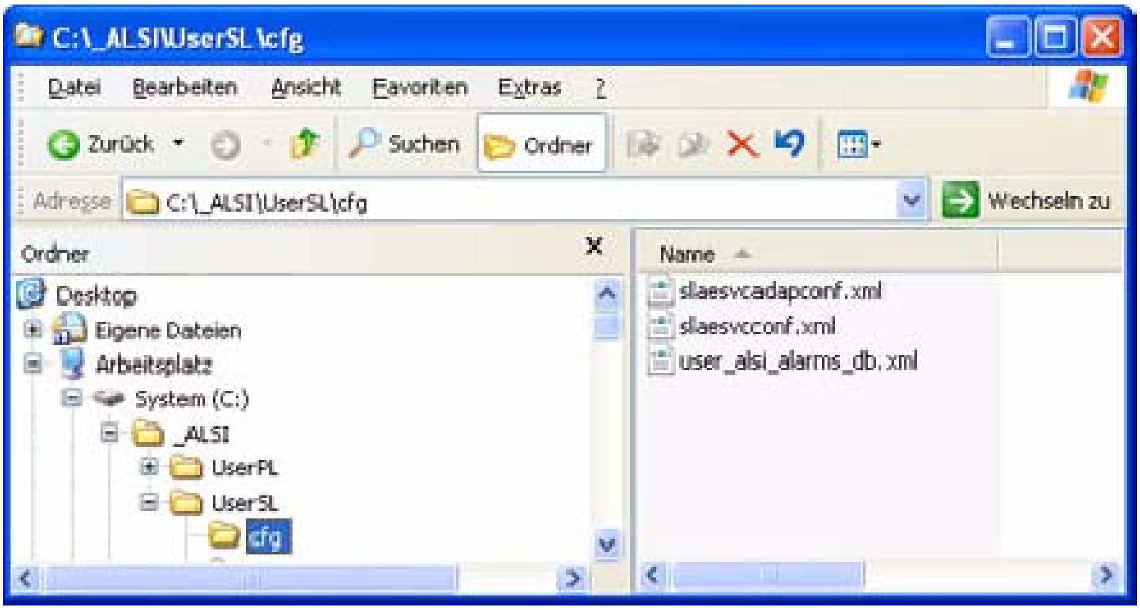


Fig. 10-22 Generating files in ”cfg”

Depending on the language, the SI user alarm files are generated in ”lng”:

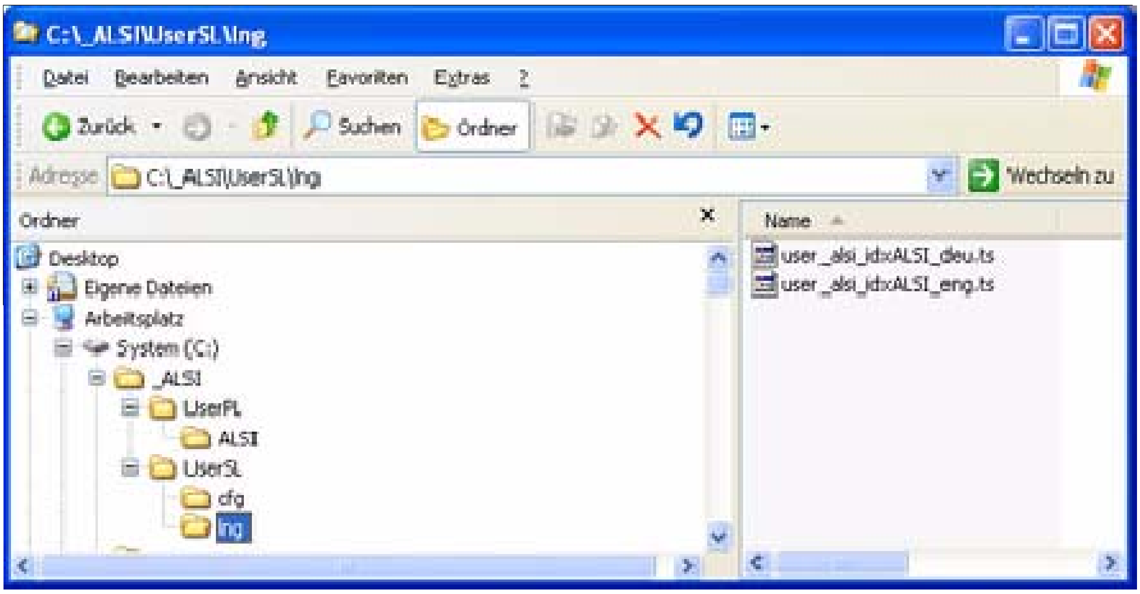


Fig. 10-23 Generating files in "cfg"

The files / directories are now copied with WinSCP to card/user/sinumerik/hmi/cfg or card/user/sinumerik/hmi/lng or card/oem/sinumerik/hmi/cfg or card/oem/sinumerik/hmi/lng.

These files must now be copied to the card using WINSCP:

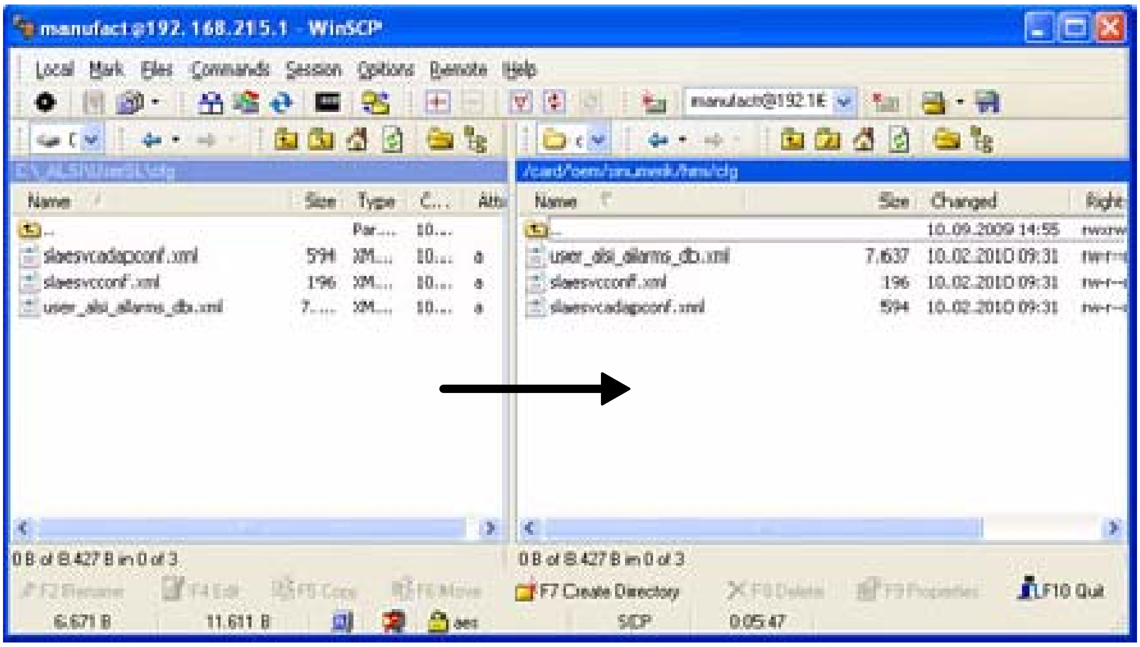


Fig. 10-24 Copying the files into the user directory using WinSCP

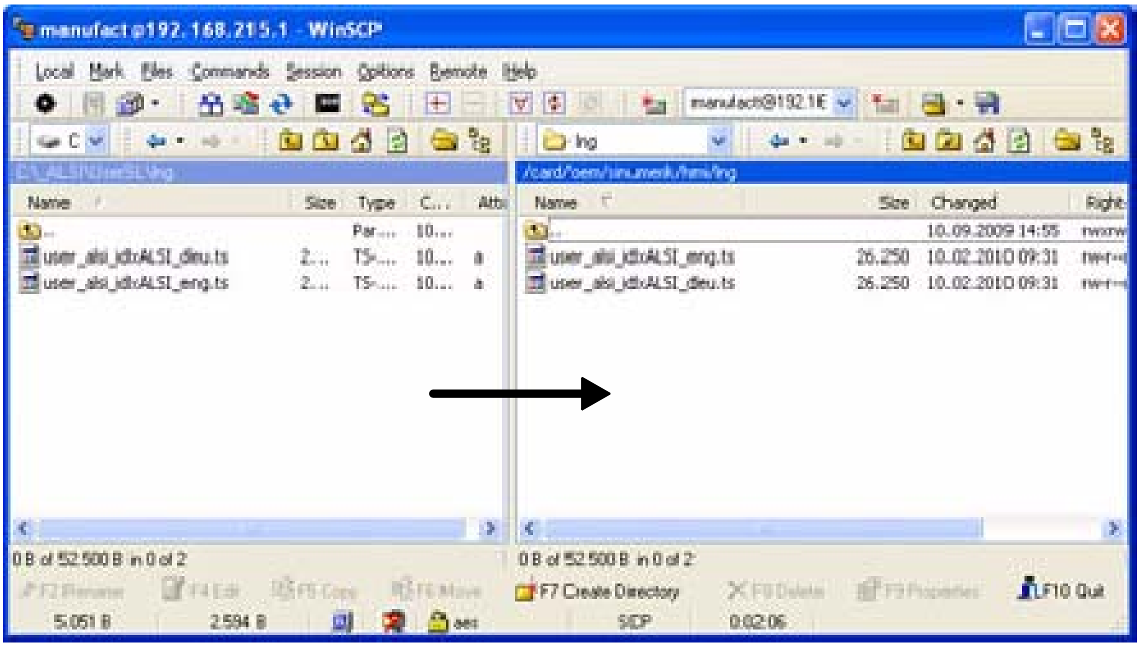


Fig. 10-25 Fig. 10-26 Copying the files into the oem directory using WINSCP

If files with the same name already exist on the CF card, then the contents of the generated files should be supplemented in the already existing ones. Additional information on this is provided in the readme.txt in the installation path of the alarm text converter.

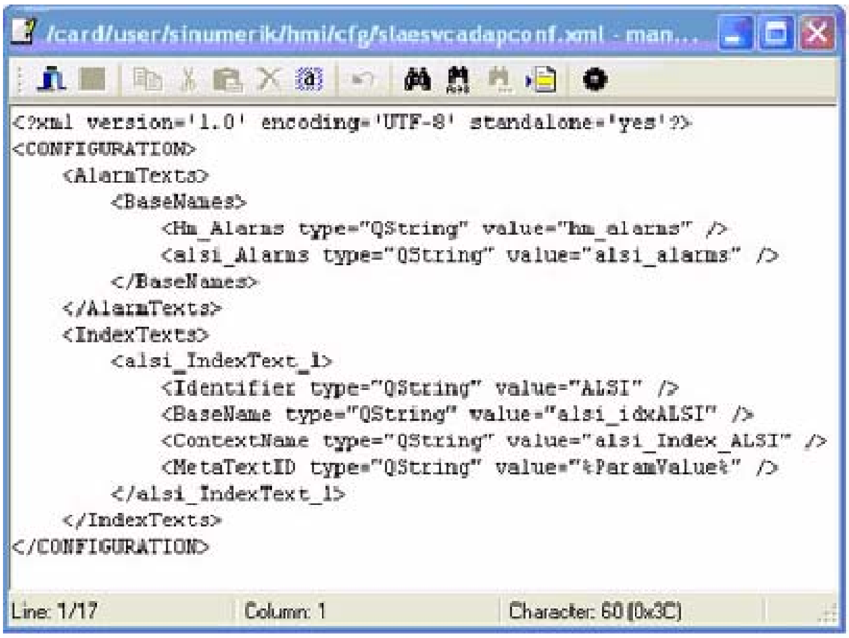


Fig. 10-27 Extending the slaesvcadapconf.xml

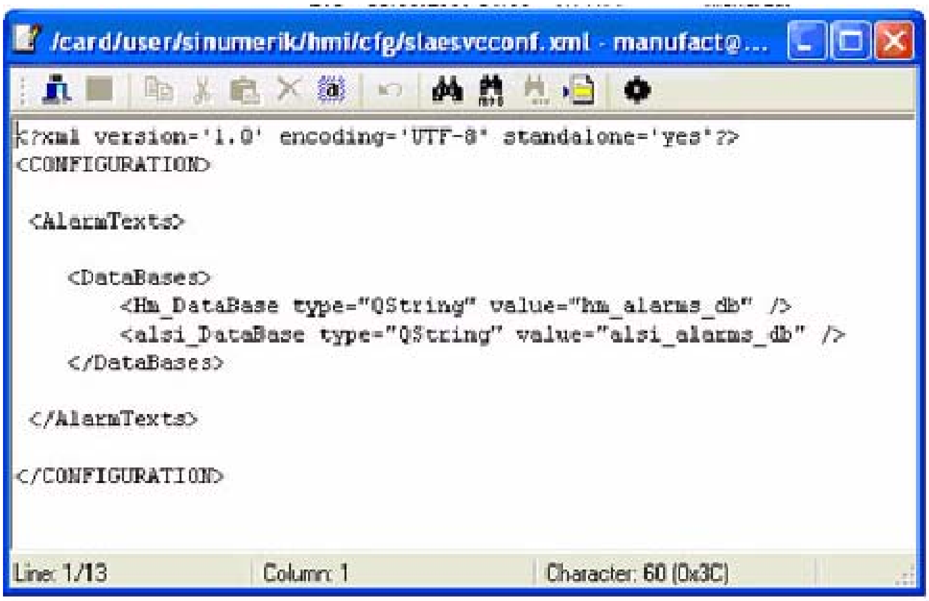


Fig. 10-28 Extending the slaesvcconf.xml

Generating, converting, and integrating SINUMERIK Operate safety user alarms COM files

Generating language-dependent COM files and converting into *.ts files

If there are no HMI Advanced files available, *.com files can be generated and converted into files in the SINUMERIK Operate format using the ”HMI solutionline Alarmtext Converter”.

Example of a syntax of a language-dependent *.com. File (e.g. alsi_gr.com / alsi_uk.com).

```
// Text extension for Alarms 27090 / 27254
;%4 = 000        Error SPL protection (DB18.DBX36.0 / MD11500)
;%4 = 001...064: Error in system variables $A_INSE[01...64]
;%4 = 065...128: Error in system variables $A_OUTSE[01...64]
;%4 = 129...192: Error in system variables $A_INSI[01...64]
;%4 = 193...256: Error in system variables $A_OUTSI[01...64]
;%4 = 257...320: Error in system variables $A_MARKERSI[01...64]

; SPL protection
000000 0 0 ”User text for safety SPL commissioning status (DB18.DBX36.0) / MD11500”

;

000001 0 0 ”User text for INSE(P)01”
000002 0 0 ”User text for INSE(P)02”

...
000063 0 0 ”User text for INSE(P)63”
```

000064 0 0 ”User text for INSE(P)64”

000065 0 0 ”User text for OUTSE(P)01”
000066 0 0 ”User text for OUTSE(P)02”

...
000127 0 0 ”User text for OUTSE(P)63”
000128 0 0 ”User text for OUTSE(P)64”

000129 0 0 ”User text for INSI(P)01”
000130 0 0 ”User text for INSI(P)02”

...
000191 0 0 ”User text for INSI(P)63”
000192 0 0 ”User text for INSI(P)64”

000193 0 0 ”User text for OUTSI(P)01”
000194 0 0 ”User text for OUTSI(P)02”

...
000255 0 0 ”User text for OUTSI(P)63”
000256 0 0 ”User text for OUTSI(P)64”

000257 0 0 ”User text for MARKERSI(P)01”
000258 0 0 ”User text for MARKERSI(P)02”

...
000319 0 0 ”User text for MARKERSI(P)63”
000320 0 0 ”User text for MARKERSI(P)64”

If the *.COM files have been generated, then the SINUMERIK Operate files can be converted as described above.

10.1.4 Servo trace bit graphics for Safety Integrated

General

The servo trace function is one of the measuring functions in the start-up area. Using the servo trace, for drive signals and NCK signals, measurements can be started by entering a measuring time and trigger conditions. The results of the measurements are then graphically displayed. Two curves can be displayed in 2 graphics. The results of the measurements can be saved in files. Further, the graphics can be saved as bitmap file in the HMI data manager – or directly printed out.

Starting the servo trace

The servo trace is called in the operator area "Commissioning/Optimization test/ Servo trace".

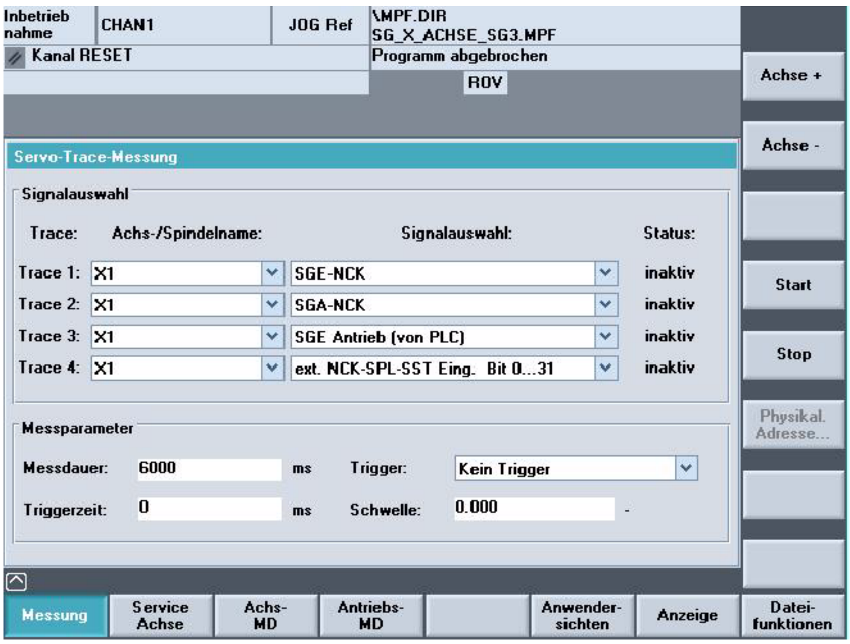


Fig. 10-29 Starting the servo trace

Signal selection

When selecting signals, axes and signal names can be selected from the appropriate lists for a maximum of 4 trace channels (trace 1 to trace 4). Trace 1 has a special significance – a signal must be selected in trace 1 otherwise when the PI service is started using the vertical "start" softkey, this is negatively acknowledged from the NCK.

Measuring parameters

For the measuring parameters, the measuring time, the trigger time, specific thresholds and various trigger signals can be set (e.g. a trigger from the part program). These settings are used to parameterize the PI services at the NCK using the vertical ”start” softkey. A measurement that has already been started can be interrupted using the vertical ”stop” softkey. In this case, the NCK does not supply any measured values.

Physical address

If the physical address entry is selected in the signal selection list, the vertical softkey having the same name is activated. Using the input masks under this softkey, segment values and offset values of NCK system variables etc. can be specified and then measured.

It is possible to scroll through the axes and spindles in the application using the vertical ”Axis +” and ”Axis –” softkeys. The axis name or spindle name is included in the selected selection list for the axis/spindle names.

Selecting SGE drive

The selection of the SI signal SGE drive (from the PLC) is shown in the following:

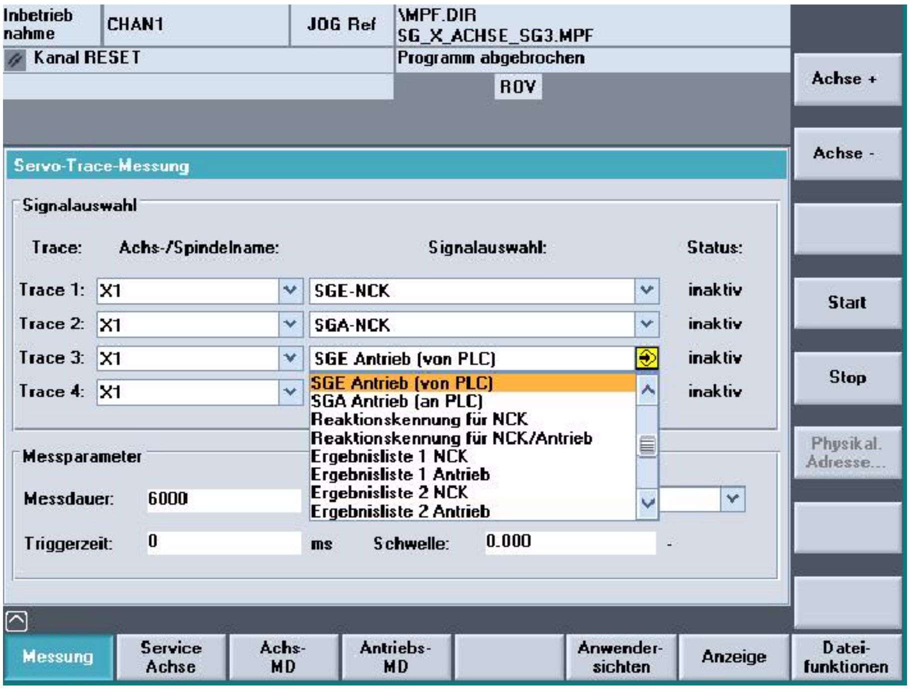


Fig. 10-30 SI signal, SGE drive

After the vertical ”start” softkey is pressed, the measurement is started on the NCK side. An appropriate note is output in the message line.

If the measurement cannot be started, appropriate error information is output. This information can be used to pinpoint the problem.

Display

Once the measurement has been completed, the results of the measurement can be graphically displayed using the horizontal ”display” softkey:

Fig. 10-31   Display of the measurement results

Graphics

Two graphics (graphic 1 and graphic 2) are displayed. Each graphic can include up to two measured value curves that are color-coded (trace 1 in graphic 1: green, trace 2 in graphic 1: blue,   trace 3 in graphic 2: green, trace 4 in graphic 2: blue)

Trace 1 and trace 2 are displayed in graphic 1, trace 3 and trace 4 in in graphic 2. The X axis of the graphics is the time axis and the Y axis is scaled in the physical units of the particular signal.

File functions

Measurement settings and the measured values of the servo trace functions can be saved, downloaded or deleted using the horizontal softkey ”File functions”.

10.1.5 Bit graphics for SI signals in the servo trace

Using the servo trace, individual bits can be selected from bit-coded SI signals and the characteristic over time can be graphically displayed similar to a logic analyzer. Bit characteristics can be displayed as a function of time for 10 character channels (tracks).

Bit-coded SI signals

The bit-coded SI signals are principally sub-divided into two groups:

- SI signals where the system allocates the names of the bits (signals: SGE-NCK, SGA-NCK, SGE-PLC and SGA-PLC)
- SI signals where the user can freely select their names and default names are entered into an Ini file (F:hmi_advibsvtsi.ini). If the user wishes to change the default assignment, he can do this in the file hmi_advibsvtsi.ini or using the appropriate forms in the operator interface.

These different bit-coded SI signals are parameterized on the operator interface.

The settings do not modify the measurement but only how the results of the measurement are actually displayed in the graphic.

No bit graphics are generated for SI signals that are not bit-coded.

The setting options are accessed using the vertical ”bit selection” softkey:

Fig. 10-32 ”Bit selection” softkey

The following screen appears after pressing the vertical ”Bit selection…” softkey:

Fig. 10-33 Bit selection, traces 1 to 4

The vertical ”Bit selection trace 1...”, ”Bit selection trace 2...”, ”Bit selection trace 3...” and ”Bit selection trace 4...” softkeys provided allow, for the SI signals selected in trace channels trace 1 to trace 4, bit names of these SI signals to be assigned a possible 10 character channels (tracks) in the bit graphics for these signals. A dedicated graphic is displayed for trace 1, trace 2, trace 3 and trace 4.

If a bit-coded SI signal is not selected in a trace channel, then when the corresponding softkey is pressed, it has no effect; information is output in the dialog line to signal that it does not involve a bit-coded SI signal.

Bit selection, trace 1...

In the example, the signal ***SGE-NCK*** has been read-in to graphic 1 for trace 1. The following screen is displayed when the vertical ”Bit selection trace 1…” softkey is pressed:

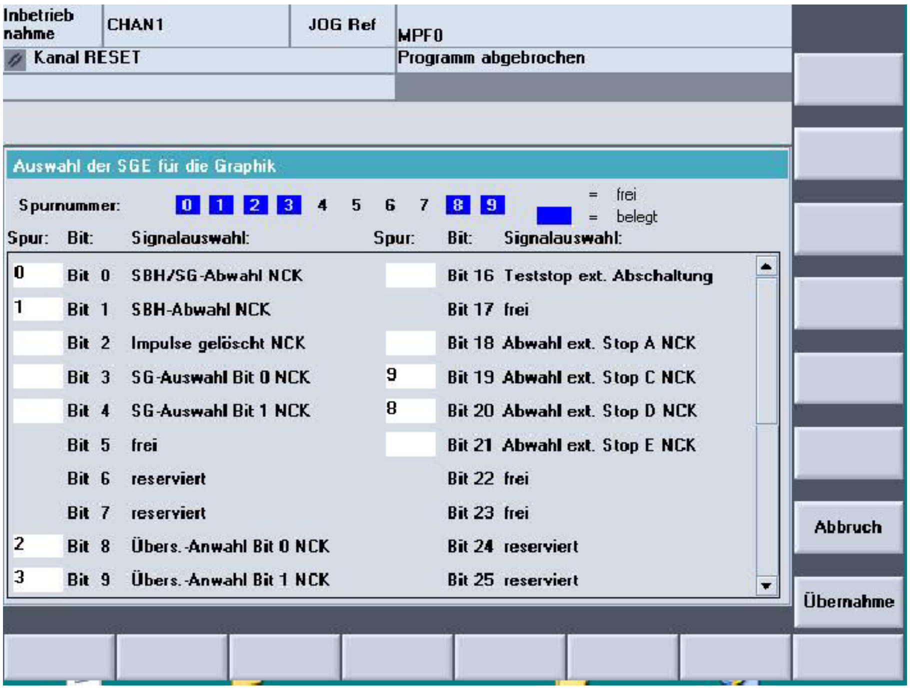


Fig. 10-34 ”Bit selection, trace 1” softkey

The bits of this signal are consecutively numbered. Every bit is permanently assigned an associated bit name. In the input box ”track”, by assigning a value in the range between 0..9 it is possible to define in which of the 10 character channels (tracks) the bit should be graphically displayed. In the example, for trace 1, *bit 0 SBH/SD deselection NCK* is displayed in track 0 of the bit graphic. *Bit 19 deselection ext. Stop C NCK* is displayed in track 9 of the bit graphic for trace 1.

The user is shown which track numbers have already been allocated (in the label ”track number:” they have a blue background) If a track number is allocated twice, an error message is displayed. All of the signal bits are listed; bits that are not available are either designated as free or reserved. Using the scrollbar, it is possible to scroll over the bit range from 0 to bit 31.

Starting values for the track assignments have been entered into the file F:hmi_advibsvtsi.ini. If the user does not like these, then he can make the appropriate changes. These changes to the bit graphics become effective by pressing the vertical ”Accept” softkey and are also transferred into the file hmi_advibsvtsi.ini as new starting values. This means that they also apply for new measurements with this signal as default settings.

Using the vertical ”Abort” softkey, the screen is exited without accepting possible changes made to values.

Bit selection, trace 2... to trace 4...

A similar procedure is also obtained for trace 2.. to trace 4 that, in this particular example, contains the following signals:

Trace 2	SGE drive (from PLC)
Trace 3	SGA-NCK
Trace 4	SG drive (from PLC)

The handling is the same as described under bit selection, trace 1.

Mixing traces...

Using the vertical softkey ”Mix traces”, the user can select individual bits of SI signals from 4 traces and display these in the tracks as bit graphics for comparison purposes. This means that especially inputs and outputs of various SI signals can be combined.

Result of the bit selection

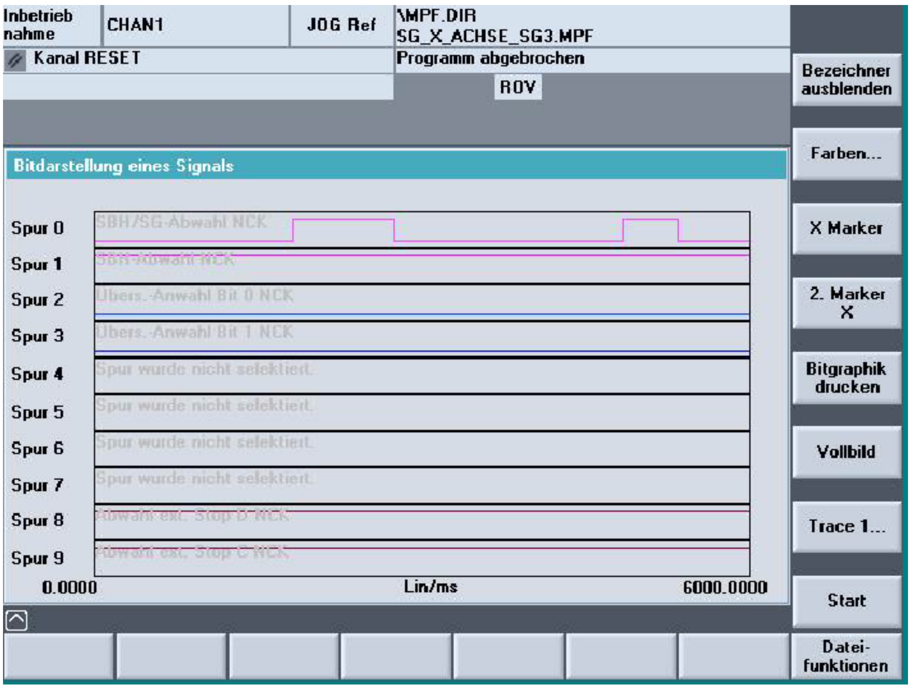


Fig. 10-35 Result of the bit selection

10.1.6 Servo trace signals

The following states are made accessible via the trace functionality:

Table 10-1 Servo trace signals

System quantity	Associated system variable	Update
Safe actual position	$VA_IS[Axis]	Monitoring clock cycle
Safe actual drive position	–	Axis CDC clock cycle
Axial SGE NCK	–	Monitoring clock cycle
Axial SGA NCK	–	Monitoring clock cycle
Axial SGE drive	–	OB1 clock cycle
Axial SGA drive	–	Monitoring clock cycle
Response ID for IPO 0 = no STOP active 1 = STOP F active 2 = STOP E active 3 = STOP D active 4 = STOP C, B or A active Comment: The values returned can deviate from this rule for the duration of the acceptance test mode.	–	Monitoring clock cycle
Response ID for servo/drive 0 = no STOP or STOP F, E, D active 1 = STOP B active 2 = STOP C active 4 = STOP A active Comment: The returned values can deviate from this rule for the duration of the acceptance test mode and the boot phase.	–	Monitoring clock cycle
Result list 1 NCK	–	Monitoring clock cycle
Result list 1, drive	–	Axis CDC clock cycle
Result list 2 NCK	–	Monitoring clock cycle
Result list 2, drive	–	Monitoring clock cycle
Result list 3 NCK	–	Monitoring clock cycle
Result list 3, drive	–	Axis CDC clock cycle
Result list 4 NCK	–	Monitoring clock cycle
Result list 4, drive	–	Axis CDC clock cycle
Result list 5 NCK	–	Monitoring clock cycle
Result list 5, drive	–	Axis CDC clock cycle
Result list 6 NCK	–	Monitoring clock cycle
Result list 6, drive	–	Axis CDC clock cycle
Result list 7 NCK	–	Monitoring clock cycle
Result list 7, drive	–	Axis CDC clock cycle

Table 10-1 Servo trace signals

System quantity	Associated system variable	Update
Safety partial actual value Position change per monitoring clock cycle	–	Monitoring clock cycle
Actual speed limit	–	Monitoring clock cycle
Setpoint speed limit	–	Monitoring clock cycle
Actual value difference NCK drive	–	Axis CDC clock cycle
Actual slip speed NCK drive	–	Axis CDC clock cycle
Actual SBR limit value	–	Monitoring clock cycle
ext. NCK-SPL interface inputs	$A_INSED[1]	IPO cycle clock
ext. NCK-SPL interface inputs	$A_INSED[2]	IPO cycle clock
ext. NCK-SPL interface outputs	$A_OUTSED[1]	IPO cycle clock
ext. NCK-SPL interface outputs	$A_OUTSED[2]	IPO cycle clock
int. NCK-SPL interface inputs	$A_INSID[1]	IPO cycle clock
int. NCK-SPL interface inputs	$A_INSID[2]	IPO cycle clock
int. NCK-SPL interface outputs	$A_OUTSID[1]	IPO cycle clock
int. NCK-SPL interface outputs	$A_OUTSID[2]	IPO cycle clock
ext. PLC-SPL interface inputs	$A_INSEPD[1]	SPL-CDC clock cycle
ext. PLC-SPL interface inputs	$A_INSEPD[2]	SPL-CDC clock cycle
ext. PLC-SPL interface outputs	$A_OUTSEPD[1]	SPL-CDC clock cycle
ext. PLC-SPL interface outputs	$A_OUTSEPD[2]	SPL-CDC clock cycle
int. PLC-SPL interface inputs	$A_INSIPD[1]	SPL-CDC clock cycle
int. PLC-SPL interface inputs	$A_INSIPD[2]	SPL-CDC clock cycle
int. PLC-SPL interface outputs	$A_OUTSIPD[1]	SPL-CDC clock cycle
int. PLC-SPL interface outputs	$A_OUTSIPD[2]	SPL-CDC clock cycle
NCK-SPL markers	$A_MARKERSID[1]	IPO cycle clock
NCK-SPL markers	$A_MARKERSID[2]	IPO cycle clock
PLC-SPL markers	$A_MARKERSIPD[1]	SPL-CDC clock cycle
PLC-SPL markers	$A_MARKERSIPD[2]	SPL-CDC clock cycle
SPL timer 1	$A_TIMERSI[1]	IPO cycle clock
SPL timer 2	$A_TIMERSI[2]	IPO cycle clock
SPL timer 3	$A_TIMERSI[3]	IPO cycle clock
SPL timer 4	$A_TIMERSI[4]	IPO cycle clock
SPL timer 5	$A_TIMERSI[5]	IPO cycle clock
SPL timer 6	$A_TIMERSI[6]	IPO cycle clock
SPL timer 7	$A_TIMERSI[7]	IPO cycle clock
SPL timer 8	$A_TIMERSI[8]	IPO cycle clock
SPL timer 9	$A_TIMERSI[9]	IPO cycle clock

Table 10-1 Servo trace signals

System quantity	Associated system variable	Update
SPL timer 10	$A_TIMERSI[10]	IPO cycle clock
SPL timer 11	$A_TIMERSI[11]	IPO cycle clock
SPL timer 12	$A_TIMERSI[12]	IPO cycle clock
SPL timer 13	$A_TIMERSI[13]	IPO cycle clock
SPL timer 14	$A_TIMERSI[14]	IPO cycle clock
SPL timer 15	$A_TIMERSI[15]	IPO cycle clock
SPL timer 16	$A_TIMERSI[16]	IPO cycle clock
Cam SGA NCK	–	Monitoring clock cycle
SGA drive 16 bit SGA from the drive	–	Monitoring clock cycle
Cam SGA drive	–	Monitoring clock cycle
Actual value difference fine position – redundant coarse position	–	Monitoring clock cycle
Safe smoothed actual velocity value	–	Monitoring clock cycle

The meanings are as follows:

Monitoring clock cycle =	SI monitoring clock cycle
Axis CDC clock cycle =	Cycle for the crosswise data comparison between the NCK and drive
SPL–CDC clock cycle =	Cycle for the crosswise data comparison between the NCK and PLC

10.2 NCK safety alarms for Sinumerik 840D sl

Alarms for SINUMERIK 840D / SINAMICS S120

Detailed explanations of all alarms that are not described here can be found in the following references for the SINUMERIK 840D system with SINAMICS S120:

Reference: /DA/ Diagnostics Manual SINUMERIK 840D
/LH1/ SINAMICS S List Manual

Alarms for SINUMERIK Safety Integrated

The alarms that can occur in connection with the SI option are listed below:

14710 **Channel %1 Block %2 Error in initialization sequence in function %3**

Parameters
%1 = channel number
%2 = block number
%3 = identifier

Explanation
After the control has booted, (program)RESET and (program)START, depending on machine data MD 20110: $MC_RESET_MODE_MASK and MD 20112: %MC_START_MODE_MASK initialization sets generated (or also not generated).
In this case, errors can occur due to incorrect machine data settings.
The errors are output with the same error messages, which are also issued if the function was incorrectly programmed in the part program.
In order to clearly indicate that an error refers to the initialization sequence, in addition, this alarm is generated.
Parameter %3 specifies which function initiated the alarm:
Control boot and (program) RESET:
Value:
0: Error when synchronizing, preprocessing/main run
1: Error when selecting the tool length compensation
2: Error when selecting the transformation
3: Error when selecting the work offset
When booting, the macro definitions and cycle interfaces are also read-in. If an error occurs here, then this is signaled with value=4 or value=5.
6: Error when creating 2 1/2-D protection zones when booting (program) START
Value:
100: Error when synchronizing, preprocessing/main run
101: Error when selecting the tool length compensation
102: Error when selecting the transformation
103: Error when selecting the synchronous spindle
104: Error when selecting the work offset

It is especially important to note that when the tool manager is active, it is possible that a locked tool is in the spindle or in the tool holder that in spite of this should be activated.
For RESET, these tools are activated without having to do anything else. For START, in addition, using MD 22562: $MC_TOOL_CHANGE_ERROR_MODE it can be set whether an alarm should be generated or an automatic bypass strategy should be selected.
If the parameter contains 3 values from 200 to 203, then this means that for certain commands (ASUB start, select overstore, teach in) there are not enough NC blocks for NC block preparation.
Remedy: MD 28070: Increase $MC_MM_NUM_BLOCKS_IN_PREP.

Response

Alarm display
Mode group not ready
NC start inhibit in this channel
Interface signals are set

Remedy

Please inform the authorized personnel/service department
For parameter %3=0-3:
If the alarm(s) occur(s) at RESET:
Check the setting of machine data MD 20110 $MC_RESET_MODE_MASK, MD 20120: $MC_TOOL_RESET_VALUE, MD 20121: $MC_TOOL_PRESEL_RESET_VALUE, MD 20122: $MC_TOOL_RESET_NAME (only when the tool manager is active), MD 20130: $MC_CUTTING_EDGE_RESET_VALUE, MD 20132: $MC_SUMCOR_RESET_VALUE, MD 20126: $MC_TOOL_CARRIER_RESET_VALUE, MD 20150: $MC_GCODE_RESET_VALUES, MD 20154: $MC_EXTERN_GCODE_RESET_VALUES, MD 20140: $MC_TRAFO_RESET_VALUE, MD 21330: $MC_COUPLE_RESET_MODE_1, MD 24002: $MC_CHBFRAME_RESET_MASK.
For parameters %3= 100 -104:
Check the setting of MD 20112: $MC_DTART_MODE_MASK and the machine data "..._RESET_..." specified under RESET. When the tool manager is active, possibly unload the tool - specified in the associated alarm - from toolholder/spindle - or reset the "locked" state.
For parameters %3= 4 or 5:
Check the macrodefinitions in _N_DEF_DIR.
Check cycle directories _N_CST_DIR and _N_CUS_DIR.
For parameter %3= 6:
In addition, Alarm 18002 or 18003 is output. This alarm contains the number of the incorrectly defined protection zone and an identifier defining what is incorrect in the protection zone definition. The system variables must then be appropriately corrected.
For parameter %3= 200 to 203:
MD 28070: Increase $MC_MM_NUM_BLOCKS_IN_PREP.

Program continuation

Clear the alarm with the RESET key. Restart the part program.

14751	**Channel %1 block%2 resources for motion synchronizing actions not sufficient (identifier: %3)**
Parameters	%1 = channel number %2 = block number %3 = identifier
Explanation	To process motion synchronizing actions resources are required. They are configured via the machine data $MC_MM_IPO_BUFFER_SIZE, $MC_MM_NUM_BLOCKS_IN_PREP, $MC_MM_NUM_SAFE_SYNC_ELEMENTS, $MC_MM_NUM_SYNC_ELEMENTS. If these resources are insufficient for executing the part program, then this alarm is issued. The parameter %3 shows which resource has run out: Identifier <= 2: Increase $MC_MM_IPO_BUFFER_SIZE or $MC_MM_NUM_BLOCKS_IN_PREP. Identifier > 2: Increase $MC_MM_NUM_SYNC_ELEMENTS, $MC_MM_NUM_SAFE_SYNC_ELEMENTS.
Response	Alarm display Interface signals are set
Remedy	Correct the part program or increase the resources.

15189	**Channel %1 Block %2 Error executing SAFE.SPF**
Parameters	%1 = channel number %2 = block number, label
Explanation	Alarm 15189 is used to signal that an error has occurred when processing the NC initialization program for Safety Integrated /_N_CST_DIR/_N_SAFE_SPF. Alarm 15189 is output together with the alarm that describes the cause of the error. The function is activated with MD 20108: $MC_PROG_EVENT_MASK, Bit5=1 In order to test or commission a SAFE.SPF there is the MD 10095: $MN_SAFE_MODE_MASK, bit 2.
Response	NCK stop
Remedy	Carry out an NCK reset (warm restart)
Program continuation	Switch control system OFF and ON again.

15420 **Channel %1 Block %2 Instruction in current mode not allowed**

Parameters
%1 = channel number
%2 = block number, label

Explanation
The alarm is output in the following situations:
- When executing an INI file or definition file (macro or GUD), the interpreter has identified an illegal instruction (e.g. traversing command).
- In a GUD file, access protection to a machine data with REDEF is to be changed, although an ACCESS file (_N_SACCESS_DEF, _N_MACCESS_DEF, _NUACCESS_DEF) is available. Access rights for machine data may then only be changed using one of the ACCESS files with REDEF.
- When executing the safety initialization program /_N_CST_DIR/_N_SAFE_SPF, due to the reduced language scope that was configured for the purpose, an illegal statement was identified.

Response
Interpreter stop
NC start inhibit in this channel.
Interface signals are set
Alarm display

Remedy
Correct INI, GUD, or macro file
Correct part program

Program continuation
Clear the alarm with the RESET key. Restart the part program.

16964 **Channel %1 Executing of init blocks not fully completed**

Parameters
%1 Channel number

Explanation
When booting, init blocks are executed. These ensure that the control is correctly initialized. The alarm is output if the execution was not able to be correctly ended (generally due to an already existing alarm).

Response
Alarm display

Remedy
Remove the existing alarm.

Program continuation
Switch control system OFF and ON again.

16965 **Channel %1 SAFE.SPF ramp-up not completed**

Parameters
%1 Channel number

Explanation
The alarm is initiated if the safety program /N_CST_DIR/N_SAFE_SPF should be executed when booting and was not completed after four times the time, which is defined in MD $MN_SPL_START_TIMEOUT. One reason could be an extremely long execution time of SAFE.SPF. The channel number specifies which channel is the cause of the error.

Response	Alarm display NC not ready NC start inhibit in this channel Mode group not ready Interface signals are set NC stop for alarm
Remedy	Increase MD $MN_SAFE_SPL_START_TIMEOUT
Program continuation	Clear the alarm with the RESET key. Restart the part program.

20095 Axis %1 illegal torque, current torque %2

Parameters
%1 = axis name, spindle number
%2 = measured holding torque when selecting the brake test

Explanation
The actually measured holding torque cannot be provided with the existing parameterization of the brake test.

Response
Alarm display
The function test of the mechanical brake system is aborted
The PLC block FB11 for the sequence control to test the mechanical brake system is exited with a fault (fault detection = 2). This means that the request – ”start brake test” – isn't even effective for the axis.

Remedy
Check the actual parameterization of the function test of the mechanical braking system:
- The torque due to weight in drive parameter p1532 should be as far as possible equal to the currently measured holding torque. The measured holding torque is displayed in this alarm.
- The holding torque for the brake test in MD $MA_SAFE_BRAKETEST_TORQUE must be parameterized higher than the currently set holding torque.

Program continuation
Clear the alarm with the Clear key or with NC–START.

20096 Axis %1 brake test aborted, additional info %2

Parameters
%1 = axis name, spindle number
%2 = fault information, based on $VA_FXS_INFO

Explanation
The brake test has detected a problem. The additional information provides details of the cause of the alarm. An explanation is provided in the documentation about the system variables $VA_FXS_INFO
Supplementary info:
0: No additional information available
1: Axis type is neither a PLC nor a command axis
2: Limit position reached, motion stopped
3: Interrupted by an axis RESET (DB31–61, DBB28 bit1)
4: Monitoring window exited
5: Torque reduction rejected by drive
6: PLC has withdrawn the enable signal

Response | Alarm display
Interface signals are set.

Remedy | Note the supplementary conditions of the brake test, refer to supplementary information.

Program continuation | Clear the alarm with the Clear key or with NC-START.

20097 **Axis %1 incorrect direction, brake test**

Parameters: %1 = axis name, spindle number

Explanation: As a result of the selected traversing direction, the brake test is carried out for the existing load torque with an incorrect torque.

Response: Alarm display

Remedy:
- Carry out the brake test in the other traversing direction
- Adapt drive parameter p1532 more precisely to the actual situation. This alarm only occurs if the actual torque deviates by more than 7.5% of SINAMICS parameter p1532
- Using MD $MA_SAFE_BRAKETEST_CONTROL, bit 0 = 1, activate the automatic load torque determination at the beginning of the brake test.

Program continuation: Clear the alarm with the Clear key or with NC-START.

20149 **Channel %1 block%2 motion synchronous action: Index invalid**

Parameters: %1 = channel number
%2 = block number

Explanation: An invalid index was used when accessing a variable in the motion-synchronous action.
Example: ...DO $R[$AC_MARKER[1]] = 100
The error occurs if marker 1 has a higher value than the maximum permissible R-parameter number.

Response: NC start inhibit in this channel
Interface signals are set
Alarm display
NC stop for alarm

Remedy: Use a valid index.

Program continuation: Clear the alarm with the RESET key. Restart the part program.

22001 **Channel %1 Block%2 Axis %3: Braking ramp longer than STOP D time. Reason: %4**

Parameters: %1 Channel number
%2 Block number
%3 Axis name
%4 Identification of cause

Explanation	The actual axis dynamic performance is not sufficient to come to a standstill in time when a STOP D is initiated. The reasons specified in parameter 4 are: 1: $MA_MAX_AX_ACCEL too low 2: $MA_MAX_AX_JERK too low 3: Excessively high acceleration reduction programmed with ACC 4: Excessively high jerk reduction programmed with JERKLIM
Response	Alarm display
Remedy	Increase SAFE_STOP_SWITCH_TIME_D. Increase MAX_AX_ACCEL and MAX_AX_JERK. Increase programmed acceleration (ACC) or jerk (JERKIM) Alarm can be suppressed using MD11415 $MN_SUP-PRESS_ALARM_MASK_2 Bit 13
Program continuation	Clear the alarm with the Clear key or with NC START

22002 **Channel %1 Spindle%2: Braking ramp longer than STOP D time. Gear stage %3. Reason: %4**

Parameters	%1 Channel number %2 Spindle %3 Gear stage %4 Identification of cause
Explanation	The configured dynamic values of the spindle are not sufficient to come to a standstill in time when a STOP D is initiated. Parameter 3 contains the gear stage, whose braking time - from the configured dynamic values - exceeds the STOP D time the most. Parameter 4 includes an ID for the MD involved: 10: Dynamic response for closed-loop speed control: MD35130 $MA_GEAR_STEP_MAX_VELO_LIMIT, MD35200 $MA_GEAR_STEP_SPEEDCTRL_ACCEL 11: Dynamic response for closed-loop position control: MD35135 $MA_GEAR_STEP_PC_MAX_VELO_LIMIT, MD35210 GEAR_STEP_POSCTRL_ACCEL 21: Dynamic response for tapping using G331, G332: MD35135 $MA_GEAR_STEP_PC_MAX_VELO_LIMIT, MD35212 GEAR_STEP_POSCTRL_ACCEL2
Response	Alarm display
Remedy	Increase MD36953 SAFE_STOP_SWITCH_TIME_D or reduce the braking time by changing the configured dynamic response of the spindle. The Alarm can be suppressed using MD11415 $MN_SUP-PRESS_ALARM_MASK_2 Bit 13
Program continuation	Clear the alarm with the Clear key or with NC START

27000 **Axis %1 is not safely referenced**

Parameters
%1 axis number

Explanation
There are two reasons for this alarm:
- the user has still not acknowledged the machine position,
- the machine position has not yet been verified through follow-up referencing.

Even if the axis is already referenced there is no acknowledgement that referencing has supplied the correct result. For example, incorrect results can occur if the axis was moved after the control was powered-down - with the result that the stop position saved prior to powering-down is no longer correct. To ensure that this does not happen, the user must acknowledge the displayed actual position after the first referencing operation.
After the user agreement has been set for the first time, the axis must be subsequently referenced each time that the control is booted (with absolute encoders, this subsequent referencing is automatically executed). This procedure is carried out to verify the stop position saved prior to powering-down the control.
The alarm display can be set using MD $MN_SAFE_ALARM_SUPPRESS_LEVEL (MD>=3) so that the group alarm 27100 is displayed for all SI axes.

Response
Alarm display
The SGA ”axis safely referenced” is not set. SE is disabled if the safety actual position has not yet been acknowledged by the user agreement. If the user agreement is set, SE remains active. The safe cams are calculated and output, but their significance is limited because referencing has not been acknowledged.

Remedy
Move the axis to a known position, change to the ”referencing” mode and press the softkey ”Agreement”. Check the positions in the agreement screen at the machine. If these correspond to those expected at the known position, confirm this using the toggle key. If the user agreement has already been set, re-reference the axis.
The user agreement can only be changed in key-actuated switch setting 3 or after entering a password.

Program continuation
The alarm is no longer displayed when the alarm cause has been removed. No other operator actions are required

Warning

If the axis has not been safely referenced and the user has not issued a user agreement, then the following applies:
- the safe cams are still not safe
- the safe limit positions are still not active

27001 **Axis %1 error in a monitoring channel, Code %2, values: NCK %3, drive %4**

Parameters

%1 = axis number
%2 = supplementary information, crosswise data comparison index
%3 = supplementary information, comparison value, NCK
%4 = supplementary information, comparison value, drive

Explanation

The status of the safety-related monitoring functions are cyclically and mutually compared between the two monitoring channels (NCK and drive). The comparison is carried out separately for each NCK/drive combination.
A criterion in a comparison list is compared between the NCK and drive in each monitoring clock cycle (MD 10091); the next criterion is compared in the next monitoring clock cycle etc. Once the complete comparison list has been processed, the comparisons are processed again from the start. The total comparison time to process the list is displayed in MD 10092 (factor x MD 10091 – the factor can differ depending on the SW version).
The "Error in a monitoring channel" Alarm is only output if the mutual comparison of the two monitoring channels detects a difference between the input data or results of the monitoring. One of the monitoring functions is no longer operating reliably.
The crosswise comparison index, output under %2, is also known as STOP F code. The STOP F code is also output in Alarm 27001 where the NCK detected a crosswise comparison error <u>for the first time</u>. The STOP F code of the drive (belonging to Alarm F30611) can be taken from the diagnostics screen or the drive parameter r9795. If a difference is detected at several comparison steps, then also several STOP F code values can be displayed, alternating, at these positions.
There are error profiles that are identified as a result of several comparison operations of the comparison list. This means that the displayed STOP F code value doesn't always provide a clear statement regarding the cause of the error. The associated procedure is then explained for each of the individual error codes.
The following error codes are possible:

0

No error has been detected in this monitoring channel.
Alarm 27001 means that it was one of the subsequent alarms (follow-on alarms) of alarm F01711 – and the valid STOP F code value is to be determined using the diagnostics display or the drive MD.

1

For the monitoring functions SBH, SG, SBR or SE, a different state has occurred between the NCK and drive. The actual status image (result list 1) is output from the NCK as supplementary input %3 (comparison value, NCK) and the actual status image from the drive is output as supplementary info %4 (comparison value, drive). The two supplementary infos are also saved in drive parameters r9710[0] (NCK) and r9710[1] (drive).

An example for evaluating the bit-coded result list is provided in the description of the drive machine data.

Remedy

The difference in the states between the drive and NCK should be determined and the function involved should be investigated in more detail.

Example

State, NCK: SBH is active and ok

State, drive: SG1 is active and ok

The fault is caused due to the fact that the SGE "SBH deselection" is controlled differently. The signal source should be checked on both the NCK and drive sides. Generally, the different control (in operation) is a result of a hardware failure associated with the sensor signal involved. In the commissioning phase, the cause can also be parameterization or programming errors.

2

For the monitoring function SN or $n < n_x$, a different state has occurred between the NCK and drive.

The actual status image of the NCK (result list 2) is output as supplementary info %3 (comparison value NCK) and the actual status image from the drive is output as supplementary info %4 (comparison value, drive). The two result lists are also written into as parameter r9711[0] (NCK) and r9711[1] (drive). An example for evaluating the bit-coded result list is provided in the description of the drive parameter.

Remedy

The difference in the states between the drive and NCK should be determined and the function involved should be investigated in more detail.

3

The difference between the safe actual value NCK and drive is greater than that set in MD 36942 $MA_SAFE_POS_TOL.

When using the actual value synchronization, the difference of the speed (determined based on the safety actual values) is greater than that set in MD 36949 $MA_SAFE_SLIP_VELO_TOL.

Remedy

Commissioning phase:

The encoder evaluation for the NCK and drive is not correctly set -> correct the encoder evaluation.

In operation:

The actual values differ due to mechanical faults (transmission belts, traversing to mechanical limit, wear and tolerance windows that have been set too narrow, encoder faults...)

-> check the mechanical design and the encoder signals

4

Not assigned.

5

The setting in MD 36901 $MA_SAFE_FUNCTION_ENABLE does not correspond with the associated drive parameter assignment.

Remedy

Copy SI data

6
The setting in MD 36931 $MA_SAFE_VELO_LIMIT[0] does not correspond with the associated drive parameter assignment.
Remedy
Copy SI data
7
The setting in MD 36931 $MA_SAFE_VELO_LIMIT[1] does not correspond with the associated drive parameter assignment.
Remedy
Copy SI data.
8
The setting in MD 36931 $MA_SAFE_VELO_LIMIT[2] does not correspond with the associated drive parameter assignment.
Remedy
Copy SI data.
9
The setting in MD 36931 $MA_SAFE_VELO_LIMIT[3] does not correspond with the associated drive parameter assignment.
Remedy
Copy SI data.
10
The setting in MD 36930 $MA_SAFE_STANDSTILL_TOL does not correspond with the associated drive parameter assignment.
Remedy
Copy SI data.
11
The setting in MD 36934 $MA_SAFE_POS_LIMIT_PLUS[0] does not correspond with the associated drive parameter assignment.
Remedy
Copy SI data.
12
The setting in MD 36935 $MA_SAFE_POS_LIMIT_MINUS[0] does not correspond with the associated drive parameter assignment.
Remedy
Copy SI data.
13
The setting in MD 36934 $MA_SAFE_POS_LIMIT_PLUS[1] does not correspond with the associated drive parameter assignment.
Remedy
Copy SI data.
14
The setting in MD 36935 $MA_SAFE_POS_LIMIT_MINUS[1] does not correspond with the associated drive parameter assignment.
Remedy
Copy SI data.
15
The setting in MD 36936 $MA_SAFE_CAM_POS_PLUS[0] + MD 36940 $MA_SAFE_CAM_TOL does not correspond with the associated drive parameter assignment.

Remedy
Copy SI data.
16
The setting in MD 36936 $MA_SAFE_CAM_POS_PLUS[0] does not correspond with the associated drive parameter assignment.
Remedy
Copy SI data.
17
The setting in MD 36937 $MA_SAFE_CAM_POS_MINUS[0] + MD 36940 $MA_SAFE_CAM_TOL does not correspond with the associated drive parameter assignment.
Remedy
Copy SI data.
18
The setting in MD 36937 $MA_SAFE_CAM_POS_MINUS[0] does not correspond with the associated drive parameter assignment.
Remedy
Copy SI data.
19
The setting in MD 36936 $MA_SAFE_CAM_POS_PLUS[1] + MD 36940 $MA_SAFE_CAM_TOL does not correspond with the associated drive parameter assignment.
Remedy
Copy SI data.
20
The setting in MD 36936 $MA_SAFE_CAM_POS_PLUS[1] does not correspond with the associated drive parameter assignment.
Remedy
Copy SI data.
21
The setting in MD 36937 $MA_SAFE_CAM_POS_MINUS[1] + $MA_SAFE_CAM_TOL does not correspond with the associated drive parameter assignment.
Remedy
Copy SI data.
22
The setting in MD 36937 $MA_SAFE_CAM_POS_MINUS[1] does not correspond with the associated drive parameter assignment.
Remedy
Copy SI data.
23
The setting in MD 36936 $MA_SAFE_CAM_POS_PLUS[2] + MD 36940 $MA_SAFE_CAM_TOL does not correspond with the associated drive parameter assignment.

Remedy
Copy SI data.
24
The setting in MD 36936 $MA_SAFE_CAM_POS_PLUS[2] does not correspond with the associated drive parameter assignment.
Remedy
Copy SI data.
25
The setting in MD 36937 $MA_SAFE_CAM_POS_MINUS[2] + MD 36940 $MA_SAFE_CAM_TOL does not correspond with the associated drive parameter assignment.
Remedy
Copy SI data.
26
The setting in MD 36937 $MA_SAFE_CAM_POS_MINUS[2] does not correspond with the associated drive parameter assignment.
Remedy
Copy SI data.
27
The setting in MD 36936 $MA_SAFE_CAM_POS_PLUS[3] + MD 36940 $MA_SAFE_CAM_TOL does not correspond with the associated drive parameter assignment.
Remedy
Copy SI data.
28
The setting in MD 36936 $MA_SAFE_CAM_POS_PLUS[3] does not correspond with the associated drive parameter assignment.
Remedy
Copy SI data.
29
The setting in MD 36937 $MA_SAFE_CAM_POS_MINUS[3] + MD 36940 $MA_SAFE_CAM_TOL does not correspond with the associated drive parameter assignment.
Remedy
Copy SI data.
30
The setting in MD 36937 $MA_SAFE_CAM_POS_MINUS[3] does not correspond with the associated drive parameter assignment.
Remedy
Copy SI data.
31
The settings in MD 36942 $MA_SAFE_POS_TOL. and MD 36949 $MA_SAFE_SLIP_VELO_TOL do not correspond with the associated drive parameter assignment.

Remedy
Copy SI data.
32
The setting in MD 36944 $MA_SAFE_REFP_POS_TOL does not correspond with the associated drive parameter assignment.
Remedy
Copy SI data.
33
The setting in MD 36951 $MA_SAFE_VELO_SWITCH_DELAY does not correspond with the associated drive parameter assignment.
Remedy
Copy SI data.
34
The setting in MD 36950 $MA_SAFE_MODE_SWITCH_TIME does not correspond with the associated drive parameter assignment.
Remedy
Copy SI data.
35
The setting in MD 36956 $MA_SAFE_PULSE_DISABLE_DELAY does not correspond with the associated drive parameter assignment.
Remedy
Copy SI data.
36
The setting in MD 36957 $MA_SAFE_PULSE_DIS_CHECK_TIME does not correspond with the associated drive parameter assignment.
Remedy
Copy SI data.
37
The setting in MD 36952 $MA_SAFE_STOP_SWITCH_TIME_C does not correspond with the associated drive parameter assignment.
Remedy
Copy SI data.
38
The setting in MD 36953 $MA_SAFE_STOP_SWITCH_TIME_D does not correspond with the associated drive parameter assignment.
Remedy
Copy SI data.
39
The setting in MD 36954 $MA_SAFE_STOP_SWITCH_TIME_E does not correspond with the associated drive parameter assignment.
Remedy
Copy SI data.
40
The setting in MD 36961 $MA_SAFE_VELO_STOP_MODE does not correspond with the associated drive parameter assignment.
Remedy
Copy SI data.

41
The setting in MD 36962 $MA_SAFE_POS_STOP_MODE does not correspond with the associated drive parameter assignment.
Remedy
Copy SI data.
42
The setting in MD 36960 $MA_SAFE_STANDSTILL_VELO_TOL does not correspond with the associated drive parameter assignment.
Remedy
Copy SI data.
43
Stop response, memory test.
44 - 57
Explanation
Fault codes 44-57 cannot be clearly assigned to a fault cause. For the monitoring functions that run internally (e.g. SG), monitoring limits are internally generated that are referred to a monitoring clock cycle.
Example:
SG1 = 2000 mm/min, monitoring clock cycle = 12 ms
If SG1 is active, then a check is made in every monitoring clock cycle (MCC) as to whether SG1 was exceeded.
This means that in MCC[n], based on the actual value, a positive and negative actual value limit is defined that may not be exceeded in MCC[n+1] in order to still comply with SG1.
SG1 = 2000 mm/min = 33.33 mm/s = 0.4 mm/MCC (for each 12 ms)
If the axis moves more than 0.4 mm in a monitoring clock cycle, then SG1 would be violated.
The limit values, specified above, in MCC[n+1] are then
positive: Position actual value (MCC[n]) + 0.4 mm
negative: position actual value (MCC[n]) -0.4 mm
The resulting monitoring limits (positive and negative) that are, in turn determined independently for both monitoring channels (NCK and drive) are also compared just like the safe actual positions (refer to fault code 3). The comparison is for a difference < MD 36942 $MA_SAFE_POS_TOL.
If the difference is greater than MD 36942 $MA_SAFE_POS_TOL, then the appropriate fault code is output.
The limit values are then re-generated and compared in every monitoring cycle independently of whether the associated monitoring function is active or not.
This means that there are three possible causes for this fault code group.

Causes and remedy
Possible cause 1 (only when commissioning or changing the MD)
The tolerance value for the monitoring function is set differently for the NCK and drive. This situation actually only occurs when commissioning the system or making changes and is generally already covered by the previous fault codes.

Remedy: Set the relevant machine data the same.
Possible cause 2 (in operation)
The limit values are determined based on the actual value. This means that when the safe actual values of the NCK and drive differ then the limit values are also different by the defined clearance -> i.e. the fault code corresponds to the fault image of fault code 3. This can be determined by checking the safe actual positions.
Remedy: Refer to fault code 3.
Possible cause 3 (in operation)
The associated monitoring function is already active in a monitoring channel - while in the other monitoring channel another monitoring function is still active. This is the case if the safe actual positions of the NCK and drive do not differ but instead there is an entry in drive parameters r9710/r9711 (and the 1 appears in parameter r9725) -> i.e. the fault code corresponds to the fault profile of fault code 1. This can also be identified using the fault message if for %3 = supplementary info comparison value NCK or %4 = supplementary info comparison value drive no real limit value is output but only the value of the calculated tolerance (refer to the example above (SG1 = 2000 mm/min = 0.4 mm/monitoring clock cycle), a value of 400 would be displayed as 4%).
Remedy: Refer to fault code 1.

44
Upper limit value for SG1 = position actual value + MD 36931 $MA_SAFE_VELO_LIMIT[0] referred to a monitoring clock cycle
Remedy
Refer to Section 44-57 (hidden fault code 3 or 1)

45
Lower limit value for SG1 = position actual value - MD 36931 $MA_SAFE_VELO_LIMIT[0] referred to a monitoring clock cycle
Remedy
Refer to Section 44-57 (hidden fault code 3 or 1)

46
Upper limit value for SG2 = position actual value + MD 36931 $MA_SAFE_VELO_LIMIT[1] referred to a monitoring clock cycle
Remedy
Refer to Section 44-57 (hidden fault code 3 or 1)

47
Lower limit value for SG2 = position actual value - MD 36931 $MA_SAFE_VELO_LIMIT[1] referred to a monitoring clock cycle
Remedy
Refer to Section 44-57 (hidden fault code 3 or 1)

48
Upper limit value for SG3 = position actual value + MD 36931 $MA_SAFE_VELO_LIMIT[2] referred to a monitoring clock cycle
Remedy
Refer to Section 44-57 (hidden fault code 3 or 1)

49
Lower limit value for SG3 = position actual value – MD 36931 $MA_SAFE_VELO_LIMIT[2] referred to a monitoring clock cycle
Remedy
Refer to Section 44–57 (hidden fault code 3 or 1)
50
Upper limit value for SG4 = position actual value + MD 36931 $MA_SAFE_VELO_LIMIT[3] referred to a monitoring clock cycle
Remedy
Refer to Section 44–57 (hidden fault code 3 or 1)
51
Lower limit value for SG4 = position actual value – MD 36931 $MA_SAFE_VELO_LIMIT[3] referred to a monitoring clock cycle
Remedy
Refer to Section 44–57 (hidden fault code 3 or 1)
52
Upper limit value for SBH
Position actual value (when SBH is activated) + MD 36930 $MA_SAFE_STANDSTILL_TOL.
Remedy
Refer to Section 44–57 (hidden fault code 3 or 1)
53
Lower limit value for SBH
Position actual value (when SBH is activated) – MD 36930 $MA_SAFE_STANDSTILL_TOL.
Remedy
Refer to Section 44–57 (hidden fault code 3 or 1)
54
Upper limit value for $n < n_x$ (plus tolerance)
Position actual value + MD 36946 $MA_SAFE_VELO_X (referred to a monitoring clock cycle) + MD 36942 $MA_SAFE_POS_TOL.
Remedy
Refer to Section 44–57 (hidden fault code 3 or 1)
55
Upper limit value for n<nx
Position actual value + MD 36946 $MA_SAFE_VELO_X (referred to a monitoring clock cycle).
Remedy
Refer to Section 44–57 (hidden fault code 3 or 1)
56
Lower limit value for $n< n_x$
Position actual value – MD 36946 $MA_SAFE_VELO_X (referred to a monitoring clock cycle).
Remedy
Refer to Section 44–57 (hidden fault code 3 or 1)
57
Upper limit value for $n < n_x$ (plus tolerance)
Position actual value + MD 36946 $MA_SAFE_VELO_X–(referred to a monitoring clock cycle) – MD 36942 $MA_SAFE_POS_TOL.

Remedy
Refer to Section 44–57 (hidden fault code 3 or 1)
58
There is a difference in the active request for an external STOP. Two factors determine the resulting external STOP request for a monitoring channel.

- The STOP requested via the SGE interface
- The STOP passed-through from the other monitoring channel

The STOP of the active request is specified as fine error code for the NCK and drive.
The following values are possible:
0 = No Stop
2 = Stop E
3 = Stop D
4 = Stop C
7 = Stop A
59
The setting in MD 36932 $MA_SAFE_VELO_OVR_FACTOR[0] does not correspond with the associated drive parameter assignment.
Remedy
Copy SI data.
60
The setting in MD 36932 $MA_SAFE_VELO_OVR_FACTOR[1] does not correspond with the associated drive parameter assignment.
Remedy
Copy SI data.
61
The setting in MD 36932 $MA_SAFE_VELO_OVR_FACTOR[2] does not correspond with the associated drive parameter assignment.
Remedy
Copy SI data.
62
The setting in MD 36932 $MA_SAFE_VELO_OVR_FACTOR[3] does not correspond with the associated drive parameter assignment.
Remedy
Copy SI data.
63
The setting in MD 36932 $MA_SAFE_VELO_OVR_FACTOR[4] does not correspond with the associated drive parameter assignment.
Remedy
Copy SI data.
64
The setting in MD 36932 $MA_SAFE_VELO_OVR_FACTOR[5] does not correspond with the associated drive parameter assignment.
Remedy
Copy SI data.

65
The setting in MD 36932 $MA_SAFE_VELO_OVR_FACTOR[6] does not correspond with the associated drive parameter assignment.
Remedy
Copy SI data.
66
The setting in MD 36932 $MA_SAFE_VELO_OVR_FACTOR[7] does not correspond with the associated drive parameter assignment.
Remedy
Copy SI data.
67
The setting in MD 36932 $MA_SAFE_VELO_OVR_FACTOR[8] does not correspond with the associated drive parameter assignment.
Remedy
Copy SI data.
68
The setting in MD 36932 $MA_SAFE_VELO_OVR_FACTOR[9] does not correspond with the associated drive parameter assignment.
Remedy
Copy SI data.
69
The setting in MD 36932 $MA_SAFE_VELO_OVR_FACTOR[10] does not correspond with the associated drive parameter assignment.
Remedy
Copy SI data.
70
The setting in MD 36932 $MA_SAFE_VELO_OVR_FACTOR[11] does not correspond with the associated drive parameter assignment.
Remedy
Copy SI data.
71
The setting in MD 36932 $MA_SAFE_VELO_OVR_FACTOR[12] does not correspond with the associated drive parameter assignment.
Remedy
Copy SI data.
72
The setting in MD 36932 $MA_SAFE_VELO_OVR_FACTOR[13] does not correspond with the associated drive parameter assignment.
Remedy
Copy SI data.
73
The setting in MD 36932 $MA_SAFE_VELO_OVR_FACTOR[14] does not correspond with the associated drive parameter assignment.
Remedy
Copy SI data.
74
The setting in MD 36932 $MA_SAFE_VELO_OVR_FACTOR[15] does not correspond with the associated drive parameter assignment.

Remedy
Copy SI data.
75
The setting in MD 36946 $MA_SAFE_VELO_X does not correspond with the associated drive parameter assignment.
Remedy
Copy SI data.
76
The setting in MD 36963 $MA_SAFE_VELO_STOP_REACTION[0] does not correspond with the associated drive parameter assignment.
Remedy
Copy SI data.
77
The setting in MD 36963 $MA_SAFE_VELO_STOP_REACTION[1] does not correspond with the associated drive parameter assignment.
Remedy
Copy SI data.
78
The setting in MD 36963 $MA_SAFE_VELO_STOP_REACTION[2] does not correspond with the associated drive parameter assignment.
Remedy
Copy SI data.
79
The setting in MD 36963 $MA_SAFE_VELO_STOP_REACTION[3] does not correspond with the associated drive parameter assignment.
Remedy
Copy SI data.
80
Modulo value, safe cam $MA_SAFE_MODULO_RANGE
Remedy
Copy SI data.
81
The setting in MD 36948 $MA_SAFE_STOP_VELO_TOL does not correspond with the associated drive parameter assignment.
Remedy
Copy SI data.
82
When controlling the SG correction factor-SGEs[0..3] to select the SG correction factor a difference has occurred. If, as supplementary info for a monitoring channel, -1 is output this means that the SG-override function isn't even active.

- SG2 and SG4 are not active.
- Function hasn't even been enabled using the function enable MD 36901/ parameter p9501.

Remedy
Control the SG stage and check the SG-override signals and align the control.
83
The setting in MD 36958 $MA_SAFE_ACCEPTANCE_TST_TIMEOUT does not correspond with the associated drive parameter assignment.
Remedy
Copy SI data.
84
The setting in MD 36955 $MA_SAFE_STOP_SWITCH_TIME_F does not correspond with the associated drive parameter assignment.
Remedy
Copy SI data.
85
The setting in MD 10089 $MN_SAFE_PULSE_DIS_TIME_BUSFAIL does not correspond with the associated drive parameter assignment.
Remedy
Copy SI data.
86
Single-encoder system $MA_SAFE_SINGLE_ENC.
Remedy
Align machine data $MA_SAFE_SINGLE_ENC and drive parameter p9526.
87
Encoder assignment $MA_SAFE_ENC_INPUT_NR.
Remedy
Set $MA_SAFE_ENC_INPUT_NR and drive parameter p9526 so that they are equal.
88
Cam enable: The setting in MD 36903 $MA_SAFE_CAM_ENABLE does not correspond with the drive parameter assignment.
89
The settings for the encoder limit frequency do not match in the two monitoring channels.
Remedy
Replace the hardware.
90
Cam SGA differ by more than the tolerance
Remedy
Cam positions, check $MA_SAFE_CAM_TOL
91
Cam position: The setting in MD 36936 $MA_SAFE_CAM_POS_PLUS[4] + $MA_SAFE_CAM_TOL does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 5+ (+ tolerance). Enter the same MDs.

92
Cam position: The setting in MD 36936 $MA_SAFE_CAM_POS_PLUS[4] does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 5+. Enter the same MDs.
93
Cam position: The setting in MD 36937 $MA_SAFE_CAM_POS_MINUS[4] + $MA_SAFE_CAM_TOL does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 5– (+ tolerance). Enter the same MDs.
94
Cam position: The setting in MD 36937 $MA_SAFE_CAM_POS_MINUS[4] does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 5–. Enter the same MDs.
95
Cam position: The setting in MD 36936 $MA_SAFE_CAM_POS_PLUS[5] + $MA_SAFE_CAM_TOL does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 6+ (+ tolerance). Enter the same MDs.
96
Cam position: The setting in MD 36936 $MA_SAFE_CAM_POS_PLUS[5] does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 6+. Enter the same MDs.
97
Cam position: The setting in MD 36937 $MA_SAFE_CAM_POS_MINUS[5] + $MA_SAFE_CAM_TOL does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 6– (+ tolerance). Enter the same MDs.
98
Cam position: The setting in MD 36937 $MA_SAFE_CAM_POS_MINUS[5] does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 6–. Enter the same MDs.
99
Cam position: The setting in MD 36936 $MA_SAFE_CAM_POS_PLUS[6] + $MA_SAFE_CAM_TOL does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 7+ (+ tolerance). Enter the same MDs.

100
Cam position: The setting in MD 36936 $MA_SAFE_CAM_POS_PLUS[6] does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 7+. Enter the same MDs.
101
Cam position: The setting in MD 36937 $MA_SAFE_CAM_POS_MINUS[6] + $MA_SAFE_CAM_TOL does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 7– (+ tolerance). Enter the same MDs.
102
Cam position: The setting in MD 36937 $MA_SAFE_CAM_POS_MINUS[6] does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 7–. Enter the same MDs.
103
Cam position: The setting in MD 36936 $MA_SAFE_CAM_POS_PLUS[7] + $MA_SAFE_CAM_TOL does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 8+ (+ tolerance). Enter the same MDs.
104
Cam position: The setting in MD 36936 $MA_SAFE_CAM_POS_PLUS[7] does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 8+. Enter the same MDs.
105
Cam position: The setting in MD 36937 $MA_SAFE_CAM_POS_MINUS[7] + $MA_SAFE_CAM_TOL does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 8– (+ tolerance). Enter the same MDs.
106
Cam position: The setting in MD 36937 $MA_SAFE_CAM_POS_MINUS[7] does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 8–. Enter the same MDs.
107
Cam position: The setting in MD 36936 $MA_SAFE_CAM_POS_PLUS[8] + $MA_SAFE_CAM_TOL does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 9+ (+ tolerance). Enter the same MDs.

108
Cam position: The setting in MD 36936 $MA_SAFE_CAM_POS_PLUS[8] does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 9+. Enter the same MDs.
109
Cam position: The setting in MD 36937 $MA_SAFE_CAM_POS_MINUS[8] + $MA_SAFE_CAM_TOL does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 9– (+ tolerance). Enter the same MDs.
110
Cam position: The setting in MD 36937 $MA_SAFE_CAM_POS_MINUS[8] does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 9–. Enter the same MDs.
111
Cam position: The setting in MD 36936 $MA_SAFE_CAM_POS_PLUS[9] + $MA_SAFE_CAM_TOL does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 10+ (+ tolerance). Enter the same MDs.
112
Cam position: The setting in MD 36936 $MA_SAFE_CAM_POS_PLUS[9] does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 10+. Enter the same MDs.
113
Cam position: The setting in MD 36937 $MA_SAFE_CAM_POS_MINUS[9] + $MA_SAFE_CAM_TOL does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 10– (+ tolerance). Enter the same MDs.
114
Cam position: The setting in MD 36937 $MA_SAFE_CAM_POS_MINUS[9] does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 10–. Enter the same MDs.
115
Cam position: The setting in MD 36936 $MA_SAFE_CAM_POS_PLUS[10] + $MA_SAFE_CAM_TOL does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 11+ (+ tolerance). Enter the same MDs.

116
Cam position: The setting in MD 36936 $MA_SAFE_CAM_POS_PLUS[10] does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 11+. Enter the same MDs.
117
Cam position: The setting in MD 36937 $MA_SAFE_CAM_POS_MINUS[10] + $MA_SAFE_CAM_TOL does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 11– (+ tolerance). Enter the same MDs.
118
Cam position: The setting in MD 36937 $MA_SAFE_CAM_POS_MINUS[10] does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 11–. Enter the same MDs.
119
Cam position: The setting in MD 36936 $MA_SAFE_CAM_POS_PLUS[11] + $MA_SAFE_CAM_TOL does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 12+ (+ tolerance). Enter the same MDs.
120
Cam position: The setting in MD 36936 $MA_SAFE_CAM_POS_PLUS[11] does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 12+. Enter the same MDs.
121
Cam position: The setting in MD 36937 $MA_SAFE_CAM_POS_MINUS[11] + $MA_SAFE_CAM_TOL does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 12– (+ tolerance). Enter the same MDs.
122
Cam position: The setting in MD 36937 $MA_SAFE_CAM_POS_MINUS[11] does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 12–. Enter the same MDs.
123
Cam position: The setting in MD 36936 $MA_SAFE_CAM_POS_PLUS[12] + $MA_SAFE_CAM_TOL does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 13+ (+ tolerance). Enter the same MDs.

124
Cam position: The setting in MD 36936 $MA_SAFE_CAM_POS_PLUS[12] does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 13+. Enter the same MDs.
125
Cam position: The setting in MD 36937 $MA_SAFE_CAM_POS_MINUS[12] + $MA_SAFE_CAM_TOL does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 13– (+ tolerance). Enter the same MDs.
126
Cam position: The setting in MD 36937 $MA_SAFE_CAM_POS_MINUS[12] does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 13–. Enter the same MDs.
127
Cam position: The setting in MD 36936 $MA_SAFE_CAM_POS_PLUS[13] + $MA_SAFE_CAM_TOL does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 14+ (+ tolerance). Enter the same MDs.
128
Cam position: The setting in MD 36936 $MA_SAFE_CAM_POS_PLUS[13] does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 14+. Enter the same MDs.
129
Cam position: The setting in MD 36937 $MA_SAFE_CAM_POS_MINUS[13] + $MA_SAFE_CAM_TOL does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 14– (+ tolerance). Enter the same MDs.
130
Cam position: The setting in MD 36937 $MA_SAFE_CAM_POS_MINUS[13] does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 14–. Enter the same MDs.
131
Cam position: The setting in MD 36936 $MA_SAFE_CAM_POS_PLUS[14] + $MA_SAFE_CAM_TOL does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 15+ (+ tolerance). Enter the same MDs.

132
Cam position: The setting in MD 36936 $MA_SAFE_CAM_POS_PLUS[14] does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 15+. Enter the same MDs.
133
Cam position: The setting in MD 36937 $MA_SAFE_CAM_POS_MINUS[14] + $MA_SAFE_CAM_TOL does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 15– (+ tolerance). Enter the same MDs.
134
Cam position: The setting in MD 36937 $MA_SAFE_CAM_POS_MINUS[14] does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 15–. Enter the same MDs.
135
Cam position: The setting in MD 36936 $MA_SAFE_CAM_POS_PLUS[15] + $MA_SAFE_CAM_TOL does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 16+ (+ tolerance). Enter the same MDs.
136
Cam position: The setting in MD 36936 $MA_SAFE_CAM_POS_PLUS[15] does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 16+. Enter the same MDs.
137
Cam position: The setting in MD 36937 $MA_SAFE_CAM_POS_MINUS[15] + $MA_SAFE_CAM_TOL does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 16– (+ tolerance). Enter the same MDs.
138
Cam position: The setting in MD 36937 $MA_SAFE_CAM_POS_MINUS[15] does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 16–. Enter the same MDs.
139
Cam position: The setting in MD 36936 $MA_SAFE_CAM_POS_PLUS[16] + $MA_SAFE_CAM_TOL does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 17+ (+ tolerance). Enter the same MDs.

140
Cam position: The setting in MD 36936 $MA_SAFE_CAM_POS_PLUS[16] does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 17+. Enter the same MDs.
141
Cam position: The setting in MD 36937 $MA_SAFE_CAM_POS_MINUS[16] + $MA_SAFE_CAM_TOL does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 17– (+ tolerance). Enter the same MDs.
142
Cam position: The setting in MD 36937 $MA_SAFE_CAM_POS_MINUS[16] does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 17–. Enter the same MDs.
143
Cam position: The setting in MD 36936 $MA_SAFE_CAM_POS_PLUS[17] + $MA_SAFE_CAM_TOL does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 18+ (+ tolerance). Enter the same MDs.
144
Cam position: The setting in MD 36936 $MA_SAFE_CAM_POS_PLUS[17] does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 18+. Enter the same MDs.
145
Cam position: The setting in MD 36937 $MA_SAFE_CAM_POS_MINUS[17] + $MA_SAFE_CAM_TOL does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 18– (+ tolerance). Enter the same MDs.
146
Cam position: The setting in MD 36937 $MA_SAFE_CAM_POS_MINUS[17] does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 18–. Enter the same MDs.
147
Cam position: The setting in MD 36936 $MA_SAFE_CAM_POS_PLUS[18] + $MA_SAFE_CAM_TOL does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 19+ (+ tolerance). Enter the same MDs.

148
Cam position: The setting in MD 36936 $MA_SAFE_CAM_POS_PLUS[18] does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 19+. Enter the same MDs.
149
Cam position: The setting in MD 36937 $MA_SAFE_CAM_POS_MINUS[18] + $MA_SAFE_CAM_TOL does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 19– (+ tolerance). Enter the same MDs.
150
Cam position: The setting in MD 36937 $MA_SAFE_CAM_POS_MINUS[18] does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 19–. Enter the same MDs.
151
Cam position: The setting in MD 36936 $MA_SAFE_CAM_POS_PLUS[19] + $MA_SAFE_CAM_TOL does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 20+ (+ tolerance). Enter the same MDs.
152
Cam position: The setting in MD 36936 $MA_SAFE_CAM_POS_PLUS[19] does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 20+. Enter the same MDs.
153
Cam position: The setting in MD 36937 $MA_SAFE_CAM_POS_MINUS[19] + $MA_SAFE_CAM_TOL does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 20– (+ tolerance). Enter the same MDs.
154
Cam position: The setting in MD 36937 $MA_SAFE_CAM_POS_MINUS[19] does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 20–. Enter the same MDs.
155
Cam position: The setting in MD 36936 $MA_SAFE_CAM_POS_PLUS[20] + $MA_SAFE_CAM_TOL does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 21+ (+ tolerance). Enter the same MDs.

156
Cam position: The setting in MD 36936 $MA_SAFE_CAM_POS_PLUS[20] does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 21+. Enter the same MDs.
157
Cam position: The setting in MD 36937 $MA_SAFE_CAM_POS_MINUS[20] + $MA_SAFE_CAM_TOL does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 21– (+ tolerance). Enter the same MDs.
158
Cam position: The setting in MD 36937 $MA_SAFE_CAM_POS_MINUS[20] does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 21–. Enter the same MDs.
159
Cam position: The setting in MD 36936 $MA_SAFE_CAM_POS_PLUS[21] + $MA_SAFE_CAM_TOL does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 22+ (+ tolerance). Enter the same MDs.
160
Cam position: The setting in MD 36936 $MA_SAFE_CAM_POS_PLUS[21] does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 22+. Enter the same MDs.
161
Cam position: The setting in MD 36937 $MA_SAFE_CAM_POS_MINUS[21] + $MA_SAFE_CAM_TOL does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 22– (+ tolerance). Enter the same MDs.
162
Cam position: The setting in MD 36937 $MA_SAFE_CAM_POS_MINUS[21] does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 22–. Enter the same MDs.
163
Cam position: The setting in MD 36936 $MA_SAFE_CAM_POS_PLUS[22] + $MA_SAFE_CAM_TOL does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 23+ (+ tolerance). Enter the same MDs.

164
Cam position: The setting in MD 36936 $MA_SAFE_CAM_POS_PLUS[22] does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 23+. Enter the same MDs.
165
Cam position: The setting in MD 36937 $MA_SAFE_CAM_POS_MINUS[22] + $MA_SAFE_CAM_TOL does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 23– (+ tolerance). Enter the same MDs.
166
Cam position: The setting in MD 36937 $MA_SAFE_CAM_POS_MINUS[22] does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 23–. Enter the same MDs.
167
Cam position: The setting in MD 36936 $MA_SAFE_CAM_POS_PLUS[23] + $MA_SAFE_CAM_TOL does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 24+ (+ tolerance). Enter the same MDs.
168
Cam position: The setting in MD 36936 $MA_SAFE_CAM_POS_PLUS[23] does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 24+. Enter the same MDs.
169
Cam position: The setting in MD 36937 $MA_SAFE_CAM_POS_MINUS[23] + $MA_SAFE_CAM_TOL does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 24– (+ tolerance). Enter the same MDs.
170
Cam position: The setting in MD 36937 $MA_SAFE_CAM_POS_MINUS[23] does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 24–. Enter the same MDs.
171
Cam position: The setting in MD 36936 $MA_SAFE_CAM_POS_PLUS[24] + $MA_SAFE_CAM_TOL does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 25+ (+ tolerance). Enter the same MDs.

172
Cam position: The setting in MD 36936 $MA_SAFE_CAM_POS_PLUS[24] does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 25+. Enter the same MDs.
173
Cam position: The setting in MD 36937 $MA_SAFE_CAM_POS_MINUS[24] + $MA_SAFE_CAM_TOL does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 25– (+ tolerance). Enter the same MDs.
174
Cam position: The setting in MD 36937 $MA_SAFE_CAM_POS_MINUS[24] does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 25–. Enter the same MDs.
175
Cam position: The setting in MD 36936 $MA_SAFE_CAM_POS_PLUS[25] + $MA_SAFE_CAM_TOL does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 26+ (+ tolerance). Enter the same MDs.
176
Cam position: The setting in MD 36936 $MA_SAFE_CAM_POS_PLUS[25] does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 26+. Enter the same MDs.
177
Cam position: The setting in MD 36937 $MA_SAFE_CAM_POS_MINUS[25] + $MA_SAFE_CAM_TOL does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 26– (+ tolerance). Enter the same MDs.
178
Cam position: The setting in MD 36937 $MA_SAFE_CAM_POS_MINUS[25] does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 26–. Enter the same MDs.
179
Cam position: The setting in MD 36936 $MA_SAFE_CAM_POS_PLUS[26] + $MA_SAFE_CAM_TOL does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 27+ (+ tolerance). Enter the same MDs.

180
Cam position: The setting in MD 36936 $MA_SAFE_CAM_POS_PLUS[26] does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 27+. Enter the same MDs.
181
Cam position: The setting in MD 36937 $MA_SAFE_CAM_POS_MINUS[26] + $MA_SAFE_CAM_TOL does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 27– (+ tolerance). Enter the same MDs.
182
Cam position: The setting in MD 36937 $MA_SAFE_CAM_POS_MINUS[26] does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 27–. Enter the same MDs.
183
Cam position: The setting in MD 36936 $MA_SAFE_CAM_POS_PLUS[27] + $MA_SAFE_CAM_TOL does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 28+ (+ tolerance). Enter the same MDs.
184
Cam position: The setting in MD 36936 $MA_SAFE_CAM_POS_PLUS[27] does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 28+. Enter the same MDs.
185
Cam position: The setting in MD 36937 $MA_SAFE_CAM_POS_MINUS[27] + $MA_SAFE_CAM_TOL does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 28– (+ tolerance). Enter the same MDs.
186
Cam position: The setting in MD 36937 $MA_SAFE_CAM_POS_MINUS[27] does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 28–. Enter the same MDs.
187
Cam position: The setting in MD 36936 $MA_SAFE_CAM_POS_PLUS[28] + $MA_SAFE_CAM_TOL does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 29+ (+ tolerance). Enter the same MDs.

188
Cam position: The setting in MD 36936 $MA_SAFE_CAM_POS_PLUS[28] does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 29+. Enter the same MDs.
189
Cam position: The setting in MD 36937 $MA_SAFE_CAM_POS_MINUS[28] + $MA_SAFE_CAM_TOL does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 29– (+ tolerance). Enter the same MDs.
190
Cam position: The setting in MD 36937 $MA_SAFE_CAM_POS_MINUS[28] does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 29–. Enter the same MDs.
191
Cam position: The setting in MD 36936 $MA_SAFE_CAM_POS_PLUS[29] + $MA_SAFE_CAM_TOL does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 30+ (+ tolerance). Enter the same MDs.
192
Cam position: The setting in MD 36936 $MA_SAFE_CAM_POS_PLUS[29] does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 30+. Enter the same MDs.
193
Cam position: The setting in MD 36937 $MA_SAFE_CAM_POS_MINUS[29] + $MA_SAFE_CAM_TOL does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 30– (+ tolerance). Enter the same MDs.
194
Cam position: The setting in MD 36937 $MA_SAFE_CAM_POS_MINUS[29] does not correspond with the associated drive parameter assignment.
Remedy
Safe cam 30–. Enter the same MDs.
195
Cam track assignment: The setting in MD 36938 $MA_SAFE_CAM_TRACK_ASSIGN[0] does not correspond with the associated drive parameter assignment.
Remedy
Cam track assignment SN1. Enter the same MDs and check the cam enable and cam parameterization

196
Cam track assignment: The setting in MD 36938 $MA_SAFE_CAM_TRACK_ASSIGN[1] does not correspond with the associated drive parameter assignment.
Remedy
Cam track assignment SN2. Enter the same MDs and check the cam enable and cam parameterization
197
Cam track assignment: The setting in MD 36938 $MA_SAFE_CAM_TRACK_ASSIGN[2] does not correspond with the associated drive parameter assignment.
Remedy
Cam track assignment SN3. Enter the same MDs and check the cam enable and cam parameterization
198
Cam track assignment: The setting in MD 36938 $MA_SAFE_CAM_TRACK_ASSIGN[3] does not correspond with the associated drive parameter assignment.
Remedy
Cam track assignment SN4. Enter the same MDs and check the cam enable and cam parameterization
199
Cam track assignment: The setting in MD 36938 $MA_SAFE_CAM_TRACK_ASSIGN[4] does not correspond with the associated drive parameter assignment.
Remedy
Cam track assignment SN5. Enter the same MDs and check the cam enable and cam parameterization
200
Cam track assignment: The setting in MD 36938 $MA_SAFE_CAM_TRACK_ASSIGN[5] does not correspond with the associated drive parameter assignment.
Remedy
Cam track assignment SN6. Enter the same MDs and check the cam enable and cam parameterization
201
Cam track assignment: The setting in MD 36938 $MA_SAFE_CAM_TRACK_ASSIGN[6] does not correspond with the associated drive parameter assignment.
Remedy
Cam track assignment SN7. Enter the same MDs and check the cam enable and cam parameterization
202
Cam track assignment: The setting in MD 36938 $MA_SAFE_CAM_TRACK_ASSIGN[7] does not correspond with the associated drive parameter assignment.
Remedy
Cam track assignment SN8. Enter the same MDs and check the cam enable and cam parameterization

203
Cam track assignment: The setting in MD 36938 $MA_SAFE_CAM_TRACK_ASSIGN[8] does not correspond with the associated drive parameter assignment.
Remedy
Cam track assignment SN9. Enter the same MDs and check the cam enable and cam parameterization
204
Cam track assignment: The setting in MD 36938 $MA_SAFE_CAM_TRACK_ASSIGN[9] does not correspond with the associated drive parameter assignment.
Remedy
Cam track assignment SN10. Enter the same MDs and check the cam enable and cam parameterization
205
Cam track assignment: The setting in MD 36938 $MA_SAFE_CAM_TRACK_ASSIGN[10] does not correspond with the associated drive parameter assignment.
Remedy
Cam track assignment SN11. Enter the same MDs and check the cam enable and cam parameterization
206
Cam track assignment: The setting in MD 36938 $MA_SAFE_CAM_TRACK_ASSIGN[11] does not correspond with the associated drive parameter assignment.
Remedy
Cam track assignment SN12. Enter the same MDs and check the cam enable and cam parameterization
207
Cam track assignment: The setting in MD 36938 $MA_SAFE_CAM_TRACK_ASSIGN[12] does not correspond with the associated drive parameter assignment.
Remedy
Cam track assignment SN13. Enter the same MDs and check the cam enable and cam parameterization
208
Cam track assignment: The setting in MD 36938 $MA_SAFE_CAM_TRACK_ASSIGN[13] does not correspond with the associated drive parameter assignment.
Remedy
Cam track assignment SN14. Enter the same MDs and check the cam enable and cam parameterization
209
Cam track assignment: The setting in MD 36938 $MA_SAFE_CAM_TRACK_ASSIGN[14] does not correspond with the associated drive parameter assignment.
Remedy
Cam track assignment SN15. Enter the same MDs and check the cam enable and cam parameterization

210
Cam track assignment: The setting in MD 36938 $MA_SAFE_CAM_TRACK_ASSIGN[15] does not correspond with the associated drive parameter assignment.
Remedy
Cam track assignment SN16. Enter the same MDs and check the cam enable and cam parameterization
211
Cam track assignment: The setting in MD 36938 $MA_SAFE_CAM_TRACK_ASSIGN[16] does not correspond with the associated drive parameter assignment.
Remedy
Cam track assignment SN17. Enter the same MDs and check the cam enable and cam parameterization
212
Cam track assignment: The setting in MD 36938 $MA_SAFE_CAM_TRACK_ASSIGN[17] does not correspond with the associated drive parameter assignment.
Remedy
Cam track assignment SN18. Enter the same MDs and check the cam enable and cam parameterization
213
Cam track assignment: The setting in MD 36938 $MA_SAFE_CAM_TRACK_ASSIGN[18] does not correspond with the associated drive parameter assignment.
Remedy
Cam track assignment SN19. Enter the same MDs and check the cam enable and cam parameterization
214
Cam track assignment: The setting in MD 36938 $MA_SAFE_CAM_TRACK_ASSIGN[19] does not correspond with the associated drive parameter assignment.
Remedy
Cam track assignment SN20. Enter the same MDs and check the cam enable and cam parameterization
215
Cam track assignment: The setting in MD 36938 $MA_SAFE_CAM_TRACK_ASSIGN[20] does not correspond with the associated drive parameter assignment.
Remedy
Cam track assignment SN21. Enter the same MDs and check the cam enable and cam parameterization
216
Cam track assignment: The setting in MD 36938 $MA_SAFE_CAM_TRACK_ASSIGN[21] does not correspond with the associated drive parameter assignment.
Remedy
Cam track assignment SN22. Enter the same MDs and check the cam enable and cam parameterization

217
Cam track assignment: The setting in MD 36938 $MA_SAFE_CAM_TRACK_ASSIGN[22] does not correspond with the associated drive parameter assignment.
Remedy
Cam track assignment SN23. Enter the same MDs and check the cam enable and cam parameterization
218
Cam track assignment: The setting in MD 36938 $MA_SAFE_CAM_TRACK_ASSIGN[23] does not correspond with the associated drive parameter assignment.
Remedy
Cam track assignment SN24. Enter the same MDs and check the cam enable and cam parameterization
219
Cam track assignment: The setting in MD 36938 $MA_SAFE_CAM_TRACK_ASSIGN[24] does not correspond with the associated drive parameter assignment.
Remedy
Cam track assignment SN25. Enter the same MDs and check the cam enable and cam parameterization
220
Cam track assignment: The setting in MD 36938 $MA_SAFE_CAM_TRACK_ASSIGN[25] does not correspond with the associated drive parameter assignment.
Remedy
Cam track assignment SN26. Enter the same MDs and check the cam enable and cam parameterization
221
Cam track assignment: The setting in MD 36938 $MA_SAFE_CAM_TRACK_ASSIGN[26] does not correspond with the associated drive parameter assignment.
Remedy
Cam track assignment SN27. Enter the same MDs and check the cam enable and cam parameterization
222
Cam track assignment: The setting in MD 36938 $MA_SAFE_CAM_TRACK_ASSIGN[27] does not correspond with the associated drive parameter assignment.
Remedy
Cam track assignment SN28. Enter the same MDs and check the cam enable and cam parameterization
223
Cam track assignment: The setting in MD 36938 $MA_SAFE_CAM_TRACK_ASSIGN[28] does not correspond with the associated drive parameter assignment.
Remedy
Cam track assignment SN29. Enter the same MDs and check the cam enable and cam parameterization

224
Cam track assignment: The setting in MD 36938 $MA_SAFE_CAM_TRACK_ASSIGN[29] does not correspond with the associated drive parameter assignment.
Remedy
Cam track assignment SN30. Enter the same MDs and check the cam enable and cam parameterization
225
For the "Safe cam track" monitoring function there is a different status between the NCK and drive for cams SN1 to SN6. The actual status image of the NCK (result list 3) is output as supplementary info %3 (comparison value NCK) and the actual status image from the drive is output as %4.
Supplementary infos %3 and %4 are also saved in drive parameters r9735[0] (NCK) and r9735[1] (drive).
Remedy
Result list 3. Check the tolerance of the cams, evaluate the fault code in drive parameter r9735[0,1].
226
For the "Safe cam track" monitoring function there is a different status between the NCK and drive for cams SN7 to SN12. The actual status image of the NCK (result list 4) is output as supplementary info %3 (comparison value NCK) and the actual status image from the drive is output as %4.
Supplementary infos %3 and %4 are also saved in drive parameters r9736[0] (NCK) and r9736[1] (drive).
Remedy
Result list 4. Check the tolerance of the cams, evaluate the fault code in drive parameter r9736[0,1].
227
For the "Safe cam track" monitoring function there is a different status between the NCK and drive for cams SN13 to SN18. The actual status image of the NCK (result list 5) is output as supplementary info %3 (comparison value NCK) and the actual status image from the drive is output as %4.
Supplementary infos %3 and %4 are also saved in drive parameters r9737[0] (NCK) and r9737[1] (drive).
Remedy
Result list 5. Check the tolerance of the cams, evaluate the fault code in drive parameter r9737[0,1].
228
For the "Safe cam track" monitoring function there is a different status between the NCK and drive for cams SN19 to SN24. The actual status image of the NCK (result list 6) is output as supplementary info %3 (comparison value NCK) and the actual status image from the drive is output as %4.
Supplementary infos %3 and %4 are also saved in drive parameters r9738[0] (NCK) and r9738[1] (drive).

Remedy
Result list 6. Check the tolerance of the cams, evaluate the fault code in drive parameter r9738[0,1].
229
For the ”Safe cam track” monitoring function there is a different status between the NCK and drive for cams SN25 to SN30. The actual status image of the NCK (result list 7) is output as supplementary info %3 (comparison value NCK) and the actual status image from the drive is output as %4.
Supplementary infos %3 and %4 are also saved in drive parameters r9739[0] (NCK) and r9739[1] (drive).
Remedy
Result list 7. Check the tolerance of the cams, evaluate the fault code in drive parameter r9739[0,1].
230
Filter time constant for $n<n_x$: the calculation or setting in MD 36945 $MA_SAFE_VELO_X_FILTER_TIME does not correspond with the associated drive value.
Remedy
Copy SI data
231
Velocity hysteresis $n<n_x$: the setting in MD 36947 $MA_SAFE_VELO_X_HYSTERESIS does not correspond with the associated drive parameter assignment.
Remedy
Copy SI data
232
Smoothed actual velocity value for $n<n_x$ does not correspond with the drive value
Remedy
Check $MA_SAFE_VELO_X, $MA_SAFE_VELO_X_HYSTERESIS, $MA_SAFE_VELO_X_FILTER_TIME
233
Velocity actual value n_x: upper limit value for $n<n_x$: MD 36946 $MA_SAFE_VELO_X (applicable only if function synchronization $n<n_x$ active).
Remedy
Check $MA_SAFE_VELO_X, $MA_SAFE_VELO_X_HYSTERESIS, $MA_SAFE_VELO_X_FILTER_TIME, safe smoothed velocity actual value
234
Velocity actual value n_x:+tol: upper limit value for $n<n_x$: – tolerance: MD 36946 $MA_SAFE_VELO_X – MD 36947 $MA_SAFE_VELO_X_HYSTERESIS (applicable only if function synchronization $n<n_x$ active).
Remedy
Check $MA_SAFE_VELO_X, $MA_SAFE_VELO_X_HYSTERESIS, $MA_SAFE_VELO_X_FILTER_TIME, safe smoothed velocity actual value

235
Velocity actual value $-n_x$+tol: lower limit value for n<n_x + tolerance: -MD 36946 $MA_SAFE_VELO_X + MD 36947 $MA_SAFE_VELO_X_HYSTERESIS (applicable only if function synchronization n<n_x active)
Remedy
Check $MA_SAFE_VELO_X, $MA_SAFE_VELO_X_HYSTERESIS, $MA_SAFE_VELO_X_FILTER_TIME, safe smoothed velocity actual value
236
Actual velocity value -nx: lower limit value for n<n_x: -MD 36946 $MA_SAFE_VELO_X (applicable only if function synchronization n<n_x active).
Remedy
Check $MA_SAFE_VELO_X, $MA_SAFE_VELO_X_HYSTERESIS, $MA_SAFE_VELO_X_FILTER_TIME, safe smoothed velocity actual value
237
SGA n<n_x out of tolerance, different.
Remedy
Check $MA_SAFE_VELO_X_HYSTERESIS

Fault fine codes that do not come from the crosswise data comparison

1000
The check timer has expired while the change timer has still not expired. If, in a monitoring channel, an SGE change (e.g. SBH is selected), then the so-called change timer is started (timer value = MD 36950/p9550).
In addition, a so-called checking timer is started in the other channel (timer value = 10xMD 36950).
While the change timer is running, if the same SGE is changed again, the timer value is extended and the check timer in the other channel only runs once.
If the change timer is extended so often that the run time is greater than for the check timer then the fault is output.
Too many signal changes were detected during the checking timer runtime.
Remedy
Determine the SGE involved and the associated hardware signal and investigate the situation. There may be contact problems at the sensor (e.g. poor contact) or there were too many switching operations. If necessary, the behavior can be improved by changing the timer setting.
1001
Only in the drive: Initialization error of the check timer, refer to F01711.
1002
The user agreement is not consistent: The status of the user agreement is, after 2 s has expired, different for both monitoring channels.

%3 = status of the user agreement, NCK.
%4 = status of the user agreement, drive.
This effect can occur if the user agreement is only set or reset through one channel.
An additional fault cause is that if the F code 1003 only occurs in one monitoring channel and then the user agreement is only withdrawn through one channel. This means that code 1002 is then the result of a code 1003 only in one channel.

1003

With the user agreement is set, the difference between the newly determined reference point (NC actual value) after booting (absolute value encoder) or reference point approach [homing] (distance-coded or incremental measuring system) and the safe actual position (saved value + traversing distance) is greater than the reference tolerance MD 36944/p9544. In this case, the user agreement is withdrawn.

Remedy

Check the mechanical system of the axis - it is possible that the axis was moved when powered-down and the actual value last saved by the control no longer corresponds with the new value the next time the system is booted. It is also possible that the tolerance window for the check has been set too narrow. The cause should be determined and after checking the actual values the user agreement can be again reset after an NCK-RESET.

1004

Violated plausibility, user agreement

- Although the user agreement was already set, an attempt was made to set it again.
- The user agreement is set although the axis has still not been referenced.

1005

When activating the SGEs test stop selection, the shutdown path test cannot be carried out because the pulses have already been cancelled.

Remedy

Check the starting conditions for carrying out the test and if required, correct. In the commissioning phase, it is also possible that there is incorrect parameterization (or wiring) for the feedback signal regarding pulse cancellation.

1007

Only in the drive: see F01711
Cyclic communications between the PLC and drive have failed.

Remedy

If required, replace the hardware, drive control.
Check the drive bus and PLC

1008

Only in the drive: see F01711
Data transfer error between the PLC and drive.

Remedy
If required, replace the hardware, drive control.
Check the drive bus and PLC
1009
After activating the SGEs test stop selection, the pulses have still not been cancelled after timer MD 36957/p9557 has elapsed.
1010
Pulses not cancelled for external test stop.
Remedy
Checking the parameterization.
Remedy
Check the parameterization for the timer – it is possible that the value has been selected too low.
1011
The internal status ”acceptance test status” when using the acceptance test support indicates different states for the NCK/drive for at least 2 seconds.
1012
Only in the drive: see F01711
The actual value has violated the plausibility for the higher-level control. The redundant coarse position does not match the actual value.
1013
NCK user agreement from the PLC-SRAM and NCK user agreement from the NCK machine data are different.
Remedy
Re-establish data consistency using power on.
Remedy
Upgrade the Sensor Module software.
1014
NCK axis number from the PLC-SRAM and NCK axis number from the boot operation are different.
Remedy
Re-establish data consistency using power on.
1016
Only in the drive: see F01711
Telegram has failed several times with the same crosswise data comparison data.
In the crosswise comparison clock cycle (= monitoring clock cycle * number of crosswise comparison data) the comparison of the same list data was not carried out several times in a row due to telegram failures.
Remedy
Check communications between the drive and control.
1020
Cyclic communications between the NCK and drive no longer functions.
Remedy
Analyze the other fault/error messages. Restart using power on.
1021
Only in the drive: see F01711
The telegram failed several times in the DRIVE-CLiQ communications

between the Sensor Module and drive. A sign-of-life error in the status word of the Sensor Module was detected several times in a row.
Remedy
Check communications between the Sensor Module and the drive.
1023
Effectiveness test error in the Sensor Module.
Remedy
Check the Sensor Module.
1024
Saved standstill positions of NCK and PLC different.
Remedy
Re-establish data consistency using power on.
1025
The drive or encoder signaled ”parking active” - however the control had not requested ”parking axis”.
Remedy
Check the control signals to select the ”parking” state.
1026
Plausibility error for cam synchronization between NCK and PLC.
Remedy
Check communication between the PLC and drive and between PLC and NCK.

Response

NC start inhibit in this channel
Alarm display
If a safety monitoring function was active (SBH, SG, SE, SN), then a STOP B was also automatically initiated. It is then necessary to power-down the control and power it up again (power on).

Program continuation

Clear the alarm with the RESET key. Restart the part program.
If a STOP B was initiated, then the control must be power-down/powered-up (power on).

27002 **Axis %1 Test stop in progress**

Parameters

%1 = axis number

Explanation

The proper and correct functioning of the shutdown path is presently being tested by setting the SGE ”test stop selection”.

Response

Alarm display

Remedy

This message only provides information for the user.

Program continuation

The alarm is no longer displayed when the alarm cause has been removed. No other operator actions are required.
The alarm automatically disappears after the delay time has expired that is defined in MD $MA_SAFE_PULSE_DIS_CHECK_TIME - and the withdrawal of the SGE ”test stop selection” if the control detects that the drive pulses have been cancelled - i.e. the test has been successfully completed. An unsuccessful test can be recognized as a result of Alarm 27001 with fault code 1005 or Alarm 27024.

27003 Checksum error occurred %1 %2

Parameters

%1 = reference to the code section or table
%2 = table number

Explanation

Checksum error in safety-related code or safety-related data. The safety monitoring functions (Safety Integrated) in the NCK could be corrupted.

Response

Alarm display

Remedy

Please take extreme caution when continuing with any work. It is necessary to power-down/power-up the control (power on). If this fault occurs again, contact the service department.

Program continuation

Power-down the control system and power-up again.

27004 Axis %1 difference safe input %2, NCK %3, drive %4

Parameters

%1 = axis number
%2 = monitoring function involved
%3 = interface identifier, NCK input
%4 = interface identifier, drive input

Explanation

A difference has been detected at the specified safe input. The state of the specified input signal differs in the two monitoring channels NCK and drive during the time set in $MA_SAFE_MODE_SWITCH_TIME.
Monitoring function involved (%2):
SS/SV Difference in SGE ”deselect safe operating stop / safely reduced speed”
SS Difference in SGE ”deselect safe operating stop”
SV Difference in SGE ”select safely reduced speed”
SP Difference in SGE ”select safe limit positions”
SVOVR Difference in SGEs ”select SG correction”

For the case that SGE is parameterized at the SPL interface
<io> = parameterized system variable range (01=$A_INSID, 02=$A_INSED)
<dword> = system variable - double word (1,2)
<bit> = bit number in the system variable - double word (1...32)
<value> = value of the NCK-SGE (0,1)

Interface identifier, drive input (%4):
DBX<byte><bit>=<value>
<byte> = byte number in the axial DB (22, 23, 32, 33)
<bit> = bit number in the byte (0...7)
<value> = value of the drive SGE (0,1)
This alarm can be suppressed using the MD $MN_SAFE_DIAGNOSIS_MASK, bit 0=0.

Response	Alarm display
Remedy	Check the interface of the safety-related input signals (SPL parameterization, PLC-DB supply).
Program continuation	Clear the alarm with the RESET key. Restart the part program.

27005 **Axis %1 error for crosswise data comparison: Static actual value difference**

Parameters	%1 = axis number
Explanation	A difference in the actual values was detected using the crosswise data comparison between NCK and drive monitoring channel. This difference is greater than the maximum tolerance defined in MD $MA_SAFE_POS_TOL. This can be checked using the safe position actual values of the two monitoring channels displayed in the service screen. The alarm is only displayed, if monitoring with absolute reference (SE/SN) has been enabled for the specified axis and if the user agreement has been set. As soon as the user agreement is deleted or the actual difference between the two monitoring channels again drops below the maximum permissible difference, the alarm is cleared.
Response	Alarm display
Remedy	The user agreement must be deleted if the alarm is present as a steady-state alarm. When the control is then rebooted, the machine can be brought into the safe state again and operation resumed by a new referencing process and setting the user agreement. Prior to setting the user agreement, the actual position of the axis displayed in the "User enable" screen must be compared with the current machine position. This is absolutely necessary to ensure proper functioning of the safe limit positions (SE) and safe cams (SN). The user agreement can only be changed in key-actuated switch setting 3 or after entering a password.
Program continuation	The alarm is no longer displayed when the alarm cause has been removed. No other operator actions are required.

27007	**Axis %1 acceptance test mode is active**
Parameters	%1 = axis number
Explanation	An SI acceptance test has been started with the acceptance test wizard at the operator panel. The acceptance test mode is activated for the NCK and drive for the duration of this acceptance test. In the acceptance test mode, SI power on alarms can be acknowledged with the reset key.
Response	Alarm display
Remedy	Deselect the acceptance test, e.g. using the acceptance test Wizard or wait until it has been completed (the duration of the acceptance test can be parameterized using MD $MA_SAFE_ACCEPTANCE_TST_TIMEOUT).
Program continuation	The alarm is no longer displayed when the alarm cause has been removed. No other operator actions are required.

27008	**Axis %1 SW limit switch deactivated**
Parameters	%1 = axis number
Explanation	An SI acceptance test ”safe limit positions” has been started with the acceptance test wizard at the operator panel. For these acceptance tests, the single-channel SW limit switches are deactivated for the axis/spindle in order to ensure that the safe limit positions can be approached.
Response	Alarm display
Remedy	Deselect the acceptance test, e.g. using the acceptance test Wizard or wait for the end of the test.
Program continuation	The alarm is no longer displayed when the alarm cause has been removed. No other operator actions are required.

27010	**Axis %1 tolerance for safe operating stop exceeded**
Parameters	%1 = axis number
Explanation	The axis has moved too far away from the reference position. It has moved farther away than permitted in MD $MA_SAFE_STANDSTILL_TOL. The alarm can be re-configured in the MD $MN_ALARM_REACTION_CHAN_NOREADY (channel not ready). Stop the axis with speed setpoint = 0 (STOP B). As soon as the speed actual value is less than that defined in the MD $MA_SAFE_STANDSTILL_VELO_TOL, at the latest however, after the time in MD $MA_SAFE_PULSE_DISABLE_DELAY expires, the pulses are cancelled (STOP A).

Response
Mode group not ready
Channel not ready
NC start inhibit in this channel
Interface signals are set
Alarm display
NC stop for alarm
Channel not ready

Remedy
Check the tolerance for the standstill monitoring: does the value match the precision and control dynamic performance of the axis?
If not, increase the tolerance. If yes, check the machine for damage and repair it.

Program continuation
Power-down the control and power-up again

27011 **Axis %1 safely reduced speed exceeded**

Parameters
%1 = axis number

Explanation
The axis has moved too quickly and faster than that specified in MD $MA_SAFE_VELO_LIMIT.
When SBH/SG is active in a configuration with a 1-encoder system, the speed that corresponds to the encoder limit frequency was exceeded.
The axis is stopped with STOP A, C, D or E, depending on what has been configured in MD $MA_SAFE_VELO_STOP_MODE or MD $MA_SAFE_VELO_STOP_REACTION.

Response
NC start inhibit in this channel
Interface signals are set
Alarm display
NC stop for alarm

Remedy
If no obvious operator error has occurred: Check the value entered into the MDs, check the SGEs: Was the correct safely reduced speed selected? If the MDs and SGEs are o.k., check the machine for any damage and rectify.

Program continuation
Clear the alarm with the RESET key. Restart the part program.

27012 **Axis %1 safe limit position exceeded**

Parameters
%1 = axis number

Explanation
The axis has passed the limit position entered in MD $MA_SAFE_POS_LIMT_PLUS or MD $MA_SAFE_POS_LIMIT_MINUS.
This axis is stopped with STOP C,D or E, according to the configuration in MD $MA_SAFE_POS_STOP_MODE.

Response
NC start inhibit in this channel
NC start inhibit in this channel
Interface signals are set
Alarm display
NC stop for alarm

Remedy
If no obvious operator error has occurred: Check the value entered in the machine data, check the SGEs: Was the correct one of 2 limit positions selected? If the MDs and SGEs are o.k., check the machine for any damage and rectify.

Program continuation
Clear the alarm with the RESET key. Restart the part program. Withdraw the user agreement for this axis. Then press the RESET key. The program is aborted and the alarm reset. Move the axis - in the JOG mode - to the valid traversing range. After the NC program error has been eliminated and the position of this axis carefully checked, the user agreement can be re-issued and the program can be restarted.

27013 **Axis %1 Safe acceleration monitoring exceeded**

Parameters
%1 = axis number

Explanation
After the initiation of STOP B or C, the speed exceeded the tolerance value entered in MD $MA_SAFE_STOP_VELO_TOL.
The pulses are locked by initiating a STOP A.

Response
Mode group not ready
Channel not ready
NC start inhibit in this channel
Interface signals are set
Alarm display
NC stop for alarm

Remedy
Check the MD $MA_SAFE_STOP_VELO_TOL. Check the braking characteristics of the drive involved.

Program continuation
Power-down the control and power-up again

27020 **Axis %1 STOP E activated**

Parameters
%1 = axis number

Explanation
This alarm comes with alarms 27011 "Safely reduced speed exceeded" or 27012 "Safe limit position exceeded" (according to the configuration in MD 36961: $MA_SAFE_VELO_STOP_MODE, MD 36963: $MA_SAFE_VELO_STOP_REACTION or MD 36962: $MA_SAFE_POS_STOP_MODE) or Alarm 27090 after an SPL crosswise data comparison error occurs.
A LIFTFAST-ASUB (sub-routine) is initiated and the safe operating stop (SBH) is internally activated after the time set in MD 36954: $MA_SAFE_STOP_SWITCH_TIME_E has expired.

Response
NC start inhibit in this channel
Interface signals are set
Alarm display
NC stop for alarm

Remedy
Remove the causes for ”safely reduced speed exceeded” or ”safe limit position exceeded” alarm (refer to a description of the alarms).

Program continuation
Clear the alarm with the RESET key. Restart the part program.

27021 **Axis %1 STOP D activated**

Parameters
%1 = axis number

Explanation
This alarm comes with alarms 27011 ”Safely reduced speed exceeded” or 27012 ”Safe limit position exceeded” (according to the configuration in MD 36961: $MA_SAFE_VELO_STOP_MODE, MD 36963: $MA_SAFE_VELO_STOP_REACTION or MD 36962: $MA_SAFE_POS_STOP_MODE).
”Braking along the path” is initiated and the safe operating stop (SBH) is internally activated after the time set in MD 36953: $MA_SAFE_STOP_SWITCH_TIME_D has expired.

Response
NC start inhibit in this channel
Interface signals are set
Alarm display
NC stop for alarm

Remedy
Remove the causes for ”safely reduced speed exceeded” or ”safe limit position exceeded” alarm (refer to a description of the alarms).

Program continuation
Clear the alarm with the RESET key. Restart the part program.

27022 **Axis %1 STOP C activated**

Parameters
%1 = axis number

Explanation
This alarm comes with alarms 27011 ”Safely reduced speed exceeded” or 27012 ”Safe limit position exceeded” (according to the configuration in MD 36961: $MA_SAFE_VELO_STOP_MODE, MD 36963: $MA_SAFE_VELO_STOP_REACTION or MD 36962: $MA_SAFE_POS_STOP_MODE).
”Braking at the current limit” is initiated and the safe operating stop (SBH) is internally activated after the time, set in MD 36952: $MA_SAFE_STOP_SWITCH_TIME_C has expired.

Response
NC start inhibit in this channel
Interface signals are set
Alarm display
NC stop for alarm

Remedy
Remove the causes for ”safely reduced speed exceeded” or ”safe limit position exceeded” alarm (refer to a description of the alarms).

Program continuation
Clear the alarm with the RESET key. Restart the part program.

27023	**Axis %1: STOP B initiated**
Parameters	%1 = axis number
Explanation	This alarm comes with the alarm 27010 ”Tolerance for safe operating stop exceeded” or after the alarm 27001 ”STOP F initiated” or 2710x ”Difference for function...”. The alarm can be re-configured in the MD ALARM_REACTION_CHAN_NOREADY (channel not ready).
Response	Mode group not ready Channel not ready NC start inhibit in this channel Interface signals are set Alarm display NC stop for alarm ”Braking at the current limit” is initiated and the timer for changeover to STOP A is activated (refer to MD $MA_SAFE_PULSE_DISABLE_DELAY).
Remedy	Remove the cause for ”tolerance for safe standstill exceeded” or for ”STOP F initiated” (refer to the description of the alarms).
Program continuation	Power-down the control and power-up again
27024	**Axis %1 STOP A activated**
Parameters	%1 = axis number
Explanation	This alarm is output as a result of - Alarm 27011 ”safely reduced speed exceeded” (for the appropriate configuring in $MA_SAFE_VELO_STOP_MODE, $MA_SAFE_VELO_STOP_REACTION), - Axis 27013 ”Safe acceleration monitoring exceeded” - Alarm 27023 ”Stop B initiated” - Unsuccessful test stop. The alarm can be re-configured in the MD ALARM_REACTION_CHAN_NOREADY (channel not ready).
Response	Mode group not ready Channel not ready NC start inhibit in this channel Interface signals are set Alarm display NC stop for alarm ”Pulse cancellation” initiated.
Remedy	Remove the causes of - Alarm ”safely reduced speed exceeded”, - Alarm ”Safe acceleration monitoring exceeded” - Alarm ”Stop B initiated” - Unsuccessful test stop. (refer to the description of the alarms).
Program continuation	Power-down the control and power-up again

27032 **Axis %1 checksum error, safety-relevant monitoring functions. Confirmation and acceptance test required!**

Parameters %1 = axis number

Explanation A checksum protects the relevant MDs to parameterize the axial safety functionality. The alarm indicates that the current checksum is no longer the same as the reference checksum that has been saved, i.e. this means that an MD value has either been changed illegally or data is corrupted.
In the commissioning phase (SPL commissioning mode active), an axial group alarm is displayed instead of the axial acceptance test individual alarms. MD $MN_SAFE_ALARM_SUPPRESS_LEVEL can be used to further reduce the alarm display so that only one alarm is displayed for all axes (global group alarm).

Response Mode group not ready
Channel not ready
NC start inhibit in this channel
Interface signals are set
Alarm display
NC stop for alarm

Remedy Check MDs. Have the checksum re-calculated. Safety functions (motion monitoring functions) should be subject to a new acceptance test.

Program continuation Power-down the control and power-up again

27033 **Axis %1 parameterization of the MD %2[%3] not valid**

Parameters %1 = axis number
%2 = machine data identifier
%3 = machine data index

Explanation The parameterization of machine data %2 is incorrect. An additional indication is the field index of the machine data. If the machine data is a single machine data, a zero is specified as array index. This alarm occurs in the following contexts:

- The conversion of the specified MD into the internal computation format resulted in an overflow.
- Error when parameterizing the input/output assignments for the SGEs/SGAs.
- One of the activated cam positions is outside the actual value modulo range.
- The function "actual value synchronization 2-encoder system" (slip) is selected for a single-encoder system or a function with absolute reference (SE/SN) is simultaneously selected .
- $MA_SAFE_FUNCTION_ENABLE
  A safety function was enabled without the safety function SBH/SG having been enabled.
  An axial SGE/SGA was parameterized at the SPL interface (segment number = 4) and the function enable for the external stops (bit 6) is missing.

The cam synchronization was activated via bit 7 without the cams having been enabled via bit 8 ... bit 15 or via $MA_SAFE_CAM_ENABLE.
When enabling the "Safe cam track" function, it is not permitted to set bit 7. The cam synchronization is implicitly active.

- $MA_SAFE_STANDSTILL_VELO_TOL
  For a linear axis, a value greater than 1000 mm/min was entered.
- MD $MA_SAFE_STOP_VELO_TOL
  For a linear axis, a value greater than 20000 mm/min was entered.
- MD $MA_SAFE_SLIP_VELO_TOL
  For a linear axis, a value greater than 1000 mm/min was entered.
- MD $MA_SAFE_POS_TOL
  For a linear axis, a value greater than 10 mm was entered.
- MD $MA_SAFE_REFP_POS_TOL
  For a linear axis, a value greater than 1 mm was entered.
- $MA_SAFE_VELO_X
  For a linear axis, a value greater than 1000 mm/min was entered.
- $MA_SAFE_ENC_GRID_POINT_DIST
  A zero was entered.
- MD $MA_SAFE_ENC_INPUT_NR
  A non-existent measuring circuit was parameterized in this MD.
- MD $MA_SAFE_ENC_RESOL
  A zero was entered.
- $MA_SAFE_MODULO_RANGE
  The parameterized cam modulo range is not an integral multiple of 360 Degrees.
- $MA_SAFE_EXT_STOP_INPUT[0]
  An axial SGE/SGA was parameterized at the SPL interface (segment number = 4) and the SGE "Deselect ext. Stop A" was parameterized inverted (bit 31 = 1) or the SGE "Deselect ext. Stop A" was not parameterized at the SPL interface $A_OUTSI.
- $MN_SAFE_SPL_STOP_MODE
  Value 4 (Stop E) was parameterized without the external Stop E having been enabled in all axes where the SI function was enabled (MD $MA_SAFE_FUNCTION_ENABLE not equal to 0).
  Remedy: Parameterize $MN_SAFE_SPL_STOP_MODE to another stop or in the specified axes, enable the external stop E (set bits 4 and 6 in $MA_SAFE_FUNCTION_ENABLE).
- $MA_SAFE_DRIVE_PS_ADDRESS
  An invalid value (drive parameter p9810 is saved there when booting) was read or the same address was assigned to several axes.
- $MA_SAFE_ENC_PULSE_SHIFT
  It was not possible to internally pre-assign from the drive parameterization as the values must have been entered outside the permissible range. Adapt the encoder parameterization in the drive.
- $MA_SAFE_VELO_OVR_FACTOR
  It was parameterized with decimal places.

- $MA_SAFE_POS_LIMIT_PLUS / $MA_SAFE_POS_LIMIT_MINUS – the entered values have been interchanged. The upper limit is less than or equal to the lower limit.
- $MA_IS_ROT_AX / $MA_SAFE_IS_ROT_AX
  Different settings were made in both MD.
- The limit values for the ”n<n_x” monitoring function, calculated from MD $MA_SAFE_VELO_X and MD $MA_SAFE_POS_TOL are the same magnitude.
- The parameterized cam modulo range MD $MA_SAFE_MO-DULO_RANGE and the modulo range in MD $MA_MO-DULO_RANGE cannot be divided by one another to result in an integral number.
- The mechanical brake system test was enabled in MD $MA_FI-XED_STOP_MODE (bit 1 = 1), without safe operation having been enabled for this axis in MD $MA_SAFE_FUNCTION_ENABLE. The mechanical brake system test is only permissible in this axis with safety functions.
- An illegal value was parameterized in MD $MA_SAFE_VELO_STOP_MODE or MD $MA_SAFE_VELO_STOP_REACTION.
- The function ”Save actual value with incremental encoder” is enabled in MD $MA_ENC_REFP_STATE for the parameterizable incremental encoder, and a monitoring function with absolute reference (SE/SN) is enabled in MD $MA_SAFE_FUNCTION_ENABLE. This combination of functions is not permitted.
- The Alarms 27000/C01797 should be suppressed when parking (MD $MA_SAFE_PARK_ALARM_SUPPRESS=1). In this case, the SGA ”axis safely referenced” must be parameterized using the MD $MA_SAFE_REFP_STATUS_OUTPUT.
- The logical basis address configured in HW config and that addressed via MD $MA_SAFE_CTRLOUT_NR, $MN_SAFE_DRIVE_LO-GIC_ADDRESS do not match or the slot that is addressed has the incorrect length.
- Cam position $MA_SAFE_CAM_POS_PLUS[n] or $MA_SAFE_CAM_POS_MINUS[n] has been parameterized too close to the modulo limit.
- ”Safe cams” have been enabled in $MA_SAFE_FUNC-TION_ENABLE in bits 8....15, while the ”Safe cam track” function was enabled at the same time in $MA_SAFE_CAM_ENABLE.
- The assignment of the logical I/O address of this SI telegram of this drive via $MA_SAFE_DRIVE_LOGIC_ADDRESS does not match the configured telegram (Step 7).

- Minus cam position $MA_SAFE_CAM_POS_MINUS[n] is greater than the plus cam position $MA_SAFE_CAM_POS_PLUS[n]. This is not permitted for the ”safe cam track” function.
- The distance between 2 cams on a cam track ($MA_SAFE_CAM_POS_MINUS[n] and $MA_SAFE_CAM_POS_PLUS[n]) is too short.
- The cam length, i.e. the distance between the plus cam position ($MA_SAFE_CAM_POS_PLUS[n]) and minus cam position ($MA_SAFE_CAM_POS_MINUS[n]) is too short.
- For at least 2 cams enabled in $MA_SAFE_CAM_ENABLE, identical values have been entered into $MA_SAFE_CAM_TRACK_ASSIGN[n].
- The value parameterized in $MA_SAFE_CAM_TRACK_ASSIGN[n] for a cam enabled in $MA_SAFE_CAM_ENABLE is invalid.
- A cam track has been assigned more than 15 cams using $MA_SAFE_CAM_TRACK_ASSIGN[n].
- The cam modulo functionality in $MA_SAFE_MODULO_RANGE is selected but is presently still not supported for the ”safe cam track” function.
- The parameterized monitoring clock cycle $MN_INFO_SAFETY_CYCLE_TIME does not match the monitoring clock cycle (p9500) parameterized in the drive monitoring channel.
- The velocity hysteresis n_x in $MA_SAFE_VELO_X_HYSTERESIS is greater than half the velocity limit n_x in $MA_SAFE_VELO_X.

Response
Mode group not ready
Channel not ready
NC start inhibit in this channel
Interface signals are set
Alarm display
NC stop for alarm

Remedy
Check and modify the MD named in the alarm text. Have the checksum re-calculated. Safety functions should be subject to a new acceptance test.

Program continuation
Power-down the control and power-up again

27034 **Parameterization of MD %1[%2] invalid**

Parameters
%1 = machine data identifier
%2 = machine data index for $MN_SAFE_RDP_SYSVAR_INDEX, $MN_SAFE_SDP_SYSVAR_INDEX

Explanation
The parameterization of machine data %1 is incorrect. This alarm occurs in conjunction with the following:
- An invalid value was set for MD $MN_SAFE_ALARM_SUPPRESS_LEVEL.

- An invalid value was set for MD $MN_SAFE_RDP_SYSVAR_INDEX.
- An invalid value was set for MD $MN_SAFE_SDP_SYSVAR_INDEX.

Response
Mode group not ready
Channel not ready
NC start inhibit in this channel
Interface signals are set
Alarm display
NC stop for alarm

Remedy
Check and correct the specified machine data.

Program continuation
Power-down the control and power-up again

27035 **Axis %1 new HW component, acknowledgement and function test required**

Parameters
%1 = axis number

Explanation
The IDs for the associated HW components (encoder, motor, module) read out of the drive do not match the NCK parameterization.
In the commissioning phase (SPL commissioning mode active), an axial group alarm is displayed instead of the axial acceptance test individual alarms. MD $MN_SAFE_ALARM_SUPPRESS_LEVEL can be used to further reduce the alarm display so that only one alarm is displayed for all axes (global group alarm).

Response
Mode group not ready
Channel not ready
NC start inhibit in this channel
Interface signals are set
Alarm display
NC stop for alarm

Remedy
If the alarm occurs while commissioning, then the following should be done:
- Acknowledge the checksum SAFE_ACT_CHECKSUM[1] (key switch setting 3 or password must be entered), continue with commissioning.

If the alarm occurs after the replacement of an encoder module or DRIVE-CLiQ motor/encoder, then the following should be done:
- In the Diagnostics operator area, acknowledge the hardware checksum SAFE_ACT_CHECKSUM[1] via softkey (key switch setting 3 or password must be entered)
- Re-calibration of the actual value encoder
- Check the SI actual value acquisition: Speeds, traversing direction, absolute position (if required, set the user agreement)
- Document the new checksum value in SAFE_ACT_CHECKSUM[1] and the last entry in the change history in MD SAFE_CONFIG_CHANGE_DATE[0]

- Document the hardware and software version data of the new component

Program continuation
Clear the alarm with the RESET key. Restart the part program.

27036 **Axis %1 encoder parameterization MD %2[%3] was adapted**

Parameters
%1 = axis number
%2 = machine data identifier
%3 = machine data index

Explanation
The encoder parameterization for the SI monitoring functions, read out of the drive, does not match the NCK parameterization displayed in the MD. The appropriate NCK-MD was adapted.

Response
Mode group not ready
Channel not ready
NC start inhibit in this channel
Interface signals are set
Alarm display
NC stop for alarm
In addition, a STOP F is initiated, that can result in the subsequent Alarm 27001 with fault IDs 0, 27023 and 27024. Alarm 27001 with fault ID 0 can be prevented using the alarm reduction ($MA_SAFE_ALARM_SUPPRESS_LEVEL greater than or equal to 1).

Remedy
Continue commissioning, correct checksums.

Program continuation
Power-up and power-down the control

27037 **Axis %1 and %2 with the same PROFIsafe address %3**

Parameters
%1 = axis number
%2 = axis number
%3 = PROFIsafe address

Explanation
The PROFIsafe address read out from the drive is identical for these two axes.

Response
Mode group not ready
Channel not ready
NC start inhibit in this channel
Interface signals are set
Alarm display
NC stop for alarm

Remedy
Correctly set the PROFIsafe address of the drive.

Program continuation
Power-up and power-down the control

27038 **Axis %1 value %2 in drive parameter %3 violates the limits of NCK MD %4**

Parameters
%1 = axis number
%2 = value in the drive parameter
%3 = number of the drive parameter
%4 = name of the NCK machine data

Explanation
Values that violate the permissible value range for an NCK machine data are supplied in a parameter from a Sinamics drive.

Response
Alarm display

Remedy
Investigate as to why incorrect values were entered into the specified parameter (r0979 (PROFIdrive encoder format), r047x (DRIVE-CLiQ encoder format) or r9527 (encoder evaluation type)) (e.g. for internal software errors in the drive, refer to the drive documentation).

Program continuation
Power-up and power-down the control

27039 **Axis %1 parameterization MD %2[%3] was changed, acknowledge and acceptance required**

Parameters
%1 = axis number
%2 = machine data identifier
%3 = machine data index

Explanation
The parameterization for the SI monitoring functions, read out of the drive, does not match the NCK parameterization displayed in the MD.
The appropriate NCK-MD was adapted.
The following relationship exists between NCK MDs and drive parameters:
$MA_SAFE_BRAKETEST_TORQUE_NORM corresponds to p2003

Response
Mode group not ready
Channel not ready
NC start inhibit in this channel
Interface signals are set
Alarm display
NC stop for alarm

Remedy
Continue commissioning, correct checksums.
- for the display of MD $MA_SAFE_BRAKETEST_TORQUE_NORM:
Changes to p2003 must be taken into account when parameterizing MD $MA_SAFE_BRAKETEST_TORQUE. The holding torque to be parameterized for the brake test must be reselected:
$MA_SAFE_BRAKETEST_TORQUE = required test torque of the brake / p2003 * 100
An acceptance test must then be performed to ensure that the brake test functions correctly.

Program continuation
Power-up and power-down the control

27040 **Axis %1 waiting for the Motor Module**

Parameters: %1 = axis name, spindle number

Explanation: Alarm when booting as long as the Motor Module is still not ready for SI. When booting, communications to the Motor Module have still not been established as the safety functions are still not available.
MD $MN_SAFE_ALARM_SUPPRESS_LEVEL can be used to set the alarm display so that only one alarm is displayed for all axes.

Response: Alarm display
Interface signals are set

Remedy: The alarm is continuously active when booting if the drive does not communicate. Otherwise, the alarm is only briefly present and is then automatically cleared again.
Possible causes that the alarm is permanently present:

- The safety motion monitoring functions are only activated in $MA_SAFE_FUNCTION_ENABLE, however, not in the corresponding parameter of the associated drive (p9501).
- The axis -> drive assignment via MD $MA_SAFE_CRTLOUT_MODULE_NR, $MN_SAFE_DRIVE_LOGIC_ADDRESS or p0978 is incorrect
- PROFIBUS connector fallen out.

Program continuation: The alarm is no longer displayed when the alarm cause has been removed. No other operator actions are required.

27050 **Axis %1 failure SI communications**

Parameters: %1 = axis number

Explanation: Communications with the drive for the Safety Integrated motion monitoring functions is additionally monitored. This monitoring function has detected an error.

Response: Alarm display
Interface signals are set
NC start inhibit in this channel
NC stop for alarm
In addition, a STOP F is initiated, that can result in the subsequent Alarm 27001 with fault IDs 0, 27023 and 27024. Alarm 27001 with fault ID 0 can be prevented using the alarm reduction ($MA_SAFE_ALARM_SUPPRESS_LEVEL greater than or equal to 1).

Remedy: Check the connections between the NCK and drive.
Check the configuring of the PROFIBUS telegram (e.g. SI slot configured).
Check the assignment between the NCK SI axis and SI slot ($MA_SAFE_CTRLOUT_MODULE_NR, $MN_SAFE_DRIVE_LOGIC_ADDRESS).
Check the assignment of the telegram configuration for the OEM slave
Check and ensure that the EMC conditions are complied with.

Program continuation: Clear the alarm with the RESET key. Restart the part program.

27060 **Axis %1 checksum error, drive assignment, acknowledgement and acceptance test required!**

Explanation: The axial MDs $MA_SAFE... and $MN_SAFE_DRIVE_LOGIC_ADDRESS are protected by a checksum. The alarm indicates that the actual checksum no longer matches the saved checksum, i.e. that either a piece of data was illegally changed or is corrupt.
In the commissioning phase (SPL commissioning mode active), an axial group alarm is displayed instead of the axial acceptance test individual alarms. MD $MN_SAFE_ALARM_SUPPRESS_LEVEL can be used to further reduce the alarm display so that only one alarm is displayed for all axes (global group alarm).

Response: Alarm display
Interface signals are set
NC start inhibit in this channel
NC stop for alarm
Mode group not ready

Remedy: Check the machine data, recalculate the checksum and correct. Re-accept the safety functions (connections, NCK axis - drive encoder).

Program continuation: Power-down the control and power-up again

27070 **Checksum error, parameterization SPL and SPL interfaces. Confirmation and acceptance test required!**

Explanation: The NCK-MDs $MN_SAFE_IN/OUT...- $MN_PROFISAFE...- $MN_SAFE_SDP/RDP... are protected using a checksum. The alarm indicates that the actual checksum no longer matches the saved checksum, i.e. that either a piece of data was illegally changed or is corrupt.

Response: Alarm display
Interface signals are set
NC start inhibit in this channel
NC stop for alarm
Mode group not ready

Remedy: Check the machine data, recalculate the checksum and confirm. Re-accept the safety functions (PROFIsafe I/O, SPL I/O, FSEND/FRECV).

Program continuation: Power-down the control and power-up again

27071 **Checksum error, safe SPL parameterization. Confirmation and acceptance test required!**

Explanation
The NCK-MDs $MN_SAFE_SPL_USER_DATA are protected by a checksum. The alarm indicates that the actual checksum no longer matches the saved checksum, i.e. that either a piece of data was illegally changed or is corrupt.

Response
Alarm display
Interface signals are set
NC start inhibit in this channel
NC stop for alarm
Mode group not ready

Remedy
Check the machine data, recalculate the checksum and correct. Safety functions should be subject to a new acceptance test.

Program continuation
Power-down the control and power-up again

27072 **Checksum error, enabling safe communication. Confirmation and acceptance test required!**

Explanation
The NCK-MDs $MN_PROFISAFE_..._ENABLE, $MN_SAFE_RDP/SDP_ENABLE are protected by a checksum. The alarm indicates that the actual checksum no longer matches the saved checksum, i.e. that either a piece of data was illegally changed or is corrupt.

Response
Alarm display
Interface signals are set
NC start inhibit in this channel
NC stop for alarm
Mode group not ready

Remedy
Check the machine data, recalculate the checksum and correct. Re-accept the safety functions (PROFIsafe, FSEND/FRECV).

Program continuation
Power-down the control and power-up again

27073 **Checksum error, enabling safe communication. Confirmation and acceptance test required!**

Explanation: The F parameters required for PROFIsafe communication are protected by a checksum. The alarm indicates that the actual checksum no longer matches the saved checksum, i.e. that either a piece of data was illegally changed or is corrupt.

Response: Alarm display
Interface signals are set
NC start inhibit in this channel
NC stop for alarm
Mode group not ready

Remedy: Check the PROFIsafe configuring on the S7 side, recalculate the checksum and correct. Re-accept the safety functions (PROFIsafe I/O).

Program continuation: Power-down the control and power-up again

27090 **Error in crosswise data comparison NCK-PLC %1 [%2], NCK: %3; %4<ALSI>**

Parameters: %1 = name of the system variable in which the error was detected
%2 = supplementary info, system variables - field index
%3 = supplementary information, comparison value, NCK
%4 = supplementary information, crosswise data comparison - field index

Explanation: For the cyclic crosswise data comparison between NCK and PLC, differences have occurred in the data being compared. Parameter %1 specifies the incorrect system variable ($A_INSI, $A_OUTSI, $A_INSE, $A_OUTSE or $A_MARKERSI) with field index %2.
Special situations:

- Display "Error for crosswise Data comparison NCK-PLC, $MN_PREVENT_SYNACT_LOCK[0], ..." means that the SPL commissioning status is set differently in the NCK and PLC.
- Display "Error for crosswise Data comparison NCK-PLC, $MN_SPL_STOP_MODE[0], ..." means that the SPL stop response (Stop D or E) is set differently in the NCK and PLC.
- Display "Error for crosswise data comparison NCK-PLC, TIMEOUT[0], NCK: 0" means that there is a communication error between NCK and PLC, and no crosswise data comparison can be performed.
- Display "Error for crosswise data comparison NCK-PLC, $MN_SAFE_SPL_USER_DATA[n], ..." means that the user data are set differently in the NCK and PLC.
- Display "Error for crosswise data comparison NCK-PLC, $A_FRDP_SUBS[n], $A_FRDP_ERR_REAC[n], ..." means that the specified system variables are different in the NCK and PLC.

Using parameter %4, a specific alarm message can be configured on the HMI for each of the listed system variables:

- **%4 = 0**: Error SPL commissioning status ($MN_PREVENT_SYNACT_LOCK[0,1] - DB18.DBX36.0)
- Error, stop response
  ($MN_SAFE_SPL_STOP_MODE - DB18.DBX36.1)
- Error, user data
  ($MN_SAFE_SPL_USER_DATA - DB18.DBW256, 260, 264, 268)
- Error, programmable FSEND/FRECV data
  $A_FSDP_ERR_REAC[n] - DB18.DBW190, 200, 210
  $A_FRDP_ERR_REAC[n] - DB18.DBW222, 234, 246
  $A_FRDP_SUBS - DB18.DBW220, 232, 244

%4 = 1.... 64: Error in system variables $A_INSE[1...64]
%4 = 65...128: Error in system variables $A_OUTSE[1...64]
%4 = 129...192: Error in system variables $A_INSI[1...64]
%4 = 193...256: Error in system variables $A_OUTSE[1...64]
%4 = 257...320: Error in the system variables $A_MARKERSI[1...64]

In order to parameterize Alarm 27090, file ALSI_xx.com must be incorporated in the data management and communicated to the HMI via MBDDE.INI in Section [IndexTextFiles] ALNX=f:dhmb.diralsi_. The machine manufacturer can re-define this file in order to incorporate sensible supplementary texts in the alarm for his particular machine/system. If the file is to be re-defined, the new file to be created must be made known to the system via MBDDE.INI.
The display of Alarm 27090 can be influenced using the MD $MN_SAFE_ALARM_SUPPRESS_LEVEL: MD $MN_SAFE_ALARM_SUPPRESS_LEVEL = 2 : Alarm 27090 is only displayed for the first data difference found.

Response
Alarm display
A STOP D/E is initiated (this can be set using MD $MN_SPL_STOP_MODE) on all of the axes with safety functionality if the SPL commissioning phase (MD $MN_PREVENT_SYNACT_LOCK[0,1] not equal to 0) has been completed.

Remedy
Analyze the displayed value and evaluate DB18: SPL_DELTA on the PLC side.
Find the difference between the monitoring channels.
Possible causes:
- Incorrect wiring
- Incorrect SPL
- The axial SGEs have been incorrectly assigned to the internal interface $A_OUTSI
- The axial SGAs have been incorrectly assigned to the internal interface $A_INSI
- The SPL-SGEs have been incorrectly assigned to the external interface $A_INSE
- The SPL-SGAs have been incorrectly assigned to the external interface $A_OUTSE

Program continuation
Clear the alarm with the RESET key. Restart the part program.

27091	**Error in crosswise data comparison, NCK-PLC, STOP of %1**
Parameters	%1 = supplementary information about the monitoring channel that has initiated the stop
Explanation	The monitoring channel specified in %1 (NCK or PLC) has initiated a STOP D or E (depending on the parameterization in MD $MN_SAFE_SPL_STOP_MODE). Alarm 27090 provides additional information about the reason for the Stop D/E.
Response	Alarm display A STOP D/E is initiated (this can be set using MD $MN_SPL_STOP_MODE) on all of the axes with safety functionality if the SPL commissioning phase (MD $MN_PREVENT_SYN-ACT_LOCK[0,1] not equal to 0) has been completed.
Remedy	Evaluate the alarm parameters of Alarm 27090 and correct the SPL, or check the I/O modules/wiring or the internal SPL interfaces to the safety monitoring channels in the NCK and drive.
Program continuation	Clear the alarm with the RESET key. Restart the part program.
27092	**Communications interrupted for crosswise data comparison NCK-PLC, error detected by %1**
Parameters	%1 = supplementary information about the detecting monitoring channel
Explanation	The delay stage (1 s) for the communication monitoring has been exceeded in the monitoring channel specified in %1 (NCK or PLC). The other monitoring channel did not send new data within this time.
Response	Alarm display A STOP D/E is initiated (this can be set using MD $MN_SPL_STOP_MODE) on all of the axes with safety functionality if the SPL commissioning phase (MD $MN_PREVENT_SYN-ACT_LOCK[0,1] not equal to 0) has been completed. A timer of 5 s is started - after it has expired - The external NCK-SPL outputs are deleted (cleared) - the PLC goes to stop.
Remedy	Do not start the SPL anymore. Check the system components (PLC must have the correct version of FB15 and have DB18).
Program continuation	Power-down the control and power-up again
27093	**Checksum error NCK-SPL, %1, %2, %3**
Parameters	%1 = supplementary information about the type of error %2 = supplementary information about the reference size %3 = supplementary information about the current size

Explanation	The checksum error in the NCK SPL. The file /_N_CST_DIR/_N_SAFE_SPF was subsequently modified. The safe programmable logic (SPL) in the NCK may be corrupted. Parameter %1 provides further information about the type of change: %1 = FILE_LENGTH: The file length has changed. %1 = FILE_CONTENT: The file contents have changed. %1 = FILE_PROTECT: The access rights to the file are restricted and have been violated as the SPL commissioning phase has been exited. %2 specifies the variable calculated as the reference (file length, checksum over file contents), %3 specifies the current size calculated cyclically.
Response	Alarm display
Remedy	Check the file and when the file was last changed. Reload the original file and start the monitoring system again with a power on.
Program continuation	Power-down the control and power-up again

27094 **Write access to system variable %1 only allowed from NCK-SPL**

Parameters	%1 = name of the safety system variable involved
Explanation	It is only possible to write access one of the safety system variables from the part program /_N_CST_DIR/_N_SAFE_SPF. If this error occurs, an instruction from another part program was detected.
Response	Alarm display
Remedy	Check the part program used to write access safety system variables.
Program continuation	Clear the alarm with the RESET key. Restart the part program.

27095 **%1 SPL protection not activated**

Parameters	%1 = name of the component for which the protection is not activated (NCK or PLC)
Explanation	The protective mechanisms for the SPL have not been activated. The commissioning phase of the SPL has not yet been completed. For an error in the crosswise data comparison between NCK and PLC, a stop response (Stop D or E) is not initiated.
Response	Alarm display
Remedy	Remedy for NCK: Activate the protective mechanisms by writing to MD $MN_PREVENT_SYNACT_LOCK [0,1]. The number range of the synchronous action IDs used in the SPL must be entered in this MD. Remedy for the PLC: Activate the protective mechanisms by setting the appropriate data bit in DB18.
Program continuation	Clear the alarm with the RESET key. Restart the part program.

27096 **SPL start not allowed**

Explanation

To start the SPL in the protected state ($MN_PREVENT_SYN-ACT_LOCK[0,1] not equal to 0), at least one axis must have Safety Integrated functionality activated (via MD $MA_SAFE_FUNC-TION_ENABLE) beforehand. Without this functionality it is only possible to operate the SPL in the commissioning state.

Response

Mode group not ready
Channel not ready
NC start inhibit in this channel
NC stop for alarm
Alarm display
Interface signals are set

Remedy

Commissioning the axial Safety Integrated functionality or cancellation of the SPL protection using MD $MN_PREVENT_SYNACT_LOCK[0,1]

Program continuation

Power-down the control and power-up again

27097 **SPL not started**

Explanation

After the time defined in MD SAFE_SPL_START_TIMEOUT expired, the SPL had not started. Please note MDs 13310: $MN_SAFE_SPL_START_TIMEOUT and 10096 $MN_SAFE_DIA-GNOSIS_MASK, bit 1.

Response

Alarm display

Remedy

Find the reason why SPL did not start. Possible causes could be:
- There is either an NC or drive fault (e.g. after replacing an encoder, Emergency Stop, PROFIsafe alarms)
- There is a syntax error in the SPL itself
- A safety alarm is present (e.g. "safe end position exceeded")
- At PROG_EVENT start, the name or path of the SPL was not correctly written to; observe upper and lower case letters
- Simultaneous start of an ASUB and PROG_EVENT, parameterizing MD 11602 (stop reasons, read-in inhibit)
- Problems when calling FB4/FC9

Program continuation

Power-down the control and power-up again

27098 **SPL commissioning phase completed**

Explanation

The SPL commissioning phase was just ended by changing MD $MN_PREVENT_SYNACT_LOCK.
The /_N_CST_DIR/_N_SAFE_SPF is, from the next power on, subject to the monitoring mechanisms defined for the SPL (access protection, checksum calculation).
Changes to SPL can only be made in the unprotected state.

Response

Alarm display

Remedy	Carry out a power on for the control. Check and monitor the changes of the logic in the SPL using an acceptance test.
Program continuation	Power-down the control and power-up again
27099	**Double assignment in the SPL assignment MD %1[%2] - MD %3[%4]**
Parameters	%1 = $MN_PROFISAFE_IN_ASSIGN, $MN_SAFE_RDP_ASSIGN %2 = Machine data index %3 = $MN_PROFISAFE_IN_ASSIGN, $MN_SAFE_RDP_ASSIGN %4 = Machine data index
Explanation	SPL inputs ($A_INSE) have been assigned twice by various applications in the displayed machine data. These can be: - PROFIsafe communication - F_DP communication Possible values for the alarm parameters: %1 and %3: - $MN_PROFISAFE_IN_ASSIGN - $MN_SAFE_RDP_ASSIGN %2 and %4: MD index
Response	Mode group not ready Channel not ready NC start inhibit in this channel Interface signals are set Alarm display
Remedy	Correctly displayed MD
Program continuation	Switch control system OFF and ON again.

27100 **At least one axis is not safely referenced**

Explanation

There are two reasons for this alarm:
- the machine position of at least one of the axes monitored with SI has not been acknowledged by the user or
- the machine position of at least one of the axes monitored with SI has still not been verified by subsequent referencing

Even if the axis is already referenced there is no acknowledgement that referencing has supplied the correct result. For example, incorrect results can occur if the axis was moved after the control was powered-down - with the result that the stop position saved prior to powering-down is no longer correct.
To ensure that this does not happen, the user must acknowledge the displayed actual position after the first referencing operation.
When the user agreement has been set for the first time, the axis must be subsequently referenced each time that the control is booted (when absolute encoders are used, this subsequent referencing is automatically executed). This procedure is carried out to verify the stop position saved prior to powering-down the control.
The alarm display can be set in MD $MN_SAFE_ALARM_SUPPRESS_LEVEL (MD<3) in such a way that incorrect referencing is displayed separately for each axis.

Response

Alarm display
The SGA "axis safely referenced" is not set. SE is disabled if the safe actual position has not yet been acknowledged by the user agreement. If the user agreement is set, SE remains active. The safe cams are calculated and output, but their significance is limited because referencing has not been acknowledged.

Remedy

Move all of the SI axes to the known positions and change into the "Referencing" mode. Check the positions on the machine displayed in the user agreement screen and set the "User agreement" using the selection/toggle key.
If the user agreement has already been set for the axis, then re-reference the axes. The user agreement can only be changed in key-actuated switch setting 3 or after entering a password.

Program continuation

The alarm is no longer displayed when the alarm cause has been removed. No other operator actions are required.

27101 **Axis %1, difference in function safe operating stop, NCK: %2, drive: %3**

Parameters

%1 = axis number
%2 = monitoring status, safe operating stop
%3 = monitoring status, safe operating stop

Explanation

In the crosswise data comparison of result list 1 between the NCK and drive monitoring channels, a difference was detected in the state of the safe operating stop monitoring.
Safe operating stop: Bit 0,1 in result list 1
Monitoring state (%2, %3):
- OFF = monitoring inactive in this monitoring channel
- OK = monitoring active in this monitoring channel, limit values not violated
- L+ = monitoring active in this monitoring channel, upper limit value violated
- L- = monitoring active in this monitoring channel, lower limit value violated

Response

Alarm display
NC start inhibit in this channel
A STOP F was initiated. If a safety monitoring function was active, then a STOP B was also automatically initiated. It is then necessary to power-down the control and power it up again (power on).

Remedy

Check that the safe inputs in both monitoring channels have switched into the same state within the permissible time tolerance.
For further diagnostics refer to the drive parameters r9710[0], r9710[1] and the servo-trace signals "result list 1 NCK" and "result list 1 drive".

Program continuation

Clear the alarm with the RESET key. Restart the part program.

27102 **Axis %1, difference in function safely reduced speed %2, NCK: %3, drive: %4**

Parameters

%1 = axis number
%2 = SG stage for which the difference was detected
%3 = monitoring status, safely reduced speed
%4 = monitoring status, safely reduced speed

Explanation

In the crosswise data comparison of result list 1 between the NCK and drive monitoring channels, a difference in the monitoring state of the safely reduced speed monitoring was detected.
- Safely reduced speed 1: Bits 6, 7 in result list 1
- Safely reduced speed 2: Bits 8, 9 in result list 1
- Safely reduced speed 3: Bits 10, 11 in result list 1
- Safely reduced speed 4: Bits 12, 13 in result list 1

Monitoring state (%3, %4):
- OFF = monitoring inactive in this monitoring channel
- OK = monitoring active in this monitoring channel, limit values not violated
- L+ = monitoring active in this monitoring channel, upper limit value violated
- L- = monitoring active in this monitoring channel, lower limit value violated

Response
Alarm display
NC start inhibit in this channel
A STOP F was initiated. If a safety monitoring function was active, then a STOP B was also automatically initiated. It is then necessary to power-down the control and power it up again (power on).

Remedy
Check that the safe inputs in both monitoring channels have switched into the same state within the permissible time tolerance.
For further diagnostics refer to the drive parameters r9710[0], r9710[1] and the servo-trace signals "result list 1 NCK" and "result list 1 drive".

Program continuation
Clear the alarm with the RESET key. Restart the part program.

27103 **Axis %1, difference in function safe limit position %2, NCK: %3, drive: %4**

Parameters
%1 = axis number
%2 = number of the SE limit
%3 = monitoring status, safe limit position
%4 = monitoring status, safe limit position

Explanation
In the crosswise data comparison of result list 1 between the NCK and drive monitoring channels, a difference was detected in the monitoring state of the safe limit position monitoring.
- Safe limit position 1: Bits 2, 3 in result list 1
- Safe limit position 2: Bits 4, 5 in result list 1

Monitoring state (%3, %4):
- OFF = monitoring inactive in this monitoring channel
- OK = monitoring active in this monitoring channel, limit values not violated
- L+ = monitoring active in this monitoring channel, upper limit value violated
- L- = monitoring active in this monitoring channel, lower limit value violated

Response
Alarm display
NC start inhibit in this channel
A STOP F was initiated. If a safety monitoring function was active, then a STOP B was also automatically initiated. It is then necessary to power-down/power-up the control (power on).

Remedy
Check that the safe inputs in both monitoring channels have switched into the same state within the permissible time tolerance.
For further diagnostics refer to the drive parameters r9710[0], r9710[1] and the servo-trace signals "result list 1 NCK" and "result list 1 drive".

Program continuation
Clear the alarm with the RESET key. Restart the part program.

27104 **Axis %1, difference in function safe cam plus %2, NCK: %3, drive: %4**

Parameters
%1 = axis number
%2 = number of the cam
%3 = monitoring status, safe cam plus
%4 = monitoring status, safe cam plus

Explanation
In the crosswise comparison of result list 2 (”Safe cams” function) or result list 3/4/5/6/7 (”Safe cam track” function) a difference was identified between the NCK and drive monitoring channels in the monitoring state of the safe cam plus monitoring function.
<u>The following applies to the ”Safe cams” function:</u>
Safe cam 1+: Bits 0, 1 in result list 2
Safe cam 2+: Bits 4, 5 in result list 2
Safe cam 3+: Bits 8, 9 in result list 2
Safe cam 4+: Bits 12, 13 in result list 2

<u>The following applies to the ”Safe cam track” function:</u>
(each of the result lists 3–7 includes 6 cam results)
Safe cam 1+: Bits 0, 1 in result list 3
Safe cam 2+: Bits 4, 5 in result list 3
Safe cam 3+: Bits 8, 9 in result list 3
Safe cam 4+: Bit 12,13 in result list 3
Safe cam 5+: Bit 16,17 in result list 3
Safe cam 6+: Bit 20,21 in result list 3

Safe cam 7+: Bits 0, 1 in result list 4
Safe cam 8+: Bits 4, 5 in result list 4
Safe cam 9+: Bits 8, 9 in result list 4
Safe cam 10+: Bit 12,13 in result list 4
Safe cam 11+: Bit 16,17 in result list 4
Safe cam 12+: Bit 20,21 in result list 4

Safe cam 13+: Bits 0, 1 in result list 5
Safe cam 14+: Bits 4, 5 in result list 5
Safe cam 15+: Bits 8, 9 in result list 5
Safe cam 16+: Bit 12,13 in result list 5
Safe cam 17+: Bit 16,17 in result list 5
Safe cam 18+: Bit 20,21 in result list 5

Safe cam 19+: Bits 0, 1 in result list 6
Safe cam 20+: Bits 4, 5 in result list 6
Safe cam 21+: Bits 8, 9 in result list 6
Safe cam 22+: Bit 12,13 in result list 6
Safe cam 23+: Bit 16,17 in result list 6
Safe cam 24+: Bit 20,21 in result list 6

Safe cam 25+: Bits 0, 1 in result list 7
Safe cam 26+: Bits 4, 5 in result list 7
Safe cam 27+: Bits 8, 9 in result list 7
Safe cam 28+: Bit 12,13 in result list 7
Safe cam 29+: Bit 16,17 in result list 7
Safe cam 30+: Bit 20,21 in result list 7

Monitoring state (%3, %4):
- OFF = monitoring inactive in this monitoring channel
- OK = monitoring active in this monitoring channel, limit values not violated
- L+ = monitoring active in this monitoring channel, upper limit value violated
- L- = monitoring active in this monitoring channel, lower limit value violated

Response

Alarm display
NC start inhibit in this channel
A STOP F was initiated. If a safety monitoring function was active, then a STOP B was also automatically initiated. It is then necessary to power-down/power-up the control (power on).

Remedy

If a safety monitoring function was active (SBH, SG, SE, SN), then a STOP B was also automatically initiated. It is then necessary to power-down the control and power it up again (power on).
Check that the safe actual values in both monitoring channels match.
Drive parameters r9711[0,1] (diagnostics, result list 2 [NCK, drive]) or r9735[0,1] / r9736[0,1] / r9737[0,1] /r9738[0,1] / r9739[0,1] (diagnostics, result list 3/4/5/6/7 [NCK, drive]) can be used for further diagnostics. Further, diagnostics is possible using the servo trace signals "Result list 2/3/4/5/6/7 NCK" and "Result list 2/3/4/5/6/7 drive".

Program continuation

Clear the alarm with the RESET key. Restart the part program.

27105 Axis %1, difference in function safe cam minus %2, NCK: %3, drive: %4

Parameters

%1 = axis number
%2 = number of the cam
%3 = monitoring status, safe cam minus
%4 = monitoring status, safe cam minus

Explanation

In the crosswise comparison of result list 2 ("Safe cams" function) or result list 3/4/5/6/7 ("Safe cam track" function) a difference was identified between the NCK and drive monitoring channels in the monitoring state of the safe cam minus monitoring function.
The following applies to the "Safe cams" function:
Safe cam 1-: Bits 2, 3 in result list 2
Safe cam 2-: Bits 6, 7 in result list 2
Safe cam 3-: Bit 10,11 in result list 2
Safe cam 4-: Bit 14,15 in result list 2

The following applies to the ”Safe cam track” function:
(each of the result lists 3–7 includes 6 cam results)
Safe cam 1–: Bits 2, 3 in result list 3
Safe cam 2–: Bits 6, 7 in result list 3
Safe cam 3–: Bit 10,11 in result list 3
Safe cam 4–: Bit 14,15 in result list 3
Safe cam 5–: Bit 18,19 in result list 3
Safe cam 6–: Bit 22,23 in result list 3

Safe cam 7–: Bits 2, 3 in result list 4
Safe cam 8–: Bits 6, 7 in result list 4
Safe cam 9–: Bit 10,11 in result list 4
Safe cam 10–: Bit 14,15 in result list 4
Safe cam 11–: Bit 18,19 in result list 4
Safe cam 12–: Bit 22,23 in result list 4

Safe cam 13–: Bits 2, 3 in result list 5
Safe cam 14–: Bits 6, 7 in result list 5
Safe cam 15–: Bit 10,11 in result list 5
Safe cam 16–: Bit 14,15 in result list 5
Safe cam 17–: Bit 18,19 in result list 5
Safe cam 18–: Bit 22,23 in result list 5

Safe cam 19–: Bits 2, 3 in result list 6
Safe cam 20–: Bits 6, 7 in result list 6
Safe cam 21–: Bit 10,11 in result list 6
Safe cam 22–: Bit 14,15 in result list 6
Safe cam 23–: Bit 18,19 in result list 6
Safe cam 24–: Bit 22,23 in result list 6

Safe cam 25–: Bits 2, 3 in result list 7
Safe cam 26–: Bits 6, 7 in result list 7
Safe cam 27–: Bit 10,11 in result list 7
Safe cam 28–: Bit 14,15 in result list 7
Safe cam 29–: Bit 18,19 in result list 7
Safe cam 30–: Bit 22,23 in result list 7

Monitoring state (%3, %4):
- OFF = monitoring inactive in this monitoring channel
- OK = monitoring active in this monitoring channel, limit values not violated
- L+ = monitoring active in this monitoring channel, upper limit value violated
- L– = monitoring active in this monitoring channel, lower limit value violated

Response | Alarm display
NC start inhibit in this channel
A STOP F was initiated. If a safety monitoring function was active, then a STOP B was also automatically initiated. It is then necessary to power-down/power-up the control (power on).

Remedy | Check that the safe actual values in both monitoring channels match. Drive parameters r9711[0,1] (diagnostics, result list 2 [NCK, drive]) or r9735[0,1] / r9736[0,1] / r9737[0,1] /r9738[0,1] / r9739[0,1] (diagnostics, result list 3/4/5/6/7 [NCK, drive]) can be used for further diagnostics. Further, diagnostics is possible using the servo trace signals "Result list 2/3/4/5/6/7 NCK" and "Result list 2/3/4/5/6/7 drive".

Program continuation | Clear the alarm with the RESET key. Restart the part program.

27106 **Axis %1, difference for the function safely-reduced speed n_x, NCK: %2, drive: %3**

Parameters | %1 = axis number
%2 = monitoring status, safely reduced speed n_x
%3 = monitoring status, safely reduced speed n_x

Explanation | In the crosswise data comparison of result list 2 between the NCK and drive monitoring channels, a difference was detected in the monitoring state of the safely reduced speed n_x monitoring.
- Safely reduced speed n_x+: Bits 16, 17 in result list 2
- Safely reduced speed n_x-: Bits 18, 19 in result list 2

Monitoring state (%2, %3):
- OFF = monitoring inactive in this monitoring channel
- OK = monitoring active in this monitoring channel, limit values not violated
- L+ = monitoring active in this monitoring channel, upper limit value violated
- L- = monitoring active in this monitoring channel, lower limit value violated

Response | Alarm display
NC start inhibit in this channel
A STOP F was initiated. If a safety monitoring function was active, then a STOP B was also automatically initiated. It is then necessary to power-down/power-up the control (power on).

Remedy | Check that the safe actual values in both monitoring channels match. For further diagnostics refer to the drive parameters r9711[0], r9711[1] and the servo-trace signals "result list 2 NCK" and "result list 2 drive".

Program continuation | Clear the alarm with the RESET key. Restart the part program.

27107 **Axis %1, difference with cam modulo monitoring function, NCK: %2, drive: %3**

Parameters
%1 = axis number
%2 = monitoring status, safe cam modulo range
%3 = monitoring status, safe cam modulo range

Explanation
In the crosswise data comparison of result list 2 between the NCK and drive monitoring channels, a difference was detected in the monitoring status of the cam modulo range monitoring. Safe cam modulo range: Bits 20, 21 in result list 2
Monitoring state (%2, %3):

- OFF = monitoring inactive in this monitoring channel
- OK = monitoring active in this monitoring channel, limit values not violated
- L+ = monitoring active in this monitoring channel, upper limit value violated
- L- = monitoring active in this monitoring channel, lower limit value violated

Response
Alarm display
NC start inhibit in this channel
A STOP F was initiated. If a safety monitoring function was active, then a STOP B was also automatically initiated. It is then necessary to power-down/power-up the control (power on).

Remedy
Check that the safe actual values in both monitoring channels match. For further diagnostics refer to the drive parameters r9711[0], r9711[1] and the servo-trace signals ”result list 2 NCK” and ”result list 2 drive”.

Program continuation
Clear the alarm with the RESET key. Restart the part program.

27110 **Axis %1 data transfer error, index %2**

Parameters
%1 = axis number
%2 = index in the crosswise data comparison

Explanation
Communication errors between the NCK and drive have meant that for three times in a row, the crosswise data comparison of the data with the specified index was not able to be carried out.

Response
Alarm display
In addition, a STOP F is initiated, that can result in the subsequent Alarm 27001 with fault IDs 0, 27023 and 27024. Alarm 27001 with fault ID 0 can be prevented using the alarm reduction ($MA_SAFE_ALARM_SUPPRESS_LEVEL greater than or equal to 1).

Remedy

Check the connections between the NCK and drive
Check the configuring of the PROFIBUS telegram (e.g. SI slot configured).
Check the assignment between the NCK SI axis and SI slot ($MA_SAFE_CTRLOUT_MODULE_NR, $MN_SAFE_DRIVE_LOGIC_ADDRESS).
Check the assignment of the telegram configuration for the OEM slave.
Replace the hardware
Check and ensure that the EMC conditions are complied with.

Program continuation

Clear the alarm with the RESET key. Restart the part program.

27111 **Axis %1 encoder evaluation error of the safety-related actual value**

Parameters

%1 = axis number

Explanation

The redundantly determined safety-related actual value does not match the actual value - with fine resolution - of the same encoder.

Response

Alarm display
In addition, a STOP F is initiated, that can result in the subsequent Alarm 27001 with fault IDs 0, 27023 and 27024. Alarm 27001 with fault ID 0 can be prevented using the alarm reduction ($MA_SAFE_ALARM_SUPPRESS_LEVEL greater than or equal to 1).

Remedy

Check the encoder mounting
Check the encoder parameterization
Check the NCK_MD ($MA_SAFE_ENC_IS_LINEAR, $MA_SAFE_ENC_GRID_POINT_DIST, $MA_SAFE_ENC_RESOL and the drive parameter field r0979)
Replace the hardware
Check and ensure that the EMC conditions are complied with.

Program continuation

Clear the alarm with the RESET key. Restart the part program.

27112 **Axis %1 CRC error of the safety-related actual value**

Parameters

%1 = axis number

Explanation

When checking the data consistency of the safety-related actual value (CRC), an error was detected.

Response

Alarm display
In addition, a STOP F is initiated, that can result in the subsequent Alarm 27001 with fault IDs 0, 27023 and 27024. Alarm 27001 with fault ID 0 can be prevented using the alarm reduction ($MA_SAFE_ALARM_SUPPRESS_LEVEL greater than or equal to 1).

Remedy

Check the encoder mounting
Check the encoder parameterization
Check the NCK_MD ($MA_SAFE_ENC_IS_LINEAR, $MA_SAFE_ENC_GRID_POINT_DIST, $MA_SAFE_ENC_RESOL and the drive parameter field r0979)
For DRIVE-CLiQ encoders: Check the NCK-MDs ($MA_SAFE_ENC_NUM_BITS, $MA_SAFE_ENC_CONF and drive parameter r047x)
Check whether the encoder evaluation was replaced (SMI, SMC, SME)
Check whether the encoder evaluation type was exchanged (SMx, DRIVE-CLiQ encoder)
Check the encoder ID in the MD $MA_SAFE_ENC_IDENT
Replace the hardware
Check and ensure that the EMC conditions are complied with.

Program continuation

Clear the alarm with the RESET key. Restart the part program.

27113 **Axis %1 hardware encoder fault of the safety-related actual value**

Parameters

%1 = axis number

Explanation

The encoder evaluation signals a hardware fault. Causes could be dirt in the optical encoder evaluation or problems associated with the signal transfer.

Response

Alarm display
In addition, a STOP F is initiated, that can result in the subsequent Alarm 27001 with fault IDs 0, 27023 and 27024. Alarm 27001 with fault ID 0 can be prevented using the alarm reduction ($MA_SAFE_ALARM_SUPPRESS_LEVEL greater than or equal to 1).

Remedy

Replace the encoder hardware
Check and ensure that the EMC conditions are complied with.

Program continuation

Clear the alarm with the RESET key. Restart the part program.

27124 **Stop A initiated for at least one axis**

Explanation

This alarm only indicates that Stop A has been initiated in at least one axis and power on is required to acknowledge the alarm. The alarm is output if the alarm priority function was activated in MD $MN_SAFE_ALARM_SUPPRESS_LEVEL.

Response

Alarm display
Interface signals are set
"Pulse cancellation" is initiated for the axis involved.

Remedy

Locate the cause of the error by evaluating additional alarm messages

Program continuation

Power-down the control and power-up again

27132 **Axis %1 checksum group error, safety-relevant monitoring functions. Confirmation and acceptance test required!**

Parameters %1 = axis number

Explanation A checksum protects the relevant MDs to parameterize the axial safety functionality. The alarm indicates that at least one of the axial checksums no longer matches the saved checksum, i.e. that either a data item was illegally changed or is corrupt.
In the commissioning phase (SPL commissioning mode active), this axial group alarm is displayed instead of the axial acceptance test individual alarms. MD $MN_SAFE_ALARM_SUPPRESS_LEVEL can be used to further reduce the alarm display so that only one alarm is displayed for all axes (global group alarm).

Response Alarm display
Interface signals are set
Mode group not ready
Channel not ready
NC start inhibit in this channel
NC stop for alarm

Remedy Check MDs. Have the checksum re-calculated and confirm. Check the hardware components and drive assignment. Safety functions (motion monitoring functions) should be subject to a new acceptance test.

27135 **Axis %1 checksum group error, safety-related monitoring functions on at least one axis. Confirmation and acceptance test required!**

Parameters %1 = axis number

Explanation A checksum protects the relevant MDs to parameterize the axial safety functionality. The alarm indicates that at least on one axis, at least one of the axial checksums no longer matches the saved checksum, i.e. that a data item was illegally changed or is corrupt.
In the commissioning phase (SPL commissioning mode active), this axial group alarm is displayed instead of the axial acceptance test individual alarms. MD $MN_SAFE_ALARM_SUPPRESS_LEVEL can be used to further reduce the alarm display so that only one alarm is displayed for all axes.

Response Alarm display
Interface signals are set
Mode group not ready
Channel not ready
NC start inhibit in this channel
NC stop for alarm

Remedy Check MDs. Have the checksum re-calculated and confirm. Check the hardware components and drive assignment. Safety functions (motion monitoring functions) should be subject to a new acceptance test.

27140	**Wait for Motor Module for at least one axis**
Explanation	Alarm when booting as long as the Motor Module of at least one axis is still not ready for SI. When booting, communications to the Motor Module have still not been established as the safety functions for at least one axis are still not available. The alarm display can be set in MD $MN_SAFE_ALARM_SUPPRESS_LEVEL (MD < 3) in such a way that it can be individually displayed as to whether communications have already been established for each axis.
Response	Alarm display Interface signals are set
Remedy	The alarm is continuously active when booting if at least one drive does not communicate. Otherwise, the alarm is only briefly present and is then automatically cleared again. Possible causes that the alarm is permanently present: - The safety motion monitoring functions are only activated in $MA_SAFE_FUNCTION_ENABLE, however, not in the corresponding parameter of the associated drive (p9501). - The axis -> drive assignment via MD $MA_SAFE_CTRLOUT_MODULE_NR, $MN_SAFE_DRIVE_LOGIC_ADDRESS or p0978 is incorrect. - PROFIBUS connector fallen out.
Program continuation	The alarm is no longer displayed when the alarm cause has been removed. No other operator actions are required.

27200	**PROFIsafe: Cycle time %1 [ms] is too long**
Parameters	%1 = parameterized cycle time
Explanation	The PROFIsafe communication cycle time resulting from MD $MN_PROFISAFE_IPO_TIME_RATIO and $MN_IPO_CYCLE_TIME exceeds the permissible limit value of 25 ms.
Response	Mode group not ready Channel not ready NC start inhibit in this channel Interface signals are set Alarm display NC stop for alarm
Remedy	Correct the cycle time.
Program continuation	The alarm is initiated when booting if parameterized too long. No program can be started. Only delete the alarm with a power on.

27201	**PROFIsafe: MD %1[%2]: Bus segment %3 error**
Parameters	%1 = MD name %2 = MD field index %3 = parameterized bus segment

Explanation — An incorrect bus segment was entered in the specified machine data. The value must be 5.

Response — Mode group not ready
Channel not ready
NC start inhibit in this channel
Interface signals are set
Alarm display
NC stop for alarm

Remedy — Correct the specified MD.

Program continuation — The alarm is initiated when booting. No program can be started. Only delete the alarm with a power on.

27202 **PROFIsafe: MD %1[%2]: Address %3 error**

Parameters — %1 = MD name
%2 = MD field index
%3 = parameterized PROFIsafe address

Explanation — The PROFIsafe address, parameterized in the specified MD is incorrect.

Response — Mode group not ready
Channel not ready
NC start inhibit in this channel
Interface signals are set
Alarm display
NC stop for alarm

Remedy — Correct the MD.

Program continuation — The alarm is initiated when booting. No program can be started. Only delete the alarm with a power on.

27203 **PROFIsafe: MD %1[%2]: Incorrect SPL assignment**

Parameters — %1 = MD name
%2 = MD field index

Explanation — The parameterization in the specified MD for the connection between the SPL interface and a PROFIsafe module is incorrect. The reasons for this are as follows:

- Bit values greater than in the definition of the SPL interface (bit value> 64)
- Number of bits higher than the number of bits per slot (upper bit value – lower bit value > 32)
- No SPL assignment was parameterized (both bit values are equal to zero)
- Incorrect SPL assignment (bit value equal to zero)

Response — Mode group not ready
Channel not ready
NC start inhibit in this channel
Interface signals are set
Alarm display
NC stop for alarm

Remedy
Correct the displayed MD.

Program continuation
The alarm is initiated when booting. No program can be started. Only delete the alarm with a power on.

27204 **PROFIsafe: Double assignment MD %1[%2] □ MD %3[%4]**

Parameters
%1 = MD name 1
%2 = MD field index for MD name 1
%3 = MD name 2
%4 = MD field index for MD name 2

Explanation
A double assignment has been illegally parameterized in the specified machine data.
- $A_INSE are parameterized on several PROFIsafe modules.

MD $MN_PROFISAFE_IN_ASSIGN
- several input terminals of PROFIsafe modules parameterized at the same $A_INSE.

MD $MN_PROFISAFE_IN_ASSIGN
- Several $A_OUTSE parameterized at the same output terminal of a PROFIsafe module.

MD $MN_PROFISAFE_OUT_FILTER
- Several substitute values of passive SPL couplings parameterized to the same $A_INSE.

MD $MN_PROFISAFE_IN_ASSIGN

Response
Mode group not ready
Channel not ready
NC start inhibit in this channel
Interface signals are set
Alarm display
NC stop for alarm

Remedy
Correct the displayed MD.

Program continuation
The alarm is initiated when booting. No program can be started. Only delete the alarm with a power on.

27205 **PROFIsafe: Number of signals in MD %1[%2] < > MD %3[%4]**

Parameters
%1 MD name 1
%2 MD field index to the MD name 1
%3 MD name 2
%4 MD field index to the MD name 2

Explanation
The parameterized number of signals used must be the same in both machine data.

Response
Mode group not ready
Channel not ready
NC start inhibit in this channel
Interface signals are set
Alarm display
NC stop for alarm

Remedy	Correct the MD.
Program continuation	The alarm is initiated when booting. No program can be started. Only delete the alarm with a power on.

27206 **PROFIsafe: MD %1[%2] max. number of F net data (%3 bits) exceeded**

Parameters	%1 MD name %2 MD field index to the MD name %3 F net data bits
Explanation	Data parameterized in the specified machine data lie outside the F net (useful) data area of the F module. Note When displaying machine data PROFISAFE_IN/OUT_ADDRESS, the sub-slot address parameterized in the machine data exceeds the F net data area of the F module.
Response	Mode group not ready Channel not ready NC start inhibit in this channel Interface signals are set Alarm display NC stop for alarm
Remedy	Correct the MD.
Program continuation	Switch control system OFF and ON again.

27207 **PROFIsafe: MD %1[%2] max. sub-slot number: %3 exceeded**

Parameters	%1 MD name %2 MD field index to the MD name %3 max. number of sub-slots
Explanation	The sub-slot parameterized in the specified machine data exceeds the max. permissible number of sub slots per PROFIsafe module.
Response	Mode group not ready Channel not ready NC start inhibit in this channel Interface signals are set Alarm display NC stop for alarm
Remedy	Reduce the number of sub-slots by changing the F net (useful) data distribution of the PROFIsafe module.
Program continuation	Switch control system OFF and ON again.

27208 **PROFIsafe: MD %1[%2] max. sub-slot address %3 exceeded**

Parameters
%1 MD name
%2 MD field index to the MD name
%3 address, sub-slots

Explanation
An excessively high sub-slot address was entered in the specified MD. The entered value may not exceed the displayed maximum sub-slot address.

Response
Mode group not ready
Channel not ready
NC start inhibit in this channel
Interface signals are set
Alarm display
NC stop for alarm

Remedy
Correct the MD

Program continuation
Switch control system OFF and ON again.

27220 **PROFIsafe: Number of NCK F modules (%1) <> number of S7-F modules (%2)**

Parameters
%1 = number of parameterized NCK-F modules
%2 = number of parameterized S7-F modules

Explanation
The number of F modules parameterized using the NCK machine data $MN_PROFISAFE_IN/OUT_ADDRESS is greater than the known modules in the S7 I/O configuration.
The number of F modules parameterized using NCK-MD is not the same as the known modules configured in the S7 I/O that are assigned to this F master.

Response
Mode group not ready
Channel not ready
NC start inhibit in this channel
Interface signals are set
Alarm display
NC stop for alarm

Remedy
Check the F parameterization in the MD $MN_PROFISAFE_IN/OUT_ADDRESS.
Check the F configuration in the Step7 HW configuration.

Program continuation
Switch the control OFF - ON.

27221 **PROFIsafe: NCK F module MD %1[%2] unknown**

Parameters
%1 = MD name
%2 = MD field index

Explanation
The F module parameterized in the specified machine data is unknown under this PROFIsafe address in the S7 configuration.

Response | Mode group not ready
Channel not ready
NC start inhibit in this channel
Interface signals are set
Alarm display
NC stop for alarm

Remedy | Check the PROFIsafe addresses in the NCK-MD and S7-I/O (peripherals) configuration

Program continuation | Switch control system OFF and ON again.

27222 **PROFIsafe: S7 F module PROFIsafe address %1 unknown**

Parameters: %1 = PROFIsafe address

Explanation: The F module with the specified PROFIsafe address has not been parameterized as an F module in the NCK MD

Response: Mode group not ready
Channel not ready
NC start inhibit in this channel
Interface signals are set
Alarm display
NC stop for alarm

Remedy: Check the S7 PROFIBUS configuration. Register the module in the NCK MD

Program continuation: Switch control system OFF and ON again.

27223 **PROFIsafe: NCK F module MD %1[%2] is not a %3 module**

Parameters: %1 = MD name
%2 = MD field index
%3 = module type

Explanation: The F module parameterized in the specified NCK MD has not been designated as an appropriate input/output module in the S7 PROFIBUS configuration.
- %3 = INPUT: NCK F parameterization expects an INPUT module
- %3 = OUTPUT: NCK F parameterization expects an OUTPUT module
- %3 = IN/OUT: NCK F parameterization expects an INPUT/OUTPUT module

Response: Mode group not ready
Channel not ready
NC start inhibit in this channel
Interface signals are set
Alarm display
NC stop for alarm

Remedy: Check the module in the S7 PROFIBUS configuration

Program continuation: Switch control system OFF and ON again.

27224 **PROFIsafe: F module MD %1[%2] MD %3[%4]: Double assignment of thePROFIsafe address**

Parameters
%1 = MD name 1
%2 = MD field index 1
%3 = MD name 2
%4 = MD field index 2

Explanation
In the NCK MD or in the S7 F parameters, the same PROFIsafe address has been parameterized for the F modules parameterized in the specific machine data. This means that a clear communications relationship between the F master and F slave is not possible.

Response
Mode group not ready
Channel not ready
NC start inhibit in this channel
Interface signals are set
Alarm display
NC stop for alarm

Remedy
Check and correct the S7 F parameterization and NCK-MD.

Program continuation
Switch control system OFF and ON again.

27225 **PROFIsafe: Slave %1, configuration error, %2**

Parameters
%1 = PROFIBUS slave address
%2 = configuration error

Explanation
An error has occurred during the evaluation of the S7 PROFIBUS configuration for the specific slave. This is further specified in alarm parameter %2.
%2 = PRM header: The PRM telegram for this slave could not be clearly interpreted (is currently not initiated).

Response
Mode group not ready
Channel not ready
NC start inhibit in this channel
Interface signals are set
Alarm display
NC stop for alarm

Remedy
Check the S7 PROFIBUS configuration and correct.

Program continuation
Switch control system OFF and ON again.

27299 **PROFIsafe: Diagnostics %1 %2 %3**

Parameters
%1, %2, %3 = alarm parameters

Explanation
Errors in the PROFIsafe configuration.
Alarm parameter %1 contains a reference to the component (NCK or PLC), which had detected the error.

Response
Alarm display

Remedy
Generate a Support Request with the error text.

Program continuation
Deleting the alarm with the Cancel key

27240	**PROFIsafe: DP M has not run-up, DP info: %1**
Parameters	%1 = actual information from the DP interface NCK-PLC
Explanation	There is no DP configuration available to the NCK after the time specified using the MD $MN_PLC_RUNNINGUP_TIMEOUT.
Response	Mode group not ready Channel not ready NC start inhibit in this channel Interface signals are set Alarm display NC stop for alarm
Remedy	increase MD $MN_PLC_RUNNINGUP_TIMEOUT check the PLC operating state check the PLC operating system software release delete the F parameterization in the NCK-MD
Program continuation	Switch control system OFF and ON again.

27242	**PROFIsafe: F module %1, %2 faulty**
Parameters	%1 = PROFIsafe address %2 = F parameter error
Explanation	An error was detected while evaluating F parameters. %2 = CRC1: CRC error, F parameters. %2 = F_WD_Timeout: The monitoring time parameterized in Step 7 is too short for the PROFIsafe cycle time defined by the NCK-MD $MN_PROFISAFE_IPO_TIME_RATIO. %2 = CRC2_Len: Incorrect length of the telegram CRC. %2 = F_Data_Len: Incorrect telegram length has been defined for the stated module.
Response	Mode group not ready Channel not ready NC start inhibit in this channel Interface signals are set Alarm display NC stop for alarm
Remedy	%2 = CRC1: General PLC reset, reload the S7 F configuration. %2 = F_WD_Timeout: Re-parameterize the PROFIsafe clock cycle time or F monitoring time. %2 = CRC2_Len: General PLC reset, reload the S7 F configuration.
Program continuation	Switch control system OFF and ON again.

27250 **PROFIsafe: Configuration in DP-M changed; error code %1 – %2**

Parameters
%1 = NCK project number
%2 = current PLC project number

Explanation
The DP master indicates a modified S7 PROFIBUS configuration. Error-free operation can no longer be guaranteed.

Response
Mode group not ready
Channel not ready
NC start inhibit in this channel
Interface signals are set
Alarm display
NC stop for alarm

Remedy
Restart the PLC/NCK

Program continuation
Switch control system OFF and ON again.

27251 **PROFIsafe: F module %1, %2 reports error %3**

Parameters
%1 = PROFIsafe address or name
%2 = signaling components (master/slave)
%3 = error detection

Explanation
F module signals a PROFIsafe communication error. There is a communication error between the F master and the specified F module.
The error detecting component is displayed in %2:
%2 = master: Error was detected in the F master.
%2 = slave: Error was detected in the F slave.
The detected error cause is displayed in %3:
For %2 = **Slave** the following values are possible for %3:
- %3 = CN: an error was detected in the telegram sequence.
- %3 = CRC: A CRC error was detected
- %3 = TO: The parameterized communication timeout has been exceeded

For %2 = **Master** the following values are possible for %3:
- %3 = CN: an error was detected in the telegram sequence
- %3 = CRC: A CRC error was detected
- %3 = TO: The parameterized communication timeout has been exceeded
- %3 = EA: F slave sends empty telegrams

All of the specified values for %3 can, depending on the error profile, also be displayed in a combination.

Response
Mode group not ready
Channel not ready
NC start inhibit in this channel
Interface signals are set
Alarm display
NC stop for alarm

Remedy
Check the I/O bus.

Program continuation
Clear the alarm with the RESET key. Restart the part program.

27252 **PROFIsafe: Slave/Device %1, Bus %2, sign-of-life error**

Parameters
%1 = DP slave address
%2 = bus to which ds slave/device is connected

Explanation
The specified DP slave no longer communicates with the master.

Response
Mode group not ready
Channel not ready
NC start inhibit in this channel
Interface signals are set
Alarm display
NC stop for alarm
Stop D/E is initiated.

Remedy
Check the I/O bus. Connection to the slave interrupted? Supply voltage of the slave has decreased?

Program continuation
Clear the alarm with the RESET key. Restart the part program.

27253 **PROFIsafe: Communications fault F master component %1, error %2**

Parameters
%1 = faulty components (NCK/PLC)
%2 = error detection

Explanation
The F master signals a communications error between the NCK and PLC.
The cause of the error is indicated in error code %1:
- %1 = PLC: The PLC no longer executes the OB40 request.
- %1 = PLC-DPM: DP master is no longer in the OPERATE state.

Parameter %2 provides additional information about the reason for the error:
- %2 = < > 0: PLC processing of the OB40 not finished.

Response
Mode group not ready
Channel not ready
NC start inhibit in this channel
Interface signals are set
Alarm display
Stop D/E is initiated
Stopped PROFIsafe driver - type F-DI or F-DI/DO F modules - output fail-safe values (0) towards the SPL as F net data.

Remedy
Check whether the selected F clock cycle is too short.

Program continuation
Remove the fault. After changing the F clock cycle, power on

27254 **PROFIsafe: F module %1, error on channel %2; %3<ALSI>**

Parameters
%1 = PROFIsafe address or name
%2 = IN/OUT
%3 = supplementary info, system variables – field index

Explanation
The specified ET200–F PROFIsafe module signals an error for the displayed channel. The type of channel (input or output channel) is displayed in %2 using the IN and OUT abbreviation).
With parameter %3, a specific alarm message can be configured on the HMI. Contrary to Alarm 27090, for this alarm, parameter %3 can assume the following value ranges:

- %3 = 1....64: Error in system variables $A_INSE[1...64]
- %3 = 65...128: Error in system variables $A_OUTSE[1...64]
- %3 = –1: Error in the input or output channel for which there is no SPL assignment.

Response
Mode group not ready
Channel not ready
NC start inhibit in this channel
Interface signals are set
Alarm display
NC stop for alarm

Remedy
Check the wiring. Wiring OK: Replace the F module.

Program continuation
Remove the error and press RESET.

27255 **PROFIsafe: F module %1, general error**

Parameters
%1 = PROFIsafe address or name

Explanation
The specified PROFIsafe module signals an error: Additional information on the cause of the error cannot be made without any additional resources.
This alarm is initiated for all types of PROFIsafe slaves.

Response
Mode group not ready
Channel not ready
NC start inhibit in this channel
Interface signals are set
Alarm display
NC stop for alarm

Remedy
Check the wiring

Program continuation
Remove the error and press RESET.

27256 **PROFIsafe: Actual cycle time %1 [ms] > parameterized cycle time**

Parameters
%1 = actual PROFIsafe communications cycle time

Explanation
The actual PROFIsafe communication cycle time is greater than the value set using MD $MN_PROFISAFE_IPO_TIME_RATIO. The parameterized PROFIsafe communication cycle time is continually exceeded on the PLC side.

Response
Mode group not ready
NC start inhibit in this channel
Interface signals are set
Alarm display
NC stop for alarm

Remedy
Adapt the cycle time using MD $MN_PROFISAFE_IPO_TIME_RATIO.
As a minimum, the value displayed in %1 must be set.
The selected cycle time has an effect on the runtime utilization of the PLC module. This must be taken into account in the setting.

Program continuation
Remove the error and press RESET

27257 **PROFIsafe: %1 %2 signals system error %3 (%4)**

Parameters
%1 = communication type, F module, SPL
%2 = Component involved
%3 = detected error cause
%4 = Component involved

Explanation
A system error was detected within the scope of the PROFIsafe communication. Depending on the error, the particular PROFIsafe driver is stopped or the complete PROFIsafe communication.
In **%2** the F component involved is displayed:
For %1 = F module: The PROFIsafe address or the name of the F module is displayed in %2.
For %1 = SPL: There is no display in %2
The detected error cause is displayed in **%3**:
%3 = SF: Asynchronous fault state (StateFault)
%3 = SP: The SPL input/output data are not updated (SPL I/O-communication)
The specified values for %3 can, depending on the error profile, also be displayed in a combination.
The component involved is displayed in **%4**:
%4 = NCK
%4 = PLC

Response
NC start inhibit in this channel
Alarm display
STOP D/E is initiated
Stopped PROFIsafe driver - type F-DI or F-DI/DO F modules - output fail-safe values (0) towards the SPL as F net data.

Remedy
Switch the control off/on (power on). If this fault occurs again, contact the service department.

Program continuation
Power-down the control and power-up again

27299 **PROFIsafe: Diagnostics %1 %2 %3 %4**

Parameters
%1 error ID 1
%2 error ID 2
%3 error ID 3
%4 error ID 4

Explanation
Internal error in the NCK PROFIsafe implementation.

Response
Alarm display

Remedy
With the error text, open a Siemens Request at:
http://www.siemens.com/automation/support-request

Program continuation
Power-down the control and power-up again

27300 **F_DP: Cycle time %1 [ms] is too long**

Parameters
%1 cycle time

Explanation
The cycle type of the F_DP communication resulting from MD $MN_SAFE_SRDP_IPO_TIME_RATIO and $MN_IPO_CYCLE_TIME exceeds the permissible limit value of 250 ms.

Response
Alarm display
NC start inhibit in this channel
Interface signals are set
Mode group not ready
Channel not ready

Remedy
Correct the cycle time using MD $MN_SAFE_SRDP_IPO_TIME_RA-TIO and/or $MN_IPO_CYCLE_TIME

Program continuation
Power-down the control and power-up again

27301 **F_DP: MD %1[%2]: SPL coupling incorrect**

Parameters
%1 = machine data identifier
%2 = machine data index

Explanation
The SPL coupling in the displayed MD is incorrect. Possible causes:
- - bit values greater than in the definition of the SPL interface (bit value> 64)
- - too many bits (higher bit value - lower bit value > 16)
- - no SPL assignment was parameterized (both bit values are equal to zero)
- - incorrect SPL assignment (bit value equal to zero)

Response
Alarm display
NC start inhibit in this channel
Interface signals are set
Mode group not ready
Channel not ready

Remedy
Correct the displayed MD

Program continuation
Power-down the control and power-up again

27302 **F_DP: Double assignment MD %1[%2] □ MD %3[%4]**

Parameters
%1 = machine data identifier
%2 = machine data index
%3 = machine data identifier
%4 = machine data index

Explanation
A double assignment has been illegally parameterized in the specified machine data.

- %1 and %3 = $MN_SAFE_RDP_ASSIGN:
  SPL inputs ($A_INSE) are assigned a multiple number of times by the F_DP communication
- %1 and %3 = $MN_SAFE_SDP_FILTER:
  F net data of an F_SENDDP are assigned a multiple number of times by sub-slots
- %1 and %3 = $MN_SAFE_SDP_LADDR, $MN_SAFE_RDP_LADDR:
  Logical basis addresses are assigned a multiple number of times by various SPL connections
- %1 and %3 = $MN_SAFE_SDP_CONNECTION_NR, $MN_SAFE_RDP_CONNECTION_NR:
  Connection numbers are assigned a multiple number of times by various SPL connections
- %1 and %3 = $MN_SAFE_SDP_ID, $MN_SAFE_RDP_ID:
  Parameter DP_DP_ID is assigned a multiple number of times by various SPL connections
- %2 and %4: MD index of the SPL connection

Response
Alarm display
NC start inhibit in this channel
Interface signals are set
Mode group not ready
Channel not ready

Remedy
Correct the displayed MD

Program continuation
Power-down the control and power-up again

27303 **F_DP: Number of signals in MD %1[%2] < > MD %3[%4]**

Parameters
%1 = machine data identifier
%2 = machine data index
%3 = machine data identifier
%4 = machine data index

Explanation
In the machine data:
MD $MN_SAFE_SDP/RDP_ASSIGN
MD $MN_SAFE_SDP/RDP_FILTER
A different number of F net data signals was parameterized.

Response	Alarm display NC start inhibit in this channel Interface signals are set Mode group not ready Channel not ready
Remedy	Correct the specified MD
Program continuation	Power-down the control and power-up again

27305 **F_DP: Parameter MD %1[%2] < > MD %3[%4]**

Parameters	%1 = $MN_SAFE_SDP/RDP_LADDR or $MN_SAFE_SDP/RDP_TIMEOUT or $MN_SAFE_SDP/RDP_CONNECTION_NR or $MN_SAFE_SDP/RDP_ERR_REAC or $MN_SAFE_RDP_SUBS %2 = machine data index %3 = $MN_SAFE_SDP/RDP_LADDR or $MN_SAFE_SDP/RDP_TIMEOUT or $MN_SAFE_SDP/RDP_CONNECTION_NR or $MN_SAFE_SDP/RDP_ERR_REAC or $MN_SAFE_RDP_SUBS %4 = machine data index
Explanation	An SPL connection with several SPL couplings (sub-slots) was parameterized, where different values are entered in the F_DP communication parameters or the connection numbers (%1 and %3). Note SPL couplings (sub-slots) of an SPL connection are designated using the same values for: - F_DP communication parameters - Connection number
Response	Alarm display NC start inhibit in this channel Interface signals are set Mode group not ready Channel not ready
Remedy	Correct the specified MD
Program continuation	Power-down the control and power-up again

27306 **F_DP: Max. number of active SPL connections (%1) for (%2) exceeded**

Parameters
%1 = maximum number of possible SPL connections
%2 = F_SENDDP, F_RECVDP

Explanation
In the active parameterizing data sets for %2, more than the permissible number of SPL connections %1 are parameterized, identified by different identifiers ($MN_SAFE_SDP/RDP_ID).

Response
Alarm display
NC start inhibit in this channel
Interface signals are set
Mode group not ready
Channel not ready

Remedy
Correct the incorrect identifiers of the active SPL connections or deactivate the SPL connections ($MN_SAFE_SDP/RDP_ENABLE_MASK).

Program continuation
Power-down the control and power-up again

27350 **F_DP: %1 communication, connection %2 signals error %3**

Parameters
%1 = F_SENDDP, F_RECVDP
%2 = Name or identifier of the F_DP communication relationship
%3 = SN: An error was detected in the telegram sequence.
%3 = CRC: A CRC error was detected.
%3 = TO: The parameterized communication timeout has been exceeded.
All of the specified values for %3 can, depending on the error profile, also be displayed in a combination.

Explanation
There is an F_DP communication error with the external communication partners and the programmed error response is:
$A_FSDP_/FRDP_ERR_REAC = 0 or 1.

Response
1. F_SENDDP/F_RECVDP: System variable $A_FSDP/FRDP_ERROR = TRUE
2. F_SENDDP/F_RECVDP: System variable $A_FSDP/FRDP_DIAG ≠ 0
3. F_RECVDP: System variable $A_FRDP_ACK_REQ = TRUE
4. F_RECVDP: Output of the substitute values specified in the system variable $A_FRDP_SUBS
5. Display of the alarms.
6. Interlock NC start and display at the VDI interface.
7. For a programmed error response $A_FSDP_/FRDP_ERR_REAC = 0, in addition, an alarm and Stop D/E are initiated.

Remedy
Check the PROFIBUS communication and the communication partner.

Program continuation	Remove the error and issue a user acknowledgement via a channel_1 reset. Note Only the F_DP communication is acknowledged for a user acknowledgement via DB18.FRDP_ACK_REI. The alarm is still displayed and must be separately acknowledged using NC-RESET.
27351	**F_DP: %1 communication, connection %2 signals error %3**
Parameters	%1 = F_SENDDP, F_RECVDP %2 = Name or identifier (DP_DP_ID) of the F_DP communication relationship %3 = SN: An error was detected in the telegram sequence. %3 = CRC: A CRC error was detected. %3 = TO: The parameterized communication timeout has been exceeded. All of the specified values for %3 can, depending on the error profile, also be displayed in a combination.
Explanation	There is an F_DP communication error with the external communication partners and the programmed error response is: $A_FSDP_/FRDP_ERR_REAC = 2.
Response	1. F_SENDDP/F_RECVDP: System variable $A_FSDP/FRDP_ERROR = TRUE 2. F_SENDDP/F_RECVDP: System variable $A_FSDP/FRDP_DIAG ≠ 0 3. F_RECVDP: System variable $A_FRDP_ACK_REQ = TRUE 4. F_RECVDP: Output of the substitute values specified in the system variable $A_FRDP_SUBS 5. Alarm display
Remedy	Check the PROFIBUS communication and the communication partner.
Program continuation	Remove the error and issue a user acknowledgement via the DB18.FRDP_ACK_REI interface signal or a channel_1 reset.
27352	**F_DP: Communication error %1, error %2**
Parameters	%1 = PLC: The PLC was not able to process the OB40 request for F_DP communication within the maximum monitoring time of 500 ms. %2 < > 0: PLC processing OB40 not finished
Explanation	Communication between the NCK and PLC can no longer function. The cause of the error is indicated in error code %1.
Response	Alarm display NC start inhibit in this channel Interface signals are set STOP D/E is initiated Stopped SPL connections - type F_RECVDP - output fail-safe values (0) in the direction of the SPL as F net data.
Remedy	Check and possibly increase the F_DP clock cycle
Program continuation	Switch control system OFF and ON again.

27353	**F_DP: Actual cycle time %1 [ms] >, parameterized cycle time**
Parameters	%1 = cycle time
Explanation	The actual F_DP communication cycle time is greater than the value set using MD $MN_SAFE_SRDP_IPO_TIME_RATIO. The parameterized communication cycle time is continually exceeded on the PLC side.
Response	Alarm display NC start inhibit in this channel Interface signals are set STOP D/E is initiated
Remedy	Adapt the cycle via MD $MN_SAFE_SRDP_IPO_TIME_RATIO. As a minimum, the value displayed in %1 must be set. The selected cycle time has an effect on the runtime utilization of the PLC module. This must be taken into account in the setting.
Program continuation	Switch control system OFF and ON again.

27354	**F_DP: %1 communication, connection %2 signals SFC%3 error %4**
Parameters	%1 = F_SENDDP, F_RECVDP %2 = Name or identifier (DP_DP_ID) of the F_DP communication relationship %3 = PLC module that detected an error %4 = Error cause display
Explanation	There is an F_DP communication error with the external communication partner. When attempting to access via the parameterized interface, the PLC signaled an error. This alarm can be suppressed using the MD $MN_SAFE_DIAGNOSIS_MASK, bit 2 = 1.
Response	Alarm display
Remedy	Check the communication path. Check the parameterized logical basis address in $MN_SAFE_SDP/RDP_LADDR.
Program continuation	Channel_1 reset

27355 **F_DP: %1 communication, connection %2 signals system error %3 (%4)**

Parameters
%1 = Communication type F_SENDDP, F_RECVDP, SPL
%2 = Name or identifier (DP_DP_ID) of the SPL connection (for %1 = F_SENDDP or F_RECVDP)
%2 = - (for %1 = SPL)
%3 = error cause
%3 = SF: Asynchronous fault state (StateFault)
%3 = LS: Sign-of-life monitoring (LifeSign)
%3 = TD: Discrepancies in the F telegram data (TelegramDiscrepancy)
%3 = OD: Discrepancies in the output data (OutputdataDiscrepancy)
- for %1 = F_SENDDP: $A_FSDP_ERR_REAC - DB18.DBW190,200,210)
- for %1 = F_RECVDP: $A_FRDP_SUBS - DB18.DBW220,232,244)
$A_FRDP_ERR_REAC - DB18.DBW222,234,246)
%3 = SP: The SPL input/output data are not updated (SPL I/O-communication)
The specified values for %3 can, depending on the error profile, also be displayed in a combination.
%4 = Component involved
%4 = NCK
%4 = PLC
%4 = System variable (for %3 = OD)

Explanation
A system error was detected within the scope of the F_DP communication. Dependent on the error, processing of the particular SPL connection or the complete F_DP communication is stopped.

Response
Alarm display
NC start inhibit in this channel
STOP D/E is initiated
Stopped SPL connections - type F_RECVDP - output fail-safe values (0) in the direction of the SPL as F net data.

Remedy
Power-down/power-up the control (power on). If this fault occurs again, contact the service department.

Program continuation
Power On

27900 **Profibus-DP: SI fault, axis %1, code %2, value %3, time %4**

Parameters
%1 axis number
%2 fault code of the drive (p9747)
%3 fault value of the drive (p9749)
%4 fault time of the drive (p9748)

Explanation
SINAMICS drive fault.

Response
Alarm display

Remedy
Fault codes/fault values, refer to the drive documentation.

Program continuation
The alarm is no longer displayed when the alarm cause has been removed. No other operator actions are required.

27901	**Profibus-DP: SI fault, axis %1, code %2, value %3, time %4**
Parameters	%1 axis number %2 fault code of the drive (p9747) %3 fault value of the drive (p9749) %4 fault time of the drive (p9748)
Explanation	SINAMICS drive fault.
Response	Alarm display
Remedy	Fault codes/fault values, refer to the drive documentation.
Program continuation	Remove the error and press RESET.

10.3 Safety messages for SINAMICS S120

10.3.1 General information

Note

In the HMI environment, faults and alarms are displayed specifying a six-digit number that always starts with 2. This means, e.g. F01600 then 201600. In this Chapter, faults and alarms are described with numbers from the SINAMICS environment.

In the HMI environment, faults and alarms are treated like alarms.

Differences between faults and alarms

Table 10-2 Differences between faults and alarms

Type	Description
Faults	What happens when a fault occurs? • The appropriate fault reaction is triggered. • Status signal ZSW1.3 is set. • The fault is entered in the fault buffer. How are the faults eliminated? • Remove the cause of the fault. • Acknowledge the fault.
Warnings	What happens when an alarm occurs? • Status signal ZSW1.7 is set. • The alarm is entered in the alarm buffer. How are alarms eliminated? • Alarms are self acknowledging, that is, they are reset automatically when the cause of the alarm has been eliminated.

Fault reactions

The standard fault responses according to PROFIdrive, that are used for safety, are described in the Table 10-3. The OFF 2 fault response is used as additional stopping measure while the pulses are safely cancelled via the safety-related shutdown paths.

Table 10-3 Fault reactions

Fault reaction	Response	Description	Safety stop response
OFF 2 (OFF 2)	Internal/external pulse inhibit	• Instantaneous pulse suppression, the drive ”coasts” to a standstill. • The motor holding brake (if parameterized) is closed immediately. • Switching on inhibited is activated.	STOP A, Test stop
OFF 3	Brakes along the OFF 3 down ramp and then the pulses are cancelled	• n_set = 0 is input immediately to brake the drive along the OFF3 deceleration ramp (p1135). • When zero speed is detected, the motor holding brake (if parameterized) is closed. The pulses are cancelled when the brake application time (p1217) expires. • Zero speed is detected if the actual speed drops below the threshold (p1226) or if the monitoring time (p1227) started when the speed setpoint <= speed threshold (p1226) has expired.	STOP B (after r9556 has expired or p9560 is fallen below, STOP A is initiated)
STOP 2 (Halt 2)	n_set = 0	• The drive is braked along the OFF 3 down ramp (p1135) by immediately entering n_set = 0. • The drive remains in closed loop speed control.	STOP C

Acknowledging faults

The list of faults and alarms specifies how to acknowledge each fault after the cause has been remedied.

Table 10-4 Acknowledging faults

List	Description
POWER ON	The fault is acknowledged by a POWER ON process (switch drive unit off and on again). Note: If the fault cause has still not been resolved, then the fault is immediately displayed again after booting. Re-establishing communications to the NCK or PLC after a communication failure has been detected to this component is an exception. In this case, just the same as for a normal boot, the fail-safe values are activated, however the alarms present are acknowledged for a new communication failure.

Table 10-4 Acknowledging faults, continued

List	Description
IMMEDI-ATELY	Starting from a drive object, the fault can be acknowledged by the following methods: 1. Acknowledge by setting parameter: p3981 = 0 –> 1 2. Acknowledge via binector inputs: p2103 BI: 1st acknowledge faults p2104 BI: 2nd acknowledge faults p2105 BI: 3rd acknowledge faults 3. Acknowledge using PROFIBUS control signal: STW1.7 = 0 –> 1 (edge) Note: • This fault can also be acknowledged using POWER ON. • If the cause of the fault has not been removed the fault is not cleared after acknowledgement. • Faults from SH/SBC The safe standstill (SH) function must be deselected
READY TO OPERATE	The fault can only be acknowledged in the READY state. In this state, the DC link is charged and the pulses are inhibited.

How faults and alarms are represented

Axxxxx	Alarm xxxxx
Axxxxx (F, N)	Alarm xxxxx (message type can be changed into F or N)
Fxxxxx	Fault xxxxx
Fxxxxx (A, N)	Fault xxxxx (message type can be changed to A or N)
Nxxxxx	No message
Nxxxxx (A)	No message (message type can be changed to A)
Cxxxxx	Safety message (dedicated message buffer

A message comprises a letter followed by the relevant number.

The meaning of the letters is as follows:

- A means ”Alarm”
- F means ”Fault”
- N means ”No message” or ”Internal message” or ”No report”
- C means ”Safety message”

The optional brackets indicates whether the type specified for this message can be changed and which message types can be selected via parameter.

Information about the response and acknowledgement are independently specified for a message with adjustable message type (e.g. response to F, acknowledgement for F).

10.3.2 List of faults and alarms

Note

- In the HMI environment, faults and alarms are displayed specifying a six-digit number that always starts with 2. This means, e.g. F01600 then 201600. In this Chapter, faults and alarms are described with numbers from the SINAMICS environment.
- In the HMI environment, faults and alarms are treated like alarms.

List of faults (Control Unit)

F01600 **SI CU: STOP A initiated**

Response: OFF2

Acknowledgement: IMMEDIATELY (POWER ON)

Explanation: The ”Safety Integrated” function integrated in the drive on the Control Unit has detected a fault and initiated a STOP A (pulse cancellation via the safety shutdown path of the Control Unit).

- Forced checking procedure of the safety shutdown path of the Control Unit unsuccessful.
- Subsequent response to fault F01611 (defect in a monitoring channel).

Fault value (r0949, interpret as decimal):

0: Stop request from the Motor Module
1005: Pulses cancelled although STO not selected and there is no internal STOP A present.
1010: Pulses enabled although STO is selected or an internal STOP A is present.
9999: Subsequent response to fault F01611.

Remedy: Select safe standstill and then deselect again.
- Replace the Motor Module involved.

Re fault value = 9999:
- Carry out diagnostics for fault F01611 that is present.

F01611 **SI CU: Defect in a monitoring channel**

Response: NONE (OFF1, OFF2, OFF3)

Acknowledgement: IMMEDIATELY (POWER ON)

Explanation: The "Safety Integrated" function integrated in the drive on the Control Unit (CU) has detected a fault in the crosswise data comparison between CU and Motor Module (MM) and has initiated a STOP F.
As a result of this fault, after the parameterized transition has expired (p9658), fault F01600 (SI CU: STOP A initiated) is output.
Fault value (r0949, interpret as decimal):

0: Stop request from the Motor Module

1 to 999: Number of the crosswise compared data that resulted in this fault.
This number is also displayed in r9795.
1: SI monitoring clock cycle (r9780, r9880).
2: SI enable safety functions (p9601, p9801). Only the supported bits are crosswise compared.
3: SI SGE changeover, tolerance time (p9650, p9850).
4: SI transition time STOP F to STOP A (p9658, p9858).
5: SI enable safe brake control (p9602, p9802).
6: SI motion, enable safety functions (p9501, internal value).
7: SI delay time of the pulse cancellation for Safe Stop 1 (p9652, p9852).
9: Debounce time for STO/SBC/SS1 (MM) (p9651, p9851)
10: SI delay time for pulse suppression with ESR (p9697, p9897)

1000: Check (watchdog) timer has expired. Within the time of approx. 5 x p9650 too many switching operations have occurred at terminal EP of the Motor Module.

1001: Initialization error, change timer / check timer.

1900: CRC error in sector SAFETY

2000: Status of the STO selection on the Control Unit and Motor Module are different.

2001: Feedback signal for safe pulse cancellation on the Control Unit and Motor Module are different.

2002: Status of the delay timer SS1 on the Control Unit and Motor Module are different.

2004: Status of the STO selection for modules connected in parallel are different.

2005: Feedback signal of the safe pulse cancellation on the Control Unit and Motor Modules connected in parallel are different.

Remedy: Re fault value = 1 to 5 and 7 to 999:

- Check the crosswise compared data that resulted in a STOP F.
- Carry out a POWER ON (power off/on) for all components.
- Upgrade the Motor Module software.
- Upgrade the Control Unit software.

Re fault value = 6:

- Carry out a POWER ON (power off/on) for all components.
- Upgrade the Motor Module software.
- Upgrade the Control Unit software.

Re fault value = 1000:
- Check the EP terminal at the Motor Module (contact problems).

Re fault value = 1001, 1002:
- Carry out a POWER ON (power off/on) for all components.
- Upgrade the Motor Module software.
- Upgrade the Control Unit software.

Re fault value = 2000, 2001, 2002, 2004, 2005:
- Check the tolerance time SGE changeover and if required, increase the value (p9650/p9850, p9652/p9852).
- Check the wiring of the safety-related inputs (SGE) (contact problems).
- Replace the Motor Module involved.

N01620 (F, A)	**SI CU: Safe Torque Off active**
Response	NONE
Acknowledgement	NONE
Explanation	The ”Safe Torque Off” (STO) function has been selected on the Control Unit (CU) via the input terminal and is active. Note: This message does not result in a safety stop response.
Remedy	Not necessary.
Response as for F	OFF2
Acknowledgement for F	IMMEDIATELY (POWER ON)
Response for A	NONE
Acknowledgement for A	NONE

N01621 (F, A)	**SI CU: Safe Stop 1 active**
Response	NONE
Acknowledgement	NONE
Explanation	The ”Safe Stop 1” (SS1) function has been selected on the Control Unit (CU) and is active. Note: This message does not result in a safety stop response.
Remedy	Not necessary.
Response as for F	OFF3
Acknowledgement for F	IMMEDIATELY (POWER ON)
Response for A	NONE
Acknowledgement for A	NONE

F01625 **SI CU: Sign-of-life error in safety data**

Response: OFF2

Acknowledgement: IMMEDIATELY (POWER ON)

Explanation: The "Safety Integrated" function integrated in the drive on the Control Unit (CU) has detected an error in the sign-of-life of the safety data between the CU and Motor Module (MM) and initiated a STOP A.
- There is either a DRIVE-CLiQ communications error or communications have failed.
- A time slice overflow of the safety software has occurred.

Fault value (r0949, interpret as decimal):
Only for internal Siemens troubleshooting.

Remedy: Select Safe Torque Off and then deselect again.
- Carry out a POWER ON (power off/on) for all components.
- Check whether there is a DRIVE-CLiQ communications error between the Control Unit and the Motor Module involved and if required, carry out a diagnostics routine for the faults identified.
- Deselect all drive functions that are not absolutely necessary.
- Reduce the number of drives.
- Check the electrical cabinet design and cable routing for EMC compliance.

F01630 **SI CU: Brake control defective**

Response: OFF2

Acknowledgement: IMMEDIATELY (POWER ON)

Explanation: The "Safety Integrated" function integrated in the drive on the Control Unit (CU) has detected a brake control fault and initiated a STOP A.
Fault value (r0949, interpret as decimal):
10, 11:
Fault for "Open brake".
- Parameter p1278 incorrectly set.
- Brake not connected or interrupted cable (check whether for p1278 = 1 and p9602/p9802 = 0 (SBC switched-out) the brake opens).

20:
Fault in the "Brake open" state.
- Short-circuit in the brake winding.

30, 31:
Fault for "Close brake".
- Brake not connected or interrupted cable (check whether for p1278 = 1 and p9602/p9802 = 0 (SBC switched-out) the brake opens).
- Short-circuit in the brake winding.

40:
Fault in the "Brake closed" state.

50:
Fault in the brake control of the Control Unit or communications error between the Control Unit and Motor Module (diagnostics of the brake control).
Note:
The following causes can be involved for all fault values:
- The motor cable shield is not correctly connected.
- Defect in the brake control circuit of the Motor Module.

Remedy

Check parameter p1278 (with SBC only p1278 = 0 is permissible).
- Select Safe Torque Off and then deselect again
- Check the motor holding brake connection.
- Check the function of the motor holding brake.
- Check whether there is a DRIVE-CLiQ communications error between the Control Unit and the Motor Module involved and if required, carry out a diagnostics routine for the faults identified.
- Check that the control cabinet is EMC-compliant and the cable routing (e.g. connect the motor cable shield and brake conductors with the shield connecting plate or screw the motor connector to the enclosure).
- Replace the Motor Module involved.

F01649 **SI CU: Internal software error**

Response: OFF2

Acknowledgement: IMMEDIATELY (POWER ON)

Explanation

An internal error in the Safety Integrated software on the Control Unit has occurred.
Note:
This fault results in a STOP A that cannot be acknowledged.
Fault value (r0949, interpret as hexadecimal):
Only for internal Siemens troubleshooting.

Remedy

Carry out a POWER ON (power off/on) for all components
- Re-commission the "Safety Integrated" function and carry out a power on.
- Upgrade the Control Unit software.
- Contact the Hotline.
- Replace the Control Unit.

F01650 **SI CU: Acceptance test required**

Response: OFF2

Acknowledgement: IMMEDIATELY (POWER ON)

Explanation

The "Safety Integrated" function integrated in the drive on the Control Unit requires an acceptance test.
Note:
This fault results in a STOP A that can be acknowledged.
Fault value (r0949, interpret as decimal)

130: No safety parameters available for the Motor Module.

1000: Reference and actual checksum on the Control Unit are not identical (when booting).
- At least one checksum-checked piece of data is defective.

2000: Reference and actual checksum on the Control Unit are not identical (commissioning mode).
- Reference checksum incorrectly entered into the Control Unit (p9799 not equal to r9798).
- When deactivating the safety functions p9501 or p9503 not deleted.

2001: Reference and actual checksum on the Motor Module are not identical (commissioning mode).
- Reference checksum incorrectly entered into the Motor Module (p9899 not equal to r9898).
- When deactivating the safety functions p9501 or p9503 not deleted.

2002: Enable of safety-related functions between the Control Unit and Motor Module differ (p9601 not equal to p9801).

2003: Acceptance test is required as a safety parameter has been changed.

2004: Acceptance test required due to a project download with enabled safety functions.

2005: The safety logbook has identified that a functional checksum has changed. An acceptance test must be carried out.

2010: Safe brake control is enabled differently the Control Unit and Motor Module (p9602 not equal to p9802).

2020: Error when saving the safety parameters for the Motor Module.

3003: An acceptance test is required, as one of the safety parameters referred to the hardware has been changed.

3005: The safety logbook has identified that a functional checksum referred to the hardware has changed. An acceptance test must be carried out.

9999: Subsequent response of another safety-related fault that occurred when booting that requires an acceptance test.

Remedy

Re fault value = 130:
- Carry out safety commissioning routine.

Re fault value = 1000:
- Repeat safety commissioning.
- Replace the CompactFlash Card.

Re fault value = 2000:
- Check the safety parameters in the Control Unit and adapt the reference checksum (p9799).

Re fault value = 2001:
- Check the safety parameters on the Motor Module and adapt the reference checksum (p9899).

Re fault value = 2002:

- Safety-related functions on the Control Unit and on the Motor Module are enabled differently (p9601 not equal to p9801).

Re fault value = 2003, 2004, 2005:
- Carry out acceptance test and create test certificate. The procedure when carrying out the acceptance test and an example for the acceptance report are provided in the documentation for SINAMICS Safety Integrated. The fault with fault value 3005 can only be acknowledged when the "STO" function is deselected.

Re fault value = 2010:
- Enable the safe brake control in the Control Unit and check on the Motor Module (p9602 = p9802).

Re fault value = 2020:
- Repeat safety commissioning.
- Replace the CompactFlash Card.

Re fault value = 3003:
- Carry out function tests for the modified hardware and generate an acceptance report. The procedure when carrying out the acceptance test as well as an example for the acceptance report can be found in the following reference: SINAMICS S120 Safety Integrated Function Manual

Re fault value = 3005:
- Carry out function tests for the modified hardware and generate an acceptance report. The fault with fault value 3005 can only be acknowledged when the "STO" function is deselected.

Re fault value = 9999:
- Carry out diagnostics for the other safety-related fault that is present.

F01651 **SI CU: Synchronization, safety time slices unsuccessful**

Response: OFF2

Acknowledgement: IMMEDIATELY (POWER ON)

Explanation: The "Safety Integrated" function requires synchronization of the safety time slices between the Control Unit (CU) and the Motor Module (MM) and between the Control Unit and the higher-level control. This synchronization routine was not successful.
Note:
This fault results in a STOP A that cannot be acknowledged.
Fault value (r0949, interpret as decimal):
Only for internal Siemens troubleshooting.

Remedy: Carry out a POWER ON (power off/on) for all components
- Upgrade the Motor Module software.
- Upgrade the Control Unit software.
- Upgrade the software of the higher-level control.

F01652 **SI CU: Monitoring clock cycle not permissible**

Response: OFF2

Acknowledgement: IMMEDIATELY (POWER ON)

Explanation: The Safety Integrated monitoring clock cycle is not permissible:

- The monitoring clock cycle integrated in the drive cannot be maintained due to the communication conditions requested in the system.
- The monitoring clock cycle for the safety-related motion monitoring functions with the higher-level control is not permissible (p9500).

Note:

This fault results in a STOP A that cannot be acknowledged.

Fault value (r0949, interpret as decimal):

- When the SI monitoring, integrated in the drive is enabled (p9601/p9801 > 0): Minimum setting for the monitoring clock cycle (in µs).
- When the motion monitoring is enabled (p9501 > 0):

100: It was not possible to find an appropriate monitoring clock cycle.

101: The monitoring clock cycle is not an integer multiple of the actual value clock cycle.

102: An error has occurred when transferring the DP clock cycle to the Motor Module (MM).

103: An error has occurred when transferring the DP clock cycle to the Sensor Module.

104, 105: Four times the current controller sampling time is greater than 1 ms for operation with non-clock-cycle synchronous PROFIBUS.

Four times the current controller sampling time is greater than the DP clock cycle for operation with clock-cycle synchronous PROFIBUS.

The DP clock cycle is not an integer multiple of the current controller sampling time

Remedy: When the SI monitoring, integrated in the drive is enabled (p9601/p9801 > 0).

- Upgrade the Control Unit software.

When the motion monitoring is enabled (p9501 > 0):

- Correct the monitoring clock cycle (p9500) and carry out a POWER ON.

Re fault value = 101:

- Per default, the actual value acquisition clock cycle is the position controller clock cycle / DP clock cycle.
- For the drive-based motion monitoring functions (p9601/p9801bit 2 = 1), the actual value acquisition clock cycle can be directly parameterized in p9511/p9311.

Re fault value 104, 105:

- Set your own actual value acquisition clock cycle in p9511.
- Restrict operation to a maximum of two vector drives. For the default settings in p0112, p0115, the current controller sampling time is automatically reduced to 250 µs. If the default values have been changed, then the current controller sampling time (p0112, p0115) must be correspondingly set.

- When operating with clock cycle synchronous PROFIBUS, increase the DP clock cycle so that an integer clock cycle ratio of at least 4:1 is obtained between the DP clock cycle and the current controller sampling time.
- – upgrade the Control Unit software.

F01655 **SI CU: Align the monitoring functions**

Response OFF2

Acknowledgement IMMEDIATELY (POWER ON)

Explanation An error has occurred when aligning the Safety Integrated monitoring functions on the Control Unit (CU) and Motor Module (MM). Control Unit and Motor Module were not able to determine a common set of supported SI monitoring functions.
- DRIVE–CLiQ communications has an error or failed.
- Safety Integrated software releases on the Control Unit and the Motor Module are not compatible with one another.

Note:
This fault results in a STOP A that cannot be acknowledged.
Fault value (r0949, interpret as hexadecimal):
Only for internal Siemens troubleshooting.

Remedy Carry out a POWER ON (power off/on) for all components
- Upgrade the Motor Module software.
- Upgrade the Control Unit software.
- Check the electrical cabinet design and cable routing for EMC compliance.

F01656 **SI CU: Incorrect Motor Module parameter**

Response OFF2

Acknowledgement IMMEDIATELY (POWER ON)

Explanation When accessing the Safety Integrated parameters for the Motor Module (MM) on the CompactFlash Card, an error has occurred.
Note:
This fault results in a STOP A that can be acknowledged.
Fault value (r0949, interpret as decimal):

129: Safety parameters for the Motor Module corrupted.
131: Internal Motor Module software error.
132: Communication errors when uploading or downloading the safety parameters for the Motor Module.
255: Internal software error on the Control Unit.

Remedy

Re-commission the safety functions.
- Upgrade the Control Unit software.
- Upgrade the Motor Module software.
- Replace the CompactFlash Card.

Re fault value = 132:
- Check the electrical cabinet design and cable routing for EMC compliance.

F01659 **SI CU: Write task for parameter rejected**

Response: OFF2

Acknowledgement: IMMEDIATELY (POWER ON)

Explanation: The write task for one or several Safety Integrated parameters on the Control Unit (CU) was rejected.
Note:
This fault does not result in a safety stop response.
Fault value (r0949, decimal):

1: The Safety Integrated password is not set.
2: A drive parameter reset was selected. However, the Safety Integrated parameters cannot be reset as Safety Integrated is presently enabled.
3: The interconnected STO input is in the simulation mode.
10: An attempt was made to enable the SH function although this cannot be supported.
11: An attempt was made to enable the SBC function although this cannot be supported.
12: An attempt was made to enable the SBC function although this cannot be supported for a parallel circuit configuration.
13: An attempt was made to enable the SS1 function although this cannot be supported.
14: An attempt was made to enable the PROFIsafe communication although this cannot be supported.
15: An attempt was made to enable the motion monitoring functions integrated in the drive although this cannot be supported.
16: An attempt was made to enable the SH function although this cannot be supported when the internal voltage protection (p1231) is enabled.

See also: p0970 (reset infeed parameters), p3900 (complete fast commissioning), r9771 (SI common functions (Control Unit)), r9871 (SI common functions (Motor Module))

Remedy

Re fault value = 1:
- Set the Safety Integrated password (p9761).

Re fault value = 2:
- Inhibit Safety Integrated and again reset the drive parameters.

Re fault value = 3:
- Simulation mode for the digital input ended (p0795).

Re fault value = 10, 11, 12, 13, 14, 15:
- Check whether there are faults in the safety function alignment between the Control Unit and the Motor Module involved (F01655, F30655) and if required, carry out diagnostics for the faults involved.
- Use a Motor Module that supports the function "Safe Torque Off", "Safe Brake Control" PROFIsafe/PROFIsafe V2", "motion monitoring functions integrated in the drive".
- Upgrade the Motor Module software.
- Upgrade the Control Unit software.

Re fault value = 16:
- Inhibit the internal voltage protection (p1231).

See also: p9501 (SI motion enable safe functions), p9601 (SI enable functions integrated in the drive (Control Unit)), p9620 (SI signal source for SH/SBC/SS1 (Control Unit)), p9761 (SI password input), p9801 (SI enable functions integrated in the drive (Motor Module))

F01660 **SI CU: Safety-related functions not supported**

Response: OFF2

Acknowledgement: IMMEDIATELY (POWER ON)

Explanation: The Motor Module (MM) does not support the safety-related functions (e.g. the Motor Module version is not the correct one). Safety Integrated cannot be commissioned.
Note:
This fault does not result in a safety stop response.

Remedy: Use a Motor Module that supports the safety-related functions.
- Upgrade the Motor Module software.

F01664 **SI CU: No automatic firmware update**

Response: OFF2

Acknowledgement: IMMEDIATELY (POWER ON)

Explanation: Parameter p7826 "Automatic firmware update" does not have the value "1" when booting - which is required for the automatic firmware upgrade/downgrade. This means that a combination of versions that is not permissible can occur when the safety functions are enabled.
Note:
This fault does not result in a safety stop response.
See also: p7826 (automatic firmware update)

Remedy	When the SI monitoring function integrated in the drive is enabled: 1. Set parameter p7826 to a value of 1 2. Save parameter (p0977 = 1) and carry out a power on reset When deactivating the SI monitoring function integrated in the drive (p9601 = 0), the alarm can be acknowledged after existing the Safety commissioning mode.

F01670 **SI motion: Invalid Sensor Module parameterization**

Response: OFF2

Acknowledgement: IMMEDIATELY (POWER ON)

Explanation: The parameterization of a Sensor Module used for Safety Integrated is not permissible.
Note:
This fault results in a STOP A that cannot be acknowledged.
Fault value (r0949, interpret as decimal):

1: No encoder was parameterized for Safety Integrated.
2: An encoder was parameterized for Safety Integrated that does not have an A/B (sine/cosine) track.
3: The encoder data set selected for Safety Integrated is still not valid.
4: The communications error with the encoder has occurred.
5: Number of relevant bits in the coarse encoder position invalid.
6: DRIVE-CLiQ encoder configuration invalid.
10: For an encoder used for Safety Integrated, not all of the drive data sets (DDS) are assigned to the same encoder data set (EDS) (p0187 ...p0189).

Remedy: Re fault value = 1, 2:
- Use and parameterize an encoder that Safety Integrated supports (encoder with A/B track, sinusoidal, p0404.4 = 1)

Re fault value = 3:
- Check whether the device or drive commissioning is active and if required, initiate this (p0009 = p0010 = 0), save the parameters (p0971 = 1) and carry out a power on.

Re fault value = 4:
- Check whether there is a DRIVE-CLiQ communications error between the Control Unit and the Sensor Module involved and if required, carry out a diagnostics routine for the faults identified.

Re fault value = 6:
- The encoder configuration data are corrupted or an encoder with impermissible configuration data was used. Therefore, replace the encoder or use a different type of encoder.

Re fault value = 10:
- Align the EDS assignment for all encoders used for Safety Integrated (p0187 ...p0189).

F01671	**SI motion: Encoder parameterization error**
Response	OFF2
Acknowledgement	IMMEDIATELY (POWER ON)
Explanation	The parameterization of the encoder used for Safety Integrated is not the same as the parameterization of the standard encoder. Note: This fault does not result in a safety stop response. Fault value (r0949, interpret as decimal): Parameter number of the non-corresponding safety parameter.
Remedy	Align the encoder parameterization between the safety encoder and the standard encoder.

F01672	**SI motion: Motor Module software/hardware not compatible**
Response	OFF2
Acknowledgement	IMMEDIATELY (POWER ON)
Explanation	The existing Motor Module software does not support the safe motion monitoring, is incompatible to the software on the Control Unit or there is a communication error between the Control Unit and Motor Module. Note: This fault results in a STOP A that cannot be acknowledged. Fault value (r0949, interpret as decimal): 1: The existing Motor Module software does not support the safety-related motion monitoring. 4, 5, 7: The existing Motor Module software is incompatible to the software on the Control Unit. 2, 3, 6, 8: There is a communication error between the Control Unit and Power Module.
Remedy	Check whether there are errors in the safety function alignment between the Control Unit and the Motor Module involved (F01655, F30655) and if required, carry out diagnostics for the errors involved. Re fault value = 1: - Use a Motor Module that supports the safety-related motion monitoring functions. Re fault value = 4, 5, 7: - Upgrade the Motor Module software. Re fault value = 2, 3, 6, 8: - Check whether there is a DRIVE-CLiQ communications error between the Control Unit and the Motor Module involved and if required, carry out a diagnostics routine for the faults identified.

F01673	**SI motion: Sensor Module software/hardware not compatible**
Response	OFF2
Acknowledgement	IMMEDIATELY (POWER ON)
Explanation	The existing Sensor Module software or hardware does not support the safety-related motion monitoring with the higher-level control. Note: This fault does not result in a safety stop response. Fault value (r0949, decimal): Only for internal Siemens troubleshooting.
Remedy	Use a Sensor Module that supports the safety-related motion monitoring functions. - Upgrade the Sensor Module software.

F01680	**SI motion CU: Checksum error, safety-related monitoring functions**
Response	OFF2
Acknowledgement	IMMEDIATELY (POWER ON)
Explanation	The actual checksum calculated by the drive and entered into r9728 over the safety-related parameters does not match the reference checksum in p9729 saved when the machine was accepted the last time. The safety-related parameters have been changed or there is an error. Note: This fault results in a STOP A that cannot be acknowledged. Fault value (r0949, interpret as decimal): 0: Checksum error for SI parameters for motion monitoring 1: Checksum error for SI parameters for actual values 2: Checksum error for SI parameters for component assignment
Remedy	Check the safety-related parameters and if required correct. - Execute POWER ON - Carry out an acceptance test.

C01681	**SI motion CU: Incorrect parameter value**
Response	NONE
Acknowledgement	IMMEDIATELY (POWER ON)
Explanation	The parameter value may not be parameterized with this value. Note: This fault does not result in a safety stop response. Fault value (r0949, interpret as decimal): Parameter number with the incorrect value
Remedy	Correct the parameter value.

F01682 **SI motion CU: Monitoring function is not supported**

Response OFF2

Acknowledgement IMMEDIATELY (POWER ON)

Explanation The monitoring function enabled in p9501, p9601 or p9801is not supported in this firmware version.
Note:
This fault results in a STOP A that cannot be acknowledged.
Fault value (r0949, interpret as decimal):

1: SLP monitoring function is not supported (p9501.1)
2: Monitoring function SCA is not supported (pp9501.7 and p9501.8 – 15 and p9503)
3: Monitoring function SLS override is not supported (p9501.5)
10: Only the servo drive object supports monitoring functions.
20: Motion monitoring functions integrated in the drive only supported in conjunction with PROFIsafe (p9501 and p9601.1 – 2 and p9801.1 –2)
21: PROFIsafe only supported in conjunction with motion monitoring functions integrated in the drive (p9501 and p9601.1 – 2 and p9801.1 –2)

Remedy Deselect monitoring function involved (p9501, p9503, p9601, p9801).

F01683 **SI motion CU: SOS/SLS enable missing**

Response OFF2

Acknowledgement IMMEDIATELY (POWER ON)

Explanation In p9501, the safety–related basic function SOS/SLS has not been enabled although other safety–related monitoring functions have been enabled.
Note:
This fault results in a STOP A that cannot be acknowledged.

Remedy Enable the function ”SOS/SLS” (p9501.0) and carry out a POWER ON.

F01684 **SI motion: Safely limited position limit values interchanged**

Response OFF2

Acknowledgement IMMEDIATELY (POWER ON)

Explanation For the function ”Safely limited position” (SLP), in p9534 there is a value less than that in p9535.
Note:
This fault does not result in a safety stop response.
Fault value (r0949, interpret as decimal):

1: Limit values SLP1 interchanged
2: Limit values SLP2 interchanged

Remedy Correct the limit values in p9534 and p9535 and carry out a POWER ON.

F01685	**SI motion CU: Safely limited speed limit value too high**
Response	OFF2
Acknowledgement	IMMEDIATELY (POWER ON)
Explanation	The limit value for the function ”Safely limited speed” (SLS) is greater than the speed that corresponds to an encoder limit frequency of 500 kHz. Note: This fault does not result in a safety stop response. Fault value (r0949, interpret as decimal): Maximum permissible speed
Remedy	Correct the limit values for SLS and carry out a POWER ON.

F01686	**SI motion: Cam position parameterization not permissible**
Response	OFF2
Acknowledgement	IMMEDIATELY (POWER ON)
Explanation	At least one enabled ”safe cam” (SCA) is parameterized in p9536 or p9537 too close to the tolerance range around the modulo position. The following conditions must be maintained to assign cams to a cam track: - The cam length of cam x = p9536[x]-p9537[x] must be greater than or equal to the cam tolerance + the position tolerance (= p9540 + p9542). This means that for cams on a cam track, the minus position value must be less than the plus position value. - The distance between 2 cams x and y (minus position value[y] - plus position value[x] = p9537[y] - p9536[x]) on a cam track must be greater than or equal to the cam tolerance + the position tolerance (= p9540 + p9542). Note: This fault does not result in a safety stop response. Fault value (r0949, interpret as decimal): Number of the ”safe cam” with an illegal position. See also: p9501 (SI motion enable safety functions (Control Unit))
Remedy	Correct the cam position and carry out a POWER ON.

F01687	**SI motion: Illegal parameterization of modulo value SCA (SN)**
Response	OFF2
Acknowledgement	IMMEDIATELY (POWER ON)
Explanation	The parameterized modulo value for the function ”safe cams” (SCA) is not a multiple of 360 000 mDegree. Note: This fault does not result in a safety stop response.
Remedy	Correct the modulo value for SCA and carry out a POWER ON.

F01688	**SI motion CU: Actual value synchronization not permissible**
Response	OFF2
Acknowledgement	IMMEDIATELY (POWER ON)
Explanation	It is not permissible to enable the actual value synchronization and simultaneously a monitoring function with absolute reference (SCA/SLP). Note: This fault results in a STOP A that cannot be acknowledged.
Remedy	Either deselect the ”actual value synchronization” function or the monitoring functions with absolute reference (SCA/SLP) and carry out a POWER ON.

C01689	**SI motion: Axis re-configured**
Response	OFF2
Acknowledgement	POWER ON
Explanation	The axis configuration was changed (e.g. changeover between a linear axis and rotary axis). Parameter p0108.13 is internally set to the correct value. Note: This fault does not result in a safety stop response. Fault value (r0949, interpret as decimal): Parameter number that initiated the change. See also: p9502 (SI motion axis type)
Remedy	The following must be carried out after the changeover: - Exit the safety commissioning mode (p0010). - Save all parameters (p0977 = 1 or ”Copy RAM to ROM”). - Carry out a POWER ON. Note: For the commissioning software, the units are only displayed consistently after a project upload.

A01698 (F)	**SI CU: Commissioning mode active**
Response	NONE
Acknowledgement	NONE
Explanation	The commissioning of the ”Safety Integrated” function is selected. This message is withdrawn after the safety functions have been commissioned. Note: This message does not result in a safety stop response. See also: p0010 (infeed commissioning, parameter filter)
Remedy	Not necessary
Response	NONE (OFF1, OFF2, OFF3)
Acknowledgement for F	IMMEDIATELY (POWER ON)

A01699 (F)	**SI CU: Shutdown paths must be tested**
Response	NONE
Acknowledgement	NONE
Explanation	The time set in p9659 for the forced checking procedure of the safety shutdown paths has been exceeded. The safety shutdown paths must be re-tested. After the next time that the ”STO” function is deselected, the message is withdrawn and the monitoring time is reset. Note: This message does not result in a safety stop response. See also: p9659 (SI forced checking procedure, timer)
Remedy	Select STO and then deselect again
Response	NONE (OFF1, OFF2, OFF3)
Acknowledgement for F	IMMEDIATELY (POWER ON)

C01700	**SI motion CU: STOP A initiated**
Response	OFF2
Acknowledgement	IMMEDIATELY (POWER ON)
Explanation	The drive is stopped using a STOP A (the pulses are cancelled via the safety shutdown path of the Control Unit). Possible causes: - Stop request from the higher-level control. - Pulses have not been cancelled after a parameterized time (p9557) after the test stop was selected. - Subsequent response of message C01706 ”SI motion: Safe acceleration monitoring exceeded”. - Subsequent response of message C01714 ”SI motion: Safely reduced speed exceeded”. - Subsequent response of message C01701 ”SI motion: STOP B initiated”.

Remedy	Remove the cause of the fault on the control and carry out a power on. - Check the value in p9557 - if required increase the value and carry out a power on. - Check the shutdown path of the Control Unit (check DRIVE-CLiQ communications). - Carry out diagnostics for message C01706. - Carry out diagnostics for message C01714. - Carry out diagnostics for message C01701. - Replace the module. - Replace the Control Unit This message can only be acknowledged as follows in the acceptance test mode without POWER ON: - Motion monitoring functions with SINUMERIK: From the machine control panel.

C01701	**SI motion CU: STOP B initiated**
Response	OFF3
Acknowledgement	IMMEDIATELY (POWER ON)
Explanation	The drive is stopped using STOP B (braking along the OFF3 down ramp). As a result of this fault, after the time parameterized in p9556 has expired or the speed threshold parameterized in p9560 has been fallen below, message C01700 ”STOP A initiated” is output. Possible causes - Stop request from the higher-level control. - Subsequent response of message C01714 ”SI motion: Safely reduced speed exceeded”. - Subsequent response of message C01711 ”SI motion: Defect in a monitoring channel”.
Remedy	Remove the cause of the fault on the control and carry out a power on. - Carry out diagnostics for message C01714. - Carry out diagnostics for message C01711. This message can only be acknowledged as follows in the acceptance test mode without POWER ON: - Motion monitoring functions with SINUMERIK: From the machine control panel.

C01706	**SI motion CU: Safe acceleration monitoring limit exceeded**
Response	NONE
Acknowledgement	IMMEDIATELY (POWER ON)

Explanation
After the initiation of STOP B or STOP C, the speed exceeded the selected tolerance value.
The drive is stopped by the message C01700 ”STOP A initiated”.

Remedy
Check the braking behavior and if required adapt the tolerance for ”safe acceleration monitoring” (SBR).
This message can only be acknowledged as follows in the acceptance test mode without POWER ON:
- Motion monitoring functions with SINUMERIK: From the machine control panel.

C01707 SI motion CU: Tolerance for safe operating stop exceeded

Response
NONE

Acknowledgement
IMMEDIATELY (POWER ON)

Explanation
The actual position has moved further away from the setpoint position than permitted in the stop tolerance. The drive is stopped with the message C01701 ”SI motion: STOP B initiated”.

Remedy
Check whether additional safety faults are present and if required, carry out the diagnostics for the faults involved.
- Check whether the stop tolerance matches the accuracy and dynamic performance of the axis.
- Carry out a POWER ON.

This message can only be acknowledged as follows in the acceptance test mode without POWER ON:
- Motion monitoring functions with SINUMERIK: From the machine control panel

C01708 SI motion CU: STOP C activated

Response
STOP2

Acknowledgement
IMMEDIATELY (POWER ON)

Explanation
The drive is stopped using STOP C (braking along the OFF3 ramp).
”Safe operating stop” (SOS) is activated after the parameterized timer has expired.
Possible causes:
- Stop request from the higher-level control
- Subsequent response of message C01714 ”SI motion: Safely reduced speed exceeded”.
- Subsequent response of message C01715 ”SI motion: Safe limit position exceeded”.

See also: p9552 (SI motion transition time STOP C to SOS (SBH) (Control Unit))

Remedy	Remove the cause of the fault on the control. - Carry out diagnostics for message C01714. This message can be acknowledged as follows: - Motion monitoring functions with SINUMERIK: From the machine control panel

C01709	**SI motion CU: STOP D is activated**
Response	NONE
Acknowledgement	IMMEDIATELY (POWER ON)
Explanation	The drive is stopped using STOP D (braking along the path). ”Safe operating stop” (SOS) is activated after the parameterized timer has expired. Possible causes: - Stop request from the higher-level control - Subsequent response of message C01714 ”SI motion: Safely reduced speed exceeded”. - Subsequent response of message C01715 ”SI motion: Safe limit position exceeded”. See also: p9553 (SI motion transition time STOP D to SOS (SBH) (Control Unit))
Remedy	Remove the cause of the fault on the control and carry out a power on. - Carry out diagnostics for message C01714. This message can be acknowledged as follows: - Motion monitoring functions with SINUMERIK: From the machine control panel

C01710	**SI motion CU: STOP E activated**
Response	NONE
Acknowledgement	IMMEDIATELY (POWER ON)
Explanation	The drive is stopped using STOP E (retraction motion). ”Safe operating stop” (SOS) is activated after the parameterized timer has expired. Possible causes: - Stop request from the higher-level control - Subsequent response of message C01714 ”SI motion: Safely reduced speed exceeded”. - Subsequent response of message C01715 ”SI motion: Safe limit position exceeded”. See also: p9554 (SI motion transition time STOP E to SOS (SBH) (Control Unit))
Remedy	Remove the cause of the fault on the control. - Carry out diagnostics for message C01714. This message can be acknowledged as follows: - Motion monitoring functions with SINUMERIK: From the machine control panel

C01711	**SI motion CU: Defect in a monitoring channel**
Response	NONE
Acknowledgement	IMMEDIATELY (POWER ON)
Explanation	For a crosswise comparison, the drive found a difference between input data or results of the monitoring functions and initiated a STOP F. One of the monitoring functions no longer functions reliably, i.e. safe operation is no longer possible. If at least one monitoring function is active, then after the parameterized timer has expired, message C01701 ”SI motion: STOP B initiated” is output. The message value that resulted in a STOP F is displayed in r9725. The message values described involve the crosswise data comparison between the Control Unit and Motor Module. **If the drive is operated together with a SINUMERIK, the message values are written to Alarm 27001 of the SINUMERIK 840D sl**.
Remedy	In general: The monitoring clock cycles in both channels must be checked to ensure that they are identical and if required, they must be set the same. Re fault value = 0: - No error has been detected in this monitoring channel. Note the error message of the other monitoring channel (for MM: F30711). Re fault value = 4: - The monitoring clock cycles in both channels must be checked to ensure that they are identical and if required, they must be set the same. Re fault value = 1 ... 999: - Check the crosswise compared parameters that resulted in the STOP F, if required, copy the Safety parameters. - Carry out a POWER ON (power off/on) for all components. - Upgrade the Motor Module software. - Upgrade the Control Unit software. - Correct the encoder evaluation. The actual values differ due to mechanical faults (transmission belts, traversing to mechanical limit, wear and tolerance windows that have been set too narrow, encoder faults, ...) Re fault value = 1000: - Investigate the signal associated with the safety-related input (contact problems). Re fault value = 1001: - Carry out a POWER ON (power off/on) for all components. - Upgrade the Motor Module software. - Upgrade the Control Unit software. Re fault value = 1005: - Check the conditions for pulse enable. Re fault value = 1011: - For diagnostics, refer to parameter (r9571).

Re fault value = 1012:
- Upgrade the Sensor Module software.

Re fault value = 1020, 1021:
- Check the communication connection.
- Carry out a POWER ON (power off/on) for all components.
- Hardware exchange

Re fault value = 5000, 5014, 5023, 5024, 5030, 5031, 5032, 5042, 5043, 5052, 5053, 5068, 5072, 5073, 5082 ... 5087, 5090, 5091, 5122 ... 5125, 5132 ... 5135, 5140:
- Carry out a POWER ON (power off/on) for all components.
- Check whether there is a DRIVE-CLiQ communications error between the Control Unit and the Motor Module involved and if required, carry out a diagnostics routine for the faults identified.
- Upgrade firmware to later version.
- Contact the Hotline.
- Replace the Control Unit.

Re fault value = 5012:
- Check the setting of the PROFIsafe address of the Control Unit (p9610) and that of the Motor Modules (p9810). The PROFIsafe address must not be 0 or FFFF!

Re fault value = 5013, 5025:
- Carry out a POWER ON (power off/on) for all components.
- Check the setting of the PROFIsafe address of the Control Unit (p9610) and that of the Motor Modules (p9810).
- Check whether there is a DRIVE-CLiQ communications error between the Control Unit and the Motor Module involved and if required, carry out a diagnostics routine for the faults identified.

Re fault value = 5022:
- Check the value settings of the F parameters at the PROFIsafe slave (F_SIL, F_CRC_Length, F_Par_Version, F_Source_Add, F_Dest_add, F_WD_Time).

Re fault value = 5026:
- Check the value settings of the F parameters and the F parameter CRC (CRC1) calculated from this value at the PROFIsafe slave and update.

Re fault value = 5065:
- Check the configuring and communication at the PROFIsafe slave (Consecutive No./ CRC).
- Check the value setting of the F parameter F_WD_Time at the PROFIsafe slave and possibly increase.
- Check whether there is a DRIVE-CLiQ communications error between the Control Unit and the Motor Module involved and if required, carry out a diagnostics routine for the faults identified.

Re fault value = 5066:
- Check the value setting of the F parameter F_WD_Time at the PROFIsafe slave and possibly increase.

Re fault value = 6000, 6072:
- Carry out a POWER ON (power off/on) for all components.
- Check whether there is a DRIVE-CLiQ communications error between the Control Unit and the Motor Module involved and if required, carry out a diagnostics routine for the faults identified.
- Upgrade firmware release.
- Contact the Hotline.
- Replace the Control Unit.

Re fault value = 6064:
- Check the value setting in the F parameter F_Dest_Add at the PROFIsafe slave.
- Check the setting of the PROFIsafe address of the Control Unit (p9610) and that of the Motor Modules (p9810).

Re fault value = 6065:
- Check the value setting in the F parameter F_Dest_Add at the PROFIsafe slave. The target address must not be 0 or FFFF!

Re fault value = 6066:
- Check the value setting in the F parameter F_Source_Add at the PROFIsafe slave. The source address must not be 0 or FFFF!

Re fault value = 6067:
- Check the value setting in the F parameter F_WD_Time at the PROFIsafe slave. The watchdog time value must not be 0!

Re fault value = 6068:
- Check the value set in the F parameter F_SIL at the PROFIsafe slave. The SIL must correspond to SIL2!

Re fault value = 6069:
- Check the value setting in the F parameter F_CRC_Length at the PROFIsafe slave. The setting of the CRC2 length is 2 byte CRC in the V1 mode and 3 byte CRC in the V2 mode!

Re fault value = 6070:
- Check the value setting in the F parameter F_Par_Version at the PROFIsafe slave. The value for the F parameter version is 0 in the V1 mode and 1 in the V2 mode!

Re fault value = 6071:
- Check the value settings of the F parameters and the F parameter CRC (CRC1) calculated from these at the PROFIsafe slave and if required update.

Re fault value = 6165:
- Check the configuring and communication at the PROFIsafe slave.
- Check the value setting of the F parameter F_WD_Time at the PROFIsafe slave and possibly increase.
- Check whether there is a DRIVE-CLiQ communications error between the Control Unit and the Motor Module involved and if required, carry out a diagnostics routine for the faults identified.

Re fault value = 6166:
- Check the configuring and communication at the PROFIsafe slave.
- Check the value setting of the F parameter F_WD_Time at the PROFIsafe slave and possibly increase.

This message can be acknowledged as follows:
- Motion monitoring functions integrated in the drive: Via Terminal Module 54F (TM54F) or PROFIsafe
- Motion monitoring functions with SINUMERIK: From the machine control panel

See also: p9300 (SI motion monitoring clock cycle (Motor Module)), p9500 (SI motion monitoring clock cycle (Control Unit))

C01714 **SI motion CU: Safely limited speed exceeded**

Response NONE

Acknowledgement IMMEDIATELY (POWER ON)

Explanation The drive has moved faster than that specified by the speed limit value (p9531). The drive is stopped by the configured stop response (p9563).
Message value: (r9749, interpret as decimal):
100: SLS1 exceeded
200: SLS2 exceeded
300: SLS3 exceeded
400: SLS4 exceeded
1000: Encoder limit frequency exceeded.

Remedy Check the traversing program on the control.
- Check the limits for ”Safely limited speed” (SLS) and if required adapt (p9531).

This message can be acknowledged as follows:
- Motion monitoring functions with SINUMERIK: From the machine control panel

C01715 **SI motion CU: Safe end position exceeded**

Response NONE

Acknowledgement IMMEDIATELY (POWER ON)

Explanation: The axis has passed a parameterized end position that is monitored by the function ”safe software limit switch” (SE).
Message value: (r9749, decimal):
10: SE1– fallen below
11: SE1+ exceeded
20: SE2– fallen below
21: SE2+ exceeded

Remedy: Check the traversing program on the control.
- Check the limits for ”safe software limit switch” (SE) and if required adapt (p9534, p9535).

C01745 **SI motion CU: Check the braking torque for the brake test**

Response: NONE

Acknowledgement: IMMEDIATELY (POWER ON)

Explanation: Parameter 2003 was used to change the normalization of the braking torque for the braking test. A new acceptance test must be carried out for the brake test. This identifies as to whether the brake test is still to be carried out with the correct braking torque.

Remedy: Carry out a POWER ON/OFF.
- Repeat the acceptance test for the safe brake test if the braking test is used.

C01750 **SI motion CU: Hardware fault, safety–related encoder**

Response: NONE

Acknowledgement: IMMEDIATELY (POWER ON)

Explanation: The encoder that is used for the safety–related motion monitoring functions outputs a hardware fault.
Message value (r9749, interpret as decimal):
Encoder status word 1, encoder status word 2, which resulted in the message.

Remedy: Check the encoder connection
- Replace the encoder.

This message can be acknowledged as follows:
- Motion monitoring functions with SINUMERIK: From the machine control panel.

C01751 **SI motion CU: Effectiveness test error, safety–related encoder**

Response: NONE

Acknowledgement: IMMEDIATELY (POWER ON)

Explanation — The DQ encoder that is used for the safety-related motion monitoring functions outputs an effectiveness test error.
Message value (r9749, interpret as decimal):
1 - TFD bit in GeberStatusWort2 is set in the last effectiveness test set
2 - Actual effectiveness test number in the last effectiveness test set less than/greater than expected
3 - IG1/IG2 bits in the GeberStatusWort2 in the last effectiveness test set longer than expected
4 - F1/F2 bits in the GeberStatusWort2 in the last effectiveness test set not updated
5 - Effectiveness tests performed too frequently
6 - LS1/LS2 was not frozen during the effectiveness tests
7 - Effectiveness tests performed either too infrequently / not at all

Remedy — Replace the encoder.
This message can be acknowledged as follows:
- Motion monitoring functions with SINUMERIK: From the machine control panel.

A01796 (F, N) SI motion CU: Waiting for communication

Response — NONE

Acknowledgement — NONE

Explanation — The drive waits for communications to be established with the higher-level control to execute the safety motion monitoring functions.
Note:
In this state, the pulses are safely cancelled.

Remedy — If the message is not automatically withdrawn after a longer period of time then the following checks should be made:
For communication with SINUMERIK, the following applies:
- Check and remove any additional messages that are present regarding PROFIBUS communication.
- Check the correct assignment of the axes on the higher-level control to the drives in the drive unit.
- Check that the safety motion monitoring functions for the corresponding axis on the higher-level control are enabled and if required, set.

See also: p9601 (SI enable, functions integrated in the drive (Control Unit)), p9801 (SI enable, functions integrated in the drive (Motor Module)), p10010 (SI drive object assignment)

Response for F — NONE (OFF1, OFF2, OFF3)

Acknowledgement for F — IMMEDIATELY (POWER ON)

Response for N — NONE

Acknowledgement for N — NONE

C01797	**SI motion CU: Axis not safely referenced**
Response	NONE
Acknowledgement	IMMEDIATELY (POWER ON)
Explanation	The stop position saved before powering-down does not coincide with the actual position that is determined when powering-up. Message value: (r9749, interpret as decimal): 1: Axis not referenced 2: User agreement missing
Remedy	If the axis cannot be automatically and safely referenced, then the user must enter a user agreement for the new position using the appropriate softkey. This therefore designates this position as being a safety-related position.

C01798	**SI motion CU: Test stop running**
Response	NONE
Acknowledgement	IMMEDIATELY (POWER ON)
Explanation	The test stop is active.
Remedy	Not necessary. The message is withdrawn when the test stop is completed.

C01799	**SI motion: Acceptance test mode is active**
Response	NONE
Acknowledgement	IMMEDIATELY (POWER ON)
Explanation	The acceptance test mode is active. The POWER ON messages of the safe motion monitoring functions can be acknowledged during the acceptance test using the RESET key of the higher-level control.
Remedy	Not necessary. The message is withdrawn when exiting the acceptance test mode.

List of faults and alarms (Motor Module)

F30600	**SI MM: STOP A initiated**
Response	OFF2
Acknowledgement	IMMEDIATELY (POWER ON)

Explanation

The "Safety Integrated" function integrated in the drive on the Motor Module (MM) has detected a fault and initiated STOP A (pulse cancellation via the safety shutdown path of the Motor Module).

- Forced checking procedure of the safety shutdown path of the Motor Module unsuccessful.
- Subsequent response to fault F30611 (defect in a monitoring channel).

Fault value (r0949, interpret as decimal):

0: Stop request from the Control Unit

1005: Pulses cancelled although STO not selected and there is no internal STOP A present.

1010: Pulses enabled although STO is selected or an internal STOP A is present.

1020: Internal software error in the "Internal voltage protection" function. The "Internal voltage protection" function is cancelled. A STOP A that cannot be acknowledged is initiated.

9999: Subsequent response to fault F30611

Remedy

Select Safe Torque Off and then deselect again.

- Replace the Motor Module involved.

Re fault value = 1020:

- Carry out a POWER ON (power off/on) for all components.
- Upgrade the Motor Module software.
- Replace the Motor Module.

Re fault value = 9999:

- Carry out diagnostics for fault F30611.

F30611 **SI MM: Defect in a monitoring channel**

Response NONE (OFF1, OFF2, OFF3)

Acknowledgement IMMEDIATELY (POWER ON)

Explanation

The "Safety Integrated" function integrated in the drive on the Motor Module (MM) has detected a fault in the crosswise data comparison between the Control Unit (CU) and MM and initiated a STOP F.
As a result of this fault, after the parameterized transition has expired (p9858), fault F30600 (SI MM: STOP A initiated) is output.
Fault value (r0949, interpret as decimal):

0: Stop request from the Control Unit

1 to 999:

Number of the crosswise compared data that resulted in this fault.

1: SI monitoring clock cycle (r9780, r9880)

2: SI enable safety functions (p9601, p9801)

3: SI SGE changeover, tolerance time (p9650, p9850)

4: SI transition time STOP F to STOP A (p9658, p9858)

5: SI enable safe brake control (p9602, p9802)

6: SI motion, enable safety functions (p9501, internal value). This number is also displayed in r9895.

7: SI delay time of the pulse cancellation for Safe Stop1 on the Control Unit and Motor Module are different.

9: Debounce time for STO/SBC/SS1 (MM) (p9651, p9851)

10: SI delay time for pulse suppression with ESR (p9697, p9897)

1000: Check (watchdog) timer has expired. Within the time of approx. 5 x p9850 too many switching operations have occurred at the safety-related inputs of the Control Unit.

1001, 1002: Initialization error, change timer / check timer.

2000: Status of the SH terminals on the Control Unit and Motor Module are different.

2001: Feedback signal for safe pulse cancellation on the Control Unit and Motor Module are different.

2002: Status of the delay timer SS1 on the Control Unit and Motor Module are different.

Remedy

Re fault value = 1 to 5 and 7 to 999:
- Check the crosswise compared data that resulted in a STOP F.
- Carry out a POWER ON (power off/on) for all components.
- Upgrade the Motor Module software.
- Upgrade the Control Unit software.

Re fault value = 6:
- Carry out a POWER ON (power off/on) for all components.
- Upgrade the Motor Module software.
- Upgrade the Control Unit software.

Re fault value = 1000:
- Check the wiring of the safety-related inputs (SGE) on the Control Unit (contact problems).

Re fault value = 1001, 1002:
- Carry out a POWER ON (power off/on) for all components.
- Upgrade the Motor Module software.
- Upgrade the Control Unit software.

Re fault value = 2000, 2001, 2002:
- Check the tolerance time SGE changeover and if required, increase the value (p9650, p9850).
- Check the wiring of the safety-related inputs (SGE) (contact problems).
- Replace the Motor Module involved.

N30620 (F, A) **SI MM: Safe Torque Off active**

Response	NONE
Acknowledgement	NONE
Explanation	The ”Safe Torque Off” function was selected on the Motor Module (MM) via input terminal and is active. Note: This message does not result in a safety stop response.
Remedy	Not necessary.
Response as for F	OFF2
Acknowledgement for F	IMMEDIATELY (POWER ON)
Response	NONE
Acknowledgement for A	NONE

N30621 (F, A) **SI MM: Safe Stop 1 active**

Response	NONE
Acknowledgement	NONE
Explanation	The ”Safe Stop 1” (SS1) function has been selected on the Motor Module (MM) and is active. Note: This message does not result in a safety stop response.
Remedy	Not necessary.
Response as for F	OFF2
Acknowledgement for F	IMMEDIATELY (POWER ON)
Response	NONE
Acknowledgement for A	NONE

F30625 **SI MM: Sign-of-life error in safety data**

Response: OFF2

Acknowledgement: IMMEDIATELY (POWER ON)

Explanation: The "Safety Integrated" function integrated in the drive on the Motor Module (MM) has detected an error in the sign-of-life of the safety data between the Control Unit (CU) and MM and initiated a STOP A.
- There is either a DRIVE-CLiQ communications error or communications have failed.
- A time slice overflow of the safety software has occurred.

Fault value (r0949, interpret as decimal):
Only for internal Siemens troubleshooting.

Remedy: Select Safe Torque Off and then deselect again.
- Carry out a POWER ON (power off/on) for all components.
- Check whether there is a DRIVE-CLiQ communications error between the Control Unit and the Motor Module involved and if required, carry out a diagnostics routine for the faults identified.
- Deselect all drive functions that are not absolutely necessary.
- Reduce the number of drives.
- Check the electrical cabinet design and cable routing for EMC compliance.

F30630 **SI MM: Brake control defective**

Response: OFF2

Acknowledgement: IMMEDIATELY (POWER ON)

Explanation: The "Safety Integrated" function integrated in the drive on the Motor Module ((MM) has detected a brake control fault and initiated a STOP A.
Fault value (r0949, interpret as decimal):
10:
Fault for "Open brake"
- Parameter p1278 incorrectly set
- Brake not connected or interrupted cable (check whether for p1278 = 1 and p9602/p9802 = 0 (brake switched-out) the brake opens).
- Ground fault, brake cable

30:
Fault for "Close brake"
- Brake not connected or interrupted cable (check whether for p1278 = 1 and p9602/p9802 = 0 (brake switched-out) the brake opens).
- Short-circuit in the brake winding

40:
Fault in the "Brake closed" state
60, 70:
Fault in the brake control of the Control Unit or communication error between the Control Unit and Motor Module (brake control).
Note:
The following causes can be involved for all fault values:
- The motor cable shield is not correctly connected.
- Defect in the brake control circuit of the Motor Module.

Remedy

Check parameter p1278 (with SBC, only p1278 = 0 is permissible)
- Select Safe Torque Off and then deselect again.
- Check the motor holding brake connection.
- Check the function of the motor holding brake.
- Check whether there is a DRIVE-CLiQ communications error between the Control Unit and the Motor Module involved and if required, carry out a diagnostics routine for the faults identified.
- Check the electrical cabinet design and cable routing for EMC compliance.
- Replace the Motor Module involved.

F30640 **SI MM: Fault in the shutdown path of the second channel**

Response: OFF2

Acknowledgement: IMMEDIATELY (POWER ON)

Explanation

The Motor Module has a detected a communication error with the higher-level control to transfer safety-relevant information.
Note:
This fault results in a STOP A that can be acknowledged.
Fault value (r0949, interpret as decimal):
Only for internal Siemens troubleshooting.

Remedy

For a higher-level control, the following applies:
- Check the PROFIsafe address in the higher-level control and Motor Module and if required, correct
- Save all parameters (p0977 = 1).
- Carry out a POWER ON for all components.

In general:
- Upgrade the Motor Module software.

F30649 **SI MM: Internal software error**

Response: OFF2

Acknowledgement: IMMEDIATELY (POWER ON)

Explanation

An internal error in the Safety Integrated software on the Motor Module has occurred.
Note:
This fault results in a STOP A that cannot be acknowledged.
Fault value (r0949, interpret as hexadecimal):
Only for internal Siemens troubleshooting.

Remedy

Carry out a POWER ON (power off/on) for all components.
- Re-commission the Safety Integrated function and carry out a POWER ON.
- Upgrade the Motor Module software.
- Contact the Hotline.
- Replace the Motor Module.

F30650 **SI MM: Acceptance test required**

Response OFF2

Acknowledgement IMMEDIATELY (POWER ON)

Explanation

The ”Safety Integrated” function on the Motor Module requires an acceptance test.
Note:
This fault results in a STOP A that can be acknowledged.
Fault value (r0949, interpret as decimal)

130: Safety parameters for the Motor Module not available.

1000: Reference and actual checksum in the Motor Module are not identical (boot).
- At least one checksum-checked piece of data is defective.

2000: Reference and actual checksum on the Motor Module are not identical (commissioning mode).
- Reference checksum incorrectly entered into the Motor Module (p9899 not equal to r9898).

2003: Acceptance test is required as a safety parameter has been changed.

2005: The safety logbook has identified that safety checksums have been changed. An acceptance test is required.

3003: An acceptance test is required, as one of the safety parameters referred to the hardware has been changed.

9999: Subsequent response of another safety-related fault that occurred when booting that requires an acceptance test.

Remedy

Re fault value = 130:
- Carry out safety commissioning routine.

Re fault value = 1000:
- Repeat safety commissioning.
- Replace the CompactFlash Card.

Re fault value = 2000:
- Check the safety parameters on the Motor Module and adapt the reference checksum (p9899).

Re fault value = 2003, 2005:
- Carry out acceptance test and create test certificate.

The procedure when carrying out the acceptance test as well as an example for the acceptance report can be found in the following reference:
SINAMICS S120 Safety Integrated Function Manual

Re fault value = 9999:
- Carry out diagnostics for the other safety-related fault that is present.

See also: p9799 (SI reference checksum SI parameters (Control Unit)), p9899 (SI reference checksum, SI parameters (Motor Module)).

F30651 **SI MM: Synchronization with the Control Unit unsuccessful**

Response: OFF2

Acknowledgement: IMMEDIATELY (POWER ON)

Explanation: The ”Safety Integrated” function integrated in the drive is requesting synchronization of the safety time slices on the Control Unit and Motor Module. This synchronization routine was not successful.
Note:
This fault results in a STOP A that cannot be acknowledged.
Fault value (r0949, interpret as decimal):
Only for internal Siemens troubleshooting.

Remedy: Carry out a POWER ON (power off/on) for all components
- Upgrade the Motor Module software.
- Upgrade the Control Unit software.

F30652 **SSI MM: Monitoring clock cycle not permissible**

Response: OFF2

Acknowledgement: IMMEDIATELY (POWER ON)

Explanation: The Safety Integrated monitoring clock cycle cannot be maintained due to the communication conditions requested in the system.
Note:
This fault results in a STOP A that cannot be acknowledged.
Fault value (r0949, interpret as decimal):
Only for internal Siemens troubleshooting.

Remedy: Upgrade the Motor Module software.

F30655 **SI MM: Align the monitoring functions**

Response: OFF2

Acknowledgement: IMMEDIATELY (POWER ON)

Explanation: An error has occurred when aligning the Safety Integrated monitoring functions on the Control Unit (CU) and Motor Module (MM). Control Unit and Motor Module were not able to determine a common set of supported SI monitoring functions.
- DRIVE-CLiQ communications has an error or failed.
- Safety Integrated software releases on the Control Unit and the Motor Module are not compatible with one another.

Note:
This fault results in a STOP A that cannot be acknowledged.
Fault value (r0949, interpret as hexadecimal):
Only for internal Siemens troubleshooting.

Remedy

Carry out a POWER ON (power off/on) for all components
- Upgrade the Motor Module software.
- Upgrade the Control Unit software.
- Check the electrical cabinet design and cable routing for EMC compliance.

F30656 **SI MM: Incorrect Motor Module parameter**

Response
OFF2

Acknowledgement
IMMEDIATELY (POWER ON)

Explanation
When accessing the Safety Integrated parameters for the Motor Module (MM) on the CompactFlash Card, an error has occurred.
Note:
This fault results in a STOP A that can be acknowledged.
Fault value (r0949, interpret as decimal):

129: Safety parameters for the Motor Module corrupted.
131: Internal software error on the Control Unit.
255: Internal Motor Module software error.

Remedy
Re-commission the safety functions.
- Upgrade the Control Unit software.
- Upgrade the Motor Module software.
- Replace the CompactFlash Card.

F30659 **SI MM: Write task for parameter rejected**

Response
OFF2

Acknowledgement
IMMEDIATELY (POWER ON)

Explanation
The write task for one or several Safety Integrated parameters on the Motor Module (MM) was rejected.
Note:
This fault does not result in a safety stop response.
Fault value (r0949, interpret as decimal):

10: An attempt was made to enable the STO function although this cannot be supported.
11: An attempt was made to enable the SBC function although this cannot be supported.
13: An attempt was made to enable the SS1 function although this cannot be supported.
14: An attempt was made to enable the safe motion monitoring with the higher-level control although this cannot be supported.
15: An attempt was made to enable the motion monitoring functions integrated in the drive although these cannot be supported.
16: An attempt was made to enable the PROFIsafe communication although this cannot be supported or the version of the PROFIsafe driver on the CU and MM differ.

	See also: r9771 (SI common functions (Control Unit)), r9871 (SI common functions (Motor Module))
Remedy	Re fault value = 10, 11, 13, 14, 15, 16: - Check whether there are faults in the safety function alignment between the Control Unit and the Motor Module involved (F01655, F30655) and if required, carry out diagnostics for the faults involved. - Use a Motor Module that supports the function (Safe Torque Off or Safe Brake Control, PROFIsafe/PROFIsafe V2, motion monitoring functions integrated in the drive). - Upgrade the Motor Module software. - Upgrade the Control Unit software.

F30672 **SI motion: Control Unit software incompatible**

Response	OFF2
Acknowledgement	IMMEDIATELY (POWER ON)
Explanation	The existing Control Unit software does not support the safe drive-based motion monitoring function. Note: This fault results in a STOP A that cannot be acknowledged. Fault value (r0949, interpret as decimal): Only for internal Siemens troubleshooting.
Remedy	Check whether there are faults in the safety function alignment between the Control Unit and the Motor Module involved (F01655, F30655) and if required, carry out diagnostics for the faults involved. - Use a Control Unit that supports the safety-related motion monitoring functions. - Upgrade the Control Unit software.

F30680 **SI motion MM: Checksum error, safety-related monitoring functions**

Response	OFF2
Acknowledgement	IMMEDIATELY (POWER ON)
Explanation	The checksum calculated by the Motor Module and entered into r9398 over the safety-related parameters does not match the reference checksum in p9399 saved when the machine was accepted the last time. The safety-related parameters have been changed or there is an error. Note: This fault results in a STOP A that cannot be acknowledged. Fault value (r0949, interpret as decimal): 0: Checksum error for SI parameters for motion monitoring. 1: Checksum error for SI parameters for component assignment.

Remedy
Check the safety-related parameters and if required correct.
- Set the reference checksum to the actual checksum.
- Carry out a POWER ON.
- Carry out an acceptance test.

C30681 **SI motion MM: Incorrect parameter value**

Response NONE

Acknowledgement IMMEDIATELY (POWER ON)

Explanation
The parameter value may not be parameterized with this value.
Note:
This message does not result in a safety stop response.
Fault value (r0949, interpret as decimal):
Parameter number with the incorrect value.

Remedy
Correct the parameter value.

C30682 **SI motion MM: Monitoring function is not supported**

Response OFF2

Acknowledgement IMMEDIATELY (POWER ON)

Explanation
The monitoring function enabled in p9301, p9501, p9601 or p9801 is not supported in this firmware version.
Note:
This message does not result in a safety stop response.
Fault value (r0949, interpret as decimal):
30: The firmware version of the Motor Module is older than the version of the Control Unit.

Remedy
Deselect monitoring function involved (p9301, p9301, p9303, p9601, p9801).
- Upgrade the Motor Module firmware.
See also: p9301 (SI motion enable safety functions (Motor Module)), p9501 (SI motion enable safety functions (Control Unit)), p9503 (SI motion SCA (SN) enable (Control Unit)), p9601 (SI enable functions integrated in the drive (Control Unit)), p9801 (SI enable functions integrated in the drive (Motor Module))

C30706 **SI motion MM: Safe acceleration monitoring limit exceeded**

Response NONE

Acknowledgement IMMEDIATELY (POWER ON)

Explanation
After the initiation of STOP B or STOP C, the speed exceeded the selected tolerance value. The drive is stopped with the message C30700 ”SI motion MM: STOP A initiated”.

Remedy Check the braking behavior and if required adapt the tolerance for ”safe acceleration monitoring (SBR).
This message can only be acknowledged in the acceptance test mode without POWER ON via PROFIsafe.

See also: p9548 (SI motion SBR actual speed tolerance (Control Unit))

10.4 Safety PLC alarms

400253 **PLC-STOP due to an SPL system error**

Explanation: After an interruption in the communications between NCK and PLC regarding the SPL crosswise data comparison, the PLC was switched into the STOP state with a delay of 5 s.

Response: Alarm display

Remedy: Do not start the SPL anymore. Check the system components (the PLC must have the correct version of the FB 15 and have DB18).

Program continuation: Remove the fault. Power-down the control and power-up again

400254 **Checksum error has occurred: %1 parameter: %1 = reference to the code section or table**

Explanation: Checksum error in safety-related code or safety-related data. The safety monitoring functions (Safety Integrated) in the PLC could be corrupted.

Response: Alarm display

Remedy: Power-down the control and power-up again (PowerOn). If this fault occurs again, contact the service department. In addition perform a general reset for NC, PLC and reload the archive.

Program continuation: Power-down the control and power-up again

400551 **Error on the MPI/DP bus**

Explanation: Error on the I/O bus detected

Response: Alarm display

Remedy: Check the I/O, resolve I/O errors

Program continuation: Internal

400552 **Error on the DP bus**

Explanation: Error on the I/O bus detected

Response: Alarm display

Remedy: Check the I/O, resolve I/O errors

Program continuation: Internal

411101	**FB11, illegal axis number**
Explanation	Parameter axis not in the permissible range
Response	Alarm display PLC STOP
Remedy	PLC general reset, use the basic program with the correct version.
Program continuation	Remove the fault. Power-down the control and power-up again

10.5 Reducing the number of alarms

In some cases, alarms having the same significance are initiated by the NCK, PLC and SINAMICS S120 monitoring channels. In order to make the alarm screen more transparent, the alarms that were initiated sometime later - but have the same significance - are suppressed or even an alarm that occurred earlier is cleared again if it apparently involves a subsequent (follow-on) fault/error.

Alarm suppression and alarm priority are not involved when it comes to initiating a stop through two channels. This functionality is implemented independently of the alarm being initiated and is still maintained.

10.5.1 Alarm suppression

When the alarm suppression function is active, the alarm of the monitoring channel is displayed that first detected the fault/error that initiated the alarm.
This only applies to some of the alarms. Alarms whose information content differs depending on the monitoring channels are still separately displayed.

All of the NCK and SINAMICS S120 safety alarms are shown in the following table, that can be suppressed with the appropriate parameterization of $MN_SAFE_ALARM_SUPPRESS_LEVEL.

Table 10-5 Comparison of the NCK and SINAMICS S120 safety alarms

NCK alarm number	SINAMICS S120 alarm number	Alarm suppression using the following values in $MN_SAFE_ALARM_SUPPRESS_LEVEL, several values are alternatively possible.
27000	C01797	3, 13, replaced by Alarm 27100
27010	C01707	1, 2, 3, 12, 13
27011	C01714	1, 2, 3, 12, 13
27012	C01715	1, 2, 3, 12, 13
27013	C01706	1, 2, 3, 12, 13
27020	C01710	1, 2, 3, 12, 13
27021	C01709	1, 2, 3, 12, 13
27022	C01708	1, 2, 3, 12, 13
27023	C01701	1, 2, 3, 12, 13
27024	C01700	1, 2, 3, 12, 13

All of the NCK alarms are listed in the following table which can be prevented from being initiated twice due to a PLC request.

Table 10-6 NCK alarms initiated twice

NCK alarm number	Alarm suppression using the following values in $MN_SAFE_ALARM_SUPPRESS_LEVEL, several values are alternatively possible.
27090	2, 3, 12, 13
27091	2, 3, 12, 13
27092	2, 3, 12, 13
27095	2, 3, 12, 13
27250	2, 3, 12, 13
27251	2, 3, 12, 13
27252	2, 3, 12, 13
27253	2, 3, 12, 13
27254	2, 3, 12, 13
27255	2, 3, 12, 13
27256	2, 3, 12, 13

Activation

The alarm is suppressed using MD 10094 $MN_SAFE_ALARM_SUPPRESS_LEVEL. When standard data is loaded, the function is already active. This means that a reduced number/scope of alarms is displayed. Alarms 27000 and C01797 can be replaced by Alarm 27100 using MD 10094.

MD $MN_SAFE_ALARM_SUPPRESS_LEVEL can also be used to set that Alarm 27040 is replaced by the group alarm 27140 ”Waiting for motor module of at least one axis”.

SPL commissioning mode

The following alarm reductions are made in the commissioning phase:

The axial acceptance test alarm 27032 ”Axis %1 Checksum error of safe monitoring. Confirmation and acceptance test required!”, 27035 ”Axis %1 new hardware component, confirmation and functional test required” and 27060 ”Axis %1 Drive assignment checksum error, confirmation and acceptance test required!” are replaced by the axial group alarm 27132 ”Axis %1 checksum group error safe monitors. Confirmation and acceptance test are required!”

An additional alarm reduction can be set using MD $MN_SAFE_ALARM_SUPPRESS_LEVEL (100’s position set). As a result, the axial acceptance test alarms are replaced by the global acceptance test group alarm 27135 ”Axis %1 checksum group error, safety–related monitoring functions on at least one axis. Confirmation and acceptance test are required!”

Note

The alarm reduction is only made in the SPL commissioning mode (MD $MN_PREVENT_SYNACT_LOCK[0,1] = 0). Outside this mode, when changing the parameter assignment, the corresponding individual axial alarms 27032, 27035 and 27060 are always output.

Acceptance test alarms of the drive are not included in the alarm reduction. The reason for this is that a parameterization change, which results in acceptance test alarms, can be performed independently of one another in the two monitoring channels.

It does not make sense to reduce the global acceptance test alarms (27070-27073). The reason for this is that these alarms, which refer to a checksum error in the SPL parameterization, PROFIsafe configuration or I/O coupling (peripherals), is only output if the axial monitoring functions have been enabled.

Boundary condition

The MD is not incorporated in the axial safety MD checksum. This means that the function can be enabled/disabled at any time by changing the MD. In the acceptance test, the alarm suppression should be internally deactivated so that the two-channel fault/error detection can be checked. It can then be subsequently activated in order to reduce the number of alarms that end users have to cope with.

10.5.2 Assigning priorities to alarms

Especially for machines with an extremely high number of axes, the previously described alarm suppression function is not adequate in order to obtain a display of the real fault/error codes.

Just one single defective input signal can cause alarm 27001 (or 27101 to 27107) to occur for many axes if this input signal has been configured as SGE on several axes. The cause of the fault/error can be hidden as a result of the large alarm list.

This is the reason that priorities are assigned to Alarms 27090, 27004, 27001 and 27101 to 27107. For these alarms

- a subsequent (follow-on) alarm that occurs afterwards is no longer displayed. This alarm is also not visible in the alarm log.
- a subsequent (follow-on) alarm that already occurred beforehand is cleared again. This alarm is then visible in the alarm log.

Assigning priorities to Alarm 27090 only becomes effective if it occurs due to differences in the $A_INSE system variables. Only then will this alarm be initiated as a result of different input signals. For Alarms 27004, 27001 and 27101 to 27107, no additional condition is required, as

- Alarms 27001 and 27101 to 27107 cannot occur if a STOP B or a STOP A is already present. When the SI functionality is active, STOP B and STOP A always occur as subsequent error and do not provide the user with any additional information about the cause of the fault or error.
- Alarm 27004 only occurs if differences are determined in the input signals.

Subsequent alarm for Alarm 27090

If Alarm 27090 is output, the following alarms are no longer displayed:

- 27001 defect in a monitoring channel
- 27004 difference, safety inputs
- 27020 STOP E initiated
- 27021 STOP D initiated
- 27022 STOP C initiated
- 27023 STOP B initiated
- 27024 STOP A initiated
- 27091 error for crosswise data comparison, NCK-PLC
- 27101 difference for the function, safe operating stop
- 27102 difference for the function, safely reduced speed
- 27103 difference for the function, safe end position
- 27104 difference for the function, safe cam plus
- 27105 difference for the function, safe cam minus
- 27106 difference for the function, safely reduced speed n_x
- 27107 difference for the function, cam modulo monitoring

Subsequent alarm for Alarm 27004

- 27001 defect in a monitoring channel
- 27023 STOP B initiated
- 27024 STOP A initiated
- 27101 difference for the function, safe operating stop
- 27102 difference for the function, safely reduced speed
- 27103 difference for the function, safe end position
- 27104 difference for the function, safe cam plus
- 27105 difference for the function, safe cam minus
- 27106 difference for the function, safely reduced speed n_x
- 27107 difference for the function, cam modulo monitoring

Subsequent alarms for Alarms 27001 and 27101 to 27107

- 27023 STOP B initiated
- 27024 STOP A initiated

Activation

Priorities are assigned to alarms by appropriately parameterizing MD 10094 $MN_SAFE_ALARM_SUPPRESS_LEVEL. When this MD is set to either 12 or 13, in addition to the alarm suppression, set with values 2 and 3, the function that assigns priorities to alarms is also activated.

Alarm 27124

By assigning priorities to alarms, alarms with the power on clear criterion are also cleared or no longer displayed. In spite of this, the system is in a state in which a power on is required. If alarm 27024 ”Stop A initiated” has occurred, but is no longer displayed, then at least group alarm 27124 ”Stop A for at least 1 axis” is displayed.

11 Interaction with Other Functions

11.1 Limiting the speed setpoint

The setpoint speed is parameterized as a function of the active safety monitoring in MD 36933: $MA_SAFE_DES_VELO_LIMIT. This machine data is not included in the axial checksum MD 36998: $MA_SAFE_ACT_CHECKSUM, so that changes can be make to the MD for the acceptance test without having to again change the checksum.

If the spindle speed is limited by the SG-specific setpoint limiting, then this is displayed using the axis-specific status signal DB3x.DBX83.1.

MD = 0%:
Setpoint limiting not active

MD > 0%:
Setpoint limiting = active SG limit multiplied by the MD value
For SBH, setpoint limit = 0

MD = 100%:
Setpoint limit = active SG limit
For SBH, setpoint limit = 0

- The function is effective in one channel in the NCK interpolator. The safety monitoring channel provides a limit value that corresponds to the selected safety monitoring type.
- This function influences both axes and spindles.
- The active setpoint limit can be viewed in the safety service screen:
  Display value = -1. corresponds to ”setpoint limiting not active”
  Display value >= 0. corresponds to ”setpoint limiting active”
- The setpoint limit is changed-over when the SGE is changed-over:
  SGE ”SBH/SG deselection”
  SGE ”SBH deselection”
  SGE ”active SG stage, bits 0,1”
  SGE ”SG override, bits 0, 1, 2, 3”
  Further, internal changeover operations in SBH have an effect as a result of a stop response (STOP D, C, E).

- For the changeover via SGEs, the states from **both** monitoring channels are taken into consideration to take into account differences in the times. This results in the following rules:
  1. Changing-over from non-safe operation in SG/SBH
     There is no delay (VELO_SWITCH_DELAY), so that this changeover must always be performed at zero speed or below the enabled SG limit.
  2. Changing-over from SGx to SGy
     A) SGx > SGy (braking): A lower setpoint is entered as soon as changeover is detected in one of the two channels.
     B) SGx < SGy (acceleration): A higher setpoint is only entered if both channels have changed-over.
  3. Changing-over from SG to SBH (braking)
     A lower setpoint (= 0) is entered as soon as the changeover has been detected in one of the two channels.
  4. Changing-over from SBH to SG (accelerating)
     A higher setpoint is only entered if both channels have changed-over.
  5. Changing-over from SBH/SG into non-safe operation (accelerating)
     A higher setpoint is only entered if both channels have changed-over.
- Effect of the function in the NCK interpolator:
  - Setpoint limiting is active in both the AUTO as well as in the JOG modes.
  - When changing-over while moving to higher safely reduced speeds, the position control loop should be set so that it does not overshoot. This means that a sudden setpoint limit change does not cause the monitoring to respond on the actual value side.
  - When transformation is active, safety setpoint limits, axially effective in the interpolator are reduced by the transformation itself depending on the actual position.

Note

There are no restrictions for motion from synchronous actions.

11.2 Measuring system changeover

When measuring systems are changed-over (selected) via interface signals
"Position measuring system 1" (DB 31..., DBX1.5)
"Position measuring system 2" (DB 31..., DBX1.6) the following applies:

The encoder used by the position controller is changed-over.

Note

SI continues to work with the configured encoder.

11.3 Gantry axes

Stop responses Stop A, B, C for gantry axes are initiated as fast as possible for all of the axes in the group. However, if unacceptable offsets result because of the differing braking behavior of the axes, then stop response Stop D should be configured.

11.4 Parking axis

When the park state is activated (using the interface signal "parking"), then the system automatically cancels the pulses using an external STOP A. After the park state has been removed, the external STOP A is automatically deactivated again.

Warning

When the "parking" function is selected, actual value acquisition and the position measuring system monitoring are deactivated for an axis/spindle. The NCK actual value is frozen and mechanical actual value changes are no longer detected. This also applies to the actual value acquisition of the two safety monitoring channels NCK and SINAMICS S120. This means that all of the actual value related safety motion monitoring functions (SBH, SG, n<nx, SBR, SE, SN) are ineffective.

The user can align the actual value acquisition of the safety monitoring channels after re-selecting parking by again referencing/synchronizing to the machine position.

Parking an axis with absolute reference (SE/SN)

As a result of the fact that the actual value sensing of the two safety monitoring channels NCK and SINAMICS S120 has been disabled, then the absolute reference of the axis is no longer detected in a safety-related fashion. The safety monitoring channels then respond as follows:

- Alarms 27000/C01797 are displayed ”Axis no longer safely referenced”
- SGA ”Axis safely referenced” cancelled on NCK and drive side

These alarms are only displayed for axes for which safety monitoring functions with absolute reference are activated, i.e. for SE and SN. Alarms are not displayed for axes that do not have these monitoring functions.

Machine data SAFE_PARK_ALARM_SUPPRESS can be used to suppress Alarms 27000/C01797 until parking has been withdrawn.

Note

If ”parking axis” was not requested, however ”parking active” is signaled from the drive or encoder, then Alarm 27001 is output with fine code 1025.

Note

When a drive object that has Safety Integrated functions released is switched to ”Parking” state, the Safety Integrated software responds by activating STO without generating a separate message.

11.5 OEM applications

Information for HMI-OEM users

If SINUMERIK Safety Integrated) (SI) and OEM applications (for HMI) are used at the same time, the following points must be observed.

Warning

1. The PLC interface signals (DB31, ...) with safety-related drive inputs and outputs may not be written into using the variable service (utility) of the NCDDE/CAP server.
2. Write machine data using variable service
An acceptance test must be carried if the SI machine data were changed using the variable service of the NCDDE/CAP server.
3. Changing alarm priorities
The alarm priorities selected for SI must be retained.
4. Changing alarm tests
The alarm texts of the SI alarms can be modified: This must be clearly documented for the user.
5. Carry out ”acceptance test” message box
The ”carry out acceptance test” may not be modified!
6. User acknowledgement
Functions relating to the user agreement (e.g. call, protective mechanism) may not be altered.

Information for NCK-OEM users

SINUMERIK Safety Integrated can also be used for NCK-OEM applications.

Note

System memory change
System memory changes caused by the OEM application result in Alarm 27003 ”Checksum error occurred”.

11.6 NCU link

An NCU link involves a group of several NCUs to control a machine. In this case, the interpolation function of the various SERVO axes is distributed across the various NCUs.

The following definitions have been made when operating systems such as these with safety functionality:

- An SPL must be used on each NCU.
- An SPL is used to evaluate the local PROFIsafe I/O and the control of the local SERVO axes. The monitoring behavior of SERVO axes of other NCUs is controlled by the SPL of the corresponding NCU.
- Safety-related statuses are exchanged between various SPLs via the safety-related communication F_SENDDP/F_RECVDP.
- Errors in the SPL context (SPL CDC) or F communication context (PROFIsafe, F_SENDDP/F_RECVDP) only act on the local SERVO axes.
- Errors from motion monitoring functions with stop responses on the IPO act on the axes of the channel of the axis, which initiated this response. These responses can also affect other NCUs.

11.7 Behavior of the Sim-NCK systems

For simulation systems, a distinction is made in systems, which can be used to verify

- that a part program can be executed
- the ability of the control to function - including the I/O circuitry

Simulation to check that the part program can be executed

It is not expected that the safety functionality is effective for these systems (Linux-based, Windows-based with PLC simulation). The machine data, with which safety functionality can be activated, are therefore write protected.

The following machine data are write protected:

- $MN_PROFISAFE_MASTER_ADDRESS
  Enable PROFIsafe master functionality
- $MN_PROFISAFE_IN_ADDRESS
  Enable PROFIsafe input modules
- $MN_PROFISAFE_OUT_ADDRESS
  Enable PROFIsafe output modules
- $MN_PROFISAFE_IN_ENABLE_MASK
  Enable PROFIsafe input modules

- $MN_PROFISAFE_OUT_ENABLE_MASK
  Enable PROFIsafe output modules
- $MN_SAFE_SDP_ENABLE_MASK
  Enable F_SENDDP connections
- $MN_SAFE_RDP_ENABLE_MASK
  Enable F_RECVDP connections
- $MA_SAFE_FUNCTION_ENABLE
  Enable axial SI functions

This means that the safety functionality in these systems is not activated and they behave neutrally.

Correct operation of the general NC functionality is guaranteed (start and protection of the SPL program does not have a disturbing effect). However, the safety functionality implemented in the application (i.e. not within the context of the simulation) is not corrected. Influencing the part program sequence by querying safety system variables or querying the above-mentioned enable machine data is not changed.

Simulation, machine integration

For these systems (Windows-based with simulated PLC), the complete safety functionality (axis motion monitoring), PROFIsafe and F_SENDDP/F_RECVDP coupling should function just the same as in a real system.

The safety functionality can be parameterized and programmed just the same as in a real control system. The communication mechanisms on the PLC side ensure that the PROFIsafe and F_SENDDP/F_RECVDP protocols are maintained. External software components can read-in or read-out net data in/out of the PROFIsafe module adapter.

11.8 Behavior of Safety Integrated when the communication fails

When the communication required for the SI fails between the drive and the NCK, then both channels cancel the pulses. Under certain circumstances, this can be delayed to enable retraction motion (see Chapter 11.8.1 "Delayed pulse cancellation in the event of communication failure")

11.8.1 Delayed pulse cancellation in the event of communication failure

Responses integrated in the drive can also be configured using the function "extended stop and retract" ESR. In this case, for each axis it is defined whether:

- the axis should continue to operate with a constant speed setpoint for a parameterized time and only then should braking be initiated (stop)
- the axis should continue to operate with a parameterized velocity for a parameterized time and then be braked along the current limit (retract)

The ESR integrated in the drive is configured for fault/error situations where the NC can no longer enter a setpoint at the drive.

Even when communication fails with the SI functionality active, ESR integrated in the drive is possible to protect machine. For this purpose, in the NCK monitoring channel and in the drive monitoring channel, after a communication failure has been identified, pulse cancellation is delayed in order to permit retraction motion. The selected axial SI functionality (SG, SE, SBH) at the instant that the communication fails, is still available through one channel in the drive monitoring channel. For the NCK monitoring channel, due to the missing actual value, monitoring is no longer possible.

The PLC-SPL remains functional in so much that the drive monitoring channel is not required. (transport of the drive SGE is interrupted.) However, from the PLC-SPL it is not possible to select another monitoring function or immediately cancel the pulses via an external Stop A.

Also the NCK-SPL remains functional, since it receives its input variables ($A_INSE) via PROFIsafe I/O. The selection of another axial monitoring function (e.g. SE level switchover) remains, however, ineffective, since the axial NCK monitoring functions have been deactivated.

<u>Activation</u>

The delay time up to pulse cancellation must be set in MD 10089 $MN_SAFE_PULSE_DIS_TIME_BUSFAIL and in the corresponding drive parameterization p9580 SI Motion, pulse cancellation delay time after bus failure (CU) must be parameterized for values greater than 0. With the default value 0, this function is deactivated; in the case of a communication failure between the NCK and drive, the pulses are immediately canceled.

Note

When MD 10089 is changed, for the drive-independent ESR function, the value must also be transferred to the drives. This is realized using the "Copy SI Data" function. The "Confirm SI data" softkey is used to confirm the checksums (this is also necessary). Further, the user must also enter the values into drive parameters p9697 and p9897. Before this,"Activate drive commissioning" softkey must be pressed. After changing the data, by pressing the "Deactivate drive commissioning" softkey, the checksums are automatically acknowledged and saved by "Save".

After communication to the drive monitoring channel has failed, the delay timer to cancel the pulses is started if

- a pulse cancellation delay has been parameterized using $MN_SAFE_PULSE_DIS_TIME_BUSFAIL
- an SG stage with machine protection is active MD 36963 $MA_SAFE_VELO_STOP_REACTION (for the individual SG stages) or MD 36961 $MA_SAFE_VELO_STOP_MODE (for all SG stages together) and the corresponding drive parameter assignment (p9563, p9561).

The criterion for a communication failure to the drive is when the sign-of-life between the NCK and drive monitoring channel fails twice. This leads to Alarm 27050 "Axis %1 failure SI communication".

<u>Behavior of the axial NCK monitoring channel</u>

If a pulse suppression delay is parameterized using $MN_SAFE_PULSE_DIS_TIME_BUSFAIL, after a communication failure, the SGA of all axial SI monitoring channels are first left in their old state. All SGAs are deleted after this delay time has expired. The axial monitoring functions are no longer processed immediately after communication fails as the basis for the monitoring functions, the safe actual value, is no longer available.

In the following cases, in the event of a communication failure, the axial NCK-SGA are immediately deleted, even if a delay time is parameterized in $MN_SAFE_PULSE_DIS_TIME_BUSFAIL:

- a) an external STOP A is selected
- b) a test stop is selected
- c) the function SBH is or will be selected
- d) An SG stage is selected or will be selected, where it was previously explicitly specified that in this SG stage no ESR should be performed in the event of a communication failure (e.g. SG stage for personnel protection), (see $MA_SAFE_VELO_STOP_REACTION or $MA_SAFE_VELO_STOP_MODE).

Since the NCK monitoring channel is assigned to the shutdown path of the Motor Module, the Motor Module must also know whether, in the event of communication failure, the pulses should be canceled with a delay. The NCK cyclically provides the Motor Module with this information. If the Motor Module detects a communication failure, dependent on the latest information of the NCK, it starts its delay timer with the parameterized time from p9897 and then independently deletes the pulses.

Behavior of the drive monitoring channel

The drive monitoring channel, just like the NCK monitoring channel, delays its pulse cancellation by the parameterized time. However, in addition it also keeps the monitoring functions active, which were active at the time of the failure. The drive can continue to monitor as it still has the correct actual value.

In the following cases, communication failure immediately triggers pulse cancellation, even if a delay time has been configured:

- The SBH function is selected.
- An SG stage has been selected, where it has been previously defined that in this SG stage no ESR should be performed in the event of communication failure (for example: SG stage for personnel protection).

ESR executed autonomously in the drive when communications fail

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Note

In the event of a communication failure between the NCK and Control Unit, only an ESR executed autonomously in the drive is possible, which must be initiated from the Control Unit itself. The precondition in this case is that pulse cancellation is delayed.

Example

The following parameterization ensures that when the communication fails there is 200ms time for an ESR – integrated in the drive – before the pulses are cancelled. The SG stages for personnel protection are defined differently in the individual axes:

$MN_SAFE_PULSE_DIS_TIME_BUSFAIL= 0.2

```
; Parameterization for the X axis (AX1):
; pulses are immediately cancelled in all SG stages, Stop D is initiated when an SG is
; exceeded
$MA_SAFE_VELO_STOP_MODE[AX1] = 3


; Parameterization for the Y axis (AX2):
; pulses are not immediately cancelled in all SG stages, Stop D is initiated when an SG is
; exceeded
$MA_SAFE_VELO_STOP_MODE[AX2] = 13
```

; Parameterization for the Z axis (AX3):

; pulses are immediately canceled in all SG stages, Stop D is initiated when an SG is ex-
; ceeded in SG stages 1 and 2, Stop C in SG stages 3 and 4

$MA_SAFE_VELO_STOP_MODE[AX3] = 5; => $MA_SAFE_VELO_STOP_REACTION becomes effective

$MA_SAFE_VELO_STOP_REACTION[0, AX3] = 3 ; SG stage 1

$MA_SAFE_VELO_STOP_REACTION[1, AX3] = 3 ; SG stage 2

$MA_SAFE_VELO_STOP_REACTION[2, AX3] = 2 ; SG stage 3

$MA_SAFE_VELO_STOP_REACTION[3, AX3] = 2 ; SG stage 4

; Parameterization for the A axis (AX4):

; pulses are not immediately canceled in all SG stages, Stop D is initiated when an SG is
; exceeded in SG stages 1 and 2, Stop C in SG stages 3 and 4

$MA_SAFE_VELO_STOP_MODE[AX4] = 5; => $MA_SAFE_VELO_STOP_REACTION becomes effective

$MA_SAFE_VELO_STOP_REACTION[0, AX4] = 13 ; SG stage 1

$MA_SAFE_VELO_STOP_REACTION[1, AX4] = 13 ; SG stage 2

$MA_SAFE_VELO_STOP_REACTION[2, AX4] = 12 ; SG stage 3

$MA_SAFE_VELO_STOP_REACTION[3, AX4] = 12 ; SG stage 4

; Parameterization for the B axis (AX5):

; the pulses are only immediately cancelled in SG stages 1 and 3, Stop D is initiated when
; an SG is exceeded in all stages

$MA_SAFE_VELO_STOP_MODE[AX5] = 5; => $MA_SAFE_VELO_STOP_REACTION becomes effective

$MA_SAFE_VELO_STOP_REACTION[0, AX5] = 3 ; SG stage 1

$MA_SAFE_VELO_STOP_REACTION[1, AX5] = 13 ; SG stage 2

$MA_SAFE_VELO_STOP_REACTION[2, AX5] = 3 ; SG stage 3

$MA_SAFE_VELO_STOP_REACTION[3, AX5] = 13 ; SG stage 4

; Parameterization for the C axis (AX6):

; immediate pulse cancellation only in SG stages 1 and 3, Stop D is initiated when an SG
; is exceeded in SG stages 1 and 2, Stop C in SG stage 3 and Stop E in SG stage 4

$MA_SAFE_VELO_STOP_MODE[AX6] = 5; => $MA_SAFE_VELO_STOP_REACTION becomes effective

$MA_SAFE_VELO_STOP_REACTION[0, AX6] = 3 ; SG stage 1

$MA_SAFE_VELO_STOP_REACTION[1, AX6] = 13 ; SG stage 2

$MA_SAFE_VELO_STOP_REACTION[2, AX6] = 2 ; SG stage 3

$MA_SAFE_VELO_STOP_REACTION[3, AX6] = 14 ; SG stage 4

Space for your notes

Application Examples

12

The examples listed below are intended to provide support when engineering and using Safety Integrated. The examples must be considered to be pure engineering support and not as engineering specifications, i.e. there may be possible alternative solutions that address the particular problem in a similar fashion.

12.1 Application example for the safety-related CPU-CPU communication

Using the application examples described in the following, the principle approach when programming the NCK-SPL and when using the system variables of the F_DP interfaces is shown.

Specifications

- Machine tool (MT) equipped with a SINUMERIK NCU as F_CPU_1
- Loading gantry (LG) with a SINUMERIK NCU as F_CPU_2
- Three safety areas (1 – 3) must be taken into account (1 is the safety area with the highest safety level and 3 with the lowest safety level). The safety areas refer to the position of the loading gantry LG.

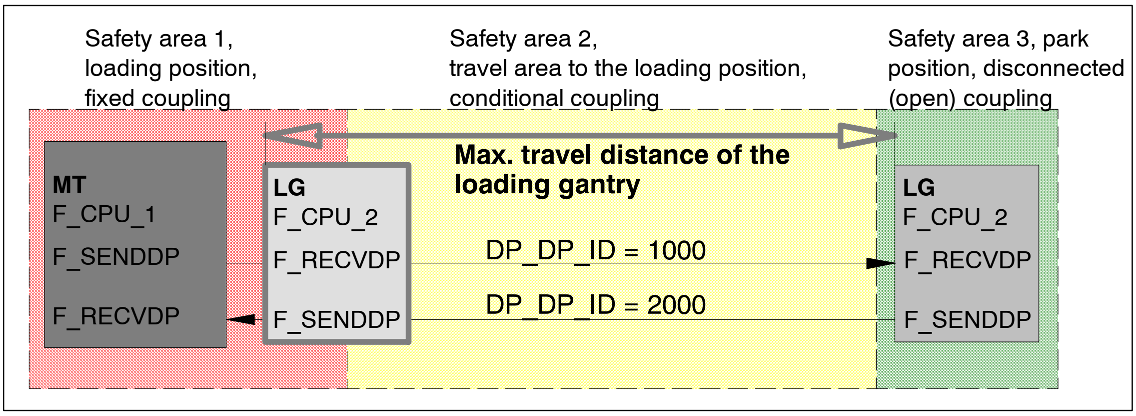

Fig. 12-1 Machine tool and loading gantry with safety areas

- Both F_CPUs should be able to be shut down e.g. for service purposes without initiating an alarm with the communication partner.
- When an F_DP communication error occurs, which has not been caused by deliberately switching-off of a component, then a specific response must be executed in each safety area:

Safety area	Fault response, machine tool	Fault response, loading gantry
3	Alarm (display only, self-clearing)	Alarm (display only, self-clearing)
2	Alarm (display only, self-clearing)	Alarm with NCK interlocks, further travel is to be prevented
1	Alarm with Stop D/E	Alarm with Stop D/E

Implementation

The realization shown for the following examples only refers to the implementation of the SPL programming on the NCK side. The same procedure should be applied for the PLC side.

In order to specifically switch-off both F_CPUs, and to inform the other F_CPU about this, an F_SENDDP and F_RECVDP-SPL connection must be parameterized on each F_CPU.

- SPL connection 1: MT -> LG, DP_DP_ID = 1000

Machine tool: F_SENDDP	**Loading gantry**: F_RECVDP
$MN_SAFE_SDP_ID[0] = 1000	$MN_SAFE_RDP_ID[0] = 1000

- SPL connection 2: LG -> MT, DP_DP_ID = 2000

Machine tool: F_RECVDP	**Loading gantry**: F_SENDDP
$MN_SAFE_SDP_ID[1] = 2000	$MN_SAFE_RDP_ID[1] = 2000

Note

The behavior of the individual components SPL, F_SENDDP and F_RECVDP of the particular F-CPU is described in the overall relationship in the following examples:

- SPL: The user must generate the specified behavior by appropriately programming the SPL
- F_SENDDP/F_RECVDP: Description to show the behavior that has been implemented

F net data of the machine tool

The following information must be contained in the F net data of SPL connection 1 (MT -> LG), that is transferred to the loading gantry:

- Preparation for the failure of the communication (communication error: timeout) when switching-off the machine tool.

F net data of the loading gantry

The following information must be contained in the F net data of SPL connection 2 (LG -> MT), that is transferred to the machine tool:

- Preparation for the failure of the communication (communication error: timeout) when switching-off the loading gantry.
- Actual position of the loading gantry referred to the safety areas.

Example 1: Change from safety area 2 to 3

In example 1, the loading gantry is traveling from the loading position back to the park position. The loading gantry is just leaving safety area 2 and enters safety area 3. The fault response must be adapted when entering safety level 3.

Initial state:

- The loading gantry is just leaving safety area 2 and is now in safety area 3 in the park position.
- F_SENDDP and F_RECVDP of both SPL connections communicate cyclically and error-free.
- System variables

SPL connection 1 (MT -> LG)		
System variables	**Machine Tool** $A_FSDP_...	**Loading gantry** $A_FRDP_...
..._ERR_REAC[0]	2	1
..._ERROR[0]	FALSE	FALSE
..._SUBS_ON[0]	FALSE	FALSE
..._DIAG[0]	0H	0H
..._SUBS[0]	–	0H
..._ACK_REQ[0]	–	FALSE
DB18.FRDP_ACK_REI	–	0

SPL connection 2 (LG -> MT)		
System variables	**Machine Tool** $A_FRDP_...	**Loading gantry** $A_FDDP_...
..._ERR_REAC[1]	2	1
..._ERROR[1]	FALSE	FALSE
..._SUBS_ON[1]	FALSE	FALSE
..._DIAG[1]	0H	0H
..._SUBS[1]	0H	–
..._ACK_REQ[1]	FALSE	–
DB18.FRDP_ACK_REI	0	–

Event: LG reaches safety area 3

- Behavior

  LG

  - SPL: Detects when safety area 3 is reached as a result of the SPL input configured for the purpose
  - SPL: Sets the signal ”safety area 3” in the F net data of the communication relationship 2 (LG -> MT) using the SPL output intended for the purpose.
  - SPL: Sets the error response of the SPL connection 2 to 2 (alarm, display only, self-clearing).

  MT

  - SPL: Detects the signal transferred from the LG via SPL connection 2: ”Safety area 3” using the SPL input intended for the purpose.
  - SPL: Sets the error response of the SPL connection 2 to 2 (alarm, display only, self-clearing).

Note

Setting the error response of SPL connection 2 to 2 is not absolutely required, as it was already 2 in the example. To simplify the SPL programming, it is assumed that the error response is set when changing the safety area, without observing the actual status of the error response.

Resulting state:

- System variables

SPL connection 1 (MT -> LG)		
System variables	**Machine Tool** $A_FSDP_...	**Loading gantry** $A_FRDP_...
..._ERR_REAC[0]	2	**2**

SPL connection 2 (LG -> MT)		
System variables	**Machine Tool** $A_FRDP_...	**Loading gantry** $A_FSDP_...
..._ERR_REAC[1]	2	**2**

Example 2: Traveling in safety area 2 and a communication error

In example 2, the loading gantry is traveling in safety area 2 on the way to the loading position. A communication error occurs while it is traveling.

Initial state:

- The loading gantry is just entering into safety area 2 on the way to the loading position.
- F_SENDDP and F_RECVDP of both SPL connections communicate cyclically and error-free.
- System variables

SPL connection 1 (MT -> LG)		
System variables	**Machine Tool** $A_FSDP_...	**Loading gantry** $A_FRDP_...
..._ERR_REAC[0]	2	1
..._ERROR[0]	FALSE	FALSE
..._SUBS_ON[0]	FALSE	FALSE
..._DIAG[0]	0H	0H
..._SUBS[0]	-	0H

System variables	Machine Tool $A_FSDP_...	Loading gantry $A_FRDP_...
..._ACK_REQ[0]	–	FALSE
DB18.FRDP_ACK_REI	–	0

SPL connection 2 (LG -> MT)		
System variables	**Machine Tool** $A_FRDP_...	**Loading gantry** $A_FDDP_...
..._ERR_REAC[1]	2	1
..._ERROR[1]	FALSE	FALSE
..._SUBS_ON[1]	FALSE	FALSE
..._DIAG[1]	0H	0H
..._SUBS[1]	0H	–
..._ACK_REQ[1]	FALSE	–
DB18.FRDP_ACK_REI	0	–

Event: Communication error regarding SPL connection 2

- Behavior

  MT

  - F_RECVDP: Detects a communication error, e.g. CRC error
  - F_RECVDP: Initiates an error response corresponding to $A_FRDP_ERR_REAC[1]
  - F_RECVDP: Sets the system variables: $A_FRDP_ERROR[1], ...DIAG[1] and ...SUBS_ON[1]
  - F_RECVDP: Outputs substitute values corresponding to $A_FRDP_SUBS[1]
  - F_RECVDP: Requests user acknowledgement via $A_FRDP_ACK_REQ[1]
  - F_RECVDP: No longer sends acknowledgement telegrams to F_SENDDP
  - F_RECVDP: Waits for re-initialization of the communication by F_SENDDP

  LG

  - F_SENDDP: Detects a communication error due to the missing acknowledgement telegram from F_RECVDP
  - F_SENDDP: Initiates an error response corresponding to $A_FSDP_ERR_REAC[1]
  - F_SENDDP: Sets the system variables: $A_FSDP_ERROR[1], ...DIAG[1] and ...SUBS_ON[1]
  - F_SENDDP: Starts to re-initialize the communication
  - F_SENDDP: Waits for user acknowledgement

  MT

  - F_RECVDP: Starts to re-initialize the communication
  - F_RECVDP: Waits for user acknowledgement

- System variables

SPL connection 2 (LG -> MT)		
System variables	**Machine Tool** $A_FRDP_...	**Loading gantry** $A_FDDP_...
..._ERR_REAC[1]	2	1
..._ERROR[1]	TRUE	TRUE
..._SUBS_ON[1]	TRUE	TRUE
..._DIAG[1]	40H	10H
..._SUBS[1]	0H	–
..._ACK_REQ[1]	TRUE	–
DB18.FRDP_ACK_REI	0	–

Event: User acknowledgement regarding SPL connection 2

MT

- SPL: Detects the user acknowledgement using the PLC input configured for the purpose and sets the user acknowledgement for F_RECVDP via DB18.FRDP_ACK_REI
- F_RECVDP: Detects user acknowledgement via DB18.FRDP_ACK_REI
- F_RECVDP: Resumes normal operation
- F_RECVDP: Sets the system variables: $A_FRDP_ERROR[1], ...DIAG[1] and ...SUBS_ON[1]
- F_RECVDP: Initiates that the alarm is reset
- F_RECVDP: Resets the status signal SUBS_ON in the acknowledgement telegram F_SENDDP
- F_RECVDP: Outputs process values

LG

- F_SENDDP: Detects that normal operation is resumed by resetting status signal SUBS_ON in the acknowledgement telegram from F_RECVDP
- F_SENDDP: Sets the system variables: $A_FRDP_ERROR[1], ...DIAG[1] and ...SUBS_ON[1]
- F_SENDDP: Initiates that the alarm is reset

Resulting state:

- System variables

SPL connection 2 (LG -> MT)		
System variables	**Machine Tool** $A_FRDP_...	**Loading gantry** $A_FDDP_...
..._ERR_REAC[1]	2	1
..._ERROR[1]	FALSE	FALSE
..._SUBS_ON[1]	FALSE	FALSE
..._DIAG[1]	0H	0H
..._SUBS[1]	0H	–
..._ACK_REQ[1]	FALSE	–

System variables	Machine Tool $A_FRDP_...	Loading gantry $A_FDDP_...
DB18.FRDP_ACK_REI	0 -> 1 -> 0	–

Example 3: Loading operation in safety area 1 and shutting down the LG

In example 3, the load gantry is at the loading position. For a communication error in one of the two communication partners, for safety reasons, both communication partners must respond with an alarm and Stop D/E. A general fault/error occurs while loading. For service purposes, the loading gantry should be switched-off without causing the machine tool to stop machining as a result of the ”timeout” due to the resulting communication error. After the loading gantry is switched-on again and the user acknowledgement from SPL connection 2 (LG -> MT) has been issued, the error response must be set again depending on the actual position of the loading gantry referred to the safety areas.

Initial state:

- The loading gantry is at the loading position in safety area 1.
- F_SENDDP and F_RECVDP of both SPL connections communicate cyclically and error-free.
- System variables

SPL connection 1 (MT -> LG)		
System variables	**Machine Tool** $A_FSDP_...	**Loading gantry** $A_FRDP_...
..._ERR_REAC[0]	0	0
..._ERROR[0]	FALSE	FALSE
..._SUBS_ON[0]	FALSE	FALSE
..._DIAG[0]	0H	0H
..._SUBS[0]	–	0H
..._ACK_REQ[0]	–	FALSE
DB18.FRDP_ACK_REI	–	0

SPL connection 2 (LG -> MT)		
System variables	**Machine Tool** $A_FRDP_...	**Loading gantry** $A_FDDP_...
..._ERR_REAC[1]	0	0
..._ERROR[1]	FALSE	FALSE
..._SUBS_ON[1]	FALSE	FALSE
..._DIAG[1]	0H	0H

System variables	Machine Tool $A_FRDP_...	Loading gantry $A_FDDP_...
..._SUBS[1]	0H	-
..._ACK_REQ[1]	FALSE	-
DB18.FRDP_ACK_REI	0	-

Event: General fault/error in LG => shutdown request from the LG to the MT.

- Behavior

  LG

  - SPL: Detects the shutdown request using the SPL input configured for the purpose
  - SPL: Sets the shutdown request in the F net data of the F_DP communication relationship 2 (LG -> MT) using the SPL output intended for the purpose.

  MT

  - SPL: Detects the shutdown request from the LG via SPL connection 2 (LG -> MT) using the SPL input intended for the purpose
  - SPL: Changes the error response of SPL connection 2 (LG -> MT) from 0 (alarm with Stop D/E) to 3 (no response): $A_FRDP_ERR_REAC[1] = 3
  - SPL: Sets the substitute values of SPL connection 2 (LG -> MT) corresponding to the actual machining situation, e.g. $A_FRDP_SUBS[1] = actual process values
  - SPL: Changes the error response of SPL connection 1 (MT -> LG) from 0 (alarm with Stop D/E) to 3 (no response): $A_FSDP_ERR_REAC[1] = 3

Event: Switch off of LG

- Behavior

  MT

  SPL connection 1

  - F_SENDDP: Detects a communication error ”timeout”
  - F_SENDDP: Initiates an error response corresponding to $A_FSDP_ERR_REAC[0]
  - F_SENDDP: Sets the system variables: $A_FSDP_ERROR[0], ...DIAG[1] and ...SUBS_ON[0]
  - F_SENDDP: Starts to re-initialize communication

  SPL connection 2

  - F_RECVDP: Detects a communication error ”timeout”
  - F_RECVDP: Initiates error responses corresponding to $A_FRDP_ERR_REAC[1]
  - F_RECVDP: Sets the system variables: $A_FRDP_ERROR[1], ...DIAG[1] and ...SUBS_ON[1]
  - F_RECVDP: Outputs substitute values corresponding to $A_FRDP_SUBS[1]
  - F_RECVDP: Requests user acknowledgement via $A_FRDP_ACK_REQ[1]
  - F_RECVDP: No longer sends acknowledgement telegrams to LG: F_SENDDP
  - F_RECVDP: Waits for LG to re-initialize the communication: F_SENDDP

Resulting state:

- System variables

SPL connection 1 (MT -> LG)		
System variables	**Machine Tool** $A_FSDP_...	**Loading gantry** $A_FRDP_...
..._ERR_REAC[0]	3	”switched off”
..._ERROR[0]	TRUE	”switched off”
..._SUBS_ON[0]	TRUE	”switched off”
..._DIAG[0]	10H	”switched off”
..._SUBS[0]	–	”switched off”
..._ACK_REQ[0]	–	”switched off”
DB18.FRDP_ACK_REI	–	”switched off”

SPL connection 2 (LG -> MT)		
System variables	**Machine Tool** $A_FRDP_...	**Loading gantry** $A_FSDP_...
..._ERR_REAC[1]	3	”switched off”
..._ERROR[1]	TRUE	”switched off”
..._SUBS_ON[1]	TRUE	”switched off”
..._DIAG[1]	10H	”switched off”
..._SUBS[1]	0H	–
..._ACK_REQ[1]	TRUE	–
DB18.FRDP_ACK_REI	0	–

Event: LG is switched-on again

- Behavior

  LG

  SPL connection 2

  - F_SENDDP: Starts with the initialization of the communication
  - F_SENDDP: Waits for user acknowledgement

  SPL connection 1
  - F_RECVDP: Starts to re-initialize the communication
  - F_RECVDP: Waits for user acknowledgement

  MT

  SPL connection 1

  - F_SENDDP: Starts with the initialization of the communication
  - F_SENDDP: Waits for user acknowledgement

SPL connection 2
- F_RECVDP: Starts to re-initialize the communication
- F_RECVDP: Waits for user acknowledgement

Event: User acknowledgement regarding SPL connection 1 (MT -> LG)

- Behavior

LG

- SPL: Detects the user acknowledgement using the PLC input configured for the purpose and sets the user acknowledgement for F_RECVDP via DB18.FRDP_ACK_REI
- F_RECVDP: Detects user acknowledgement via DB18.FRDP_ACK_REI
- F_RECVDP: Resumes normal operation
- F_RECVDP: Sets the system variables: $A_FRDP_ERROR[1], ...DIAG[0] and ...SUBS_ON[0]
- F_RECVDP: Resets the status signal SUBS_ON in the acknowledgement telegram to F_SENDDP (Signal for F_SENDDP: "User acknowledgment made")
- F_RECVDP: Outputs process values
- SPL: Detects resumption of the normal operation by resetting system variables: $A_FRDP_ERROR[0] and sets error response for SPL connection 1 back to 0 (alarm with Stop D/E) and sets the substitute values $A_RECVDP_SUBS[0] back, e.g. to 0, corresponding to the requirements

LG

- F_SENDDP: Detects that normal operation is resumed by resetting status signal SUBS_ON in the acknowledgement telegram from F_RECVDP
- F_SENDDP: Sets the system variables: $A_FRDP_ERROR[0], ...DIAG[0] and ...SUBS_ON[0]
- SPL: Detects resumption of the normal operation by resetting system variables: $A_FSDP_ERROR[0] and sets the error response for SPL connection 1 back to 0 (alarm with Stop D/E)

Resulting state:

- System variables

SPL connection 1 (MT -> LG)		
System variables	**Machine Tool** $A_FSDP_...	**Loading gantry** $A_FRDP_...
..._ERR_REAC[0]	0	0
..._ERROR[0]	FALSE	FALSE
..._SUBS_ON[0]	FALSE	FALSE
..._DIAG[0]	0H	0H
..._SUBS[0]	-	0H
..._ACK_REQ[0]	-	FALSE
DB18.FRDP_ACK_REI	-	0 -> 1 -> 0

Event: User acknowledgement regarding SPL connection 2 (LG -> MT)

- Behavior
  The response from LG: F_SENDDP and MT: F_RECVDP for SPL connection 2 is principally identical with that of SPL connection 1. In this case, the user acknowledgement is realized via F_RECVDP of the machine tool.
- System variables

SPL connection 2 (LG -> MT)		
System variables	**Machine Tool** $A_FRDP_...	**Loading gantry** $A_FSDP_...
..._ERR_REAC[1]	0	0
..._ERROR[1]	FALSE	FALSE
..._SUBS_ON[1]	FALSE	FALSE
..._DIAG[1]	0H	0H
..._SUBS[1]	0H	-
..._ACK_REQ[1]	FALSE	-
DB18.FRDP_ACK_REI	0 -> 1 -> 0	-

Appendix

A

A.1 Customer support

The Center of Competence Service (CoCS) – Sinumerik Safety Integrated® offers users a wide range of services.

Contact addresses

Hotline:	Tel.:	0180–5050–222
	Fax:	0180–5050–223
	e–mail:	ad.support@siemens.com
	Inquiry with subject 840D Safety Integrated	
Contact:	Tel.:	+49 (0) 9131 98 4386
	Fax:	+49 (0) 9131 98 1359

Table A-1 Range of services for machine manufacturers and end customers

Quotation	Description of services
Concept development	The safety functions are adapted to the machine based on the hazard analysis and the customer's operating philosophy. This includes e.g.: • Planned operating modes • Safety functions when the protective doors are closed • Safety functions when the protective doors are open • Emergency stop concept • A study of the safety–related external signals and elements
Standard engineering	Based on the concept developed, the standard functions • Safe standstill (SH), safe operating stop (SBH) • Safely–reduced speed (SG) are integrated into the circuit diagram of the machine. External safety elements (e.g. door interlocking, Emergency Stop button, ...) are either configured conventionally or logically combined using the "safe programmable logic" (SPL) function.
SPL configuration	Based on the standard configuration, the following objects are created: • Function diagram • Logic program for the PLC area • Logic program for the NC area • Data blocks required (e.g. DB 18) These objects are incorporated/linked into the complete system.

Table A-1 Range of services for machine manufacturers and end customers

Quotation	Description of services
Commissioning	The safety functions are commissioned based on the configuration that has been created. The customer provides the machine so that the drives can be traversed and the control cabinet is wired according to the configuration.
Acceptance report	Based on the submitted configuration documentation and commissioning, an acceptance report for the safety functions is drawn-up. This includes: • Description of the machine (name, type, ...) • Description of the safety and operator concept • Description of the axis-specific safety functions • All of the safety functions are tested including the SPL logic • The test results are recorded The customer receives the acceptance report as hard copy and on an electronic data medium.
Approval procedure	Support with the handling and line of argument for the approval procedure by certified bodies (e.g. the appropriate regulatory bodies/institutes for safety and health) or large end customers.
Workshop	Workshops are held on the subject of machine safety adapted to customer-specific requirements; if required, these workshops can be held at the customer's site. Possible contents: • Machinery Directive, Standards in general • C Standards (machine-specific) • Hazard analysis, risk analysis • Control categories (acc. to EN 954-1) • SINUMERIK Safety Integrated® - function and system description • Configuration, machine data • Commissioning • Acceptance report
Hotline	An expert for "SINUMERIK Safety Integrated®" can be reached at the Hotline number should series errors or problems occur during installation and commissioning (start-up).
On-site service (local)	Experts analyze problems that are encountered on-site. The causes are eliminated or counter-measures are drawn-up and implemented where necessary.

A.2 List of references

/ASI/

Low–Voltage Switchgear and Systems, Catalog
Drive, Switchgear and Installation Technology from Siemens
Order No.: E20002–K1002–A101–A6

/6/

Reinert, D./Schäfer, M./Umbreit, M.: Antriebe und CNC–Steuerungen mit integrierter Sicherheit (Antriebe und CNC–Steuerungen), in: ETZ–Heft 11/98.

Documentation

An overview of publications that is updated monthly is provided in a number of languages in the Internet at:

http://www.siemens.com/motioncontrol

Follow menu items --> "Support" -> "Technical Documentation" --> "Overview of Documents" or "DOConWEB".

A.3 Abbreviations

1v1	1 from 1 evaluation: Encoder signal is available through one channel, is read once
2v2	2 from 2 evaluation: Encoder signal is available through one channel, is read twice and compared
A...	Alarm
AB	Output Byte
ACX	**A**ccess description **C**ompressed and e**X**tensible, binary format to describe data
ASIC	Application Specific Integrated Circuit (semiconductor module developed for special applications)
ASUB	Asynchronous subroutine
β	Susceptibility to common cause failure
BAG-STOP	Stop in corresponding mode group
BG	Professional association (in Germany)
BGIA	German statutory industrial accident insurance institution
BiCo	Binector-Connector (technology)
BO	Binector Output
CCF	Common Cause Failure
CFG	Configuration telegram
Channel_1 reset	Channel reset in the 1st channel of the NCU
CO	Connector Output
CPU	Central Processing Unit
CRC	Cyclic Redundancy Check
CU	Control Unit (control unit of the drive device)
DA	Digital Output
DAC	Digital-to-Analog Converter
DB	Data block
DC	Diagnostic Coverage
DDS	DRIVE DATA SET (drive parameters that can be changed over together as a set)
DI	Digital Input
DKE-AK	German Electrotechnical Working Committee
DL	Data Left
DMS	Direct Measuring System
DO	Digital Output

DP	Distributed I/O
DPM	DP master
DPR	Dual Port RAM
DR	Data Right
DRIVE-CLiQ	”DRIVE Component Link with IQ” (official name for DSA-Link or SA-Link: Serial bus to connect A&D drive components)
DW	Data Word
EB	Input Byte
EMF	Electromagnetic force
EN	European standard
ENDAT	Encoder Data (interface for absolute encoder)
EP	Pulse enable
EQN/ERN	Part of an order code for absolute/incremental encoders made by Heidenhain
ESD	ElectroStatic Discharge
ESR	Extended Stop and Retract
F...	Fault (F)
F-...	Failsafe...
FD	Feed Drive
F-DI	Fail-safe input module
F-DO	Fail-safe output module
F_RCVDP	Fail-safe plant communication (SIMATIC)
F_RECVDP	Fail-safe plant communication, receiver (SINUMERIK)
F_SENDDP	Fail-safe plant communication, sender (SINUMERIK, SIMATIC)
FOC	Travel with limited torque/force (force control)
FSR	F_SENDDP/F_RECVDP
FV	Fail-safe Values
FXS	Travel to fixed stop
GSD	Device master data
GSTR	Number of encoder pulses
HHU	HandHeld Unit
HMS	High-resolution Measuring System
HW	Hardware
IBN	Commissioning
IE	Industrial Ethernet
IEC	International Electrotechnical Commission

IMP	Pulse suppression
IMS	Indirect Measuring System
INSE	Input data of the safe programmable logic (SPL) from the I/O
INSI	Input data of the safe programmable logic (SPL) from the output data of the axial monitoring functions
I/O	Input/output
IPO	Interpolator
I/R	Infeed/Regenerative Feedback unit
IS	Interface Signal
KDV	Crosswise data comparison
λ	Failure rate
LEC	Leadscrew Error Compensation
LIFTFAST	Fast retraction from contour
LL	Lower Limit
LSB	Least Significant Bit
MAKSIP	Machine Coordinate System Actual Position
MCP	Machine Control Panel
MD	Machine Data or Marker Doubleword
MDD	Machine Data Dialog
MDIR	Machinery Directive
Mixed-IO	I/O module with analog and digital signals
MLFB	Machine-readable product designation
MM	Motor Module (power unit/power module)
MMC	Man Machine Communication (user interface for man-machine communication)
Mod.	Module
Mode group	Mode group
MSB	Most Significant Bit
MSD	Main Spindle Drive
MT	Machine Tool
MTTFd	Mean time to dangerous failure
N...	No message or internal message
NC	NC contact
NC	Numerical Control
NCK	NC Kernel
NE	Line infeed

Node Id	Node-Identification Code (unique ID of each DRIVE-CLiQ node)
OA	Operator Acknowledge
OB	Organization block
OP	Operator Panel
OPI	Operator Panel Interface
p...	Adjustable parameters
PFH_D	Probability of dangerous failure per hour
PII	Process image inputs
PIQ	Process image outputs
PL	Performance Level
PLC	Programmable Logic Controller
PM-E F	Power Module Electronic Fail-safe
PNO	PROFIBUS user organization
PROFIBUS	Bus system for communication between automation components
PROFIsafe	Communication profile based on PROFIBUS for safety-related communications
PSC	PROFIsafe clock cycle
QVK	Slave-to-slave communication (Peer-to-peer communication)
RPM	Revolutions Per Minute
SA link	Sensor-Actuator link
SBC	Safe Brake Control
SBH	Safe operating stop
SBM	Safe Brake Management
SBR	Safe acceleration monitoring
SBT	Safe Brake Test
SCA	Safe cam
SG	Safely reduced speed
SGA	Safety-related output
SGE	Safety-related input
SH	Safe standstill
SI	SINUMERIK Safety Integrated® (integrated safety technology)
SIL	Safety Integrity Level
SILCL	SIL Claim Limit
SK	Softkey
SLP	Safely Limited Position

SLS	Safely limited speed
SMC	Sensor Module Cabinet Mounted: External adapter box to connect an encoder to DRIVE-CLiQ
SME	Sensor Module Externally Mounted: Sensor Module with a high degree of protection for mounting outside the electrical/control cabinet
SMI	Sensor Module Integrated: External adapter box to connect an encoder to DRIVE-CLiQ, integrated in the motor
SMM	Safe Motion Monitoring
SMx	Common term for SMI, SMC and SME
SN	Safe software cam, safe cam track
SOS	Safe Operating Stop
SPL	Safe programmable logic
SS1	Safe Stop 1 (corresponds to Stop Category 1 acc. to EN 60204)
SS1	Safe stop 1
SS2	Safe stop 2
SSM	Safe speed monitor
STO	Safe Torque Off
STOP A, B, C, D, E, F	Stop response: In the event of a fault, the system responds corresponding to the configured stop response (see Chapter 6.3)
SV	Power supply
SW	Software
T1	Lifetime
T2	Diagnostic test interval
TCP	Tool Center Point
TEA	Testing Data Active (machine data identifier)
Ü	Gear ratio
UI	User interface
UL	Upper Limit

A.4 Terms

Actuator

Converter that converts electrical signals into mechanical or other non-electrical quantities.

Fail-safe

The ability of a control system, also when faults occur (failure), to maintain a safe condition of the controlled equipment (e.g. machine, process), or to bring the equipment into a safe condition.

Failure/Fault

Failure
A piece of equipment or device can no longer execute the demanded function.

Fault
Undesirable condition of a piece of equipment or a device, characterized by the fact that it is unable to execute the demanded function.

Note: ”Failure” is an event and ”fault” is a condition.

Fault tolerance

Fault tolerance N means that a piece of equipment can still execute the required task even if N faults are present. For N+1 faults, the equipment can no longer execute the required function.

Category

Used in EN 954-1 to ”Classify safety-related parts of control with reference to their immunity to faults and their behavior when a fault condition exists as a result of the structural arrangement of the parts/components and/or their reliability”.

Channel

Element or group of elements that execute function(s) independently of one another.

2-channel structure
This is a structure that is used to achieve fault tolerance.
For instance, a 2-channel protective door control can only be implemented if at least two enable circuits are available and the main circuit is redundantly shut down or a sensor (e.g. Emergency Stop switch) with two contacts is interrogated and these are separately routed to the evaluation unit.

Performance Level (PL)

The revision of ISO 13849-1 (with EN designation EN 954-1) includes guidelines to simply develop, test and certify safety-related machine controls. Deterministic and probability requirements are combined with one another in a practical fashion. The control category (defined e.g. using redundancy and testing) and probability aspects (failure rate of the components and quality of the tests, expressed in the form of MTTFd and DC, as well as common cause faults) are used as basis to define the so-called ”Performance Levels” (PL). Markov models, based on typical control architectures, were used to derive the average, hazardous probability of failure per hour.

Redundancy

Availability of more than the necessary equipment to execute the required tasks.

Risk

Combination of the probability of damage occurring and the extent of the damage.

Safety

Free from any unacceptable risk.

Functional safety
The part of the safety of a piece of equipment (e.g. machine, plant) that depends on the correct function.

Safety function

Function of a machine, whereby failure of a function (malfunction) can directly increase the risk.

Safety functions of controls

A function ”initiated by an input signal and processed by the safety-related parts of controls, that allows the machine (as system) to reach a safe condition”.

Safety goal

To keep the potential hazards for personnel and the environment as low as possible without restricting more than absolutely necessary, industrial production, the use of machines or the manufacture of chemical products.

Safety Integrity Level (SIL)

Measure, defined in EN 61508, for the safety-related performance of an electrical or electronic control device.

Shutting down

Function that is intended to avoid or reduce impending or existing hazards for personnel, damage to the machine or the execution of work. This has priority over all operating modes.

Stop Category

Term used in EN 60204-1 to designate three different stopping functions.

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