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Warning notice system

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

**DANGER**

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

**WARNING**

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

**CAUTION** with a safety alert symbol, indicates that minor personal injury can result if proper precautions are not taken.

**CAUTION** without a safety alert symbol, indicates that property damage can result if proper precautions are not taken.

**NOTICE**

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

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

Qualified Personnel

The device/system may only be set up and used in conjunction with this documentation. Commissioning and operation of a device/system may only be performed by qualified personnel. Within the context of the safety notes in this documentation qualified persons are defined as persons who are authorized to commission, ground and label devices, systems and circuits in accordance with established safety practices and standards.

Proper use of Siemens products

Note the following:

**WARNING**

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

Trademarks

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Disclaimer of Liability

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

SINAMICS documentation

The SINAMICS documentation is organized in 2 parts:

- General documentation / Catalogs
- Manufacturer/service documentation

A current overview of the documentation in the available languages is provided in the Internet:

http://www.siemens.com/motioncontrol

Select the menu items "Support" --> "Technical Documentation" --> "Overview of Publications."

The Internet version of DOConCD (DOConWEB) is available on the Internet:

http://www.automation.siemens.com/doconweb

Information on the range of training courses and FAQs (Frequently Asked Questions) is available on the Internet:

http://www.siemens.com/motioncontrol

Follow the menu item "Support".

Usage phases and their tools/documents (as an example)

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<td>• SIZER configuration tool</td>
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<td>• Configuration Manuals, Motors</td>
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<tr>
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<td>• SINAMICS S120 Equipment Manual for AC Drives</td>
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Preface

Target group

This documentation is intended for machine manufacturers, plant manufacturers, commissioning engineers, and service personnel who use the SINAMICS S drive system.

Benefits

The Safety Integrated Function Manual covers all information, procedures and operations required for commissioning safety functions and servicing of SINAMICS S120.

Search guides

The following guides are provided to help you locate information in this manual:

1. Contents
2. List of abbreviations
3. Index

Standard scope

The scope of the functionality described in this document can differ from the scope of the functionality of the drive system that is actually supplied.

- Other functions not described in this documentation might be able to be executed in the drive system. However, no claim can be made regarding the availability of these functions when the equipment is first supplied or in the event of servicing.

- Functions can be described in the documentation that are not available in a particular product version of the drive system. The functionality of the supplied drive system should only be taken from the ordering documentation.

- Extensions or changes made by the machine manufacturer must be documented by the machine manufacturer.

For reasons of clarity, this documentation does not contain all of the detailed information on all of the product types. This documentation cannot take into consideration every conceivable type of installation, operation and service/maintenance.

<table>
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<tr>
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<td>Usage/operation</td>
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<td>• SINAMICS S120/S150 List Manual</td>
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Technical Support

In case of questions, please contact us through the following hotline:

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Note
Country-specific telephone numbers for technical support are provided under the following Internet address:

http://www.siemens.com/automation/service&support

Calls are subject to charge (e.g. € 0.14/min from fixed lines within Germany).
Tariffs of other telephone providers may differ.

Questions on the manual

If you have any questions (suggestions, corrections) regarding this documentation, please fax or e-mail us at:

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<th>Fax</th>
<th>+49 9131 98 63315</th>
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<tr>
<td>E-mail</td>
<td>E-mail to: <a href="mailto:docu.motioncontrol@siemens.com">docu.motioncontrol@siemens.com</a></td>
</tr>
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</table>

A fax form is available in the appendix of this document.

Internet address for SINAMICS

Internet address for Safety Integrated

http://www.siemens.com/safety
This address contains detailed application examples for Safety Integrated.

Notation

The following notation and abbreviations are used in this documentation:

Notation for parameters (examples):
- p0918 Adjustable parameter 918
- r1024 Display parameter 1024
- p1070[1] Adjustable parameter 1070, index 1
- p2098[1].3 Adjustable parameter 2098, index 1, bit 3
- p0099[0...3] Adjustable parameter 99 indices 0 to 3
- r0945[2](3) Display parameter 945 index 2 of drive object 3
- p0795.4 Adjustable parameter 795 bit 4

Notation for faults and alarms (examples):
- F12345 Fault 12345
- A67890 Alarm 67890
- C01700 Safety message 1700

Safety information

This manual contains notices you have to observe in order to ensure your personal safety, as well as to prevent damage to property. 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 indicated in a descending order as follows:

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

⚠️ WARNING
indicates that death or serious injury may result if proper precautions are not taken.
CAUTION

with a safety alert symbol, indicates that minor personal injury may result if proper precautions are not taken.

CAUTION

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

NOTICE

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

In the event of a number of levels of danger prevailing simultaneously, the warning corresponding to the highest level of danger is always used. A warning with a warning triangle indicating possible injury to personnel may also include a warning relating to property damage.

Qualified personnel

The device/system may only be set up and used in conjunction with this documentation. Commissioning and operation of a device/system may only be performed by qualified personnel. For the purpose of the safety information in this documentation, a "qualified person" is someone who is authorized to energize, ground, and tag equipment, systems, and circuits in accordance with established safety procedures.

Proper use

Please observe the following:

WARNING

This device may only be used for the applications described in the catalog or the technical description and only in conjunction with devices or components from other manufacturers which have been approved or recommended by Siemens. Correct transport, storage, installation and assembly, as well as careful operation and maintenance, are required to ensure that the product operates safely and without faults.
ESD Notes

⚠️ CAUTION

Electrostatic sensitive devices (ESD) are single components, integrated circuits or devices that can be damaged by electrostatic fields or electrostatic discharges.

Regulations for the ESD handling:

During the handling of electronic components, pay attention to the grounding of the person, workplace and packaging!

Electronic components may be touched by persons only when
- these persons are grounded using an ESD bracelet, or
- these persons in ESD areas with a conducting floor wear ESD shoes or ESD grounding straps.

Electronic components should be touched only when this is unavoidable. The touching is permitted only on the front panel or on the circuit board edge.

Electronic components must not be brought into contact with plastics or clothing made of artificial fibers.

Electronic components may only be placed on conducting surfaces (table with ESD coating, conducting ESD foamed material, ESD packing bag, ESD transport container).

Electronic components may not be placed near display units, monitors or televisions (minimum distance from the screen > 10 cm).

Measurements must only be taken on boards when the measuring instrument is grounded (via protective conductors, for example) or the measuring probe is briefly discharged before measurements are taken with an isolated measuring device (for example, touching a bare metal housing).
Safety notices

⚠️ DANGER
- Commissioning must not start until you have ensured that the machine in which the components described here are to be installed complies with Directive 98/37/EC.
- SINAMICS devices and AC motors must only be commissioned by suitably qualified personnel.
- The personnel must take into account the information provided in the technical customer documentation for the product, and be familiar with and follow the specified danger and warning notices.
- When electrical equipment and motors are operated, the electrical circuits automatically conduct a dangerous voltage.
- When the machine or system is operated, hazardous axis movements can occur.
- All of the work carried-out on the electrical machine or system must be carried-out with it in a no-voltage condition.
- SINAMICS devices with AC motors must only be connected to the power supply via an AC-DC residual-current-operated device with selective switching once verification has been provided that the SINAMICS device is compatible with the residual-current-operated device in accordance with EN 50178, Chapter 5.2.11.2.

⚠️ WARNING
- The successful and safe operation of this equipment and motors is dependent on correct transport, proper storage, installation and mounting as well as careful operator control, service and maintenance.
- For special versions of the drive units and motors, information and data in the Catalogs and quotations additionally apply.
- In addition to the danger and warning information provided in the technical customer documentation, the applicable national, local, and plant-specific regulations and requirements must be taken into account.
- Only protective extra-low voltages (PELV, DVC-A) that comply with EN 60204-1:2006 can be connected to the connections and terminals between 0 V and 48 V.

⚠️ CAUTION
- The motors can have surface temperatures of over +80 °C.
- This is the reason that temperature-sensitive components, e.g. cables or electronic components may neither be in contact nor be attached to the motor.
- When attaching the connecting cables, you must ensure that:
  - they are not damaged
  - they are not under tension
  - they cannot come into contact with any rotating parts
### CAUTION

- As part of routine tests, SINAMICS devices with AC motors undergo a voltage test in accordance with EN 50178. Before the voltage test is performed on the electrical equipment of industrial machines to EN 60204-1:2006, Section 19.4, all connectors of SINAMICS equipment must be disconnected/unplugged to prevent the equipment from being damaged.
- Motors should be connected-up according to the circuit diagram provided. otherwise they can be destroyed.

### Note

When operated in dry operating areas, SINAMICS equipment with AC motors conforms to Low-Voltage Directive 73/23/EEC.
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1.1 General information

1.1.1 Aims

Manufacturers and operating companies of equipment, machines, and products are responsible for ensuring the required level of safety. This means that plants, machines, and other equipment must be designed to be as safe as possible in accordance with the current state of the art. To ensure this, companies describe in the various standards the current state of the art covering all aspects relevant to safety. When the relevant Standards are observed, this ensures that state-of-the-art technology has been utilized and, in turn, the erector/builder of a plant or a manufacturer of a machine or a piece of equipment has fulfilled his appropriate responsibility.

Safety systems are designed to minimize potential hazards for both people and the environment by means of suitable technical equipment, without restricting industrial production and the use of machines more than is necessary. The protection of man and environment must be assigned equal importance in all countries, which is it is important that rules and regulations that have been internationally harmonized are applied. This is also designed to avoid distortions in the competition due to different safety requirements in different countries.

There are different concepts and requirements in the various regions and countries of the world when it comes to ensuring the appropriate degree of safety. The legislation and the requirements of how and when proof is to be given and whether there is an adequate level of safety are just as different as the assignment of responsibilities.

The most important thing for manufacturers of machines and companies that set up plants and systems is that the legislation and regulations in the country where the machine or plant is being operated apply. For example, the control system for a machine that is to be used in the US must fulfill local US requirements even if the machinery construction company (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, in turn, the technical measures to avoid them can vary significantly. This is why a differentiation is made between different types of safety (e.g. by specifying the cause of possible hazards). "Functional safety" is involved if safety depends on the correct function.

To ensure the functional safety of a machine or plant, the safety-related parts of the protection and control devices must function correctly. In addition, the systems must behave in such a way that either the plant remains in a safe state or it is brought into a safe state if a fault occurs. In this case, it is necessary to use specially qualified technology that fulfills the requirements described in the associated Standards. The requirements to achieve functional safety are based on the following basic goals:

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

Benchmarks for establishing whether or not a sufficient level of functional safety has been achieved include the probability of hazardous failures, the fault tolerance, and the quality that is to be ensured by minimizing systematic faults. This is expressed in the Standards using different terms. In IEC/EN 61508, IEC/EN 62061, IEC/EN 61800-5-2: "Safety Integrity Level" (SIL), in EN 954-1: "Categories" and EN ISO 13849-1 "Performance Level" (PL).
1.2 Safety of machinery in Europe

The EU Directives that apply to the implementation of products are based on Article 95 of the EU contract, which regulates the free exchange of goods. These are based on a new global concept ("new approach", "global approach"):

- EU Directives only specify general safety goals and define basic safety requirements.
- Technical details can be defined by means of standards by Standards Associations that have the appropriate mandate from the commission of the European Parliament and Council (CEN, CENELEC). These standards are harmonized in line with a specific directive and listed in the official journal of the commission of the European Parliament and Council. Legislation does not specify that certain standards have to be observed. When the harmonized Standards are observed, it can be assumed that the safety requirements and specifications of the Directives involved have been fulfilled.
- EU Directives specify that the Member States must mutually recognize domestic regulations.

The EU Directives are equal. This means that if several Directives apply for a specific piece of equipment or device, the requirements of all of the relevant Directives apply (e.g. for a machine with electrical equipment, the Machinery Directive and the Low-Voltage Directive apply).

1.2.1 Machinery Directive (98/37/EC)

When the European common market was launched, a decision was made that the domestic Standards and regulations of all of the EU Member States relating to the technical implementation of machines would be harmonized. This meant that, as an internal market Directive, the content of the Machinery Directive had to be implemented by the individual member states as national legislation. For the Machinery Directive, this was realized with the aim of achieving standard protective goals and, in turn, removing technical trade barriers. In accordance with the definition of a machine ("an assembly of linked parts or components, at least one of which moves"), this Directive is extremely extensive. The range of applications was subsequently expanded to include "safety-related components" and "exchangeable equipment" in the form of revision Directives.

The Machinery Directive involves the implementation of machines. It has 14 Articles and 7 Annexes. The basic safety and health requirements specified in Annex I of the Directive must be fulfilled for the safety of machines. The manufacturer must carefully observe the following principles when it comes to integrating safety (Annex I, Paragraph 1.1.2):
"Machinery must be constructed in such a way that it can be operated, set up, and maintained as part of its proper use without endangering personnel."
"The measures must exclude the risk of accidents."

"When selecting the most appropriate methods, the manufacturer must apply the following principles (in the order specified):

- Eliminate or minimize hazards (by integrating the safety concept into the development and construction of the machine);
- Apply and use the necessary protective measures to protect against dangers that cannot be avoided;
- Inform the user about the residual dangers due to the fact that the safety measures applied are not completely effective."

The protective goals must be implemented responsibly to ensure compliance with the Directive.

Manufacturers of a machine must verify that their machine complies with the basic requirements. This verification is facilitated by means of harmonized standards.

1.2.2 Harmonized European Standards

The two Standards Organizations CEN (Comité Européen de Normalisation) and CENELEC (Comité Européen de Normalisation Électrotechnique), which are mandated by the EU Commission, have elaborated harmonized European Standards in order to detail the requirements of the EU Directives for a specific product. These standards (EN standards) are published in the official journal of the commission of the European Parliament and Council and must be included without revision in domestic standards. They are designed to fulfill basic health and safety requirements as well as the protective goals specified in Annex I of the Machinery Directive.

When the harmonized standards are observed, it is "automatically assumed" that the Directive is fulfilled. As such, manufacturers can assume that they have observed the safety aspects of the Directive under the assumption that these are also covered in this standard. However, not every European Standard is harmonized in this sense. Key here is the listing in the official journal of the commission of the European Parliament and Council.

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

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

Type A standards/basic standards

A standards include basic terminology and definitions relating to all types of machine. This includes EN ISO 12100 (previously EN 292) "Safety of Machines, Basic Terminology, General Design Principles."
A standards are aimed primarily at the bodies responsible for setting the B and C standards. The measures specified here for minimizing risk, however, may also be useful for manufacturers if no applicable C standards have been defined.

**Type B standards/group standards**

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

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

- **Type B1 standards** for higher-level safety aspects (e.g. ergonomic principles, safety clearances from sources of danger, minimum clearances to prevent parts of the body from being crushed).

- **Type B2 standards** for protective safety devices are defined for different machine types (e.g. EMERGENCY STOP devices, two-hand operating circuits, interlocking elements, contactless protective devices, safety-related parts of controls).

**Type C standards/product standards**

C standards are product-specific standards (e.g. for machine tools, woodworking machines, elevators, packaging machines, printing machines etc.). Product standards cover machine-specific requirements. In some cases, the requirements may differ from the basic and group standards. Type C/product standards have the highest priority for machine manufacturers who can assume that it fulfills the basic requirements of Annex I of the Machinery Directive (automatic presumption of compliance). If no product standard has been defined for a particular machine, type B standards can be applied when the machine is constructed.

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


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

1.2 Safety of machinery in Europe

1.2.3 Standards for implementing safety-related controllers

If the functional safety of a machine depends on various control functions, the controller must be implemented in such a way that the probability of the safety functions failing is sufficiently minimized. 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. These standards ensure that the relevant safety requirements of the Machinery Directive are fulfilled.

Figure 1-1 Standards for implementing safety-related controllers

The application areas of EN ISO 13849-1, EN 62061, and EN 61508 are very similar. To help users make an appropriate decision, the IEC and ISO associations have specified the application areas of both standards in a joint table in the introduction to the standards. 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.

<table>
<thead>
<tr>
<th>Systems for executing safety-related control functions</th>
<th>EN ISO 13849-1</th>
<th>EN 62061</th>
</tr>
</thead>
<tbody>
<tr>
<td>A Non-electrical (e.g. hydraulic, pneumatic)</td>
<td>X</td>
<td>Not covered</td>
</tr>
<tr>
<td>B Electromechanical (e.g. relay and/or basic electronics)</td>
<td>Restricted to the designated architectures (see comment 1) and max. up to PL = e</td>
<td>All architectures and max. up to SIL 3</td>
</tr>
<tr>
<td>C Complex electronics (e.g. programmable electronics)</td>
<td>Restricted to the designated architectures (see comment 1) and max. up to PL = d</td>
<td>All architectures and max. up to SIL 3</td>
</tr>
</tbody>
</table>
1.2 Safety of machinery in Europe

### Systems for executing safety-related control functions

<table>
<thead>
<tr>
<th>Systems for executing safety-related control functions</th>
<th>EN ISO 13849-1</th>
<th>EN 62061</th>
</tr>
</thead>
<tbody>
<tr>
<td>D A combined with B</td>
<td>Restricted to the designated architectures (see comment 1) and max. up to PL = e</td>
<td>X See comment 3</td>
</tr>
<tr>
<td>E C combined with B</td>
<td>Restricted to the designated architectures (see comment 1) and max. up to PL = d</td>
<td>All architectures and max. up to SIL 3</td>
</tr>
<tr>
<td>F C combined with A or C combined with A and B</td>
<td>X See comment 2</td>
<td>X See comment 3</td>
</tr>
</tbody>
</table>

"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: Use of designated architectures in compliance with EN ISO 13849-1 to PL = d, or every architecture in compliance with EN 62061.

**Comment 3:** For non-electrical systems: Use components that comply with EN ISO 13849-1 as sub-systems.

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

A qualitative analysis (to EN 954-1) is not sufficient for modern controllers due to their technology. Among other things, EN 954-1 does not take into account time behavior (e.g. test interval and/or cyclic test, lifetime). This led to the probability-based approach of 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. In addition to the qualitative approach of EN 954-1, EN ISO 13849-1 now includes a quantitative analysis of the safety functions. 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
- MTTFₜ: Mean time to dangerous failure
- DC: Diagnostic coverage
- CCF: Common cause failure

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

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

**Note**

Since May 2007, EN ISO 13849-1 has been harmonized as part of the Machinery Directive. EN 954-1 will still apply until November 30, 2009.
1.2.5  EN 62061

EN 62061 (identical to IEC 62061) is a sector-specific standard subordinate to IEC/EN 61508. It describes the implementation of safety-related electrical machine control systems and looks at the complete lifecycle, from the conceptual phase to decommissioning. The standard is based on the quantitative and qualitative analyses of safety functions, whereby it systematically applies a top-down approach to implementing complex control systems (known as "functional decomposition"). The safety functions derived from the risk analysis are sub-divided into sub-safety functions, which are then assigned to real devices, sub-systems, and sub-system elements. Both the hardware and software are covered. EN 62061 also describes 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 PFH₀).

Programmable electronic devices (e.g. PLCs or variable-speed drives) must fulfill EN 61508. They can then be integrated in the controller as sub-systems. The following safety-related characteristic quantities must be specified by the manufacturers of these devices.

Safety-related characteristic quantities for subsystems:
- SIL CL: SIL claim limit
- PFH₀: Probability of dangerous failures per hour
- T₁: Lifetime

Simple sub-systems (e.g. sensors and actuators) in electromechanical components can, in turn, comprise sub-system elements (devices) interconnected in different ways with the characteristic quantities required for determining the relevant PFH₀ value of the sub-system.

Safety-related characteristic quantities for subsystem elements (devices):
- λ: Failure rate
- B₁₀ value: For elements that are subject to wear
- T₁: Lifetime

For electromechanical devices, a manufacturer specifies a failure rate λ with reference to the number of operating cycles. The failure rate per unit time and the lifetime must be determined using the switching frequency for the particular application.

Parameters for the sub-system, which comprises sub-system elements, that must be defined during the design phase:
- T₂: Diagnostic test interval
- β: Susceptibility to common cause failure
- DC: Diagnostic coverage

The PFH₀ value of the safety-related controller is determined by adding the individual PFH₀ values for subsystems.
The user has the following options when setting up a safety-related controller:

- Use devices and sub-systems that already comply with EN 954-1 (or EN ISO13849-1), IEC/EN 61508, or IEC/EN 62061. The standard provides information specifying how qualified devices can be integrated when safety functions are implemented.

- Develop own sub-systems.
  - Programmable, electronic systems and complex systems: Application of EN 61508 or EN 61800-5-2.
  - Simple devices and sub-systems: 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 must be applied for non-electrical systems.

Note
Details of simple sub-systems 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 the current state of the art.

EN 61508 is not harmonized in line with any EU directives, which means that an automatic presumption of conformity for fulfilling the protective requirements of a directive is not implied. The manufacturer of a safety-related product, however, can also use EN 61508 to fulfill basic requirements of European directives in accordance with the latest conceptual design, for example, in the following cases:

- If no harmonized standard exists for the application in question. In this case, the manufacturer can use EN 61508, although no presumption of conformity exists here.
- A harmonized European standard (e.g. EN 62061, EN 954 or EN ISO 13849, EN 60204-1) references EN 61508. This ensures that the appropriate requirements of the directives are fulfilled ("standard that is also applicable"). When manufacturers apply EN 61508 properly and responsibly in accordance with this reference, they can use the presumption of conformity of the referencing standard.

EN 61508 covers all the aspects that must be taken into account when E/E/PES systems (electrical, electronic, and programmable electronic System) are used in order to execute safety functions and/or to ensure the appropriate level of functional safety. Other hazards (e.g. electric shock) are, like EN 954, not part of the standard.

EN 61508 has recently been declared the "International Basic Safety Publication", which makes it a framework for other, sector-specific standards (e.g. EN 62061). As a result, this standard is now accepted worldwide, particularly in North America and in the automotive industry. Today, many regulatory bodies already stipulate it (e.g. as a basis for NRTL listing).

Another recent development with respect to EN 61508 is its system approach, which extends the technical requirements to include the entire safety installation from the sensor to the actuator, the quantification of the probability of hazardous failure due to random hardware failures, and the creation of documentation covering all phases of the safety-related lifecycle of the E/E/PES.
### 1.2.7 Risk analysis/assessment

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

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

EN ISO 12100-1 focuses on the risks to be analyzed and the design principles for minimizing risk. EN ISO 14121-1 describes the iterative process for assessing and minimizing risk to achieve the required level of safety.

The risk assessment is a procedure that allows hazards resulting from machines to be systematically investigated. Where necessary, the risk assessment is followed by a risk reduction procedure. When the procedure is repeated, this is known as an iterative process. This can help eliminate hazards (as far as this is possible) and can act as a basis for implementing suitable protective measures.

The risk assessment involves the following:

- **Risk analysis**
  - Determining the limits of the machine (EN ISO 12100-1, EN ISO 14121-1 Paragraph 5)
  - Identifying the hazards (EN ISO 12100-1, EN ISO 14121-1 Paragraph 6)
  - Estimating the level of risk (EN 1050 Paragraph 7)
- **Risk assessment** (EN ISO 14121-1 Paragraph 8)

As part of the iterative process to achieve the required level of safety, a risk assessment is carried out after the risk estimation. A decision must be made here as to whether the residual risk needs to be reduced. If the risk is to be further reduced, suitable protective measures must be selected and applied. The risk assessment must then be repeated.
Risks must be reduced by designing and implementing the machine accordingly (e.g. by means of controllers or protective measures suitable for the safety-related functions).

If the protective measures involve the use of interlocking or control functions, these must be designed 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 IEC/EN 61508.
1.2.8 Risk reduction

Risk reduction measures for a machine can be implemented by means of safety-related control functions in addition to structural measures. To implement these control functions, special requirements graded according to the magnitude of the risk must be taken into account. These are described in EN 954-1 or EN ISO 13849-1 (previously EN 954-1) or, in the case of electrical controllers (in particular, 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. Annex B describes a method of selecting the required category for designing and implementing the safety-related controller components.

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

IEC/EN 62061 uses "Safety Integrity Level" (SIL) for classification purposes. This is a quantified measure of the safety-related performance of a controller. The required SIL is also determined in accordance with the risk assessment principle to ISO 14121 (EN 1050). Annex A of the standard describes a method for determining the required Safety Integrity Level (SIL).

Regardless of which standard is applied, steps must be taken to ensure that all the machine controller components required for executing the safety-related functions fulfill these requirements.

1.2.9 Residual risk

In today’s technologically advanced world, the concept of safety is relative. In practice, the ability to ensure safety to the extent that risk is permanently excluded – "zero-risk guarantee" – is impossible. The residual risk is the risk that remains once all the relevant protective measures have been implemented in accordance with the latest state of the art.

Machine/plant documentation must always refer to the residual risk (user information to EN ISO 12100-2).
1.3 Machine safety in the USA

A key difference in the legal requirements regarding safety at work between the USA and Europe is that, in the USA, no legislation exists regarding machinery safety that is applicable in all of the states and that defines the responsibility of the manufacturers/supplier. A general requirement exists stating that employers must ensure 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 specified in Section 5 "Duties".

The requirements of the OSH Act are managed by the Occupational Safety and Health Administration (also known as OSHA). OSHA employs regional inspectors who check whether or not workplaces comply with the applicable regulations.


The application of standards is regulated in 29 CFR 1910.5 "Applicability of standards". The concept is similar to that used in Europe. Product-specific standards have priority over general standards insofar as they cover the relevant aspects. Once the standards are fulfilled, employers can assume that they have fulfilled the core requirements of the OSH Act with respect to the aspects covered by the standards.

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

In addition to the OSHA regulations, the current standards defined by organizations such as NFPA and ANSI must be carefully observed and the extensive product liability legislation that exists in the US taken into account. Due to the product liability legislation, it is in the interests of manufacturing and operating companies that they carefully maintain the applicable regulations and are "forced" to fulfill the requirement to use state-of-the-art technology.

Third-party insurance companies generally demand that their customers fulfill the applicable standards of the standards organizations. Self-insured companies are not initially subject to this requirement but, in the event of an accident, they must provide verification that they have applied generally-recognized safety principles.

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 (e.g. NFPA 79) and international standards (e.g. IEC/EN 61508 for E/E/PES systems) are the basis for testing.
1.3.3 NFPA 79

NFPA 79 (Electrical Standard for Industrial Machinery) applies to the electrical equipment of industrial machines with rated voltages of less than 600 V (a group of machines that operate with one another in a coordinated fashion is also considered to be a machine).

NFPA 79 contains basic requirements for programmable electronics and communications buses that specify that these devices must be listed if they are used for executing safety-relevant functions. The devices must be listed. When these requirements are fulfilled, electronic controllers and communications buses can also be used for EMERGENCY STOP functions in stop categories 0 and 1 (see NFPA 79 9.2.5.4.1.4).

Like EN 60204-1, NFPA 79 no longer specifies that the electrical energy must be disconnected by electromechanical means for EMERGENCY STOP functions.

The core requirements regarding programmable electronics and communication buses are:

1. Control systems that contain software-based controllers must:
   - In the event of a single fault
     (a) cause the system to switch to a safe shutdown mode
     (b) prevent the system from restarting until the fault has been rectified
     (c) prevent an unexpected restart
   - Offer the same level of protection as hard-wired controllers
   - Be implemented in accordance with a recognized standard that defines the requirements for such systems.

2. The following suitable standards IEC 61508, IEC 62061, ISO 13849-1/2, and IEC 61800-5-2 are specified in a note.

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 various committees, such as the Association for Manufacturing Technology (AMT), and the Robotic Industries Association (RIA).

The hazards of a machine are evaluated by means of a risk analysis/assessment. 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 from that in Europe and the US. Legislation such as that prescribed in Europe does not exist. Similarly, product liability does not play such an important role as it does in the USA.

Instead of legal requirements to apply standards have been defined, an administrative recommendation to apply JIS (Japanese Industrial Standard) is in place: Japan bases its approach on the European concept and uses basic standards as national standards (see table).

Table 1-1: Japanese standards

<table>
<thead>
<tr>
<th>ISO/IEC number</th>
<th>JIS number</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISO12100-1</td>
<td>JIS B 9700-1</td>
<td>Earlier designation TR B 0008</td>
</tr>
<tr>
<td>ISO12100-2</td>
<td>JIS B 9700-2</td>
<td>Earlier designation TR B 0009</td>
</tr>
<tr>
<td>ISO14121-1 / EN1050</td>
<td>JIS B 9702</td>
<td></td>
</tr>
<tr>
<td>ISO13849-1</td>
<td>JIS B 9705-1</td>
<td></td>
</tr>
<tr>
<td>ISO13849-2</td>
<td>JIS B 9705-1</td>
<td></td>
</tr>
<tr>
<td>IEC60204-1</td>
<td>JIS B 9960-1</td>
<td>Without annex F or route map of the European foreword</td>
</tr>
<tr>
<td>IEC61508-0 to -7</td>
<td>JIS C 0508</td>
<td></td>
</tr>
<tr>
<td>IEC 62061</td>
<td>JIS number not yet assigned</td>
<td></td>
</tr>
</tbody>
</table>
1.5 Equipment regulations

In addition to the requirements of the guidelines and standards, company-specific requirements must be taken into account. Large corporations in particular (e.g. automobile manufacturers) make stringent demands regarding automation components, which are often listed in their own equipment specifications.

Safety-related issues (e.g. operating modes, operator actions with access to hazardous areas, EMERGENCY STOP concepts, etc.) should be clarified with customers early on so that they can be integrated in the risk assessment/risk reduction process.
1.6 Other safety-related issues

1.6.1 Information sheets issued by the Employer's Liability Insurance Association

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

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

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

These information sheets issued by specialist committees can be obtained by all interested parties (e.g. to provide support in factories, or when regulations or safety-related measures for plants and machines are defined). They provide support in machinery construction, production systems, and steel construction.

The information sheets can be downloaded from the following Internet address:

http://www.bgmetallisued.de/downloads

Select the category of specialist information sheet you require.

1.6.2 Additional references

- Safety Integrated: The Safety System for Industry (5th Edition and supplement), order no. 6ZB5 000-0AA01-0BA1
General information about SINAMICS Safety Integrated

2.1 Supported functions

The functions mentioned here comply with IEC 61508, performance level d (PL d) to ISO 13849-1 (formerly EN 954-1), and IEC 61800-5-2.

The following Safety Integrated (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 60204-1:2006 Section 5.4.
  - Safe Stop 1 (SS1, time controlled)
    Safe Stop 1 is based on the "Safe Torque Off" function. This means that a Category 1 stop in accordance with EN 60204-1:2006 can be implemented.
  - Safe Brake Control (SBC)
    The SBC function permits the safe control of a holding brake.
    SBC is supported only by Power/Motor Modules in chassis format with order number ...3 or higher. Blocksize Power Modules also require a Safe Brake Relay for this function.

- **Safety Integrated extended functions (including the basic functions)**

  **Note**
  When a drive object for which Safety Integrated extended functions are enabled is switched to "Park" mode, the Safety Integrated software responds by selecting STO without generating a separate message.

  - Safe Stop 1 (SS1, time and acceleration controlled)
    The SS1 function is based on the "Safe Torque Off" function. This means that a Category 1 stop in accordance with EN 60204-1:2006 can be implemented.
  - Safe Stop 2 (SS2)
    The SS2 function brakes the motor safely with a subsequent transition to "Safe Operating Stop" (SOS).
  - Safe Operating Stop (SOS)
    "Safe Operating Stop" (SOS) protects against unintentional movements. The drive is in closed-loop control mode and is not disconnected from the power supply.
  - Safely Limited Speed (SLS)
    The "Safely Limited Speed" (SLS) protects against excessively high drive speeds.
  - Safe Speed Monitor (SSM)
    The SSM function reliably monitors the speed limit and issues a safe output signal, but without a response function.
Prerequisites for the extended functions

- Special license for extended functions
  Unlike the basic functions, a special license is required for Safety Integrated extended functions. The associated license key is entered in parameter p9920 in ASCII code. The license key can be activated via parameter p9921=1. For information on how to generate the license key for the product “SINAMICS Safety Integrated extended functions”, read the section “Licensing” in the SINAMICS S120 Function Manual. An insufficient license is indicated via the following alarm and LED:
  - A13000 --> License not sufficient
  - LED READY --> Flashes greed/red at 0.5 Hz

- Activation via PROFIsafe or TM54F

NOTICE
Per single Control Unit, either control via PROFIsafe or TM54F is permitted. Mixed operation is not permitted.

NOTICE
For SIMOTION
Using PROFI Safe on PROFINET is not permitted with SIMOTION.

- SINAMICS S120: as of firmware version 2.5 SP1
- SIMOTION D 410 SP2 (available soon)
- SIMOTION D4x5:
  - when controlled by TM54F:
    as of firmware version 4.1 SP1 (as of SINAMICS S120 with firmware version 2.5 SP1 integrated)
  - when controlled by PROFIsafe:
    as of firmware version 4.1 SP1 HF6 (as of SINAMICS S120 with firmware version 2.5 SP1 HF5 integrated)

- Safe actual value acquisition (see chapter "Safe actual value acquisition")
2.1 Supported functions

- An activated speed controller in the drive
- Overview of hardware components that support the extended functions:
  - Control Unit CU310 with order no.: 6SL3040-0LA00-0AA1/6SL3040-0LA01-0AA1
  - Control Unit CU320 with order no.: 6SL3040-...-0AA1 and version C
  - D410 DP with order no.: 6AU1 410-0AA00-0AA0 product version B
  - D410 PN with order no.: 6AU1 410-0AB00-0AA0 product version B
  - D425 with order no.: 6AU1 425-0AA00-0AA0 HW release D
    D435 with order no.: 6AU1 435-0AA00-0AA1 HW release D
    D445 with order no.: 6AU1 445-0AA00-0AA0 HW release B
  - CX32 (without constraints)
  - Motor Modules booksize with order no.: ...3 or higher
  - Motor Modules booksize compact
  - Power Modules blocksize
  - Control Unit adapter CUA31 with order no.: 6SL3040-0PA00-0AA1
  - Control Unit adapter CUA32 with order no.: 6SL3040-0PA01-0AA0
  - Sensor Module SMC20, SME20/25/120/125
  - Motors with DRIVE-CLiQ interface (not with resolver encoder)
2.2 Parameter, Checksum, Version, Password

Properties of Safety Integrated parameters

The following applies to Safety Integrated parameters:

- They are kept separate for each monitoring channel.
- During startup, checksum calculations (Cyclic Redundancy Check, CRC) are performed on the safety parameter data and checked. The display parameters are not contained in the CRC.
- Data storage: The parameters are stored on the non-volatile memory card.
- Factory settings for safety parameters
  
  A reset of the safety parameters to the factory setting on a drive-specific basis using p0970 or p3900 and p0010 = 30 is only possible when the safety functions are not enabled (p9301 = p9501 = p9601 = p9801 = p10010 = 0).
  
  A complete reset of all parameters to the factory settings (p0976 = 1 and p0009 = 30 on the Control Unit) is possible even when the safety functions are enabled (p9301 = p9501 = p9601 = p9801 = p10010 ≠ 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)
- p9533 SI Motion SLS setpoint speed limitation
- p9705 BI: SI Motion Test stop signal source

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 to the corresponding parameter for the setpoint 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 setpoint checksum SI parameters (Control Unit)
- r9898 SI actual checksum SI parameters (Motor Module)
- p9899 SI setpoint checksum SI parameters (Motor Module)
Extended functions

- r9398[0...1] SI Motion actual checksum SI parameters (Motor Module)
- r9399[0...1] SI Motion setpoint checksum SI parameters (Motor Module)
- r9728[0...2] SI Motion actual checksum SI parameters
- p9729[0...2] SI Motion setpoint checksum SI parameters

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 setpoint checksums are different, fault F01650/F30650 or F01680/F30680 is output and an acceptance test requested.

Safety Integrated versions

The safety firmware has a separate version ID for the Control Unit and Motor Module.

For the basic functions:
- r9770 SI version, drive-autonomous safety functions (Control Unit)
- r9870 SI version (Motor Module)

For the extended functions:
- r9590 SI Motion Version safe movement monitoring (Control Unit)
- r9390 SI Motion Version safe movement monitoring (Motor Module)
- r9890 SI version (Sensor Module)
- r10090 SI Version TM54F

**NOTICE**

The EDS cannot be changed with safe motion monitoring (refer to the chapter titled “EDS”).

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**Note**

For detailed requirements regarding Safety Integrated firmware, see “Safety Integrated firmware versions”.

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**Password**

The safety password protects the safety parameters against unintentional or unauthorized access.

In 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 or p10061 for the TM54F.
When Safety Integrated is commissioned for the first time, the following applies:
- Safety passwords = 0
- Default setting for p10061 = 0
- Default setting for p9761 = 0
In other words:
The safety password does not need to be set during first commissioning.

In the case of a series commissioning of Safety or in the case of spare part installation, the following applies:
- The safety password is retained on the memory card and in the STARTER project.
- No safety password is required in the case of spare part installation.

Change password for the drives
- p0010 = 95 Commissioning mode
- p9761 = Enter "old safety password".
- p9762 = Enter "new password".
- p9763 = Confirm "new password".
- The new and confirmed safety password is valid immediately.

Change password for the TM54F
- p0010 = 95 Commissioning mode
- p10061 = Enter "Old TM54F Safety Password" (factory setting "0")
- p10062 = Enter "new password"
- p10063 = Acknowledge "new password"
- The new and acknowledged safety password is valid immediately.

If you need to change safety parameters but you do not know the safety password, proceed as follows:
1. Set the entire drive unit (Control Unit with all connected drives/components) to the factory setting.
2. Recommission the drive unit and drives.
Or contact your regional Siemens office and ask for the password to be deleted (complete drive project must be made available).

Overview of important parameters for "Password" (see SINAMICS S120/S150 List Manual)
- p9761 SI password input
- p9762 SI password new
- p9763 SI password acknowledgement
- p10061 SI password input TM54F
- p10062 SI password new TM54F
- p10063 SI password acknowledgement TM54F
2.3 DRIVE-CLiQ rules for Safety Integrated Functions

Note
The Safety Integrated Functions (basic and extended functions) are generally governed by the same DRIVE-CLiQ rules as specified in the chapter "Rules for wiring with DRIVE-CLiQ" in References: /FH1/ SINAMICS S120 Function Manual. This specification also lists the exceptions for Safety Integrated components depending on the firmware version.

The following rules are also valid particularly for the Safety extended functions:

- Maximum of 5 servo axes for default cycle time settings (monitoring cycle: 12 ms; application cycle: at least 125 μs).
- Maximum of 4 of these servo axes in a DRIVE-CLiQ chain.
- Maximum of 3 vector axes with default cycle time settings (monitoring cycle: 12 ms; application cycle: at least 250 μs).
- TM54F must be connected directly to the CU. Motor Modules or infeeds must not be connected to a TM54F via DRIVE-CLiQ.
- One Double Motor Module, one DMC20, one TM54F and one CUA32 each correspond to two DRIVE-CLiQ participants.
General information about SINAMICS Safety Integrated

2.3 DRIVE-CLiQ rules for Safety Integrated Functions
3 System features

3.1 Certification

The safety functions of the SINAMICS S drive system meet the following requirements:

- Category 3 to EN 954-1/ISO 13849-1
- Performance Level (PL) d to EN ISO 13849-1
- Safety integrity level 2 (SIL 2) to IEC 61508

In addition, most of the safety functions of the SINAMICS S have been certified by independent institutes. An up-to-date list of certified components is available on request from your local Siemens office.

3.2 Safety instructions

Note

Additional safety information and residual risks not specified in this section are included in the relevant sections of this Function Manual.

⚠️ DANGER

Safety Integrated can be used to minimize the level of risk associated with machines and plants. Machines and plants can only be operated safely in conjunction with Safety Integrated, however, when the machine manufacturer

- is familiar with and observes every aspect of this technical user documentation, including the documented general conditions, 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.

It should be noted that Safety Integrated does not replace the machine/plant risk assessment carried out by the machine manufacturer as required by the EG Machinery Directive.

In addition to Safety Integrated, further risk reduction measures must be implemented.
### 3.2 Safety instructions

<table>
<thead>
<tr>
<th>WARNING</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>WARNING</strong></td>
</tr>
<tr>
<td>The Safety Integrated functions cannot be activated until the startup is completed. System startup is a critical operating state with increased risk. No personnel may be present in the immediate danger zone in this phase.</td>
</tr>
<tr>
<td>The drives of vertical axes must be in torque state.</td>
</tr>
<tr>
<td>A complete forced dormant error detection cycle is required after power on (see chapter &quot;Forced dormant error detection&quot;).</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>WARNING</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>WARNING</strong></td>
</tr>
<tr>
<td>EN 60204-1:2006</td>
</tr>
<tr>
<td>The EMERGENCY STOP function must be used to bring the machine to a standstill in accordance with stop category 0 or 1 (STO or SS1).</td>
</tr>
<tr>
<td>The machine must not restart automatically after EMERGENCY STOP.</td>
</tr>
<tr>
<td>When the safety functions (basic and extended functions) are deactivated, an automatic restart is permitted under certain circumstances depending on the risk analysis (except when EMERGENCY STOP is reset). An automatic start is permitted when a protective door is closed, for example.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>WARNING</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>WARNING</strong></td>
</tr>
<tr>
<td>After hardware and/or software components have been modified or replaced, all protective equipment must be closed prior to system startup and drive activation. Personnel shall not be present within the danger zone.</td>
</tr>
<tr>
<td>It may be necessary to carry out a partial or complete acceptance test (see chapter &quot;Acceptance test&quot;) after having made certain changes or replacements.</td>
</tr>
<tr>
<td>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 (+/–).</td>
</tr>
<tr>
<td><strong>To observe during power on:</strong></td>
</tr>
<tr>
<td>The safety functions can only be activated once system has booted up.</td>
</tr>
</tbody>
</table>
### WARNING

- Encoder faults within a single-encoder system are detected by means of 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 responding monitoring function, stop function category 0 or 1 to EN 60204-1:2006 (fault response functions STOP A or STOP B to Safety Integrated) is activated.

- Stop function category 0 to EN 60204-1:2006 (STO or STOP A to Safety Integrated) means that the drives are not decelerate but instead coast to a standstill (the time required to coast to standstill depends on the kinetic energy). This must be included in the logic of the protective door lock, for example, by means of logic operation of SSM (n≤nx).

- Safety Integrated is not capable of detecting parameterization errors made by the machine manufacturer. The required safety level can only be reached by means of an elaborate acceptance test.

- Motor Modules or the motor must be replaced with a device of the same type, as the parameter settings will otherwise lead to incorrect response of Safety Integrated. The corresponding drive must be re-commissioned after an encoder was replaced.

---

### WARNING

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 a delay time between STOP F and STOP B is parameterized. This applies in particular to vertical axes.
3.3 Probability of failure of the safety functions (PFH value)

Probability of failure

The probabilities of safety function failure must be specified in the form of a PHF value (Probability of Failure per Hour) to IEC 61508, IEC 62061 and ISO 13849-1. The PFH value of a safety function depends on the safety concept of the drive unit and its hardware configuration, as well as on the PFH values of other components used for this safety function.

Corresponding PFH values are provided for the SINAMICS S120 drive system, depending on the hardware configuration (number of drives, control type, number of encoders used, ...). The various integrated safety functions are not differentiated.

The PHF values can be requested from your local sales office.
3.4 Response times

Control signals by way of terminals on the Control Unit and Motor Module

Table 3-1 Response times with control signals by way of terminals on the Control Unit and Motor Module

<table>
<thead>
<tr>
<th>Function</th>
<th>Standard</th>
<th>Worst case</th>
</tr>
</thead>
<tbody>
<tr>
<td>STO</td>
<td>2 x r9780 + p0799</td>
<td>4 x r9780 + p0799</td>
</tr>
<tr>
<td>SBC</td>
<td>4 x r9780 + p0799</td>
<td>8 x r9780 + p0799</td>
</tr>
<tr>
<td>SS1 (time controlled) Call (until braking is initiated)</td>
<td>2 x r9780 + p0799 + 2 ms</td>
<td>4 x r9780 + p0799 + 2 ms</td>
</tr>
</tbody>
</table>

Control by way of PROFlsafe

Table 3-2 Response times with control by way of PROFlsafe

<table>
<thead>
<tr>
<th>Function</th>
<th>Standard</th>
<th>Worst case</th>
</tr>
</thead>
<tbody>
<tr>
<td>STO</td>
<td>4 x p9500 + r9780</td>
<td>4 x p9500 + 3 x r9780</td>
</tr>
<tr>
<td>SBC</td>
<td>4 x p9500 + 2 x r9780</td>
<td>4 x p9500 + 6 x r9780</td>
</tr>
<tr>
<td>SS1 (time and acceleration controlled), SS2 Call</td>
<td>4 x p9500 + 2 ms</td>
<td>5 x p9500 + 2 ms</td>
</tr>
<tr>
<td>Speed limit violated</td>
<td>2 x p9500 + 2 ms</td>
<td>2.5 x p9500 + r9780 + t_DP1)</td>
</tr>
<tr>
<td>SOS position tolerance violated</td>
<td>1.5 x p9500 + 2 ms</td>
<td>3 x p9500 + t_DP1) + 2 ms</td>
</tr>
<tr>
<td>SLS speed limit violated</td>
<td>2 x p9500 + 2 ms</td>
<td>3.5 x p9500 + t_DP1) + 2 ms</td>
</tr>
<tr>
<td>SSM</td>
<td>4 x p9500</td>
<td>4.5 x p9500 + t_DP1)</td>
</tr>
</tbody>
</table>

Control by way of TM54F

Table 3-3 Response times with control by way of TM54F

<table>
<thead>
<tr>
<th>Function</th>
<th>Standard</th>
<th>Worst case</th>
</tr>
</thead>
<tbody>
<tr>
<td>STO</td>
<td>2.5 x p9500 + r9780 + 1.5 ms</td>
<td>3 x p9500 + 3 x r9780 + 2 ms</td>
</tr>
<tr>
<td>SBC</td>
<td>2.5 x p9500 + 2 x r9780 + 1 ms</td>
<td>3 x p9500 + 6 x r9780 + 2 ms</td>
</tr>
<tr>
<td>SS1 (time and acceleration controlled), SS2 Call</td>
<td>2.5 x p9500 + 3 ms</td>
<td>4 x p9500 + 4 ms</td>
</tr>
<tr>
<td>Speed limit violated</td>
<td>2 x p9500 + 2 ms</td>
<td>2.5 x p9500 + r9780 + t_DP1)</td>
</tr>
<tr>
<td>SOS position tolerance violated</td>
<td>1.5 x p9500 + 2 ms</td>
<td>3 x p9500 + t_DP1) + 2 ms</td>
</tr>
<tr>
<td>SLS speed limit violated</td>
<td>2 x p9500 + 2 ms</td>
<td>3.5 x p9500 + t_DP1) + 2 ms</td>
</tr>
<tr>
<td>SSM</td>
<td>3 x p9500</td>
<td>3.5 x p9500 + t_DP1)</td>
</tr>
</tbody>
</table>

Information on the tables:

1) t_DP = PROFIBUS cycle with isochronous PROFIBUS master, otherwise 1 ms

2) SLS: Specification of the response time required for initiation of a braking reaction in the drive, or for the output of the "SOS selected" message to the motion control system.
3.5 Residual risk

The fault analysis enables the machine manufacturer to determine the residual risk at his machine with regard to the drive unit. The following residual risks are known:

⚠️ WARNING
Due to the intrinsic potential of hardware faults, electrical systems are subject to additional residual risk, which can be expressed by means of the PFH value.

⚠️ WARNING
- Faults in the absolute track (C-D track), cyclic interchange of the drive phases (V-W-U instead of U-V-W) and reversal of the control direction may cause acceleration of the drive. Due to the fault, however, category 1 and 2 stop functions (to EN 60204-1:2006 (fault response functions stop B to D in accordance with Safety Integrated)) are not activated.
  Stop function category 0 (to EN 60204-1:2006 (fault response function stop A to Safety Integrated)) is not triggered until after the transition or delay time set in the parameter has elapsed. These faults are detected when SBR is selected (fault reaction functions STOP B/C) and stop function category 0 to EN 60204-1:2006 (fault reaction function STOP A in accordance with Safety Integrated) is triggered as early as possible regardless of this delay. Electrical faults (defective components or similar) may also lead to the response stated above.
- Simultaneous failure of two power transistors (one in the upper and the other offset in the lower inverter bridge) in the inverter may cause brief movement of the drive, depending on the number of poles of the motor.
  Maximum value of this movement:
  Synchronous rotary motors: Max. movement = 180° / no. of pole pairs
  Synchronous linear motors: max. movement = pole width

⚠️ WARNING
- Violation of limits may briefly lead to a speed higher than the speed setpoint, or the axis may pass the defined position to a certain extent, depending on the dynamic response of the drive and on parameter settings.
- Mechanical forces greater than the maximum drive torque may force a drive currently operated in position control mode out of Safe Operating Stop state (SOS) and trigger stop function category 1 to EN 60204-1:2006 (fault reaction function STOP B).
**WARNING**

Within a single-encoder system:

a) a single electrical fault in the encoder

b) einen Geberwellenbruch (bzw. (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 drive is in stop state (for example, drive in SOS state).

Generally, the drive is held by the active closed-loop control. Under the aspect of closed-loop control it is conceivable that particularly vertical (suspended) drives move downward and that this movement is not detected.

The risk of an electrical fault in the encoder as described under a) is only given for few encoder types with specific function principle (for example, encoders with microprocessor controlled signal generation such as the Heidenheim EQI, Hübner HEAG 159/160, or AMO measuring systems with sin/cos signals).

The risk analysis of the machine manufacturer must include all of the faults described above. Additional safety measures have to be taken at suspended/vertical drives or for handling dragging loads in order to exclude faults as described in a). For example:

- Use of an encoder with analog signal generation
- Use of a two-encoder system

In order to exclude the fault described in b), for example:

- An FMEA regarding encoder shaft breakage (or slip of the encoder shaft coupling), and a solution to prevent loose encoder housings, integration of a fault exclusion process to CDV IEC 61800-5-2, or
- Implementation of a two-encoder system (the encoders may not be mounted on the same shaft).
System features

3.5 Residual risk
Basic functions

Note
The Basic Functions are also described in the following manual:
Reference: /FH1/SINAMICS S120 Function Manual Drive Functions

4.1 Safe Torque Off (STO)

General description
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 motor power supply.
When the function is selected, the drive unit is in a "safe status". The switching on inhibited function prevents the drive unit from being restarted.
The two-channel pulse inhibit 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; this means that a higher-level controller is not required.
- The function is drive specific, that is, it must be commissioned individually on a drive-by-drive basis.
- The function must be enabled via parameter.
- When the "Safe Torque Off" function is selected:
  - The motor cannot be started accidentally.
  - The pulse suppression safely disconnects the torque-generating motor power supply.
  - The power unit and motor are not electrically isolated.
**Basic functions**

4.1 Safe Torque Off (STO)

<table>
<thead>
<tr>
<th>WARNING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appropriate measures must be taken to ensure that the motor does not move once the motor power supply has been disconnected (&quot;coast down&quot;) (e.g. enable the &quot;Safe Brake Control&quot; function with a vertical axis).</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CAUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>If two power transistors in the power unit (one in the upper and one offset in the lower inverter bridge) fail at the same time, this can cause a momentary movement. The maximum movement can be:</td>
</tr>
<tr>
<td>Synchronous rotary motors: Max. movement = 180° / no. of pole pairs</td>
</tr>
<tr>
<td>Synchronous linear motors: Max. movement = pole width</td>
</tr>
</tbody>
</table>

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

**Enabling the "Safe Torque Off" (STO) function**

<table>
<thead>
<tr>
<th>NOTICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>It is not possible to activate the function via TM54F and PROFIsafe at the same time. It is however possible to use the onboard terminals (Control Unit and power units, see section &quot;Control via terminals on the Control Unit and the power unit&quot;) and the terminals on the TM54F and the PROFIsafe control function at the same time.</td>
</tr>
</tbody>
</table>

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

- **STO via terminals:**
  - p9601.0 = 1, p9801.0 = 1
- **STO via TM54F (only with "Extended Functions" option):**
  - p9601.2 = 1, p9801.2 = 1
  - p9601.3 = 0, p9801.3 = 0
- **STO via PROFIsafe (only with "Extended Functions" option):**
  - p9601.2 = 1, p9801.2 = 1
  - p9601.3 = 1, p9801.3 = 1

**Selecting/deselecting "Safe Torque Off"**

The following occurs when "Safe Torque Off" is selected:

- Each monitoring channel triggers safe pulse suppression via its switch-off signal path.
- A motor holding brake is applied (if connected and configured).
The following occurs when "Safe Torque Off" is de-selected:

- Each monitoring channel cancels safe pulse suppression via its switch-off signal path.
- The safety prompt "Apply motor holding brake" is canceled.
- Any pending STOP F or STOP A commands are canceled (see r9772/r9872).

**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, however, you have to reconfigure N01620/N30620 via p2118 and p2119 as an alarm or fault.

### 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. Cancel the "switching on inhibited" and switch the drive back on.
   - 1/0 edge at input signal "ON/OFF1" (cancel "switching on inhibited")
   - 0/1 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 following parameters:

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

- r9772 CO/BO: SI status (Control Unit)
- r9872 CO/BO: SI status (Motor Module)
- r9773 CO/BO: SI status (Control Unit + Motor Module)
- r9774 CO/BO: SI status (STO group)

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

### Response time with the "Safe Torque Off" function

For the response times when the function is selected/deselected via input terminals, see the table in "Response times".
**4.1 Safe Torque Off (STO)**

**Examples: Booksize**

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

\[
\begin{align*}
t_{R,\text{typ}} &= 2 \times r9780 (4 \text{ ms}) + r0799 (4 \text{ ms}) = 12 \text{ ms} \\
t_{R,\text{max}} &= 4 \times r9780 (4 \text{ ms}) + r0799 (4 \text{ ms}) = 20 \text{ ms}
\end{align*}
\]

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

- 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 "Internal armature short-circuit" function cannot be selected at the same time as the "STO" function. This is because selection of STO always initiates an OFF2 which in turn deactivates the "Internal armature short-circuit" function. The STO safety function has a higher priority than the "Internal armature short-circuit" function, i.e. if STO is activated, it will deactivate an internal armature short-circuit if one is currently active.
4.2 Safe Stop 1 (SS1, time controlled)

General description

A Category 1 stop in accordance with EN 60204-1:2006 can be implemented with function "Safe Stop 1". The drive decelerates with the OFF3 ramp (p1135) once "Safe Stop 1" is selected and switches to "Safe Torque Off" once the delay time set in p9652/p9852 has elapsed.

<table>
<thead>
<tr>
<th>CAUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Once the SS1 (time-controlled) function has been selected by parameterizing a delay in p9652/p9852, STO can no longer be selected directly via terminals.</td>
</tr>
</tbody>
</table>

Functional features of "Safe Stop 1"

- SS1 is selected by setting p9652 and p9852 (delay time) 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 is automatically initiated after the delay time has expired (p9652/p9852).
  - 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.
- The selection is realized through two channels - however braking along the OFF3 ramp, only through one channel.

Release of the SS1 function

The function is enabled 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 data cross-check (p9650/p9850 and p9658/p9858).

The time in p9652/9852 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 the following parameters:

- r9772 CO/BO: SI status (Control Unit)
- r9773 CO/BO: SI status (Control Unit + Motor Module)
- r9774 CO/BO: SI status (STO group)
- r9872 CO/BO: SI status (Motor Module)

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

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

- see "Safe Torque Off" function
- 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)
4.3 Safe Brake Control (SBC)

Description
Safe brake control is used to activate holding brakes that function according to the standby current principle (e.g. motor holding brake).

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

Brake activation via the brake connection on the Motor Module/Safe Brake Relay involves a safe, two-channel method.

Note
Chassis components do not support this function.

Note
To ensure that this function can be used for Blocksize Power Modules, a Safe Brake Relay must be used (for more information, see the Equipment Manual).

When the Power Module is configured automatically, the Safe Brake Relay is detected and the motor holding brake type is defaulted (p1278 = 0).

WARNING
The "Safe Brake Control" function does not detect electrical faults in the brake itself (e.g. short-circuit of brake winding) or mechanical defects (e.g. worn brakes).

If a cable breaks, this is only detected 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 monitors are triggered, "SBC" is performed with safe pulse suppression.
- Unlike conventional brake control, SBC is executed via p1215 through two channels.
- SBC is executed regardless of the brake control or mode set in p1215. SBC is not recommended, however, when 1215 = 0 or 3.
- The function must be enabled via parameter.
- Each time "Safe Torque Off" is selected, the holding brake is applied immediately with forced dormant error detection.
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 not selected until at least one safety monitoring function has been enabled (i.e. p9601 = p9801 ≠ 0).

Two-channel brake control

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

![Two-channel brake control](image)

Figure 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.

Response time with the "Safe Brake Control" function

For the response times when the function is selected/deselected via input terminals, see the table in "Response times".
Examples

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

\[ t_{R,\text{typ}} = 4 \times r9780 \text{ (4 ms)} + r0799 \text{ (4 ms)} = 20 \text{ ms} \]

\[ t_{R,\text{max}} = 8 \times r9780 \text{ (4 ms)} + r0799 \text{ (4 ms)} = 36 \text{ ms} \]

**NOTICE**

Activation of brake via a relay with Safe Brake Control:
If Safe Brake Control is used, the brake must not be activated via a relay. This can result in incorrect feedback regarding a brake fault.

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

- \( p0799 \) CU inputs/outputs sampling time
- \( r9780 \) SI monitoring clock cycle (Control Unit)
- \( r9880 \) SI monitoring clock cycle (Motor Module)
4.4 Safety faults

The fault messages for Safety Basic Functions are stored in the standard message buffer and can be read from there. In contrast, the fault messages for Safety Integrated Extended Functions are stored in a separate safety message buffer (see section "Message buffer").

When faults associated with Safety Integrated Basic Functions occur, the following stop responses can be initiated:

Table 4-1 Stop responses to Safety Integrated Basic Functions

<table>
<thead>
<tr>
<th>Stop response</th>
<th>Triggered ...</th>
<th>Action</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>STOP A cannot be acknowledged</td>
<td>For all non-acknowledgeable safety faults with pulse suppression.</td>
<td>Trigger safe pulse suppression via the switch-off signal path for the relevant monitoring channel. During operation with SBC: apply motor holding brake.</td>
<td>The motor coasts to a standstill or is braked by the holding brake.</td>
</tr>
<tr>
<td>STOP A</td>
<td>For all acknowledgeable safety faults. As a follow-up reaction of STOP F.</td>
<td>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 &quot;Safe Torque Off (STO)&quot; 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 operating brake. When STOP A is active, &quot;Safe Torque Off&quot; (STO) is effective.</td>
<td>STOP F If an error occurs in the data cross-check. Transition to STOP A. Follow-up reaction STOP A with adjustable delay (default setting without delay) if one of the safety functions is selected STOP F is permanently assigned to the data cross-check (DCC). In this way, errors are detected in the monitoring channels. After STOP F, STOP A is triggered. When STOP A is active, &quot;Safe Torque Off&quot; (STO) is effective.</td>
</tr>
</tbody>
</table>

**WARNING**

With a vertical axis or pulling load, there is a risk of uncontrolled axis movements when STOP A/F is triggered. This can be prevented by using "Safe Brake Control (SBC)" and a holding brake (not a safety brake!) with sufficient holding force.
Acknowledging the safety faults

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

1. Remove the cause of the fault.
2. Deselect "Safe Torque Off" (STO).
3. Acknowledge the fault.

If 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 this action has not eliminated the fault cause, the fault is displayed again immediately after power up.

Description of faults and alarms

**Note**

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

References: /LH1/ SINAMICS S120/S150 List Manual
4.5 Forced checking procedure

Forced dormant error detection or test for the switch-off signal paths

The forced dormant error detection function at the switch-off signal 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 EN 954-1 / ISO 13849-1 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 functionality must be implemented by means of forced dormant error detection function, triggered either in manual mode or by the automated process.

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

- p9659 SI timer for the forced dormant error detection.

Forced dormant error detection 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, only an alarm is 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 forced dormant error detection to between 0.00 and 9000.00 hours depending on the application (factory setting: 8.00 hours).

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.
- At defined intervals (e.g. every 8 hours).
- In automatic mode (time and event dependent)

**NOTICE**

The timer of the Basic Functions will be reset if the associated forced dormant error detection is executed and the Extended Functions are used simultaneously. The corresponding alarm of the Basic Functions is not triggered.

Discrepancy is not checked at the terminals used to select the Basic Functions as long as STO is set by the Extended Functions. That is, the forced checking procedure of the Basic Functions always has to be executed without simultaneous selection of STO or SS1 by the Extended Functions. It is otherwise not possible to verify the correct control through the terminals.
5.1 Safe Stop 1 (SS1, time and acceleration controlled)

General description

The "Safe Stop 1" function allows the drive to be stopped in accordance with EN 60204-1:2006, stop category 1. The drive brakes with the OFF3 ramp (p1135) once "Safe Stop 1" is selected and switches to "Safe Torque Off" (STO) once the delay time has elapsed (p9356/p9556) or when the shutdown speed is reached (p9360/p9560).

Figure 5-1 Sequence with SS1 selection
Extended Functions

5.1 Safe Stop 1 (SS1, time and acceleration controlled)

Functional features of "Safe Stop 1"

- If SS1 is selected, the drive is brought to a stop along the OFF3 ramp (p1135) and STO/SBC is automatically triggered on expiration of the delay time (p9356/p9556), or after having reached the shutdown speed (p9360/p9560).

Once the function has been activated, the delay time elapses, even if the function is deactivated during this time. In this case, after the delay time has expired, the STO/SBC function is selected and then again de-selected immediately.

- The selection is realized through two channels - however braking along the OFF3 ramp, only through one channel.

- The "Safe Acceleration Monitor" (SBR) function is selected during braking (see "Safe Acceleration Monitor").

Note

If SS1 is selected, this can cause the device that governs the speed setpoint (PLC, motion controller, EPOS) to interrupt the ramp function by triggering OFF2. Cause: intrinsic fault response, which is triggered when OFF3 is activated unexpectedly. Parameterization or wiring must be carried out in such a way that the device that governs the speed setpoint can detect that SS1 has been triggered so that it can suppress the OFF2 fault response.

Commissioning

The function is selected by entering the delay time in p9356 and p9556. The waiting time until the pulse is canceled can be shortened by defining a shutdown speed in p9360 and p9560.

To enable the drive to decelerate to standstill, the time set in p9356/p9556 must be sufficient to allow the drive to decelerate to below the shutdown speed in p9360/p9560 with the OFF3 ramp (p1135).

The shutdown speed defined in p9360/p9560 must be set in such a way that personal safety or the safety of the machine is not compromised as of this speed and as a result of subsequent coasting by means of the pulse inhibit signal.

Responses

Speed limit violated (SBR):
- STOP A
- Safety message C01706/C30706

System errors:
1. STOP F with subsequent STOP A
2. Safety message C01711/C30711

Prerequisite

The time set in p9356/9556 must be dimensioned so that after selection, the drive brakes down to a standstill.
Extended Functions

5.1 Safe Stop 1 (SS1, time and acceleration controlled)

Status for "Safe Stop 1"

The status of the "Safe Stop 1" function is displayed using the following parameters:

- r9722.1 CO/BO: SI motion status signals, SS1 active
- r9722.0 CO/BO: SI motion status signals, STO active (power removed)

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

- p1135[0...n] OFF3 ramp-down time
- p9301 SI motion enable safety functions (Motor Module)
- p9501 SI motion enable safety functions (Control Unit)
- p9348 SI motion SBR actual speed tolerance (Motor Module)
- p9548 SI motion SBR actual speed tolerance (Control Unit)
- p9356 SI motion pulse cancelation delay time (Motor Module)
- p9556 SI motion pulse cancelation delay time (Control Unit)
- p9360 SI motion pulse cancelation shutdown speed (Motor Module)
- p9560 SI motion pulse cancelation shutdown speed (Control Unit)
- r9722.0...15 CO/BO: SI motion integrated drive status signals
5.2 Safe Stop 2 (SS2)

Description

The "Safe Stop 2" (SS2) function is used to brake the motor safely on the OFF3 deceleration ramp (p1135) with subsequent transition to the SOS state (see also "Safe Operating Stop") after the delay time expires (p9352/p9552). The delay time set must allow for the drive to brake down to a standstill within this time. The standstill tolerance (p9330/p9530) may not be violated after this time.

After the braking operation is completed, the drives remain in speed control mode (speed setpoint \( n = 0 \)). The drive is not disconnected from hazardous voltage. The default setpoint (e.g. from the setpoint channel, or from a higher-level control) remains inhibited as long as SS2 is selected. The "Safe Acceleration Monitor" (SBR) function is selected during braking.

![Sequence with SS2 selection](image)

Figure 5-2 Sequence with SS2 selection

Note

If SS2 is selected, this can cause the device that governs the speed setpoint (PLC, motion controller, EPOS) to interrupt the ramp function by triggering OFF2. Cause: intrinsic fault response, which is triggered when OFF3 is activated unexpectedly. Parameterization or wiring must be carried out in such a way that the device that governs the speed setpoint can detect that SS2 has been triggered so that it can suppress the OFF2 fault response.
Responses

**Speed limit violated (SBR):**
- STOP A
- Safety message C01706/C30706

**Standstill tolerance violated in p9330/p9530 (SOS):**
- STOP B with subsequent STOP A
- Safety message C01707/C30707

**System errors:**
- STOP F with subsequent STOP A
- Safety message C01711/C30711

**Overview of important parameters (see the SINAMICS S120/S150 List Manual)**
- p1135[0...n] OFF3 ramp-down time
- p9301 SI motion enable safety functions (Motor Module)
- p9501 SI motion enable safety functions (Control Unit)
- p9330 SI motion standstill tolerance (Motor Module)
- p9530 SI motion standstill tolerance (Control Unit)
- p9348 SI motion SBR actual speed tolerance (Motor Module)
- p9548 SI motion SBR actual speed tolerance (Control Unit)
- p9352 SI motion transition time STOP C to SOS (Motor Module)
- p9552 SI motion transition time STOP C to SOS (Control Unit)
- r9722.0...15 CO/BO: SI motion integrated drive status signals
5.3 Safe Operating Stop (SOS)

Description

This function serves for fail-safe monitoring of the standstill position of a drive. Personnel can enter the protected machine areas without having to shut down the machine as long as SOS is active.

Drive standstill is monitored by means of an SOS tolerance window (p9330 and p9530). The SOS function is activated after SOS is selected and when the delay time set in p9351/p9551 expires. The drive must be braked to standstill within this delay time (e.g. by the controller). When this function is activated, the current actual position is saved as a comparative position, until SOS is deselected again. Any delay time is cleared after SOS is canceled and the drive can start up immediately.

![Standstill Tolerance Window](image)

**Figure 5-3  Standstill tolerance**

Responses

**Standstill tolerance violated in p9330/p9530:**

- STOP B with subsequent STOP A
- Safety message C01707/C30707

**System errors:**

- STOP F
- Safety message C01711/C30711
Features

- The drive remains in the closed-loop control mode.
- A programmable standstill tolerance window is available.
- STOP B is the stop response after SOS has responded

Note
The range of the tolerance window should be oriented on the default standstill monitoring limit and be slightly higher than this limit.

Activation of the default monitoring functions may otherwise not be possible.

Note that safe position monitoring within a single-encoder system only works at a rough resolution (4 x pulses per revolution) (see "Safe actual value acquisition").

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

- p9301 SI motion enable safety functions (Motor Module)
- p9501 SI motion enable safety functions (Control Unit)
- p9330 SI motion standstill tolerance (Motor Module)
- p9530 SI motion standstill tolerance (Control Unit)
- p9351 SI motion SLS changeover delay time (Motor Module)
- p9551 SI motion SLS(SG) changeover delay time (Control Unit)
- r9722.0...15 CO/BO: SI motion integrated drive status signals
5.4 Safely Limited Speed (SLS)

Description

The "Safely Limited Speed" (SLS) function is used to protect a drive against unintentional high speed. This is achieved by monitoring the current drive speed up to a switched speed limit.

SLS is used to prevent any unintentional movements outside the valid high limit. Limits must be specified based on results of the risk analysis. Up to 4 different SLS speeds can be parameterized using p9533[0..3].

The speed limit is activated once SLS has been selected and after the delay time (p9351/p9551) has elapsed. If a lower speed limit is selected, the drive must be decelerated to a speed below the new limit (e.g. by the controller) within this delay time. A delay time is not set if a higher speed limit is selected.

![Diagram showing the delay time SLS phase changeover](image)

A speed setpoint limit can be set as percentage in p9533. This value is used to calculate a speed setpoint limit r9733, depending on the selected speed limit p9531[x].

By contrast to SI limit parameters, this parameter specifies limits on the motor side instead of limits on the load side.

- r9733[0] = p9531[x] * p9533; x = selected SLS stage
- r9733[1] = - p9531[x] * p9533; x = selected SLS stage
### Responses

**Speed limit exceeded:**
- Configured subsequent stop STOP A / B / C / D by means of p9363/p9563
- Safety message C01714/C30714

**System errors:**
- STOP F
- Safety messages C01711/C30711

### Features

- 4 programmable limits p9331[0...3] and p9531[0...3]
- Programmable stop response by means of p9363/p9563

### Changeover of speed limits

The changeover is controlled by means of binary signals from two F-DIs. The speed selection status can be checked at the r9720.9/r9720.10 parameters. Parameters r9722.9 and r9722.10 indicate the actual speed limit, bit r9722.4 must carry a "1" signal.

<table>
<thead>
<tr>
<th>F-DI for bit 0 (r9720.9)</th>
<th>F-DI for bit 1 (r9720.10)</th>
<th>Speed limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>p9331[0]/p9531[0]</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>p9331[1]/p9531[1]</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>p9331[2]/p9531[2]</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>p9331[3]/p9531[3]</td>
</tr>
</tbody>
</table>

The changeover from a lower to a higher speed limit takes effect without any delay.

The changeover from a higher to a lower limit triggers a delay time which can be set at the corresponding parameter (p9351 and p9551).

To ensure that the drive reaches the reduced speed below the new speed limit value once the delay time has elapsed, it must be decelerated accordingly within the delay time by means of the higher-level motion control/setpoint channel. However, if the actual speed is higher than the new limit value and the time has expired, an appropriate alarm with the configured stop response will be generated.

![CAUTION]

**SLS 1 must be defined as the lowest Safely Limited Speed.**

SLS level 1 is activated after two unacknowledged discrepancy errors; in other words, 0 is the failsafe value for the 2 F-DIs for speed level selection. The SLS levels to be switched between should, therefore, always be parameterized in ascending order, e.g. with SLS level 1 as the lowest speed and SLS level 4 as the highest.
Overview of important parameters (see the SINAMICS S120/S150 List Manual)

- p9301.0 SI motion enable safety functions (Motor Module)
- p9501.0 SI motion enable safety functions (Control Unit)
- p9331[0...3] SI motion SLS limits (Motor Module)
- p9531[0...3] SI motion SLS (SG) limits (Control Unit)
- p9533 SI motion speed setpoint limit (Control Unit)
- p9351 SI motion SLS changeover delay time (Motor Module)
- p9551 SI motion SLS(SG) changeover delay time (Control Unit)
- p9363[0...3] SI motion SLS stop response (Motor Module)
- p9563[0...3] SI motion SLS (SG)-specific stop response (Control Unit)
- r9720 CO/BO: SI motion integrated drive control signals
- r9722.0...15 CO/BO: SI motion integrated drive status signals
- r9733[0...1] CO: SI motion effective speed setpoint limiting
5.5 Safe Speed Monitor (SSM)

Description

The SSM function is used for reliably detecting when a speed limit value has been undershot (p9346/p9546) (e.g. for standstill detection) in both directions. A failsafe output signal is available for further processing.

The function is activated automatically as soon as the extended functions are enabled with p9301.0 = p9501.0 = 1.

**NOTICE**

The speed limit of the SSM function (p9346/p9546) is also used as shutdown limit for the SBR function (safe acceleration monitoring). The SBR is deactivated if the speed is below this limit.

The effect of the SSM safety function is therefore heavily limited if a relatively high SSM/SBR speed limit is set and the SS1 and SS2 stop functions are activated.

**WARNING**

STOP F (indicated by alarm C01711/C30711) only results in a follow-up response (STOP B / STOP A) if at least one of the safety-oriented functions (SOS or SLS) is active or has been selected. If only the SSM function is active, a STOP F crosswise comparison error does not result in a follow-up response (STOP B / STOP A).

If SSM is used as a safety function, therefore, at least one of the SOS or SLS functions must be active/selected (e.g. by selecting a high SLS level).

The parameter p9346/p9546 "SI Motion SSM (SGA n < nx) velocity limit n_\_x (CU)" is used to set the velocity limit (in mm/min). The abbreviation "SGA n < nx" indicates the safety function required for determining an output signal when a parameterizable velocity limit has been undershot.

If the velocity limit for the "Safe Speed Monitor" feedback signal (n < n_\_x) for detecting standstill is undershot, the "SSM feedback signal active" signal (SGA n < n_\_x) is set. When the set threshold value has been undershot, the "Safe Acceleration Monitor" (SBR) function is also deactivated.

The hysteresis for the SSM output signal is set in parameter p9347/p9547 "SI Motion velocity hysteresis (crosswise)". If the maximum permissible speed tolerance is overshot (i.e. one channel displays a speed less than p9546 - p9547, while the other channel displays a speed greater than p9546), a Stop F is issued.

In addition, the output signal for SSM can be smoothed by means of a PT1 filter by setting a filter time p9345/9545 "SI Motion filter time nx".

During safe motion monitoring, both functions (hysteresis and filtering) can be activated or deactivated jointly by means of an enabling bit (p9301.16 (Motor Modules) and p9501.16 (CU)). In the default setting, the functions are deactivated (p9301.16/p9501.16 = 0).
The following diagram shows the characteristic of the safe output signal SSM when the hysteresis is active:

![Diagram of SSM output signal](image)

**Figure 5-5 Safe output signal for SSM with hysteresis**

Due to the hysteresis, the safe output signal for SSM can also lie above the parameterized velocity limit at 1. This is a characteristic of the hysteresis.

**Note**

When the hysteresis and filter is activated with output signal SSM, the axes behave in a time-delayed manner. This is a characteristic of the filter.

**Features**

- Safe monitoring of the speed limit specified in p9346 and p9546
- Parameterizable hysteresis via p9347 and p9547
- Variable PT1 filter via p9345 and p9545
- Failsafe output signal
- No stop response

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

- p9345 SI Motion filter time nx (Motor Module)
- p9545 SI Motion filter time nx (Control Unit)
- p9346 SI Motion SSM velocity limit (Motor Module)
- p9546 SI Motion SSM (SGA n < nx) velocity limit _n_x (CU)
- p9347 SI Motion velocity hysteresis (crosswise) (Motor Module)
- p9547 SI Motion velocity hysteresis (crosswise) (Control Unit)
- r9722.0...15 CO/BO: SI motion integrated drive status signals
5.6 Safe Acceleration Monitor (SBR)

Description

The "Safe Acceleration Monitor" (SBR) function is used for safe monitoring of acceleration. This safety function is not autarkic and is part of the SS1 (time and acceleration controlled) and SS2 (or STOP B and STOP C) safety functions. A STOP A is generated if any drive acceleration within the ramp-down phase exceeds the tolerance defined in p9348/p9548. The monitoring function is activated after SS1 (or STOP B) and SS2 (or STOP C) are set and is deactivated after the speed drops below the value set in p9346/p9546.

NOTICE

The speed limit of the SSM function (p9346/p9546) is also used as shutdown limit for the SBR function (safe acceleration monitoring). The SBR is deactivated if the speed is below this limit.

The effect of the SSM safety function is therefore heavily limited if a relatively high SSM/SBR speed limit is set and the SS1 and SS2 stop functions are activated.

Calculating SBR tolerance of the actual speed

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

The maximum speed increase after SS1 / SS2 is triggered is derived from the effective acceleration (a) and the duration of the acceleration phase. The duration of the acceleration phase is equivalent to one monitoring clock cycle (p9300/p9500) MC (delay from detecting an SS1 / SS2 until \( n_{set} = 0 \)):

SBR tolerance

Actual speed SBR = acceleration * acceleration duration
The following setup rule is derived thereof:

At linear axes:
SBR tolerance [mm/min] = a [m/s²] * MC [s] * 1000 [mm/m] * 60 [s/min]

At rotary axes:
SBR tolerance [rev/min] = a [rev/s²] * MC [s] * 60 [s/min]

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

Responses

**Speed limit violated (SBR):**
- STOP A
- Safety message C01706/C30706

**System errors:**
- STOP F with subsequent STOP A
- Safety message C01711/C30711

Features

- Element of the SS1 (time and acceleration controlled) and SS2 functions
- Programmable minimum shutdown speed to be monitored

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

- p9346 SI Motion SSM velocity limit (Motor Module)
- p9546 SI Motion SSM (SGA n < nx) velocity limit n_x (CU)
- p9348 SI motion SBR actual speed tolerance (Motor Module)
- p9548 SI motion SBR actual speed tolerance (Control Unit)
5.7 Safety faults

Stop responses

Faults with Safety Integrated extended functions and violation of limits can trigger the following stop response:

Table 5-2 Stop response overview

<table>
<thead>
<tr>
<th>Stop response</th>
<th>Triggered ...</th>
<th>Action</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>STOP A</td>
<td>For all acknowledgeable safety faults with pulse disable. As a follow-up reaction of STOP F.</td>
<td>Immediate pulse cancelation</td>
<td>Drive coasts down</td>
</tr>
<tr>
<td>STOP B</td>
<td>Examples: - standstill tolerance violated in p9330/p9530 (SOS). - Configured subsequent stop p9363/p9563 for SLS. - When the SS2 function is active stop F results in follow-up stop B.</td>
<td>Immediate input of speed setpoint = 0 and start of timer tB. Once ts or nact &lt; nshutdown, STOP A is triggered.</td>
<td>STOP B with subsequent STOP A. The drive decelerates along the OFF3 ramp and then switches to STOP A.</td>
</tr>
<tr>
<td>STOP C</td>
<td>Configured subsequent stop p9363/p9563 with SLS. When SLS is selected, the drive is decelerated with Stop C.</td>
<td>Immediate input of speed setpoint = 0 and start of timer tc. Once tc has elapsed, SOS is selected.</td>
<td>The drive decelerates along the OFF3 ramp; SOS is then selected.</td>
</tr>
<tr>
<td>STOP D</td>
<td>Configured subsequent stop p9363/p9563 with SLS.</td>
<td>Timer tD starts. No drive-integrated response. SOS is activated on expiration of tD.</td>
<td>The drive must be decelerated by the higher-level control (within the drive group)! Once tD has elapsed, SOS is selected. An automatic response is only triggered if the standstill tolerance window is violated in SOS.</td>
</tr>
<tr>
<td>STOP F</td>
<td>If a fault occurs in the crosswise data comparison. Follow-up response STOP B.</td>
<td>Timer ts (basic functions) or ts (extended functions) No drive response</td>
<td>If a safety function (SOS, SLS) has been selected, transition to STOP A after ts (basic functions) has elapsed or STOP B after ts (extended functions) has elapsed.</td>
</tr>
</tbody>
</table>

Note

A delay time between STOP F and STOP B should only be set if an additional response is initiated during this time when the "Internal Event" (p9722.7) message signal is evaluated.

A monitoring function should also always be active even in automatic mode (e.g. SLS with a high limit speed) when the delay time is used.
On delays at the stop response transitions

- \( t_b: p9356/p9556 \)
- \( t_c: p9352/p9552 \)
- \( t_d: p9353/p9553 \)
- \( t_f1: p9658/p9858 \)
- \( t_f2: p9355/p9555 \)
- \( \text{ns} \text{shutdown}: p9360/p9560 \)

Stop response priorities

Table 5-3 Stop response priorities

<table>
<thead>
<tr>
<th>Priority classes</th>
<th>Stop response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highest priority</td>
<td>STOP A</td>
</tr>
<tr>
<td>.....</td>
<td>STOP B</td>
</tr>
<tr>
<td>...</td>
<td>STOP C</td>
</tr>
<tr>
<td>...</td>
<td>STOP D</td>
</tr>
<tr>
<td>Lowest priority</td>
<td>STOP F</td>
</tr>
</tbody>
</table>

Priorities of stop responses and extended functions

Table 5-4 Priorities of stop responses and extended functions

<table>
<thead>
<tr>
<th>Stop response / extended function</th>
<th>Highest priority</th>
<th>...</th>
<th>...</th>
<th>...</th>
<th>Lowest priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>STOP</td>
<td>STOP A</td>
<td>STOP B</td>
<td>STOP C</td>
<td>STOP D</td>
<td>STOP F</td>
</tr>
<tr>
<td>Highest priority</td>
<td></td>
<td>STOP A / STO</td>
<td>STOP B / SS1</td>
<td>STOP C / SS2</td>
<td>SS2 / STOP B&lt;sup&gt;2&lt;/sup&gt;</td>
</tr>
<tr>
<td>...</td>
<td>SS1</td>
<td>STOP A</td>
<td>STOP B / SS1</td>
<td>SS1</td>
<td>SS1</td>
</tr>
<tr>
<td>Lowest priority</td>
<td>SOS</td>
<td>STOP A&lt;sup&gt;1&lt;/sup&gt;</td>
<td>STOP B&lt;sup&gt;1&lt;/sup&gt;</td>
<td>SOS</td>
<td>SOS</td>
</tr>
<tr>
<td>...</td>
<td>SLS</td>
<td>STOP A&lt;sup&gt;3&lt;/sup&gt;</td>
<td>STOP B&lt;sup&gt;3&lt;/sup&gt;</td>
<td>STOP C&lt;sup&gt;4&lt;/sup&gt;</td>
<td>STOP D&lt;sup&gt;4&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

1) The SOS monitoring function remains active, although the fault response in the event of a fault can no longer be triggered because it is already present.

2) Stop B is the follow-up stop of Stop F, which is activated after a parameterizable time. Stop F alone does not have any effect; the active safety function is still present.

3) The SLS monitoring function remains active, although the fault response in the event of a fault can no longer be triggered because it is already present.

4) SLS remains active during the braking phase, after which the system switches to SOS.

The table above specifies which stop response / safety function is set when a stop is triggered when a safety function is active. The stops are arranged here from left to right in descending order of priority (stop A to F).
No overall priority is assigned in the individual safety functions. SOS remains active, for example, even if STO is requested. The safety functions that cause the drive to decelerate (STO, SS1, SS2) are specified from top to bottom in descending order of priority.

If a field contains two entries, the stop responses and safety functions have the same priority. Explanation:

- Stop A is equivalent to STO
- Stop B is equivalent to SS1
- Stop C is equivalent to SS2
- When the SS2 function is active, stop F results in follow-up stop B. SS2 remains active.

Examples for illustrating the information in the table:

1. Safety function SS1 has just been selected. Stop A remains active; a stop B operation that is currently in progress is not interrupted by this. Any remaining stop functions (stop C to F) would be replaced by SS1.

2. The SLS safety function is selected. This does not alter the function of stops A to D. Stop F now triggers a stop B because a safety function has been activated.

3. Stop response C is activated. If the STO or SS1 safety functions are active, this does not have any effect. If SS2 is active, this braking ramp is retained. If SOS is active, SOS remains effective, which is also the end status of stop C. When SLS is selected, the drive is decelerated with Stop C.
Acknowledging the safety faults

General

NOTICE
The safety faults can also be acknowledged (as with all other faults) by switching the drive
unit off and then on again (POWER ON).
If this action has not eliminated the fault cause, the fault is displayed again as soon as the
system has been rebooted.

Acknowledgement via TM54F
Parameter p10006 "SI acknowledgement internal event input terminal" allows faults to be
acknowledged in the safety drives and in TM54F itself.
The "safe fault acknowledgement" mechanism functions as follows:
The safe input F-DI on the TM54F parameterized with the function p10006 "SI
acknowledgement internal event input terminal" is actuated. This allows faults that occurred
in the firmware installed in the CU or Motor Module to be acknowledged by means of a safe
input signal. The falling edge at this input resets the status "Internal Event" in the drives and,
if used, in the TM54F.
To prevent safety faults from being acknowledged unintentionally or incorrectly, the signal at
the TM54F F-DI terminal, which was parameterized for acknowledgement purposes, must be
at level "0" in the idle state. To trigger the acknowledgement (falling edge at F-DI), the signal
must first be set to "1" and then back to "0". If the required idle state is not reached, an alarm
is output.
After "safe fault acknowledgement", an acknowledgement must be issued on the CU in order to:
• Delete the TM54F faults from the fault buffer
• Reset the pending, red "Ready" LED on the TM54F

Acknowledgement via PROFIsafe
The higher-level controller sets the signal "Internal Event ACK" via the PROFIsafe telegram
(STW bit 7) separately for each drive object. A falling edge in this signal sets the status
"Internal Event" in the relevant drive, which acknowledges the fault.
Faults in the drive objects (DOs) cannot be acknowledged by the higher-level controller in
the line-up but must instead be acknowledged separately for each individual drive object.

Description of faults and alarms

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

## 5.8 Message buffer

In addition to the fault buffer for F... faults and the alarm buffer for A... alarms (see the relevant section in: /IH1/ SINAMICS S120 Commissioning Manual), a special message buffer for C... safety messages is available for safety extended functions.

The fault messages for the safety basic functions are stored in the standard fault buffer (see "Buffer for faults and alarms" in /IH1/ SINAMICS S120 Commissioning Manual).

The message buffer for safety messages is similar to the fault buffer for fault messages. The message buffer comprises the message code, message value, and message time (received/resolved). The following diagram shows how the message buffer is structured:

![Message Buffer Diagram](image-url)

### Figure 5-7 Structure of the message buffer

When a safety message is present, the bit 2139.5 = 1 ("Safety message present") is set. The entry in the message buffer is delayed. For this reason, the message buffer should not be read until a change in the buffer (r9744) has been detected after "Safety message present" is output.

The messages must be acknowledged via the failsafe inputs F-DI on TM54F or via PROFIsafe.
Properties of the message buffer:

- A new message case comprises one or more messages and is entered in the "Current message case".
- The entries appear in the buffer according to the time at which they occurred.
- If a new message case occurs, the message buffer is reorganized accordingly. The history is recorded in "Acknowledged message case" 1 to 7.
- If the cause of at least one message in "Current message case" is rectified and acknowledged, the message buffer is reorganized accordingly. Messages that have not been rectified remain in "Current message case".
- If "Current message case" contains eight messages and a new message is output, the message in the parameters in index 7 is overwritten with the new message.
- r9744 is incremented each time the message buffer changes.
- A message value (r9749, r9753) can be output for a message. The message value is used to diagnose the message more accurately (refer to the message description for more details).

Deleting the message buffer:

The message buffer can be deleted as follows: p9752 = 0. Parameter p9752 (SI message cases, counter) is also reset to 0 during POWER ON.

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

- r2139.0...12 CO/BO: Status word, faults/alarms 1
- r9744 SI message buffer changes, counter
- p9752 SI message cases, counter
- r9747[0...63] SI message code
- r9748[0...63] SI message time received in milliseconds
- r9749[0...63] SI message value
- r9753[0...63] SI message value for float values
- r9754[0...63] SI message time received in days
- r9755[0...63] SI message time removed in milliseconds
- r9756[0...63] SI message time removed in days
5.9 Safe actual value acquisition

Supported encoder systems

Safety functions used to monitor movements (e.g. SS2, SOS, SLS and SSM) require safe actual value acquisition.

For safe speed/position sensing...
- Single-encoder systems or
- Two-encoder systems

...can be used.

Single-encoder system

In a single-encoder system, only the motor encoder for the safe actual values of the drive is used. This motor encoder must be appropriately qualified (see encoder types). The safety-relevant actual values are generated either directly in the encoder or in the Sensor Module and are transferred to the Control Unit by way of failsafe communication via DRIVE-CLiQ.

For motors without a DRIVE-CLiQ interface, the connection is established by means of additional Sensor Modules (SMC or SME).

Special feature in the case of linear motors:
The motor encoder (linear scale) of linear motors also acts as load measuring system. Only one measuring system is required for this reason. The system is connected by means of a Sensor Module or directly via DRIVE-CLiQ.

NOTICE

When specifying the standstill tolerance window, observe that failsafe position monitoring within a single-encoder system only works at a rough resolution with 4 pulses per revolution.

![Diagram](image)

Figure 5-8 Example: Single-encoder system with SINAMICS S110 in a linear application
Two-encoder system

The failsafe actual values for a drive are provided by two separate encoders. The actual values are transferred to the Control Unit by means of failsafe communication via DRIVE-CLiQ.

For motors without a DRIVE-CLiQ interface, the connection is established by means of additional Sensor Modules (SMC or SME).

Each measuring system requires a separate connection or a separate Sensor Module.

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**Figure 5-9** Example of a two-encoder system on a linear axis via ball bearing spindle

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**Figure 5-10** Example of a two-encoder system on a rotary axis
Encoder types

Incremental encoders or absolute encoders can be used for safe detection of the position values on a drive.

Safe actual value acquisition relies on redundant evaluation of the incremental channels A/B that supply sin/cos signals of 1 Vpp.

The absolute position values can be transferred via the serial EnDat interface or an SSI interface to the controller.

Encoder types for single-encoder system

In single-encoder systems, encoders with photoelectric sampling only are permitted for safe actual value acquisition. These optical encoders must supply sin/cos signals of 1 Vpp on the incremental channels A/B.

Note

Basic absolute encoders (e.g. ECI, EQI) that offer an EnDat interface with additional sin/cos tracks, but operate according to an inductive measuring principle internally, are not permitted for single-encoder systems.

Encoder types for two-encoder system

With a two-encoder system, the required redundancy can also be achieved using less highly qualified encoders. In this case, therefore, encoders with a microprocessor in the signal path can also be used. Each encoder output signal must also supply sin/cos signals of 1 Vpp on the incremental channels A/B.

In addition to the permissible motors with a DRIVE-CLiQ connection, encoders that can be connected to the following sensor modules can be used for safe actual value sensing:

- SMC20
- SME20/SME25
- SME120/SME125

Note

Motors with a DRIVE-CLiQ connection and resolver encoder are also permitted in a two-encoder system not designed for Safety Integrated.
Actual value synchronization

The mean value of the actual values of both encoders is calculated cyclically after actual value synchronization (p9301.3 = p9501.3 = 1) was activated. The maximum slip defined in p9349/p9549 is monitored within the crosswise comparison clock cycle (r9724). If "actual value synchronization" is not enabled, the value parameterized in p9342/p9542 is used as tolerance value for the crosswise comparison.

Two new read parameters are available for safe motion monitoring:

r9730: SI Motion maximum velocity
Displays the maximum velocity (load side) permissible due to the acquisition of actual values for safe motion monitoring functions. The maximum velocity for actual value acquisition depends on the actual value update clock cycle (p9311/p9511). Parameter p9311/p9511 can be used to set the clock cycle of actual value acquisition for safe motion monitoring.

A slower clock cycle reduces the maximum permissible velocity, but also reduces the load on the Control Unit for safe actual value acquisition.

The maximum permissible velocity which, if overshot, can trigger faults in safe actual value acquisition, is displayed in parameter r9730.

With a default value of p9311/p9511 (0 ms), the isochronous PROFIBUS clock cycle is used (or 1 ms in non-isochronous mode).
### NOTICE

**Changing the EDS with safe motion monitoring**

The encoders that are used for the safety function must not be changed when switching data records. The safety function checks the safety-relevant encoder data for changes when data records are switched. If a change is detected, the error F=1670 is displayed with a fault value of 10, which leads to a non-acknowledgeable STOP A.

The safety-relevant encoder data in the various data records must therefore be identical.

---

**r9731: SI Motion safe position accuracy**

Displays the greatest position accuracy (load side) that can be ensured due to the acquisition of the actual value for the safe motion monitoring functions.

Both parameters (r9730/r9731) depend on the relevant encoder type.

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

- p9301.3 SI motion enable safety functions (Motor Module), enable actual value synchronization
- p9501.3 SI motion enable safety functions (Control Unit), enable actual value synchronization
- p9302 SI motion axis type (Motor Module)
- p9502 SI motion axis type (Control Unit)
- p9311 SI Motion clock cycle actual value sensing (Motor Module)
- p9511 SI Motion clock cycle actual value sensing (Control Unit)
- p9515 SI Motion encoder coarse position value configuration
- p9516 SI Motion motor encoder config., safety-relevant functions (CU)
- p9317 SI motion linear scale, grid division (Motor Module)
- p9517 SI motion linear scale, grid division (Control Unit)
- p9318 SI motion encoder pulses per revolution (Motor Module)
- p9518 SI motion encoder pulses per revolution (Control Unit)
- p9319 SI Motion fine resolution Gn_XIST1 (Motor Module)
- p9519 SI motion fine resolution G1_XIST1 (Control Unit)
- p9320 SI Motion spindle pitch (Motor Module)
- p9520 SI motion spindle pitch (Control Unit)
- p9321[0...7] SI motion gearbox encoder/load denominator (Motor Module)
- p9521[0...7] SI motion gearbox encoder/load denominator (Control Unit)
- p9322[0...7] SI motion gearbox encoder/load numerator (Motor Module)
- p9522[0...7] SI motion gearbox encoder/load numerator (Control Unit)
Extended Functions

5.9 Safe actual value acquisition

- p9323 SI Motion valid bits red. coarse position value (Motor Module)
- p9324 SI Motion fine res. redund. coarse position value (Motor Module)
- p9325 SI Motion relev. bits redund. coarse pos. value (Motor Module)
- p9523 SI Motion valid bits redund. coarse pos. value (Control Unit)
- p9524 SI Motion fine resolution redund. coarse pos.val. (Control Unit)
- p9525 SI Motion relevant bits redund. coarse pos. val. (Control Unit)
- p9326 SI motion encoder assignment (Motor Module)
- p9526 SI motion encoder assignment second channel
- p9342 SI motion actual value comparison tolerance (crosswise) (Motor Module)
- p9542 SI motion actual value comparison tolerance (crosswise) (Control Unit)
- p9349 SI motion slip velocity tolerance (Motor Module)
- p9549 SI motion slip velocity tolerance (Control Unit)
- r9713[0...2] SI Motion diagnostics position action value load side
- r9724 SI motion crosswise comparison clock cycle
- r9730 SI Motion maximum velocity
- r9731 SI Motion safe position accuracy
5.10 Forced dormant error detection

Forced dormant error detection and function test through test stop

To fulfill the requirements of EN 954-1/ ISO 13849-1 and IEC61508 with respect to timely fault detection, the functions and shutdown signal paths must be tested at least once within a defined period to ensure that they function properly.

The maximum permissible interval for forced dormant error detection with the basic and extended functions is 9000 hours or once a year.

This functionality must be implemented by means of test stop triggering either in cyclic manual mode or by the automated process.

The test stop cycle is monitored. On expiration of the programmed timer, the alarm A01697: "SI motion: Test of motion monitoring required" is generated and a status bit is set which can be transferred to an output or to a PZD bit via BICO. This alarm does not affect machine operation.

The test stop must be initiated application-specific and be executed at a time which suits application requirements. This functionality is implemented by means of a single-channel parameter p9705 which can be wired via BICO either to an input terminal on the drive unit (CU), or to an IO-PZD in the drive telegram.

- p9559 SI Motion Forced dormant error detection timer (Control Unit)
- p9705 BI: SI Motion Test stop signal source
- r9723.0 CO/BO: SI Motion integrated drive diagnostics signals

A test stop does not require POWER ON. The acknowledgment is set by canceling the test stop request.

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, only an alarm is 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.

Examples of when to carry out forced dormant error detection:

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

Note

STO is triggered when a test stop is carried out for the safety functions. The axis must not be in operation.

STO must not be active before the test stop is selected.

When Blocksize Power Modules are used, the test stop must be triggered under controlled standstill conditions (speed setpoint setting 0) (OFF2 must not be active).
Forced dormant error detection F-DI/F-DO of TM54F through test stop

An automatic test stop function is available for forced dormant error detection within the F-DI/DO test.

To ensure that the test stop function of the TM54F can be used, the F-DIs that are used must be interconnected in accordance with the following wiring example. The digital inputs of F-DI0 to F-DI4 must be connected to the "L1+" power supply. The digital inputs of F-DI5 to F-DI9 must be connected to the "L2+" power supply.
5.10 Forced dormant error detection

The F-DIs must be registered for the test stop by means p10041.
CAUTION
The F-DI states are frozen for the duration of the test (approx. 100 ms).

In order to be able to use the test stop function, interconnect the F-DO used in accordance with the example of the wiring in the SINAMICS S120 GH1 Manual and wire the forced feedback signals of the two relays to the corresponding digital input (DI 20 to DI 23).

The corresponding DIs must be registered for the test stop by means of p10046.

NOTICE
F-DOs which are not registered for evaluation by means of p10046 are set to "0" for the duration of the test stop ("failsafe values").
Maximum test stop period: 19 * p10000 + 2 * 20 ms + 6 * p10001

WARNING
If the connected devices do not support the test stop function for specific F-DIs or F-DOs, the relevant F-DI/F-DO must be operated dynamically, e.g. by means of switch operation, or through specific machine functions.

The test stop must be executed at a suitable time. That is, it must be initiated application-specific. This functionality is implemented by means of a parameter p10007 which can be wired via BICO either to an input terminal on the drive unit (CU), or to an IO-PZD in the drive telegram.

The test stop cycle is monitored. On expiration of the programmed timer, the alarm A35014: "TM54F: Test stop required" is output.
- p10001 SI waiting time for test stop at F-DO 0 ... 3
- p10003 SI forced checking procedure timer
- p10007 BI: SI input terminal forced checking procedure F-DO 0 ... 3
- p10041 SI F-DI test enable
- p10046 SI test sensor feedback input DI 20 ... 23

A test stop does not require POWER ON. The acknowledgment is set by canceling the test stop request.
Control of the safety functions

6.1 Overview of F-DI/F-DOs and of their structure

Description
The safety-oriented input and output terminals (F-DI and F-DO) act as an interface between the internal Safety Integrated functionality and the process.

A dual-channel signal applied to an F-DI (Failsafe Digital Input, safety-oriented digital input = safe input terminal pair) controls the active monitoring of the activation/deactivation of safety functions. This function also depends on the status of sensors (e.g. switches).

An F-DO (Failsafe Digital Output, safety-oriented digital output = safe output terminal pair) delivers a dual-channel signal representing feedback from the safety functions. It is suitable, for example, for the safety-oriented control of actuators (e.g. line contactor). See also the figures "F-DI 0 ... 4 overview", "F-DI 5 ... 9 overview" and "F-DO overview (without showing the main contacts on the contactors)".

Dual-channel processing of I/O signals
A dual-channel structure is implemented for data input/output and for processing safety-oriented I/O signals. All requests and feedback signals for safety-oriented functions should be entered or tapped using both channels.

The following options are available for controlling Safety Integrated functions:
- Control by way of terminals on the Control Unit and Motor Module (only STO, SS1(time controlled) and SBC).
- Control by way of TM54F terminals
- Control by way of PROFIsafe

Only one of the two control modes can be selected for each drive object, that is, either TM54F or PROFIsafe. Control by way of terminals on the Control Unit and Motor Module can be activated alongside with one of the other two options.

NOTICE
Per single Control Unit, either control via PROFIsafe or TM54F is permitted. Mixed operation is not permitted.
6.2 Control signals by way of terminals on the Control Unit and Motor/Power Module

Features

- Only for the STO, SS1 (time-controlled) and SBC functions
- Dual-channel structure via two digital inputs (Control Unit/power unit)
- Input filter for test signals with a dark period of less than 1 ms
- Different terminal strips depending on design
- Automatic ANDing of up to 8 digital inputs (p9620[0...7]) on the Control Unit with parallel configuration of chassis type power units

Overview of the safety function terminals for SINAMICS S120

The different power unit formats of SINAMICS S120 have different terminal designations for the inputs of the safety functions. These are shown in the following table.

Table 6-1 Inputs for safety functions

<table>
<thead>
<tr>
<th></th>
<th>1. Switch-off signal path (p9620[0])</th>
<th>2. Switch-off signal path</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control Unit CU320</td>
<td>X122.1...4 / X132.1...4 (on the CU320)</td>
<td>(see Motor Modules / Power Modules)</td>
</tr>
<tr>
<td>CU310/D410</td>
<td>X121.1...4 (on the CU310/D410) digital inputs 0 to 3</td>
<td>(see Motor Modules / Power Modules)</td>
</tr>
<tr>
<td>D425/435/445</td>
<td>X122.1...4 / X132.1...4 (on D425/35/45) digital input 0 to 7</td>
<td>(see Motor Modules / Power Modules)</td>
</tr>
<tr>
<td>CX32</td>
<td>X122.0...3 (on CX32) digital input 0 to 3</td>
<td>(see Motor Modules / Power Modules)</td>
</tr>
<tr>
<td>Single Motor Module booksise/booksize compact</td>
<td>(see CU320)</td>
<td>X21.3 and X21.4 (on the Motor Module)</td>
</tr>
<tr>
<td>Single Motor Module chassis</td>
<td>(see CU320)</td>
<td>X41.1 and X41.2 (on the CIB*)</td>
</tr>
<tr>
<td>Double Motor Module booksise/booksize compact</td>
<td>(see CU320)</td>
<td>X21.3 and X21.4 (motor connection X1)/X22.3 and X22.4 (motor connection X2) (on the Motor Module)</td>
</tr>
<tr>
<td>Power Module blocksize with CUA31/CUA32</td>
<td>(see CU320)</td>
<td>X210.3 and X210.4 (on the CUA31/UA32)</td>
</tr>
<tr>
<td>Power Module blocksize with CU310</td>
<td>X121.1...4 (on the CU310) digital input 0 to 3</td>
<td>X120.7 and X120.8 (on the CU310)</td>
</tr>
<tr>
<td>Power Module chassis with CU310</td>
<td>X121.1...4 (on the CU310) digital input 0 to 3</td>
<td>X41.1 and X41.2 (on the CIB*)</td>
</tr>
</tbody>
</table>

*CIB: Communication Interface Board
For further information about terminals, see the Equipment Manuals.
**Terminals for STO, SS1 (time-controlled), SBC**

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

- **1. Switch-off signal path (CU310/CU320)**
  
  The desired input terminal is selected via BICO interconnection (BI: p9620[0]).

**Note**

When firmware version 2.4 is converted to 2.5 for projects with parallel-connected power units and enabled safety function STO, the following occurs:

Parameters p9620[1] and p9620[2] are assigned the value "0" as only parameter p9620[0] exists in version 2.4. Parameter p9620[0] contains the signal source for power unit 1 and p9620[1] the signal source for power unit 2. This means that the STO function for power unit 2 cannot be switched.

- **2. Switch-off signal path (Motor Module/Power Module with CUA3x or CU310)**
  
  The input terminal is the “EP” (“Enable Pulses”) terminal.

  Both terminals must be operated simultaneously, otherwise a fault will be issued.
Grouping drives (not for CU310)

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 (CU320)**
  By connecting the binector input to the joint input terminal on the drives in one group.

- **2. Switch-off signal path (Motor Module/Power Module with CUA3x)**
  By appropriately wiring the terminals for the individual Motor Modules/Power Modules with CUA31/UA32 assigned to the 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 during the test for the switch-off signal paths. The operator selects "Safe Torque Off" for each group. The check is drive-specific.

**Example: Terminal groups**

It must be possible to select/deselect "Safe Torque Off" 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.
6.2 Control signals by way of terminals on the Control Unit and Motor/Power Module

Information on the parallel connection of chassis type Motor Modules

When chassis type Motor Modules are connected in parallel, a safe AND element is created on the parallel drive object. The number of indexes in p9620 corresponds to the number of parallel chassis components in p0120.

Simultaneity and tolerance time of the two monitoring channels

The "Safe Torque Off" function must be selected/deselected simultaneously in both monitoring channels using the input terminals and is only effective for the associated drive.

1 signal: Deselecting the function
0 signal: Selecting the function

"Simultaneously" means:

The changeover must be complete 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)

If the "Safe Torque Off" function is not selected/deselected within the tolerance time, this is detected by the cross-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" on one channel.
6.3 Activating the Safety Integrated extended functions via terminals on the TM54F

6.3.1 General information

Description
Terminal Module TM54F is a terminal expansion module for snap-on rail mounting to DIN EN 60715. The TM54F features failsafe digital I/O for controlling the Safety extended functions. Each Control Unit can be assigned only one TM54F which is connected via DRIVE-CLiQ.

NOTICE
The TM54F may not be interconnected in series with the Motor Modules and must be operated on a separate DRIVE-CLiQ segment (separate port on the Control Unit). Other Terminal and Sensor Modules can be connected to this DRIVE-CLiQ line.

TM54F features the following terminals:

Table 6-2 Overview of the TM54F interfaces

<table>
<thead>
<tr>
<th>Type</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Failsafe digital outputs (F-DO)</td>
<td>4</td>
</tr>
<tr>
<td>Failsafe digital inputs (F-DI)</td>
<td>10</td>
</tr>
<tr>
<td>Sensor 1) power supplies, dynamic response supported 2)</td>
<td>2</td>
</tr>
<tr>
<td>Sensor 1) power supply, no dynamic response</td>
<td>1</td>
</tr>
<tr>
<td>Digital inputs for checking the F-DO with activated forced dormant error detection</td>
<td>4</td>
</tr>
</tbody>
</table>

1) Sensors: Fail-safe devices for command operations and status logging (e.g. EMERGENCY STOP pushbuttons, safety door locks, position switches, and light arrays/light curtains).
2) Dynamic response: The sensor power supply is cycled on and off when forced dormant error detection is active for the sensors, cable routing and the evaluation electronics of TM54F.

The TM54F provides 4 failsafe digital outputs and 10 failsafe digital inputs. A failsafe digital output consists of a 24 V DC/M switching output plus a digital input for reading back the switching state. A failsafe digital input consists of two digital inputs.

Note
You have the following options of acknowledging TM54F faults after troubleshooting:

- POWER ON
- Falling edge in signal "Internal Event ACK" with subsequent alarm acknowledgement on the Control Unit.
As of firmware version 2.6, if there are different signal states within one fail-safe FDI (see next section) on the TM54F, the signal states of the two digital inputs of the F-DI will be frozen at logic 0 (safety function selected) until a safe acknowledgement has been carried out by means of an F-DI via parameter p10006 (SI acknowledgement internal event input terminal).

The monitoring time (p10002) for the discrepancy of the two digital inputs of an F-DI may have to be increased so that previous switching operations executed by safety functions do not require safe acknowledgement.

The signal statuses at the two related digital inputs (F-DI) must, therefore, have the same status within this monitoring time. Otherwise the fault message F35151 TM54F: discrepancy error (which requires safe acknowledgment) will appear.

With firmware versions < 2.6, the relevant F-DI was evaluated as normal once the discrepancy had been rectified. A separate, safe acknowledgement was not required.

### 6.3.2 Overview of the F-DIs

**Description**

Failsafe digital inputs (F-DI) consist of two digital inputs. The cathode of the optocoupler is routed to the second digital input in order to allow the connection of an M-switching F-DO output (the anode must be wired to 24 V DC).

Parameter p10040 is used to determine whether an F-DI is operated as NC/NC or NC/NO contact. The status of DI can be read at parameter r10051 for the drive objects TM54F_MA and TM54F_SL. The same bits of both drive objects are logically linked by AND operation and return the status of the relevant F-DI.

**Explanation of terms:**

- **NC contact / NC contact:** to select the safety function, a "zero level" must be present on both inputs.

- **NC contact / NO contact:** to select the safety function, a "zero level" at input 1 and a "1 level" at input 2 must be present.
The signal states at the two associated digital inputs (F-DI) must assume the same status configured in p10040 within the monitoring time set in p10002.

In order to enable forced dormant error detection, connect the digital inputs of F-DI 0 ... 4 with the dynamic voltage supply L1+ and the digital inputs with F-DI 5 ... 9 to L2+ (for additional information on forced dormant error detection, see the corresponding function description in the chapter "Extended Functions").
Control of the safety functions

6.3 Activating the Safety Integrated extended functions via terminals on the TM54F

F-DI features

- Failsafe configuration with two digital inputs per F-DI
- Input filter for test signals with a dark period of less than 1 ms
- Configurable connection of NC/NC or NC/NO contacts by means of parameter p10040
- Status parameter r10051

Figure 6-4 Overview of F-DI 5 ... 9
6.3 Activating the Safety Integrated extended functions via terminals on the TM54F

- Adjustable time window for monitoring discrepancy at both digital inputs by means of parameter p10002 for all F-DIs
- 2. Digital input with additional tap of the optocoupler cathode for connecting an M-switching output of a failsafe controller.

<table>
<thead>
<tr>
<th>WARNING</th>
</tr>
</thead>
<tbody>
<tr>
<td>In contrast to mechanical switching contacts (e.g. EMERGENCY STOP switches), leakage currents can still flow on semiconductor switches such as those usually used at digital outputs even when they have been switched off. This can lead to false switching states if digital inputs are not connected correctly. The conditions for digital inputs/outputs specified in the relevant manufacturer documentation must be observed.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>WARNING</th>
</tr>
</thead>
<tbody>
<tr>
<td>In accordance with IEC 61131 Part 2, Chapter 5.2 (2008), only outputs that have a maximum residual current of 0.5 mA when &quot;OFF&quot; can be used to connect TM54F digital inputs with digital semiconductor outputs.</td>
</tr>
</tbody>
</table>

The inclusion of additional load resistors makes it possible to use digital outputs with larger residual currents to connect TM54F inputs.

Overview of important parameters (see the SINAMICS S120/S150 List Manual)
- p10002 SI discrepancy monitoring time
- p10040 SI F-DI input mode
- r10051.0...9 CO/BO: SI status of digital inputs

6.3.3 Overview of the F-DOs

Description
Failsafe digital outputs (F-DO) consist of two digital outputs plus one digital input that checks the switching state for forced dormant error detection. The first digital input switches 24 V DC, and the second switches M of the X514 voltage supply.

The status of each F-DO can be read at parameter r10052. The status of the associated DI can be read at parameter r10053 for the drive objects of the slave (TM54F_SL).

In order to enable forced dormant error detection, connect the corresponding digital input for the forced feedback signals of the relays (for additional information on forced dormant error detection, see the corresponding function description in the "Extended Functions" chapter).
F-DO signal sources

A drive group contains several drives with similar characteristics. The groups are parameterized at the p10010 and p10011 parameters.

The following signals are available for interconnecting (p10042 to p10045) each one of the four drive groups with the F-DO:

- Power removed (STO active)
- SS1 active
- SS2 active
- SOS active
- SLS active
- SSM feedback active
- SOS selected
- Internal event (no active safety fault)
- Safe state

The following signals can be requested by means of p10039[0...3] for each drive group (index 0 corresponds with drive group 1 etc.):

- Power removed (STO active)
- SS1 active
- SS2 active
- SOS active
- SLS active
Control of the safety functions

6.3 Activating the Safety Integrated extended functions via terminals on the TM54F

The same signals (high-active) of each drive or drive group are logically linked by means of AND operation. The different signals selected through p10039 are logically linked by means of OR operation. Result of these logic operations is the "Safe State" for each drive group.

Each F-DO supports the interconnection of up to 6 signals by way of indexing (p10042[0...5] to p10045[0...5]) and their output as logical AND operation.

F-DO features

- Each F-DO with failsafe configuration consisting of two digital outputs plus one digital input for reading back the switching state for forced dormant error detection
- Status parameters r10052/r10053

Function diagrams (see SINAMICS S120/S150 List Manual)

- 2853 TM54F (F-DO 0 ... F-DO 3, DI 20 ... DI 23)
- 2856 TM54F Safe State selection
- 2857 TM54F assignment (F-DO 0 ... F-DO 3)

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

- p10042[0..5] SI F-DO 0 signal sources
- ...
- p10045[0..5] SI F-DO 3 signal sources
- r10052.0...3 CO/BO: SI status of digital outputs
- r10053.0...3 CO/BO: SI status of digital inputs 20 ... 23 (only at slave object, TM54F_SL)
6.4 Activation via PROFIsafe

Introduction

Safety functions can also be activated via PROFIsafe telegrams in addition to terminals. Communication by PROFIsafe telegram 30 is possible with both PROFIBUS and PROFINET. This section describes the structure of the associated control and status words (see table "Description of the PROFIsafe control word" and "Description of the PROFIsafe status word").

Each drive with a PROFIsafe configuration in the drive unit represents one PROFIsafe slave (F slave) with failsafe communication to the F host via PROFIBUS (see also "PROFIsafe via PROFIBUS when SIMOTION D is used").

With SINAMICS, communication is also possible from PROFIsafe via the PROFINET interface (CBE20 or CU310PN) as of firmware version 2.6. A PROFIsafe safety channel is set up in HW Config in the SIMOTION SCOUT tool. This channel runs via the interface IF1 only. The use of both interface IF1 and IF2 is not supported when PROFIsafe is used via PROFINET.

The drive unit is equipped with dual-channel PROFIsafe communication functions, that is, with one channel in the Control Unit and one in the Motor Module.

Failsafe values are activated following the detection of a PROFIsafe communication error. This results in an immediate STO.

All parameters used to control PROFIsafe communication are protected against unintentional changes by password and checksum. The telegrams are configured using the configuration tool (e.g. HW Config + F-Configuration Pack) on the failsafe host.

A separate PROFIsafe telegram is created for each drive (PROFIsafe slot). To use PROFIsafe via PROFINET, firmware version 2.6 must be installed on the SINAMICS DOs. HW Config can then be used to configure PROFIsafe via PROFINET for the DOs (see also "PROFIsafe via PROFINET").

Control via PROFIsafe is enabled by setting p9601.3 = p9801.3 = 1.

It is not possible to enable parallel control via TM54F. Control of the basic functions via the Control Unit and Motor Module (p9601.0/p9801.0) terminals may be enabled in parallel. In this way, the STO, SBC, and SS1 functions (time controlled) can be selected via PROFIsafe as well as via the on-board terminals on the Control Unit and Motor Module.
PROFIsafe STW (S_STW1, PZD1 in telegram 30, output signals)

See function diagram [2840].

Table 6-3 Description of the PROFIsafe control word

<table>
<thead>
<tr>
<th>Bit</th>
<th>Meaning</th>
<th>Remarks</th>
<th>BICO</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>STO</td>
<td>1</td>
<td>STO deactivation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0</td>
<td>STO activation</td>
</tr>
<tr>
<td>1</td>
<td>SS1</td>
<td>1</td>
<td>SS1 deactivation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0</td>
<td>SS1 activation</td>
</tr>
<tr>
<td>2</td>
<td>SS2</td>
<td>1</td>
<td>SS2 deactivation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0</td>
<td>SS2 activation</td>
</tr>
<tr>
<td>3</td>
<td>SOS</td>
<td>1</td>
<td>SOS deactivation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0</td>
<td>SOS activation</td>
</tr>
<tr>
<td>4</td>
<td>SLS</td>
<td>1</td>
<td>SLS deactivation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0</td>
<td>SLS activation</td>
</tr>
<tr>
<td>5</td>
<td>Reserved</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>6</td>
<td>Reserved</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>7</td>
<td>Internal Event ACK</td>
<td>1/0</td>
<td>Acknowledgment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0</td>
<td>No acknowledgment*</td>
</tr>
<tr>
<td>8</td>
<td>Reserved</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>9</td>
<td>Select SLS bit 0</td>
<td>-</td>
<td>Selection of the speed limit for SLS</td>
</tr>
<tr>
<td></td>
<td>Select SLS bit 1</td>
<td>-</td>
<td>(2 bits)</td>
</tr>
<tr>
<td>11...15</td>
<td>Reserved</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

*A static zero signal must be present continuously*
Control of the safety functions
6.4 Activation via PROFIsafe

PROFIsafe ZSW (S_ZSW1, PZD1 in telegram 30, input signals)
See function diagram [2840].

Table 6-4 Description of the PROFIsafe status word

<table>
<thead>
<tr>
<th>Bit</th>
<th>Meaning</th>
<th>Remarks</th>
<th>BICO</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>STO active</td>
<td>1 STO active</td>
<td>r9722.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0 STO deactivated</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>SS1 active</td>
<td>1 SS1 active</td>
<td>r9722.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0 SS1 deactivated</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>SS2 active</td>
<td>1 SS2 active</td>
<td>r9722.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0 SS2 deactivated</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>SOS active</td>
<td>1 SOS active</td>
<td>r9722.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0 SOS deactivated</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>SLS active</td>
<td>1 SLS active</td>
<td>r9722.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0 SLS deactivated</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Reserved</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>6</td>
<td>Reserved</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>7</td>
<td>Internal Event</td>
<td>1 Internal event</td>
<td>r9722.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0 No internal event</td>
<td>inverted</td>
</tr>
<tr>
<td>8</td>
<td>Reserved</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>9</td>
<td>Active SLS level bit 0</td>
<td>- Display of the velocity</td>
<td>r9722.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>limit for SLS</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(2 bits)</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Active SLS level bit 1</td>
<td>-</td>
<td>r9722.10</td>
</tr>
<tr>
<td>11</td>
<td>SOS selected</td>
<td>1 SOS selected</td>
<td>r9722.11</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0 SOS deactivated</td>
<td></td>
</tr>
<tr>
<td>12..14</td>
<td>Reserved</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>15</td>
<td>SSM (speed)</td>
<td>1 SSM (speed below limit</td>
<td>r9722.15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>value)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0 SSM (speed higher than/equal</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>to limit)</td>
<td></td>
</tr>
</tbody>
</table>
Control of the safety functions

6.4 Activation via PROFIsafe
7.1 Safety Integrated firmware versions

Firmware versions for Safety Integrated

The safety firmware installed on the Control Unit and the safety firmware installed on the Motor Module each have separate version IDs. The parameters listed below can be used to read the version IDs from the relevant hardware.

Read the overall firmware version via:

- r0018 Control Unit firmware version

The following firmware data can be read for the basic functions:

- r9770[0...2] SI version, safety functions that run independently in the drive (Control Unit)
- r9870[0...2] SI version safety functions integrated in drive (Motor Module)

The following firmware data can be read for the extended functions:

- r9590[0...2] SI Motion version safety motion monitoring (Control Unit)
- r9390[0...2] SI Motion version safety motion monitoring (Motor Module)
- r9890[0...2] SI version (Sensor Module)
- r10090[0...2] SI TM54F version

⚠️ WARNING

Applicable to firmware version 2.5 SP1 and firmware version 2.6:

In a system configuration, the firmware versions of the DRIVE-CLIQ components can only differ from the versions installed on the memory card if

a) the automatic upgrade/downgrade (parameter p7826) is deactivated or
b) components with a more recent firmware version can no longer be downgraded to the version installed on the CF card.

Scenario a) is not permitted when Safety Integrated is used. When Safety Integrated is used, the automatic upgrade/downgrade function must not be deactivated. Parameter p7826 (automatic firmware update) must be set to 1.

Scenario b) is only permissible if this combination has been explicitly approved by the manufacturer.
Firmware versions up to 2.5 SP1 for basic functions

With regard to the use of basic functions, Control Units, Booksize Motor Modules (first generation), and Blocksize Power Modules with firmware versions 2.2, 2.3, 2.4, 2.4 SP1, and 2.5, as well as Booksize Motor Modules (second generation) with V2.5 SP1, can be combined without the need to adjust the firmware versions.

The following applies as of complete versions SINAMICS 2.5 SP1 and SIMOTION 4.1 SP1:

The firmware versions on the Motor Modules must be changed in accordance with the firmware version installed on the Control Unit. This is performed automatically during startup if parameter p7826 (automatic firmware update) is set to 1 (default setting). When the basic functions are used, parameter p7826 (automatic firmware update) must be set to 1. This setting must not be changed.

During the acceptance test for the Safety Integrated basic functions, the safety firmware versions of the Motor Modules must be read, logged, and checked against the list below.

The list of permissible safety firmware version combinations, which must be used as a reference during the test, can be found under "Product Support" at the following address: http://support.automation.siemens.com/WW/view/de/28554461

The testing procedure is described at the end of the section.

Firmware versions up to 2.5 SP1 for extended functions

To use the Safety Integrated extended functions, the DRIVE-CLiQ components required for the safety functions must have a firmware version that is compatible with the Control Unit version. To ensure this, parameter p7826 (automatic firmware update) must be set 1 (default setting). During power up, the automatic firmware update checks whether all the connected DRIVE-CLiQ components have a firmware version that is compatible with the Control Unit version. If this is not the case, the correct firmware version is downloaded from the memory card to the relevant component.

When the extended functions are used, parameter p7826 (automatic firmware update) must be set to 1. This setting must not be changed.

During the acceptance test for the Safety Integrated extended functions, the safety firmware versions of the Motor Modules, Sensor Modules and, if necessary, the Terminal Module TM54F required for the safety functions are read, logged, and checked against the list below.

When the extended functions are used, the firmware requirements for the basic functions must also be fulfilled at all times.

The list of permissible safety firmware version combinations, which must be used as a reference during the test, can be found under "Product Support" at the following address: http://support.automation.siemens.com/WW/view/de/28554461

The testing procedure is described at the end of the section.
Firmware versions as of 2.6 for basic functions and extended functions

As of firmware version 2.6, basic and/or extended functions that have been enabled are checked to determine whether the parameter for the automatic firmware update (p7826) is set to 1. This ensures that, on every power up, the firmware version of the relevant DRIVE-CLiQ components will be checked against that of the Control Unit and updated if necessary. The manual check for p7826 = 1 no longer needs to be carried out by the user.

During the acceptance test for the Safety Integrated basic functions, the safety firmware versions of the Motor Modules must be read, logged, and checked against the list below. During the acceptance test for the Safety Integrated extended functions, the safety firmware versions of the Motor Modules, Sensor Modules and, if necessary, the Terminal Module TM54F required for the safety functions are read, logged, and checked against the list below.

When the extended functions are used, the firmware requirements for the basic functions must also be fulfilled at all times.

The list of permissible safety firmware version combinations, which must be used as a reference during the test, can be found under "Product Support" at the following address: http://support.automation.siemens.com/WW/view/de/28554461

The testing procedure is described at the end of the section.

Procedure for checking the safety firmware version combinations

The document in the link provided contains tables listing the permissible safety firmware version combinations for the different safety function classes (SINAMICS basic functions, SINAMICS extended functions, SINUMERIK Safety Integrated). The safety firmware version relevant for the safety function can be read from the Control Unit. The row containing this version number specifies the associated, permissible safety firmware versions of the relevant drive components. These versions must be compatible with the versions installed on your system.
7.2 General commissioning information

7.2.1 Introduction

The safety functions are commissioned using the screen forms in the STARTER. These functions are available for each drive at "Functions" -> "Safety Integrated".

The password "0" is set by default.

<table>
<thead>
<tr>
<th>NOTICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>For safety reasons, safety functions cannot be commissioned offline with the STARTER commissioning tool (or SCOUT).</td>
</tr>
</tbody>
</table>

Prerequisites for commissioning the safety functions (basic functions)

1. Commissioning of the drives must be complete.
2. Non-safe pulse disable must be present (e.g. via OFF1 = "0" or OFF2 = "0")
   
   If the motor holding brake is connected and parameterized, the holding brake is applied.
3. The terminals for "Safe Torque Off" must be wired.
4. For operation with SBC, the following applies:
   A motor with motor holding brake must be connected to the appropriate terminal of the Motor Module.

Standard commissioning of the safety functions

1. A commissioned project that has been uploaded to STARTER can be transferred to another drive unit including the existing safety parameterization.
2. If the source and target devices have different software versions, the reference checksums (p9799, p9899) may have to be adapted. 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: 2004).

Information pertaining to operation with isochronous PROFIBUS

<table>
<thead>
<tr>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parameter p9510 is no longer evaluated as of firmware version 2.6 and as such no longer has to be set to a specific value.</td>
</tr>
</tbody>
</table>
7.2.2 Setting the sampling times

Terminology

The software functions installed in the system are executed cyclically at different sampling times (p0115, p0799 and p4099).

Safety functions are executed within the monitoring clock cycle (p9300/p9500) and TM54F is executed within the sampling time (p10000).

Communication on PROFIBUS is handled cyclically by means of the communication clock cycle.

During the PROFlsafe scan cycle, the PROFlsafe telegrams issued by the master are evaluated.

Rules for setting the sampling times

- The monitoring clock cycle (p9300/p9500) can be set between 500 μs to 25 ms.

  Note
  The monitoring clock cycle must be the same on all drives.

However, the calculation time required for the Extended Functions in the Control Unit depends on the monitoring clock cycle, that is, shorter clock cycles extend the calculation time. The availability of a specific monitoring clock cycle therefore depends on calculation time resources of the Control Unit.

Calculation time resources on the Control Unit are influenced primarily by the number of drives, the number of drives with enabled extended functions, the connected DRIVE-CLiQ components, the selected DRIVE-CLiQ topology, the use of CBE20, and by the selected technological functions.

- Isochronous PROFIBUS
  - The monitoring cycle (p9300/p9500) must be an integer multiple of the actual value update clock cycle. p9311/p9511 or when p9311/p9511 = 0, the isochronous PROFIBUS communication clock cycle is used for actual value acquisition.
  - The current controller cycle must be no more than a quarter of the length of the actual value update clock cycle.
  - The sampling time of the current controller (p0115[0]) must be at least 125 μs.
7.2 General commissioning information

- Non-isochronous PROFIBUS
  - The monitoring cycle must be an integer multiple of the actual value update clock cycle. In non.isochronous mode, this is \( p_{9311}/9511 \) or 1 ms (when \( p_{9311}/9511 = 0 \)).
  - The sampling time of the current controller \( (p0115[0]) \) must be at least 125 µs.
- The sampling time of the TM54F must be the same as the monitoring clock cycle \( \left( p_{10000} = p_{9300}/9500 \right) \).

Note
The PROFISafe scan cycle is set permanently for all safety axes of a drive unit (CUxxx incl. CX32) to 2 x monitoring cycle (Motor Module: p9300 / Control Unit: p9500).

Overview of important parameters (see the S120/S150 List Manual)
- \( p_{9300} \) SI motion monitoring clock cycle (Motor Module)
- \( p_{9500} \) SI motion monitoring clock cycle (Control Unit)
- \( p_{9311} \) SI Motion clock cycle actual value sensing (Motor Module)
- \( p_{9511} \) SI Motion clock cycle actual value sensing (Control Unit)
- \( p_{10000} \) SI sampling time (TM54F)
7.3 Commissioning TM54F by means of STARTER/SCOUT

7.3.1 Basic sequence of commissioning

The following conditions must be met before you can configure the TM54F:

- Concluded initial commissioning of all drives

Table 7-1 Configuration sequence

<table>
<thead>
<tr>
<th>Step</th>
<th>Execution</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Insert the TM54F</td>
</tr>
<tr>
<td>2</td>
<td>Configure the TM54F and generate the drive groups</td>
</tr>
<tr>
<td>3</td>
<td>Configure the drive groups</td>
</tr>
<tr>
<td>4</td>
<td>Configure the inputs</td>
</tr>
<tr>
<td>5</td>
<td>Configure the outputs</td>
</tr>
<tr>
<td>6</td>
<td>Copy the parameters to the second drive object (TM54F_SL)</td>
</tr>
<tr>
<td>7</td>
<td>Change the safety password</td>
</tr>
<tr>
<td>8</td>
<td>Activate the configuration by selecting &quot;Activate settings&quot;</td>
</tr>
<tr>
<td>9</td>
<td>Save the project in STARTER</td>
</tr>
<tr>
<td>10</td>
<td>Save the project in the drive by selecting &quot;Copy RAM to ROM&quot;</td>
</tr>
<tr>
<td>11</td>
<td>Execute POWER ON</td>
</tr>
<tr>
<td>12</td>
<td>Acceptance test</td>
</tr>
</tbody>
</table>
7.3 Commissioning TM54F by means of STARTER/SCOUT

7.3.2 Configuration start screen

Description

The following functions can be selected in the start screen:

- **Configuration**
  - Opens the "Configuration" screen
- **Inputs**
  - Opens the "Inputs" screen
- **Outputs**
  - Opens the "Outputs" screen
- **Drive group 1 ... 4**
  - Opens the corresponding screen of drive group 1 to 4
- **Copy parameters**
  - To copy the configuration to the second drive object (TM54F_SL), press "Change settings".
7.3 Commissioning TM54F by means of STARTER/SCOUT

- Change/activate settings
  - Change settings
    You can select this button and enter the TM54F password in order to edit the configuration data. The button function changes to "Activate settings".
  - Activate settings
    This function activates your parameter settings and initiates calculation of the actual CRC and the corresponding transfer to the target CRC.
    The parameters are activated after restart, and you are requested to carry out the acceptance test.
    A message is output requesting you to save the project and then restart the system. It is also required to carry out an acceptance test.

- Change password (p10061 ... p10063)
  In order to change the password, enter the old password (factory setting: 0) and then enter and confirm the new password.

7.3.3 TM54F configuration

Configuration screen of TM54F for Safety Integrated

Figure 7-2 TM54F configuration
Functions of this screen:

- Drive objects assignment (p10010)
  Selection of a drive object to be assigned to a drive group.

- Drive groups (p10011)
  Each configured safety drive can be assigned to a drive group using a drop-down list box.
  The list box displays the drives and their names.

- Safety cycle (p10000)
  The safety clock cycle corresponds to the sampling time of TM54F.
  - Enter the safety clock cycle in this input box

  **Note**
  The safety clock cycle (p10000) of the TM54F must be the same as the monitoring clock cycle set in p9300/p9500.

- Discrepancy time (p10002)
  The signal states at the two terminals of an F-DI are monitored in order to determine whether these have assumed the same logical state within the discrepancy time.

- F-DO dynamization test cycle (p10003)
  Failsafe I/O must be tested at defined intervals in order to validate their failsafe state (test stop, or forced dormant error detection). The TM54F module is provided with a function block which is selected by way of a BICO source to execute this forced dormant error detection (e.g. switch the L1+ and L2+ sensor power supply). Each selection triggers a timer in order to monitor the test cycle. An alarm is set on expiration of the monitored time.

- F-DI selection (p10006)
  The Extended Functions enter a safety alarm in a special alarm buffer upon the detection of internal errors or violation of limits. This alarm must be acknowledged safely. You can assign an F-DI terminal pair for safe acknowledgment.

- Function mode selection (in preparation)
7.3.4 F-DI/F-DO configuration

Inputs screen F-DI

![Inputs screen F-DI](image)

**NC/NO contact (p10040)**

Terminal property F-DI 0-9 (p10040.0 = F-DI 0, ... p10040.9 = F-DI 9). Configure only the property of the second (lower) digital input. Always connect an NC contact to digital input 1 (upper). Digital input 2 can be configured as NO contact.

**Activate test mode (p10041)**

A check mark at an F-DI defines whether the pair of digital inputs is to be integrated in the forced dormant error detection test of the assigned power supply (L1+ or L2+) (for additional information, see chapter "Forced dormant error detection", under Extended Functions).

**LED in F-DI screen**

The LED downstream of the AND element indicates the logical state (inactive: gray, active: green, discrepancy error: red).
Outputs screen F-DO

Signal source for F-DO (p10042 - p10045)
An AND element with 6 inputs is interconnected with each output terminal pair of an F-DO; the signal sources for the AND inputs can be selected:
- No signal source (input set to logical HIGH; default)
- Status signals of the drive of drive group 1 to 4

For additional information on status signals, see chapter "F-DO overview" in the "Control by means of TMS4F terminals".

Test selection F-DO (p10046 [0..3])
The test stop for forced dormant error detection can be activated for each F-DO via a pull-down menu (for more information, see "Forced dormant error detection", under "Extended Functions").

LED in the F-DO screen
The LED downstream of the AND element indicates the logical state (inactive: gray, active: green).
The LED of the digital inputs DI20 to DI23 indicate the status of the digital input (inactive: gray, active: green).
7.3.5 Control interface

Control interface screen

Figure 7-5  Control interface screen TM54F
Functions of this screen:

- Selection of an F-DI for the STO, SS1, SS2, SOS and SLS functions and for SLS speed limits (bit coded) (p10022 to p10028).
  
  A separate screen is available for each drive group. An F-DI can be assigned several functions in several drive groups.

- Configuration of the "Safe State" signal (p10039)
  
  A failsafe output signal "Safe State" is generated for each drive group based on the following status signals:
  
  - STO active
  - SS1 active
  - SS2 active
  - SOS active
  - SLS active

  The status signals with the same function and of different drives of a drive group are logically linked by AND operation. The status signals of the individual functions (STO active, SS1 active, etc.) are ORed.

  The "Safe State" signals can be assigned to an F-DO.
7.4 Commissioning PROFlsafe via PROFIBUS

Example configuration

The next sections deal with a sample configuration of PROFlsafe communication between a SINAMICS S120 drive unit and higher-level SIMATIC F-CPU operating as PROFIBUS master.

The configuration and operation of fail-safe communication (F communication) is based on the following software and hardware requirements:

Necessary software packages:

- STEP 7 V5.4 SP4
- S7 F Configuration Pack V5.5 SP3 or higher
- S7 Distributed Safety Programming V5.4 SP3 or higher
- STARTER V4.1.1 + Drive ES-Basic or SIMOTION SCOUT V4.1.1 HF6

Hardware:

- SIMATIC F-CPU e.g. CPU 317F-2

Topology (network view of the project)

Components participating in F communication via PROFIBUS are basically wired as follows:

![Example of a PROFlsafe topology](image-url)
Configuring PROFIsafe communication

The next sections describe the configuration of PROFIsafe communication between a SIMATIC F-CPU and a drive unit.

Create an F-CPU such as CPU 317F-2 and a SINAMICS S120 in HW Config in accordance with the hardware installed.

1. Create the SINAMICS S120 as a DP slave and the connected F CPU as the associated DP master.

2. In the DP slave properties, the PROFIsafe slots can be inserted by choosing "Insert object" on the "Configuration" tab and configured under "PROFIsafe".

3. The telegram configuration for F communication is displayed in the DP slave properties (SINAMICS S120), "Configuration" tab.

4. Double-click the icon of the SINAMICS drive unit and select the "Details" tab in the "Configuration" tab.

5. Click "PROFIsafe..." and then define the F parameters which are important to F communication.
Setting F parameters:

The top five failsafe parameters in this list are configured by default and cannot be edited. The following range of values is valid for the two remaining parameters:

**F_Dest_Add: 1-65534**

F_Dest_Add determines the PROFIsafe destination address of the drive object. Any value within the range is allowed, however, it must be entered once again in the safety configuration of the drive in the SINAMICS drive unit. The F_Dest_Add value must be set in p9610 (Control Unit) and in p9810 (Motor Module). You can handle these settings quite comfortably using the PROFIsafe STARTER screen (see the picture below). The PROFIsafe target address must be entered in hexadecimal format.
Figure 7-9  PROFIsafe STARTER configuration

F_WD_Time: 10- 65535
A valid current safety telegram must be received from the F-CPU within the monitoring time. The drive will otherwise go into safe state.
Select a monitoring time of sufficient length to let the communication functions tolerate telegram delays, however, make allowances for appropriate short fault reaction times (e.g. to interruption of communications).

For additional information on failsafe parameters, refer to the online help of the "PROFIsafe properties" dialog box ("Help" button).

Compile the F-CPU configuration data in HW Config.
7.5 Commissioning PROFIsafe via PROFINET

Description

With SINAMICS, PROFIsafe communication via the PROFINET interface (CBE20 or CU310PN) is possible as of firmware version 2.6. A PROFIsafe safety channel is set up in HW Config in the SIMOTION SCOUT tool. This channel runs via the interface IF1 only. The use of both interface IF1 and IF2 is not supported when PROFIdrive is used via PROFIsafe. To use PROFIsafe via PROFINET, firmware version 2.6 must be installed on the DOs. HW Config can then be used to configure PROFIsafe telegram 30 (sub-module ID = 30) for the DOs.

Software prerequisites for PROFIsafe on PROFINET:

- STARTER Version 4.1.2/SIMOTION SCOUT Version 4.1.1
- STEP 7 Version 5.4 SP4
- S7 F Configuration Pack Version 5.5 SP4
- S7 Distributed Safety Programming Version 5.4 SP4
- SINAMICS Firmware Version 2.6

Hardware:
The components that are compatible with PROFIsafe are listed in "Supported functions" under "Prerequisites for extended functions".

Configuring PROFIsafe communication

The next section describes how to configure PROFIsafe communication between a drive object of a SINAMICS S120 drive unit and a SIMATIC F-CPU. The SINAMICS drive unit and SIMATIC F-CPU are located in the same PROFINET subnet.

1. In HW Config, create an F-CPU (e.g. CPU 317F-2) in accordance with the hardware installed. Create a PROFINET subnet and configure the F-CPU as an IO controller. Information about configuring an IO Controller for the F-CPU 317 can be found in the reference material: SIMATIC PROFINET IO Getting Started: Collection.

2. Under PROFINET IO in the HW Config module catalog, choose the module that you want to connect to the PROFINET IO subnet as an IO device (e.g. SINAMICS S120 CBE20 version 2.6 PN-V2.2).

3. Drag the module to the line of the PROFINET IO subnet. The IO device is inserted. The Properties - Ethernet Interface SINAMICS-S120-CBE20 window opens. An IP address is defaulted here and the subnet selected. Click OK to apply the setting. For further important configuration steps for the IO device, see the section "Creating an IO device" in the SIMOTION SCOUT Communication System Manual.

4. Save and compile the settings in HW Config, and then download the configuration to the target device.

You have successfully established a PROFINET connection between F-CPU and the IO device SINAMICS S120 drive.
7.5 Commissioning PROFIsafe via PROFINET

In the drive object properties (SINAMICS S120 CBE20 as of version 2.6 PN-V2.2), you can now select the PROFIsafe telegram via PROFINET. On the "Options" tab, "PROFIsafe telegram 30" can be created via a dropdown list. The following screenshot shows the "Options" tab for the DO:

![Figure 7-10 Configuration of the PROFINET connection in HW Config](image)
In the overview for the SINAMICS drive, a PROFIsafe slot that needs to be configured is displayed under "Drive object".

Figure 7-11  Drive object option "PROFIsafe telegram"
1. Select the PROFIsafe slot and call up its properties (right-click).

2. On the "Addresses" tab, you can define the address space of the PROFIsafe addresses for the inputs on the SINAMICS CPU and the outputs on the 317F-CPU. The address spaces for the inputs and outputs each comprise 6 bytes or 3 data words. The start of the address spaces can be defined in accordance with the wiring for the hardware. The start address for inputs and output is the same. The process images are also identical and can be left in the default setting. To confirm your entries, choose "OK".

Figure 7-12 Setting PROFINET addresses
3. On the "PROFIsafe" tab, you can define the F parameters required for F communication. If the "PROFIsafe..." button is grayed out, click "Activate..." to activate it.

![Setting F parameters](image)

**Figure 7-13 Setting F parameters**

Setting F parameters:

The first four failsafe parameters in this list are configured by default and cannot be edited. The following range of values is valid for the two remaining parameters:

**F_Dest_Add: 1-65534**

F_Dest_Add determines the PROFIsafe destination address of the drive object. Any value within the range is allowed, although it must be entered again in the safety configuration of the drive in the SINAMICS drive unit. The F_Dest_Add value must be set in p9610 (CU) and in p9810 (Motor Module).

**Note**

When you close the "PROFIsafe properties" dialog box, the failsafe addresses (F-Dest_Add and F-Source_Add) are checked to ensure that they are unique. This function is only available, however, when the PROFINET link between SINAMICS S120 and SIMATIC F-CPU has already been established.
F_WD_Time: 10-65535
A valid current safety telegram must be received from the F-CPU within the monitoring time. The drive will otherwise switch to the safe state. The monitoring time should be of sufficient length to ensure not only that the communication functions tolerate telegram delays, but also that the fault response is triggered quickly enough if a fault occurs (e.g. interruption of the communication connection).

For additional information on failsafe parameters, refer to the online help of the "PROFIsafe properties" dialog box ("Help" button).

Compile HW Config of the F-CPU.

Note
For information about creating a safety program and accessing PROFIsafe user data (e.g. STW and ZSW) in the safety program, see "SIMATIC, S7 Distributed Safety - Configuring and Programming" Programming and Operating Manual.

Safety configuration (online) in the SINAMICS drive
The process of configuring the SINAMICS drive via PROFINET by means of Safety Integrated screens is identical to that for configuration via PROFIBUS. See the previous section.

Acceptance inspection
Once configuring and commissioning has been successfully completed, an acceptance test of the drive safety functions must be carried out (see Chapter 8).

When carrying out the acceptance test for PROFIsafe communication, note the information provided in the "SIMATIC, S7 Distributed Safety - Configuring and Programming" Programming and Operating Manual.

In the inspection log file for the SIMATIC F-CPU, check the F parameters of the SINAMICS slave (F_WD_TIME in particular). Make sure that the global signature in the footer of all the documents is identical to ensure that the hard copies are consistent. Archive the hard copy alongside the inspection log files of the SIMATIC F-CPU and of the STEP7 project.

Note
If F parameters of the SINAMICS drive are changed in HW Config, the global signature of the safety program in the SIMATIC F-CPU changes. In this way, the global signature can be used to identify whether safety-relevant settings in the F-CPU (F parameters of the SINAMICS slave) have changed. The global signature does not, however, contain any changes to safety-relevant drive parameters set in SCOUT.
7.6 PROFIsafe via PROFIBUS when SIMOTION D is used

The next sections deal with the configuration of PROFIsafe communication via PROFIBUS between the integrated drive unit SINAMICS S120 of a SIMOTION D or CX32 and a higher-level SIMATIC F-CPU.

The configuration and operation of failsafe communication (named F-communication in the following, F = failsafe) is based on the following software and hardware requirements:

Software packages to be installed on the programming device:

- STEP7 Version 5.4 SP4
- S7 F Configuration Pack Version 5.5 SP3
- S7 Distributed Safety Programming Version 5.4 SP3
- SIMOTION SCOUT Version 4.1.1 HF6

Hardware:

- The components which are compatible with PROFIsafe are listed in the chapter "Supported functions", under "Prerequisites for Extended Functions".

---

Note

If using a CX32

As of SCOUT firmware 4.1.1 HF10 and SINAMICS firmware 2.5 SP1 FH10, 5 drives can be configured with a CX32. With earlier firmware versions, a maximum of 4 drives can be configured.
Topography (network view of the project)

The basic topology of the components involved in PROFlsae communication via PROFIBUS is structured as follows (SIMATIC F-CPU and D4x5 integrated with SINAMICS S120 or CX32):

The drive unit (SINAMICS) and the SIMATIC F-CPU are located on different PROFIBUS subnets. This structure requires configuration of a PROFlsae network transition to SIMOTION D.
Configuring PROFIsafe communication

The next sections describe the configuration of PROFIsafe communication between a SIMATIC F-CPU and a drive object of an integrated SINAMICS drive unit of a SIMOTION D. The procedure for configuring PROFIsafe communication between a SIMATIC F-CPU and a drive unit of an CX 32 is basically the same and is not covered separately.

1. Create an F-CPU (e.g. CPU 317F-2) and a SIMOTION D4x5 controller (with integrated SINAMICS S120) in accordance with the hardware installed.
2. Define a SIMOTION CPU for operation as DP slave and the F-CPU as associated DP master.
3. Configure the SINAMICS drive unit in SIMOTION SCOUT/STARTER in accordance with your hardware configuration.
4. Create a PROFIsafe slot in the "Configuration" dialog box of the SINAMICS drive unit. Select the PROFIBUS telegram tab, select the drive object which is to communicate with the SIMATIC F-CPU via PROFIsafe, click "Insert line" and then select "PROFIsafe".

![Figure 7-15 Inserting a PROFIsafe slot](image-url)
7.6 PROFINET via PROFIBUS when SIMOTION D is used

5. Transfer the new PROFINET slot to HW Config by clicking the "Transfer to HW Config" button.

6. In HW Config for the F-CPU, connect the configured SIMOTION station to a PROFIBUS segment of the F-CPU.

**Note**

To configure the SINAMICS Safety Integrated extended functions by means of SIMOTION, the telegrams must be extended. To do so, a safety data block is appended to the PROFIdrive actual value telegram. The process of configuring and parameterizing this safety data block is described in "Support of SINAMICS Safety Integrated Extended Functions on the Axis Technology Object" in the "SIMOTION Motion Control TO Axis Electric/Hydraulic, External Encoder" Function Manual.

7. The F-communication parameters are displayed in the DP slave (SIMOTION CPU) properties, "F Configuration" tab.

**DP partner (F I/O):** Properties of the SINAMICS drive.

**local:** Properties of the SIMOTION CPU.

Enter the logical start address for F-communication of the SIMOTION CPU in the "Address" row.

The send and receive safety telegrams are assigned an address space of 6 bytes which must be located outside the process image of the SIMOTION-CPU (>= 64).
Master (safety program): SIMATIC F-CPU properties. The logical start address for F communication of the SIMATIC F-CPU must be entered here under “Address” (LADDR). The address space for sending and receiving the safety telegrams is 6 bytes and must lie within the process image of the SIMATIC F-CPU. In the SIMATIC F-CPU safety program, this address can be used to access the PROFIsafe STW or ZSW.

Figure 7-17 Master-slave coupling in PROFIsafe

8. Open HW Config of the SIMOTION CPU.

Figure 7-18 SIMOTION D configuration
9. Double-click the icon of the SINAMICS drive unit and select the "Details" tab in the "Configuration" tab.

![Figure 7-19 PROFIsafe configuration for SINAMICS drive unit]

10. Click "PROFIsafe..." and then define the F parameters which are important to F communication. If the "PROFIsafe..." button is grayed out, click "Activate..." to activate it.

![Figure 7-20 Setting F parameters]
Setting F parameters:

The top five failsafe parameters in this list are configured by default and cannot be edited. The following range of values is valid for the two remaining parameters:

**F_Dest_Add: 1-65534**
F_Dest_Add determines the PROFIsafe destination address of the drive object. Any value within the range is allowed, although it must be entered again in the safety configuration of the drive in the SINAMICS drive unit. The F_Dest_Add value must be set in p9610 (CU) and in p9810 (Motor Module).

---

**Note**

When you close the "PROFIsafe properties" dialog box, the failsafe addresses (F-Dest_Add and F-Source_Add) are checked to ensure that they are unique. This function is only available if a master-slave link has been established between the SIMOTION CPU and the SIMATIC F-CPU.

**F_WD_Time: 10-65535**
A valid current safety telegram must be received from the F-CPU within the monitoring time. The drive will otherwise switch to the safe state. The monitoring time should be of sufficient length to ensure not only that the communication functions tolerate telegram delays, but also that the fault response is triggered quickly enough if a fault occurs (e.g. interruption of the communication connection).

For additional information on failsafe parameters, refer to the online help of the "PROFIsafe properties" dialog box ("Help" button).

Compile HW Config of the SIMOTION CPU. Compile the F-CPU configuration data in HW Config.

---

**Note**

For information about creating a safety program and accessing PROFIsafe user data (e.g STW and ZSW) within the safety program, refer to the "SIMATIC, S7 Distributed Safety - Configuring and Programming" Programming and Operating Manual.
Safety configuration (online) in the SINAMICS drive

1. Call the configuration for Safety Integrated by selecting "Functions" at the SINAMICS drive entry in the tree structure.
2. Click "Change settings". Enter the default safety password "0" and then select the "Motion monitoring via PROFIsafe" setting in the screen.
3. Enable the SOS and SLS functions, click the "Configuration" button and then enter the PROFIsafe address of the drive in hexadecimal notation at the already defined parameter F_Dest_Add in the configuration screen (see chapter "Configuring PROFIsafe communication", item 10).

![PROFIsafe configuration, PROFIsafe address for the drive](image_url)
4. Click "Copy parameters" and then click "Activate settings". Click "Entire project" to save your settings. Perform a POWER ON. The safety configuration data are now active in the drive.

Figure 7-24  Copying PROFIsafe parameters
Figure 7-25 Activating PROFlsafe settings and saving the entire project
Commissioning

7.7 SIMOTION support for Safety extended functions

Acceptance inspection

Once configuring and commissioning has been successfully completed, an acceptance test of the drive safety functions must be carried out (see Chapter 8).

When carrying out the acceptance test for PROFIsafe communication, note the information provided in the “SIMATIC, S7 Distributed Safety - Configuring and Programming” Programming and Operating Manual.

In addition, note that the hardware configuration data for the SIMOTION CPU is printed out along with the required inspection log files of the SIMATIC F-CPU. Select “Station -> Print” in HW Config of the SIMOTION CPU.

Check the failsafe parameters of the SINAMICS slave (particularly F-WD_TIME) based on this hardcopy. The signatures in the footer of all hardcopies should be identical in order to guarantee consistency of the printed copies. Archive the hard copy alongside the inspection log files of the SIMATIC F-CPU and of the STEP7 project.

Note

If F parameters of the SINAMICS drive are changed in HW Config, the global signature of the safety program in the SIMATIC F-CPU changes. In this way, the global signature can be used to identify whether safety-relevant settings in the F-CPU or in HW Config of the SIMOTION-CPU (F parameters of the SINAMICS slave) have changed. The global signature does not, however, contain any changes to safety-relevant drive parameters set in SCOUT.

7.7 SIMOTION support for Safety extended functions

For more information about how SIMOTION can help support Safety Integrated extended functions, see “Support of SINAMICS Safety Integrated extended functions on the axis technology object (as of V4.1)” in the “SIMOTION Motion Control TO Axis Electric / Hydraulic, External Encoder” Function Manual. In particular, the telegram must be expanded for "PROFIsafe via PROFIBUS" communication. To do so, a safety data block is appended to the PROFIdrive actual value telegram. The process of configuring and parameterizing this safety data block is described in the section mentioned above.
7.8 Commissioning a linear/rotary axis

The next section outlines the safety commissioning procedure for a linear axis/rotary axis when a TM54F is used.

1. Go online in the STARTER, select the required drive object from the project tree of the STARTER and then select "Functions -> Safety Integrated" to open the start screen for the configuration of Safety Integrated.
   Click "Change settings". The commissioning mode is selected.
   You are only allowed to edit safety parameters in commissioning mode for Safety Integrated (p0010 = 95) after having entered the valid password in an input dialog box (parameter p9761 for drives or p10061 for TM54F).

   Figure 7-26 Safety commissioning of a linear/rotary axis

2. Select "Motion monitoring via TM54F" from the "Control selection" drop-down list box.
3. Enable the the safety functions (p9501) by selecting them from the dropdown list "Enables safety functions". Click the "Configuration" button.
4. The safety configuration screen of the drive opens.

![Configuration Screen]

5. For the drive, set the same monitoring clock cycle (safety clock cycle) as for the TM54F (see "TM54F Configuration").

6. Select the required drive type (linear/rotary axis) from the corresponding drop-down list box (p9502). Continue at item 12 if you have not changed the selected drive type.

7. Close the screen. Click "Copy parameters" and then click "Activate settings" (exit commissioning mode, p0010=0).

8. Execute the "Copy RAM to ROM" function for the entire project by clicking the "Entire project" button.

9. Perform a POWER ON. The new parameterization is now active.

10. Go online again. The alarms indicate that safety commissioning was not completed (different actual and target checksum) can be ignored.

11. Upload the project to the programming device. The display of parameter units (rotary/linear axis) will be updated accordingly in STARTER.

12. Set up further configurations and update the parameters in accordance with currently required monitoring limits, timers or encoder settings.
7.9 Modular machine concept Safety

The modular machine concept for Safety Integrated basic functions and extended functions provides support for commissioning modular machines. A complete machine, including all its available options, is created in a topology. Only those components that are actually implemented in the finished machine are later activated. Likewise, certain components can also be deactivated to begin with and reactivated if they are required at a later stage.

With the modular machine concept, a distinction is made between the following applications:

- Once the components with safety functions have been activated for the first time after series commissioning, the hardware replacement needs to be confirmed (see "Information about replacing components" in this manual).
- Once all the drives (including Safety Integrated extended functions) have been commissioned, they are to be deactivated (p0105) without changing the hardware. They can only be reactivated with a subsequent warm start or by means of POWER ON.
- The DOs of the TM54F can be deactivated by means of parameter p0105. The TM54F itself can only be deactivated when all the drives entered in p10010 "SI drive object assignment" were deactivated separately by means of p0105 beforehand.
- When spare parts are required and the drive is deactivated (p0105) during the delivery period for the required hardware component. Reactivation with subsequent warm start or POWER ON and confirmation of hardware replacement (see "Information about replacing components" in this manual).
- Component exchange on a CU (e.g. to localize faults). For "Safety", this is the same as a hardware replacement. After a warm start or POWER ON, the process of exchanging hardware must be confirmed in order to complete it (see "Information about replacing components" in this manual).

Device commissioning by means of parameter requests with enabled safety functions

The modular machine concept allows safety parameters to be maintained by means of parameter requests. Safety fault messages are output, however, if the hardware components are not suitable for the project because the serial numbers of the Motor Modules and Sensor Modules are contained in the safety checksums. The checksums (CRCs) can be adapted by confirming the hardware replacement as described above (see "Information about replacing components" in this manual).

Changing the DO number in conjunction with TM54F

When parameter p10010[0..5] (sets the DO number for the available drives with Safety function) is changed automatically, this affects the checksum (CRC). If Safety Integrated extended functions with TM54F are selected for a drive (p9601.2 = 1 and p9601.3 = 0), its DO number must be entered in just one index of p10010.

The CRC itself must not be changed automatically by the firmware. The alarm A35080 (F) "TM54F: Checksum error safety parameters" is issued after the subsequent warm start (triggered by p0009=0). To acknowledge the message, parameters p9700 and p9701 on the TM54F must be set accordingly. The copy function for the safety parameters is started with p9700 = 1D hex and the data changes can be confirmed with p9701 = EC hex.
7.10 Information pertaining to component replacements

Replacing components

For information about component replacements, see "Example of component replacements" in the SINAMICS S120 Function Manual FH1.

<table>
<thead>
<tr>
<th>WARNING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observe the instructions with regard to changes to software components or to changes to these in the chapter &quot;Safety instructions&quot;!</td>
</tr>
</tbody>
</table>

1. The faulty component was replaced in accordance with safety regulations.
2. Make sure that everybody has cleared the danger zone and then power up the machine.
3. Error F35150 (communication error, after replacement of a Motor Module) or C30711 is output with fault value 1031 (data transfer error after replacement of a Sensor Module).
4. With STARTER/SCOUT:
   - Click "Acknowledge hardware replacement" in the start screen of safety functions.
5. Programming without STARTER on SINAMICS with BOP or SIMOTION with HMI:
   - Start the copying function for Node Identifier (p9700 = 1D hex)
   - Confirm the hardware CRC on the drive object (p9701 = EC hex)
   Carry out these two tasks after having replaced a Sensor Module at drive object servo or vector, and after having replaced a Motor Module at drive object TM54F_MA (if installed).
6. Back up all parameters on the memory card (p0977=1).
7. Carry out a POWER ON (power off/on) for all components.
8. Faults F01650/F30650 (acceptance test required; see "Acceptance test and acceptance report") are output.

<table>
<thead>
<tr>
<th>WARNING</th>
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<tbody>
<tr>
<td>Before anyone is allowed to enter the danger zone again and before operation is resumed, select the STO function once and briefly move the drives affected by the component replacement in plus and minus direction (+/-) with activated safety monitoring function (SLS, if parameterized) in order to verify proper functionality.</td>
</tr>
</tbody>
</table>
7.11 Information pertaining to series commissioning

A commissioned project which has been uploaded to STARTER can be transferred to another drive unit including the existing safety parameterization.

1. Download the STARTER project to the drive unit.
2. The alarms F01650/F30650 (acceptance test required) are output.
   These fault alarms can be acknowledged because a full acceptance test is not required if no changes were made to safety function parameters.
3. Click "Acknowledge hardware replacement" in the start screen of the safety functions.
4. Back up all parameters on the memory card
5. Perform a POWER ON at all components.

⚠️ WARNING

Before anyone is allowed to enter the danger zone again and before operation is resumed, select the STO function once and briefly move the drives affected by the component replacement in plus and minus direction (+/-) with activated safety monitoring function (SLS, if parameterized) in order to verify proper functionality.
Application examples

8.1 Input/output interconnections for a safety switching device with TM54F

TM54F: interconnecting F-DO with safe input on safety switching device

![Diagram](image)

Figure 8-1 TM54F F-DO at equivalent/antivalent safe input on safety switching device XY (e.g. safety PLC)

WARNING

In contrast to mechanical switching contacts (e.g. EMERGENCY STOP switches), leakage currents can still flow on semiconductor switches such as those usually used at digital outputs even when they have been switched off. This can lead to false switching states if digital inputs are not connected correctly.

The conditions for digital inputs/outputs specified in the relevant manufacturer documentation must be observed.
**Application examples**

8.1 Input/output interconnections for a safety switching device with TM54F

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<table>
<thead>
<tr>
<th>WARNING</th>
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<tbody>
<tr>
<td>In accordance with IEC 61131 Part 2, Chapter 5.2 (2008), only outputs that have a maximum residual current of 0.5 mA when &quot;OFF&quot; can be used to connect TM54F digital inputs with digital semiconductor outputs.</td>
</tr>
</tbody>
</table>

The inclusion of additional load resistors makes it possible to use digital outputs with larger residual currents to connect TM54F inputs.

F-DI = safety-oriented dual-channel digital input  
F-DO = safety-oriented dual-channel digital output

If the digital outputs from another device (e.g. F-DOs on a safety PLC) with a residual current greater than 0.5 mA when "OFF" are connected to the F-DIs, load resistors should be connected in parallel to both connections on the F-DI.

The maximum permissible voltage for a TM54F F-DI when "OFF" is 5 V (in accordance with IEC 61131-2, 2008).

The following two figures show exactly how the protective circuits for F-DIs with additional load resistors are wired.
8.1 Input/output interconnections for a safety switching device with TM54F

**Application examples**

**Safety Integrated Function Manual, (FHS), 10/2008, 6SL3097-2AR00-0BP2**

**Figure 8-2**  TM54F F-DI at plus-minus switching safe output on safety switching device XY (e.g. safety PLC)

**TM54F: interconnecting F-DI with plus-plus switching output on safety switching device**

**Figure 8-3**  TM54F F-DI at plus-plus-switching safe output on a safety relay XY (e.g. safety PLC).

**Dimensioning of load resistors - example 1:**

According to manufacturer documentation, the leakage current of an F-DO on a safety PLC is 1 mA; in other words, it is around 0.5 mA higher than is permissible for the F-DI. The necessary load resistance is therefore $R = \frac{5 \text{ V}}{0.5 \text{ mA}} = 10 \text{ k}\Omega$.

At maximum supply voltage, the power loss for this resistor is:

$$P = \frac{(28.8 \text{ V})^2}{R} = 83 \text{ mW}.$$  

The resistor is to be permanently dimensioned for this power loss.
**Dimensioning of load resistors - example 2:**
If further conditions for the digital output (e.g. a minimum load or a maximum load resistance) are specified in the manufacturer documentation, these must be taken into account.
For example, a minimum load of 1 kΩ is specified for the SIMATIC ET200S 4 F-DO I/O module (6ES7138-4FB02-0AB0).
Therefore, two additional 1 kΩ load resistors and a continuous load capacity of at least
\[ P = \frac{(28.8 \text{ V})^2}{R} = 830 \text{ mW} \]
are required to connect an F-DO of this kind to a TM54F F-DI.
The following terminals can be used to connect the external resistors, for example:

- **Phoenix Contact**
  - P-CO component connector, part number: 3036796
  - Three-wire terminal with quick-acting locking technique QTC 1.5-TWIN-TG, part number: 3050413
    - Alternative to this terminal:
      - Universal terminal with screw connection UT 4-TWIN-TG, part number: 3046595
      - Universal terminal UDK 4-DUR, part number: 2775207

- **WAGO:**
  - Empty component plug housing, part number. 280-801
  - 4-conductor base terminal, center marking, for TS 35, front wiring, CAGE CLAMP® terminal, horizontal design
8.2 Safe Stop 1 (SS1, time-controlled) when protective door is locked, emergency stop switch-off

1) Y43 - Y44 must be open, otherwise no switch-on monitoring of S1 (Y33/34).

Figure 8-4  Application example
Application examples

8.2 Safe Stop 1 (SS1, time-controlled) when protective door is locked, emergency stop switch-off

Figure 8-5  Safety Integrated signal flow application example

Note

This example illustrates implementation options. The solution required for the machine must be suitable for the machine function, which means that parameters and control commands are defined individually.

NOTICE

The fault responses and output functions (e.g. inversion or simulation) must not be changed from the factory setting or must not be activated.
8.2 Safe Stop 1 (SS1, time-controlled) when protective door is locked, emergency stop switch-off

Description of functions

With two SIGUARD safety combinations for emergency stop and the protective door, as well as a standard PLC, the system can be configured according to EN 954-1 category 3, ISO 13849-1 and EN 1037. The drives are brought to a standstill in accordance with stop category 1 to EN 60204-1:2006.

- The "Safe Torque Off" safety function, which is integrated in the drive, complies with category 3 to EN 954-1/ ISO 13849-1 or SIL 2 to IEC 61508. The non-safe checkback signal "Safe Torque Off active" is sufficient.
- Safety combinations for emergency stop and protective door monitoring comply with category 4 (instantaneous enable circuits).
- The electric circuits for emergency stop and protective door monitoring are monitored for cross-circuits on two channels.
- Switches S4, S5, and S6 are positively-opening position switches corresponding to EN 1088.
- Being a higher-level circuit with contacts, the "Safe Stop 1" (SS1) function also works if the PLC malfunctions or fails.
- I/O communication via the digital interface between the drive and PLC can also be replaced by non-safe standard communication (e.g. PROFIBUS).
- This application example is based on the Basic Functions "Safe Torque Off" (STO) and "Safe Stop 1" (SS1).
  The speed ramps and speed thresholds are monitored in non-safe mode.

Note

To implement the EMERGENCY STOP function, the converter does not necessarily have to be electrically isolated from the line supply by means of electromechanical switching devices in accordance with EN 60204-1:2006. When work is carried out on the motor or drive converter, the voltage must be disconnected via a main circuit breaker (that can be locked out). Other standards (e.g. NFPA79-2002 / USA) specify additional requirements regarding the "EMERGENCY STOP" function. An electromechanical disconnection of the supply voltage is required to implement the "EMERGENCY OFF" function in accordance with EN 60204-1:2006. The risk analysis to be carried out by the machinery construction OEM must determine which emergency functions (emergency operations) are actually required for a specific application.

Behavior for Emergency Stop

An emergency stop is triggered by the S3 button ("Emergency stop"). The drive is brought to a standstill in accordance with stop category 1 of EN 60204-1:2006.

- Open the safe enable contacts of the safety combination A1. This activates the "Safe Stop 1" drive function on two channels via terminal X122.2 (DI 1) on the Control Unit and terminals X21.3 (EP +24 V) and X21.4 (EP M) on the Motor Module. "Safe Torque Off" is selected after the set SS1 delay time (p9852, p9652) has elapsed. When all the grouped drives have reached the "Safe Torque Off active" status, this is signaled back via terminal X122.10 (DO 10: STO group active).
- The confirmation from the safety combination and the drive is monitored in the PLC to ensure that it is plausible.
Application examples

8.2 Safe Stop 1 (SS1, time-controlled) when protective door is locked, emergency stop switch-off

Behavior when the protective door is opened

To issue a request to open the protective door, press the S2 button ("OFF"). The drive is brought to a standstill in accordance with stop category 1 of EN 60204-1:2006.

- Resetting the PLC output DO 2 will trigger an SS1 at terminal X122.2 on the CU (DI 1) and at the EP terminals of the Motor Modules. The drives are immediately braked via the speed ramp (p1135). The speed ramp is not monitored for SS1. The pulses are safely canceled after the safe SS1 delay time (p9852, p9652) has elapsed.

- When all drives have executed the safe pulse suppression, the feedback "STO in group active" (DO 10) is issued from the CU to the PLC. In addition, a request is made via the PLC (PLC: DI 7 and DI 8) if the drives have fallen below the preset speed threshold (D0 8 and DO 9: |n|<p2161).

    Only when these conditions are met, solenoid Y1 (PLC output DO 4) is energized and the lock of the protective door opened.

- When the protective doors are opened, the protective door safety circuit is interrupted and safety combination A2 opens its safety circuits.

Note

The position of the protective door interlock is monitored by S6! If a fault on the PLC causes the lock of the protective door to open, an SS1 is initiated via S6 at terminal X122.2 (DI 1) of the Control Unit and at the EP terminals of the Motor Modules. The drives are immediately braked via the speed ramp (p1135), and the pulses canceled after the SS1 delay time has elapsed. When the protective door is opened, the "Safe Stop 1" function is safely selected.

Switching on the drives

The drives can be started when the protective door is shut and emergency STOP pushbutton S3 is released. The emergency STOP pushbutton S3 must be unlocked before pushbutton S1 ("ON") is actuated. With the safety combination, the ON circuit Y33, Y34 is checked for a short-circuit when terminals Y43 , Y44 are open (i.e. if Y33 and Y34 are closed before emergency stop pushbutton S3 is closed, this is identified as a fault). The Line Module must be switched on via PLC output DO 5 on the PLC by means of an edge from "0" to "1".

- Once you have pressed button S1 ("ON"), safety combination A1 switches to "ready for operation". When PLC output DO 4 is reset, the coil of tumbler Y1 is no longer energized and the protective door is locked. Safety combination A2 is also ready for operation.

- By setting the PLC output DO 2, the SS1 and STO safety function is de-selected on two channels via terminal DI 1 X122.2 on the Control Unit and terminals X21.3 (EP +24 V) and X21.4 (EP M) on the Motor Modules.

- Due to a rising edge at PLC output DO 1, the drives can be switched back to "operation" mode via terminal X122.1 (DI 0: OFF1).
Acceptance test and acceptance report

9.1 General information

Requirements regarding acceptance tests are derived from the EC Machinery Directive and ISO 13849-1. IEC 22G WG 10 is currently working on a "Functional safety" standard which includes a detailed description of acceptance test requirements. The machine manufacturer (OEM) is committed accordingly

- to carry out an acceptance test for safety-related functions and machine parts
- to issue an "Acceptance certificate" which describes the test results.

The acceptance test for systems with Safety Integrated extended functions (SI functions) is focused on validating the functionality of Safety Integrated monitoring and stop functions implemented in the drive system. The test objective is to verify proper implementation of the defined safety functions and of test mechanisms (forced dormant error detection measures) and to examine the response of specific monitoring functions to the explicit input of values outside tolerance limits. The test must cover all drive-specific Safety Integrated motion monitoring functions and global Safety Integrated functionality of Terminal Module TM54F (if used).

<table>
<thead>
<tr>
<th>WARNING</th>
</tr>
</thead>
<tbody>
<tr>
<td>A new acceptance test must be carried out if any changes were made to SI function parameters and must be logged in the acceptance report.</td>
</tr>
</tbody>
</table>

Note

The acceptance test is designed to ensure that the safety functions are correctly parameterized. The measured values (e.g. distance, time) and the system behavior identified (e.g. initiation of a specific stop) can be used for checking the plausibility of the configured safety functions. The objective of an acceptance test is to identify potential configuration errors or to record the valid configuration. The measured values are typical but no worst case values. They represent the behavior of the machine at the time of measurement. These measurements cannot be used, for example, to derive maximum ramp-down values.
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 test. The acceptance report must be kept in the logbook of the relevant machine. Access rights to SI parameters must be protected by password and be recorded accordingly in the acceptance report. In this context this is a person who is authorized by the machine manufacturer and who has adequate professional training and knowledge of the safety functions in order to conduct the acceptance test in a proficient manner.

Note

- Observe the information in the chapter "Procedures for initial commissioning".
- The acceptance report presented below is both an example and recommendation.
- An acceptance report template in electronic format is available at your local sales office.

Necessity of an acceptance test

A complete acceptance test (as described in this chapter) is required after initial commissioning of Safety Integrated functionality on a machine. An acceptance test, possible with reduced scope, is always required after safety-related functions were extended, after the transfer of commissioned objects to other series machines, after changes were made to the hardware and after software upgrades. A summary of conditions which determine the necessary test scope or proposals in this context is provided below.

In order to define a partial acceptance test, it is necessary in the first instance to specify the acceptance test objects, and in the second instance to define logical groups which represent the elements of the acceptance test. The acceptance test must be carried out separately for each individual drive (as far as the machine allows).

Prerequisites for the acceptance test

- The machine is properly wired.
- All safety equipment such as protective door monitoring devices, light barriers or emergency-off switches are connected and ready for operation.
- Commissioning of the open-loop and closed-loop control should be concluded, as the ramp-down path may otherwise change as a result of changed dynamic response of the drive controller, for example. These include, for example:
  - Configuration of the setpoint channel
  - Position control in the higher-level controller
  - Automatic speed control.

Information about the acceptance tests

Note

As far as possible, the acceptance tests are to be carried out at the maximum possible machine speed and acceleration rates to determine the maximum braking distances and stop times that can be expected.
Information on the acceptance test mode (p9370/p9570)

The acceptance test mode can be activated for a definable period (p9358/p9558) by setting the appropriate parameters (p9370/p9570). Safety alarms which must be reset by means of POWER ON and which are generated after activation can be acknowledged as usual. The acceptance test mode also allows operation of the drive beyond SOS limits (p9331/p9531).

Activation of the acceptance test mode is therefore only useful in conjunction with the test of SOS and SLS functions with stop response STOP A or STOP B.

The SOS can be selected either directly, or by way of SS2 (with deactivated acceptance test mode). Deactivate the SS2 brake ramp in SS2 state in active acceptance test mode in order to enable drive movements after having triggered a violation of standstill limits. When an SOS violation is acknowledged in active acceptance test mode, the current position is adopted as the new stopping position.

WARNING

If a speed setpoint that is not zero is present, the active stop function SS2 is set, and the motor is at a standstill (active SOS), the axis starts to move as soon as the acceptance test is activated.

Content of the complete acceptance test

Documentation

Documentation of the machine and of safety functions
1. Machine description (with overview)
2. Specification of the controller (if this exists)
3. Configuration diagram
4. Function table
   Active monitoring functions depending on the operating mode, the protective doors and other sensors. This table should reflect the objective or results of project engineering.
5. SI functions for each drive
6. Information about safety equipment

Function test Part 1

General function test, including a check of the wiring/programming
1. Test of shutdown paths
   (Test of forced dormant error detection at the inputs and outputs)
2. Testing stop functions SS1 and SS2
3. Test the forced checking procedure of the inputs and outputs
   (only if a TM54F module is used)
4. Test of the emergency stop function and of safety circuits
5. Changeover test of SI functions
Function test Part 2
Detailed function test and valuation of SI functions used.
1. Testing the SI function "Safe Operating Stop" (SOS)
   (with evaluated measurement diagram or measured values)
2. Test of the SI function "Safely Limited Speed" (SLS)
   (with evaluated measurement diagram or measured values)
3. Test of the SI function "Safe Speed Monitor" (SSM)
   (with evaluated measurement diagram or measured values)

Conclusion of the report
Report of the commissioning status tested and countersignatures
1. Inspection of SI parameters
2. Check that the existing safety firmware versions are permissible using the table under Siemens "Product Support" on the Internet (see "Safety Integrated firmware versions").
3. Logging of checksums (for each drive)
4. Assigning and logging the Safety password
   (do not disclose in the report!)
5. RAM to ROM backup and upload of project data to the STARTER and backup of the project
6. Countersignature

Appendix
Effect of the acceptance test on specific measures

Table 9-1 Scope of the acceptance test depending on specific measures

<table>
<thead>
<tr>
<th>Measure</th>
<th>Documentation</th>
<th>Function test Part 1</th>
<th>Function test Part 2</th>
<th>Conclusion of the report</th>
</tr>
</thead>
<tbody>
<tr>
<td>Replacement of the encoder system</td>
<td>No</td>
<td>No</td>
<td>Test of failsafe actual value acquisition</td>
<td>Supplementation; new checksums and countersignature as required</td>
</tr>
<tr>
<td>Replacement of an SMC/SME Module</td>
<td>Supplementation of hardware data/configuration/soft ware version data</td>
<td>No</td>
<td>Test of failsafe actual value acquisition</td>
<td>Supplementation; new checksums and countersignature</td>
</tr>
<tr>
<td>Replacement of a motor with DRIVE- CLIQ</td>
<td>Supplementation of hardware data/configuration/soft ware version data</td>
<td>No</td>
<td>Test of failsafe actual value acquisition</td>
<td>Supplementation; new checksums and countersignature</td>
</tr>
<tr>
<td>Replacing the Control Unit / power unit - hardware</td>
<td>Supplementation of hardware data/configuration/soft ware version data</td>
<td>No</td>
<td>Partially, if the system scan cycle times or the dynamic response were changed (drive-specific)</td>
<td>Supplement; new checksums and countersignature might be required</td>
</tr>
<tr>
<td>Replacing the Power Module or Safe Brake Relay</td>
<td>Supplement; hardware data/configuration</td>
<td>Yes</td>
<td>No</td>
<td>Supplement and countersignature</td>
</tr>
<tr>
<td>Replacing the TM54F module</td>
<td>Supplementation of hardware data/configuration/soft ware version data</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Replacement of SI-relevant distributed I/O devices (e.g. EMERGENCY OFF switch)</td>
<td>Supplementation of hardware data/configuration/soft ware version data</td>
<td>Yes, with comment restriction to replaced components</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Firmware - upgrade(CU/power unit/ Sensor Modules)</td>
<td>Supplementation Version data</td>
<td>Yes, including a note informing of the time of implementation of the new functionality</td>
<td>Yes, if the system scan cycle times or the dynamic response were changed or test of the new functionality</td>
<td>Supplementation; new checksums and countersignature as required</td>
</tr>
<tr>
<td>Change to a single limit (e.g. SLS limit)</td>
<td>Supplementary SI function per drive</td>
<td>No</td>
<td>Partially, test of the changed limit</td>
<td>Supplementation; new checksums and countersignature</td>
</tr>
<tr>
<td>Enhancement of functions (e.g. additional actuator, additional SLS stage)</td>
<td>Supplementary SI functions per drive or function table</td>
<td>Yes, with note restriction to adapted parts as required</td>
<td>Partially, test of any additional limits</td>
<td>Supplement; new checksums and countersignature might be required</td>
</tr>
<tr>
<td>Transfer of project data to other machines via series commissioning</td>
<td>Possibly supplement to the machine description (check of the firmware version)</td>
<td>Yes, with note</td>
<td>No, if no changes were made to SI parameters</td>
<td>No, if data are identical (check of checksums)</td>
</tr>
</tbody>
</table>
9.2 Safety logbook

Description

The "Safety Logbook" function is used to detect changes to safety parameters that affect the associated CRC sums. CRCs are only generated when p9601/p9801 (SI enable, functions integrated in the drive CU/Motor Module) is > 0.

Data changes are detected when the CRCs of the SI parameters change. Each SI parameter change that is to become active requires the reference CRC to be changed so that the drive can be operated without SI fault messages. In addition to functional safety changes, safety changes as a result of hardware being replaced can be detected when the CRC has changed.

The following changes are recorded by the safety logbook:

- Functional changes are recorded in the checksum r9781[0]:
  - Functional CRCs of the motion monitoring functions (p9729[0]), axial (extended functions)
  - Functional CRCs of the basic safety functions integrated in the drive (p9799, SI setpoint checksum SI parameters CU), axial
  - Functional CRCs of the TM54F (p10005[0]), global (extended functions)
  - Enabling of functions integrated in the drive (p9601), axial (basic and extended functions)

- Hardware-dependent changes are recorded in the checksum r9781[1]:
  - Hardware-dependent CRCs of the motion monitoring functions (p9729[2]), axial (ncSI, basic and extended functions)
  - Hardware-dependent CRCs of the TM54F (p10005[1]), global (extended functions)

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

- r9781[0] SI checksum to check changes (Control Unit), functional
- r9781[1] SI checksum to check changes (Control Unit), hardware dependent
- r9782[0] SI time stamp to check changes (Control Unit), functional
- r9782[1] SI time stamp to check changes (Control Unit), hardware dependent
- r9728[0...2] SI Motion actual checksum SI parameters
- r9729[0...2] SI Motion setpoint checksum SI parameters
- p9799 SI setpoint checksum SI parameters (Control Unit)
- p9601 SI enable, functions integrated in the drive (Control Unit)
- p9801 SI enable, functions integrated in the drive (Motor Module)
- p10005[0...1] SI setpoint checksum TM54F parameters
9.3 Acceptance report

9.3.1 Plant description - Documentation part 1

Table 9-2 Machine description and overview diagram

<table>
<thead>
<tr>
<th>Designation</th>
<th>Type</th>
<th>Serial number</th>
<th>Manufacturer</th>
<th>End customer</th>
<th>Electrical drives</th>
<th>Other drives</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Overview diagram of machine</td>
<td></td>
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</tr>
</tbody>
</table>

Table 9-3 Values of relevant parameters

<table>
<thead>
<tr>
<th>Versions of the firmware and of Safety Integrated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Component</td>
</tr>
<tr>
<td>-----------</td>
</tr>
<tr>
<td>Parameters Control Unit</td>
</tr>
<tr>
<td>Parameters Motor Modules</td>
</tr>
<tr>
<td>Drive number</td>
</tr>
<tr>
<td>r0128 = r9390 = r9870 =</td>
</tr>
<tr>
<td>r0128 = r9390 = r9870 =</td>
</tr>
<tr>
<td>r0128 = r9390 = r9870 =</td>
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<tr>
<td>r0128 = r9390 = r9870 =</td>
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<tr>
<td>r0128 = r9390 = r9870 =</td>
</tr>
<tr>
<td>r0128 = r9390 = r9870 =</td>
</tr>
</tbody>
</table>
### 9.3 Acceptance report

#### Parameters

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Drive number</th>
<th>Firmware version</th>
<th>SI version</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensor Modules</td>
<td>r0148 =</td>
<td>r9890 =</td>
<td></td>
</tr>
<tr>
<td></td>
<td>r0148 =</td>
<td>r9890 =</td>
<td></td>
</tr>
<tr>
<td></td>
<td>r0148 =</td>
<td>r9890 =</td>
<td></td>
</tr>
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<td>r0148 =</td>
<td>r9890 =</td>
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<tr>
<td></td>
<td>r0148 =</td>
<td>r9890 =</td>
<td></td>
</tr>
<tr>
<td></td>
<td>r0148 =</td>
<td>r9890 =</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Drive number</th>
<th>Firmware version</th>
<th>SI version</th>
</tr>
</thead>
<tbody>
<tr>
<td>Terminal Modules</td>
<td>r0158 =</td>
<td>r10090 =</td>
<td></td>
</tr>
<tr>
<td></td>
<td>r0158 =</td>
<td>r10090 =</td>
<td></td>
</tr>
</tbody>
</table>

#### Monitoring clock cycles of Safety Integrated

<table>
<thead>
<tr>
<th>Drive number</th>
<th>SI monitoring clock cycle</th>
<th>SI monitoring clock cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Control Unit</td>
<td>Motor Module</td>
</tr>
<tr>
<td>Basic functions</td>
<td>r9780 =</td>
<td>r9880 =</td>
</tr>
<tr>
<td></td>
<td>r9780 =</td>
<td>r9880 =</td>
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</table>

<table>
<thead>
<tr>
<th>Drive number</th>
<th>SI monitoring clock cycle</th>
<th>SI monitoring clock cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Control Unit</td>
<td>Motor Module</td>
</tr>
<tr>
<td>Extended functions</td>
<td>p9300 =</td>
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<tr>
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<td>p9500 =</td>
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<tr>
<td></td>
<td>p9300 =</td>
<td>p9500 =</td>
</tr>
<tr>
<td>TM54F parameters</td>
<td>p10000 =</td>
<td></td>
</tr>
</tbody>
</table>
9.3.2 Description of safety functions - Documentation Part 2

9.3.2.1 Introduction

This example contains the description of a plant; the settings for a specific plant must be adapted accordingly.

9.3.2.2 Function table

Table 9-4  Example table: Active monitoring functions depending on the operating mode, the protective doors or other sensors

<table>
<thead>
<tr>
<th>Mode of operation</th>
<th>Protective door</th>
<th>Drive</th>
<th>Status of monitoring functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production</td>
<td>closed and locked</td>
<td>1, 2</td>
<td>deactivated, SLS enabled</td>
</tr>
<tr>
<td></td>
<td>unlocked</td>
<td>1, 2</td>
<td>SOS, STO deactivated</td>
</tr>
<tr>
<td>Setup</td>
<td>closed and locked</td>
<td>1, 2</td>
<td>deactivated, SLS 1 enabled</td>
</tr>
<tr>
<td></td>
<td>unlocked</td>
<td>1, 2</td>
<td>SLS 1 disabled / enabled</td>
</tr>
</tbody>
</table>

Comments:

9.3.2.3 SI functions for each drive

Table 9-5  Example: functional overview of the safety functions

<table>
<thead>
<tr>
<th>Drive</th>
<th>SI function</th>
<th>Limit</th>
<th>active if</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SOS</td>
<td>100 mm</td>
<td>refer to the function table</td>
</tr>
<tr>
<td></td>
<td>SLS 1</td>
<td>200000 mm/min</td>
<td>refer to the function table</td>
</tr>
<tr>
<td></td>
<td>SLS 2</td>
<td>50000 mm/min</td>
<td>refer to the function table</td>
</tr>
<tr>
<td>2</td>
<td>SOS</td>
<td>100 mm</td>
<td>refer to the function table</td>
</tr>
<tr>
<td></td>
<td>SLS 1</td>
<td>50 rpm</td>
<td>refer to the function table</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

Comments:

All drives use the SI function SS1 for the EMERGENCY STOP functionality.

Drive 2 is equipped with a holding brake which is controlled by two channels via the corresponding Motor Module output.
### Drive-specific data

Table 9-6  Drive-specific data (excerpt)

<table>
<thead>
<tr>
<th>SI function</th>
<th>Parameter Motor Modules / CU</th>
<th>Motor Module value / CU value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enable safety functions</td>
<td>p9301 / p9501</td>
<td>0000 bin</td>
</tr>
<tr>
<td>Axis type</td>
<td>p9302 / p9502</td>
<td>0</td>
</tr>
<tr>
<td>Encoder assignment</td>
<td>p9326 / p9526</td>
<td>1</td>
</tr>
<tr>
<td>Sensor Module node identifier</td>
<td>p9328[0..11]</td>
<td>0000 hex</td>
</tr>
<tr>
<td>Enable drive-integrated functions</td>
<td>p9801 / p9601</td>
<td>0000 bin</td>
</tr>
<tr>
<td>PROFIsafe address</td>
<td>p9810 / p9610</td>
<td>0000 hex</td>
</tr>
<tr>
<td>SOS standstill tolerance</td>
<td>p9330 / p9530</td>
<td>1.000°</td>
</tr>
<tr>
<td>PLC limit values</td>
<td>p9331[0..3] / p9531[0..3]</td>
<td>2000.00 mm/min</td>
</tr>
<tr>
<td>Actual value comparison tolerance</td>
<td>p9342 / p9542</td>
<td>0.1000°</td>
</tr>
<tr>
<td>SSM speed limit</td>
<td>p9346 / p9546</td>
<td>20.00 mm/min / 20.00 1/min</td>
</tr>
<tr>
<td>SBR actual speed tolerance</td>
<td>p9348 / p9548</td>
<td>300.00 1/min</td>
</tr>
<tr>
<td>STOP C -&gt; SOS delay time</td>
<td>p9352 / p9552</td>
<td>100.00 ms</td>
</tr>
<tr>
<td>STOP D -&gt; SOS delay time</td>
<td>p9353 / p9553</td>
<td>100.00 ms</td>
</tr>
<tr>
<td>STOP E -&gt; SOS delay time</td>
<td>p9354 / p9554</td>
<td>100.00 ms</td>
</tr>
<tr>
<td>STOP F -&gt; STOP A delay time</td>
<td>p9355 / p9555</td>
<td>0.00 ms</td>
</tr>
<tr>
<td>STOP F -&gt; STOP B delay time</td>
<td>p9858 / p9658</td>
<td>0.00 µs</td>
</tr>
<tr>
<td>Safe Stop 1 delay time</td>
<td>p9852 / 9652</td>
<td>0.00 µs</td>
</tr>
<tr>
<td>Pulse cancelation delay time</td>
<td>p9356 / p9556</td>
<td>100.00 ms</td>
</tr>
<tr>
<td>Acceptance test mode time limit</td>
<td>p9358 / p9558</td>
<td>40000.00 ms</td>
</tr>
<tr>
<td>PLC stop response</td>
<td>p9363[0..3] / p9663[0..3]</td>
<td>2</td>
</tr>
<tr>
<td>Acceptance test mode</td>
<td>p9370 / p9570</td>
<td>0000 hex</td>
</tr>
<tr>
<td>Acceptance test status</td>
<td>r9371 / r9571</td>
<td>0000 hex</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>
9.3.2.4 Parameterizing the SI functions via TM54F

Parameters for control by way of TM54F

Table 9-7 Parameters for control via the TM54F (excerpt)

<table>
<thead>
<tr>
<th>SI function</th>
<th>Parameters</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sampling time</td>
<td>p10000</td>
<td>12.00 ms</td>
</tr>
<tr>
<td>Monitoring time discrepancy</td>
<td>p10002</td>
<td>12.00 ms</td>
</tr>
<tr>
<td>Forced dynamic behavior timer</td>
<td>p10003</td>
<td>8.00 h</td>
</tr>
<tr>
<td>Input terminal</td>
<td>p10007</td>
<td>0</td>
</tr>
<tr>
<td>Forced dynamic behavior F-DO 0...3</td>
<td>p10008</td>
<td>1</td>
</tr>
<tr>
<td>TM54F operating mode</td>
<td>p10020[0...3]</td>
<td>1</td>
</tr>
<tr>
<td>Special operation mode selection</td>
<td>p10021[0...3]</td>
<td>0</td>
</tr>
<tr>
<td>EMERGENCY STOP stop response</td>
<td>p10022[0...3]</td>
<td>0</td>
</tr>
<tr>
<td>STO input terminal</td>
<td>p10023[0...3]</td>
<td>0</td>
</tr>
<tr>
<td>SS1 input terminal</td>
<td>p10024[0...3]</td>
<td>0</td>
</tr>
<tr>
<td>SS2 input terminal</td>
<td>p10025[0...3]</td>
<td>0</td>
</tr>
<tr>
<td>SOS input terminal</td>
<td>p10026[0...3]</td>
<td>0</td>
</tr>
<tr>
<td>PLC input terminal</td>
<td>p10027[0...3]</td>
<td>0</td>
</tr>
<tr>
<td>EMERGENCY STOP input terminal</td>
<td>p10028[0...3]</td>
<td>0</td>
</tr>
<tr>
<td>F-DI input mode</td>
<td>p10029[0...3]</td>
<td>0</td>
</tr>
<tr>
<td>F-DI test enable</td>
<td>p10030[0...3]</td>
<td>0</td>
</tr>
<tr>
<td>F-DO 0 signal sources</td>
<td>p10031[0...3]</td>
<td>0</td>
</tr>
<tr>
<td>F-DO 1 signal sources</td>
<td>p10032[0...3]</td>
<td>0</td>
</tr>
<tr>
<td>F-DO 2 signal sources</td>
<td>p10033[0...3]</td>
<td>0</td>
</tr>
<tr>
<td>F-DO 3 signal sources</td>
<td>p10034[0...3]</td>
<td>0</td>
</tr>
<tr>
<td>Test sensor feedback</td>
<td>p10035[0...3]</td>
<td>0</td>
</tr>
<tr>
<td>input DI 20...23</td>
<td>p10036[0...3]</td>
<td>0</td>
</tr>
<tr>
<td>New password TM54F</td>
<td>p10037[0...3]</td>
<td>0</td>
</tr>
</tbody>
</table>

Test sensor feedback input DI 20...23
9.4 Acceptance tests

Information about the acceptance tests

Note
As far as possible, the acceptance tests are to be carried out at the maximum possible machine speed and acceleration rates to determine the maximum braking distances and stop times that can be expected.
9.4.1 Acceptance test for Safe Torque Off (STO)

"Safe Torque Off" (STO) function
This test comprises the following steps:

Table 9-8 “Safe Torque Off” (STO) function

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Initial state</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Drive in “Ready” status (p0010 = 0)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>STO function enabled (p9601.0 = 1, p9801.0 = 1)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>No safety faults and alarms (r0945, r2122, r2132)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>r9772.0 = r9772.1 = 0 (STO deselected and inactive – CU)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>r9872.0 = r9872.1 = 0 (STO deselected and inactive – MM)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>r9773.0 = r9773.1 = 0 (STO deselected and inactive – drive)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>When terminals are grouped for &quot;Safe Torque Off&quot;:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>r9774.0 = r9774.1 = 0 (STO deselected and inactive - group)</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Run the drive</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Ensure that the correct drive is running</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Select STO when issuing the traversing command</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Check the following:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• The drive coasts to a standstill or is braked and stopped by the mechanical brake (if available and configured (p1215, p9602, p9802)).</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• No safety faults and alarms (r0945, r2122, r2132)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• r9772.0 = r9772.1 = 1 (STO selected and active – CU)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• r9872.0 = r9872.1 = 1 (STO selected and active – MM)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• r9773.0 = r9773.1 = 1 (STO selected and active – drive)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• When terminals are grouped for &quot;Safe Torque Off&quot;:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>r9774.0 = r9774.1 = 1 (STO selected and active - group)</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Deselect STO</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>Check the following:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• No safety faults and alarms (r0945, r2122, r2132)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• r9772.0 = r9772.1 = 0 (STO deselected and inactive – CU)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• r9872.0 = r9872.1 = 0 (STO deselected and inactive – MM)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• r9773.0 = r9773.1 = 0 (STO deselected and inactive – drive)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• When terminals are grouped for &quot;Safe Torque Off&quot;:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>r9774.0 = r9774.1 = 0 (STO deselected and inactive - group)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• r0046.0 = 1 (drive in &quot;Power-on inhibit&quot; state)</td>
<td></td>
</tr>
</tbody>
</table>

Note:
The acceptance test must be carried out for each configured control, which may be via terminals, via the TM54F or via PROFIsafe.


### 9.4 Acceptance tests

#### 9.4.1 Acceptance tests

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.</td>
<td>Acknowledge &quot;Power-on inhibit&quot; and run the drive</td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>Ensure that the correct drive is running</td>
<td></td>
</tr>
<tr>
<td></td>
<td>The following is tested:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Correct DRIVE-CLiQ wiring between Control Unit and Motor Modules</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Correct assignment of drive No. – Motor Module – motor</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• The hardware is functioning properly</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• The switch-off signal paths are wired correctly</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Correct assignment of the terminals for STO on the Control Unit</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Correct STO grouping (if available)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Correct parameterization of the STO function</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Routine for forced dormant error detection of the switch-off signal paths</td>
<td></td>
</tr>
</tbody>
</table>

#### 9.4.2 Acceptance test for Safe Stop 1, time controlled (SS1)

"Safe Stop 1" function (SS1, time-controlled)

This test comprises the following steps:

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Initial state</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Drive in &quot;Ready&quot; status (p0010 = 0)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>STO function enabled (p9601.0 = 1, p9801.0 = 1)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Enable SS1 function (p9652 &gt; 0, p9852 &gt; 0)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>No safety faults and alarms (r0945, r2122, r2132)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>r9772.0 = r9772.1 = 0 (STO deselected and inactive – CU)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>r9872.0 = r9872.1 = 0 (STO deselected and inactive – MM)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>r9773.0 = r9773.1 = 0 (STO deselected and inactive – drive)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>r9772.2 = r9872.2 = 0 (SS1 not requested – CU and MM)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>When terminals are grouped for &quot;Safe Torque Off&quot;: r9774.0 = r9774.1 = 0 (STO deselected and inactive - group)</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Run the drive</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Ensure that the correct drive is running</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Select SS1 when the run command is issued</td>
<td></td>
</tr>
</tbody>
</table>

Note:
The acceptance test must be carried out for each configured control, which may be via terminals, via the TM54F or via PROFIsafe.
<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.</td>
<td>Check the following:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• The drive is braked along the OFF3 ramp (p1135)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Before the SS1 delay time (p9652, p9852) expires, the following applies:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• r9772.0 = r9772.1 = 0 (STO deselected and inactive - CU)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• r9872.0 = r9872.1 = 0 (STO deselected and inactive – MM)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• r9772.2 = r9872.2 = 1 (SS1 active – CU and MM)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• r9773.0 = r9773.1 = 0 (STO deselected and inactive - drive)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• r9773.2 = 1 (SS1 active – drive)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>STO is initiated after the SS1 delay time expires (p9652, p9852).</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• No safety faults and alarms (r0945, r2122, r2132)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• r9772.0 = r9772.1 = 1 (STO selected and active - CU)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• r9872.0 = r9872.1 = 1 (STO selected and active – MM)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• r9772.2 = r9872.2 = 0 (SS1 inactive – CU and MM)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• r9773.0 = r9773.1 = 1 (STO selected and active – drive)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• r9773.2 = 0 (SS1 inactive – drive)</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Canceling SS1</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>Check the following:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• No safety faults and alarms (r0945, r2122, r2132)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• r9772.0 = r9772.1 = 0 (STO deselected and inactive - CU)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• r9872.0 = r9872.1 = 0 (STO deselected and inactive – MM)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• r9772.2 = r9872.2 = 0 (SS1 inactive – CU and MM)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• r9773.0 = r9773.1 = 0 (STO deselected and inactive - drive)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• r9773.2 = 0 (SS1 inactive – drive)</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>Acknowledge &quot;Power-on inhibit&quot; and run the drive</td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>Ensure that the correct drive is running</td>
<td></td>
</tr>
<tr>
<td></td>
<td>The following is tested:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Correct parameterization of the SS1 function</td>
<td></td>
</tr>
</tbody>
</table>
### 9.4 Acceptance tests

#### 9.4.3 Acceptance test for "Safe Brake Control" (SBC)

"Safe Brake Control" function (SBC)

This test comprises the following steps:

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Initial state</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Drive in &quot;Ready&quot; status (p0010 = 0)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• STO function enabled (p9601.0 = 1, p9801.0 = 1)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Enable SBC function (p9602 = 1, p9802 = 1)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Vertical axis: Brake as in sequential control (p1215 = 1)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• No vertical axis: Brake always released (p1215 = 2)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Vertical axis: Mechanical brake is applied</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• No vertical axis: Mechanical brake is released</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• No safety faults or alarms (r0945, r2122)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• r9772.0 = r9772.1 = 0 (STO deselected and inactive – CU)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• r9872.0 = r9872.1 = 0 (STO deselected and inactive – MM)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• r9773.0 = r9773.1 = 0 (STO deselected and inactive – drive)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• r9772.4 = r9872.4 = 0 (SBC not requested – CU and MM)</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Run drive (applied brake is released)</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Ensure that the correct drive is running</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Select STO/SS1 during the traversing command.</td>
<td></td>
</tr>
</tbody>
</table>

Note:
The acceptance test must be carried out for each configured control, which may be via terminals, via the TM54F or via PROFIsafe.

5. Check the following:
   • Drive is braked and stopped by the mechanical brake.
   • No safety faults or alarms (r0945, r2122)
   • r9772.0 = r9772.1 = 1 (STO selected and active – CU)
   • r9872.0 = r9872.1 = 1 (STO selected and active – MM)
   • r9773.0 = r9773.1 = 1 (STO selected and active – drive)
   • r9772.4 = r9872.4 = 1 (SBC requested – CU and MM)

6. Deselect STO
### 9.4 Acceptance tests

#### 7. Check the following:
- **Vertical axis:**
  - Mechanical brake remains applied
- **No vertical axis:**
  - Mechanical brake is released
- **No safety faults or alarms** (r0945, r2122)
- **r9772.0 = r9772.1 = 0** (STO deselected and inactive – CU)
- **r9872.0 = r9872.1 = 0** (STO deselected and inactive – MM)
- **r9773.0 = r9773.1 = 0** (STO deselected and inactive – drive)
- **r9772.4 = r9872.4 = 0** (SBC not requested – CU and MM)
- **r0046.0 = 1** (drive in "Power-on inhibit" state)

#### 8. Acknowledge "Power-on inhibit" and run the drive
(vertial axis: mechanical brake is released)

#### 9. Ensure that the correct drive is running
The following is tested:
- The brake is connected properly
- The hardware is functioning properly
- The SBC is parameterized correctly
- Routine for the forced dormant error detection of the brake control

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.</td>
<td>Check the following:</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>Acknowledge &quot;Power-on inhibit&quot; and run the drive</td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>Ensure that the correct drive is running</td>
<td></td>
</tr>
</tbody>
</table>
9.4 Acceptance tests

9.4.4 Acceptance test for Safe Stop 1, time and acceleration controlled

"Safe Stop 1" function (SS1, time and acceleration controlled)

Note
As far as possible, acceptance tests should be carried out at the maximum possible machine speed and acceleration rates. This is so that the maximum braking distances and stop times that can be expected can be determined.

This test comprises the following steps:

Table 9-11 "Safe Stop 1" function (SS1)

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Initial state</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Drive in &quot;Ready&quot; status (p0010 = 0)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Safety Integrated extended functions enabled (p9601.2 = 1)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• SOS/SLS function enabled (p9501.0 = 1)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• No safety alarm (r0945, r2122, r9747)</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Run the drive</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Ensure that the correct drive is running</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Start Trace (trigger r9720.1 = 0)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Trace recording of the following values:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Safe actual speed (r9714)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• SS1 deactivation (r9720.1)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• STO active (r9722.0)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• SS1 active (r9722.1)</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Select SS1 while the drive is moving</td>
<td></td>
</tr>
</tbody>
</table>

Note:
The acceptance test must be conducted for each configured control which can be set, for example, by way of TM54F or PROFIsafe.

6. The drive must decelerate to the standstill limit
7. Save / print the Trace (refer to the example below)
8. Canceling SS1
9. Acknowledge "Power-on inhibit" and run the drive
10. Ensure that the correct drive is running
9.4 Acceptance tests

9.4.5 Acceptance test for Safe Stop 2 (SS2)

"Safe Stop 2" function (SS2)

The functional test must be carried out separately for each drive (as far as the machine allows).

The test comprises the following steps:

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Status</th>
</tr>
</thead>
</table>
| 1.  | Initial state  
• Drive in "Ready" status (p0010 = 0)  
• Safety Integrated Extended Functions enabled (p9601.2 = 1)  
• SOS/SLS function enabled (p9501.0 = 1)  
• No safety alarm (r0945, r2122, r9747) |        |
| 2.  | Run the drive |        |
| 3.  | Ensure that the correct drive is running |        |

Figure 9-1 Example Trace SS1
9.4 Acceptance tests

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.</td>
<td>Start Trace (trigger SS2 selected r9720.2 = 0)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Trace recording of the following values:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Safe actual speed (r9714)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• SS2 deactivation (r9720.2)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• SS2 selected and active (r9722.2)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• SOS selected and active (r9722.3)</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Select SS2 while the drive is moving</td>
<td></td>
</tr>
</tbody>
</table>

**Note:**
The acceptance test must be conducted for each configured control which can be set, for example, by way of TM54F or PROFIsafe.

6. The drive must decelerate to the standstill limit

7. Save / print the Trace (refer to the example below)

8. SS2 deselected and inactive

9. Drive returns to the setpoint

---

**Example of the Trace**

---

![Trace Diagram](image)  
**Figure 9-2 Example Trace SS2**
9.4.6 Acceptance test for Safe Operating Stop (SOS)

"Safe Operating Stop" (SOS) function

The functional test must be carried out separately for each drive (as far as the machine allows).

---

**Note**

As far as possible, acceptance tests should be carried out at the maximum possible machine speed and acceleration rates. This is so that the maximum braking distances and stop times that can be expected can be determined.

---

The test comprises the following steps:

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Initial state</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Drive in &quot;Ready&quot; status (p0010 = 0)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Safety Integrated extended functions enabled (p9601.2 = 1)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• SOS/SLS function enabled (p9501.0 = 1)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• No safety alarm (r0945, r2122, r9747)</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Activation of the acceptance test mode by means of p9370 = p9570 = 00AC (hex)</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Deactivate any speed setpoint limit in the higher-level controller</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Start trace (STO trigger active)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Trace recording of the following values:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Safe actual position value (r9713[0/1])</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• STOP A or B active (r9721.12)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• STO selected and active (r9721.0)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• SOS selected and active (r9722.3)</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Run the drive beyond the standstill limit set in p9330/p9530</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>The drive must decelerate to the standstill limit</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>Save / print the Trace (refer to the example below)</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>Deactivation of the acceptance test mode by means of p9370 = p9570 = 0000 (hex)</td>
<td></td>
</tr>
</tbody>
</table>
9.4 Acceptance tests

Example of the Trace

9.4.7 Acceptance test for Safely Limited Speed (SLS)

"Safely Limited Speed" (SLS) function

The functional test must be carried out separately for each drive and for each SLS speed limit used (as far as the machine allows).

The test comprises the following steps:

Table 9- 14 "Safely Limited Speed" (SLS) function

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Initial state</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Drive in &quot;Ready&quot; status (p0010 = 0)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Safety Integrated Extended Functions enabled (p9601.2 = 1)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• SOS/SLS function enabled (p9501.0 = 1)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• No safety alarm (r0945, r2122, r9747)</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Activation of the acceptance test mode by means of p9370 = p9570 = 00AC (hex)</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Deactivate any speed setpoint limit in the higher-level controller</td>
<td></td>
</tr>
</tbody>
</table>
## 9.4 Acceptance tests

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Status</th>
</tr>
</thead>
</table>
| 4.  | Start Trace (trigger r9722.7 = 1/0 edge)  
Trace recording of the following values:  
• Safe actual speed (r9714)  
• Parameterized STOP x active (r9721.13)  
• SOS selected and active (r9722.3)  
• SLS selected and active (r9722.4) |        |
| 5.  | Operate the drive above the speed limit set in p9331/p9531, triggered by the parameterized stop function |        |
| 6.  | The drive must decelerate to the standstill limit |        |
| 7.  | Save / print the Trace (refer to the example below) |        |
| 8.  | Deactivation of the acceptance test mode by means of p9370 = p9570 = 0000 (hex) |        |

### Example of the Trace

![Example Trace SLS](image)

Figure 9-4  Example Trace SLS
9.4 Acceptance tests

9.4.8 Acceptance test for Safe Speed Monitor (SSM)

"Safe Speed Monitor" (SSM) function

The functional test must be carried out separately for each drive (as far as the machine allows).

The test comprises the following steps:

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Initial state</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Drive in &quot;Ready&quot; status (p0010 = 0)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Safety Integrated Extended Functions enabled (p9601.2 = 1)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- SOS/SLS function enabled (p9501.0 = 1)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- No safety alarm (r0945, r2122, r9747)</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Start Trace (trigger r9722.15 = 1/0 edge)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Trace recording of the following values:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Safe actual speed (r9714)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- SSM (n below limit) r9722.15</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Operate the drive above the speed limit set in p9346/p9546 plus the hysteresis set in p9347/p9547</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Operate the drive below the speed limit set in p9346/p9546 minus the hysteresis set in p9347/p9547</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Save / print the Trace (refer to the example below)</td>
<td></td>
</tr>
</tbody>
</table>
9.4 Acceptance tests

Example of the Trace

Figure 9-5  Example Trace SSM
9.5 Completion of certificate

SI parameters

<table>
<thead>
<tr>
<th></th>
<th>Specified values checked?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>Control Unit</td>
<td></td>
</tr>
<tr>
<td>Motor Module</td>
<td></td>
</tr>
</tbody>
</table>

Checksums

<table>
<thead>
<tr>
<th>Drive</th>
<th>Checksum (8 hex)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>Drive number</td>
</tr>
<tr>
<td></td>
<td>Control Unit (p9798)</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Checksum for detecting changes, see section "Safety Logbook" in SINAMICS S120 Function Manual Safety Integrated

Safety logbook

<table>
<thead>
<tr>
<th></th>
<th>Functional</th>
</tr>
</thead>
<tbody>
<tr>
<td>Checksums</td>
<td>r9781[0] =</td>
</tr>
<tr>
<td>Time stamp</td>
<td>r9782[0] =</td>
</tr>
</tbody>
</table>

Data backup

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Storage medium</th>
<th>Storage location</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Type</td>
<td>Designation</td>
</tr>
<tr>
<td>Parameter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PLC program</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Circuit diagrams</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Acceptance test and acceptance report
9.5 Completion of certificate

Countersignatures

**Commissioning engineer**
This confirms that the tests and checks have been carried out properly.

<table>
<thead>
<tr>
<th>Date</th>
<th>Name</th>
<th>Company/dept.</th>
<th>Signature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Machine manufacturer**
This confirms that the parameters recorded above are correct.

<table>
<thead>
<tr>
<th>Date</th>
<th>Name</th>
<th>Company/dept.</th>
<th>Signature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Acceptance test and acceptance report

9.5 Completion of certificate
## Appendix A

### A.1 List of abbreviations

**Note:**
The following list of abbreviations contains the abbreviations and their meanings used in the entire SINAMICS user documentation.

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Derivation of abbreviation</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A...</td>
<td>Alarm</td>
<td>Alarm</td>
</tr>
<tr>
<td>AC</td>
<td>Alternating Current</td>
<td>Alternating current</td>
</tr>
<tr>
<td>ADC</td>
<td>Analog Digital Converter</td>
<td>Analog digital converter</td>
</tr>
<tr>
<td>AI</td>
<td>Analog Input</td>
<td>Analog input</td>
</tr>
<tr>
<td>AIM</td>
<td>Active Interface Module</td>
<td>Active Interface Module</td>
</tr>
<tr>
<td>ALM</td>
<td>Active Line Module</td>
<td>Active Line Module</td>
</tr>
<tr>
<td>AO</td>
<td>Analog Output</td>
<td>Analog output</td>
</tr>
<tr>
<td>AOP</td>
<td>Advanced Operator Panel</td>
<td>Advanced Operator Panel</td>
</tr>
<tr>
<td>APC</td>
<td>Advanced Positioning Control</td>
<td>Advanced positioning control</td>
</tr>
<tr>
<td>AR</td>
<td>Automatic Restart</td>
<td>Automatic restart</td>
</tr>
<tr>
<td>ASC</td>
<td>Armature Short-Circuit</td>
<td>Armature short-circuit</td>
</tr>
<tr>
<td>ASCII</td>
<td>American Standard Code for Information Interchange</td>
<td>American Standard Code for Information Interchange</td>
</tr>
<tr>
<td>ASM</td>
<td>Asynchronmotor</td>
<td>Induction motor</td>
</tr>
<tr>
<td>BERO</td>
<td>-</td>
<td>Tradename for a type of contactless proximity switch</td>
</tr>
<tr>
<td>BI</td>
<td>Binector Input</td>
<td>Binector input</td>
</tr>
<tr>
<td>BIA</td>
<td>Berufsgenossenschaftliches Institut für Arbe-German Institute for Occupational Safety itsicherheit</td>
<td>Berufsgenossenschaftliches Institut für Arbe-German Institute for Occupational Safety itsicherheit</td>
</tr>
<tr>
<td>BICO</td>
<td>Binector Connector Technology</td>
<td>Binector connector technology</td>
</tr>
<tr>
<td>BLM</td>
<td>Basic Line Module</td>
<td>Basic Line Module</td>
</tr>
<tr>
<td>BO</td>
<td>Binector Output</td>
<td>Binector output</td>
</tr>
<tr>
<td>BOP</td>
<td>Basic Operator Panel</td>
<td>Basic Operator Panel</td>
</tr>
</tbody>
</table>
## Appendix A

### A.1 List of abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Derivation of abbreviation</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>Capacitance</td>
<td>Capacitance</td>
</tr>
<tr>
<td>C...</td>
<td>-</td>
<td>Safety message</td>
</tr>
<tr>
<td>CAN</td>
<td>Controller Area Network</td>
<td>Serial bus system</td>
</tr>
<tr>
<td>CBC</td>
<td>Communication Board CAN</td>
<td>CAN communication board</td>
</tr>
<tr>
<td>CD</td>
<td>Compact Disc</td>
<td>Compact Disc</td>
</tr>
<tr>
<td>CDS</td>
<td>Command Data Set</td>
<td>Command data set</td>
</tr>
<tr>
<td>CF Card</td>
<td>CompactFlash Card</td>
<td>CompactFlash card</td>
</tr>
<tr>
<td>CI</td>
<td>Connector input</td>
<td>Connector input</td>
</tr>
<tr>
<td>CLC</td>
<td>Clearance Control</td>
<td>Clearance control</td>
</tr>
<tr>
<td>CNC</td>
<td>Computer Numerical Control</td>
<td>Computer numerical control</td>
</tr>
<tr>
<td>CO</td>
<td>Connector Output</td>
<td>Connector output</td>
</tr>
<tr>
<td>CO/BO</td>
<td>Connector Output/Binector Output</td>
<td>Connector output/Binector output</td>
</tr>
<tr>
<td>COB-ID</td>
<td>CAN Object-Identification</td>
<td>CAN object identification</td>
</tr>
<tr>
<td>COM</td>
<td>Common contact of a change-over relay</td>
<td>Common contact of a change-over relay</td>
</tr>
<tr>
<td>COMM</td>
<td>Commissioning</td>
<td>Commissioning</td>
</tr>
<tr>
<td>CP</td>
<td>Communications Processor</td>
<td>Communications processor</td>
</tr>
<tr>
<td>CPU</td>
<td>Central Processing Unit</td>
<td>Central processing unit</td>
</tr>
<tr>
<td>CRC</td>
<td>Cyclic Redundancy Check</td>
<td>Cyclic redundancy check</td>
</tr>
<tr>
<td>CSM</td>
<td>Control Supply Module</td>
<td>Control Supply Module</td>
</tr>
<tr>
<td>CU</td>
<td>Control Unit</td>
<td>Control Unit</td>
</tr>
<tr>
<td>DAC</td>
<td>Digital Analog Converter</td>
<td>Digital Analog Converter</td>
</tr>
<tr>
<td>DC</td>
<td>Direct Current</td>
<td>Direct current</td>
</tr>
<tr>
<td>DCB</td>
<td>Drive Control Block</td>
<td>Drive Control Block</td>
</tr>
<tr>
<td>DCC</td>
<td>Drive Control Chart</td>
<td>Drive Control Chart</td>
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<tr>
<td>DCC</td>
<td>Data Cross-Check</td>
<td>Data cross-check</td>
</tr>
<tr>
<td>DCN</td>
<td>Direct Current Negative</td>
<td>Direct current negative</td>
</tr>
<tr>
<td>DCP</td>
<td>Direct Current Positive</td>
<td>Direct current positive</td>
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<td>DDS</td>
<td>Drive Data Set</td>
<td>Drive data set</td>
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<tr>
<td>DI</td>
<td>Digital Input</td>
<td>Digital input</td>
</tr>
<tr>
<td>DI/DO</td>
<td>Digital Input/Digital Output</td>
<td>Bidirectional digital input/digital output</td>
</tr>
<tr>
<td>DMC</td>
<td>DRIVE-CLIQ Hub Module Cabinet</td>
<td>DRIVE-CLIQ Hub Module Cabinet</td>
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<td>DME</td>
<td>DRIVE-CLIQ Hub Module External</td>
<td>DRIVE-CLIQ Hub Module External</td>
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<tr>
<td>DO</td>
<td>Digital Output</td>
<td>Digital output</td>
</tr>
<tr>
<td>DO</td>
<td>Drive Object</td>
<td>Drive object</td>
</tr>
<tr>
<td>DP</td>
<td>Distributed I/Os</td>
<td>Distributed I/Os</td>
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<tr>
<td>DPRAM</td>
<td>Dual-Port Random Access Memory</td>
<td>Dual-Port Random Access Memory</td>
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### Appendix A

#### A.1  List of abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Derivation of abbreviation</th>
<th>Meaning</th>
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<tbody>
<tr>
<td>DRAM</td>
<td>Dynamic Random Access Memory</td>
<td>Dynamic Random Access Memory</td>
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<td>DRIVE-CliQ</td>
<td>Drive Component Link with IQ</td>
<td>Drive Component Link with IQ</td>
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<td>DSC</td>
<td>Dynamic Servo Control</td>
<td>Dynamic servo control</td>
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<tr>
<td>E</td>
<td></td>
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<tr>
<td>EASC</td>
<td>External Armature Short-Circuit</td>
<td>External armature short-circuit</td>
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<tr>
<td>EDS</td>
<td>Encoder Data Set</td>
<td>Encoder data set</td>
</tr>
<tr>
<td>ELCB</td>
<td>Earth Leakage Circuit Breaker</td>
<td>Earth leakage circuit breaker</td>
</tr>
<tr>
<td>ELP</td>
<td>Earth Leakage Protection</td>
<td>Earth leakage protection</td>
</tr>
<tr>
<td>EMC</td>
<td>Electromagnetic Compatibility</td>
<td>Electromagnetic compatibility</td>
</tr>
<tr>
<td>EMF</td>
<td>Electromagnetic Force</td>
<td>Electromagnetic force</td>
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<tr>
<td>EN</td>
<td>Europäische Norm</td>
<td>European Standard</td>
</tr>
<tr>
<td>EnDat</td>
<td>Encoder-Data-Interface</td>
<td>Encoder interface</td>
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<td>EP</td>
<td>Enable Pulses</td>
<td>Enable Pulses</td>
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<td>EPOS</td>
<td>Einfachpositionier</td>
<td>Basic positionier</td>
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<td>Engineering System</td>
<td>Engineering system</td>
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<td>ESB</td>
<td>Ersatzschaltbild</td>
<td>Equivalent circuit diagram</td>
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<td>ESD</td>
<td>Electrostatic Sensitive Devices</td>
<td>Electrostatic sensitive devices</td>
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<tr>
<td>FSR</td>
<td>Extended Stop and Retract</td>
<td>Extended stop and retract</td>
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<td>F</td>
<td>Fault</td>
<td>Fault</td>
</tr>
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<td>FAQ</td>
<td>Frequently Asked Questions</td>
<td>Frequently asked questions</td>
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<td>Free Blocks</td>
<td>Free function blocks</td>
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<td>Function Control Chart</td>
<td>Function Control Chart</td>
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<td>FCC</td>
<td>Flux Current Control</td>
<td>Flux current control</td>
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<td>FD</td>
<td>Function Diagram</td>
<td>Function diagram</td>
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<td>F-DI</td>
<td>Failsafe Digital Input</td>
<td>Failsafe digital input</td>
</tr>
<tr>
<td>F-DO</td>
<td>Failsafe Digital Output</td>
<td>Failsafe digital output</td>
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<tr>
<td>FEM</td>
<td>Fremderregier Synchronmotor</td>
<td>Separate-field synchronous motor</td>
</tr>
<tr>
<td>FEPRM</td>
<td>Flash-EPROM</td>
<td>Non-volatile write and read memory</td>
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<tr>
<td>FG</td>
<td>Function Generator</td>
<td>Function generator</td>
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<tr>
<td>FI</td>
<td>-</td>
<td>Fault current</td>
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<tr>
<td>FO</td>
<td>Fiber Optic Cable</td>
<td>Fiber optic cable</td>
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<td>FPGA</td>
<td>Field Programmable Gate Array</td>
<td>Field Programmable Gate Array</td>
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<tr>
<td>FW</td>
<td>Firmware</td>
<td>Firmware</td>
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# Appendix A

## A.1 List of abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Derivation of abbreviation</th>
<th>Meaning</th>
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<tr>
<td>G</td>
<td>Gigabyte</td>
<td>Gigabyte</td>
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<tr>
<td>GB</td>
<td>Gigabyte</td>
<td>Global Control Telegram (Broadcast Telegram)</td>
</tr>
<tr>
<td>GC</td>
<td>Ground</td>
<td>Reference potential for all signal and operating voltages, usually defined with 0 V (also designated as M)</td>
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<tr>
<td>GND</td>
<td>Gerätetastmndatei</td>
<td>Device master file: describes the features of a PROFIBUS slave</td>
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<td>GSV</td>
<td>Gate Supply Voltage</td>
<td>Gate supply voltage</td>
</tr>
<tr>
<td>GUID</td>
<td>Globally Unique Identifier</td>
<td>Globally unique identifier</td>
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<tr>
<td>HF</td>
<td>High Frequency</td>
<td>High frequency</td>
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<tr>
<td>HFD</td>
<td>Hochfrequenzdrossel</td>
<td>High-frequency reactor</td>
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<tr>
<td>HMI</td>
<td>Human Machine Interface</td>
<td>Human Machine Interface</td>
</tr>
<tr>
<td>HTL</td>
<td>High-Threshold Logic</td>
<td>High-threshold logic</td>
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<td>HW</td>
<td>Hardware</td>
<td>Hardware</td>
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<td>I/O</td>
<td>Input/Output</td>
<td>Input/Output</td>
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<tr>
<td>I2C</td>
<td>Inter Integrated Circuit</td>
<td>Internal serial data bus</td>
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<td>IASC</td>
<td>Internal Armature Short-Circuit</td>
<td>Internal armature short-circuit</td>
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<tr>
<td>ID</td>
<td>Identifier</td>
<td>Identifier</td>
</tr>
<tr>
<td>IEC</td>
<td>International Electrotechnical Commission</td>
<td>International standard in electrical engineering</td>
</tr>
<tr>
<td>IF</td>
<td>Interface</td>
<td>Interface</td>
</tr>
<tr>
<td>IGBT</td>
<td>Insulated Gate Bipolar Transistor</td>
<td>Bipolar transistor with insulated control electrode</td>
</tr>
<tr>
<td>IGCT</td>
<td>Integrated Gate-Controlled Thyristor</td>
<td>Semiconductor circuit-breaker with integrated control electrode</td>
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<tr>
<td>IL</td>
<td>Impulslöschung</td>
<td>Pulse suppression</td>
</tr>
<tr>
<td>IP</td>
<td>Internet Protocol</td>
<td>Internet Protocol</td>
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<tr>
<td>IPO</td>
<td>Interpolator</td>
<td>Interpolator</td>
</tr>
<tr>
<td>IT</td>
<td>Isolé Terré</td>
<td>Insulated three-phase supply system</td>
</tr>
<tr>
<td>IVP</td>
<td>Internal Voltage Protection</td>
<td>Internal voltage protection</td>
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<tr>
<td>J</td>
<td>Jogging</td>
<td>Jogging</td>
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<tr>
<td>K</td>
<td>Kinetic Pufferung</td>
<td>Kinetic buffering</td>
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### A.1 List of abbreviations

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<thead>
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<th>Abbreviation</th>
<th>Derivation of abbreviation</th>
<th>Meaning</th>
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<td>Kp</td>
<td>-</td>
<td>Proportional gain</td>
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<tr>
<td>KTY</td>
<td>-</td>
<td>Special temperature sensor</td>
</tr>
<tr>
<td>L</td>
<td>-</td>
<td>Formula symbol for inductance</td>
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<tr>
<td>LED</td>
<td>Light Emitting Diode</td>
<td>Light Emitting Diode</td>
</tr>
<tr>
<td>LIN</td>
<td>Linearmotor</td>
<td>Linear motor</td>
</tr>
<tr>
<td>LR</td>
<td>Lageregler</td>
<td>Position controller</td>
</tr>
<tr>
<td>LSB</td>
<td>Least Significant Bit</td>
<td>Least Significant Bit</td>
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<tr>
<td>LSC</td>
<td>Line-Side Converter</td>
<td>Line-Side Converter</td>
</tr>
<tr>
<td>LSS</td>
<td>Line Side Switch</td>
<td>Line Side Switch</td>
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<tr>
<td>LU</td>
<td>Length Unit</td>
<td>Length Unit</td>
</tr>
<tr>
<td>M</td>
<td>-</td>
<td>Formula symbol for torque</td>
</tr>
<tr>
<td>M</td>
<td>Masse</td>
<td>Reference potential for all signal and operating voltages, usually defined with 0 V (also designated as GND)</td>
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<tr>
<td>MB</td>
<td>Megabyte</td>
<td>Megabyte</td>
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<tr>
<td>MCC</td>
<td>Motion Control Chart</td>
<td>Motion Control Chart</td>
</tr>
<tr>
<td>MDS</td>
<td>Motor Data Set</td>
<td>Motor data set</td>
</tr>
<tr>
<td>MLFB</td>
<td>Maschinenlesbare Fabrikatebezeichnung</td>
<td>Machine-readable product designation</td>
</tr>
<tr>
<td>MMC</td>
<td>Man-Machine Communication</td>
<td>Man-Machine Communication</td>
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<tr>
<td>MMC</td>
<td>Micro Memory Card</td>
<td>Micro Memory Card</td>
</tr>
<tr>
<td>MSb</td>
<td>Most Significant Bit</td>
<td>Most Significant Bit</td>
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<td>MSC</td>
<td>Motor-Side Converter</td>
<td>Motor-Side Converter</td>
</tr>
<tr>
<td>MSCY_C1</td>
<td>Master Slave Cycle Class 1</td>
<td>Cyclic communication between master (class 1) and slave</td>
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<tr>
<td>MT</td>
<td>Messtaster</td>
<td>Probe</td>
</tr>
<tr>
<td>N</td>
<td>Not Connected</td>
<td>Not connected</td>
</tr>
<tr>
<td>N..</td>
<td>No Report</td>
<td>No report or internal message</td>
</tr>
<tr>
<td>NAMUR</td>
<td>Normenarbeitsgemeinschaft für Mess- und Regeltechnik in der chemischen Industrie</td>
<td>Standardization association for measurement and control in chemical industries</td>
</tr>
<tr>
<td>NC</td>
<td>Normally Closed (contact)</td>
<td>Normally Closed (contact)</td>
</tr>
<tr>
<td>NC</td>
<td>Numerical Control</td>
<td>Numerical control</td>
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<tr>
<td>NEMA</td>
<td>National Electrical Manufac-</td>
<td>Standards association in USA</td>
</tr>
<tr>
<td></td>
<td>ters Association</td>
<td></td>
</tr>
<tr>
<td>NO</td>
<td>Normally Open (contact)</td>
<td>Normally Open (contact)</td>
</tr>
<tr>
<td>OA</td>
<td>Open Architecture</td>
<td>Open Architecture</td>
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## Appendix A

### A.1 List of abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Derivation of abbreviation</th>
<th>Meaning</th>
</tr>
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<tbody>
<tr>
<td>OC</td>
<td>Operating Condition</td>
<td>Operating condition</td>
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<tr>
<td>OEM</td>
<td>Original Equipment Manufacturer</td>
<td>Original Equipment Manufacturer</td>
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<tr>
<td>OLP</td>
<td>Optical Link Plug</td>
<td>Optical link plug</td>
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<tr>
<td>OMI</td>
<td>Option Module Interface</td>
<td>Option Module Interface</td>
</tr>
<tr>
<td>P</td>
<td></td>
<td>Setting parameter</td>
</tr>
<tr>
<td>PB</td>
<td>PROFIBUS</td>
<td>PROFIBUS</td>
</tr>
<tr>
<td>PcCtrl</td>
<td>PC Control</td>
<td>Master control</td>
</tr>
<tr>
<td>PD</td>
<td>PROFIdrive</td>
<td>PROFIdrive</td>
</tr>
<tr>
<td>PDS</td>
<td>Power unit Data Set</td>
<td>Power unit data set</td>
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<tr>
<td>PE</td>
<td>Protective Earth</td>
<td>Protective Earth</td>
</tr>
<tr>
<td>PELV</td>
<td>Protective Extra Low Voltage</td>
<td>Protective Extra Low Voltage</td>
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<td>PEM</td>
<td>Permanenterregtter Synchronmotor</td>
<td>Permanent-field synchronous motor</td>
</tr>
<tr>
<td>PG</td>
<td>Programmiergerät</td>
<td>Programming device</td>
</tr>
<tr>
<td>PI</td>
<td>Proportional Integral</td>
<td>Proportional Integral</td>
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<tr>
<td>PID</td>
<td>Proportional Integral Differential</td>
<td>Proportional Integral Differential</td>
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<tr>
<td>PLC</td>
<td>Programmable Logic Controller</td>
<td>Programmable logic controller</td>
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<tr>
<td>PLL</td>
<td>Phase-Locked Loop</td>
<td>Phase-Locked Loop</td>
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<td>PN</td>
<td>PROFINET</td>
<td>PROFINET</td>
</tr>
<tr>
<td>PNO</td>
<td>PROFIBUS Nutzerorganisation</td>
<td>PROFIBUS User Organization (PROFIBUS International)</td>
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<tr>
<td>PPI</td>
<td>Point to Point Interface</td>
<td>Point to point interface</td>
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<tr>
<td>PRBS</td>
<td>Pseudo Random Binary Signal</td>
<td>Pseudo Random Binary Signal</td>
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<tr>
<td>PROFIBUS</td>
<td>Process Field Bus</td>
<td>Serial data bus</td>
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<td>PS</td>
<td>Power Supply</td>
<td>Power supply</td>
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<td>PSA</td>
<td>Power Stack Adapter</td>
<td>Power stack adapter</td>
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<td>PTC</td>
<td>Positive Temperature Coefficient</td>
<td>Positive Temperature Coefficient</td>
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<td>PTP</td>
<td>Point-To-Point</td>
<td>Point-to-point</td>
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<td>PWM</td>
<td>Pulse Width Modulation</td>
<td>Pulse width modulation</td>
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<tr>
<td>PZD</td>
<td>Prozessdaten</td>
<td>Process data</td>
</tr>
<tr>
<td>Q</td>
<td></td>
<td>Display parameter (read only)</td>
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<td>R</td>
<td></td>
<td>Read and write memory</td>
</tr>
<tr>
<td>RAM</td>
<td>Random Access Memory</td>
<td>Residual current circuit breaker</td>
</tr>
<tr>
<td>RCCB</td>
<td>Residual Current Circuit Breaker</td>
<td>Residual current device</td>
</tr>
<tr>
<td>RCD</td>
<td>Residual Current Device</td>
<td>Ramp-function generator</td>
</tr>
<tr>
<td>RFG</td>
<td>Ramp-Function Generator</td>
<td>Ramp-function generator</td>
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<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Derivation of abbreviation</th>
<th>Meaning</th>
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<tr>
<td>RJ45</td>
<td>Registered Jack 45</td>
<td>Describes an 8-pole connector system for data transfer with shielded or unshielded multicore copper cables</td>
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<td>RKA</td>
<td>Rückkühlanlage</td>
<td>Cooling unit</td>
</tr>
<tr>
<td>RO</td>
<td>Read Only</td>
<td>Read only</td>
</tr>
<tr>
<td>RPDO</td>
<td>Receive Process Data Object</td>
<td>Receive Process Data Object</td>
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<tr>
<td>RS232</td>
<td>Recommended Standard 232</td>
<td>Interface standard for conducted serial data transfer between a transmitter and a receiver (also designated as EIA232)</td>
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<tr>
<td>RS485</td>
<td>Recommended Standard 485</td>
<td>Interface standard for a conducted differential, parallel and/or serial bus system (data transfer between several transmitters and receivers, also designated as EIA485)</td>
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<td>RTC</td>
<td>Real Time Clock</td>
<td>Real time clock</td>
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<tr>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S1</td>
<td>-</td>
<td>Continuous duty</td>
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<tr>
<td>S3</td>
<td>-</td>
<td>Intermittent duty</td>
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<tr>
<td>SBC</td>
<td>Safe Brake Control</td>
<td>Safe brake control</td>
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<td>SBH</td>
<td>Sicherer Betriebshalt</td>
<td>Safe Operating Stop</td>
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<td>SDR</td>
<td>-</td>
<td>Safe Acceleration Monitor</td>
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<td>Safe Cam</td>
<td>Safe cam</td>
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<td>SD Cord</td>
<td>ScourcDigital Cord</td>
<td>Scourc Digital Cord</td>
</tr>
<tr>
<td>SE</td>
<td>Sicherer Software-Endschalter</td>
<td>Safe software limit switch</td>
</tr>
<tr>
<td>SG</td>
<td>Sicher reduzierte Geschwindigkeit</td>
<td>Safety reduced speed</td>
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<td>SGA</td>
<td>Sicherheitsgerichteter Ausgang</td>
<td>Safety-related output</td>
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<td>SGE</td>
<td>Sicherheitsgerichteter Eingang</td>
<td>Safety-related input</td>
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<td>Sicherer Halt</td>
<td>Safe standstill</td>
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<td>SP</td>
<td>Safety Integrated</td>
<td>Safety Integrated</td>
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<td>SIL</td>
<td>Safety Integrity Level</td>
<td>Safety Integrity Level</td>
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<td>SLM</td>
<td>Smart Line Module</td>
<td>Smart Line Module</td>
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<td>SLP</td>
<td>Safely-Limited Position</td>
<td>Safely-Limited Position</td>
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<td>SLS</td>
<td>Safely-Limited Speed</td>
<td>Safely Limited Speed</td>
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<tr>
<td>SLVC</td>
<td>Sensorless Vector Control</td>
<td>Sensorless Vector Control</td>
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<td>SM</td>
<td>Sensor Module</td>
<td>Sensor Module</td>
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<td>Sensor Module Cabinet</td>
<td>Sensor Module Cabinet</td>
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<td>SME</td>
<td>Sensor Module External</td>
<td>Sensor Module External</td>
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<td>SN</td>
<td>Sicherer Software-Nocken</td>
<td>Safe software cam</td>
</tr>
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<td>SOS</td>
<td>Safe Operating Stop</td>
<td>Safe operating stop</td>
</tr>
<tr>
<td>SP</td>
<td>Service Pack</td>
<td>Service pack</td>
</tr>
<tr>
<td>SPC</td>
<td>Setpoint Channel</td>
<td>Setpoint channel</td>
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### A.1 List of abbreviations

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<thead>
<tr>
<th>Abbreviation</th>
<th>Derivation of abbreviation</th>
<th>Meaning</th>
</tr>
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<td>SPI</td>
<td>Serial Peripheral Interface</td>
<td>Serial I/O interface</td>
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<td>SS1</td>
<td>Safe Stop 1</td>
<td>Safe Stop 1 (time-monitored, ramp-monitored)</td>
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<td>Safe Stop 2</td>
<td>Safe Stop 2</td>
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<tr>
<td>SSI</td>
<td>Synchronous Serial Interface</td>
<td>Synchronous serial interface</td>
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<tr>
<td>SSM</td>
<td>Safe Speed Monitor</td>
<td>Safe feedback from speed monitor (n &lt; nx)</td>
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<tr>
<td>SSR</td>
<td>Safe Stop Ramp</td>
<td>Safe brake ramp</td>
</tr>
<tr>
<td>STO</td>
<td>Safe Torque Off</td>
<td>Safely switched-off torque</td>
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<tr>
<td>STW</td>
<td>Steuerwort</td>
<td>Control word</td>
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<tr>
<td>SVA</td>
<td>Space-vector approximation</td>
<td>Space-vector approximation</td>
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<td>T</td>
<td></td>
<td>Terminal Board</td>
</tr>
<tr>
<td>TIA</td>
<td>Totally Integrated Automation</td>
<td>Totally Integrated Automation</td>
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<tr>
<td>TM</td>
<td>Terminal Module</td>
<td>Terminal Module</td>
</tr>
<tr>
<td>TN</td>
<td>Terre Neutre</td>
<td>Grounded three-phase supply system</td>
</tr>
<tr>
<td>Tn</td>
<td></td>
<td>Integral time</td>
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<tr>
<td>TPDO</td>
<td>Transmit Process Data Object</td>
<td>Transmit Process Data Object</td>
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<tr>
<td>TT</td>
<td>Terre Terre</td>
<td>Grounded three-phase supply system</td>
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<tr>
<td>TTL</td>
<td>Transistor-Transistor Logic</td>
<td>Transistor-Transistor-Logic</td>
</tr>
<tr>
<td>Tv</td>
<td></td>
<td>Derivative action time</td>
</tr>
<tr>
<td>U</td>
<td></td>
<td>Underwriters Laboratories Inc.</td>
</tr>
<tr>
<td>UL</td>
<td>Underwriters Laboratories Inc.</td>
<td>Underwriters Laboratories Inc.</td>
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</tr>
<tr>
<td>VC</td>
<td>Vector Control</td>
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<tr>
<td>Vdc</td>
<td></td>
<td>DC link voltage</td>
</tr>
<tr>
<td>VdcN</td>
<td></td>
<td>Partial DC link voltage negative</td>
</tr>
<tr>
<td>VdcP</td>
<td></td>
<td>Partial DC link voltage positive</td>
</tr>
<tr>
<td>VDE</td>
<td>Verband Deutscher Elektrotechniker</td>
<td>Association of German Electrical Engineers</td>
</tr>
<tr>
<td>VDI</td>
<td>Verein Deutscher Ingenieure</td>
<td>Association of German Engineers</td>
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<tr>
<td>VPM</td>
<td>Voltage Protection Module</td>
<td>Voltage Protection Module</td>
</tr>
<tr>
<td>Vpp</td>
<td>Volt peak to peak</td>
<td>Volt peak to peak</td>
</tr>
<tr>
<td>VSM</td>
<td>Voltage Sensing Module</td>
<td>Voltage Sensing Module</td>
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<tr>
<td>WZM</td>
<td>Werkzeugmaschine</td>
<td>Machine tool</td>
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<tr>
<td>X</td>
<td></td>
<td>Extensible Markup Language</td>
</tr>
<tr>
<td>XML</td>
<td>Extensible Markup Language</td>
<td>Extensible Markup Language (standard language for Web publishing and document management)</td>
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### Appendix A

#### A.1 List of abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Derivation of abbreviation</th>
<th>Meaning</th>
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<td>Z</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ZK</td>
<td>Zwischenkreis</td>
<td>DC link</td>
</tr>
<tr>
<td>ZM</td>
<td>Zero Mark</td>
<td>Zero mark</td>
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<tr>
<td>ZSW</td>
<td>Zustandswort</td>
<td>Status word</td>
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Appendix A
A.2 Document structure

### SINAMICS documentation overview (10/2008)

<table>
<thead>
<tr>
<th>General documentation/catalogs</th>
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<tr>
<td>SINAMICS G110</td>
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<tr>
<td>SINAMICS G120</td>
</tr>
<tr>
<td>SINAMICS G130</td>
</tr>
<tr>
<td>SINAMICS G150</td>
</tr>
</tbody>
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| SIMOTION SINAMICS S120        |
| D11.1 Inverter Chassis Units 0.12 kW to 3 kW |
| D11.2 Converter Chassis Units  |
| PM 21 SIMOTION, SINAMICS S120 and Motors for Production Machines |
| D21.3 Converter Cabinet Units 75 kW to 1200 kW |

<table>
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<th>Manufacturer/Service Documentation</th>
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<tbody>
<tr>
<td>SINAMICS G110</td>
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<td>SINAMICS G130</td>
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<td>SINAMICS G150</td>
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| SINAMICS S110                     |
| SINAMICS S120                     |
| SINAMICS S150                     |

<table>
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<tr>
<th>Manufacturer/Service Documentation</th>
</tr>
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<td>SINAMICS S120</td>
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<td>SINAMICS S150</td>
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<thead>
<tr>
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<tbody>
<tr>
<td>SINAMICS G110/G120/Motors</td>
</tr>
<tr>
<td>DOCONCD</td>
</tr>
<tr>
<td>Configuration Manuals</td>
</tr>
<tr>
<td>Motors</td>
</tr>
<tr>
<td>EMC Configuration Guidelines</td>
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If you come across any misprints in this document, please let us know using this form. We would also be grateful for any suggestions and recommendations for improvement.

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<td>SIEMENS AG</td>
<td>Name:</td>
</tr>
<tr>
<td>I DT MC MS1</td>
<td>Address of your Company/Dept.</td>
</tr>
<tr>
<td>P.O. Box 3180</td>
<td>Street:</td>
</tr>
<tr>
<td>D-91050 Erlangen, Federal Republic of Germany</td>
<td>Postal code: Location:</td>
</tr>
<tr>
<td>Fax: +49 (0) 9131 / 98 - 2176 (documentation)</td>
<td>Phone: /</td>
</tr>
<tr>
<td><a href="mailto:docu.motioncontrol@siemens.com">mailto:docu.motioncontrol@siemens.com</a></td>
<td>Fax: /</td>
</tr>
<tr>
<td><a href="http://www.siemens.com/automation/service&amp;support">http://www.siemens.com/automation/service&amp;support</a></td>
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