SIEMENS

Manual

Industrial Controls

Safety Systems

SIRIUS 3SK2 Safety Relays

Edition 08/2017

siemens.com

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SIRIUS 3SK2 Safety Relays

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Legal information

Warning notice system

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

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

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

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

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

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

Qualified Personnel

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

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 complied with. The information in the relevant documentation must be observed.

Trademarks

All names identified by ® are registered trademarks of Siemens AG. The remaining trademarks in this publication may be trademarks whose use by third parties for their own purposes could violate the rights of the owner.

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.

Siemens AG
Division Digital Factory
Postfach 48 48
90026 NÜRNBERG
GERMANY

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Ⓟ 08/2017 Subject to change

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Introduction 1

1.1 Purpose of this manual

This manual contains a detailed description of SIRIUS 3SK2 safety relays and components that can be used with them.

This manual provides you with the information you require to configure, install, connect and diagnose 3SK2 safety relays. A few application examples provide you with a clear and practice-oriented introduction.

1.2 Required basic knowledge

A general knowledge of the following areas is needed in order to understand this manual:

- Low-voltage switchgear
- Digital circuit logic
- Automation systems
- Safety systems

1.3 Validity range

This manual is valid for the 3SK2 safety relays listed below:

Compact basic units	Article number
3SK2 safety relay width 22.5 mm	3SK2112-xAA10
3SK2 safety relay width 45 mm	3SK2122-xAA10
3SK26 diagnostics display	3SK2611-3AA00
3RK35 DP interface (interface module)	3RK3511-xBA10
Safety ES (parameterization software)	3ZS1316-*

x = 1: Screw terminals

x = 2: Spring-loaded terminals

Note

Additional information on system components

The following devices can be combined with 3SK2 safety relays using 3ZY12 device connectors:

- 3SK1 output expansions with 24 V DC supply voltage
- 3RM1 Failsafe motor starters with 24 V DC supply voltage

You will find detailed information on these devices in the relevant product information. See Section Additional documentation (Page 14).

This manual contains additional information about these devices that must be observed when using them with 3SK2 safety relays.

SIEMENS reserves the right of including a Product Information for each new component, and for each component of a later version.

1.4 Topics dealt with

The table below lists the most important topics dealt with, along with their associated subject matter.

Chapter	Contents
Introduction	• Information on this manual and on further documentation/support for configuration
Safety information	• Safety information and intended use
Description	• Features of 3SK2 safety relays • Features of the 3SK26 diagnostics display • Features of the 3RK35 DP interface
Assembly/Installation	• Safety information • Assembly and disassembly procedure
Connection	• Procedure for connection/wiring/disconnecting • Plugging on and sealing the memory module • Grounding
Operation	• Operator controls • Operating options
Planning/configuring	• Basic safety system terminology • System configuration and configuration rules • Wiring rules for inputs and outputs • Response times • Special requirements for sensors and actuators • Commissioning • Integration of the 3SK2 safety relays into DP master systems
Maintenance and service	• Factory setting • Device replacement
Diagnostics	• Diagnostics options • Diagnostics concept • Device diagnostics via LEDs/displays • Description of the device display (45 mm device) • Diagnostics with 3SK26 diagnostics display (optional) • Diagnostics via PROFIBUS with 3RK35 DP interface (optional)
Technical data	• Technical data
Dimension drawings	• Dimension drawings • Drilling plans
Circuit diagrams	• Circuit diagrams

Chapter	Contents
Spare parts/accessories	• Spare parts • Accessories
Examples/applications	• Examples of connecting sensors, actuators and complete applications

1.5 Additional documentation

Manuals

You will find further manuals in the table that may be of interest for your project planning. They are available to download from the Internet free of charge. You can create your own individual system documentation in mySupport.

Title	Document number
SIRIUS engineering Safety ES V1.0 (software)	3ZX1012-0CS13-1AC1
SIRIUS 3SK1 Safety Relays	3ZX1012-0SK11-0AC0
SIRIUS 3RM1 motor starters	3ZX1012-0RM10-2AC1
Safety Integrated Application Manual	3ZX1012-0SK11-1AC1
SIMATIC NET PROFIBUS Network Manual	C79000-G8976-C124-03

Interesting links

- Manuals in Siemens Industry Online Support (https://support.industry.siemens.com/cs/ww/en/ps/man)
- FAQs about safety engineering (http://support.automation.siemens.com/WW/view/en/60763768/133000)
- Safety Evaluation Tool (http://www.siemens.com/safety-evaluation-tool/)
- Systematic industrial safety engineering: Safety Integrated (http://www.siemens.com/safety-integrated)

1.6 Siemens Industry Online Support

Information and service

At Siemens Industry Online Support you can obtain up-to-date information from our global support database quickly and simply. To accompany our products and systems, we offer a wealth of information and services that provide support in every phase of the lifecycle of your machine or plant – from planning and implementation and commissioning, right through to maintenance and modernization:

- Product support
- Application examples
- Services
- Forum
- mySupport

Link: Siemens Industry Online Support (https://support.industry.siemens.com/cs/de/en)

Product support

Here you will find all the information and comprehensive know-how for your product:

- **FAQs**

  Our replies to frequently asked questions.
- **Manuals/operating instructions**

  Read online or download, available as PDF or individually configurable.
- **Certificates**

  Clearly sorted according to approving authority, type and country.
- **Characteristics**

  For support in planning and configuring your system.
- **Product announcements**

  The latest information and news concerning our products.
- **Downloads**

  Here you will find updates, service packs, HSPs and much more for your product.
- **Application examples**

  Function blocks, background and system descriptions, performance statements, demonstration systems, and application examples, clearly explained and represented.
- **Technical data**

  Technical product data for support in planning and implementing your project.

Link: Product support (https://support.industry.siemens.com/cs/ww/en/ps)

mySupport

With "mySupport", your personal work area, you get the very best out of your Industry Online Support experience. Everything enables you to find the right information - every time.

The following functions are now available:

- **Personal messages**
  Your personal mailbox for exchanging information and managing your contacts
- **Requests**
  Use our online form for specific solution suggestions, or send your technical request direct to a specialist in Technical Support
- **Notifications**
  Make sure you always have the latest information - individually tailored to your needs
- **Filter**
  Simple management and re-use of your filter settings from Product Support and the Technical Forum
- **Favorites / Tags**
  Create your own "knowledge base" by assigning "Favorites" and "Tags" to documents – simple and efficient
- **Entries last viewed**
  Clear history of the entries you have most recently viewed
- **Documentation**
  Configure and compile individual documentation concepts from different manuals – quickly and without complications
- **Personal data**
  Change personal data and contact information here
- **CAx data**
  Simple access to thousands of items of CAx data such as 3D models, 2D dimension drawings, EPLAN macros and much more

1.7 DataMatrix code and Siemens Industry app

DataMatrix code

A DataMatrix code is lasered onto the lower terminal cover of all 3SK2 safety relays.

DataMatrix codes are standardized in ISO/IEC 16022. The DataMatrix codes on Siemens devices use ECC200 coding for powerful error correction.

The following device information is encoded in the DataMatrix codes as a bit stream:

- Article number
- Serial number
- MAC address, if applicable

This information is stored in the following format in the DataMatrix code:

1P	Article number	+	S serial number (+ 23S MAC address)
Data identifier	Net content	Separator	

Note

The information content is displayed without spaces.

This machine-readable information simplifies and accelerates handling of the respective devices.
As well as fast access to the serial numbers of the respective devices for unique identification, the DataMatrix codes simplify communication with Siemens Technical Support.

SIEMENS Industry Support App

DataMatrix codes primarily enable extremely fast and convenient access to all the device-specific information available on an article number in the SIEMENS Service & Support Portal, such as operating instructions, manuals, data sheets, FAQs, etc.
We offer the SIEMENS Industry Support App free for this purpose. It can be used on most commercially available smartphones and tablets.
The SIEMENS Industry Support App is available for iOS and Android-based devices and can be accessed via the following links:

Link for Android

Link for iOS

1.8 Configurator for safety relays

Configurator

Various configurators are available online to assist you during the configuration process.

The configurator for safety relays with accessories is a selection and configuration tool. You can select the individual components and plan your system in accordance with your specific requirements. You can save your selection, export it as a text file or you can order it directly.

The configurator automatically compiles a document list of the information available in Service & Support for every component. You can use it as the basis for putting together your system documentation.

Link: Configurator (http://www.siemens.com/industrial-controls/configurators)

1.9 Evaluation of safety functions

Safety Evaluation Tool

The Safety Evaluation Tool from Siemens for EN 62061 and EN ISO 13849-1 supports you in evaluating the safety functions of your machine. The TÜV-tested online tool guides you step by step, from specifying the structure of the safety system and selecting the components to determining the achieved safety integrity (SIL /PL). The final result is a report in conformance with the standards that you can integrate as proof of safety into the documentation.

Link: Safety Evaluation Tool (http://www.siemens.com/safety-evaluation-tool/)

Safety Integrated

Just like the safety relay, the Safety Evaluation Tool is part of Safety Integrated, the intelligent safety solution from Siemens that features a complete product portfolio. Our certified safety technology complies with all relevant standards and is already contained in the Safety Evaluation Tool.

Link: Safety Integrated (http://www.siemens.com/safety-integrated)

1.10 User responsibility for system design and function

The products described here were developed to perform safety-related functions as part of an overall installation or machine.

A complete, safety-related system is generally equipped with sensors, evaluation units, and signaling units, and uses reliable shutdown concepts.

It is the responsibility of the manufacturer to ensure that the system or machine is functioning properly as a whole.

Siemens AG, its regional offices, and associated companies (hereinafter referred to as "Siemens") cannot guarantee all the properties of a whole installation or machine that has not been designed by Siemens.

Nor can Siemens assume liability for recommendations that appear or are implied in the following description. No new guarantee, warranty, or liability claims beyond the scope of the Siemens general terms of supply are to be derived or inferred from the following description.

1.11 History

Release number	New features
05/2015	Initial release
08/2017	Revision of the manual

Safety information 2

2.1 General safety notes

Note

SILCL 3 to EN 62061:2005
PL e/Cat. 4 to EN ISO 13849-1:2008

3SK2 safety relays are designed in such a way as to allow implementation of applications up to SILCL 3 in accordance with EN 62061 and PL e / Kat. 4 in accordance with EN ISO 13849-1.

⚠ WARNING

Hazardous Voltage
Can Cause Death, Serious Injury, or Property Damage.

Hazardous electrical voltages can cause electric shock, burns and damage.

- Turn off and lock out all power supplying the system and device before working on the device.
- To ensure protection against the hazard of electric shock when the terminal cover is open, screw in all terminal screws that are not needed to clamp conductors.
- Close the terminal covers and always keep them closed during operation.

⚠ WARNING

Bypassing the Safety Function
Can Cause Death, Serious Injury, or Property Damage.

3SK1 output expansions and 3RM1 Failsafe motor starters that are connected to a 3SK2 safety relay via 3ZY12 device connectors are supplied with voltage via the device connectors.

Do not directly connect any separate supply voltage to a 3SK1 output expansion (A1/A2) or to a 3RM1 Failsafe motor starter (A1/A2) as otherwise the safety function will be bypassed.

WARNING
Failure of the Safety Function in the Event of Adjustment of the Slide Switch on 3SK1 Output Expansions **Can Cause Death, Serious Injury, or Property Damage.** Parameterization of the logic of the 3SK2 safety relay in Safety ES must correspond to the slide switch setting on the 3SK1 output expansion in order for the safety function not to be rendered inactive. • Make sure that the setting of the slide switch on the 3SK1 output expansion corresponds to your logic parameterized in Safety ES. • Use a cover seal to protect the slide switch of the 3SK1 output expansion against unauthorized and unintentional adjustment.

WARNING
Safe functional extra-low voltage The 3SK2 safety relays with a supply voltage of 24 V DC must be operated by means of a single-fault-secure power supply with safe functional extra-low voltage (SELV, PELV). This means these modules may only be subjected to a voltage of Um even in the event of a fault. The following applies for the 3SK2 safety relays: Around < 60.0 V. You can find more detailed information about safe functional extra-low voltage in the data sheets of the power supplies to be used.

WARNING
Risk from Conductive Contamination **Can Cause Death, Serious Injury, or Property Damage.** The devices must be protected against conductive contamination while taking account of the ambient conditions. One way you can do this is to install the devices in a control cabinet with the appropriate degree of protection. You will find further information in the IEC 60529 standard, "*Degrees of protection provided by enclosures (IP Code)*" and in Section "Technical data (Page 243)".

NOTICE
Noise immunity/grounding The following must be grounded in accordance with the regulations to ensure noise immunity of the system components: • All system components • PELV / SELV power supply units (also note the documentation for the respective power supply unit in this regard). The PROFIBUS must be grounded in accordance with the installation guidelines for PROFIBUS networks (see the PROFIBUS manual).

NOTICE

Protection against electrostatic charge

When handling and installing the system components, ensure that the components are protected from electrostatic charge. Changes to the system configuration and wiring are only permissible while the supply voltage is switched off.
Connection of 3SK2 safety relays is only permissible when the power supply is switched off.

Note

Operational faults and malfunctions in communication

If the EMC Directive 2004/108/EC is not complied with when plants and devices are installed, communication breaks may occur.

Note

Simultaneity of signals

Depending on when a signal change takes place within the cycle, the signal change is detected either in the same cycle or not until the following cycle time.

This means it is possible for supposedly simultaneous signal changes to be detected at two different inputs by the logic, but not simultaneously.

Take this behavior into account when creating your configuration.

Note

Cover all unused system interfaces.

Note

Recycling and disposal

Dispose of existing packing material in accordance with applicable regulations or recycle it.

3SK2 safety relays are able to be recycled thanks to a low-pollutant manufacturing process. For environmentally-friendly recycling and disposal of your electronic waste, please contact a company certified for the disposal of electronic waste.

2.2 Intended use

WARNING

Hazardous Voltage
Can Cause Death, Serious Injury, or Property Damage.
Intended Use of Hardware Products

This equipment is only allowed to be used for the applications described in the catalog and in the technical description, and only in conjunction with non-Siemens equipment and components 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.

Before you run any sample programs or programs you have written yourself, make sure that running the plant cannot cause injury to anyone else or damage to the machine itself.

EU note regarding machine safety: Commissioning is absolutely prohibited until it has been ensured that the machine in which the component described here is to be installed complies with the stipulations of the Directive 2006/42/EC.

WARNING

Hazardous Voltage
Can Cause Death, Serious Injury, or Property Damage.
Intended Use of Software Products

The software may be used only for the applications described in the catalog or the technical description, and only in combination with the software products, components and devices of other manufacturers where recommended or permitted by Siemens.

Before you run any sample programs or programs you have written yourself, make sure that running the plant cannot cause injury to anyone else or damage to the machine itself.

WARNING

Hazardous Voltage
Can Cause Death, Serious Injury, or Property Damage.
Safe State (Safety Concept)

The basis of the safety concept is that a safe state exists for all process variables. With the 3SK2 safety relay, this is the value "0". This applies to sensors and actuators.

Note that the use of inverting functions either in the logic diagram or in the wiring outside the system may prevent the safe state from being reached.

WARNING

Hazardous Voltage
Can Cause Death, Serious Injury, or Property Damage.
Carry out function test of the system after changes

To ensure the safety of the system, any changes to it or any replacement of defective components must be followed by a thorough and successfully completed function test of the system.

A complete function test consists of the following tests:

- Configuration test (test of the configuration)
- System test (wiring test of the connected sensors and actuators)

WARNING

Hazardous Voltage
Can Cause Death, Serious Injury, or Property Damage
Test Interval for Electromechanical Actuators, e.g. 3SK1 Output Expansions, Contactors or Relays

In accordance with RFU CNB/M/11.050, when using actuators such as 3SK1 output expansions, contactors or relays in factory automation applications, a function test interval (shutdown test) ≤ 1 year for SILCL 2 or ≤ 1 month for SILCL 3 is required. Only then do the safety values apply.

Function test procedure for actuators with contacts:

- Actuate the connected sensors.
- Check their effect on the safety relay and the downstream actuators*.
- Activate the safety relay via the connected sensors.
- Check their effect on the safety relay and the downstream actuators*.
- Defective devices must be replaced.

*Since the read-back time of the delayable output functions is retriggerable, the actuation duration for switching on and off for the regular function test must be longer than the time set in the "Switching time" parameter. Only in this way can it be ensured that the expected switching state has also been set on the connected actuator.

WARNING

Unauthorized access to the 3SK2 safety relay

To prevent unauthorized access to the 3SK2 safety relay, assign a password for device access in Safety ES.

In the case of several 3SK2 safety relays, you must assign a separate password for each device.

2.3 Safety information for hazardous areas

WARNING

Hazardous Voltage
Can Cause Death, Serious Injury, or Property Damage.
Installation of the safety relay in hazardous areas

The components of the safety relay are **not** suitable for installation in hazardous areas. Please contact your ATEX specialist.

2.4 Current information about operational safety

Important note for maintaining operational safety of your system

WARNING

Hazardous Voltage
Can Cause Death, Serious Injury, or Property Damage.
Please take note of our latest information.

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

SIEMENS newsletter (http://www.industry.siemens.com/newsletter)

Request the following newsletter under "Products and Solutions":

- Industrial controls - SIRIUS News (en)
- Safety Integrated Newsletter

2.5 Security information

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

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

To stay informed about product updates as they occur, sign up for a product-specific newsletter. You can find additional information on this at: http://support.automation.siemens.com.

3 Description

3.1 Application areas for safety systems

Safety systems

Safety systems are part of machines and plants. Their task is to minimize possible hazards for humans, machines and the environment. To this end, they monitor safety functions such as Emergency Stop and switch off the plant or system in a safety-related fashion. A safety system consists of sensors for sensing signals of the protective equipment (e.g. protective doors) from safety relays (e.g. 3SK2 safety relays) that evaluate these signals, and of actuators (e.g. 3RM1 Failsafe motor starters; 3RT contactors) that are controlled by the safety system and respond accordingly.

In most countries in the world there are binding regulations on the safeguarding of machines and plants. For Europe, the European Machinery Directive (2006/42/EC) defines the basic requirements for machine safety. The technical details of these requirements are specified in "harmonized" standards such as EN 62061 or EN ISO 13849-1 with the highest classification SILCL 3 or PL e/Cat. 4 for production automation.

3SK2 safety relays

3SK2 safety relays are safety relays that can be parameterized with software and using which you can interconnect several safety applications with each other. In this way, you can set shutdown ranges, for example, and freely define other dependencies. 3SK2 safety relays are generally suitable for applications involving two or more safety-related functions. SIRIUS 3SK1 safety relays are available for applications with only one safety-related function.

3SK2 safety relays read sensor signals via inputs, interconnect these signals according to the parameterizable logic, and use the processed signals to control the outputs, and thus actuators, in a fail-safe manner.

Depending on the version of the device and the external connection of sensors and actuators, applications can be implemented at up to SILCL 3 in accordance with EN 62061 and PL e/Cat. 4 in accordance with EN ISO 13849-1.

At least one 3SK2 basic unit and the Safety ES parameterization and diagnostics software are required for every system configuration. You can decide between two sizes with different functional scopes, see Section "Features and functions (Page 32)".

Device connector interface

3SK2 safety relays can be connected to the following actuators using 3ZY12 device connectors:

- 3SK1 output expansions (24 V DC)
- 3RM1 Failsafe motor starters (24 V DC)

3SK1 output expansions and safety-related 3RM1 Failsafe motor starters can be controlled and monitored for correct function using these 3ZY12 device connectors.

Interface modules for communication via bus systems and integration in TIA

The 3SK2 safety relays communicate with higher-level controllers via an optional interface module. Thus, the basic unit can be interfaced to a PLC via PROFIBUS, for example, and therefore also be integrated in TIA. Fault diagnostics and status information can be passed on cyclically and acyclically.

Via the DP interface, the 3SK2 safety relays offer the option of exchanging process signals with a higher-level controller. This is possible in both directions. Up to 64 bits are available for this purpose in each direction. The individual signals are manually interconnected in the user program. This makes it possible to generate individual diagnostics messages, for example. Operational switching signals (such as unlocking commands for protective doors with tumblers) as well as fault acknowledgement and starting commands can be sent from the PLC to 3SK2 safety relays.

Diagnostics display

Pending messages with detailed information shown as text are displayed on the optional diagnostics display. The diagnostics display enables time-saving troubleshooting without connection to a PG / PC with Safety ES. The cause of a fault can be located quickly and easily and you can respond directly to it. The diagnostics display can be installed in the control cabinet door and is operable from the outside. Programming or parameterization of the diagnostics display is not necessary.

Diagnostics

The 3SK2 safety relays possess multiple diagnostics options:

- Diagnostics via displays on the device/LEDs
- Diagnostics with Safety ES
- Diagnostics with diagnostics display (if a diagnostics display is available)
- Diagnostics via PROFIBUS (if DP interface is available)

Interfaces

The safety relay can be accessed by Safety ES via an RS232, USB or PROFIBUS interface. Communication via the PROFIBUS interface is implemented with the optional DP interface.

WARNING

Hazardous system state due to unauthorized access via PROFIBUS

Can result in death, serious injury, or property damage.
Unauthorized access to the safety relay via PROFIBUS can enable configuration changes and overriding of safety functions.

To prevent unauthorized access to the safety relay via the PROFIBUS network, assign a password for accessing the device in Safety ES. If you operate several safety relays in one PROFIBUS network, you must assign a separate password for each safety relay to prevent confusion when accessing via PROFIBUS. In other words, the passwords must not be identical.

Safety ES parameterization and diagnostics software

The safety functions are parameterized via the Safety ES software. The software represents the wiring of the individual functions using graphical parameterization. All safety or logic functions are available as blocks and can also be easily configured and then logically combined with one another. The software checks the interconnection for errors before the safety program can be loaded into the safety relay.

Forcing

Test operation of the software assists you during commissioning. Here, output signals can be forced in order to test the logic processing or already installed system sections. Forcing means that the output signals in the logic can be set to 1 or 0, irrespective of the real signal.

Deactivating safety functions

Functions can be specifically deactivated in the software and assigned substitute values. This means that a complete safety program can be created and tested for the maximum configuration for a system. The system can then be commissioned with a partial configuration, while the parts that are not needed in the safety program remain deactivated. If the system is later expanded, these steps mean that you only need to reactivate the applicable parts of the safety program.

Diagnostics

The software allows you to monitor the safety system and, to this end, visualizes the status of the safety functions and the status of the devices. The status of each element and the configuration as a whole can be viewed online.

Documentation of the safety functions

Documentation is also created for the safety functions and, after printing, can be used for system documentation purposes in compliance with DIN EN ISO 7200.

3.2 Features and functions

Features and functions	SIRIUS 3SK2 safety relays	
	22.5 mm	45 mm
General characteristics		
Certified acc. to • SILCL 3 as per EN 62061 • PL e/Cat. 4 as per EN ISO 13849-1	✓	✓
Expansion capability with actuators via 3ZY12 device connectors: • 3SK1 output expansions (24 V DC) • 3RM1 Failsafe motor starters (24 V DC)	✓	✓
Very simple parameterization with extensive Safety ES parameterization software	✓	✓
Low wiring effort and high connection depth using function combinations in the software	✓	✓
Safety-related, freely parameterizable sensor inputs	10	20
Digital test outputs for sensor supply and monitoring	2 terminals	4 terminals; of which 2 have a decoupled test signal
Safety-related two-channel relay outputs	2	4
Digital standard outputs	1	2
Safety-related electronic outputs via 3ZY12 device connectors	2	2
Digital read-back input via 3ZY12 device connector	1	1
Support with commissioning by forcing	✓	✓
Communication		
Data exchange via PROFIBUS with optional DP interface	32/64 bits	32/64 bits
Integration into the automation environment with a GSD on each PROFIBUS-DP master irrespective of the automation system with optional DP interface module	✓	✓
Remote access (S7 routing) with optional DP interface	✓	✓
Access with Safety ES		
Configuration and diagnostics through the device interface	✓	✓
Configuration and diagnostics over PROFIBUS	✓	✓
Diagnostics		
Diagnostics via LEDs/display on the device	✓	✓
Diagnostics using Safety ES	✓	✓
Diagnostics using PROFIBUS	✓	✓
Diagnostics using the 3SK26 diagnostics display	✓	✓

Function elements in the logic diagram	SIRIUS 3SK2 safety relays	
	22.5 mm	45 mm
Cell functions		
• Input cell	✓	✓
• Output cell	✓	✓
Monitoring functions		
• Universal monitoring	✓	✓
• EMERGENCY STOP	✓	✓
• ESPE (electro-sensitive protective equipment)	✓	✓
• Safety shutdown mat (NC principle)	✓	✓
• Safety shutdown mat (cross-circuit principle)	✓	✓
• Protective door	✓	✓
• Protective door with tumbler	✓	✓
• Acknowledgment button	✓	✓
• Two-hand operation	✓	✓
• Mode selector switch	✓	✓
• AS-i 2F-DI (safety-related AS-i input)	-	-
Muting functions		
• Muting (2-sensor-parallel)	✓	✓
• Muting (4-sensor-parallel)	✓	✓
• Muting (4-sensor-sequential)	✓	✓
Status functions		
• Device status	✓	✓
• Element status	✓	✓
Control functions		
• Device command	✓	✓
Logic functions		
• AND	✓	✓
• OR	✓	✓
• XOR	✓	✓
• NAND	✓	✓
• NOR	✓	✓
• NEGATION (NEG)	✓	✓

Function elements in the logic diagram	SIRIUS 3SK2 safety relays	
	22.5 mm	45 mm
Flip-flop		
• FF-SR	✓	✓
Counter functions		
• Counter (0 -> 1)	✓	✓
• Counter (1 -> 0)	✓	✓
• Counter (0 -> 1 / 1 -> 0)	✓	✓
Timer functions		
• With ON delay	✓	✓
• With ON delay (trigger)	✓	✓
• Passing make contact	✓	✓
• Passing make contact (trigger)	✓	✓
• With OFF delay	✓	✓
• With OFF delay (trigger)	✓	✓
• Clocking	✓	✓
Start functions		
• Monitored start	✓	✓
• Manual start	✓	✓
Output functions		
• Standard output	✓	✓
• F output	✓	✓
• Standard output delayed	✓	✓
• F output delayed	✓	✓
• AS-i 1..4F-DO	-	-

3.3 3SK2 safety relay with width 22.5 mm

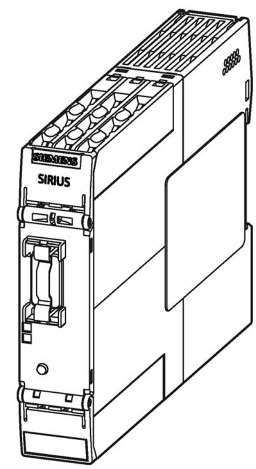


Figure 3-1 3SK2 safety relay with width 22.5 mm

Properties

The 3SK2 safety relay with width 22.5 mm for safety-related control functions can be used up to SILCL 3 as per EN 62061 and PL e / Cat. 4 as per EN ISO 13849-1.

- The 3SK2 safety relay can be parameterized using Safety ES.
- 3SK1 output expansions (24 V DC) can be connected as actuators with little wiring via 3ZY12 device connectors.
- Safety-related 3RM1 Failsafe motor starters (24 V DC) can be connected as actuators with little wiring via 3ZY12 device connectors.
- 3SK2 safety relays have an integrated memory.
- Connection of a diagnostics display is possible as an option for time-saving diagnostics.
- An additional interface module (e.g., DP interface) can be used to exchange process data with a PLC. Diagnostics data of 3SK2 safety relays are also transmitted to the PLC.

Inputs and outputs

The 3SK2 safety relay with 22.5 mm width comes with the following inputs and outputs:

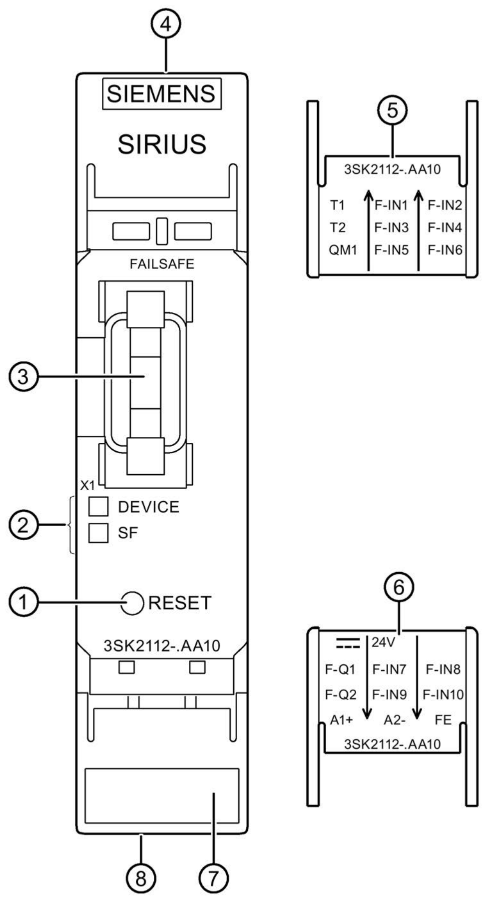
- 10 safety-related, freely parameterizable sensor inputs (22.5 mm)
- 2 two-channel, safety-related, solid-state outputs (pp switching)
- 1 solid-state standard output (not safety-related) (p switching)
- 2 test outputs (= 1 test output pair) for sensor supply and monitoring when used with safety-related sensor inputs
- 2 safety-related outputs via 3ZY12 device connector for control of 3SK1 output expansions and 3RM1 Failsafe motor starters
- 1 feedback circuit via 3ZY12 device connector for monitoring both output signals (non-safety-related)

Note

Safety-related outputs

If you use a safety-related solid-state output for a two-channel shutdown, a fault exclusion, such as a short circuit to P or M, is required. This condition is met within a control cabinet and when the connection cables are installed in such a way that they are protected.

Design of the 3SK2 safety relay with width 22.5 mm

Front	No.	Meaning
	①	RESET button
	②	Display LEDs
	③	Connection of a PC/PG, interface module, diagnostics display (X1, sealable)
	④	Top terminals (removable terminals)
	⑤	Labeling of top terminals, visible when cover tilted open
	⑥	Labeling of bottom terminals, visible when cover tilted open
	⑦	Label
	⑧	Bottom terminals (removable terminals)
	-	Rear side: Connection to 3SK1 output expansion/3RM1 Failsafe motor starter via 3ZY12 (SYS) device connector

Internal circuit diagram

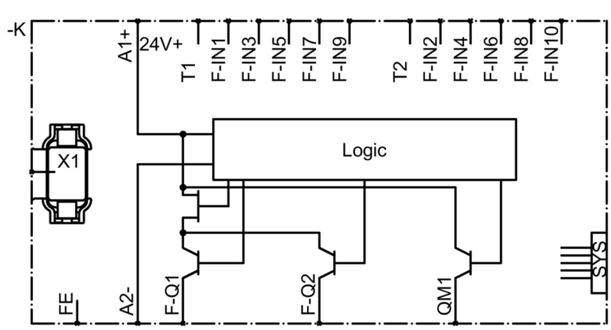


Figure 3-2 Internal circuit diagram 3SK2 safety relay with width 22.5 mm

Terminal markings of the 3SK2 safety relay with width 22.5 mm

Terminal	Meaning	Explanation
T1	Test output for inputs F-IN1, F-IN3, F-IN5, F-IN7, F-IN9	• Test outputs T1/T2 with different test signals • Connection for sensor contacts for detecting cross-circuits
T2	Test output for inputs F-IN2, F-IN4, F-IN6, F-IN8, F-IN10	
F-IN1 ... F-IN10	Safety-related sensor inputs	Terminal for safety sensors Combinations for two-channel connection: • F-IN1 with F-IN2 • F-IN3 with F-IN4 • F-IN5 with F-IN6 • F-IN7 with F-IN8 • F-IN9 with F-IN10
QM1	Solid-state output	Standard solid-state output (non-safety-related)
F-Q1, F-Q2	Safety-related solid-state outputs	Two-channel solid-state outputs for connecting actuators
A1+	Power supply	24 V DC
A2-	Ground	Ground to 24 V DC
FE	Functional ground	Shielding, equipotential bonding

Interfaces of the 3SK2 safety relay with width 22.5 mm

Interface	Meaning	Explanation
X1	System interface	Connection of PC or programming device, interface module, diagnostics display The system interface can be sealed.
SYS	Interface for device connectors	Connection to 3SK1 output expansions and to 3RM1 Failsafe motor starters via 3ZY12 device connector

Operator controls of the 3SK2 safety relay with width 22.5 mm

Element	Meaning	Explanation
RESET button	• Fault acknowledgment • Factory settings	• Confirm the acknowledgeable errors with this button. • Refer to Section "Restoring factory settings (Page 185)"

Display elements of the 3SK2 safety relay with width 22.5 mm

Element	Meaning
DEVICE	Status
SF	Group error

Connecting inputs and outputs

You can find more information on connecting inputs and outputs in Section "Wiring rules for inputs and outputs (Page 140)".

3.4 3SK2 safety relay with width 45 mm

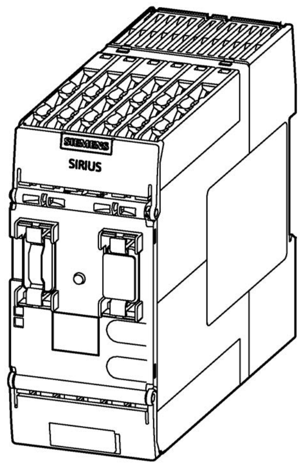


Figure 3-3 3SK2 safety relay with width 45 mm

Properties

The 3SK2 safety relay with width 45 mm for safety-related control functions can be used up to SILCL 3 as per EN 62061 and PL e / Cat. 4 as per EN ISO 13849-1.

- The 3SK2 safety relay can be parameterized using Safety ES.
- 3SK2 safety relays have a device display.
- 3SK2 safety relays are supplied with a memory module (sealable with basic unit or control cabinet).
- 3SK1 output expansions (24 V DC) can be connected as actuators with little wiring via 3ZY12 device connectors.
- Safety-related 3RM1 Failsafe motor starters (24 V DC) can be connected as actuators with little wiring via 3ZY12 device connectors.
- Connection of the diagnostics display is possible as an option for time-saving diagnostics.
- An additional interface module (e.g., DP interface) can be used to exchange process data with a PLC. Diagnostics data of 3SK2 safety relays are also transmitted to the PLC.

Inputs and outputs

The 3SK2 safety relay with 45 mm width comes with the following inputs and outputs:

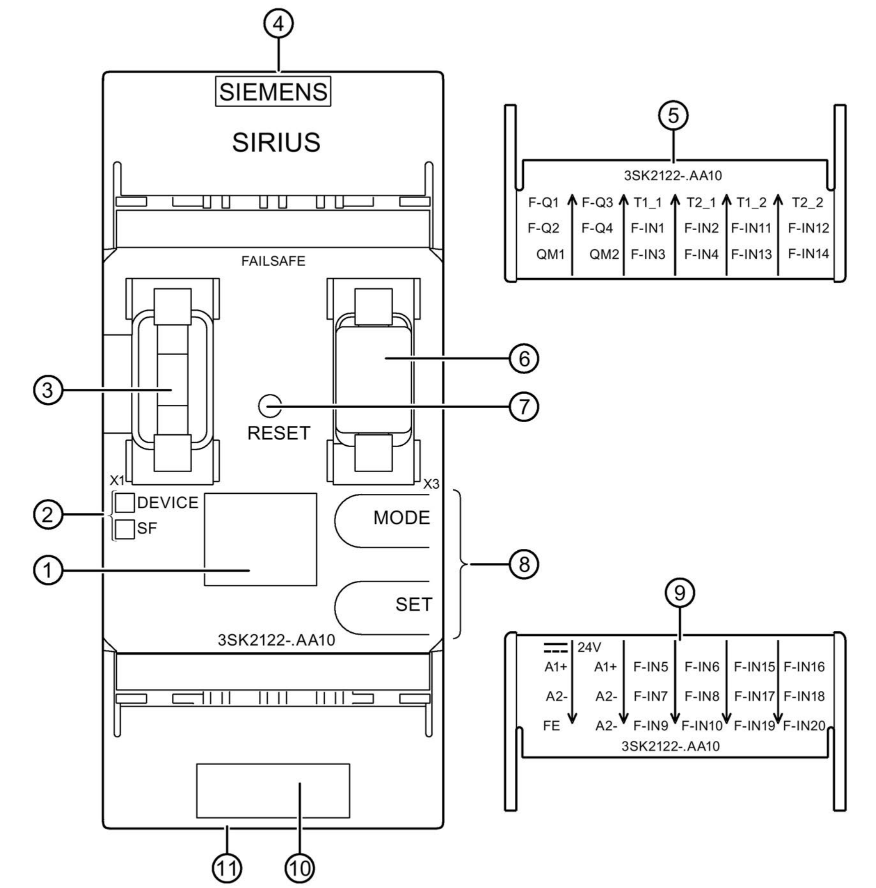
- 20 safety-related, freely parameterizable sensor inputs
- 4 two-channel, safety-related, solid-state outputs (pp switching)
- 2 solid-state standard outputs (not safety-related) (p switching)
- 4 test outputs for sensor supply and monitoring when used with safety-related sensor inputs (= 2 isolated test output pairs)
- 2 safety-related outputs via device connectors for control of 3SK1 output expansions and 3RM1 Failsafe motor starters
- 1 feedback circuit for monitoring both output signals (non-safety-related)

Note

Safety-related solid-state outputs

If you use a safety-related solid-state output for a two-channel shutdown, a fault exclusion, such as a short circuit to P or M, is required. This condition is met within a control cabinet and when the connection cables are installed in such a way that they are protected.

Design of the 3SK2 safety relay with width 45 mm

Front	No.	Meaning
	①	Device display
	②	Display LEDs
	③	Connection of a PC/PG, interface module, diagnostics display (X1, sealable)
	④	Top terminals (removable terminals)
	⑤	Labeling of top terminals, visible when cover tilted open
	⑥	Connection of a memory module (X3, sealable)
	⑦	RESET button
	⑧	SET and MODE keys for operating the device display
	⑨	Labeling of bottom terminals, visible when cover tilted open
	⑩	Label
	⑪	Bottom terminals (removable terminals)
	-	Rear side: Connection to 3SK1 output expansion/3RM1 Failsafe motor starter via 3ZY12 (SYS) device connector

Internal circuit diagram

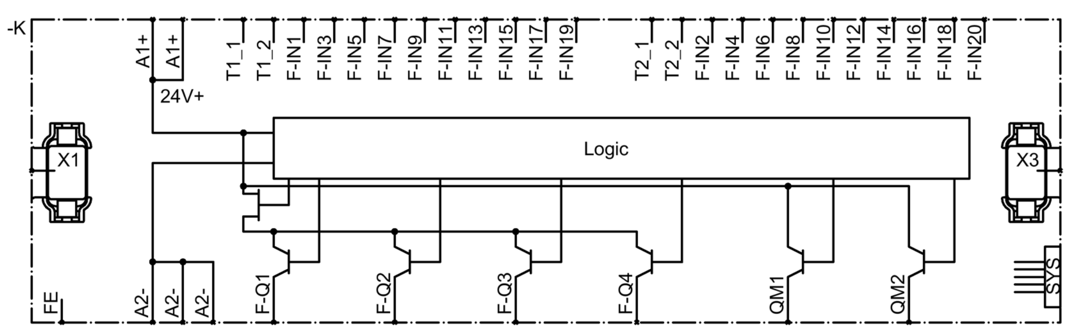


Figure 3-4 Internal circuit diagram 3SK2 safety relay with width 45 mm

Terminal markings of the 3SK2 safety relay with width 45 mm

Terminal	Meaning	Explanation
T1_1	Test output for inputs F-IN1, F-IN3, F-IN5, F-IN7, F-IN9, F-IN11, F-IN13, F-IN15, F-IN17, F-IN19	• Test outputs T1_1/T2_1 with different test signals • Connection for sensor contacts for detecting cross-circuits • Independent of T1_2/T2_2
T2_1	Test output for inputs F-IN2, F-IN4, F-IN6, F-IN8, F-IN10, F-IN12, F-IN14, F-IN16, F-IN18, F-IN20	
T1_2	Test output for inputs F-IN1, F-IN3, F-IN5, F-IN7, F-IN9, F-IN11, F-IN13, F-IN15, F-IN17, F-IN19	• Test outputs T1_2/T2_2 with different test signals • Connection for sensor contacts for detecting cross-circuits • Independent of T1_1/T2_1
T2_2	Test output for inputs F-IN2, F-IN4, F-IN6, F-IN8, F-IN10, F-IN12, F-IN14, F-IN16, F-IN18, F-IN20	
F-IN1 ... F-IN20	Safety-related sensor inputs	Terminal for safety sensors Combinations for two-channel connection: • F-IN1 with F-IN2 • F-IN3 with F-IN4 • F-IN5 with F-IN6 • ... • F-IN19 with F-IN20
QM1, QM2	Solid-state output	Standard solid-state output (non-safety-related)
F-Q1 ... F-Q4	Safety-related solid-state outputs	Two-channel solid-state outputs for connecting actuators
A1+ (2 x)	Power supply	24 V DC
A2- (3 x)	Ground	Ground to 24 V DC
FE	Functional ground	Shielding, equipotential bonding

Interfaces of the 3SK2 safety relay with width 45 mm

Interface	Meaning	Explanation
X1	System interface	Connection of PC or programming device, interface module, diagnostics display The system interface can be sealed.
X3	External memory module	Slot for external memory module with parameterization data The memory module is sealable with the 3SK2 safety relay or the control cabinet.
SYS	Interface	Connection to 3SK1 output expansions and to 3RM1 Failsafe motor starters via 3ZY12 device connector

Operator controls of the 3SK2 safety relay with width 45 mm

Element	Meaning	Explanation
RESET button	• Fault acknowledgment • Factory settings	• Confirm the acknowledgeable errors with this button. • Refer to Section "Restoring factory settings (Page 185)".
SET key	Operating the device display	• Refer to Section "Diagnostics via device display (3SK2 safety relay with width 45 mm) (Page 201)".
MODE key	Operating the device display	• Refer to Section "Diagnostics via device display (3SK2 safety relay with width 45 mm) (Page 201)".

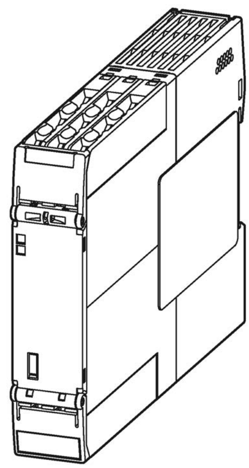
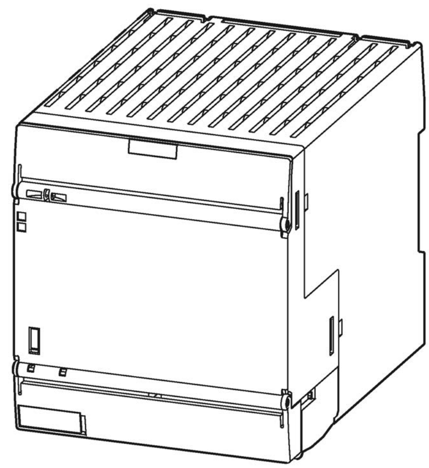
Display elements of the 3SK2 safety relay with width 45 mm

Element	Meaning
Device display	Display of the operating state and the status of the input and output terminals
DEVICE	Status
SF	Group error

Connecting inputs and outputs

You can find more information on connecting inputs and outputs in Section "Wiring rules for inputs and outputs (Page 140)".

3.5 3SK1 output expansions

3SK1211	3SK1213
	

Application

3SK1 output expansions are actuators that can be connected to the 3SK2 safety relay in a time and space-saving manner. They serve to expand the release circuits, to which additional actuators can be connected.

3SK1 output expansions are suitable for safety-related applications up to SILCL 3 as per EN 62061, PL e/Cat. 4 as per EN ISO 13849-1.

Note

Only 3SK1 output expansions with a supply voltage of 24 V DC can be combined with the 3SK2 safety relays.

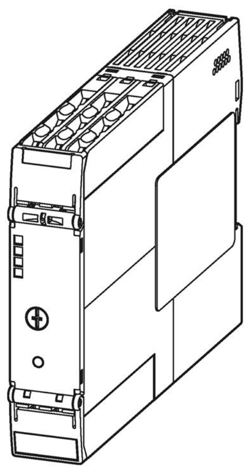
Connection to 3SK2 safety relays

3SK1 output expansions can be controlled without much complexity via 3ZY12 device connectors, see Section "Connection of 3SK1 output expansions (Page 149)".

Manual for *3SK1 safety relays*

You can find a detailed description of 3SK1 output expansions in the manual *3SK1 safety relays*; see Section "Additional documentation (Page 14)".

3.6 3RM1 Failsafe motor starters



Applications

3RM1 Failsafe motor starters are actuators that can be connected to 3SK2 safety relays in a time and space-saving manner. They can be used wherever combinations of contactors and overload relays were previously used. Thanks to their additional safety-related shutdown functionality, 3RM1 Failsafe motor starters are suited to safety-related applications up to SILCL 3 in accordance with EN 62061 and PL e/Cat. 4 in accordance with EN ISO 13849-1.

Note

Only 3RM1 Failsafe motor starters with a supply voltage of 24 V DC can be combined with 3SK2 safety relays.

Connection to 3SK2 safety relays

3RM1 Failsafe motor starters can be controlled with little effort via 3ZY12 device connectors. See Section "Connecting 3RM1 Failsafe motor starters (Page 154)".

SIRIUS 3RM1 Motor Starter Manual

You can find a detailed description of the 3RM1 Failsafe motor starters in the manual *SIRIUS 3RM1 Motor Starter*, see Section "Additional documentation (Page 14)".

3.7 3SK26 diagnostics display

Application

A diagnostics display is available for 3SK2 safety relays and the 3RK3 Modular Safety System that displays the current messages, diagnostics data, and status information of the monitored system directly on the control cabinet, enabling elementary diagnostics without PC and Safety ES. The diagnostics display has a connection to the safety relay (on the back) and a connection for the PC / PG (on the front).

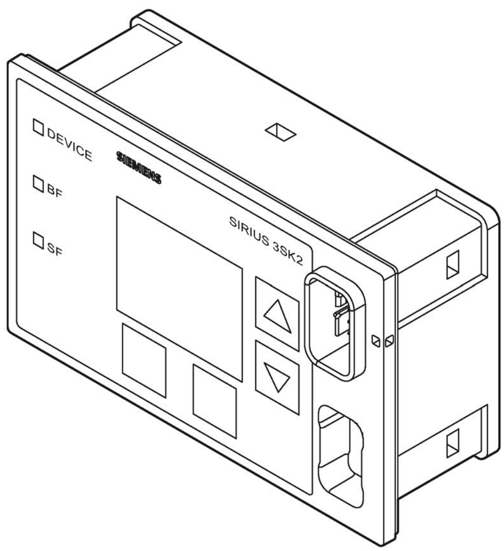


Figure 3-5 Diagnostics display

Note

3SK2 safety relays

3SK2 safety relays are only supported by the 3SK26 diagnostics display.

MSS 3RK3 Advanced/ MSS 3RK3 ASIsafe basic/ MSS 3RK3 ASIsafe extended

These 3RK3 central units are supported by the 3RK36 diagnostics display as from product version E03 and firmware version V1.1.x and higher, and/or by the 3SK26 diagnostics display.

MSS 3RK3 Basic

MSS 3RK3 Basic is supported by the 3RK36 diagnostics display as from product version E01 and higher and/or the 3SK26 diagnostics display.

	Diagnostics display		
	3SK26	**3RK36**	**3RK36**
	V1.0 / E01	V1.1 / E03	V1.0 / as from E01
3SK2	Yes	No	No
3RK3 Basic	Yes	Yes	Yes
3RK3 Advanced / ASIsafe	Yes	Yes	No

Note

Diagnostics display locked/disabled

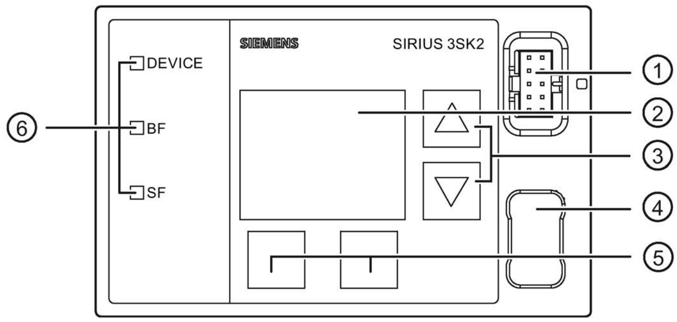
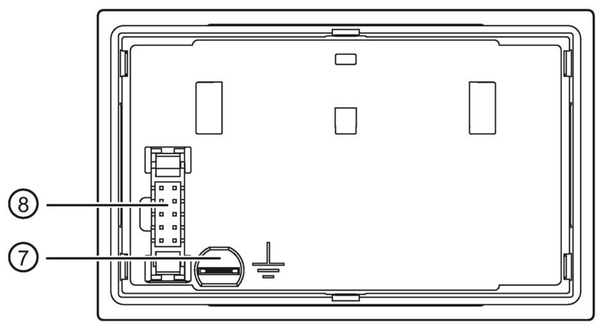
If an access path is established by the software over an extended period or the device is switched to test mode, the diagnostics display is disabled and outputs a corresponding message. The diagnostics display restarts automatically once this status ends. No measures are necessary.

Check product version for 3RK36 diagnostics display

If the safety relay is accessed by the software using PROFIBUS, the 3RK36 diagnostics display must have at least product version 3 (E03) or firmware version[1)] V1.1.x or a 3SK26 diagnostics display must be used.

[1)] The firmware version can be read at the startup of the diagnostics display or in the bottom left when the diagnostics display is locked. It can also be shown by selecting the menu command "Display settings / Identification" (see also Section "Display settings (Page 222)").

Design of the diagnostics display

<table>
<tr><th>View</th><th>No.</th><th>Meaning</th></tr>
<tr><td rowspan="8">Front view

Rear view:
</td><td>①</td><td>System interface (X1)
for connection to the PC / PG</td></tr>
<tr><td>②</td><td>Display</td></tr>
<tr><td>③</td><td>Arrow keys</td></tr>
<tr><td>④</td><td>Park position for interface cover</td></tr>
<tr><td>⑤</td><td>Keys for menu navigation</td></tr>
<tr><td>⑥</td><td>Display LED</td></tr>
<tr><td>⑦</td><td>Functional ground</td></tr>
<tr><td>⑧</td><td>System interface (X2)
for connection to safety relay</td></tr>
</table>

Internal circuit diagram

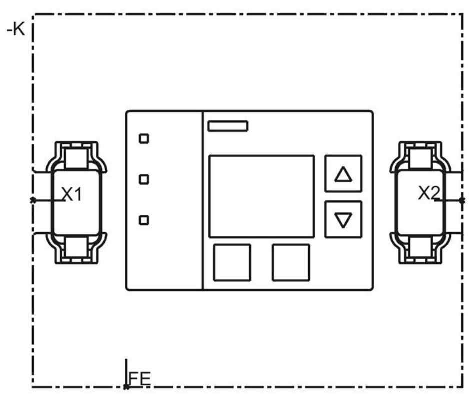


Figure 3-6 Diagnostic display internal circuit diagram

Terminal designations of the diagnostics display

Terminal	Meaning	Explanation
FE	Functional ground	Shielding, equipotential bonding

Interfaces of the diagnostics display

Interface	Meaning	Explanation
X1	System interface	Connection to the PC or programming device
X2	System interface	Connection to the safety relay

Operator controls

Element	Meaning
Keys	Navigation in the operator control menu/error acknowledgement

Displays

Element	Meaning
DEVICE	Status
BF	Bus error
SF	Group error

Operating the diagnostics display

See Chapter "Diagnostics with diagnostics display (Page 206)".

3.8 3RK35 DP interface module

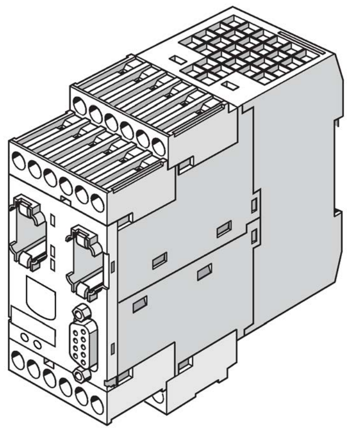


Figure 3-7 DP interface module

Application

Interface modules are the interface between the safety relay and a higher-level bus system, e.g. PROFIBUS DP. The safety relay uses them to make diagnostics and status information available to a higher-level controller. Non-safety-related input and output signals can be exchanged between the safety relay and a higher-level controller (PLC).

Device power-up of DP interface

Once the hardware has been successfully initialized, the LED and display test is carried out. Then the connection between the DP interface and the safety relay is established.

After successful startup, the DP interface appears as a PROFIBUS slave on the bus and starts data exchange if the configuration is correct.

Properties

The DP interface module has the following properties:

- The DP interface connects the safety relay to PROFIBUS DP and thus with a higher-level programmable controller or a PG / PC. Using the DP interface, the safety relay can be configured, tested and the configuration released via PROFIBUS DP.
- Integration into the higher-level control is performed by means of a GSD file.
- The properties of the DP interface are set with Safety ES. The address can also be set directly on the device.
- The DP interface is equipped with one system interface for connecting the safety relay and one system interface for connecting a PC / PG (sealable).
- The DP interface can be used to link non-safety-related signals of a higher-level controller with the safety relay logic.

- The DP interface supports a baud rate of up to 12 Mbps.
- Process and diagnostics data can be exchanged through the DP interface:
  - Cyclic: Depending on the safety relay, the PLC can exchange 32 bits or 64 bits of process data with safety relay.
  - Acyclic: The PLC can query diagnostics data data from the safety relay. With Safety ES, the diagnostics information can be displayed graphically.

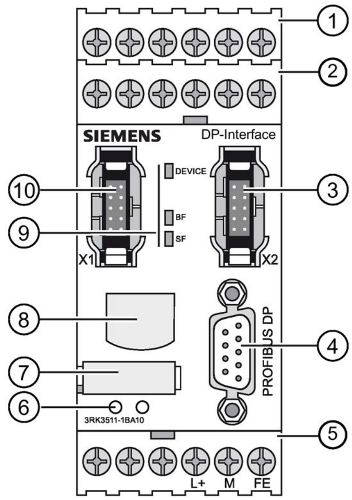
  Both options can be used at the same time.
- The DP interface supports DPV1 and DPV0 mode.

Note

Program cycle time

When the 3SK2 safety relay is in operation with a DP interface, set a program cycle time of 15 ms.

Design of the DP interface module

Front view	No.	Meaning
	①	Removable terminal block D
	②	Removable terminal block C
	③	System interface (X2)
	④	PROFIBUS DP connection
	⑤	Removable terminal block A
	⑥	SET and MODE keys for operating the device display
	⑦	Label
	⑧	LCD display
	⑨	Display LEDs
	⑩	System interface (X1)

Internal circuit diagram

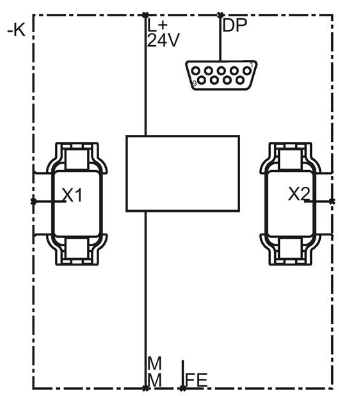


Figure 3-8 DP interface internal circuit diagram

Terminal designations of the DP interface module

Terminal	Meaning	Explanation
L+	Power supply	24 V DC
M	Ground	Ground to 24 V DC
FE	Functional ground	Shielding, equipotential bonding

Interfaces of the DP interface module

Interface	Meaning	Explanation
X1	System interface	Connection of PC / PG, diagnostics display
X2	System interface	Safety relay connection
PROFIBUS DP	9-pin sub D socket	Connection to PROFIBUS DP

Operating elements of the DP interface

Element	Meaning	Explanation
SET	Operating the display	See Chapter "Operating the 3RK35 DP interface (Page 118)".
MODE	Operating the display	

Display elements of the DP interface module

Element	Meaning
DEVICE	Status
BF	Bus error
SF	Group error

3.9 Safety systems - General information

3.9.1 What is safety?

Safety defines a state in which the risk of damage is reduced to a tolerable level, or which can be regarded as risk-free. Following on from this definition, functional safety concerns persons, machines and the environment.

The objective of safety systems is to reduce the risk for humans and machines that is posed by a use case to an acceptable level. The first step is, therefore, to identify the risk of a use case. In order to make a reliable assessment regarding the application, each individual function of a machine or plant must be analyzed for potential hazards.

You can find further information on the Siemens Safety Integrated (http://www.siemens.com/safety) Internet page.

3.9.2 Safety function

A safety function describes the reaction of a machine/plant when a specific event occurs (e.g. opening of a protective door). Execution of the safety function(s) is carried out by a safety-related control system. This usually comprises three subsystems, **detecting**, **evaluating** and **and reacting**.

Detecting (sensors):

- Detection of a safety requirement
  e.g. EMERGENCY STOP or a sensor for monitoring a hazardous area (light array, laser scanner, etc.) is operated.

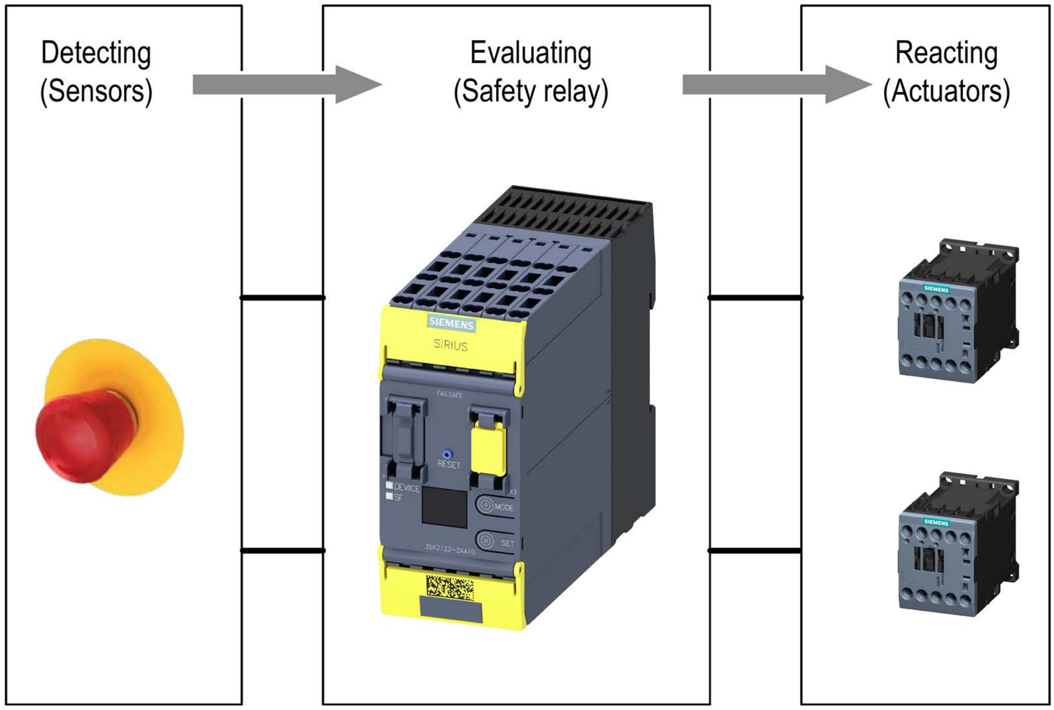
Evaluating (safety relay):

- Detection of a safety requirement and the safe initiation of the reaction, e.g. switching off the enabling circuits
- Monitoring the correct operation of sensors and actuators
- Initiating a reaction upon detection of faults

The safety relays described in this manual are evaluation units for safety functions.

Reacting (actuators):

- Switching off the hazard by means of downstream actuators



3.9.3 Basic terminology

3.9.3.1 Redundancy/single-channel and two-channel

With redundancy, more than one component is implemented for the same function, so a faulty function of a component is performed instead by the other component(s).

A redundant configuration reduces the probability of a function failing due to a single defective component. This requirement is essential for achieving SILCL 3 as per EN 62061, SIL 3 as per IEC 61508 and PL e/Cat. 4 as per EN ISO 13849-1 (also necessary for SILCL 2 / PL d under certain circumstances).

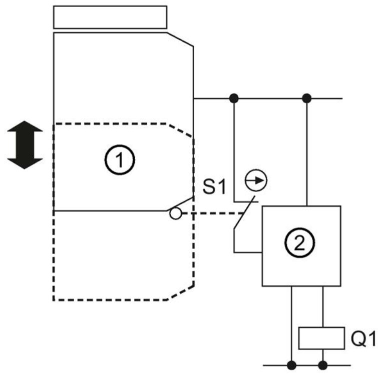
The simplest form of redundancy is **two-channel redundancy.**

If a circuit fails, two-channel redundancy ensures that the safety function is maintained.

In a redundant system configuration, the subsystems for detecting and reacting must also be implemented with two-channel redundancy.

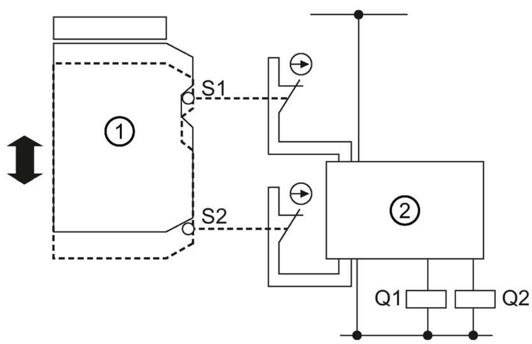
Note

All safety devices that comply with SILCL 3 as per EN 62061, SIL 3 as per IEC 61508 and PL e/Cat. 4 as per EN ISO 13849-1 are redundantly configured with regard to the internal logic and also with regard to the output circuits.



① Mechanical position switches
② Safety relay

Figure 3-9 Single-channel safety-related control system



① Mechanical position switches
② Safety relay

Figure 3-10 Two-channel safety-related control system

3.9.3.2 Cross-circuit detection

Cross-circuit detection is a diagnostic function of a safety relay that detects short circuits and cross-circuits between the input channels (sensor circuits) during two-channel detecting or reading. A cross-circuit can be caused, for example, by a cable casing being squashed. In devices without cross-circuit detection, this can mean that a two-channel emergency stop circuit does not trip even though only one NC contact is faulty (secondary error).

With the safety relays, a cross-circuit is detected in the sensor circuits by means of signals with different clock pulses. If the clocked signals overlap, the device detects a cross-circuit. With safety relays, cross-circuit detection can be deactivated to enable evaluation of electronic sensors (that monitor themselves as well as the cable to the evaluation unit).

3.9.3.3 Enabling circuit

An enabling circuit provides a safety-related output signal. From an external viewpoint, enabling circuits usually act as NO contacts.

An individual enabling circuit with two channels that is configured accordingly in the safety relay can be used for applications up to SILCL 3 / PL e / Kat. 4.

Note: Enabling current paths can also be used for signaling purposes.

3.9.3.4 Solid-state signaling output

A signaling output provides a safety-related output signal. This can be used to signal system states, for example. Signaling outputs must not be used in safety functions.

3.9.3.5 Feedback circuit

A feedback circuit serves to monitor controlled actuators. Only the actuators' positively driven NC contacts or mirror contacts may be used to read back the switch positions of coupling contacts or load contactors. The fail-safe outputs can only be activated if the feedback circuit is closed. One input of the safety relay is needed to read in the feedback circuit. Logical evaluation of the feedback circuit is implemented in the Safety ES software with the "F output" and "F output delayed" output functions.

3.9.3.6 Stop categories

Stop category 0

Non-controlled shutdown by immediately switching off the power to the machine's drive elements.

Stop category 1

Controlled stopping where the energy feed is interrupted with a time delay, or is only interrupted once standstill has been reached.

Note

Time-delayed shutdown of enabling circuits in accordance with stop category 1 is not ensured under all operating states.

In the case of some internal device faults, and when disconnecting the supply voltage, these enabling circuits are switched off **instantaneously**. This must be considered during the risk analysis and when designing the system.

3.9.3.7 Start function and types

Start functions

After triggering of a safety function and recovery of the enabled state (e.g. protective door has been opened and is closed again), it is necessary for the user to reset the safety-related control system by means of a further manual action. This reset is generally performed by operating a button.

This "start button" can be interfaced directly at an input of the safety relay or at a higher-level controller. This then sends the start signal for activation of the safety outputs to the safety relay by means of a bus signal.

Evaluation of the start command or execution of one of the start types in the logic diagram can be implemented by means of different function elements:

- **Parameterization of the monitoring functions**

  Every sensor monitoring function (except acknowledgment buttons, two-hand operation, and mode selector switches) has the automatic, manual and monitored start types. This type of realization is suitable for applications with several sensors and their own command points.

- **Parameterization of the output functions**

  Further, it is possible to activate a start type at the output functions.

- **Use of separate start functions**

  Another option is to use separate start functions. To this end, Safety ES offers start functions for manual and monitored starting. Use of separate start functions allows you to individually evaluate the process signals and thus to realize visualization for requesting button operation, for example.

Start types

You will find information on the start types in the Sections:

- Automatic start (Page 60)
- Manual start (Page 60)
- Monitored start (Page 61)

Automatic start

For an automatic start, the device is started without manual confirmation, but only after the input image has been checked and a positive test of the safety relay has been conducted. This function is also known as dynamic operation and is not permissible for EMERGENCY STOP devices. Safety devices for inaccessible danger zones can use the automatic start function if this does not pose any risk.

Note

An automatic start is not permitted for EMERGENCY STOP devices.

WARNING

Restarting the system
Can Cause Death, Serious Injury, or Property Damage.

The start type depends on the risk assessment. For PL e n accordance with EN ISO 13849-1 as well as SIL 3 in accordance with IEC 61508, the monitored start must be used in the case of EMERGENCY STOP, for example. For other safety sensors/functions, the need for a monitored start command depends on the risk assessment.

Manual start

For a manual start, the device is started by operating the START button, but only after the input image has been checked and a positive test of the safety relay has been conducted. On a manual start, the START button is not monitored for correct operation, a positive edge of the START button is sufficient for starting.

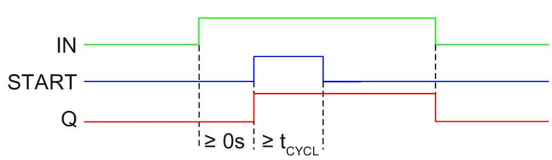


Figure 3-11 Start function "Manual start"

Note

A blocked start button is not detected in the case of this start type. Thus, for example, a disruption of the signal can trigger an undesirable start. The manual start is therefore **not** suitable for PL e in accordance with EN ISO 13849-1 or SIL 3 in accordance with IEC 61508.

WARNING

Restarting the system
Can Cause Death, Serious Injury, or Property Damage.

The start type depends on the risk assessment. For PL e n accordance with EN ISO 13849-1 as well as SIL 3 in accordance with IEC 61508, the monitored start must be used in the case of EMERGENCY STOP, for example. For other safety sensors/functions, the need for a monitored start command depends on the risk assessment.

Monitored start

For a monitored start, the device is started by operating the START button, but only after the input image has been checked and a positive test of the safety relay has been conducted.

Contrary to the manual start, the monitored start evaluates the **signal sequence** of the START button. The output is not activated until the START button is opened again and its operating duration was within the valid time window (0.15 s to 2 s). This means that the START button cannot be bypassed (misuse). For PL e n accordance with EN ISO 13849-1 as well as SILCL 3 in accordance with EN 62061, monitored start must be used in the case of EMERGENCY STOP. For other safety sensors/functions, the need for a monitored start command depends on the risk assessment.

If the START button is actuated for more than 2 seconds, the safety relay detects a wiring short circuit in the START button and the associated function element remains in the safe state.

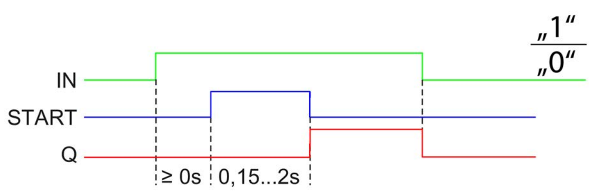


Figure 3-12 Start function "Monitored start"

WARNING

Restarting the system
Can Cause Death, Serious Injury, or Property Damage.

The start type depends on the risk assessment. For PL e n accordance with EN ISO 13849-1 as well as SIL 3 in accordance with IEC 61508, the monitored start must be used in the case of EMERGENCY STOP, for example. For other safety sensors/functions, the need for a monitored start command depends on the risk assessment.

3.9.3.8 Two-hand operation/synchronism

Synchronous sensor operation is a special form of simultaneity of sensors.

In this case, it is not sufficient for buttons 1 and 2 to be switched to the closed state "at different times". Instead, the buttons must be actuated within 0.5 seconds of each other. Before monitoring, a button is considered to have been operated if all the button's sensor contacts are closed and no fault (e.g. discrepancy, cross-circuit, etc.) has been detected.

Synchronism of sensors is required, in particular, in the case of two-hand operation of presses. This ensures that the presses only become active when the sensors are operated simultaneously with both hands. This minimizes the risk of the operator getting a hand in the press.

With the safety relays, you can achieve applications up to type IIIc in compliance with EN 574 (applications up to PL e / Cat. 4 as per EN ISO 13849-1 or SIL 3 as per IEC 61508).

Note

The safety relays support two-hand operator panels with the following contact arrangements:

- Two-channel normally open contact (NO)(NO)
- Four-channel normally open contact (NONO)(NONO)
- Four-channel normally open/normally closed contact (NONC)(NONC)

Note

The two-hand circuit must be marked in compliance with EN 574. You can find information on determining the response time in Section Response times (Page 156).

3.9.3.9 Discrepancy monitoring

Discrepancy monitoring is a diagnostics function that monitors, in the case of sensors with two contacts, whether dependence of the two contacts is correctly fulfilled. As a result, faults on one contact of the sensor can be detected. For example, such faults can be a stuck contact or a short circuit between the supplying test clock pulse and the return line from the sensor to the input. In the case of sensors without discrepancy monitoring, this can mean that a two-channel emergency stop circuit does not trip even though only one NC contact is faulty (secondary error).

In the case of the safety devices, discrepancy monitoring is set depending on the monitoring function. In the case of some functions (protective door, protective door with tumbler and universal monitoring), discrepancy monitoring can be deactivated, for example to ensure that certain variants of protective doors with tumbler do not have to be opened after every unlocking.

If the discrepancy time is set to infinite, any amount of time can elapse between closing of the first and the second contacts. However, a discrepancy fault is signaled if both contacts are closed and only one contact is opened and then closed again.

3.9.3.10 Sequence monitoring

Sequence monitoring is a diagnostics function that monitors, in the case of sensors with more than one contact, whether a change in the switching states takes place at the corresponding contacts in the intended order. A simultaneous change of the switching state at more than one contact is a sequence violation.

In the case of Safety devices, sequence monitoring can be set depending on the monitoring function (e.g. protective door).

3.9.3.11 Startup testing

The sensor or protection equipment must be properly operated once after the supply voltage is restored before the enables for the safety relay can be switched through. Startup testing ensures that any errors in the sensors are detected (again), because safety relays lose their ability to store errors at zero voltage. Unauthorized manipulation of the protection equipment can also be detected through startup testing. The plant operator decides whether startup testing should be performed (risk assessment). No general statements apply.

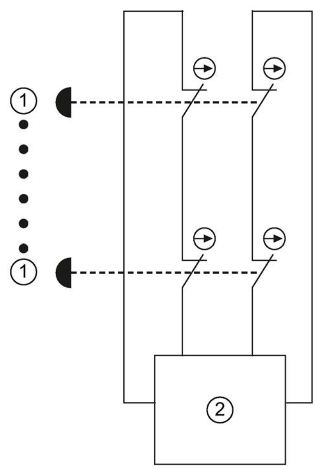
Possible startup testing applications:

- Seasonally operated machines
- Function test after extensive maintenance/repair work
- Realization of a test routine for safety functions without automatic test (e.g. EMERGENCY STOP)

3.9.4 Series connection of sensors

Series connection of EMERGENCY STOP command devices

It is possible to connect EMERGENCY STOP command elements in series up to the highest safety level (SILCL 3 as per EN 62061, SIL 3 as per IEC 61508 and PL e (Cat. 4) as per ISO 13849-1), because it is assumed that only one EMERGENCY STOP is operated at a time. This ensures that errors and defects can be detected.

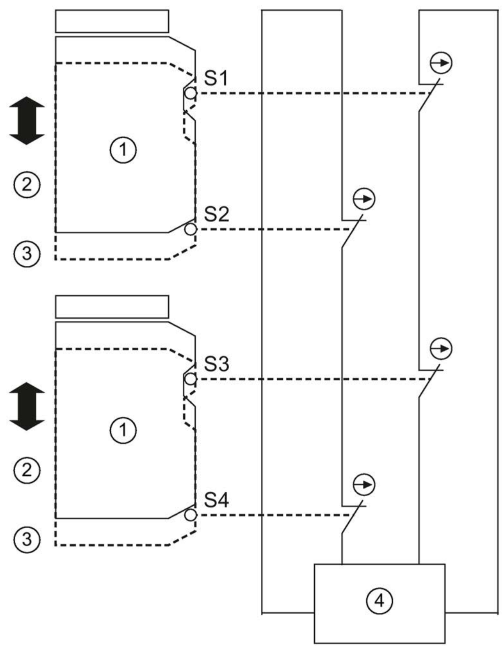


① EMERGENCY STOP
② Safety relay

Series connection of mechanical position switches

In general, position switches may be connected in series if measures ensure that several protective doors are not regularly opened simultaneously (otherwise a fault cannot be detected).

For safety level SILCL3 in accordance with EN 62061, SIL3 in accordance with IEC 61508, and PL e (Cat. 4) in accordance with ISO 13849-1, however, they must **never** be connected in series, because every hazardous error must be detected (independently of the operating personnel).



① Mechanical position switch
② Closed
③ Open
④ Safety relay

Mounting 4

4.1 General notes on installation

WARNING
Hazardous Voltage **Can Cause Death, Serious Injury, or Property Damage.** Hazardous electrical voltages can cause electric shock, burns and damage. • Turn off and lock out all power supplying the system and device before working on the device. • To ensure protection against the hazard of electric shock when the terminal cover is open, screw in all terminal screws that are not needed to clamp conductors. • Close the terminal covers and always keep them closed during operation.

4.2 3SK2 safety relays

4.2.1 Mounting the devices on a level surface

Requirements

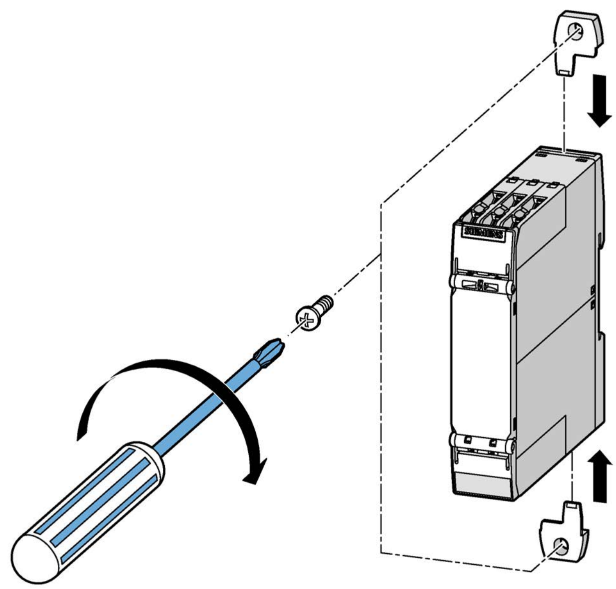
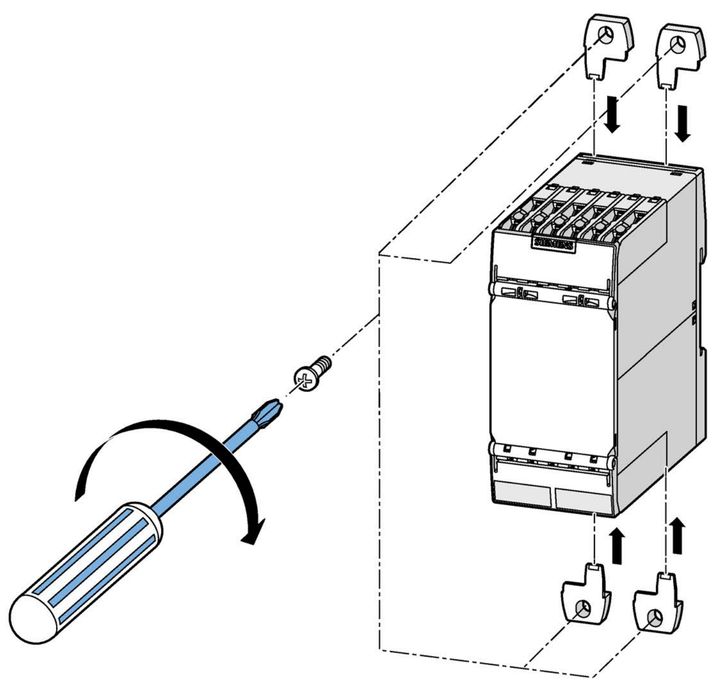
Please note the following requirements for mounting on a level surface:

- Refer to Section "System configuration guidelines (Page 125)".
- Two (22.5 mm devices) / four (45 mm devices) properly drilled holes with thread or plug on the level surface

  For details of the distances between the drilled holes, please refer to the relevant dimension drawings in Section "Dimension drawings (Page 253)".
- Two (22.5 mm devices) / four screws (45 mm devices) to fit the M4 x 12 holes in accordance with DIN 784
- Two (22.5 mm devices) / four (45 mm devices) lugs for screw fastening

  Refer to the accessories list for the relevant article number in Section "Spare parts/Accessories (Page 263)".

Procedure

Step	Instructions	Figure
1	Insert the push-in lugs for screw fixing into the openings provided on the device until they engage.	 22.5 mm device  45 mm device
2	Hold the device up to the surface prepared for screw fastening.	
3	Insert the screws through the elongated holes into the push-in lugs for screw fixing.	
4	Screw the device onto the level surface so that it is secure. Tightening torque: 1 Nm	

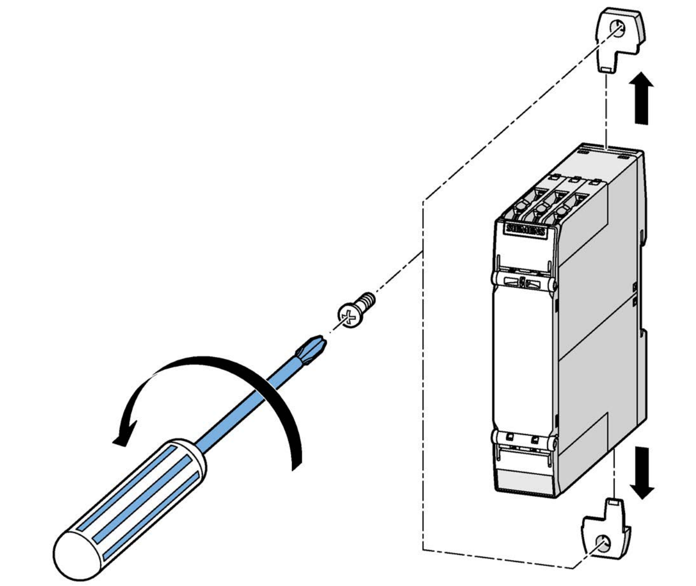
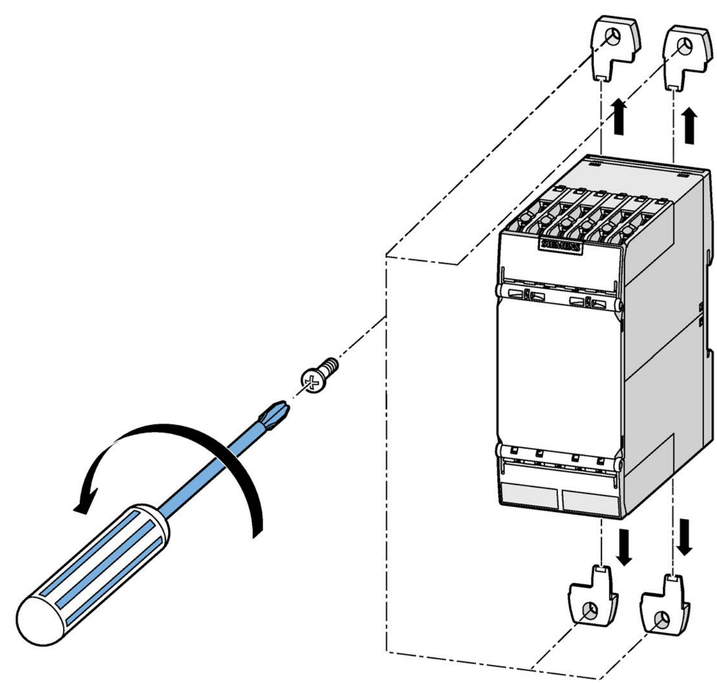
4.2.2 Disassembling the devices from a level surface

WARNING
Hazardous Voltage
Can Cause Death, Serious Injury, or Property Damage.
Before starting work, therefore, disconnect the system and devices from the power supply.

Requirements

- The terminals have been removed or disconnected.
- All system interface connections are disconnected.

Procedure

Step	Instructions	Figure
1	Hold the device firmly.	 22.5 mm device  45 mm device
2	Unscrew the cap screws.	
3	Lift the device from the level surface.	
4	Remove the push-in lugs for screw fixing from the device.	

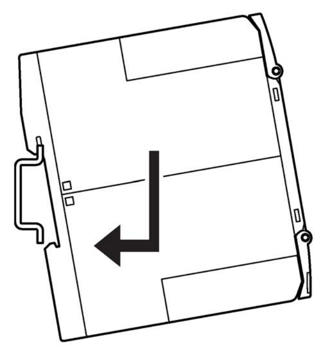
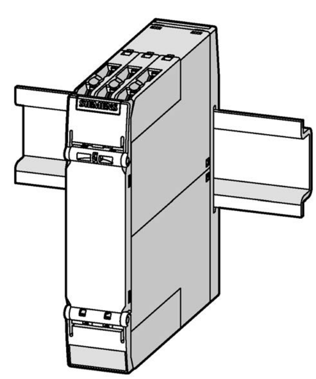
4.2.3 Mounting on a standard rail

Requirements

- A horizontal 35-mm wide mounting rail in accordance with DIN EN 60715 has been properly secured at the installation location.
- Refer to Section "System configuration guidelines (Page 125)".

Procedure

The figures show 22.5 mm devices. The 45 mm devices are mounted correspondingly.

<table>
<tr><th>Step</th><th>Instructions</th><th>Figure</th></tr>
<tr><td>1</td><td>Hang the back of the device onto the upper edge of the standard mounting rail</td><td rowspan="2">
</td></tr>
<tr><td>2</td><td>Press the lower half of the device against the rail until the device engages</td></tr>
</table>

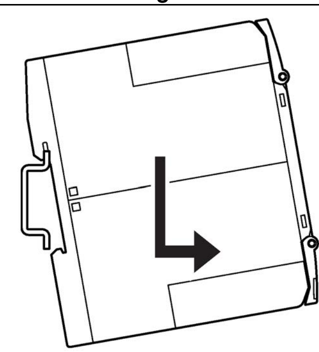
4.2.4 Disassembling devices from a standard mounting rail

⚠ WARNING
Hazardous Voltage **Can Cause Death, Serious Injury, or Property Damage.**
Before starting work, therefore, disconnect the system and devices from the power supply.

Requirements

- The terminals have been removed or disconnected.
- All system interface connections are disconnected.

Procedure

Step	Instructions	Figure
1	Press the device downwards.	
2	Pull the lower half of the device away from the DIN rail.	
3	Lift the device from the upper edge of the DIN rail.	

4.2.5 Mounting with device connector on a level surface

Requirements

Please note the following requirements for mounting on a level surface:

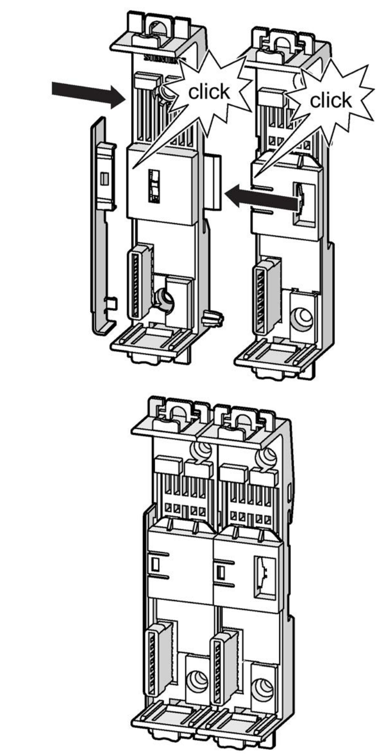
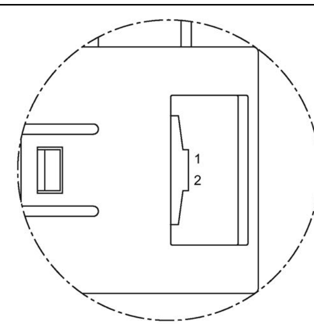
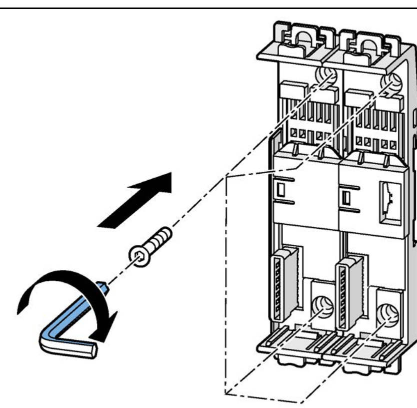
- Refer to Section "System configuration guidelines (Page 125)".
- Two properly executed drill holes (per device connector) with thread or plug on the level surface.

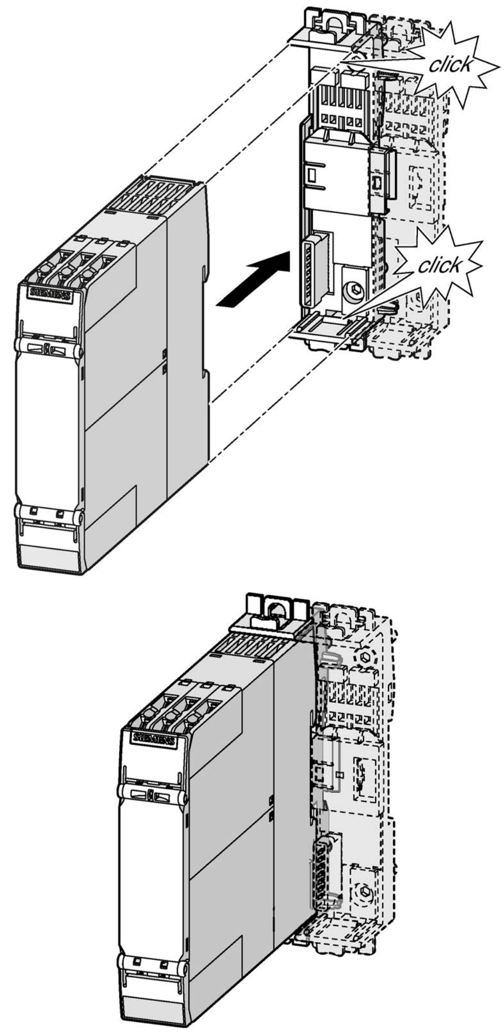
  For details of the distances between the drilled holes, please refer to the relevant dimension drawings in Section "Dimension drawings (Page 253)".
- Two screws (per device connector) to fit the holes M4 x12 in accordance with DIN 784.
- Device connector

  Refer to the accessories list for the relevant article number in Section "Spare parts/Accessories (Page 263)".

Procedure

The figures show 22.5 mm devices. The 45 mm devices are mounted correspondingly.

Step	Instructions	Figure
1	Push the device connectors together until they engage.	
2	Mount the cover on the left of the first device connector. The cover is included in the scope of supply of the device terminator.	
3	In the case of the device termination connectors of the 3SK1211 output expansions, set the slide switch to position 1 (top, i.e. closed). There is no slide switch in the case of device termination connectors of 3SK1213 output expansions and 3RM1 Failsafe motor starters.	
4	Hold the device connector against the level surface prepared for screw fastening.	
5	Insert the screws through the holes in the device connectors.	
6	Screw the device connector to the level surface so that it is secure. Tightening torques: • Top: < 0.1 Nm • Bottom: 1 Nm	

Step	Instructions	Figure
7	Mount the device on the device connector.	
8	Mount all the devices required for the system configuration in accordance with the respective installation guidelines on the device connectors.	

4.2.6 Disassembling the devices with device connectors from a level surface

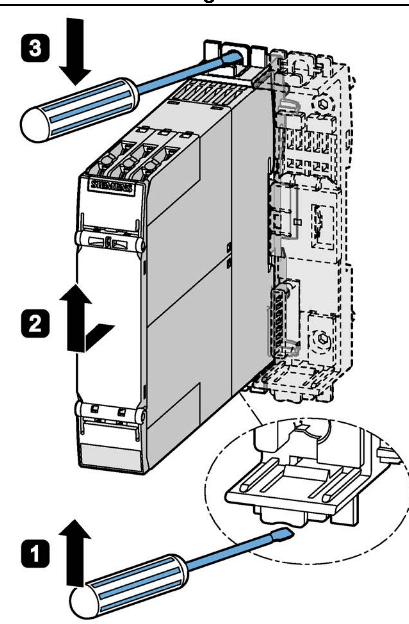
WARNING
Hazardous Voltage **Can Cause Death, Serious Injury, or Property Damage.**
Before starting work, therefore, disconnect the system and devices from the power supply.

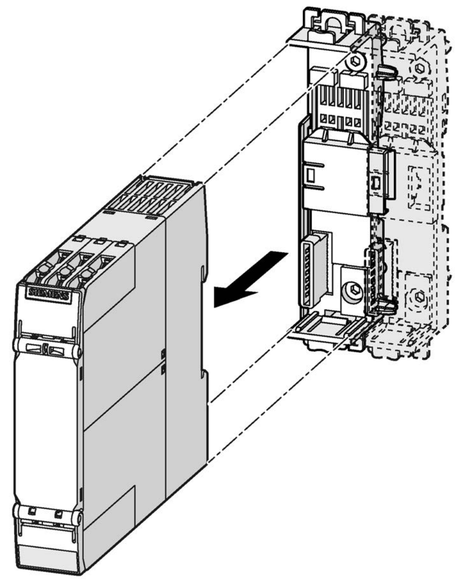
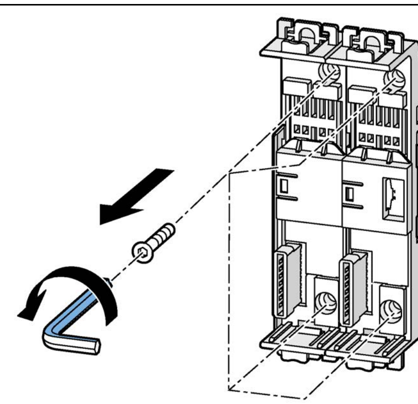
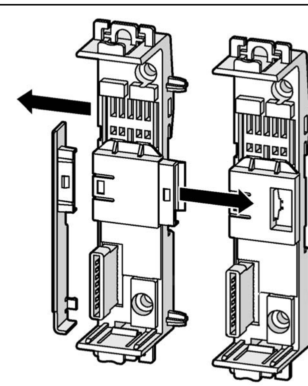
Requirements

- The terminals have been removed or disconnected.
- All system interface connections are disconnected.

Procedure

The figures show 22.5 mm devices. The 45 mm devices are disassembled correspondingly.

Step	Instructions	Figure
1	Unlock the device on the underside using a screwdriver.	
2	Pull the lower half of the device away from the device connector.	
3	Unlock the device on the top using a screwdriver.	

Step	Instructions	Figure
4	Pull the device away from the device connector.	
5	Release the screws.	
6	Separate the device connectors.	
7	Remove the cover to the left of the first device connector.	

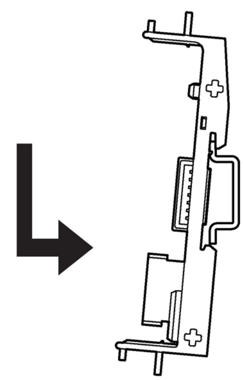
4.2.7 Mounting with device connector on a standard mounting rail

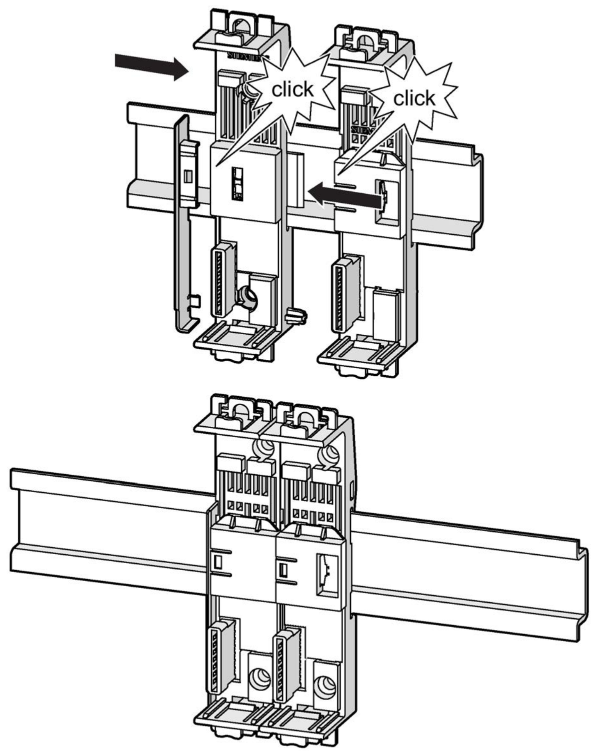
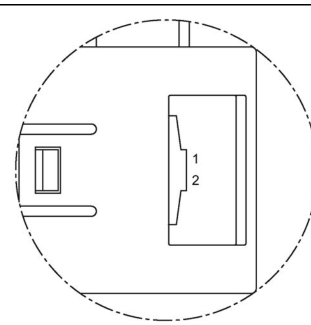
Requirements

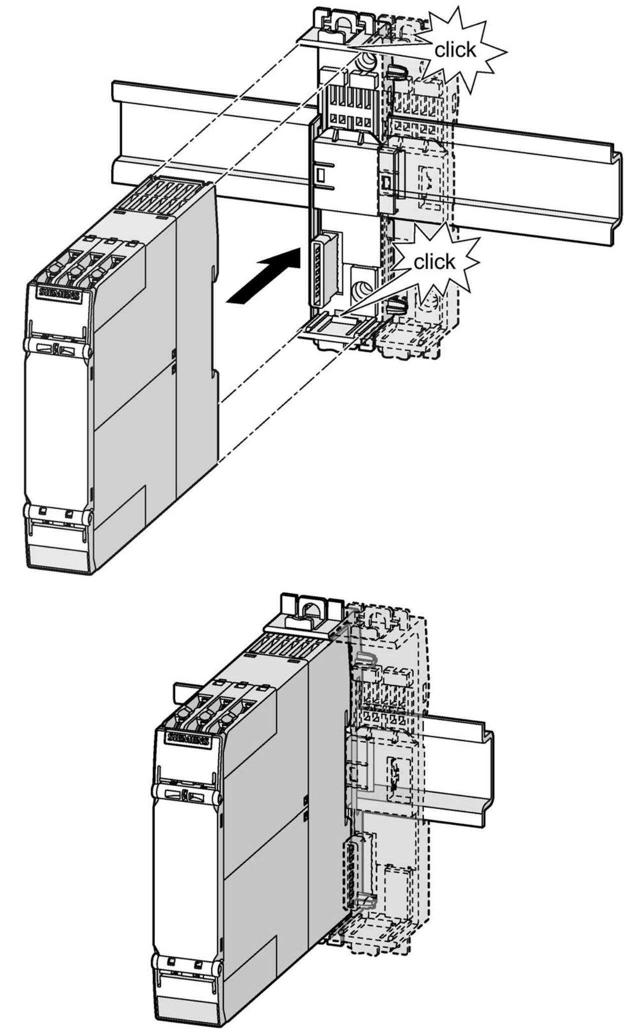
- A horizontal 35-mm wide mounting rail in accordance with DIN EN 60715 has been properly secured at the installation location.
- Refer to Section "System configuration guidelines (Page 125)".
- Device connectors:
  Refer to the accessories list for the relevant article number in Section "Spare parts/Accessories (Page 263)".

Procedure

The figures show 22.5 mm devices. The 45 mm devices are mounted correspondingly.

Step	Instructions	Figure
1	Place the back of the device connector on the upper edge of the standard mounting rail.	
2	Press the lower half of the device connector against the standard mounting rail until the connector engages.	
3	Repeat the procedure with all the required device connectors.	

<table>
<tr><th>Step</th><th>Instructions</th><th>Figure</th></tr>
<tr><td>4</td><td>Push the device connectors together until they engage.</td><td rowspan="2">
</td></tr>
<tr><td>5</td><td>Mount the cover on the left of the first device connector. The cover is included in the scope of supply of the device terminator.</td></tr>
<tr><td>6</td><td>In the case of the device termination connectors of the 3SK1211 output expansions, set the slide switch to position 1 (top, i.e. closed).
There is no slide switch in the case of device termination connectors of 3SK1213 output expansions and 3RM1 Failsafe motor starters.</td><td>
</td></tr>
</table>

Step	Instructions	Figure
7	Mount the device on the device connector.	
8	Mount all the devices required for the system configuration in accordance with the respective installation guidelines on the device connectors.	

4.2.8 Disassembling with device connector from a standard mounting rail

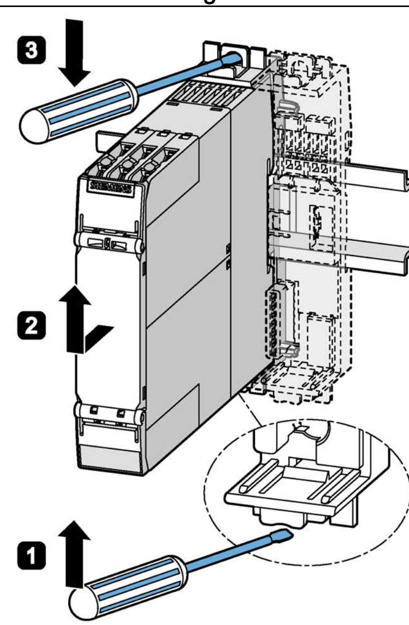
WARNING
Hazardous Voltage **Can Cause Death, Serious Injury, or Property Damage.**
Before starting work, therefore, disconnect the system and devices from the power supply.

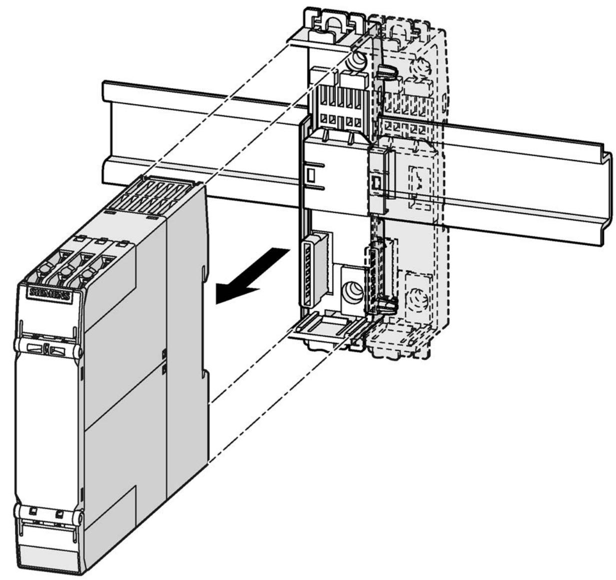
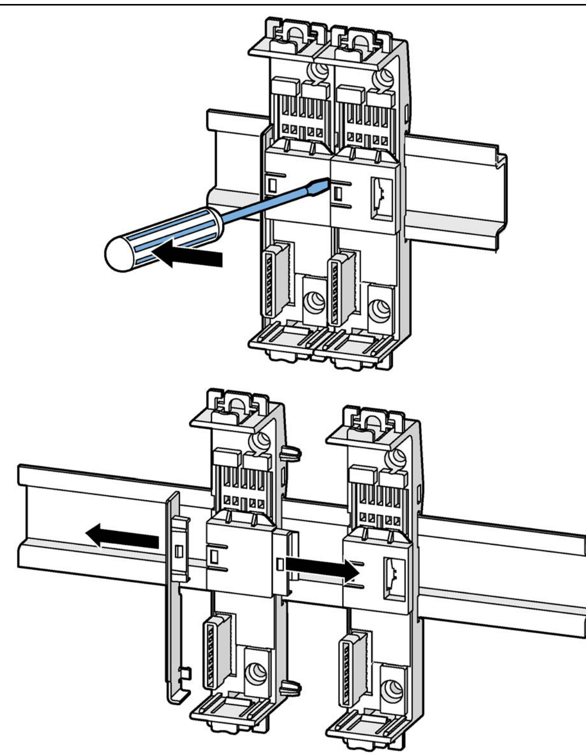
Requirements

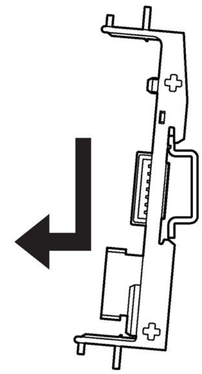
- The terminals have been removed or disconnected.
- All system interface connections are disconnected.

Procedure

The figures show 22.5 mm devices. The 45 mm devices are disassembled correspondingly.

Step	Instructions	Figure
1	Unlock the device using a screwdriver.	
2	Pull the lower half of the device away from the device connector.	
3	Unlock the device using a screwdriver.	

Step	Instructions	Figure
4	Pull the device away from the device connector.	
5	Separate the device connectors using a screwdriver.	
6	Remove the cover to the left of the first device connector.	

<table>
<tr><th>Step</th><th>Instructions</th><th>Figure</th></tr>
<tr><td>7</td><td>Press the device connector down.</td><td rowspan="3"></td></tr>
<tr><td>8</td><td>Pull the lower half of the device connector away from the standard mounting rail.</td></tr>
<tr><td>9</td><td>Lift the device connector from the upper edge of the standard mounting rail.</td></tr>
</table>

4.3 3SK26 diagnostics display

4.3.1 Installing the diagnostics display in a control cabinet door / switchboard

Requirements

- A mounting cut-out measuring H x W 55 x 92 mm must be available.
- The control cabinet door/control panel must be no more than 16 mm thick.

Note

Overall depth

Please observe the installation depth of 41 mm for the device.

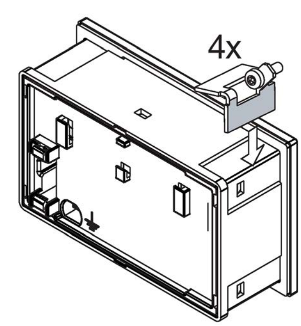
Note

Degree of protection IP54

The degree of protection IP54 on the front is only guaranteed if:

- The device has been properly installed with the fixing elements supplied.
- The system interface on the front has been protected with a system interface cover.

Procedure for installing in a control cabinet door / control panel

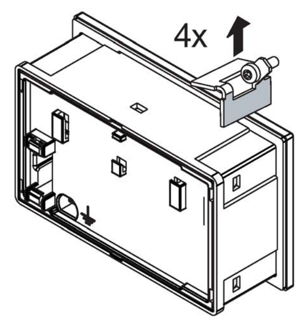
Step	Operating instruction	Figure
1	Insert the diagnostics display in the mounting cut-out from the front.	
2	Take appropriate measures to ensure the diagnostics display does not fall out of the control cabinet door/control panel.	
3	Snap the four fixing brackets on the rear into the oblong holes of the diagnostics display.	
4	Tighten the screws of the fixture bracket slightly so that the diagnostics display cannot fall out of the installation opening.	
5	Align the diagnostics display.	
6	Gently tighten the screws of the fixing brackets with 0.15 + 0.05 Nm.	

4.3.2 Removing the diagnostics display

Requirements

- All system interface connections are disconnected.

Removing the diagnostics display from a control cabinet door / control panel

Step	Instructions	Figure
1	Take appropriate measures to ensure the diagnostics display does not fall out of the control cabinet door/control panel.	
2	Unscrew the screws of the four fixing brackets on the rear.	
2	Remove the fixing brackets.	
3	Pull the diagnostics display out of the mounting cut-out from the front.	

4.4 3RK35 DP interface module

4.4.1 Mounting on a level surface

Requirements

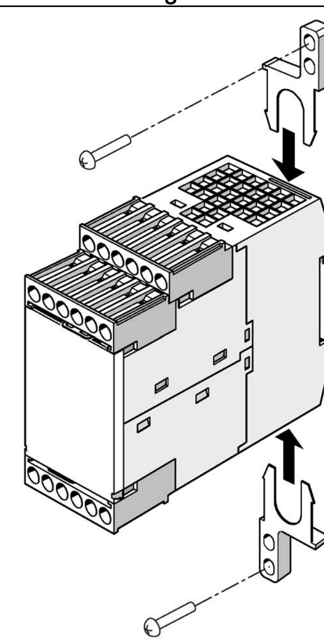
Please note the following requirements for mounting on a level surface:

- Please observe the information about the mounting position in Section "Device configuration rules (Page 134)".
- Two properly executed drill holes with thread or plug on the level surface

  Refer to the relevant dimension drawings in the appendix for the distances between the drill holes "DP interface (Page 258)".
- Two screws with a maximum thread diameter of 4.8 mm
- Two push-in lugs for screw fixing

  Refer to the accessories list for the relevant article number in Section "Spare parts/Accessories (Page 263)".

Procedure for mounting on a level surface

Step	Instructions	Figure
1	Insert the push-in lugs for screw fixing into the openings provided on the device until they engage.	
2	Hold the device up to the surface prepared for screw fastening.	
3	Insert the screws through the elongated holes into the push-in lugs for screw fixing.	
4	Screw the device onto the level surface so that it is secure.	

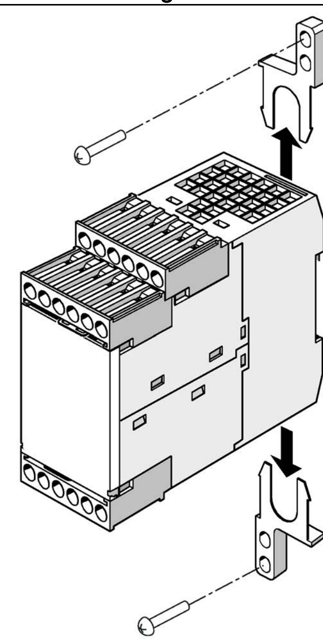
4.4.2 Disassembling the devices from a level surface

WARNING
Hazardous Voltage **Can Cause Death, Serious Injury, or Property Damage.**
Before starting work, therefore, disconnect the system and devices from the power supply.

Requirements

- All system interface connections are disconnected.
- If applicable, the PROFIBUS DP connection is terminated.
- The terminal blocks have been removed or disconnected.

Procedure

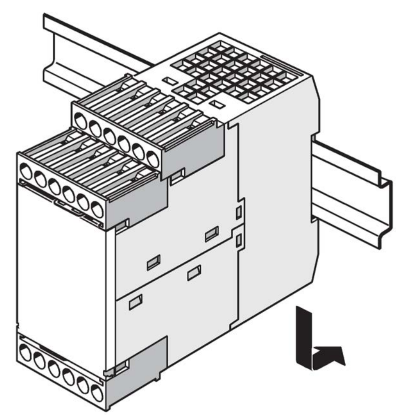
Step	Instructions	Figure
1	Hold the device firmly.	
2	Unscrew the cap screws.	
3	Lift the device from the level surface.	
4	Remove the push-in lugs for screw fixing from the device.	

4.4.3 Mounting the devices on a standard mounting rail

Requirements

- At the installation location, a horizontal 35-mm wide mounting rail per DIN EN 60715 is properly secured.
- Pay attention to the information on the mounting position in Chapter "Device configuration rules (Page 134)."

DIN rail mounting procedure

Step	Operating instruction	Figure
1	Place the back of the device onto the upper edge of the standard mounting rail.	
2	Press the lower half of the device against the DIN rail until the device engages.	

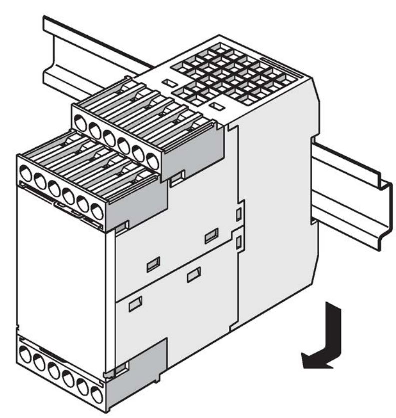
4.4.4 Disassembling devices from a standard mounting rail

WARNING
Hazardous Voltage **Can Cause Death, Serious Injury, or Property Damage.**
Before starting work, therefore, disconnect the system and devices from the power supply.

Requirements

- All system interface connections are disconnected.
- If applicable, the PROFIBUS DP connection is terminated.
- The terminal blocks have been removed or disconnected.

Procedure

Step	Instructions	Figure
1	Pull the device down until the lower half can be pulled away from the DIN rail.	
2	Pull the lower half of the device away from the DIN rail.	
3	Lift the device from the upper edge of the DIN rail.	

Connection 5

5.1 General information about connection

WARNING

Hazardous Voltage
Can Cause Death, Serious Injury, or Property Damage.

Hazardous electrical voltages can cause electric shock, burns and damage.

- Turn off and lock out all power supplying the system and device before working on the device.
- To ensure protection against the hazard of electric shock when the terminal cover is open, screw in all terminal screws that are not needed to clamp conductors.
- Close the terminal covers and always keep them closed during operation.

WARNING

Bypassing the Safety Function
Can Cause Death, Serious Injury, or Property Damage.

3SK1 output expansions and 3RM1 Failsafe motor starters that are connected to the 3SK2 safety relay via 3ZY12 device connectors are supplied with voltage via the device connectors.

Do not directly connect any separate supply voltage to a 3SK1 output expansion (A1/A2) or to a 3RM1 Failsafe motor starter (A1/A2) as otherwise the safety function will be bypassed.

NOTICE

Protection against electrostatic charge

Unused system interfaces must be closed using system interface covers; see Section "Spare parts/Accessories (Page 263)".

Note

Sealing system interfaces

To protect against unauthorized access, you can secure the system interfaces of the 3SK2 safety relay using the system interface cover, sealing wire and crimp seal.

Note

Wiring rules and options for connecting inputs and outputs

You can find more information on wiring rules and possibilities of connecting inputs and outputs in the Section "Wiring rules for inputs and outputs (Page 140)".

5.2 Power supply

Safe functional extra-low voltage

3SK2 safety relays must be operated with a safe functional extra-low voltage (SELV, PELV). This means these modules may only be subjected to a voltage of U_m even in the event of a fault. The following applies for 3SK2 safety relays: U_m < 60.0 V.

You can find more detailed information about safe functional extra-low voltage in the data sheets of the power supplies to be used.

The system's power is supplied via a power supply unit in accordance with IEC 60536 protection class III (SELV or PELV) with 24 V DC.

Note

The following components must be operated on the same power supply as the 3SK2 safety relay.

- Sensors with solid-state outputs
- Non-floating electromechanical sensors
- DP interface

5.3 Grounding

WARNING

Hazardous Voltage
Can Cause Death, Serious Injury, or Property Damage.

Before grounding or wiring an electrical device, you must ensure that the power supply for the device is switched off. Ensure that all the connected devices are also switched off.

Grounding measures

All electrical devices must be grounded and wired properly not only to ensure that your system functions as smoothly as possible but also to provide additional noise immunity for your application.

The following components must be grounded:

- FE contacts of the devices, if present
- The shield, if shielded sensor and actuator cables are used
- Flat connector on the rear of the diagnostics display
- Shield of the PROFIBUS cable

All grounding cables must be as short as possible and have the largest possible cable cross-section.

5.4 3SK2 safety relays

5.4.1 Terminal assignment

Location of the connections

The terminal covers of the 3SK2 safety relays, 3SK1 output expansions and 3RM1 Failsafe motor starters are labeled on the inside with the markings of the relevant terminals. Assignment of the markings to the terminals is shown schematically in the two illustrations below.

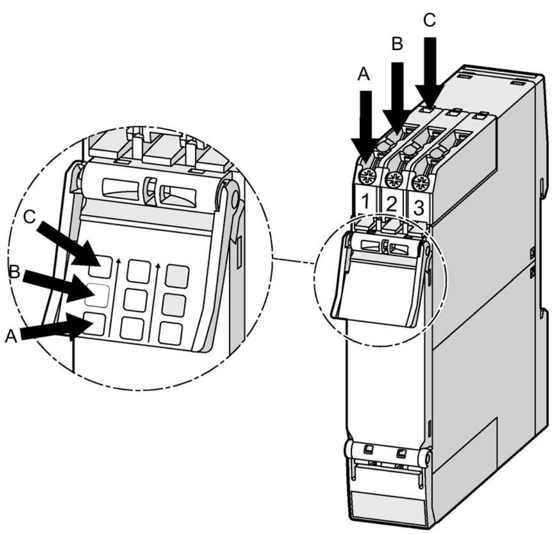


Figure 5-1 Upper terminal cover

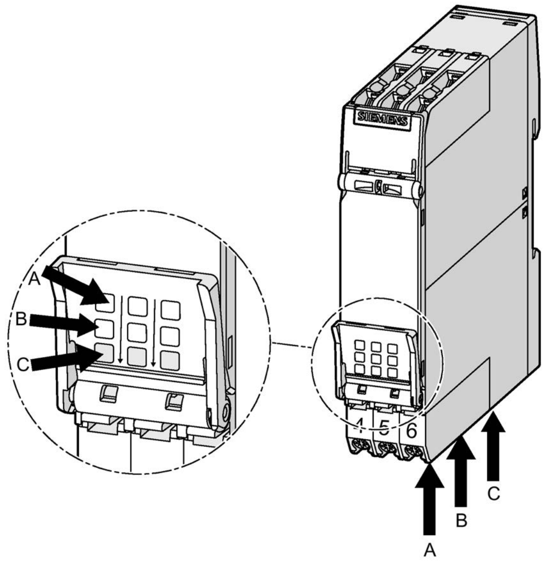


Figure 5-2 Lower terminal cover

5.4.2 Terminal coding

You can provide the terminals with coding pins (3ZY1440-1AA00). These assist you when replacing devices so as to avoid confusing terminals.

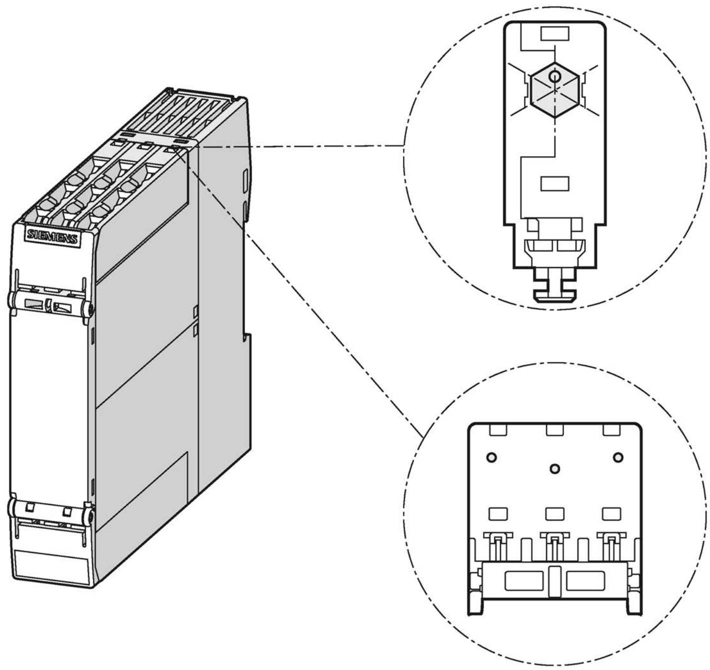


Figure 5-3 Module with coding pins

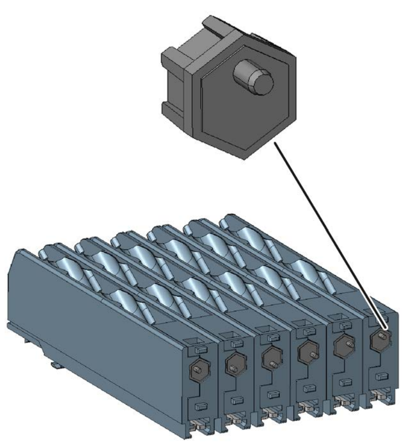


Figure 5-4 Stud position rotated by 60° in each case

5.4.3 Connecting the screw-type terminals

WARNING

Hazardous Voltage
Can Cause Death, Serious Injury, or Property Damage.

Hazardous electrical voltages can cause electric shock, burns and damage.

- Turn off and lock out all power supplying the system and device before working on the device.
- To ensure protection against the hazard of electric shock when the terminal cover is open, screw in all terminal screws that are not needed to clamp conductors.
- Close the terminal covers and always keep them closed during operation.

Note

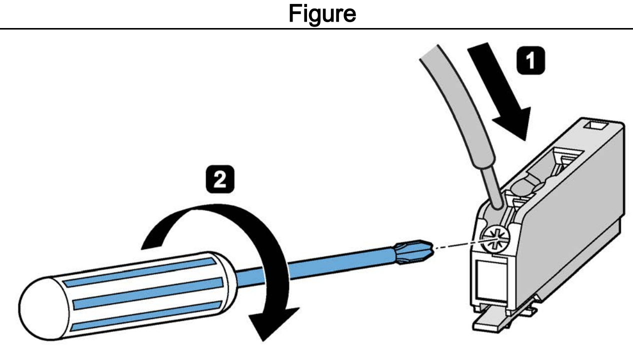
Functional ground - protective ground conductor

Terminal FE must be connected to functional ground with a low-resistance connection.

Requirements

- Cross-tip screwdriver size PZ 1 x 80
- For suitable connection cross-sections of the cables, see Section 3SK2 safety relays (Page 250).

Procedure

Step	Instructions	Figure
1	Insert the relevant cable into square on the screw terminal until it engages.	
2	Hold the cable in the screw terminal.	
3	Tighten the screw with a torque of 0.6 … 0.8 Nm.	
4	Pull on the cable to ensure it is screwed tight.	

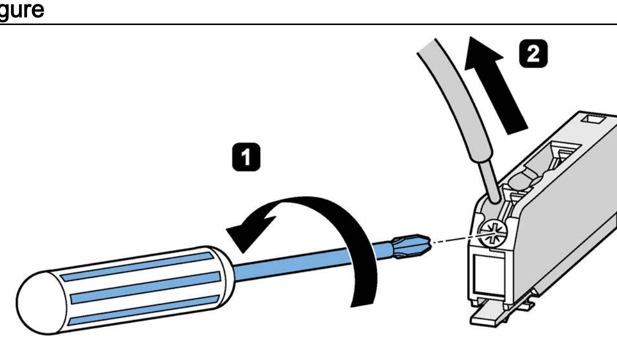
5.4.4 Disconnecting the screw-type terminals

WARNING
Hazardous Voltage **Can Cause Death, Serious Injury, or Property Damage.**
Before starting work, therefore, disconnect the system and devices from the power supply.

Requirements

- Cross-tip screwdriver size PZ 1 x 80

Procedure

<table>
<tr><th>Step</th><th>Instructions</th><th>Figure</th></tr>
<tr><td>1</td><td>Unscrew the screw of the screw-type terminal.</td><td rowspan="2">
</td></tr>
<tr><td>2</td><td>Remove the cable from the unscrewed screw-type terminal.</td></tr>
</table>

5.4.5 Connecting the push-in terminals

Wiring rules for spring-loaded terminals with push-in technology

Wiring rules for ...		Terminals
Connectable cross-sections for solid cables		2 x 0.5 ... 2 x 1.5 mm²
		(AWG[1]): 20 ... 16)
Connectable cross-sections for flexible cables	Without end sleeve	2 x 0.5 ... 2 x 1.5 mm²
		(AWG[1]): 20 ... 16)
	With end sleeve (with and without plastic sleeve)	2 x 0.5 ... 2 x 1.0 mm² [2]
		(AWG[1]): 20 ... 18)
	With TWIN end sleeve	---

Cable stripping length		10 ... 11 mm
End sleeves according to DIN 46228-4 with plastic sleeve		10 mm

1) AWG: American Wire Gauge (AWG does not define use of end sleeves)

2) When 2 x 1.0 mm² end sleeves with a plastic sleeve are used, space problems may arise with the sleeves; as an alternative, you are advised to use end sleeves without plastic sleeves

Notes on handling spring-loaded terminals with push-in technology

The terminal area of the spring-loaded terminals is rectangular, and the maximum overall dimensions of the conductor to be wired must not exceed 1.5 x 2.4 mm.

Attention must be paid to the orientation of the terminal area, which may call for vertical fitting of rectangularly crimped cables.
To make optimum use of available terminal area, you are advised to choose a form of crimping that creates a corresponding rectangular contour. Trapezoidal crimping is generally very highly suitable in this case.

When use is made of a cable that utilizes the full overall height, the terminal's spring is deflected to the maximum. Therefore, removal of this cable may become a problem because it requires further deflection of the spring.

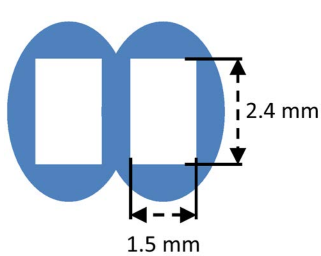


Figure 5-5 Terminal area

WARNING
Hazardous Voltage **Can Cause Death, Serious Injury, or Property Damage.**
Before starting work, therefore, disconnect the system and devices from the power supply.

Note

Functional ground - protective ground conductor

Terminal FE must be connected to functional ground with a low-resistance connection.

Push-in connections are a form of spring-loaded terminals allowing wiring without tools for rigid conductors or conductors equipped with end sleeves.

For wiring finely stranded or stranded conductors without end sleeves on push-in connections, a screwdriver is required.

Requirements

- Screwdriver DIN 5264 of the size 0.5 x 3 mm (for finely-stranded conductors only)
- For suitable connection cross-sections of the cables, see Section Connecting the push-in terminals (Page 96).

Procedure

Table 5- 1 Rigid conductors or conductors equipped with end sleeves

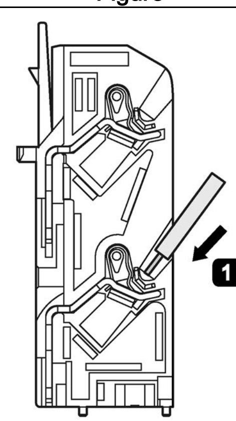
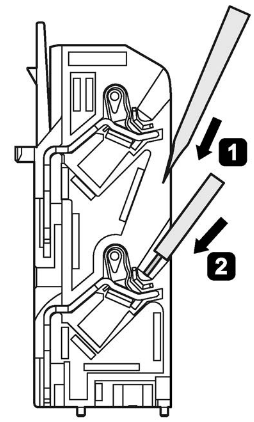
Step	Instructions	Figure
1	Insert the cable into the oval opening as far as it will go.	
2	Pull on the cable to ensure it is tight.	

Table 5- 2 Finely-stranded conductors

Step	Instructions	Figure
1	Insert the screwdriver in the rectangular opening to open the terminal (oval opening).	
2	Insert the cable as far as it will go into the oval opening and remove the screwdriver.	
3	Pull on the cable to ensure it is tight.	

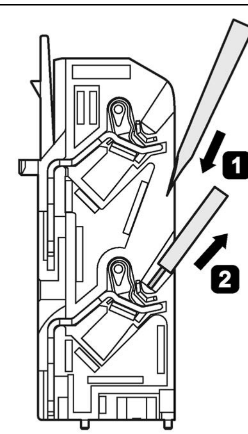
5.4.6 Disconnecting the push-in terminals

> **WARNING**
>
> **Hazardous Voltage**
> **Can Cause Death, Serious Injury, or Property Damage.**
>
> Before starting work, therefore, disconnect the system and devices from the power supply.

Requirements

- Screwdriver DIN 5264 of the size 0.5 x 3 mm

Procedure

Step	Instructions	Figure
1	Insert the flat-head screwdriver into the rectangular opening of the spring-loaded terminal until it engages.	
2	Remove the cable from the oval opening.	
3	Remove the screwdriver.	

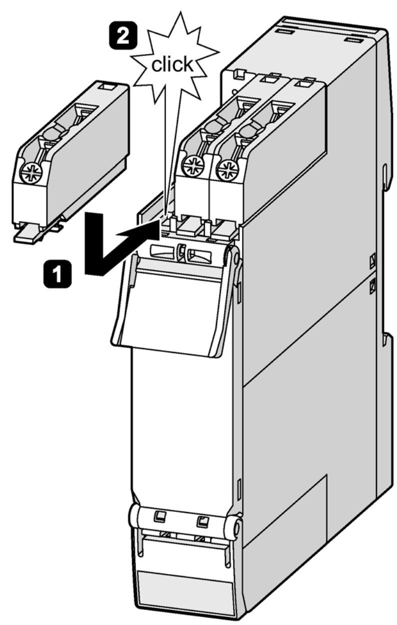
5.4.7 Attaching the terminals

WARNING
Hazardous Voltage **Can Cause Death, Serious Injury, or Property Damage.** Before starting work, therefore, disconnect the system and devices from the power supply.

Requirements

- You must have removed the terminal blocks, for the purpose of replacing a device, for example.

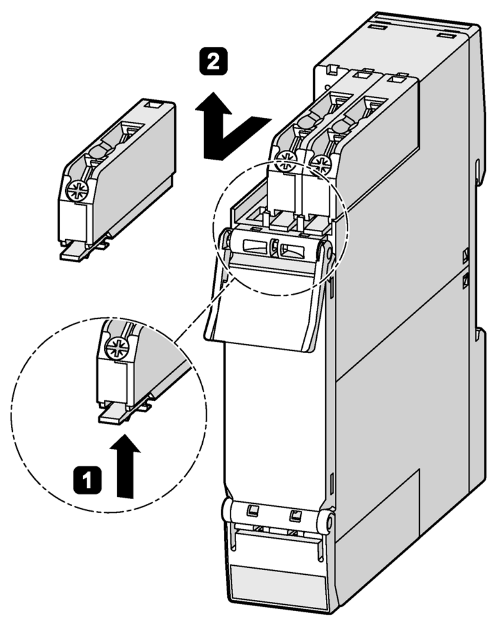
Procedure

Step	Instructions	Figure
1	Insert the terminal into the guide rail of the device.	
2	Slide the terminal back until it audibly engages.	

5.4.8 Removing the terminals

WARNING
Hazardous Voltage **Can Cause Death, Serious Injury, or Property Damage.** Before starting work, therefore, disconnect the system and devices from the power supply.

Procedure

Step	Instructions	Figure
1	Press the clip of the terminal block upwards.	
2	Pull the terminal out to the front.	
3	Lift the terminal out of the guide rail of the device.	

5.4.9 Plugging on and sealing the memory module

The memory module is included in the scope of supply of the 3SK2 safety relay with a width of 45 mm. The 3SK2 safety relay with a width of 22.5 mm has no external memory module.

Connecting the memory module

Note

Data loss on the 3SK2 safety relay (45 mm)

Connect or disconnect the external memory module only when the power is switched off.

Open the locking element of the interface X3 ① on the front of the 3SK2 safety relay. Plug the memory module into the interface X3 on ②. Engage the locking elements ③.

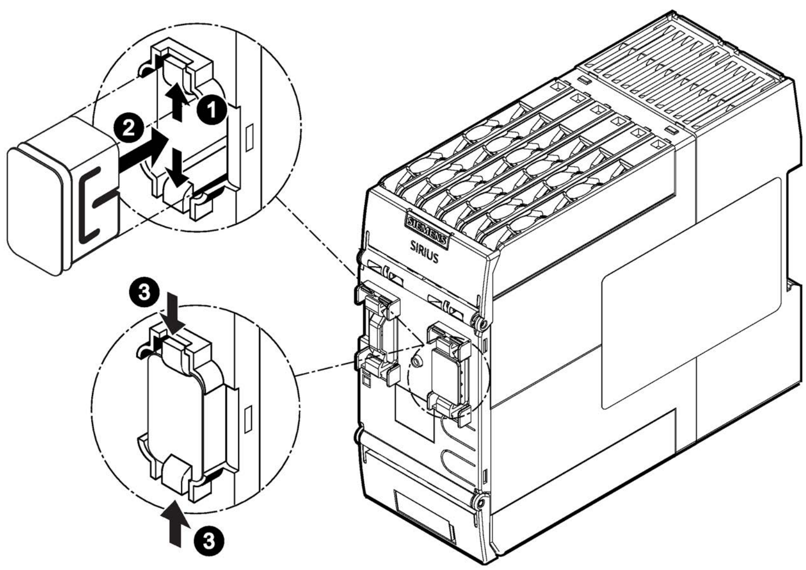


Figure 5-6 Connecting the memory module

Note

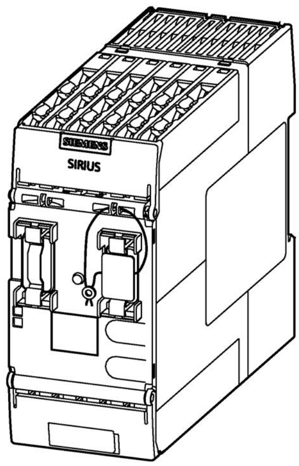
Correct position of the memory module

Check to ensure that the memory module is positioned correctly (the locking elements must be locked ③).

Sealing the memory module

Depending on the specific requirements, the memory module can be sealed with a sealing wire and a suitable crimp seal:

- Sealing with the control cabinet
- Sealing with the 3SK2 safety relay



Note on the memory module

If you connect a memory module to a 3SK2 safety relay (45 mm width) on which a configuration has already been released for another safety relay, e.g. MSS 3RK3, a configuration error is returned and the device remains in configuring mode.

If a memory module with a configuration for a 3SK2 safety relay is plugged into an MSS 3RK3, release of the configuration is revoked.

5.5 3RK35 DP interface module

5.5.1 Connecting terminal blocks

WARNING
Hazardous Voltage **Can Cause Death, Serious Injury, or Property Damage.**
Before starting work, therefore, disconnect the system and devices from the power supply.

Note

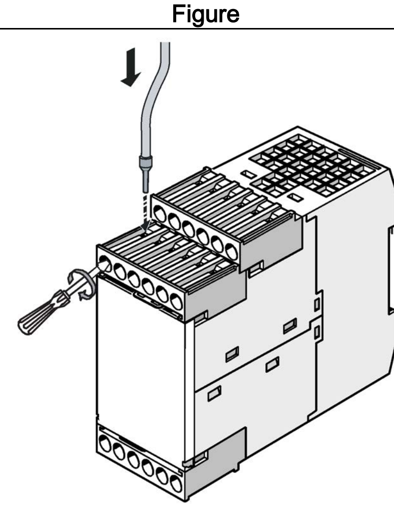
Functional ground - protective ground conductor

Terminal FE must be connected to functional ground with a low-resistance connection.

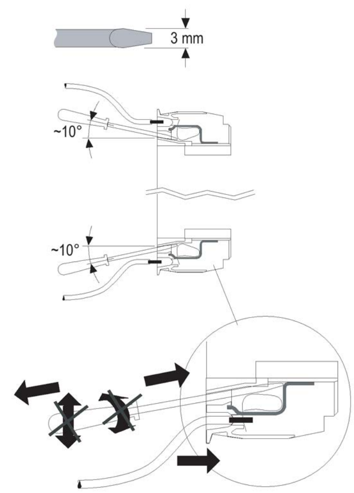
Requirements

- The insulation on the connection cables must be properly stripped to a length of 10 mm.
- Flexible cables must be fitted with end sleeves or cable lugs for connection to screw-type terminal blocks. For suitable connection cross-sections of the cables, see Section 3RK35 DP interface (Page 251).

Procedure for screw-type terminal blocks

Step	Instructions	Figure
1	Insert the relevant cable into square on the screw-type terminal until it engages.	
2	Hold the cable in the screw terminal.	
3	Tighten the screw of the terminal in which the cable is inserted.	
4	Pull on the cable to ensure it is screwed tight.	

Procedure for spring-loaded terminal blocks

Step	Instructions	Figure
1	To release the terminal spring, insert the 3-mm flat-head screwdriver into the square opening of the spring-loaded terminal until it engages. Please observe a 10° horizontal angular deviation of the screwdriver to the oval opening.	
2	Insert the cable into the oval opening as far as it will go.	
3	Hold the cable in the spring-loaded terminal.	
4	Remove the screwdriver.	
5	Pull on the cable to ensure it is tight.	

5.5.2 Establishing a PROFIBUS DP connection

PI installation guidelines

In the case of electric PROFIBUS networks, note also the PROFIBUS DP/FMS installation guidelines defined by the PROFIBUS user organization. These contain important information about installing cables and commissioning PROFIBUS networks.

Publisher:

PROFIBUS-Nutzerorganisation e. V.
Haid-und-Neu-Straße 7
76131 Karlsruhe, Germany

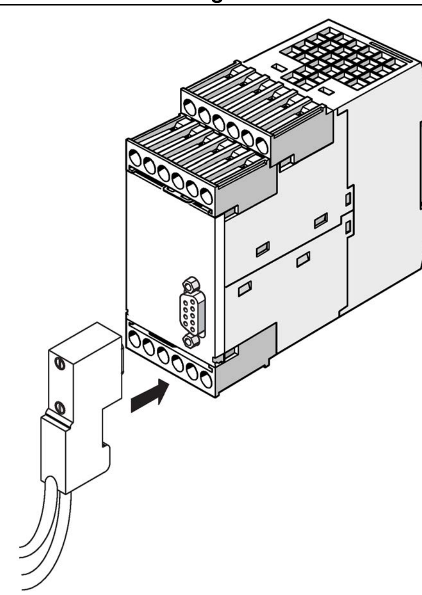
Tel.: +49 721 / 9658 590
Fax: +49 721 / 9658 589
Internet (http://www.profibus.com)
guidelines, article no. 2.111

See also "SIMATIC NET PROFIBUS Network Manual (https://support.industry.siemens.com/cs/ww/en/view/35222591)"

Requirement

PROFIBUS DP connection cable with 9-pin sub-D connector is available.

Connection to PROFIBUS DP

Step	Instructions	Figure
1	Connect the PROFIBUS DP connector to the PROFIBUS DP interface.	
2	Tighten the screws on the PROFIBUS DP connector.	
3	If the device is located at the end of the PROFIBUS DP cable, switch on the terminating resistor on the PROFIBUS DP connector.	

5.5.3 Connecting system interfaces (diagnostics display / DP interface)

Instructions

⚠ CAUTION
Protection against electrostatic charge
Unused system interfaces must be closed using system interface covers.

NOTICE
Off-circuit installation
Connect the system interfaces only in a voltage-free state!
If you connect system interfaces while the system is connected to the power supply, this can damage the safety components which, in turn, means that the safety function is no longer available.

Note

Reverse polarity protection

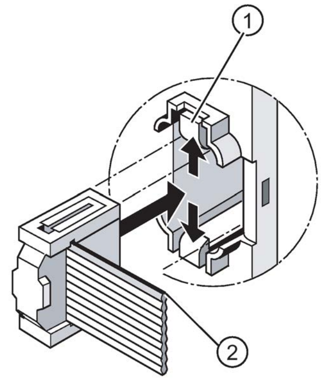
Observe the color coding and mechanical coding on the connection cables.

Connection cables

The DP interface and the diagnostics display are connected to the 3SK2 safety relay at the interfaces using connecting cables.

- The DP interface is configured side-by-side with the 3SK2 safety relay. A connecting cable with a length of 0.025 m is available for this purpose.
- Connection cables up to max. 2.5 m in length are available for connecting to the diagnostics display.

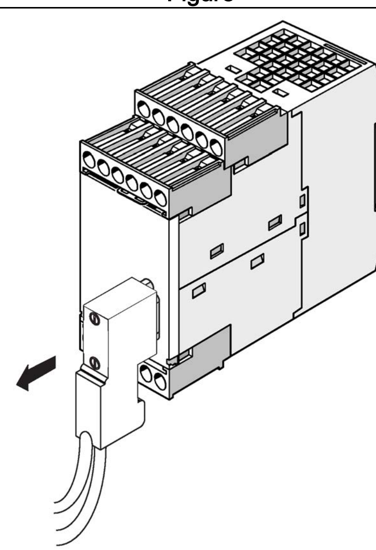
Procedure for connecting the DP interface and diagnostics display

Step	Instructions	Figure
1	Observe the color coding ② and mechanical coding. Insert the cable connector into the connector slot. Engage the locking mechanisms ①.	
2	Pull on the connection cable to ensure the locking element has engaged.	
3	Close unused interfaces with system interface covers. Observe the mechanical coding.	

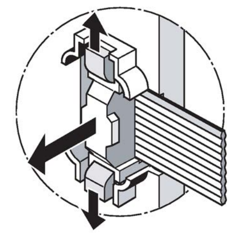
5.5.4 Disconnecting

⚠WARNING
Hazardous Voltage **Can Cause Death, Serious Injury, or Property Damage.**
Before starting work, therefore, disconnect the system and devices from the power supply.

Disconnecting PROFIBUS DP connection (if applicable)

Step	Instructions	Figure
1	Loosen the screws of the PROFIBUS DP connector.	
2	Remove the PROFIBUS DP connector.	

Disconnecting system interfaces

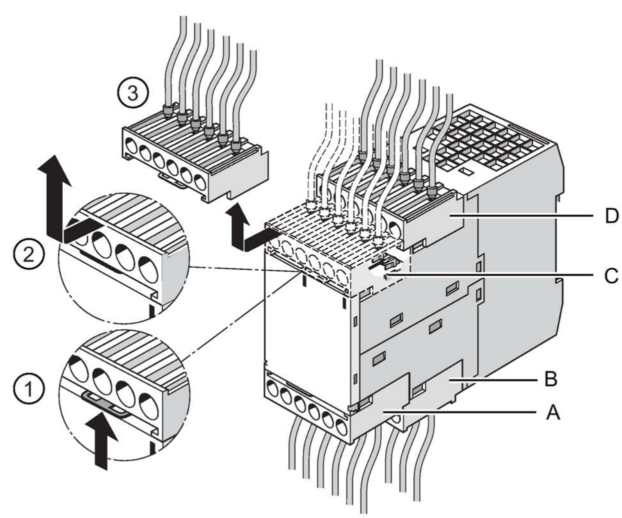
Step	Instructions	Figure
1	Press the locking element apart and then pull the connection cable out of the connector slot of the system interface.	

Removing terminal blocks from the device

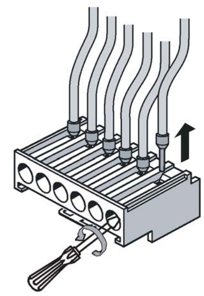
Note

Order of removal

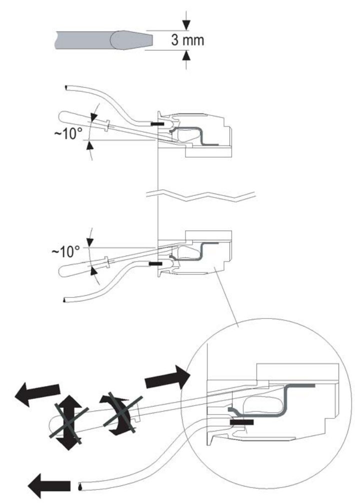
Remove terminal block A before terminal block B, and C before D.

Step	Instructions	Figure
1	Insert a flat-head screwdriver between the clip of the terminal block and the front panel ①.	
2	Pull the terminal block out to the front ②.	
3	Lift the terminal block out of the mechanically coded guiderail of the device ③.	

Disconnecting screw-type terminals

Step	Instructions	Figure
1	Unscrew the screw of the screw-type terminal.	
2	Remove the cable from the unscrewed screw terminal.	

Disconnecting spring-loaded terminals

Step	Instructions	Figure
1	Insert the flat-head screwdriver into the square opening of the spring-loaded terminal until it engages. Please observe a 10° horizontal angular deviation of the screwdriver to the oval opening.	
2	Remove the cable from the oval opening.	
3	Remove the screwdriver.	

5.5.5 Plugging in terminal blocks

⚠WARNING
Hazardous Voltage.
Can Cause Death, Serious Injury, or Property Damage.
Before starting work, therefore, disconnect the system and devices from the power supply.

Requirement

You must have removed the terminal blocks, for the purpose of replacing a device, for example.

Procedure when plugging in the terminal blocks

Note

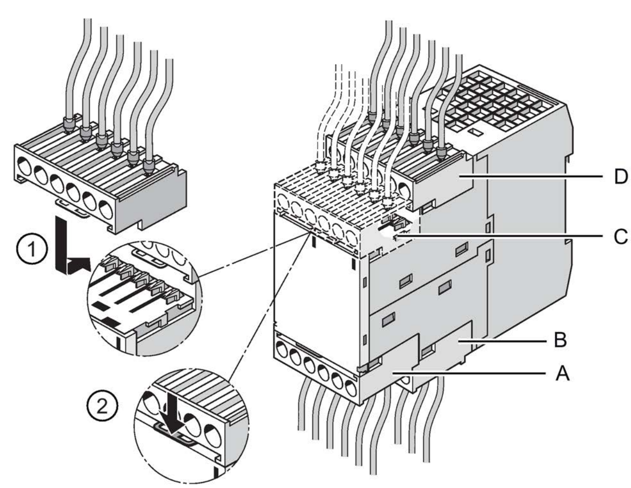
Removable terminal blocks are mechanically coded to prevent polarity reversal

The removable terminal blocks are mechanically coded to prevent polarity reversal and are labeled with A, B, C or D on the inside. Only use the slots shown in the diagram below.

Note

Plug-in sequence

Connect terminal block B before terminal block A, and D before C.

Step	Operating instruction	Figure
1	Insert the removable terminal block into the mechanically coded guiderail of the device ①.	
2	Slide the removable terminal block back until it audibly engages.	
3	Check that the clip of the removable terminal block closes flush with the front panel ②.	

5.6 Diagnostics display

5.6.1 Connecting a diagnostics display

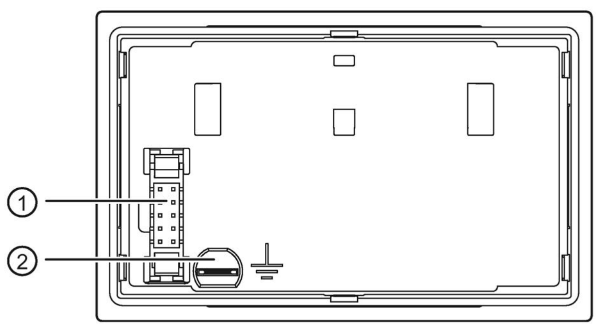
Connections on the rear

Note

Cable length

The connection cable between the diagnostics display and the safety relay or interface module must not exceed 2.5 m in length.

Each diagnostics display has two connections on the rear:



① System interface X2

② Functional ground

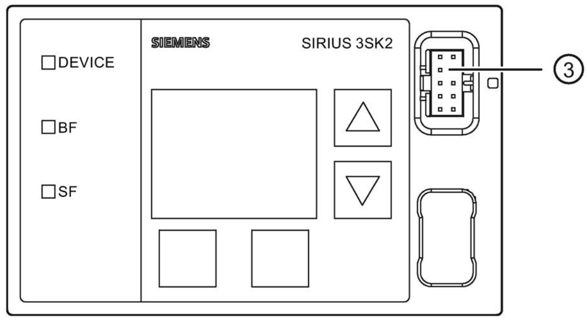
The rear is normally not accessible if the diagnostics display is installed. The connection cable from the safety relay / interface module is connected to the system interface X2 ② there. The diagnostics display also has to be grounded at the functional ground ①.

You will find additional information in Section "Grounding (Page 90)".

Note

Only the safety relay or interface module may be connected to the system interface X2 ② on the rear of the diagnostics display.

Connections on the front



③ System interface X1

The front is normally accessible if the diagnostics display is installed. Components are only directly inserted in the system interface X1 ③ as required and removed after use. These can be:

- PC cable for connecting a PC/PG
- Cover (when the system interface is not used)

Note

Only one PC / PG may be connected to the system interface X1 ③ on the front of the diagnostics display.

CAUTION

Protection against electrostatic charge

If the system interface X1 is not used, it must be closed with the interface cover supplied to retain the degree of protection of the diagnostics display and to prevent damage due to electrostatic charge.

5.6.2 Connecting system interfaces (diagnostics display / DP interface)

Instructions

CAUTION
Protection against electrostatic charge
Unused system interfaces must be closed using system interface covers.

NOTICE
Off-circuit installation
Connect the system interfaces only in a voltage-free state!
If you connect system interfaces while the system is connected to the power supply, this can damage the safety components which, in turn, means that the safety function is no longer available.

Note

Reverse polarity protection

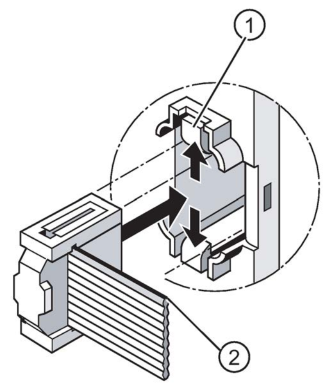
Observe the color coding and mechanical coding on the connection cables.

Connection cables

The DP interface and the diagnostics display are connected to the 3SK2 safety relay at the interfaces using connecting cables.

- The DP interface is configured side-by-side with the 3SK2 safety relay. A connecting cable with a length of 0.025 m is available for this purpose.
- Connection cables up to max. 2.5 m in length are available for connecting to the diagnostics display.

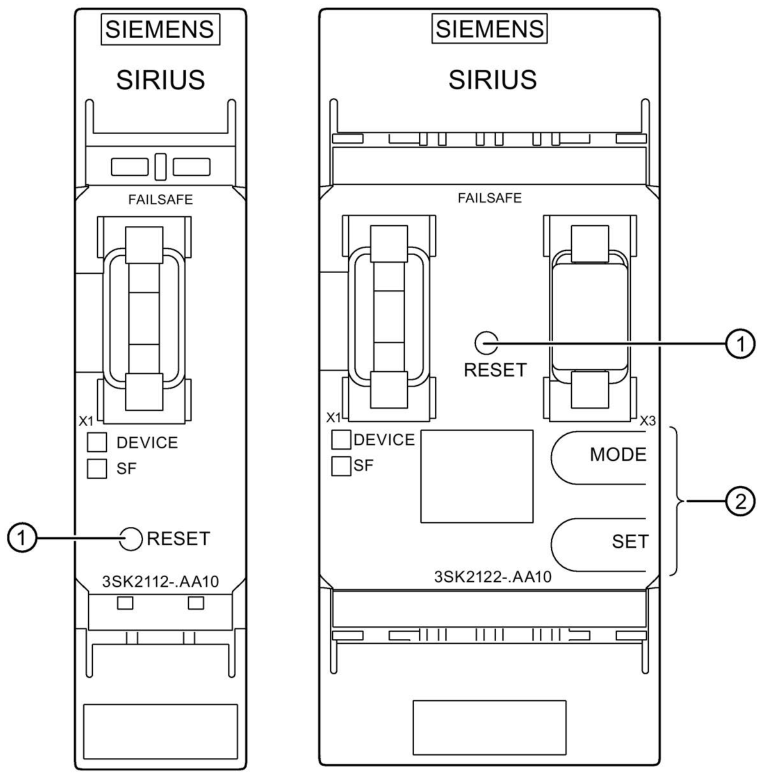
Procedure for connecting the DP interface and diagnostics display

Step	Instructions	Figure
1	Observe the color coding ② and mechanical coding. Insert the cable connector into the connector slot. Engage the locking mechanisms ①.	
2	Pull on the connection cable to ensure the locking element has engaged.	
3	Close unused interfaces with system interface covers. Observe the mechanical coding.	

Operation 6

6.1 Operating the 3SK2 safety relay

6.1.1 Operator controls on the 3SK2 safety relay



① RESET button

② MODE and SET keys for operating the device display

Figure 6-1 Operator controls

RESET button

Both 3SK2 safety relays have a RESET button on the front with the following functions:

- Acknowledging messages
- Restoring the basic factory settings (Page 185)

MODE and SET keys for operating the device display (3SK2 safety relay 45 mm only)

3SK2 safety relays (45 mm width) have two additional keys on the front to navigate the diagnostics menu on the device display; see Section "Diagnostics via device display (3SK2 safety relay with width 45 mm) (Page 201)".

The device display of the 3SK2 safety relay (45 mm width) shows the states of the central unit's inputs and outputs.

Safety ES software

The 3SK2 safety relay is parameterized with the Safety ES software, see Section "Application areas for safety systems (Page 29)".

6.2 Operating the 3SK26 diagnostics display

6.2.1 Operator controls and displays on the diagnostics display

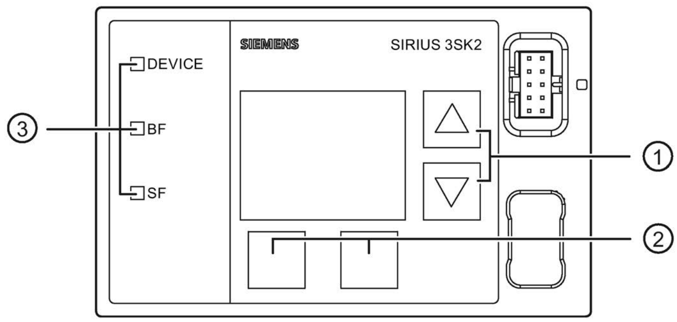


Figure 6-2 Display and operating elements on the diagnostics display

Two arrow keys ①

They serve to navigate the menu or change the display settings, e.g. to change the contrast setting or to scroll through displayed content.

Two softkeys ②

They can have different functions depending on the menu displayed (e.g. open menu, exit menu, reset). The current assigned functions are displayed on the bottom left or right of the display.

LED displays ③

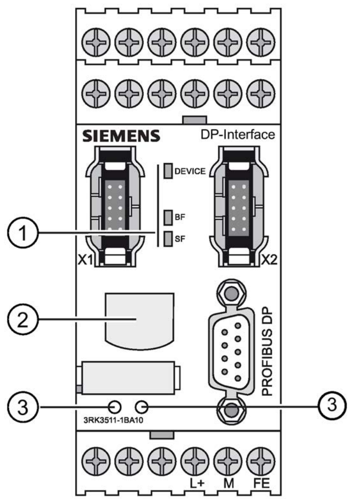
LED	Meaning
DEVICE	Status
BF	Bus error
SF	Group error

Reference

You will find additional information in Section "Diagnostics with diagnostics display (Page 206)".

6.3 Operating the 3RK35 DP interface

6.3.1 Operator controls and display elements on the DP interface



① LED display
② Display (LCD display)
③ MODE and SET keys for operating the display

Figure 6-3 DP interface module

Display

The display has two device statuses:

- Standard mode with status display
- Menu mode:
  - Setting the DP address
  - Resetting to factory settings

Operating elements of the DP interface

Pushbutton	Meaning
SET	Operating the display
MODE	Operating the display

LED statuses

LED	Meaning
DEVICE	Status
BF	Bus error
SF	Group error

6.3.2 Standard mode with status display

Messages

Various status messages are output during normal operation:

Display		Meaning
`RUN•` `DPXXX`	1st line not flashing 2nd line: DP address	No error
`SF••` `SB•••`	1st line flashing 2nd line not flashing	**System fault** No connection to the safety relay via system interface.
`BF••` `noEx•`	1st line flashing 2nd line not flashing	**Bus error** No process data exchange with DP master.
`BF••` `CFG••`	1st line flashing 2nd line not flashing	**Bus error** Error in configuration
`BF••` `PRM••`	1st line flashing 2nd line not flashing	**Bus error** Parameterization error
`BF••` `noCon`	1st line flashing 2nd line not flashing	**Bus error** No connection with DP master.

If several messages are active, a cursor line runs from one end of the affected line to the other. To scroll through the messages, press "MODE".

A corrected error is automatically deleted from the display.

If you do not press any buttons for 30 seconds, the display automatically returns to the error with the highest priority.

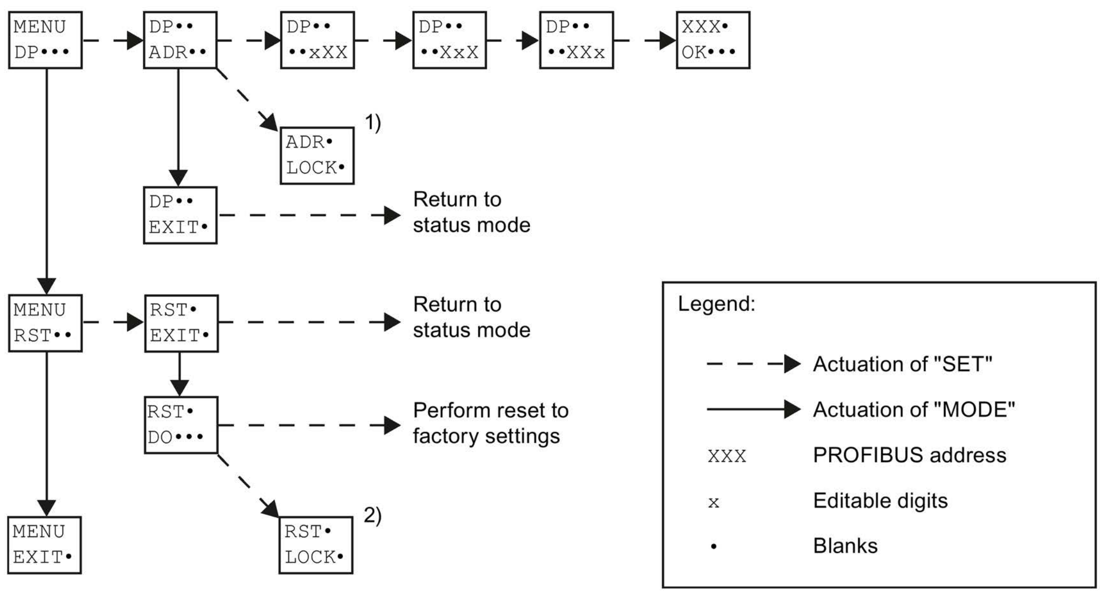
6.3.3 Menu of the DP interface

Navigation

To switch from standard mode to menu mode, choose "SET". Different actions can be carried out in menu mode:

- Setting the PROFIBUS address (Page 121)
- Restoring factory settings (Page 123)

To switch between the sub-menus, choose "MODE". When you confirm "EXIT" with "SET", the system switches to standard mode. When you confirm the other entries with "SET", the system switches to the relevant sub-menu. The system also returns to standard mode after an extended period of inactivity (30 s).



1) Changing the PROFIBUS address is not possible as this function has been disabled (e.g. with Safety ES).

2) Restoring the factory settings is not possible since the DP interface is in cyclic data exchange with a DP master.

Figure 6-4 DP interface menu

6.3.4 Setting the PROFIBUS address

Note

Only addresses 1 to 126 can be set. Other addresses are not possible.

Key functions

The menu option `DP••` is used to change the PROFIBUS address. You start input of the hundreds digit by pressing "SET".

The buttons have the following functions when entering the address:

Pushbutton	Result
"SET"	• Accepting the setting • Moving to the next digit: Hundreds, tens, units digit • Acceptance of the DP address following input of the units digit
"MODE"	• Setting the flashing digit of the DP address • Counts up
Double-click on "SET"	• Jumps back one place to the previous digit: Units, tens, hundreds digit
Double-click on "MODE"	• Sets the flashing digit of the DP address • Counts down
"MODE" and "SET" simultaneously	• The operation is canceled. "EXIT" must then be confirmed by pressing "SET".

Example: Setting the hundreds digit

Display		Action
DP•• ••*26	1st line: not flashing 2nd line: 1st digit in DP address flashing	The 2nd line in the display contains the current DP address (0 ... 126; right-justified). If an address has not yet been set, the default address 126 is displayed. • By pressing "MODE", the hundreds are incremented (sequence: 0, 1, 0, etc.) • When you choose "SET", this digit is confirmed and the system switches to the tens. • By double-clicking on "SET", you can go back one digit (i.e. from the hundreds to the units). The address is not applied when you do this.

Result

Display		Meaning
•XXX OK•••	1st line: not flashing 2nd line: flashing	The message above indicates that the PROFIBUS address was successfully saved. You can acknowledge this message by choosing "SET" or "MODE". The display then returns to standard mode. The set PROFIBUS address is applied immediately on the bus side. You do not need to switch the power OFF / ON.

Error

Display		Meaning
•XXX NOK••	1st line: not flashing 2nd line: flashing	An error has occurred, the PROFIBUS address could not be saved. You can acknowledge this message by pressing "SET" or "MODE". The display then returns to standard mode.

Address input blocked

If the DP address cannot be changed on a device, the following message is displayed when you select "ADR":

Display		Meaning
ADR• LOCK•	1st line: not flashing 2nd line: flashing	Changing the PROFIBUS address is not possible as this function has been disabled (e.g. with Safety ES). You can acknowledge this message by pressing "SET" or "MODE". After 30 seconds of inactivity, the display automatically returns to standard mode.

6.3.5 Restoring factory settings

Restoring factory settings

The factory settings of the DP interface can be restored in the RST• menu. You can use the "MODE" button to switch between the two menu options:

Display		Action
RST• EXIT•	1st line: not flashing 2nd line: flashing	When you confirm with "SET", the process of restoring the factory settings is interrupted and the display returns to standard mode.
RST• DO•••	1st line: not flashing 2nd line: flashing	Confirmation with "SET" restores the factory settings of the DP interface.

Restoring factory settings blocked

Display		Action
RST• LOCK	1st line: not flashing 2nd line: flashing	Restoring the factory settings is not permissible since the DP interface is in cyclic data exchange with a DP master.

Planning/configuring

7

7.1 System configuration guidelines

7.1.1 System components

WARNING
Failure of Safety Functions **Can Cause Death, Serious Injury, or Property Damage.** Connect only released 3SK1 output expansions and 3RM1 Failsafe motor starters to a 3SK2 safety relay via device connectors.

Released devices

The following devices can be used for system configuration with a 3SK2 safety relay. When configuring the system, please observe Device configuration rules (Page 134).

<table>
<tr><th>Description</th><th>Article number</th><th colspan="2">Number of devices per system</th></tr>
<tr><td colspan="4">3SK2 basic units</td></tr>
<tr><td>3SK2 safety relay
with width 22.5 mm</td><td>3SK2112-xAA10</td><td colspan="2" rowspan="2">Precisely 1</td></tr>
<tr><td>3SK2 safety relay
with width 45 mm</td><td>3SK2122-xAA10</td></tr>
<tr><td colspan="4">Expansion units (actuators)</td></tr>
<tr><td colspan="3">3SK1 output expansions (24 V DC)</td><td rowspan="7">Up to 5</td></tr>
<tr><td>3SK1211 (22.5 mm) output expansion
with 24 V DC supply voltage</td><td>3SK1211-xBB40</td><td>Up to 5</td></tr>
<tr><td>3SK1213 (90 mm) output expansion
with 24 V DC supply voltage</td><td>3SK1213-xAB40</td><td>max. 1</td></tr>
<tr><td colspan="3">Safety related 3RM1 Failsafe motor starters (24 V DC)</td></tr>
<tr><td>3RM11 Failsafe direct-on-line starters
with 24 V DC supply voltage</td><td>3RM11..-xAA04 1)</td><td>Up to 5</td></tr>
<tr><td>3RM13 Failsafe reversing starters
with 24 V DC supply voltage</td><td>3RM13..-xAA04 1)</td><td>Up to 5</td></tr>
<tr><td colspan="4">Communication and diagnostics</td></tr>
<tr><td>DP interface</td><td>3RK3511-xBA10</td><td colspan="2">max. 1</td></tr>
<tr><td>Diagnostics display</td><td>3SK2611-3AA00</td><td colspan="2">max. 1</td></tr>
</table>

x = 1: Version with screw-type terminals:

x = 2: Version with spring-type terminals (some with push-in technology)

1) x = 3 hybrid connection: Control circuit realized as push-in spring-loaded terminal and main circuit as screw terminal

Accessories

You can find an overview of available accessories in Section "Spare parts/Accessories (Page 263)".

7.1.2 Slots

Slots of system components

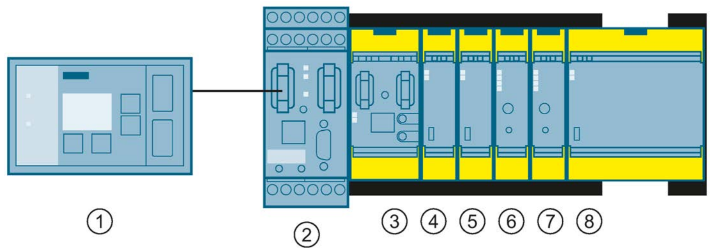


Figure 7-1 3SK2 safety relay slots

The 3SK2 safety relay forms the basis of the system. A diagnostics display and/or a DP interface module can be fitted on the left of it. On the right of the 3SK2 safety relay, a maximum of five expansion units (3SK1 output expansions and 3RM1 Failsafe motor starters) can be fitted using 3ZY12 device connectors.

Assign the slots from left to right in the following order:

- Slot ①: Diagnostics display (optional); connect to interface module or 3SK2 safety relay
- Slot ②: Interface module (optional)
- Slot ③: 3SK2 safety relay (precisely 1 device per system)
- Slots ④ to ⑧ actuators, in total five devices:
  - 3SK1211 (22.5 mm) output expansions
  - 3RM1 Failsafe safety-related motor starters
  - 3SK1213 output expansion (90 mm) (maximum of 1 device)

Note

3SK1213 (90 mm) output expansion

One 3SK1213 output expansion must be placed on the right as the last device in the system structure because expansion on the right is not possible.

3ZY12 device connectors

Connection is established via a 3ZY12 device connector; see Section "3ZY12 device connectors (Page 131)".

A suitable device termination connector must be placed under the last device on the right in the system structure.

7.1.3 Operating conditions

7.1.3.1 Mounting position

Operation of 3SK2 safety relays is permissible up to an altitude of 2000 m.

Device	Permissible mounting position
3SK2 safety relays	Any
3SK1 output expansions	Any **Exception:** 3SK1213: +/- 22.5° lateral inclination
3RM1 Failsafe motor starters	Vertical, horizontal, standing
3SK26 diagnostics display	Vertical securing surface (+10°/ -10°)
3RK35 DP interface	Vertical securing surface (+10°/ -10°)

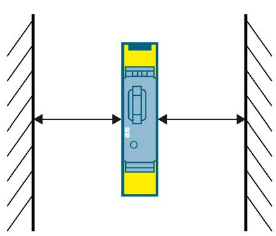
7.1.3.2 Ambient temperature

The maximum ambient temperature depends on the following factors:

- Configuration (stand-alone installation, system configuration **with** or **without** DP interface)
- Total maximum output currents I_{max}

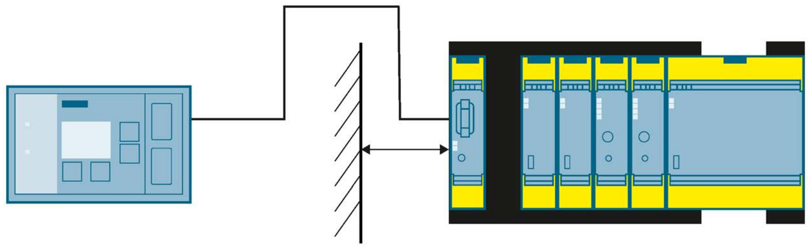
3SK2 safety relay with width 22.5 mm

- Stand-alone installation



Maximum output currents			Maximum ambient temperature	Required clearance
I_{max}F-Q	**I_{max}Q**	**$I_{max}\Sigma$**	**T_{max}**	
2 A	0.5 A	**4.5 A**	**60 °C**	Both ends: 22.5 mm

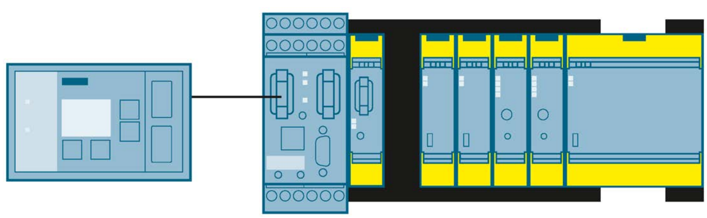
- System configuration without DP interface



Maximum output currents			Maximum ambient temperature	Required clearance
I_{max} F-Q	I_{max} Q	I_{max} Σ	T_{max}	
2 A	0.5 A	**4.5 A**	**60 °C**	• On the left: 22.5 mm • On the right: 22.5 mm[1)]
4 A	0.5 A	**6.5 A**	**40 °C**	• On the left: 22.5 mm • On the right: No clearance required

1) With loop-through connector, article number: 3ZY1212-2AB00

- System configuration with DP interface

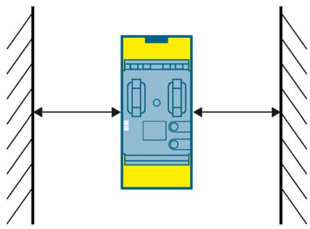


Maximum output currents			Maximum ambient temperature	Required clearance
I_{max}F-Q	I_{max}Q	$I_{max}\Sigma$	T_{max}	
4 A	0.5 A	**6.5 A**	**40 °C**	• On the left: No clearance required • On the right: 22.5 mm[1)]

1) With loop-through connector, article number: 3ZY1212-2AB00

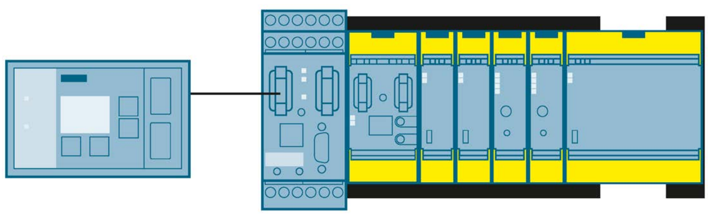
3SK2 safety relay with width 45 mm

- Stand-alone installation



Maximum output currents			Maximum ambient temperature	Required clearance
I_{max}F-Q	I_{max}Q	$I_{max}\Sigma$	T_{max}	
4 A	0.5 A	7 A	60 °C	Both ends: 22.5 mm

- System configuration with DP interface



Maximum output currents			Maximum ambient temperature	Required clearance
I_{max} F-Q	I_{max} Q	I_{max} Σ	T_{max}	
4 A	0.5 A	7 A	40 °C	No clearance required

Instructions

Note

3SK1 output expansions and 3RM1 Failsafe motor starters

You will find clearances to be observed and mounting position restrictions for 3SK1 output expansions and 3RM1 Failsafe motor starters in the associated manuals, see Section "Additional documentation (Page 14)".

Note

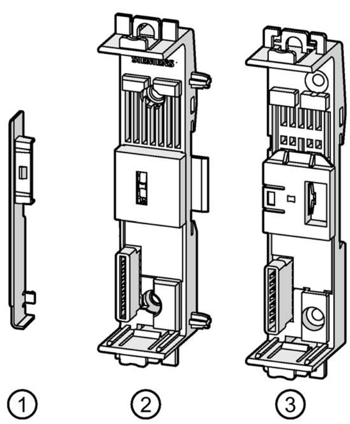
Use in accordance with EN 50156-1

When operated in stand-alone configuration in utility rooms (boiler rooms, for instance) the 3SK2 safety relay with a width of 22.5 mm can be operated at a maximum ambient temperature of 60° C.

The 3SK2 safety relay with either 3SK1 output expansions or a 3RM1 Failsafe motor starter may be operated only in electrical utility rooms with a maximum ambient temperature of 40° C.

7.1.4 3ZY12 device connectors

3ZY12 device connectors



① Cover (included in the scope of supply of each device termination connector.)
② 3ZY12 device connectors
③ 3ZY12 device termination connectors

There are suitable 3ZY12 device connectors for every device in the system and, in this respect, you must observe the following:

Device	Device connector type/article number	Description
Basic unit 22.5 mm 3SK2112-xAA10	• Device connector / 3ZY1212-2GA00 • Device connector for looping through signals / 3ZY1212-2AB00	• The device connector must be provided with a cover (included in the scope of supply of each device termination connector). • The device connector is not required if no devices are connected to the right side of the basic unit. • The device connectors for looping through signals are needed to achieve improved cooling.
Basic unit 45 mm 3SK2122-xAA10	• Device connector set / 3ZY1212-4GA01	• The set consists of two device connectors. • The connector with the device interface is fitted on the left. • The connector without the device interface is a device connector for looping through signals and is fitted on the right. • The left connector must be provided with a cover (included in the scope of supply of each device termination connector).
Output expansion 22.5 mm 3SK1211-xBB40 (24V DC)	• Device connector / 3ZY1212-2BA00 • Device termination connector / 3ZY1212-2DA00	• The device connector is needed if a further device*) is to be connected to the 3SK1 output expansion on the right. • The device termination connector is needed if the 3SK1 output expansion is the last device on the right in the system structure. The switch on the device termination connector must always be set to 1.

Device	Device connector type/article number	Description
Output expansion 90 mm 3SK1213-xAB40 (24V DC)	• Device connector set / 3ZY1212-0FA01	• The set consists of two connectors, one device termination connector and one device connector without interface for fastening. No switch needs to be set on the device termination connector.
3RM1 Failsafe motor starters	• Device connector / 3ZY1212-2EA00 • Device termination connector / 3ZY1212-2FA00 • Device connector for looping through signals / 3ZY1212-2AB00	• The device connector is needed if a further device*) is to be connected to the 3RM1 Failsafe motor starter on the right. • The device termination connector is needed if the 3RM1 Failsafe motor starter is the last device on the right in the system structure. No switch needs to be set on the device termination connector for 3RM1 Failsafe motor starters. • The device connectors for looping through signals are needed to achieve improved cooling. Thus, derating of the load current can be reduced in the case of the 3RM1 Failsafe motor starter.

x = 1: Version with screw-type terminals:

x = 2: Version with spring-loaded terminals with push-in technology

*) Pay attention to the rules for the system configuration

7.1.5 Device configuration rules

3SK2 safety relay (precisely 1 device per system)

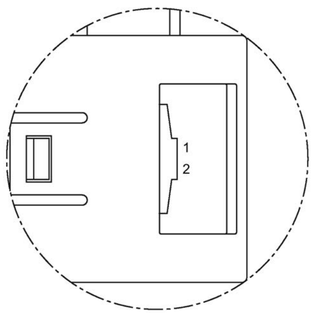
- The 3SK2 safety relay forms the basis of the safety system and it is the smallest possible configuration of the system.
- If a basic unit is operated without expansion units, no device connector or device termination connector is necessary.
- If the 3SK2 safety relay is extended with 3SK1 output expansions or 3RM1 Failsafe motor starters, then the matching device connector must be used under the 3SK2 safety relay; see Section "3ZY12 device connectors (Page 131)".

  This device connector must be provided with a cover on the left. The cover is included in the scope of supply of the device termination connector.
- Beyond certain load limits/temperature ranges, the 22.5 mm 3SK2 safety relay should be placed a safe distance from other devices. To this end, there are appropriate device connectors for looping through signals. For further information, see Section "Ambient temperature (Page 128)".
- An additional 3SK2 safety relay in a single system configuration is not admissible.

3SK1211 (22.5 mm) output expansions (24 V DC)

- 3SK1211 output expansions can be placed in slots 4 to 8.
- Connection is established via a 3ZY12 device connector that matches the device; see Section "3ZY12 device connectors (Page 131)".
- If there are no other devices on the right of the 3SK1211 output expansions, a suitable device termination connector must be placed on the right in the system configuration.

  The switch of the device termination connector must be closed, i.e. in position 1 at the top.



- The 3SK1211 output expansion is controlled via a safety-related output of the 3SK2 safety relay in the device connector.

  The output is parameterized in Safety ES and via the slide switch on the output expansion; see Section "Setting the slide switch of 3SK1 output expansions (Page 150)".
- The 3SK1211 output expansions are powered exclusively via the device connector.

> **WARNING**
>
> **Bypassing the Safety Function When Using Device Connectors**
> **Can Cause Death, Serious Injury, or Property Damage.**
>
> When operating with a 3SK2 safety relay and device connectors, the supply voltage for the 3SK1 output expansion is established via the 3ZY12 device connectors.
>
> Do not connect any separate supply voltage to a 3SK1 output expansion as otherwise the safety function will be bypassed.

3SK1213 (90 mm) output expansions (24 V DC)

- Only one 3SK1213 output expansion can be used in the system.
- If a 3SK1213 output expansion is used in the system, it is always the last station on the right in the system structure. Expansion on the right is not possible because there is no connection via the device connector.
- Connection is established via matching 3ZY12 device connectors; see Section "3ZY12 device connectors (Page 131)".
- The associated device connector set contains a device termination connector. The second device connector serves as a holder. No switch needs to be set on the device termination connector for 3SK1213 output expansions.
- The 3SK1213 output expansion is controlled via a safety-related output of the 3SK2 safety relay in the device connector.

  The output is parameterized in Safety ES and via the slide switch on the output expansion.
- The 3SK1213 output expansions are powered exclusively via the device connectors.

WARNING

Bypassing the Safety Function When Using Device Connectors
Can Cause Death, Serious Injury, or Property Damage.

When operating with a 3SK2 safety relay and device connectors, the supply voltage for the 3SK1 output expansion is established via the 3ZY12 device connectors.

Do not connect any separate supply voltage to a 3SK1 output expansion as otherwise the safety function will be bypassed.

3RM1 Failsafe safety-related motor starters

- 3RM1 Failsafe safety-related motor starters can be placed in slots 4 to 8.
- Connection is established via a matching 3ZY12 device connector; see Section "3ZY12 device connectors (Page 131)".
- If there are no other devices on the right of the 3RM1 Failsafe motor starters, a suitable device termination connector must be placed on the right in the system configuration. No switch needs to be set on the device termination connector for 3RM1 Failsafe motor starters.
- As from certain load limits/temperature ranges, clearances between individual devices must be observed for 3RM1 Failsafe motor starters. To this end, there are appropriate device connectors for looping through signals. You can find further information on the configuration guidelines for 3RM1 Failsafe motor starters in the *SIRIUS 3RM1 motor starters* manual, in Section "Load feeders - protection against short circuit". See Section "Additional documentation (Page 14)".
- The 3RM1 Failsafe safety-related motor starter is controlled via a safety-related output of the 3SK2 safety relay in the device connector, see Section "Connecting 3RM1 Failsafe motor starters (Page 154)".
- The 3RM1 Failsafe motor starter is powered exclusively via the device connectors.

WARNING
Bypassing the Safety Function When Using Device Connectors **Can Cause Death, Serious Injury, or Property Damage.** When operating with a 3SK2 safety relay and 3ZY12 device connectors, the supply voltage for 3RM1 Failsafe motor starters is established via the device connectors. Do not connect any separate voltage supply to a 3RM1 Failsafe motor starter as otherwise the safety function will be bypassed.

Interface module (optional)

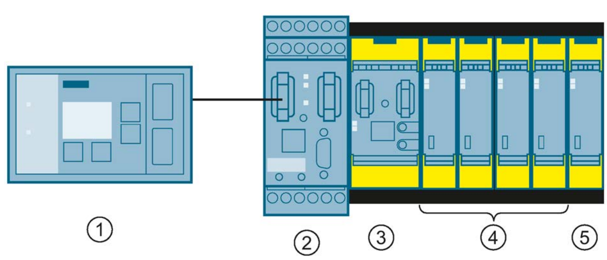
- One interface module must be placed side-by-side on the left of the 3SK2 safety relay.
- It is connected via the X2 interface of the interface module to the X1 interface of the 3SK2 safety relay with a connecting cable. The connecting cable must not be more than 25 mm long.
- The interface module must be operated on the same power supply as the 3SK2 safety relay.

Diagnostics display (optional)

- The diagnostics display is connected to the optional interface module. The diagnostics display is connected to the 3SK2 safety relay if the system does not have an interface module.
- It is connected via the X2 interface of the diagnostics display to the X1 interface of the 3SK2 safety relay / interface module with a connecting cable, see Section Spare parts/Accessories (Page 263). The cable must not be more than 2.5 m long.
- The power supply is provided from the 3SK2 safety relay via the connecting cable.

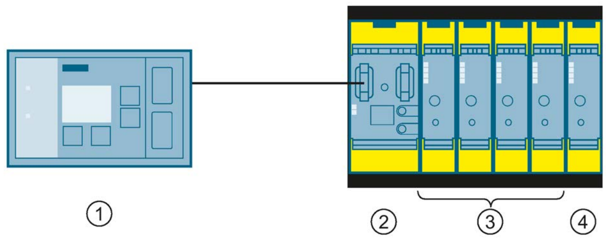
7.1.6 System configuration examples for 3SK2 safety relays

Typical system configuration with 3SK1 output expansions



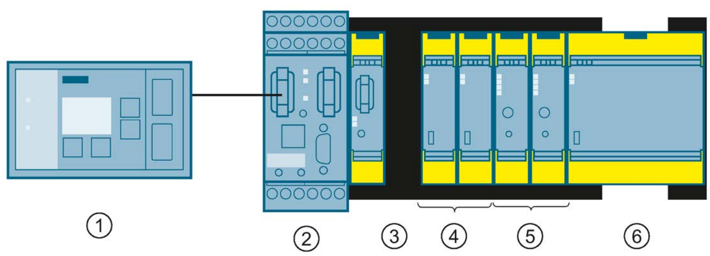
① Diagnostics display
② DP interface
③ 3SK2 safety relay, 45 mm, with device connector set 3ZY1212-4GA01
④ 3SK1211 output expansion actuator with device connector 3ZY1212-2BA00
⑤ 3SK1211 output expansion actuator with device termination connector 3ZY1212-2DA00
Please note that the switch on the terminating connector must be set to "1".

Typical system configuration with 3RM1 Failsafe motor starter



① Diagnostics display
② 3SK2 safety relay, 45 mm, with device connector set 3ZY1212-4GA01
③ 3RM1 Failsafe motor starter actuator with device connector 3ZY1212-2EA00
④ 3RM1 Failsafe motor starter actuator with device termination connector 3ZY1212-2FA00

Typical system configuration with 3RM1 Failsafe motor starter and 3SK1 output expansions



① Diagnostics display
② DP interface
③ 3SK2 safety relay, 22.5 mm, with device connector set 3ZY1212-4GA01
④ 3SK1211 output expansion actuator with device connector 3ZY1212-2BA00
⑤ 3RM1 Failsafe motor starter actuator with device connector 3ZY1212-2EA00
⑥ 3SK1213 output expansion actuator with device connector set 3ZY1212-0FA01

7.2 Wiring rules for inputs and outputs

7.2.1 Safety information

WARNING

Hazardous Voltage
Can Cause Death, Serious Injury, or Property Damage.

To minimize any risk to humans or the environment, you must not bypass any safety functions or implement measures that cause such safety functions to be bypassed. The manufacturer is not liable for the consequences of any such manipulation or for any damage resulting if this warning is not observed.

WARNING

Bypassing the Safety Function
Can Cause Death, Serious Injury, or Property Damage.

3SK1 output expansions and 3RM1 Failsafe motor starters that are connected to the 3SK2 safety relay via 3ZY12 device connectors are supplied with voltage via the device connectors.

Do not directly connect any separate supply voltage to a 3SK1 output expansion or to a 3RM1 Failsafe motor starter as otherwise the safety function will be bypassed.

WARNING

Hazardous Voltage
Can Cause Death, Serious Injury, or Property Damage.

A two-channel safety application that is parameterized with two separate monitoring functions does not achieve the same safety integrity level as a redundantly parameterized monitoring function.

WARNING

Hazardous Voltage
Can Cause Death, Serious Injury, or Property Damage.

When safety-related outputs or inputs are used on a single channel, a cable cross-circuit or the reaction of loads can result in a dangerous malfunction. When stringent requirements regarding safety must be fulfilled, the risk of dangerous malfunctions must be minimized by implementing appropriate measures (e.g., protected cable installation).

Note

To achieve SILCL 2/3 as per EN 62061 or PL d/e as per EN ISO 13849-1, a fault exclusion such as a short circuit to P or M is required. This can be implemented e.g. within a control cabinet and by installing the connection cables in such a way that they are protected. If that is not possible, the outputs must be implemented with two channels. For this purpose, separate cables must be laid to actuators/contactors. In the associated function element "F output," the output type "F output redundant" must be chosen.

7.2.2 Wiring rules for cross-circuit detection

Cross-circuit detection

Cross-circuit detection enables detection of an inadmissible connection between a sensor cable and another sensor cable (= cross-circuit), a ground cable (= short circuit to ground) or a power supply cable (= short circuit to P). The test outputs are available for this purpose.

Wiring rules for cross-circuit detection

To ensure reliable cross-circuit detection, note the following points:

1. All components (that is, all devices including the sensors) must be operated on the same power supply.
2. Cross-circuit detection is not possible with single-channel sensors. **Exception:** Single-channel acknowledgment button
3. A two-channel sensor must be connected to test outputs T1 and T2 (22.5 mm devices) or T1_x/T2_x (45 mm devices) to ensure cross-circuit detection.

   In the case of 45 mm devices, two independent test output pairs T1_x/T2_x are available:

   – T1_1/T2_1

   – T1_2/T2_2

   Note

   Connection to the pairs T1_1/T2_2 or T1_2/T2_1 is not allowed.

   Note

   If a cross-circuit is detected, it applies to the complete module (22.5 mm devices) or to all inputs that are connected to the same test output pair (45 mm devices).

4. Test output T1 (22.5 mm devices) or T1_x (45 mm devices) must always be combined with an odd-numbered sensor input (F-IN1, F-IN3, ..., F-IN19).
5. Test output T2 (22.5 mm devices) or T2_x (45 mm devices) must always be combined with an even-numbered sensor input (F-IN2, F-IN4, ..., F-IN20).

6. Cross-circuit detection of the applicable safety function must be deactivated in Safety ES.
7. Non-floating sensors cannot be operated on test outputs T1_x / T2_x. Cross-circuit detection of non-floating sensors with a 3SK2 safety relay is therefore not possible. These sensors must be able to monitor and evaluate themselves and also the line to the evaluation unit to ensure the safety of the application. In this case, cross-circuit detection must be deactivated in the Safety ES software.
8. Cross-circuit detection between three, four, or more inputs on one sensor is not possible.
9. If a safety shutdown mat (cross-circuit principle) is connected to a 3SK2 safety relay (22.5 mm width), cross-circuit detection must be deactivated for the remaining inputs on this device because otherwise the monitoring functions configured for these inputs will also signal a cross-circuit when somebody steps on the safety shutdown mat.

   In the case of 45 mm devices, the second, isolated test output pair (T1_2/T2_2) can be used to enable detection of cross-circuits on these monitoring functions.

   If a cross-circuit occurs on a test output pair (T1_1/T2_1), only the safety-related inputs connected to this pair detect the cross-circuit. The safety-related inputs that are connected to the other test output pair (T1_2/T2_2) do not detect this cross-circuit.
10. Since a cross-circuit is a fault that requires acknowledgment, a cross-circuit that has been rectified must therefore be acknowledged by means of a reset.

Monitoring functions with cross-circuit detection

The following table provides an overview of cross-circuit detection for the monitoring functions in Safety ES:

Monitoring function	Cross-circuit detection	Note
Universal monitoring	can be set to on/off	-
EMERGENCY STOP	can be set to on/off	-
ESPE (electro-sensitive protective equipment)	can be set to on/off	• If the ESPE is equipped with solid-state outputs, cross-circuit detection must be deactivated. • In the case of ESPE with floating contacts, only the sensor line between the 3SK2 safety relay and the ESPE is tested when cross-circuit detection is activated. The light barrier is not tested. • Type 4 ESPE is supported (self-monitoring); Applications up to SIL3 are possible. • Type 2 ESPE is only supported with integrated automatic testing; SIL1 and SIL2 applications are possible.
Safety shutdown mat (NC principle)	can be set to on/off	-
Safety shutdown mat (cross-circuit principle)	ON	In the case of this monitoring function, a cross-circuit is not a fault, but corresponds to the safety requirement. Therefore, a cross-circuit is not evaluated as a fault and need not be acknowledged. To be able to ensure absence of interaction of the safety shutdown mat with the cross-circuit detection of other sensors, only the safety shutdown mat is connected to the test outputs T1_x and T2_x.
Protective door	can be set to on/off	-
Protective door with tumbler	can be set to on/off	-
Acknowledgment button	ON	Cross-circuit monitoring is always implemented in the case of a single-channel acknowledgment button. This is why a single-channel acknowledgment button must also be connected via a test output. Non-floating wiring is not possible.
Two-hand operation	can be set to on/off	A two-hand control type III C (Cat. 4) can only be implemented if cross-circuit detection is activated.
Mode selector switch	Off	-
AS-i 2F-DI	Off	-

Wiring

The Section "Connecting safety-related inputs (Page 144)" describes how to connect the sensors to the 3SK2 safety relay.

7.2.3 Connecting safety-related inputs

Single- and two-channel sensors

To achieve the required Safety Integrity Level or Performance Level, you can have single-channel or two-channel interconnection of the inputs of the 3SK2 safety relay. The following connection options are available:

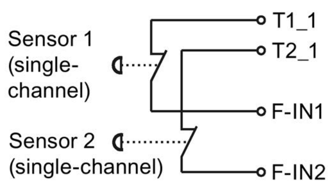
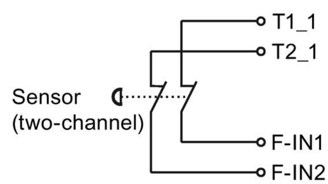
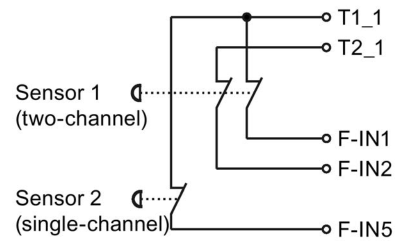
- In the case of single-channel connection, only one input terminal is assigned for each sensor.
- In the case of two-channel connection, two input terminals are assigned for each sensor. Both single-channel and two-channel sensors can be interconnected on one 3SK2 safety relay. The number of connectable sensors thus varies according to the connection method on the respective 3SK2 safety relay:
  - Up to 5 two-channel sensors or 10 single-channel sensors can be connected to the 3SK2 safety relay (22.5 mm width).
  - Up to 10 two-channel sensors or 20 single-channel sensors can be connected to the 3SK2 safety relay (45 mm width).
- The safety-related inputs can also be used to read standard signals (non-safety-related).
- Cross-circuit detection is possible when the test outputs are used with two-channel sensors.
  - Basic units with 22.5 mm width: one test output pair T1/T2
  - Basic units with 45 mm width: two isolated test output pairs T1_1/T2_1 and T1_2/T2_2

Note

Non-floating sensors

When sensors with non-floating outputs (e.g. light curtains, laser scanners) are used, they must **not** be supplied with power via test outputs T1_x/T2_x. Cross-circuit detection of the applicable function element must be deactivated in Safety ES.

Connection options with test output

<table>
<tr><th>2 single-channel sensors</th><th>1 two-channel sensor*)</th><th>Single-channel and two-channel sensor mixed*)</th></tr>
<tr><td>
</td><td>
</td><td>
</td></tr>
</table>

T1_1 (or T1_2 or T1) test output for F-IN1, F-IN3, ..., F-IN19

T2_1 (or T2_2 or T2) test output for F-IN2, F-IN4, ..., F-IN20

*) Two-channel sensors are monitored for cross-circuits

Note

SILCL 3 in accordance with EN 62061 or PL e/Cat. 4 in accordance with EN ISO 13849-1

The following conditions must be met to achieve SILCL 3 in accordance with EN 62061 or PL e/Cat. 4 in accordance with EN ISO 13849-1:

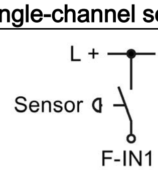
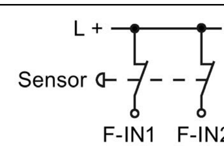
- The two-channel sensor is connected to a test output pair on the 3SK2 safety relay in compliance with the wiring rules (Page 141).
- Cross-circuit detection of the applicable safety function is activated in Safety ES.

Note

Single-channel acknowledgement button

Cross-circuit monitoring is always implemented in the case of a single-channel acknowledgment button. This is why a single-channel acknowledgment button must also be connected via a test output. Non-floating wiring is not possible.

Connection options without test output (for non-floating sensors)

<table>
<tr><th>1 single-channel sensor</th><th>1 two-channel sensor</th></tr>
<tr><td>
</td><td>
</td></tr>
</table>

F-IN1, F-IN2 sensor inputs

Application examples

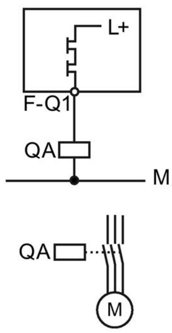
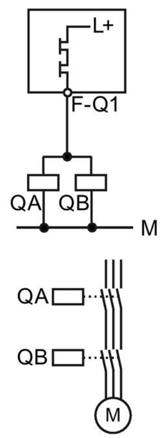
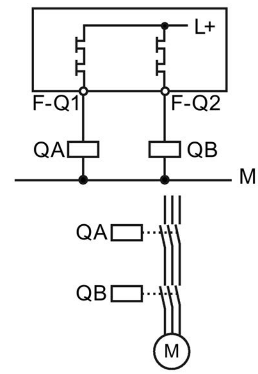
For examples of how to connect sensors, see Section "Connection of sensors (Page 272)."

7.2.4 Connecting safety-related outputs

Solid-state outputs

Internally, safety-related solid-state outputs always have a two-channel structure. Each of these outputs can therefore be used for applications up to SILCL 3 in compliance with EN 62061 or PL e in compliance with EN ISO 13849-1.

Connection options

Single-channel actuator wiring	Two-channel actuator wiring via 1 safety-related output*)	Two-channel actuator wiring via 2 safety-related outputs
		

QA/QB contactors

F-Q1, F-Q2 Safety-related solid-state outputs

Note

***)SILCL 2/3 in accordance with EN 62061 or PL d/e in accordance with EN ISO 13849-1**

To achieve SILCL 2/3 as per EN 62061 or PL d/e as per EN ISO 13849-1, a fault exclusion such as a short circuit to P or M is required. This can be implemented e.g. within a control cabinet and by installing the connection cables in such a way that they are protected.

If this is not possible, the actuators must be wired via two safety-related outputs; see the right-hand image. For this purpose, separate cables must be laid to actuators/contactors. In the associated function element "F output," the output type "F output redundant" must be chosen.

Note

Protective circuit

A suitable protective circuit is needed for inductive loads. In this way, electromagnetic interference can be suppressed and service life increased. You will find additional information in Section "Requirements for actuators (Page 171)."

Application examples

For examples of how to connect actuators, see Section "Connection of actuators (Page 295)."

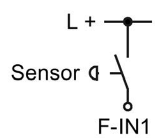
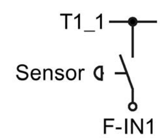
7.2.5 Connecting non-safety-related inputs

Non-safety-related sensors

3SK2 safety relays only have safety-related inputs. Therefore, these inputs are also used for non-fail-safe signals (e.g. fault acknowledgement).

Just like single-channel sensors, non-safety-related signals such as start buttons can be supplied not only in a non-floating fashion via L+, but also via the test outputs.

Connection possibility

Single-channel sensor, non-floating	Single-channel sensor, supplied via test output
	

F-IN1 Sensor input

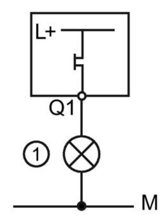
7.2.6 Connecting non-safety-related outputs

Signaling outputs

Besides the safety-related outputs, 3SK2 safety relays also feature one (22.5 mm version) or two (45 mm version) non-safety-related signaling outputs.

These can be used for signaling purposes, to signal system states, for example. The safety-related outputs can also be used for signaling purposes.

Connection possibility

Single-channel actuator wiring


① Indicator light

Q1 Non-safety-related solid-state output

Note

Protective circuit

A suitable protective circuit is needed for inductive loads. In this way, electromagnetic interference can be suppressed and service life increased. You will find additional information in Section "Requirements for actuators (Page 171)."

7.2.7 Device connector interface inputs and outputs

Function of the device connector interface

"3SK1 output expansions" and "3RM1 Failsafe motor starter" actuators can be connected to a 3SK2 safety relay with little wiring using 3ZY12 device connectors via the device connector interface.

This interface provides two further safety-related outputs for control of the actuators and one feedback circuit for monitoring the two outputs. The signals of the interface can be wired in the logic diagram.

7.2.7.1 Connection of 3SK1 output expansions

Connection to a 3SK2 safety relay with 3ZY12 device connectors

3SK1 output expansions can be controlled without much complexity via 3ZY12 device connectors. The 3SK2 safety relay provides two safety-related outputs with which the 3SK1 output expansions can be controlled via 3ZY12 device connectors. Each of the 3SK1 output expansions can be assigned separately to one of the two logical outputs via a slide switch. Control is independent of the other outputs (terminals) of the 3SK2 safety relay.

WARNING
Bypassing the Safety Function When Using 3ZY12 Device Connectors Can Cause Death, Serious Injury, or Property Damage. When operating with a 3SK2 safety relay and 3ZY12 device connectors, the supply voltage for the 3SK1 output expansion is established via the 3ZY12 device connectors. Do not connect any separate supply voltage to a 3SK1 output expansion (A1/A2) as otherwise the safety function will be bypassed.

Pay attention to the system configuration rules; see Section "System configuration guidelines (Page 125)".

Application examples

For examples of how to connect 3SK1 output expansions, see Section "Examples/applications (Page 269)."

7.2.7.2 Setting the slide switch of 3SK1 output expansions

Setting the slide switch of 3SK1 output expansions

The 3SK1 output expansion is assigned to a logical output of the 3SK2 safety relay by means of the slide switch on the front of the 3SK1 output expansion.

WARNING

Failure of the Safety Function in the Event of Adjustment of the Slide Switch on 3SK1 Output Expansions
Can Cause Death, Serious Injury, or Property Damage.

Parameterization of the logic of the basic unit in Safety ES must correspond to the slide switch setting on the 3SK1 output expansion in order for the safety function not to be rendered inactive.

- Make sure that the setting of the slide switch on the 3SK1 output expansion corresponds to your logic parameterized in Safety ES.
- Use a cover seal to protect the slide switch of the 3SK1 output expansion against unauthorized and unintentional adjustment.

Note

Using the output expansions with conventional wiring

The slide switch **does not** function when connected via conventional wiring.

Here, the terminal A1 of the 3SK1 output expansion must be connected to the corresponding safety-related output F-Qx of the 3SK2 safety relay and A2 to ground (0 V).

Slide switch	The 3SK1 output expansion switches with output ...	
Marking	22.5 mm unit	45 mm unit
"UNDELAYED" switch position	F-Q3-C	F-Q5-C
"DELAYED" switch position	F-Q4-C	F-Q6-C

7.2.7.3 Monitoring 3SK1 output expansions

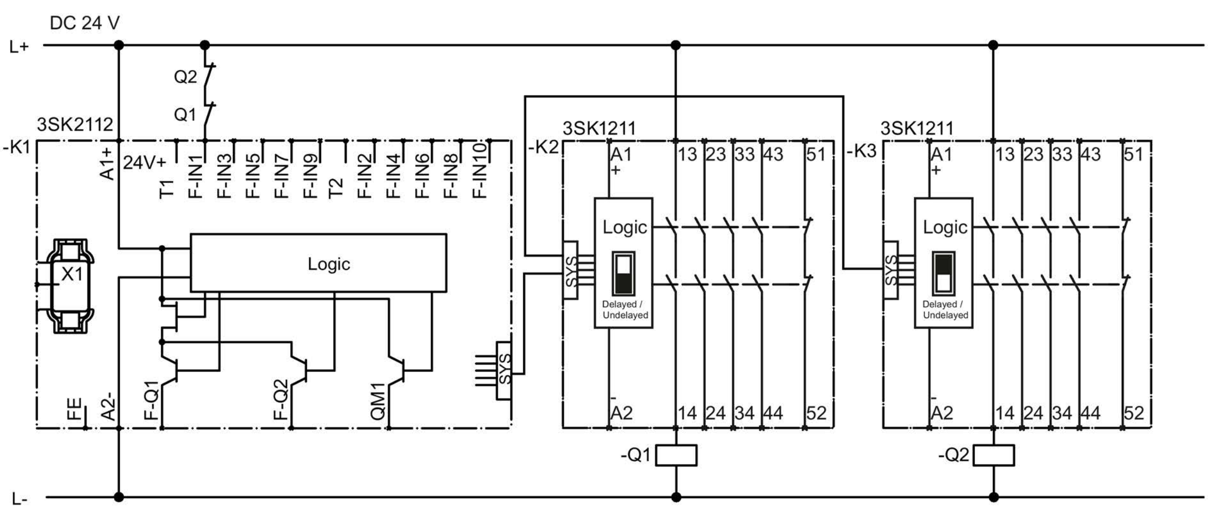
Monitoring 3SK1 output expansions

When the both F-Qx-C outputs are used, 3SK1 output expansions can be monitored in three ways:

- Wiring the internal feedback circuit (IN1-C) of the 3ZY12 device connectors in the logic diagram (**stop category 1**)
- Conventional wiring of the feedback contact (51-52) of the 3SK1 output expansions with an input (F-INx) of the 3SK2 safety relay
- Looping the feedback contact (51-52) of the 3SK1 output expansions into the feedback circuit of the downstream actuators and conventional wiring of the downstream actuators' feedback circuits to an input (F-INx) of the 3SK2 safety relay.

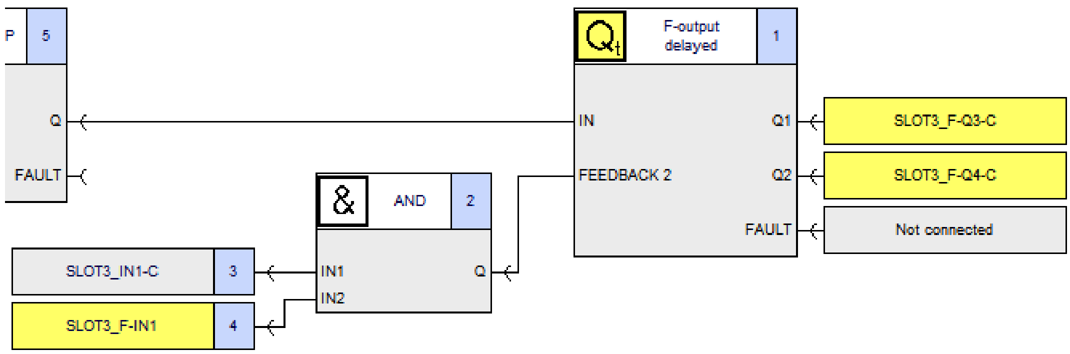
Interconnecting the internal feedback circuit (IN1-C) in the logic

The feedback circuit (IN1-C) is routed through all expansions via the 3ZY12 device connectors. Therefore, when the feedback circuit (IN1-C) is used, the two outputs (F-Qx-C) cannot be used independently of one another. One application for the dependent use of the two outputs (F-Qx-C) is an application with **stop category 1** in compliance with EN 60204-1 Chapter 9.2.2, in which the feedback circuit is checked before reactivation.



-K1	3SK2 safety relay 22.5 mm
-K2	3SK1211 output expansion (24 V DC), slide switch setting: Undelayed (black area)
-K3	3SK1211 output expansion (24 V DC), slide switch setting: Delayed (black area)
-Q1/-Q2	Contactors

In this case, use the "F output delayed" output function for parameterization in Safety ES. Set the "Monitoring" parameter for feedback circuit 2 to "To OFF and ON status". Link feedback circuit of the actuators (F-IN1) with an AND operation to the feedback circuit (IN1-C) and in this way interconnect both to the FEEDBACK 2 input of the "F output delayed" output function.



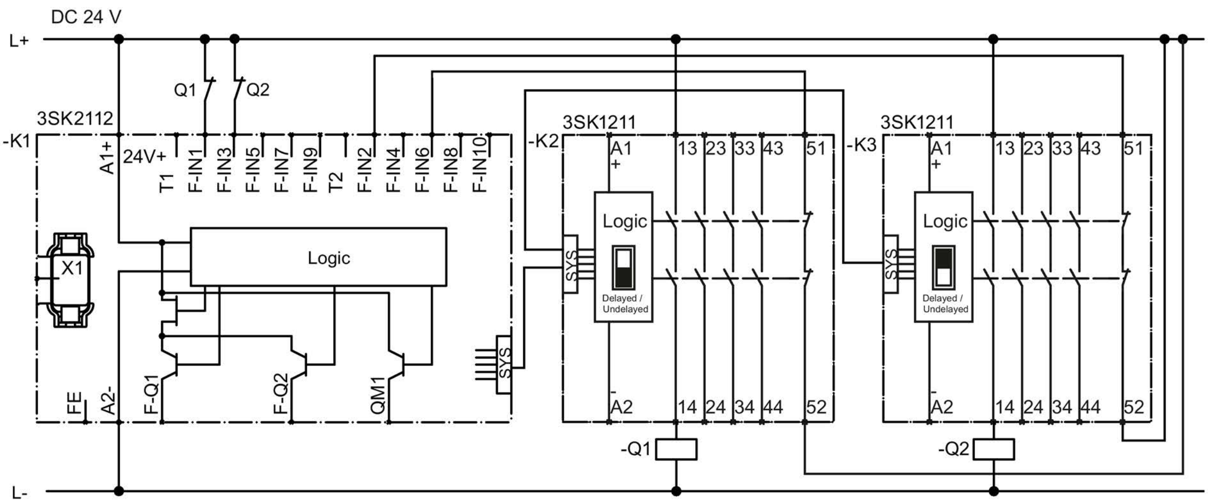
Note

If you only interconnect one output (FQx-C) of the device connector interface, you can use the internal feedback circuit (IN1-C) without restriction.

Interconnecting the feedback contact (51-52) of 3SK1 output expansions

If both outputs (F-Qx-C) are to be used independently of each other, then the feedback circuit (IN1-C) must not be interconnected in the logic diagram.

In this case, the feedback contacts (51-52) of 3SK1 output expansions are wired conventionally to the 3SK2 safety relay via the corresponding input terminals (F-INx).



-K1 3SK2 safety relay 22.5 mm

-K2 3SK1211 output expansion (24 V DC), slide switch setting: Undelayed (black area)

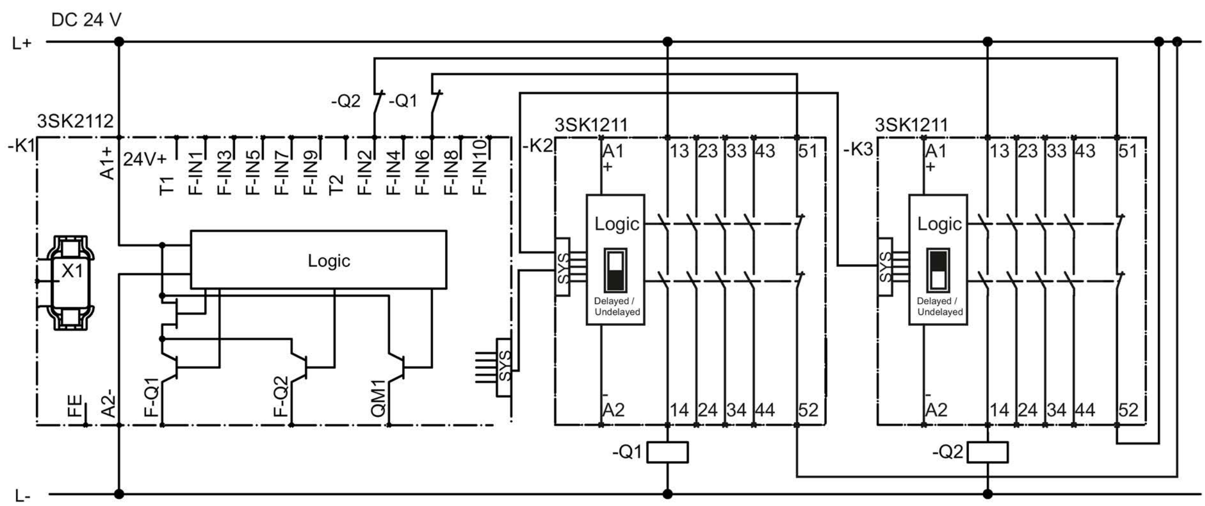
-K3 3SK1211 output expansion (24 V DC), slide switch setting: Delayed (black area)

-Q1/-Q2 Contactors

Looping the feedback contact (51-52) into the feedback circuit of the downstream actuators

If both outputs (F-Qx-C) are to be used independently of each other, then the feedback circuit (IN1-C) must not be interconnected in the logic diagram.

The feedback contacts (51-52) of the 3SK1 output expansions are looped into the downstream actuators, e.g. Q1 and Q2. In this case, the feedback contacts of the actuators Q1 and Q2 are wired conventionally to the 3SK2 safety relay via the corresponding input terminals (F-INx).



-K1	3SK2 safety relay 22.5 mm
-K2	3SK1211 output expansion (24 V DC), slide switch setting: Undelayed (black area)
-K3	3SK1211 output expansion (24 V DC), slide switch setting: Delayed (black area)
-Q1/-Q2	Contactors

Reference

You can find additional information in Sections "Stop categories (Page 58)" and "Connection of actuators (Page 295)".

7.2.7.4 Connecting 3RM1 Failsafe motor starters

Connecting 3RM1 Failsafe motor starters with 3ZY12 device connector

3RM1 Failsafe motor starters can be controlled and evaluated with little overhead via 3ZY12 device connectors. The 3SK2 safety relay provides two safety-related outputs via the 3ZY12 device connectors. 3RM1 Failsafe motor starters have a fixed assignment to one of the two safety-related outputs:

22.5 mm unit	45 mm unit
F-Q3-C	F-Q5-C

It is not possible to change over to the other output. Control is independent of the other outputs (terminals) of the 3SK2 safety relay.

Pay attention to the system configuration rules; see Section "System configuration guidelines (Page 125)".

WARNING

Bypassing the Safety Function When Using Device Connectors Can Cause Death, Serious Injury, or Property Damage.

When operating with a 3SK2 safety relay and 3ZY12 device connectors, the supply voltage for 3RM1 Failsafe motor starters is established via the device connectors.

Do not connect any separate supply voltage to a 3RM1 Failsafe motor starter (A1/A2) as otherwise the safety function will be bypassed.

Monitoring 3RM1 Failsafe motor starters

In the case of 3RM1 Failsafe motor starters, the OFF state is defined as the safe state. 3RM1 Failsafe motor starters are self-monitoring in compliance with SILCL 3/PL e and therefore do not need to be monitored in the feedback circuit of the upstream evaluation unit/control.

Note

Feedback circuit (IN1-C) of the device connector interface for monitoring 3RM1 Failsafe motor starters

As 3RM1 Failsafe motor starters do not need to be monitored in the feedback circuit by the 3SK2 safety relay, they do not influence the feedback signal of the 3ZY12 device connectors either.

In this case, do not interconnect the feedback circuit of the device connector interface (IN1-C) in the logic diagram, or set the "monitoring" parameter in Safety ES to the "To OFF state" value accordingly.

When 3RM1 Failsafe motor starters are combined with 3SK1 output expansions, the feedback circuit must be evaluated so that SIL 3 in compliance with EN 61508 or PL e / Cat. 4 in compliance with EN ISO 13849-1 is achieved.

Application examples

For examples of how to connect 3RM1 motor starters, see Section "Connection of actuators (Page 295)".

7.3 Response times

7.3.1 Notes and definitions

Response time (in error-free operation)

The response time is the time up to which a system responds after a change of an input variable at an output, i.e. the time between the event and the action, e.g. terminal-terminal or sensor-actuator in the event of operational switching.

The response time in error-free operation is calculated in order to define the process in the system. This time is **not** suitable for the determination of safety clearances in the system.

Fault response time (response time in the event of a fault)

The fault response time is the time between detecting a hazardous fault in a system and that system assuming the safe state.

The fault response time of the 3SK2 safety relay depends on whether an output is controlled through one channel or two.

Verification of response times in the case of safety circuits

When safety equipment is commissioned, steps must be taken to verify that it will shut down within a maximum permissible time after requesting the safety function.

To provide this verification, you must determine the response times of the application you have configured.

> **WARNING**
>
> **Level of Safety**
> **Can Cause Death, Serious Injury, or Property Damage.**
>
> Note that the calculation of the response time affects the level of safety and influences the overall design of the system.

> **WARNING**
>
> **Increasing of Fault Response Time When Using Flags**
> **Can Cause Death, Serious Injury, or Property Damage.**
>
> Flags are written at the end of a program cycle and can be read in again at the input by functions in the next program cycle.
>
> Each flag that is contained in a signal path increases the fault response time.
>
> Please note this when calculating the overall response time.

Note

3SK1 output expansions and 3RM1 Failsafe motor starters

The response times of 3SK1 output expansions or 3RM1 Failsafe motor starters are part of the actuator response time t_A.

7.3.2 Calculating the "sensor - actuator" response time

Formulas for calculating the response time without flags

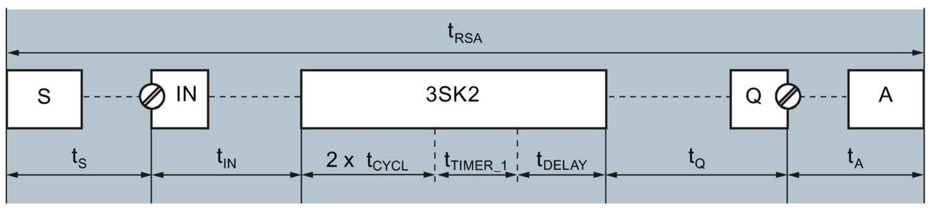


Figure 7-2 "Sensor - actuator" response time without use of flags

Without flags:	$t_{RSA} = t_S + t_{IN} + 2*t_{CYCL} + t_{TIMER\_1} + t_{DELAY} + t_Q + t_A$

Formulas for calculating the response time with flags

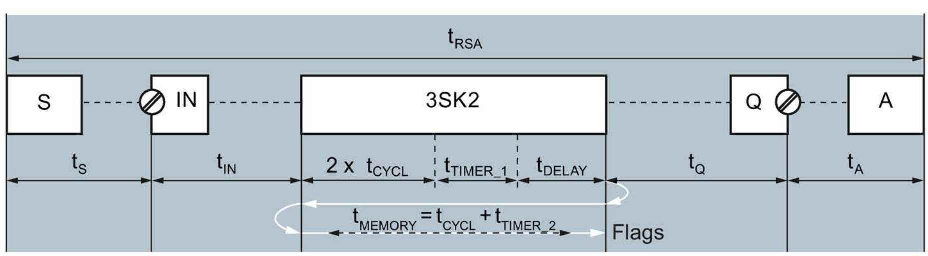


Figure 7-3 "Sensor - actuator" response time when using flags

With a flag:	$t_{RSA} = t_S + t_{IN} + 2*t_{CYCL} + t_{TIMER\_1} + t_{DELAY} + t_{CYCL} + t_{TIMER\_2} + t_Q + t_A$

Legend (Page 160)

7.3.3 Calculating the "sensor - actuator" fault response time (single-channel actuator wiring)

Formulas for calculating fault response times in the case of single-channel actuator wiring without flags

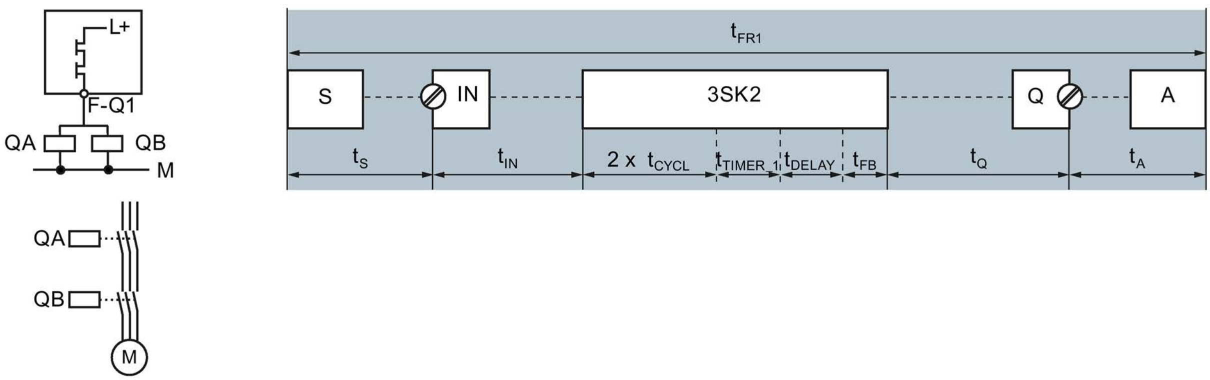


Figure 7-4 "Sensor - actuator" fault response time in the case of single-channel actuator wiring without using flags

Without flags:	$t_{FR1} = t_S + t_{IN} + 2*t_{CYCL} + t_{TIMER\_1} + t_{DELAY} + t_{FB} + t_Q + t_A$

Formulas for calculating fault response times in the case of single-channel actuator wiring with flags

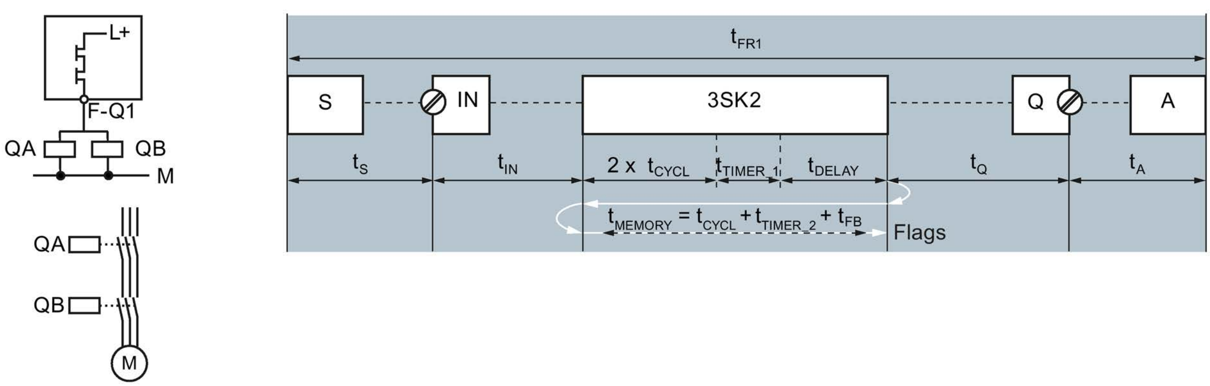


Figure 7-5 "Sensor - actuator" fault response time in the case of single-channel actuator wiring with use of flags

With a flag:	$t_{FR1} = t_S + t_{IN} + 2*t_{CYCL} + t_{TIMER\_1} + t_{DELAY} + t_{CYCL} + t_{TIMER\_2} + t_{FB} + t_Q + t_A$

Legend (Page 160)

7.3.4 Calculating the "sensor - actuator" fault response time (two-channel actuator wiring)

Formulas for calculating fault response time in the case of two-channel actuator wiring without flags

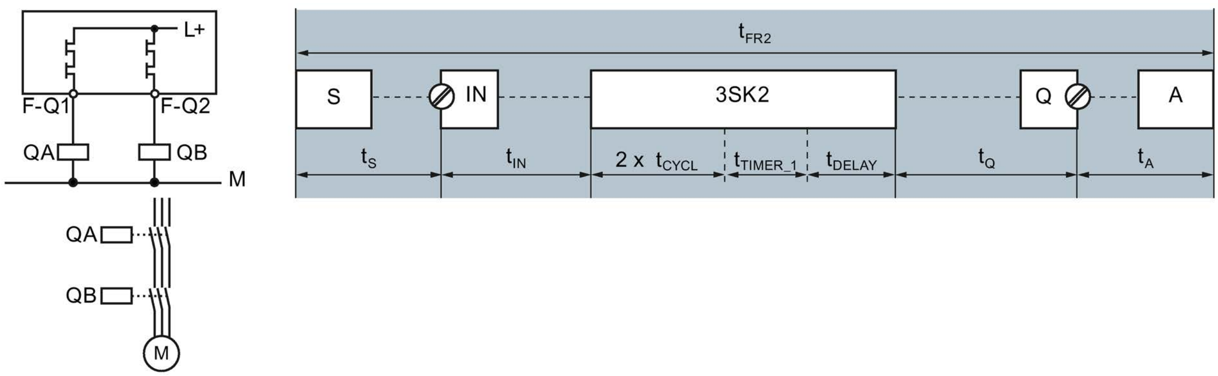


Figure 7-6 "Sensor - actuator" fault response time in the case of two-channel actuator wiring used without flags

Without flags:	$t_{FR2} = t_S + t_{IN} + 2*t_{CYCL} + t_{TIMER\_1} + t_{DELAY} + t_Q + t_A$

Formulas for calculating fault response time in the case of two-channel actuator wiring with flags

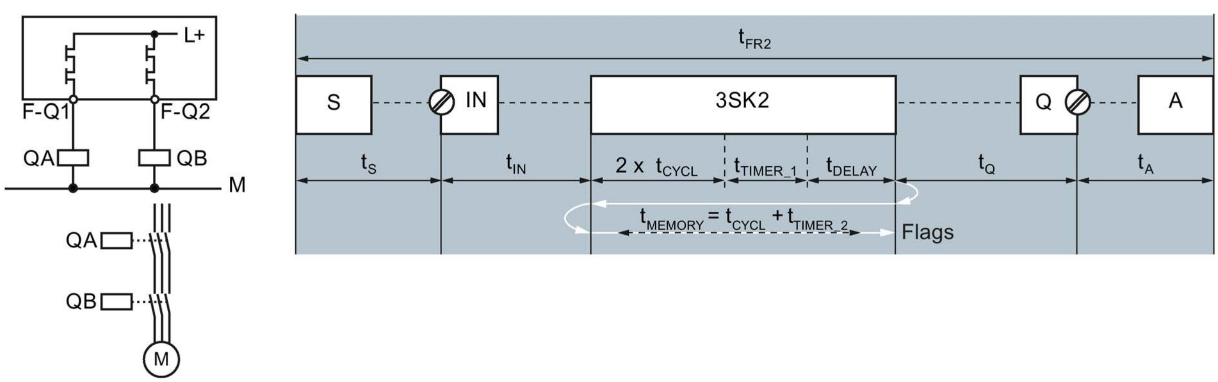


Figure 7-7 "Sensor - actuator" fault response time in the case of two-channel actuator wiring used with flags

With a flag:	$t_{FR2} = t_S + t_{IN} + 2*t_{CYCL} + t_{TIMER\_1} + t_{DELAY} + t_{CYCL} + t_{TIMER\_2} + t_Q + t_A$

Legend (Page 160)

7.3.5 Legend for the response times

S	Sensor (provides an OFF or ON signal) • "OFF signal" means the change from the ON state to the OFF state (1 > 0). • "ON signal" means the change from the OFF state to the ON state (0 > 1).
IN	Input terminal
Q	Output terminal
A	Actuator, 3SK1 output expansion, 3RM1 Failsafe motor starter
t_{RSA}	Response time of the system from a sensor **(S)** to an actuator **(A)** in error-free operation
t_{FR1}	Fault response time in the case of single-channel shutdown
t_{FR2}	Fault response time in the case of two-channel shutdown
t_S	For the response time of the sensor **(S)**, see the documentation of the sensor
t_{IN}	Transmission duration from signal acquisition at the input terminal **(IN)** to the logic of the 3SK2 safety relay; depending on the signal; the following always applies to the 3SK2 safety relay: $t_{IN} = t_{CYCL}$
t_{MEMORY}	Additional time for flags: depending on the application An additional time of t_{MEMORY} must be considered for every flag in the signal flow (sensor → actuator).
t_{TIMER_1}	Parameterizable timer functions in the logic, which lies between reading of the input state to writing into the flag.
t_{TIMER_2}	Parameterizable timer functions in the logic, lying between reading of the flag to writing the output state.
t_{DELAY}	Parameterizable input delay time in the case of monitoring functions and input cells
t_{FB}	Max. read-back time of the safety-related outputs in the dark test The maximum read-back time of the safety-related outputs depends on which function element in the logic diagram controls the output: • F output: 3 ms (fixed setting) • Output cell, linked with safety-related output terminal: 3 ms (fixed setting) • F output delayed: 3 ms – 400 ms
t_Q	Transmission duration from the logic of the 3SK2 safety relay to the output terminal **(Q)**; On the 3SK2 safety relay, the response time of the output terminal **(Q)** • Solid-state outputs: < 5 ms
t_A	For the response time of the actuator **(A)** including the time until the signal has been received and processed by the actuator, see the actuator documentation
t_{CYCL}	Parameterized program cycle time of the 3SK2 safety relay

7.3.6 Parameterizing in Safety ES

Parameterizing the program cycle time t_{CYCL} in Safety ES

The parameter for the program cycle time can be defined as follows:

1. In the "Configuration > Main system" work window, double-click the configured 3SK2 safety relay.
2. Enter a value for "Program cycle time [ms]" that is suitable for the scope of your configuration in the "Basic unit properties - System Slot 3" dialog box.
   – 3SK2 safety relay: 10 ... 60 ms

   Note

   Operation with DP interface,

   When the 3SK2 safety relay is operated with a DP interface, set a program cycle time of 15 ms.

Note

Support by Safety ES

Safety ES helps you configure the program cycle time. The "status bar" shows the current utilization of the parameterized program cycle time.

Parameterizing the input delay time t_{DELAY} in Safety ES

WARNING

Increasing the fault response time
can cause death, serious injury, or damage to property.

If the input delay increases, the response time and the fault response time of the safety program increase.

The parameter for the input delay time can be defined as follows:

1. Double-click the monitoring function/input cell in the work window of the logic diagram for which an input delay time is to be parameterized.
2. Enter a value between 0 ms and 150 ms for "Input delay [ms]" that is suitable for the scope of your configuration in the "Central unit properties" dialog box.

Note

Input delay

The input delay time must be an integer multiple of the program cycle time. If that is not the case, the 3SK2 safety relay rounds the input delay time to an integer multiple of the program cycle time for safety reasons and Safety ES outputs a warning.

Parameterizing the delay time t_{TIMER} in Safety ES

In Safety ES there are various timer functions with which delay times can be parameterized in the logic:

- With ON delay
- With ON delay (trigger)
- Passing make contact
- Passing make contact (trigger)
- With OFF delay
- With OFF delay (trigger)
- Clocking

Note

Response time when powering down

Not every delay time has to be considered in the (fault) response time of the 3SK2 safety relay. For example, for calculating the (fault) response time when powering down, a parameterized start delay time can be ignored because it does not apply in this case.

The parameter for the delay time can be defined as follows:

1. Double-click on the timer function in the work window of the logic diagram for which a delay time is to be parameterized.
2. Enter an integer multiple of the program cycle time that is suitable for the scope of our configuration for "Time t1 [ms]" in the "Properties ..." dialog box. Setting range: 10 ms ... 655 s.

Note

Delay time

The delay time must be an integer multiple of the program cycle time. If that is not the case, the 3SK2 safety relay rounds the delay time to an integer multiple of the program cycle time for safety reasons and Safety ES outputs a warning.

Parameterizing the maximum read-back time t_{FB} of the safety-related outputs

The maximum read-back time during the dark test of the safety-related outputs can be set in the logic diagram when using the "F output delayed" function element.

In the case of all other output elements, the maximum read-back time for fail-safe outputs is 3 ms.

> **WARNING**
>
> **Increasing the fault response time**
> **can cause death, serious injury, or damage to property.**
>
> If the maximum read-back time is increased, the (fault) response time is increased in the case of single-channel actuator wiring.

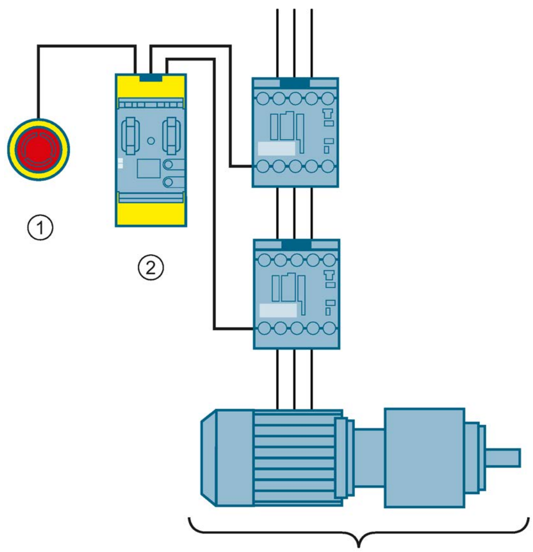
You can set the maximum read-back time as follows:

1. Double-click on the F output delayed output function in the work window of the logic diagram for which the maximum read-back time is to be parameterized.
2. Enter the required value of the program cycle time that is suitable for the scope of your configuration for "Maximum read-back time [ms]" in the "Properties ..." dialog box. Setting range: 3 ms ... 400 ms.

7.3.7 Example of calculating the (fault) response time

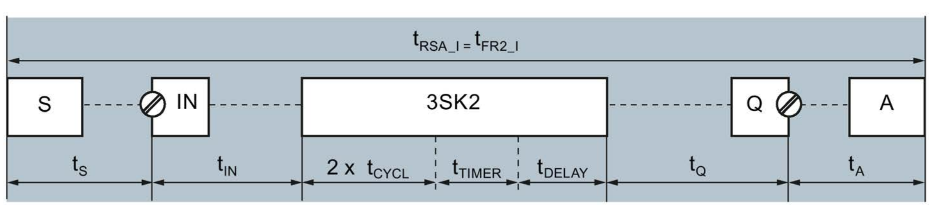
Example I: emergency stop shutdown of a motor (two-channel actuator wiring)

The 3SK2 safety relay monitors the EMERGENCY STOP. When an EMERGENCY STOP is triggered (OFF signal), the 3SK2 safety relay opens the enabling circuits and shuts down the power contactors via **two** safety-related outputs, thus shutting down the motor safely.



① Sensor: SIRIUS 3SB3 EMERGENCY STOP
② 3SK2 safety relay
③ Actuator consisting of two SIRIUS 3RT20 contactors and one motor

In this case, the **response time** is identical with the **fault response time** and is calculated as follows:

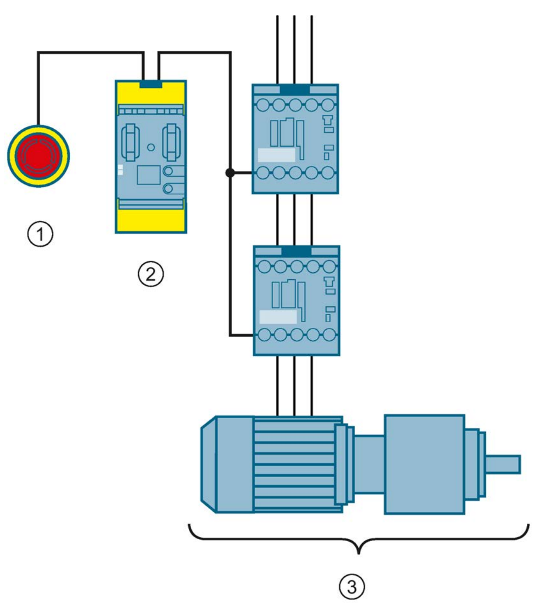


$$t_{RSA\_I} = t_{FR2\_I} = t_S + t_{IN} + 2{*}t_{CYCL} + t_{TIMER} + t_{DELAY} + t_Q + t_A$$

Formula	Explanation
S	Sensor: SIRIUS 3SB3 EMERGENCY STOP
IN	Input terminals
Q	Output terminals
A	Actuator consisting of two SIRIUS 3RT20 contactors and one motor
t_{RSA_I}	Response time in the example
t_{FR2_I}	Fault response time in the example (**two**-channel actuator wiring)
t_S	Refer to the associated documentation for details of the EMERGENCY STOP response time
t_{IN}	For the 3SK2 safety relay: $t_{IN} = t_{CYCL}$ (set program cycle time)
t_{CYCL}	Program cycle time of the 3SK2 safety relay, configured in Safety ES
t_{TIMER}	Timer functions in the logic (timer)
t_{DELAY}	Input delay for monitoring functions and input cells at the inputs
t_Q	Response time of the output terminal (Q): Solid-state outputs: < 5 ms
t_A	Sum of the following times: • Refer to the associated documentation for the response time of the SIRIUS 3RT20 contactor • Refer to the associated documentation for the response time of the motor

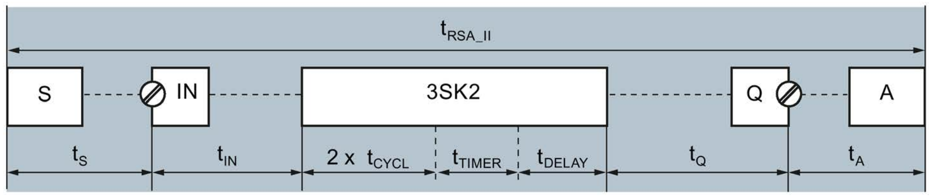
Example II: emergency stop shutdown of a motor (single-channel actuator wiring)

The 3SK2 safety relay monitors the EMERGENCY STOP. When an EMERGENCY STOP is triggered (OFF signal), the 3SK2 safety relay opens the enabling circuits and shuts down the power contactors via **one** safety-related output, thus shutting down the motor safely.



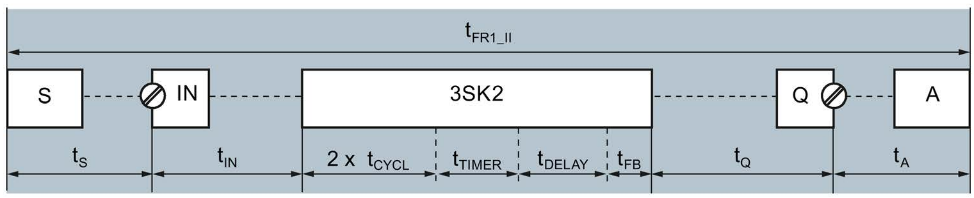
① Sensor: SIRIUS 3SB3 EMERGENCY STOP
② 3SK2 safety relay
③ Actuator consisting of two SIRIUS 3RT20 contactors and one motor

The **response time** is calculated as follows:



$$t_{RSA\_II} = t_S + t_{IN} + 2*t_{CYCL} + t_{TIMER} + t_{DELAY} + t_Q + t_A$$

The **fault response time** is calculated as follows:

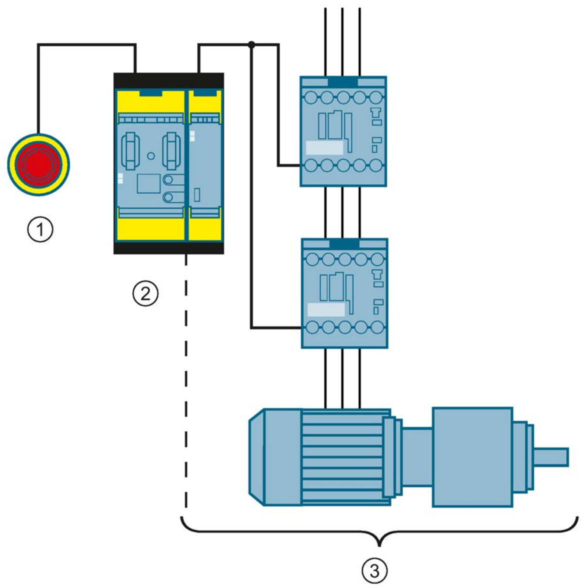


$$t_{FR1\_II} = t_S + t_{IN} + 2*t_{CYCL} + t_{TIMER} + t_{DELAY} + t_{FB} + t_Q + t_A$$

Formula	Explanation
S	Sensor: SIRIUS 3SB3 EMERGENCY STOP
IN	Input terminals
Q	Output terminals
A	Actuator consisting of two SIRIUS 3RT20 contactors and one motor
t_{RSA_II}	Response time in the example
t_{FR1_II}	Fault response time in the example (**single**-channel actuator wiring)
t_S	Refer to the associated documentation for details of the EMERGENCY STOP response time
t_{IN}	For the 3SK2 safety relay: $t_{IN} = t_{CYCL}$ (set program cycle time)
t_{CYCL}	Program cycle time of the 3SK2 safety relay, configured in Safety ES
t_{TIMER}	Timer functions in the logic (timer)
t_{DELAY}	Input delay for monitoring functions and input cells at the inputs
t_{FB}	Max. read-back time of the safety-related outputs in the dark test The maximum read-back time of the safety-related outputs depends on which function element in the logic diagram controls the output: • F output: 3 ms (fixed setting) • Output cell, linked with safety-related output terminal: 3 ms (fixed setting) • F output delayed: 3 ms – 400 ms
t_Q	Response time of the output terminal (Q): Solid-state outputs: < 5 ms
t_A	Sum of the following times: • Refer to the associated documentation for the response time of the SIRIUS 3RT20 contactor • Refer to the associated documentation for the response time of the motor

Example III: shutdown via 3SK1 output expansion with device connector (single-channel actuator wiring)

The 3SK2 safety relay monitors the EMERGENCY STOP. When the EMERGENCY STOP (OFF signal) is triggered, the 3SK2 safety relay controls the 3SK1 output expansion via **one** safety-related output by means of 3ZY12 device connectors. The 3SK1 output expansions opens the enabling circuits and shuts down the motor safely via power contactors.

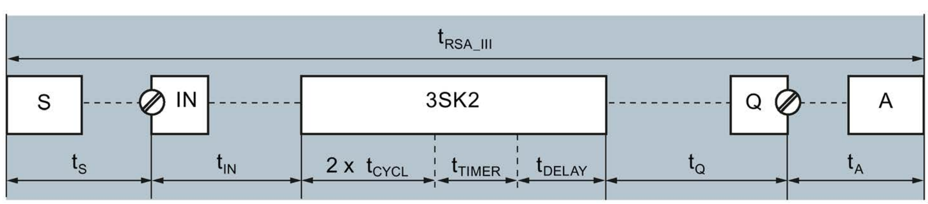


① Sensor: SIRIUS 3SB3 EMERGENCY STOP

② 3SK2 safety relay

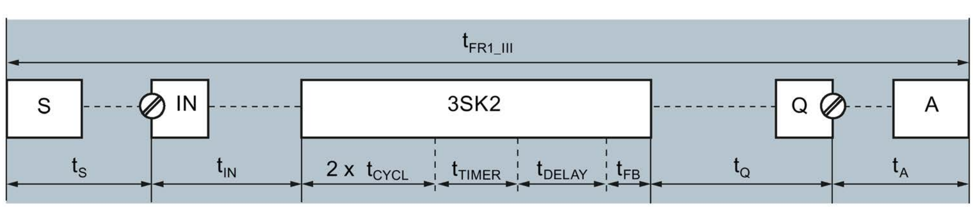
③ Actuator consisting of 3SK1 output expansion, two SIRIUS 3RT20 contactors and one motor

The **response time** is calculated as follows:



$$t_{RSA\_III} = t_S + t_{IN} + 2*t_{CYCL} + t_{TIMER} + t_{DELAY} + t_Q + t_A$$

The **fault response time** is calculated as follows:

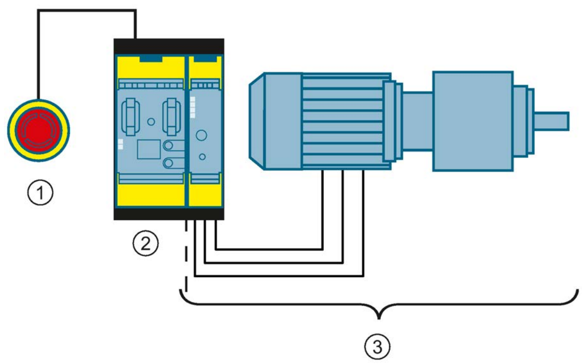


$$t_{FR1\_III} = t_S + t_{IN} + 2*t_{CYCL} + t_{TIMER} + t_{DELAY} + t_{FB} + t_Q + t_A$$

Formula	Explanation
S	Sensor: SIRIUS 3SB3 EMERGENCY STOP (two-channel)
IN	Input terminals
Q	Output terminals
A	Actuator consisting of 3SK1 output expansion, two SIRIUS 3RT20 contactors and one motor
t_{RSA_III}	Response time in the example
t_{FR1_III}	Fault response time in the example (**single**-channel actuator wiring)
t_S	Refer to the associated documentation for details of the EMERGENCY STOP response time
t_{IN}	For the 3SK2 safety relay: $t_{IN} = t_{CYCL}$ (set program cycle time)
t_{CYCL}	Program cycle time of the 3SK2 safety relay, configured in Safety ES
t_{TIMER}	Timer functions in the logic (timer)
t_{DELAY}	Input delay for monitoring functions and input cells at the inputs
t_{FB}	Max. read-back time of the safety-related outputs in the dark test The maximum read-back time of the safety-related outputs depends on which function element in the logic diagram controls the output: • F output: 3 ms (fixed setting) • Output cell, linked with safety-related output terminal: 3 ms (fixed setting) • F output delayed: 3 ms – 400 ms
t_Q	Response time of the output terminal (Q), solid-state outputs: < 5 ms
t_A	Sum of the following times: • Refer to the associated documentation for the response time of the 3SK1 output expansion • Refer to the associated documentation for the response time of the SIRIUS 3RT20 contactor • Refer to the associated documentation for the response time of the motor

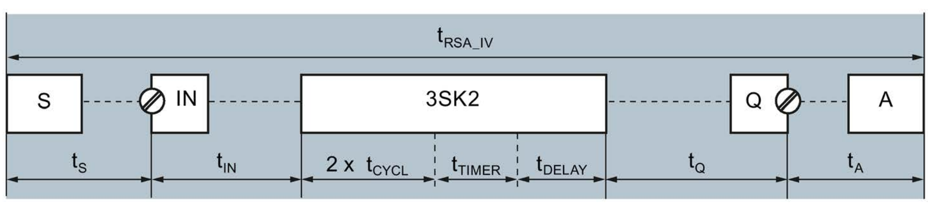
Example IV: shutdown via 3RM1 Failsafe motor starter with device connector (single-channel actuator wiring)

The 3SK2 safety relay monitors the EMERGENCY STOP. When the EMERGENCY STOP (OFF signal) is triggered, the 3SK2 safety relay controls the 3RM1 Failsafe motor starter via **one** safety-related output by means of 3ZY12 device connectors. The 3RM1 Failsafe motor starter shuts down the motor safely.



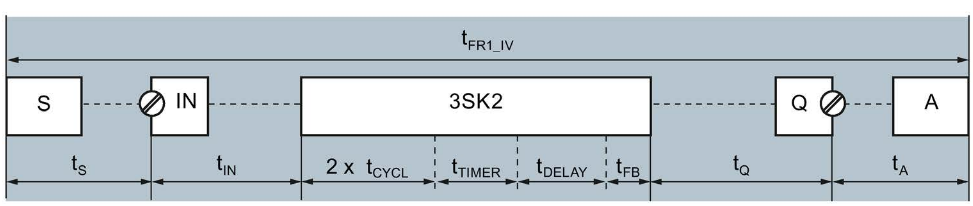
①	Sensor: SIRIUS 3SB3 EMERGENCY STOP
②	3SK2 safety relay
③	Actuator consisting of 3RM1 Failsafe motor starter and motor

The **response time** is calculated as follows:



$$t_{RSA\_IV} = t_S + t_{IN} + 2*t_{CYCL} + t_{TIMER} + t_{DELAY} + t_Q + t_A$$

The **fault response time** is calculated as follows:



$$t_{FR1\_IV} = t_S + t_{IN} + 2*t_{CYCL} + t_{TIMER} + t_{DELAY} + t_{FB} + t_Q + t_A$$

Formula	Explanation
S	Sensor: SIRIUS 3SB3 EMERGENCY STOP
IN	Input terminals
Q	Output terminals
A	Actuator consisting of 3RM1 Failsafe motor starter and motor
t_{RSA_IV}	Response time in the example
t_{FR1_IV}	Fault response time in the example (**single**-channel actuator wiring)
t_S	Refer to the associated documentation for details of the EMERGENCY STOP response time
t_{IN}	For the 3SK2 safety relay: t_{IN} = t_{CYCL} (set program cycle time)
t_{CYCL}	Program cycle time of the 3SK2 safety relay, configured in Safety ES
t_{TIMER}	Timer functions in the logic (timer)
t_{DELAY}	Input delay for monitoring functions and input cells at the inputs
t_{FB}	Max. read-back time of the safety-related outputs in the dark test The maximum read-back time of the safety-related outputs depends on which function element in the logic diagram controls the output: • F output: 3 ms (fixed setting) • Output cell, linked with safety-related output terminal: 3 ms (fixed setting) • F output delayed: 3 ms – 400 ms
t_Q	Response time of the output terminal (Q): Solid-state outputs: < 5 ms
t_A	Sum of the response times of: • Refer to the associated documentation for the response time of the 3RM1 Failsafe motor starter • Refer to the associated documentation for the response time of the motor

7.4 Selection of sensors and actuators

7.4.1 Requirements for sensors

Design of sensors

The minimum actuating duration at the input of the 3SK2 safety relay is the length of time for which a signal must be present at the input to ensure that it can be reliably detected. Please observe this time when selecting suitable sensors.

$$t_{MIN} = 2 \times t_{CYCL}$$

t_{MIN} Minimum actuating duration at the input terminals of the 3SK2 safety relay

t_{CYCL} Program cycle time of the 3SK2 safety relay

7.4.2 Requirements for actuators

Design of actuators

When actuators are selected, the following attributes of the actuators must be suitably designed:

- Response time of the actuator
- Capacitive load of the actuator
- Inductive load of the actuator

Response time

The response time is the time between application of the actuation voltage by the 3SK2 safety relay and closing of the contacts or switching of the actuator.

When selecting suitable actuators, make sure that the actuator's response time is adequately long; see also Section "Light test (Page 173)".

WARNING

Hazardous State Due to Too Short a Response Time of the Actuator Can Cause Death, Serious Injury, or Property Damage.

The 3SK2 safety relay continually runs self-tests to monitor whether the outputs are operating without faults, for example. Please observe the actuator's minimum response time when selecting suitable actuators.

By default, the light test is activated for every fail-safe output and can only be deactivated via the "F output delayed" output function.

If the light test is **activated**, the response time of the actuator must be greater than the duration of the maximum read-back time plus the light test time:

- Greater than 6 ms when using an "output cell" combined with the safety-related output terminal or the element "F output".
- Greater than 6 … 403 ms when using the "F output delayed" output function.

Even if the light test is **deactivated**, in the case of single-channel wiring of the actuators, a brief light pulse can occur in the event of a fault of the 3SK2 safety relay. In this case, use actuators with a response time of more than 4 ms or implement two-channel wiring using two safety-related outputs.

Capacitive load

A specific capacitive load must not be exceeded at the connected actuators. The maximum capacitive load depends on the load current.

When selecting suitable actuators, make sure that the actuator does not exceed the permissible capacitive load; see also Section "Guidelines for capacitive loads (Page 176)". If necessary, adjust the maximum read-back time of the dark test in Safety ES, see Section "Dark test (Page 174)".

Inductive load

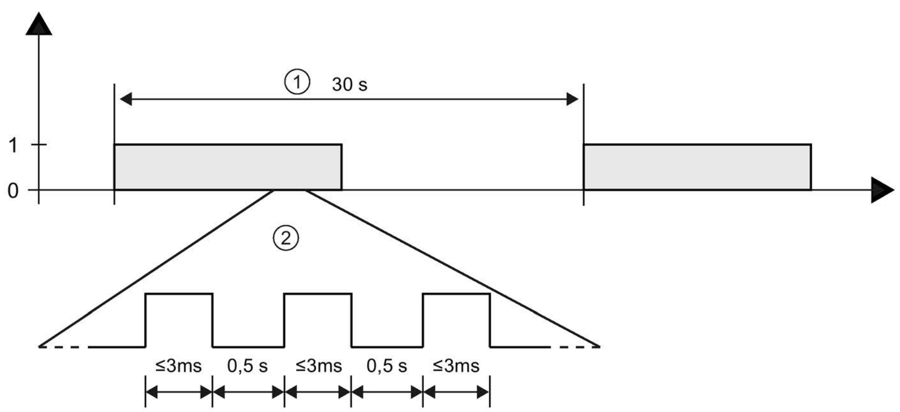
The outputs of the 3SK2 safety relay do not feature internal induction protection. If inductive loads are operated at the safety-related outputs of the 3SK2 safety relay, then they must be provided with inductive interference protection, see Section "Guidelines for inductive loads (Page 177)".

7.4.2.1 Light test

Light test

The light test is understood to consist of brief activation of a deactivated safety-related output to test whether the output is functioning without faults. A sufficiently slow actuator does not respond to this and remains switched off.

Test pulses of the light test



① Test interval time (fixed setting of 30 s)

② Fault case with three light pulses with maximum light testing time of ≤ 3 ms

Within the test interval time, a light pulse normally appears with a maximum light testing time of ≤ 3 ms.

If a light pulse detects a fault, the light pulse is repeated twice at an interval of 0.5 s. If the fault is then still present, all safety-related outputs are set to the safe state. The 3SK2 safety relay changes to configuring mode.

Deactivating the light test

The light test can be deactivated when using the "F output delayed" output function in Safety ES.

> **⚠ WARNING**
>
> **Reduced Diagnostic Coverage Due to Deactivation of the Light Test**
> **Can Cause Death, Serious Injury, or Property Damage.**
>
> The light test can be deactivated in the case of the "F output delayed" output function. Deactivating the light test has an impact on diagnostic coverage. This has an impact on the category according to EN ISO 13849. Note that Cat. 4 in compliance with EN ISO 13849 at the respective terminal is achieved only if the light test has been activated. In addition, the function test interval (shutdown test) reduces to ≤ 1 year for electronic actuators. You can find further information on test intervals in the Machinery Directive 2006/42/EC.

7.4.2.2 Dark test

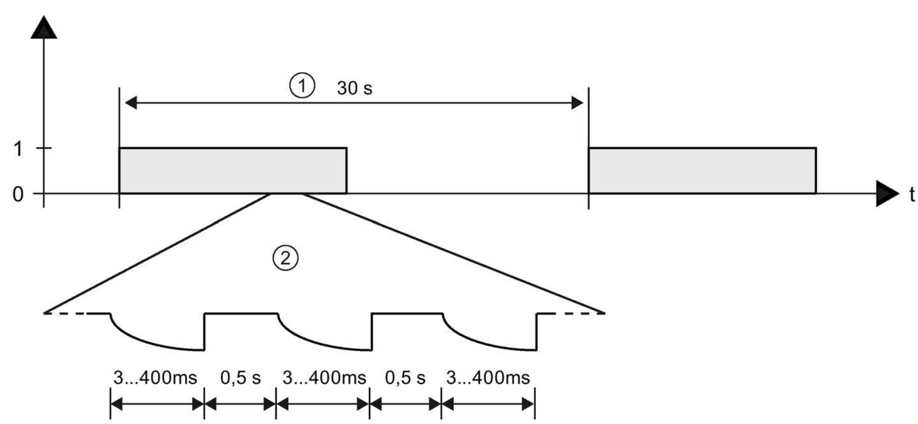
Dark test

A dark test is the brief deactivation of an activated safety-related output of the 3SK2 safety relay to ensure that the output can be deactivated at any time should safety requirements dictate it. To this end, the chosen test pulse is so short that a connected actuator does not shut down as a result.

Maximum read-back time of the dark test

The maximum read-back time of the dark test determines its maximum duration. The restart standby time is also determined by the maximum read-back time. The activation lock must not be canceled again until an output has been detected as having been deactivated.

Test pulses of the dark test



① Test interval time (fixed setting of 30 s)

② Fault with three dark pulses with maximum read-back time of 3 ... 400 ms

Within the test interval time, a dark pulse normally appears with a maximum read-back time of 3 to 400 ms.

If a dark pulse detects a fault, the dark pulse is repeated twice at an interval of 0.5 s. If the fault is then still present, all safety-related outputs are set to the safe state. The 3SK2 safety relay changes to configuring mode.

Parameterizing in Safety ES

The maximum read-back time can be set in the logic diagram when using the "F output delayed" output function. In the case of all other output elements, the maximum read-back time for fail-safe outputs is 3 ms.

WARNING

Increasing the Fault Response Time
Can Cause Death, Serious Injury, or Property Damage.

When the maximum read-back time is increased, the fault response time of the 3SK2 safety relay also increases; see Section "Response times (Page 156)".

Please note this when designing your system.

As the fault response time is extended by the maximum read-back time, the chosen maximum read-back time should be set to as low a value as possible by approximation, but should be so high that no fault is detected by the 3SK2 safety relay.

Use the diagram in Section "Guidelines for capacitive loads (Page 176)" to determine the maximum read-back time required for your actuator. If the actuator's capacitance is not known, it may be necessary for you to approximate the value for the maximum read-back time. This may also be necessary because of component spread or external influences.

Proceed as follows:

- Set the maximum read-back time so that the output is read back correctly but your actuator does not yet respond.
- If the output is sporadically deactivated, set a higher value for the maximum read-back time.
- If the output is deactivated, the maximum read-back time is too short for a connected capacitive load. Discharging cannot take place within the parameterized maximum read-back time. Increase the maximum read-back time.

  If you have set the maximum read-back time to the maximum value of 400 ms and the output is still deactivated, either an internal fault has occurred or the connected capacitance is outside the permissible range.

Note

Maximum read-back time of actuators with 3ZY12 device connectors

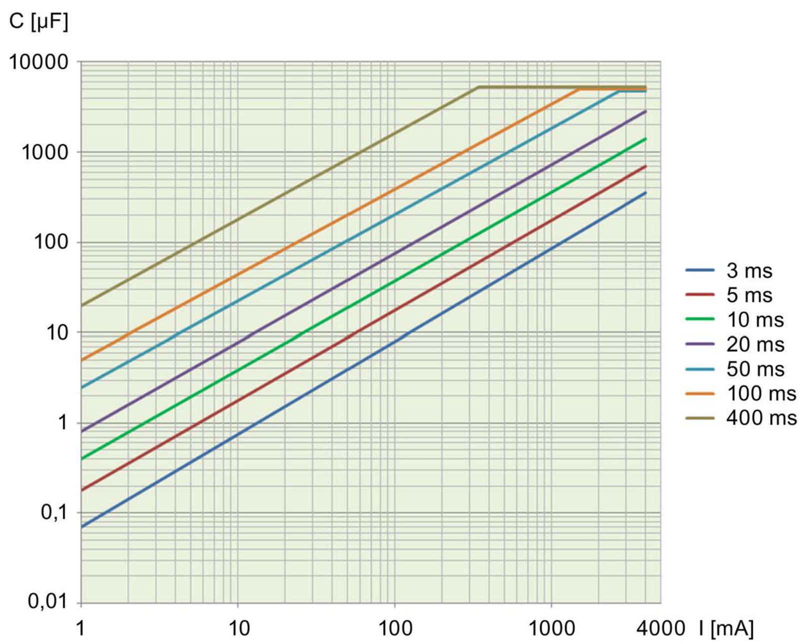
In the case of 3SK1 output expansions and 3RM1 Failsafe motor starters connected to the 3SK2 safety relay via 3ZY12 device connectors, a maximum read-back time of 3 ms is sufficient.

7.4.2.3 Guidelines for capacitive loads

Characteristics

The following figure shows typical characteristics for the relationship between the maximum capacitive load C (µF) at load current I (A) at the safety-related outputs for different parameterizable maximum read-back times [ms] of the dark test (Page 174).

The maximum read-back time can be set in Safety ES when using the "F output delayed" output function.



7.4.2.4 Guidelines for inductive loads

NOTICE
High inductive switching currents
The outputs of the safety relay do not feature internal induction protection. If inductive loads are operated at the binary outputs of the safety relay, they must be provided with inductive interference protection.

Inductive loads must be provided with protective circuits that limit the voltage rise when the controller output is switched off. Protective circuits protect the outputs against premature failure due to high inductive switched currents. They also limit the electrical faults that can occur when inductive loads are connected.

Note

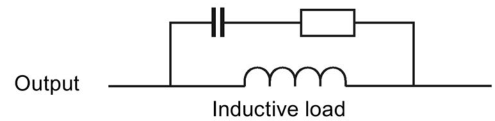
The effectiveness of a protective circuit depends on the respective application and must always be checked on a case-by-case basis. The components in a protective circuit must always be rated in line with the relevant application.

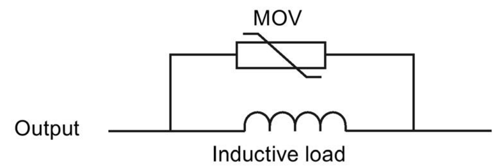
Protective circuit for outputs that switch inductive loads

WARNING
Increasing the Fault Response Time **Can Cause Death, Serious Injury, or Property Damage.**
Note that the (fault) response time is made longer by the protective circuit.

WARNING
Failure of the Safety Function **Can Cause Death, Serious Injury, or Property Damage.**
In the case of inductive loads, the external protective circuit must be arranged in parallel with the load. Connection in parallel with the outputs can prevent shutdown of the machine or process.

<table>
<tr>
<td>The diagrams show examples of protective circuits for inductive loads. You will find details of protective circuits from SIEMENS in the catalog and the relevant documentation.</td>
<td>Example:
Protective circuit for an inductive load

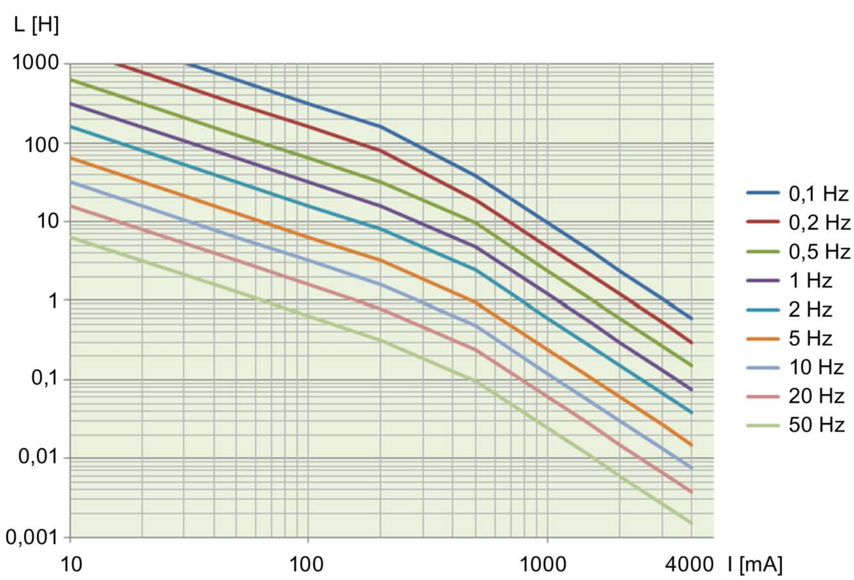




</td>
</tr>
</table>

Characteristics

The figure below shows typical characteristics for the relationship between the maximum inductive loads L [H] with respect to the load current I [mA] and switching frequency f [Hz].



7.5 Commissioning

Safety information

Note

Since commissioning of the safety relay is an important, safety-related step, it must be carried out by qualified personnel.

WARNING

Hazardous Voltage
Can Cause Death, Serious Injury, or Property Damage.

Conduct a function test of the system.

To ensure the safety of the system, a full functional test of the system must be conducted after commissioning, and a successful result obtained.

A complete function test consists of the following tests:

- Configuration test (test of the configuration)
- System test (wiring test of the connected sensors and actuators)

Requirements for commissioning

You will find further information about the procedure for configuring, planning and commissioning in the Operating Manual Safety ES (software) in Section "Additional documentation (Page 14)".

7.5.1 Modes

The safety relay always differentiates between three operating modes:

- Configuring mode
- Test mode
- Safety mode

Configuring mode (DEVICE LED: yellow)

The monitoring functions are not active in configuring mode. No signals are output at the terminals. In configuring mode, you can modify existing parameters. This is done by creating a configuration in the PC / PG with Safety ES and downloading it to the safety relay. It is also possible to upload and edit a configuration available in the safety relay.

Test mode (DEVICE LED: flickering green)

Test mode can only be accessed online from configuration mode using a PG/PC and a password-protected command. You can switch to test mode even if the configuration has not been released.

The user program is processed in test mode. All monitoring functions are active in accordance with the set parameterization. Logic outputs of function elements can be set (forced). This makes it easier to carry out troubleshooting in the application and check the wiring.

⚠ WARNING
System Starting in the Test Mode **Can Cause Death, Serious Injury, or Property Damage.** In the test mode, the safety program is executed and the outputs are controlled according to the safety program. Take appropriate organizational measures, such as deactivating the main circuit or cordoning off parts of the system, to ensure safety for persons and the system.

Safety mode (DEVICE LED: green)

In safety mode, all monitoring functions are active in accordance with the set parameterization. Safety mode can only be exited by means of a command.

Startup/self-test

Once the power supply has been applied, the safety relay performs a self-test. During the self-test phase, both LEDs on the safety relay light up for 2 seconds (lamp test). Two-color LEDs light up yellow. The safety relay then loads the configuration from the memory and checks whether a valid configuration or parameterization is stored and released and automatically switches to safety mode (DEVICE LED lights up green).

The safety relay enters configuration mode (the DEVICE LED lights up yellow) when:

- No configuration exists,
- The TARGET configuration differs from the ACTUAL configuration (the SF LED lights up red)
- The existing configuration has not been released.
- The memory module (45 mm unit) is missing or defective: In this case, only diagnostics of the safety relay are possible (DEVICE LED flashes red, SF LED lights up red).

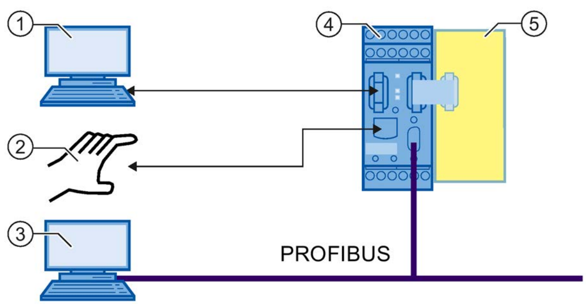
7.6 Integrating into DP master systems

7.6.1 DP address of the DP interface

Options for setting the DP address

The DP interface offers three ways of setting and changing the DP address:

- Assignment in Safety ES during the configuration phase
- Setting on the DP interface using the pushbuttons and display
- Setting using the PROFIBUS service SET_SLAVE_ADD, e.g. in SIMATIC Manager: "Target system" > "PROFIBUS" > "Assign PROFIBUS address"



① PC / PG with Safety ES using the device interface on the DP interface
② Manual setting on the DP interface using the pushbuttons and display
③ PC / PG with PROFIBUS interface
④ DP interface
⑤ Safety relay

Figure 7-8 Options for setting the DP address

The DP address can in principle be changed using all three access channels. The DP address last written or set in the DP interface is the valid address.

Individual access paths for changing the DP address can also be disabled. This can be carried out via the parameterization of the DP interface in Safety ES.

WARNING

Hazardous system state due to unauthorized access via PROFIBUS

Can result in death, serious injury, or property damage.
Unauthorized access to the safety relay via PROFIBUS can enable configuration changes and overriding of safety functions.

To prevent unauthorized access to the safety relay via the PROFIBUS network, assign a password for accessing the device in Safety ES. If you operate several safety relays in one PROFIBUS network, you must assign a separate password for each safety relay to prevent confusion when accessing via PROFIBUS. In other words, the passwords must not be identical.

Setting and disabling the DP address in Safety ES

In Safety ES, the DP address is set in the object properties of the DP interface module during configuration (see the Operating Manual Safety ES (software) in Section "Additional documentation (Page 14)". When downloading the entire configuration, the DP address (station address) is transferred to the device.

In Safety ES, individual methods of changing the DP address can also be disabled. The following protection levels are available for this purpose:

- Can be changed without restriction
  The DP address can be changed by downloading the configuration to the device (data set) by means of Safety ES, on the DP interface itself using the pushbuttons and display, and using the PROFIBUS service SET_SLAVE_ADD.
- Can only be changed by data set or setting element

  The DP address can only be changed with Safety ES and on the device itself using pushbuttons and the display.
  It is not possible to change the DP address via SET_SLAVE_ADD.
- Can only be changed via the data set
  The DP address can only be changed with Safety ES.
  The "DP-Adr" menu command is still available, but the DP address cannot be changed and is rejected with the message "Lock".

Setting the DP address on the DP interface

The DP address can be set and changed on the DP interface itself using the pushbuttons and display. The DP interface displays the current DP address, see Section "Setting the PROFIBUS address (Page 121)".

Setting the DP address with STEP 7

In STEP 7, you can assign a new DP address via the PROFIBUS service SET_SLAVE_ADD. If the safety relay does not yet have a configuration, the DP interface displays the default address 126.

Further changes to the DP address can be blocked via the PROFIBUS service SET_SLAVE_ADD. This block can only be revoked as follows:

- By restoring the factory settings of the safety relay (deleting the configuration).
- By downloading the new configuration to the device.

7.6.2 Configuring in STEP 7 with GSD file

Requirements

You require a GSD file for the DP interface. You can download this file from the Internet (http://support.automation.siemens.com/WW/view/en/113630):

If you want to use the DP interface as a DP slave, your configuring tool must support GSD files (Revision 5) -- e.g. STEP7 V5.3 and higher.

Configuring the DP interface as a PROFIBUS DP slave

The DP interface of the PROFIBUS DP slave is configured with the configuring tool of the PROFIBUS DP master (e.g. STEP 7). The slave properties (PROFIBUS address, DP process data structure width 32-bit/64-bit) set in the configuring tool must be identical to the properties set in Safety ES. Otherwise, the configuration is rejected by the DP interface.

WARNING

Hazardous system state due to unauthorized access via PROFIBUS

Can result in death, serious injury, or property damage.
Unauthorized access to the safety relay via PROFIBUS can enable configuration changes and overriding of safety functions.

To prevent unauthorized access to the safety relay via the PROFIBUS network, assign a password for accessing the device in Safety ES. If you operate several safety relays in one PROFIBUS network, you must assign a separate password for each safety relay to prevent confusion when accessing via PROFIBUS. In other words, the passwords must not be identical.

Installation of the GSD file with STEP 7

You can find out how to install the GSD file in the Online Help of STEP 7.

7.6.3 Failure and restoration in the case of PROFIBUS

PROFIBUS failure

The DP interface reports a PROFIBUS interruption to the safety relay. The safety relay then uses the substitute value "0" for the PROFIBUS logic inputs. Safety mode is not exited. The bus failure can be diagnosed in Safety ES.

Indication failure PROFIBUS			
LED	**DP interface**	**DP interface display**	**Safety relay**
DEVICE	Green	BF DPXXX	Green
BF	Red		-
SF	off		off

Restoration of PROFIBUS

Once the PROFIBUS connection has been restored, the safety relay will work with the real values again.

Indication of PROFIBUS restoration			
LED	**DP interface**	**DP interface display**	**Safety relay**
DEVICE	Green	RUN DPXXX	Green
BF	Off		-
SF	off		off

XXX stands for the set PROFIBUS address.

8 Maintenance and service

8.1 Restoring factory settings

To restore the factory settings of the safety relay, proceed as follows:

Step	Action
①	Switch the 24 V DC power supply off.
②	Hold down the "RESET" key.
③	Switch the 24 V DC power supply on again.
④	Release the "RESET" key only when the DEVICE LED flickers yellow.
⑤	Keep holding down the "RESET" key if the DEVICE LED flickers red.
⑥	Release the "RESET" key when the DEVICE LED flickers yellow.
⑦	Keep holding down the "RESET" key if the DEVICE LED flickers red.
⑧	When the DEVICE LED goes out, release the "RESET" key within 10 s. The DEVICE LED starts to flash yellow.
⑨	Once the factory settings have been restored, the 3SK2 safety relay automatically restarts and switches to configuring mode.

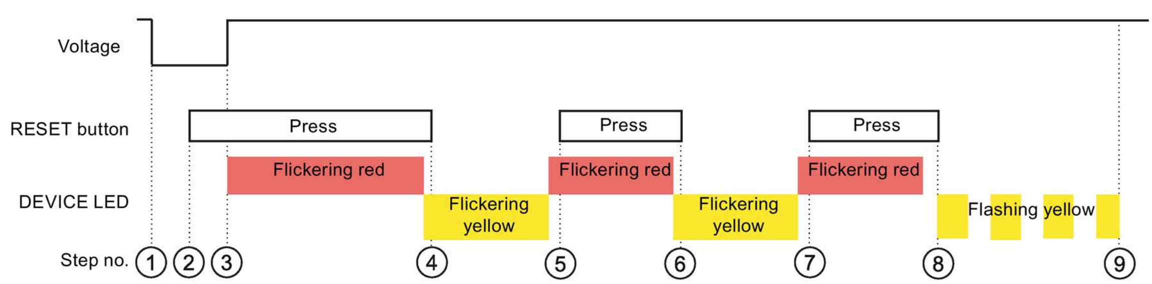


Figure 8-1 Factory setting

Result

The procedure for restoring the factory settings has the following effects:

- All configuration information in the internal memory of the 3SK2 safety relay is deleted.
- If the external memory module is plugged in, all the existing data is deleted (Only affects 3SK2 safety relays with 45 mm width)
- The DP address is deleted and set to DP address 126.

Note

Alternatively, the factory settings can be restored by Safety ES.

Note

Factory settings with connected DP interface

As communication with the DP interface is interrupted when the factory settings are being restored, you must switch the entire system off and then on again once the they have been restored.

Note

Factory settings of the diagnostics display

The factory settings for the diagnostics display can also be restored; see Section "Display settings (Page 222)".

Note

Factory settings for DP interface

The factory settings for the DP interface can also be restored; see Section "Restoring factory settings (Page 123)".

8.2 Device replacement

Defective devices

Replace a defective device with a new device. Note the following safety instructions and the described procedure when doing so. Device replacement must be carried out by authorized specialist personnel.

Safety information

WARNING

Hazardous Voltage
Can Cause Death, Serious Injury, or Property Damage.

Hazardous electrical voltages can cause electric shock, burns and damage.

- Turn off and lock out all power supplying the system and device before working on the device.
- To ensure protection against the hazard of electric shock when the terminal cover is open, screw in all terminal screws that are not needed to clamp conductors.
- Close the terminal covers and always keep them closed during operation.

WARNING

Hazardous Voltage
Can Cause Death, Serious Injury, or Property Damage.
Carry out function test of the system

To ensure the safety of the system, any changes to it or any replacement of defective components must be followed by a thorough and successfully completed function test of the system.

A complete function test consists of the following tests:

- Configuration test (test of the configuration)
- System test (wiring test of the connected sensors and actuators)

Note

Recycling and disposal

Dispose of existing packing material in accordance with applicable regulations or recycle it.

3SK2 safety relays are able to be recycled thanks to a low-pollutant manufacturing process. For environmentally-friendly recycling and disposal of your electronic waste, please contact a company certified for the disposal of electronic waste.

Note

When replacing a device, you do not need to re-wire it. The terminals can be disconnected from the defective device and then connected to the new device. Please observe this sequence.

Replacing 3SK2 safety relays

Note

Replace a defective device only with a device of an identical type.

Note

Data loss on the 3SK2 safety relay with 45 mm width

Connect or disconnect the external memory module only when the power is switched off.

1. When replacing a 3SK2 safety relay with 22.5 mm width, back up the configuration via Safety ES or save the configuration on the optional diagnostics display.
2. Disconnect the defective device at the terminals.
3. Uninstall the defective device.
4. In the case of the 3SK2 safety relay with 45 mm width, remove the memory module containing the device configuration.
5. Mount the new device.
6. Connect the device at the terminals.
7. In the case of the 3SK2 safety relay with width 45 mm, use the memory module with the existing configuration data.

   Note

   If you connect a memory module to a 3SK2 safety relay with a width of 45 mm that contains a configuration already released by another safety relay family (e.g. 3RK3 MSS), a configuration error is returned and the device remains in configuring mode. Once you have withdrawn the configuration release, you can modify and release the configuration again and load it into the 3SK2 safety relay.

8. In the case of the 3SK2 safety relay with width 22.5 mm, load the configuration into the new device via Safety ES, or load the configuration backed up in the first step from the diagnostics display to the 3SK2 safety relay.

WARNING

System Restart After Module Replacement
Can Cause Death, Serious Injury, or Property Damage.

After applying the supply voltage, the new 3SK2 safety relay checks whether the hardware configuration matches the device configuration. If there are no discrepancies, the system re-enters safety mode and the safety program is executed.

Take appropriate measures (e.g. start button with monitored starting) to prevent unintentional restarting and to ensure a defined start of the system.

Replacing the DP interface / diagnostics display

Note

Replace a defective device only with a device of an identical type.

1. Disconnect the defective device at the terminals.
2. Uninstall the defective device.
3. Mount the new device.
4. Connect the device at the terminals.

WARNING

System Restart After Module Replacement
Can Cause Death, Serious Injury, or Property Damage.

After applying the supply voltage, the 3SK2 safety relay checks whether the hardware configuration matches the device configuration. If there are no discrepancies, the system re-enters safety mode and the safety program is executed.

Take appropriate measures (e.g. start button with monitored starting) to prevent unintentional restarting and to ensure a defined start of the system.

Diagnostics 9

Diagnostics options

A number of methods are available for diagnosing errors:

- Diagnostics with LEDs
- Diagnostics via device display (on the 3SK2 safety relay with width 45 mm)
- Diagnostics with Safety ES
- Diagnostics with diagnostics display (optional)
- Diagnostics via PROFIBUS (via DP interface; optional)

9.1 Troubleshooting procedure

Local troubleshooting

There are different options for local troubleshooting.

1. Troubleshooting with diagnostics display
   - Read queued messages of the elements as plain text locally on the control cabinet. The cabinet does not need to be opened for this if the diagnostics display is built into the control cabinet door.
   - The diagnostics display shows the active fault.
   - The diagnostics display shows the affected element (sensor / actuator) causing the fault.
2. Troubleshooting with LEDs
   - You can see the status of the safety relay from the LEDs.
3. Troubleshooting with device display (45 mm device)
   - The device display shows which signals are active at which terminals (1 / 0 / fault).
4. Troubleshooting with Safety ES
   - Safety ES offers you detailed diagnostics of all elements with a locally connected PG / PC.
   - In the logbooks of the safety relay, all messages are saved with a time stamp, and a log is thus created that you can read out with Safety ES.

Online troubleshooting

1. Troubleshooting with Safety ES via PROFIBUS interface
   – Safety ES offers you detailed diagnostics of all elements with a PG / PC connected via PROFIBUS and DP interface.
   – In the logbooks of the safety relay, all messages are saved with a time stamp, and a log is thus created that you can read out with Safety ES.
2. Troubleshooting via PROFIBUS diagnostics frame
   – With the connection to PROFIBUS via a DP interface, you can evaluate diagnostics data sets with a higher-level controller, and respond accordingly. You need to have a sound knowledge of writing/reading data sets using PROFIBUS.

Fault acknowledgment

Acknowledge the message after resolving the cause.

WARNING

System Restart After Fault Acknowledgement/Restart
Can Cause Death, Serious Injury, or Property Damage.

When the power-on condition is fulfilled, the system immediately continues to operate with the values and outputs specified by control following fault acknowledgement/restart.

Take appropriate measures (e.g. start button with monitored starting) to prevent unintentional restarting and to ensure a defined start of the system.

9.2 Diagnostics concept

The diagnostics concept of the 3SK2 safety relay is illustrated in the following diagram:

The various device messages result in an entry in DS92. Some of the messages then trigger a higher-level error, for example, group errors (SF), bus faults (BF), group warnings (SW), and group prewarnings (SVW) in the group status.

Messages output by the function elements initially result in a certain element status, which itself can result in an entry in DS92.

This status is then indicated by the LEDs. Data set 92 can be read out via the diagnostics via PROFIBUS.

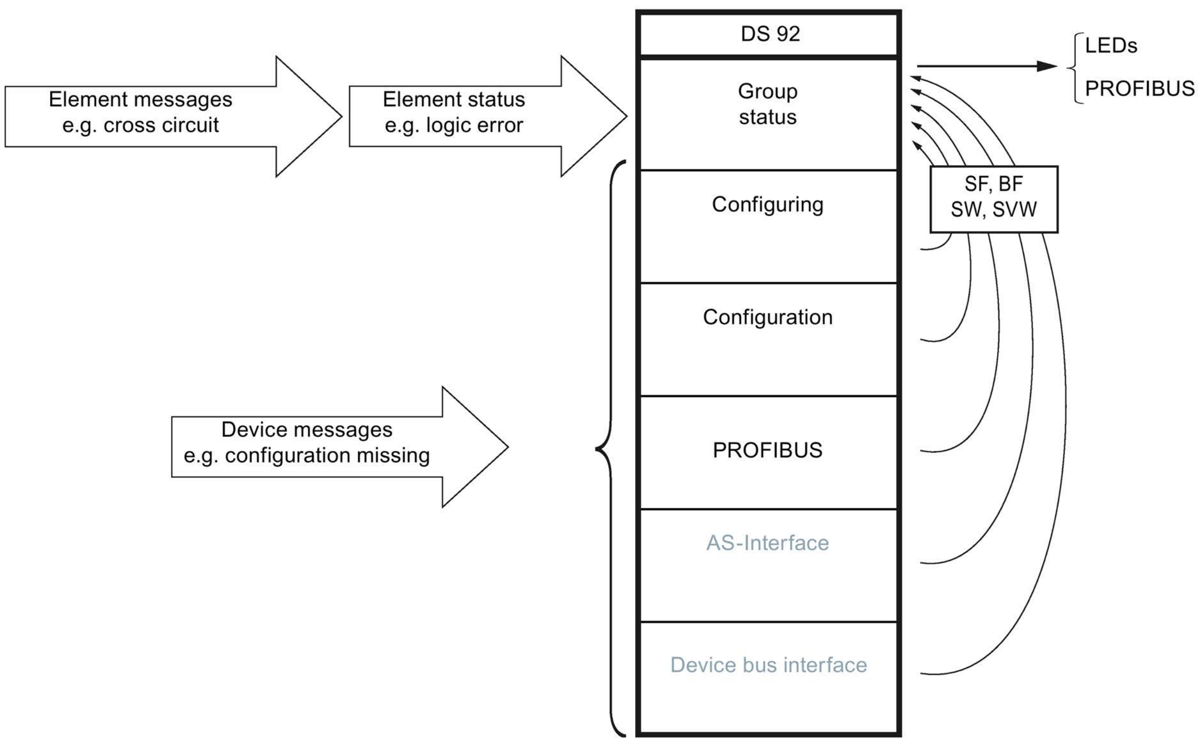


Figure 9-1 Diagnostics concept of the 3SK2 safety relay

9.2.1 Display philosphy

In error management, the following display concept applies:

- Errors requiring acknowledgment are displayed by a red SF LED.

> **WARNING**
>
> **System Restart After Fault Acknowledgement/Restart**
> **Can Cause Death, Serious Injury, or Property Damage.**
>
> When the power-on condition is fulfilled, the 3SK2 safety relay immediately continues to operate with the values and outputs specified by the control following fault acknowledgement/restart.
>
> Take appropriate measures (e.g. start button with monitored starting) to prevent unintentional restarting and to ensure a defined start of the system.

- Self-acknowledging errors are displayed by a red flashing SF LED.
- If more than one error is present at the same time, red has priority over red flashing.

9.2.2 Error management

Error categories

Error management makes a distinction between five different error categories:

- Device error
- System error
- Logic or wiring error
- Parameterization or configuration error
- Handshake error

Device error

A device error causes the system to stop. Communication between the devices is not possible. This error is caused either by internal system errors or a defective 3SK2 safety relay.

This error category can occur in any operating mode.

Display on the safety relay		Remedy
LED	Display	
DEVICE	red	The 3SK2 safety relay can only exit the system stop by means of a restart after switching the power supply off and on. If the error is still present after the system has been restarted, you must replace the 3SK2 safety relay. **Exception:** In the event of overvoltage or undervoltage, the device LED and SF LED do not light up:
SF	red	
Display (45 mm)	-	

Note

Diagnostics not possible

In this state, no diagnostics information can be queried.

System error

If a system error occurs, the 3SK2 safety relay switches from safety/test mode to a safe state (configuring mode) and switches off all the outputs. The option of reading out status and diagnostics messages is still available.

Display on the safety relay		Remedy
LED	Display	
DEVICE	• Red flashing (coming out of safety mode) • Yellow (coming out of test mode)	• **Coming out of safety mode**: Following error correction, perform a reset or a restart to be able to switch back to safety mode. • **Coming out of test mode:** Following error correction, you can change back to test mode. Reset or restart leads to configuring mode.
SF	red	
Display (45 mm)	• PROJ ERR (coming out of safety mode) • PROJ (coming out of test mode)	

Logic or wiring error

A logic or wiring error does not cause the operating state to change; the 3SK2 safety relay remains in safety/test mode. This error category can have the following causes:

- **Wiring error**

  (e.g., feedback circuit switching time violation, cross-circuit between cables):

Display on the safety relay		Remedy
LED	Display	
DEVICE	Depending on the operating state	Resolve the cause and then acknowledge the error with reset.
SF	red	
Display (45 mm)	• Operating state • Status of the input / output terminals*)	

*) Diagnostics also possible with the 3SK26 diagnostics display for all 3SK2 safety relays

- **Logic error**

  (e.g., discrepancy time violation, violation of a signal sequence):

Display on the safety relay		Remedy
LED	Display	
DEVICE	Depending on the operating state	Acknowledgment is not necessary. If the logic is correct then the warning is automatically canceled.
SF	flashing red	
Display (45 mm)	• Operating state • Status of the input / output terminals*)	

*) Diagnostics also possible with the 3SK26 diagnostics display for all 3SK2 safety relays

- **Group prewarning**

  (e.g., wait for startup test; safety sensor tripped)

Display on the safety relay		Remedy
LED	Display	
DEVICE	Depending on the operating state	Acknowledgment is not necessary. If the logic is correct then the warning is automatically canceled.
SF	-	
Display (45 mm)	• Operating state • Status of the input / output terminals*)	

*) Diagnostics also possible with the 3SK26 diagnostics display for all 3SK2 safety relays

Parameterization or configuration error

This category of error only occurs in configuring mode. This error is caused if the configuration is incorrect, for example.

Display on the safety relay		Remedy
LED	**Display**	
DEVICE	yellow	Acknowledgment is not necessary. If the parameterization is correct then the error is automatically canceled.
SF	red	
Display (45 mm)	Operating state: PROJ	

Handshake error

This category of error only occurs in test mode. This error is caused by an interruption in the connection between Safety ES and the 3SK2 safety relay. The safety relay changes from test mode to configuring mode.

Display on the safety relay		Remedy
LED	**Display**	
DEVICE	yellow	Acknowledgment is not necessary. The error is automatically canceled when a connection is correctly re-established.
SF	red	
Display (45 mm)	Operating state: PROJ	

9.3 Diagnostics via LEDs

9.3.1 Displays on the safety relay

LED	Display	Explanation
DEVICE	Off	No voltage Undervoltage, overvoltage
	green	Device OK, user program in safety mode
	Green flashing 0.5 Hz (ratio 1:1)	System power-up
	Flickering green	Device OK, user program in test mode
	yellow	User program stopped; (configuring mode; configuration not released; configuration missing)
	Yellow flashing 0.5 Hz (ratio 1:1)	Factory settings restored
	Flickering yellow	See Section "Restoring factory settings (Page 185)"
	red	System stop The system stop can only be exited by means of a restart after switching the power supply off and on. If the error is still present after the system has been restarted, you must replace the 3SK2 safety relay.
	Red flashing 0.5 Hz (ratio 1:1)	Configuration error or wiring fault (e.g. cross-circuit, short circuit to ground at an output/input; memory module removed during operation)
	Flickering red	See Section "Restoring factory settings (Page 185)"
SF	off	No group error
	red	Group fault that requires acknowledgement[1)] (wiring, communication, parameterization or configuration fault)
	Red flashing 0.5 Hz (ratio 1:1)	Self-acknowledging group fault (logic error) (e.g., discrepancy time violation, violation of a signal sequence):

[1)] Please note the safety information below.

WARNING

System Restart After Fault Acknowledgement/Restart
Can Cause Death, Serious Injury, or Property Damage.

When the power-on condition is fulfilled, the system immediately continues to operate with the values and outputs specified by control following fault acknowledgement/restart.

Take appropriate measures (e.g. start button with monitored starting) to prevent unintentional restarting and to ensure a defined start of the system.

Reference

You will find more information on the LED display during startup in the Section "Modes (Page 179)"

9.3.2 Displays on the DP interface

LED	Display	Explanation
DEVICE	Off	No voltage
	Green	Device OK
	Green flashing 0.5 Hz (ratio 1:1)	Device is in power-up phase
	Red	Device defective
	Yellow flashing 0.5 Hz (ratio 1:1)	Factory settings restored, see Chapter "Restoring factory settings (Page 123)"
BF	Off	PROFIBUS bus communication OK
	Red	• DP interface in device power-up • PROFIBUS error, e.g. wrong PROFIBUS address (DP interface module not addressed)
	Red flashing 0.5 Hz (ratio 1:1)	PROFIBUS parameterization/configuration error
SF	Off	No group error
	Red	Group error (communications error, etc.)

9.3.3 Displays on diagnostic display

LED	Display	Explanation
DEVICE	Off	• No voltage, undervoltage, overvoltage • Device error
	green	Device OK, user program in safety mode
	flickering green	Device OK, user program in test mode
	yellow	User program stopped; device in safe state (configuring mode; configuration not released; no configuration)
BF	Off	No bus error
	red	Error, e.g., incorrect PROFIBUS address (DP interface not addressed)
	Red flashing 0.5 Hz (ratio 1:1)	Parameterization or configuration error
SF	Off	No group error
	red	Group error (communications error, etc.)
	Red flashing 0.5 Hz (ratio 1:1)	Group error: logic error (sequence, etc.)

9.4 Diagnostics via device display (3SK2 safety relay with width 45 mm)

Display

The device display of the 3SK2 safety relay with 45 mm width displays the operating state and the states of the input and output terminals.

The following operating states can be displayed:

Display	Meaning
RUN	The 3SK2 safety relay is in safety mode.
TEST	The 3SK2 safety relay is in test mode.
PROJ	The 3SK2 safety relay is in configuring mode.
PROJ ERR	An error has occurred that prevents further processing of the safety application
INIT	The factory settings are being restored.

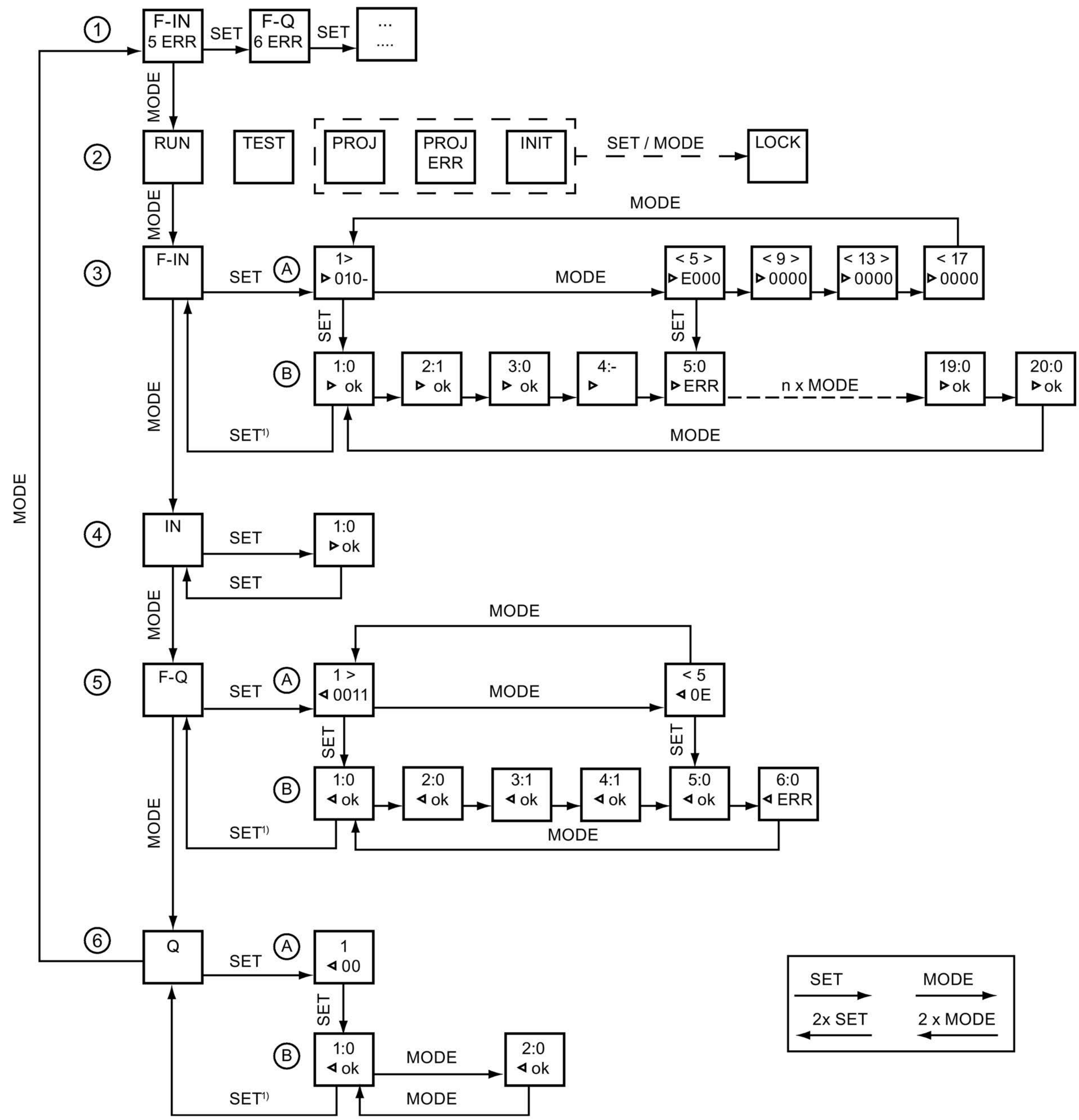
Navigation

The "SET" and "MODE" keys are used for navigation in the menus and submenus:

- "SET" changes to the menu levels.
- "MODE" scrolls through the menu items.
- Single click: scroll forward
- Double-click: scroll back

After 30 seconds of inactivity, you are returned to the top menu level (menu ① or menu ②).

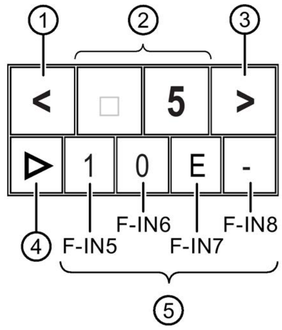
Menu structure



Menu ①	Error display, which is shown only if there is a message The display shows the number and the type of the affected terminal, e.g. fault at F-IN5 and at F-Q6
Menu ②	Operating state
Menu ③	Status of the safety-related inputs (F-IN1 to F-IN20) • A: Overview • B: Detail view
Menu ④	Status of the feedback circuit via device connector (IN1-C)
Menu ⑤	Status of the safety-related outputs (F-Q1 to F-Q6) • A: Overview • B: Detail view
Menu ⑥	Status of the standard outputs (Q1 to Q2) • A: Overview • B: Detail view
SET[1)]	This applies analogously to all menu items at this level.

Overview A

Four terminals and their states are displayed in this menu.



① Indicates whether you can scroll to the left in the menu (2 x Mode)

② Number of the first of the four terminals, in this case F-IN5.

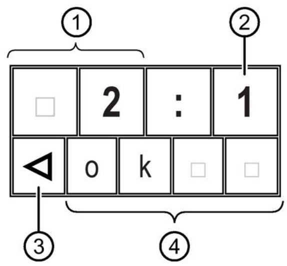
③ Indicates whether you can scroll to the right in the menu (1 x Mode)

④ Type of the terminal
- Right arrow = input
- Left arrow = output

⑤ Status of the four terminals, in this case of the terminals F-IN5 to F-IN8.
The following states can be displayed:
- 0 = there is no signal
- 1 = a signal is present
- - = unknown status
- E = a message is pending.

Detail view B

The details of a terminal are displayed in this menu:



① Number of the terminal

② Indicates whether a signal is present:
- 0 = there is no signal
- 1 = a signal is present
- - = unknown status

③ Type of the terminal
- Right arrow = input
- Left arrow = output

④ Status of the terminal
- ok = configured and ok
- Err = fault or message pending (discrepancy, sequence, feedback circuit or cross-circuit fault is pending or start-up test is necessary)
- "Blank line" = unknown status

9.5 Diagnostics with diagnostics display

9.5.1 Diagnostics display

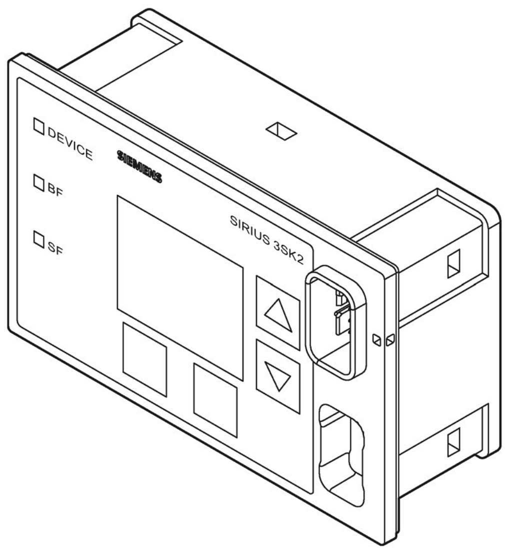


Figure 9-2 Diagnostics display

A diagnostics display is available for the safety relays that is able to display the current messages, diagnostics data, and status information of the monitored system. It has three status LEDs and makes the system interface easily accessible outside of the control cabinet.

Note

3SK2 safety relays

3SK2 safety relays are only supported by the 3SK26 diagnostics display.

MSS 3RK3 Advanced/ MSS 3RK3 ASIsafe basic/ MSS 3RK3 ASIsafe extended

These 3RK3 central units are supported by the 3RK36 diagnostics display as from product version E03 and firmware version[1)]V1.1.x and higher, and/or by the 3SK26 diagnostics display.

MSS 3RK3 Basic

MSS 3RK3 Basic is only supported by the 3RK36 diagnostics display as from product version E01 and higher and/or the 3SK26 diagnostics display.

[1)] The firmware version can be read at the startup of the display or at the bottom left when the display is disabled. It can also be shown by selecting the menu command "Display settings / Identification" (see also Section "Display settings (Page 222)").

	Diagnostics display		
	3SK26	3RK36	3RK36
	V1.0 / E01	V1.1 / E03	V1.0 / as from E01
3SK2	Yes	No	No
3RK3 Basic	Yes	Yes	Yes
3RK3 Advanced / ASIsafe	Yes	Yes	No

Diagnostics and fault acknowledgment

The pending messages/errors can be read and acknowledged with the keys, current status information is shown on the display. The display can also be set for different ambient conditions. The following represent all the operator controls available for diagnostics and operation:

- 4 keys for navigating the display menu, 2 keys are softkeys with different functions (e.g., test/reset)
- 1 graphical display
- 3 LEDs (DEVICE, BF, SF)

The diagnostic display is connected directly to the safety relay / DP interface via the rear system interface. Power is supplied from the safety relay / DP interface. A PC /PG can be connected to Safety ES with a PC cable via the system interface on the front (with a cover cap for IP54).

NOTICE
Damage to property
The diagnostics display must only be removed or connected when the system is de-energized.

"Park position" for cover

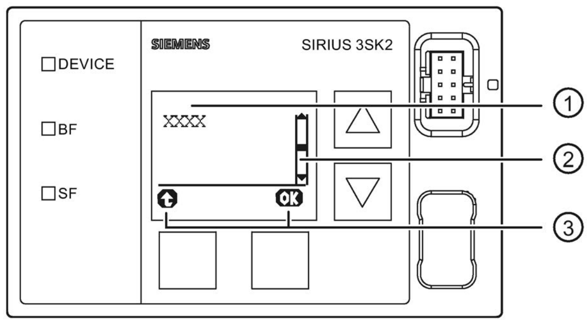
The cover can be "parked" on the front of the diagnostics display under the system interface.

Securing the device interface against unauthorized use

The front cover offers the option of sealing the device interface of the diagnostics display in order to prevent unauthorized access to the system.

9.5.2 Displays

You can read current operating and diagnostics data, as well as status information of the safety relay in plain text, via the display.



Display on the diagnostic display

Display ①

Messages and status information of the safety relay can be displayed in plain text here. Short values (e.g.: plant identifiers) are displayed directly under the heading, long texts (e.g. the comment) are shown in a submenu. It can be seen on the (OK) key that a submenu can be launched.

Scrollbar ②

As shown in the graphic, this bar shows whether there are any more menu items or messages. These items can be selected and displayed using the arrow keys.

If no other entries are present, the inside of the bar is black.

Function of the softkeys ③

Displays the current function of the two softkeys.

Possible displays:

Key left (meaning)	Key right (meaning)
⇑ (moves you one menu level higher)	OK (selects / confirms)
	Reset (acknowledges error)

9.5.3 Menus

You can navigate the menu with the arrow keys and softkeys. Any menu option may have additional sub-menus. The menu structure and display are in part directly dependant on the device parameterization (e. g. selected control function) and hardware configuration (e.g. type and number of expansion modules used).

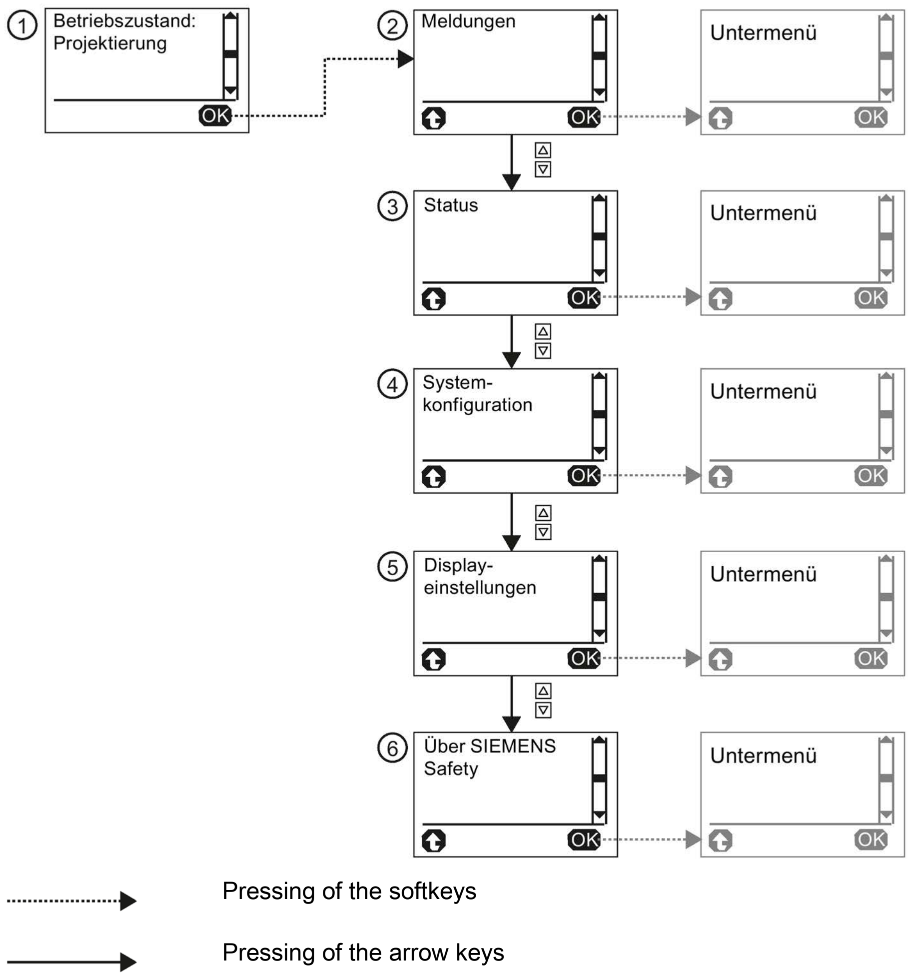


Figure 9-3 First level of the menu of the diagnostics display

Status display ①

The "status display" is the standard display of the diagnostics display. It displays the equipment identifier, the operating status and the status of the configuration.

You can navigate to the individual menus via the right softkey (OK). With the left softkey (reset), pending errors can be acknowledged directly.

If messages are pending, they are displayed directly, that is, the diagnostics menu switches directly to the message menu and to the message with the highest priority. This function can be deactivated via the display settings. If multiple messages are pending, they are displayed as a list that is visible on the scrollbar on the right side of the display. You can scroll to the individual messages with the arrow keys.

Messages ②

The "Messages" menu provides an overview of all current pending error messages and warnings for the entire system.

You will find detailed information in Section "Messages (Page 211)"

Status ③

The "Status" menu displays all relevant status information and messages for the configured function elements. Pending messages can be acknowledged after they are dealt with.

You will find detailed information in Section "Status (Page 215)"

System configuration ④

The "System configuration" menu provides all relevant information for configuration and for the individual devices.

You will find detailed information in Section "System configuration (Page 219)"

Display settings ⑤

All settings affecting the diagnostics display can be made via the "Display settings" menu. In addition to selecting the language and adjusting contrast and brightness, it is also possible to reset to the factory settings.

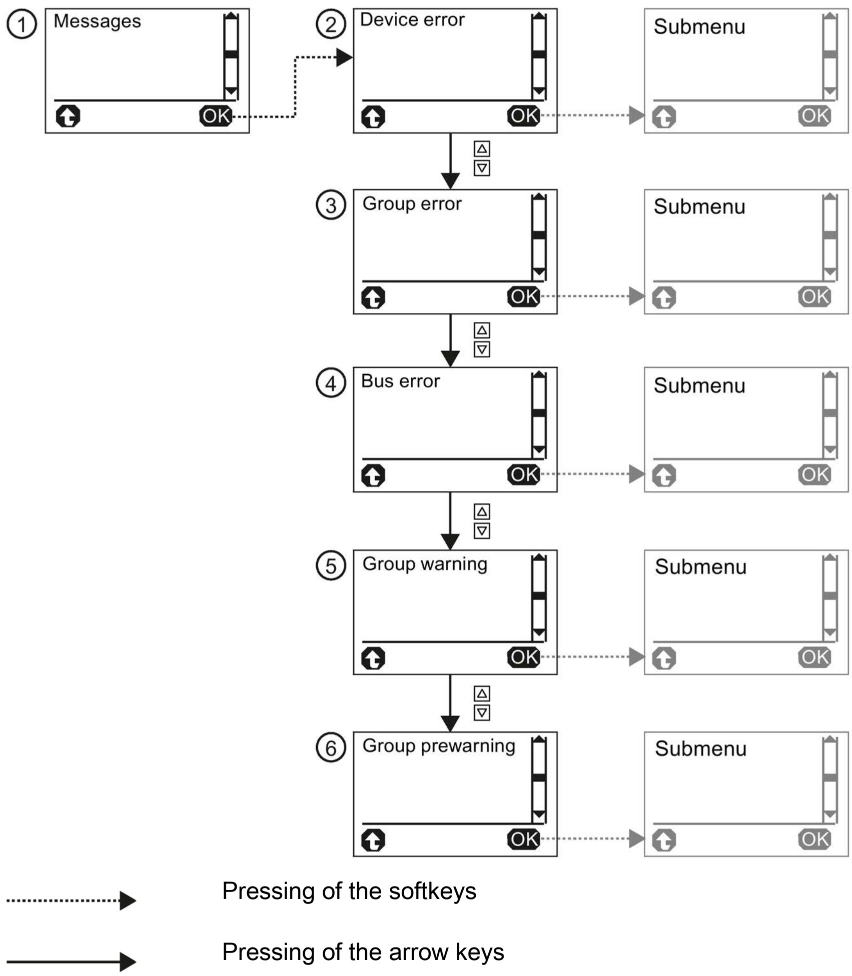
You will find detailed information in Section "Display settings (Page 222)"

About SIRIUS Safety ⑥

The menu option "About SIRIUS Safety" provides more information on the safety relay.

9.5.3.1 Messages

The "Messages" menu option provides an overview of all current pending error messages and warnings for the entire system.



Pressing of the softkeys

Pressing of the arrow keys

Figure 9-4 Second level of the menu of the diagnostics display - "Messages" menu option

Message categories

The following message categories may be displayed, according to the cause of error:

- Device errors ②
- Group errors ③
- Bus errors ④
- Group warning ⑤
- Group prewarning ⑥

If multiple errors from different categories are pending, you can switch between the individual error categories with the arrow keys.

Errors and error causes

You can access the pending error messages by pressing the right key (OK).

With some errors, a distinction is made between different causes, e.g., in the case of group errors. In this case, the cause can be displayed as a plaintext message with the right key (OK):

If multiple errors/error causes from different categories are pending, you can switch between the individual messages categories with the arrow keys.

With the left key, the display moves up one menu level.

Acknowledging errors

For individual errors, you can switch directly to the applicable function element in the status menu by marking the error message with the arrow keys and by pressing the right key (OK).

WARNING
System Restart After Fault Acknowledgement/Restart **Can Cause Death, Serious Injury, or Property Damage.** When the power-on condition is fulfilled, the system immediately continues to operate with the values and outputs specified by control following fault acknowledgement/restart. Take appropriate measures (e.g. start button with monitored starting) to prevent unintentional restarting and to ensure a defined start of the system.

You can switch to the status display for the affected function element when the following messages occur:

- Group prewarning from user program
- Group warning from user program
- Wiring error
- Logic error
- Group error from user program

In the "Status" menu, you can acknowledge the error after having dealt with it with the right key (reset).

Device errors ②

Possible causes for device errors/self-test errors are:

- Output wiring error
- Faulty input or output
- Defective device

Group errors ③

The following group errors can be diagnosed:

Message	Meaning(s)
Configuration error[1)]	• Memory module not plugged in • SC configuration error[3)] • Memory module defective • Memory module too small
Configuration error[1)]	An error occurred during the configuration phase: • Release denied due to incorrect configuration CRC • Release canceled due to incorrect configuration release CRC • Max. number of elements exceeded • Max. size of memory exceeded • Program cycle time exceeded • TARGET≠ACTUAL configuration • TARGET≠ACTUAL slot expanded configuration • Invalid parameter value • Interconnection rule violated • Data structure incorrect
Safety protocol error[4)]	• Multiple ASIsafe code tables[4)] • ASIsafe 8x4-bit code sequence error[4)] • ASIsafe 7x4-bit code sequence error[4)]
Wiring error[2)]	Faulty wiring of a sensor connection or in the sensor itself.
Logic error[2)]	Protection fault: Processing sequence on the sensor not coherent.
Handshake error	An error was detected during connection monitoring in test mode.
Group error from user program[2)]	At least one error from the user program is present.
SC bus error[3)]	Communication via the device bus interface is interrupted.[3)]
SC configuration error[3)]	The actual configuration of an existing communication connection does not match the target configuration. This resulted in an error.[3)]
Memory module defective	Memory module is defective.
User memory too small	More configuration data were transferred to the safety relay than can be stored in the configuration memory.

1) Different error causes are possible. The cause is displayed by pressing the right key (OK).

2) Pressing the right key (OK) switches the diagnostics display directly to the relevant function element in the status menu.

3) 3RK3 only

4) 3RK3 Advanced and 3RK3 ASIsafe only

Bus errors ④

The following bus errors can be diagnosed:

Message	Meaning
DP bus error	Communication via the fieldbus interface PROFIBUS DP is interrupted.
DP parameterization error	An error occurred during parameterization for an existing communication connection.
DP configuration error	The actual configuration of an existing communication connection does not match the target configuration. This resulted in an error.
ASi bus error[1)]	Communication via the AS-i interface is interrupted.[1)]
ASi parameterization error[1)]	An error occurred during parameterization for an existing communication connection.[1)]
ASi configuration error[1)]	The actual configuration of an existing communication connection does not match the target configuration. This resulted in an error.[1)]
SC bus error[2)]	Communication via the device bus interface is interrupted.[2)]
SC parameterization error[2)]	An error occurred during parameter assignment for an existing communication connection.[2)]
SC configuration error[2)]	The actual configuration of an existing communication connection does not match the target configuration. This resulted in an error.[2)]

1) 3RK3 Advanced and 3RK3 ASIsafe only

2) 3RK3 only

Group warning ⑤

The following group warnings can be diagnosed:

Message	Meaning
Disconnect	The monitoring time has been exceeded During monitoring time, the safety relay has not received any data set from the communication partner with write access to the safety relay.
Group warning from user program[1)]	At least one warning from the user program is present.
Configuration missing	No valid configuration is stored in the safety relay.

1) Pressing the right key (OK) switches the diagnostics display directly to the element in the status menu.

Group prewarning ⑥

The following group prewarnings can be diagnosed:

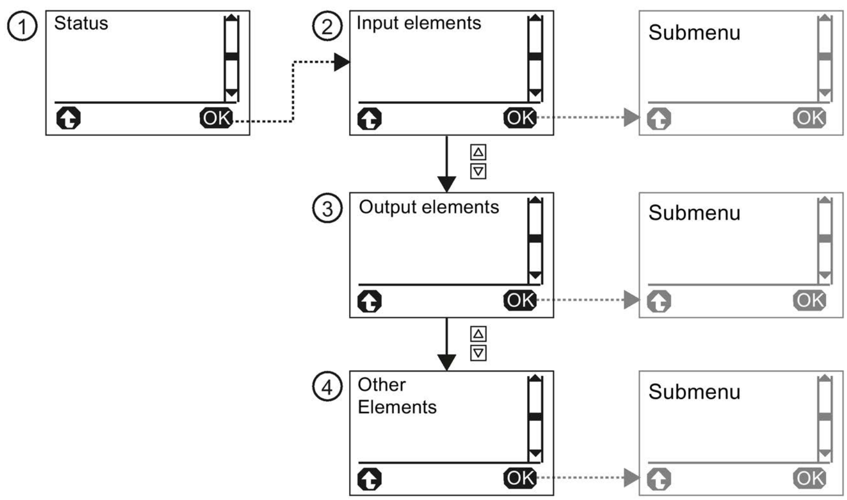
Message	Meaning
User program stopped.	The safety relay is not processing the safety circuit.
Group prewarning from user program [1)]	At least 1 configured function element has a group prewarning.

1) Pressing the right key (OK) switches the diagnostics display directly to the element in the status menu.

9.5.3.2 Status

Selection of the individual functions

The status display makes a distinction between input elements ②, output elements ③, and other elements ④.



Pressing of the softkeys

Pressing of the arrow keys

Figure 9-5 Second level of the menu of the diagnostics display - "Status" menu option

In the respective submenu, either

- all function elements,
- function elements with an error, or
- function elements without an error

can be displayed as a list.

To differentiate between identical function elements, the function elements are each displayed with their name, number, and element type in Safety ES. The name remains in the first line when navigating the submenu.

Status information and error acknowledgment

You can select the marked function element with the right key (OK) to display status information and any pending messages.

If several error messages are pending, you can scroll up and down to the individual information via the arrow keys. The error can be acknowledged with the right key (reset) after the cause of the error has been remedied.

Note

Here some of the information directly depends on the parameterized function element of the individual inputs and outputs, as well as the hardware configuration of the safety relay, and may vary.

WARNING
System Restart After Fault Acknowledgement/Restart **Can Cause Death, Serious Injury, or Property Damage.** When the power-on condition is fulfilled, the system immediately continues to operate with the values and outputs specified by control following fault acknowledgement/restart. Take appropriate measures (e.g. start button with monitored starting) to prevent unintentional restarting and to ensure a defined start of the system.

Possible status information

The following status information can be diagnosed:

- Substitute input value active
- At least one function output active
- Waiting for start signal
- Timer is active
- Waiting for startup test
- Logic error
- Wiring error
- Hardware fault
- Group error
- Group warning
- Group prewarning

Possible element messages

The following element messages can be diagnosed:

- Pushbutton stuck
- Do not release both pushbuttons
- Safety sensor triggered
- Protective door closed
- Lock engaged
- Lock released
- Start override active
- Protective door opened when interlock was active
- Interlock not possible because the protective door is open
- Muting operation active
- Muting operation not active
- Muting restart possible
- Restart signal duration invalid
- Protective field not free
- System not running
- Start muting condition not met
- Max. muting time exceeded
- Discrepancy condition sensor pair n violated
- Muting indicator light defective
- Output n active
- Invalid output selection
- Auxiliary control signal n active
- Reset active
- Startup test required
- Sequence condition not fulfilled
- Discrepancy condition violated
- Cross-circuit at input n/output n
- Start signal duration invalid
- Start condition not fulfilled
- Wire break at input n
- Synchronous operation time exceeded
- Enabling button OFF/ON
- Switchover time exceeded

- Invalid operating mode selection
- Incoming/outgoing alarm
- Counter limit value exceeded/undershot
- Last count pulse was up/down
- OFF delay active
- ON delay active
- Passing make pulse contact active
- Clock-pulse generator active
- Standby time is ON
- Control mode selection invalid
- Output n active
- Output n overloaded
- Output n defective
- Feedback circuit signal n and switching status do not match

9.5.3.3 System configuration

Structure of the menu

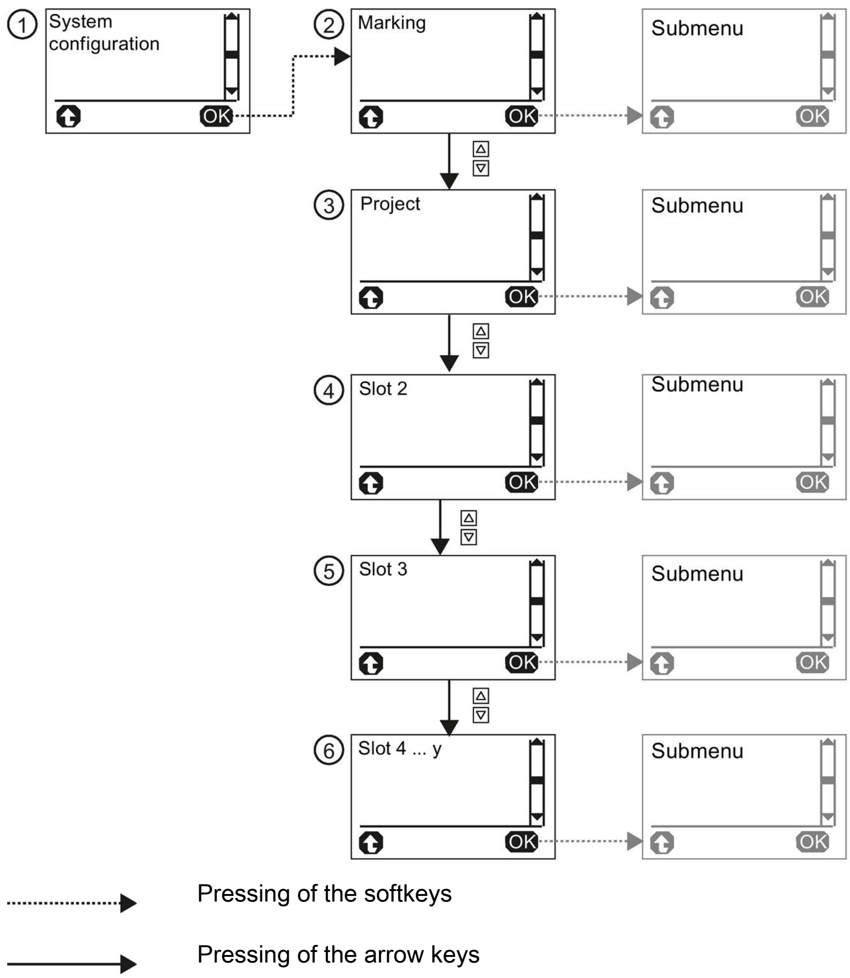


Figure 9-6 Second level of the menu of the diagnostics display - "System configuration" menu option

Information on the following topics is provided in the "System configuration" menu:

- Marking ②
- Project ③
- Slot 2 (DP interface if present) ④
- Slot 3 (safety relay) ⑤
- Slot 4 ... n (max. 12) ⑥

You can select the marked menu with the right key (OK), thereby displaying information.

With the left key, the display moves back one menu level.

Marking

The following plant information is available:

- Plant identifier
- Location identifier
- Installation date
- Description
- Author
- Comment

Project

The following project information is available:

- Project name
- Name of configuration engineer
- Company name
- Config CRC
- Time stamp
- Configuration released
- Cycle time
- Number of slot modules
- Number of elements

Slot 2 (DP interface)

The following information on the DP interface is available:

- Reference designation (BMK)
- Article number
- DP address
- Short designation
- HW revision level
- FW revision level
- Time stamp

Slot 3 (safety relay)

The following information is available about the safety relay:

- Reference designation (BMK)
- Article number
- Short designation
- HW revision level
- FW revision level
- Time stamp

Slot 4 ... n (3RK3 expansion modules)

Note

This information is only relevant in conjunction with an MSS 3RK3:

The following information is available on the 3RK3 expansion modules:

- Reference designation (BMK)
- Article number
- FW revision level

9.5.3.4 Display settings

All settings affecting the diagnostics display can be made via the display settings.

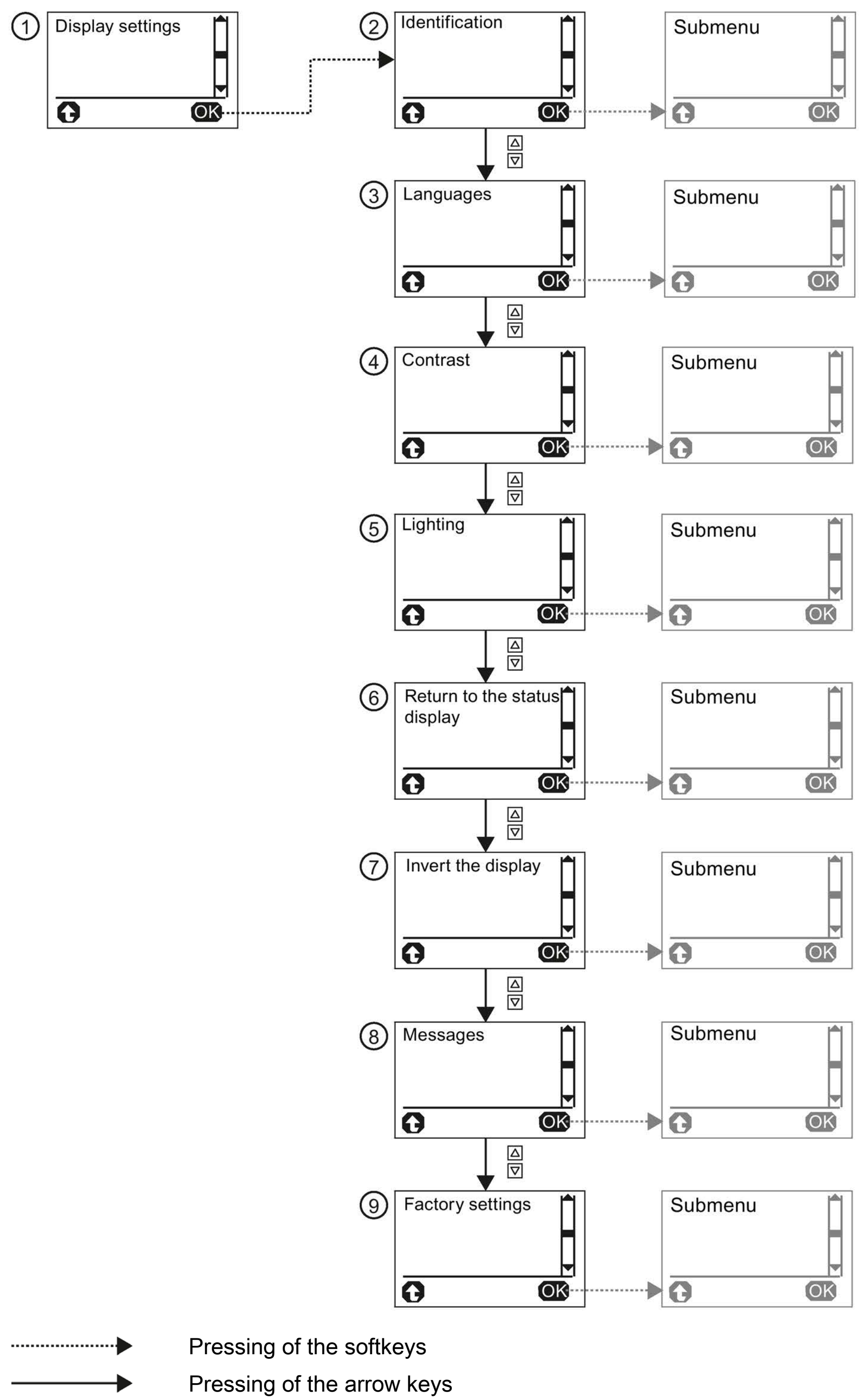


Figure 9-7 Second level of the menu of the diagnostics display - "Display settings" menu option

In this menu, you will also find information on the diagnostics display itself. The display settings can be reset to the factory settings under the "Factory settings" menu option.

You can access the individual submenus by pressing the right key (OK):

- Identification ②
- Languages ③
- Contrast ④
- Lighting ⑤
- Return to the status display ⑥
- Invert display ⑦
- Messages ⑧
- Factory settings ⑨

With the left key, the display moves back one menu level.

Identification ②

The following information for identifying the diagnostics display is to be found here:

- Article number of the diagnostics display
- Hardware version (HW revision level)
- Firmware version (FW revision level)

Languages ③

The following languages can be selected:

- English (default setting)
- German
- French
- Spanish
- Italian
- Portuguese

The desired language can be marked with the arrow keys. The right key (OK) selects the marked language.

Contrast ④

You can set the desired contrast of the display with the arrow keys and with the right key (OK).

- Setting range: 10% ... 90% (default setting: 50 %)
- Increment: 5 %

Lighting ⑤

This menu option specifies how long the backlit display will remain on after the last keystroke and enables permanent activation or deactivation of the backlit display.

The following settings are possible:

- Off
- 3 s
- 10 s (default setting)
- 1 min
- 5 min
- On

The desired setting can be marked with the arrow keys. The right key (OK) selects the marked setting.

Return to the status display ⑥

This menu option specifies whether and at what time to switch back to the status display from the current menu.

The following settings are possible:

- Manual
- 3 s
- 10 s (default setting)
- 1 min
- 5 min

The desired setting can be marked with the arrow keys. The right key (OK) selects the marked setting.

Invert display ⑦

This setting makes it possible to specify whether the display should be displayed normally or inverted. The readability of the display can be improved in the event of difficult lighting conditions.

The desired setting can be marked with the arrow keys. The right key (OK) selects the marked setting.

Messages ⑧

This setting makes it possible to specify whether to automatically switch to the "Messages" menu if messages are pending and to display the messages (default setting) or whether the status display should remain.

The desired setting can be marked with the arrow keys. The right key (OK) selects the marked setting.

Factory settings ⑨

The factory setting makes it possible to reset the display settings to the default settings.

The desired setting can be marked with the arrow keys. The right key (OK) selects the marked setting. A prompt for confirmation then follows that also has to be confirmed with the right key (OK).

9.6 Diagnostics using PROFIBUS

9.6.1 Using data sets

Note

Diagnostics block

A diagnostics block is available for diagnostics using PROFIBUS. You will find more information on the Internet under FAQs (https://support.industry.siemens.com/cs/ww/en/ps/16380/faq).

Required knowledge

This section is aimed at the following target groups:

- Planners
- PLC programmers

You need to have a sound knowledge of writing/reading data sets using PROFIBUS.

Data sets: overview

Module	Data set no.	Description	Read/write
3SK2 basic unit	0 / 1	System diagnostics	Read
DP interface			
3SK2 basic unit	92	Device diagnostics (faults, warnings, messages)	Read

Reading data sets

Accessing data sets via slot:

- Access to data set from DP interface via Slot_0
- Access to data set from the 3SK2 basic unit via slot_1

Reading data sets with STEP 7

You can access the data sets from the user program.

Reading data sets:

- S7-DPV1 master: by calling SFB 52 "RDREC" or SFC 59 "RD_REC
- S7 master: by calling SFC 59

Settings in STEP 7

Set the properties of the PROFIBUS subnet in STEP 7: The DP alarm mode must be set to DPV1 for operation downstream of a Y link. Individual PROFIBUS diagnostics can be deselected in the device-specific parameters. The length of the diagnostics frame must be adjusted accordingly. If all diagnostics are transmitted, the length of the diagnostics frame is 42 bytes. The diagnostics must only be deselected from bottom to top in the hierarchy. For example, it is not permissible to deselect on the module status; the channel-specific diagnostics must then also be deactivated.

The following table shows the length of the DP diagnosis to be set when deselecting diagnoses:

Diagnostic type	Activated	Deactivated	Length
ID-specific diagnosis	X	-	42
Module status	X	-	
Channel-specific diagnosis	X	-	
ID-specific diagnosis	X	-	24
Module status	X	-	
Channel-specific diagnosis	-	X	
ID-specific diagnosis	X	-	12
Module status	-	X	
Channel-specific diagnosis	-	X	
ID-specific diagnosis	-	X	6
Module status	-	X	
Channel-specific diagnosis	-	X	

Byte arrangements

When data longer than one byte is stored, the bytes are arranged as follows ("big endian"):

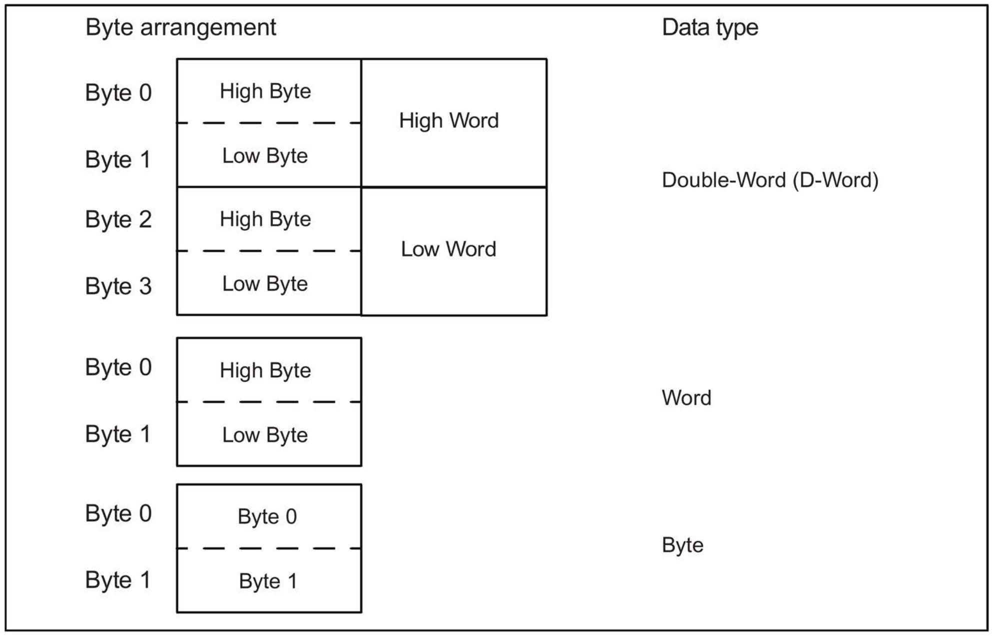


Figure 9-8 Byte arrangement

Additional information

You will find more information about the SFCs and SFBs

- Reference manual "System Software for S7-300/400, System and Standard Functions"
- In the STEP7 online help

9.6.2 Structure of the diagnostics frame

Diagnostics concept via PROFIBUS

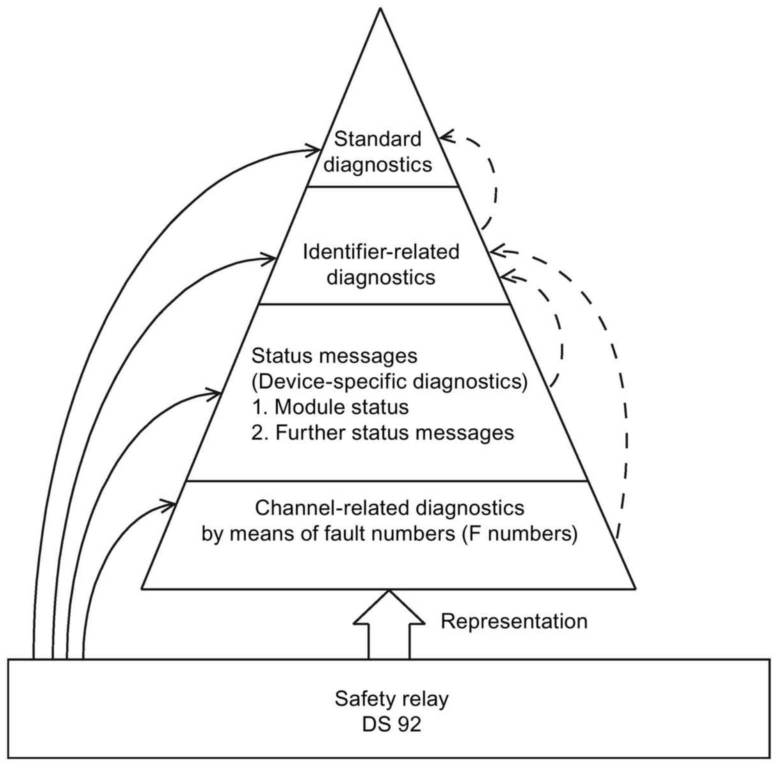


Figure 9-9 Diagnostics pyramid

Byte	Length	Diagnostics block
0 ... 5	6 bytes	Standard diagnostics DPV0 standard
6 ... 11	6 bytes	ID-related diagnosis
12 ... 23	12 bytes	Status messages Device-related diagnostics
24...x (max. 41)	0 ... 18 bytes	Channel-related diagnostics (max. 6 channels of 3 bytes each) Error numbers

Channel-related diagnostics

Channel-related diagnostics contains the error number from DS92. Up to six errors can be transferred simultaneously. The safety relay uses the following error numbers:

DP error numbers			
Error no.	**Description**	**Explanation**	**Remedy**
7	Upper limit exceeded	Memory module too small	Reduce configuring
8	Lower limit undershot	• Max. number of elements exceeded • Max. size of memory exceeded • Program cycle time exceeded	Adapt configuring
9	Error	• Output wiring error • Device error • Self-test error	The device self-test has detected an error Check external wiring of the application. If the self-test error persists, replace the device.
16	Parameterization error	Configuring error: • Release denied due to incorrect configuration CRC • Release canceled due to incorrect configuration release CRC • Invalid parameter value • Interconnection rule violated • Data structure incorrect	• Correct configuring
19	Communication error	Bus error: • Error on PROFIBUS • Error on the system interface	• Checking the bus system • Check device configuration
23	Actuator warning	Group prewarning from the user program	Eliminate cause of warning and acknowledge

DP error numbers			
Error no.	**Description**	**Explanation**	**Remedy**
24	Actuator disconnection	Group error: • Error in configuration • Configuring error • Protocol error on a bus • Handshake error • Group error from user program • Wiring error • Logic error • Release denied due to incorrect configuration CRC • Release canceled due to incorrect configuration release CRC • Max. number of elements exceeded • Max. size of memory exceeded • Program cycle time exceeded • TARGET≠ACTUAL configuration • TARGET≠ACTUAL slot expanded configuration • Invalid parameter value • Interconnection rule violated • Data structure incorrect • Memory module not plugged in • Memory module defective • Programming error • Memory module too small • Self-test error (device error) • System interface configuration error	Eliminate cause of error and acknowledge
25	Safety-related shutdown	Logic error (user program)	Eliminate cause of message

DP error numbers			
Error no.	**Description**	**Explanation**	**Remedy**
26	External error	• Wiring error (user program) • Memory module not plugged in (3SK2 45 mm)	• Eliminate cause of message • Insert the memory module
27	Unclear error	Unclear errors include errors that have no equivalent in the other error numbers. • Error in configuration • Safety protocol error • Handshake error • TARGET≠ACTUAL configuration • TARGET≠ACTUAL slot expanded configuration • Memory module defective • Programming error • System interface configuration error	Eliminate cause of error

9.6.3 Data set 0

9.6.3.1 General data set 0

This DS is available for both the 3SK2 safety relay and the DP interface. DS0 in the 3SK2 safety relay can be queried via DP slot number 1 on the PROFIBUS slot model, and DS0 in the DP interface can be queried via DP slot number 0.

9.6.3.2 Data set 0 in the 3SK2 safety relay

The content of DS0 for the 3SK2 safety relay is described below:

Byte	Meaning	Note
0^0	Module fault	SF (group error) on the 3SK2 safety relay
0^1	Internal error	Device fault on the 3SK2 safety relay
0^2	External error	Logic or wiring error
0^3 ... 0^5	Reserved=0	
0^6	Module not parameterized	No configuration saved in device
0^7	Incorrect parameters in device	Incorrect configuration saved in device
1^0 ... 1^3	Type class	0000 CPU
1^4	Channel information available	DS1 exists
1^5	User information available	Always 1, because diagnostics information is available via DS92
1^6	Diagnostic interrupt from substitute	Not set by 3SK2 safety relay.
1^7	Reserved=0	
2^0	No user module / user module incorrect	Error in configuration: TARGET ≠ ACTUAL
2^1	Communication fault	Bus error or safety protocol error
2^2	[0]: RUN mode [1]: STOP mode	RUN: Safety / test mode STOP: Configuration mode
2^3	Time monitoring	Program cycle time exceeded
2^4 ... 2^7	Reserved=0	
3^0	Rack failure	System interface failed
3^1	Reserved=0	
3^2	Memory module error	Error in external memory module
3^3 ... 3^7	Reserved=0	

9.6.3.3 Data set 0 in DP interface

The content of DS0 for DP interface is described below:

Byte	Meaning	Note
0^0	Module fault	SF on the DP interface
0^1	Internal error	e.g. error mode, int. EEP
0^2 ... 0^7	Reserved=0	
1^0... 1^3	Type class	0011 DP slave
1^4	Reserved=0	
1^5	User information available	Always 1, because there is no diagnostics information available via DS92
1^6 ... 2^0	Reserved=0	
2^1	Communication fault	DeviceConnect failed
2^2	[0]: RUN mode [1]: STOP mode	RUN: Process data exchange with master
2^3 ... 2^7	Reserved=0	
3^0	Rack failure	DeviceConnect failed
3^1 ... 3^7	Reserved=0	

9.6.4 Data set 1

9.6.4.1 Data set 1 in the 3SK2 safety relay

The content of DS1 for the 3SK2 safety relay is described below:

Byte	Meaning
Diagnostics data part 1	
0^0 ... 3^7	Same as DS0
Diagnostics data part 2	
4^0 ... 4^7	$7D_H$ channel type
5^0 ... 5^7	20_H number of diagnostics bits per channel
6^0 ... 6^7	01_H number of channels (1 channel)
7^0	[1] (channel 0) module faulty (error present) [0] module OK
7^1 ... 8^6	Reserved=0
8^7	Upper limit exceeded (memory module too small)
9^0	Lower limit exceeded (no. of elements / memory exceeded)
9^1	Error (device error present)
9^2 ... 9^7	Reserved=0
10^0	Parameterization error
10^1 ... 10^6	Reserved=0
10^7	Actuator alarm (e.g. group warning)
11^0	Actuator shutdown (e.g. group error)
11^1	Safety-related shutdown (e.g. logic error)
11^2	External fault (e.g. memory module not connected)
11^3	Unclear error (e.g. configuration error)
11^4	Reserved=0
11^5	Wiring error
11^6	Logic error
11^7	Configuring / test mode active
12^0 ... 15^7	Reserved=0

9.6.4.2 Data set 1 in DP interface

The content of DS1 for DP interface contains the same information as DS0 because certain CPUs first request DS1 for diagnostic purposes. If DS1 is rejected by DP interface, the CPU does not request any further diagnoses. Diagnostics bits that are not within the scope of DS0 always remain set to 0.

Byte	Meaning
Diagnostics data part 1	
0^0 ... 3^7	Same as DS0
4^0 ... 4^7	$7D_H$ channel type
5^0 ... 5^7	20_H number of diagnostics bits per channel
6^0 ... 6^7	01_H number of channels (1 channel)
7^0	[1] (channel 0) module faulty (error present) [0] module OK
7^1 ... 11^2	Reserved=0
11^2	Unclear error (e.g. configuration error)
11^4 ... 15^7	Reserved=0

9.6.5 Data set 92

All device-specific messages and information about the individual device function statuses are collected centrally and stored in the message memory of the 3SK2 safety relay. The message memory can be read via DS92. The current device status is stored as of byte 12.

The content of DS92 is described below:

DS92 (device messages)				
Byte	**Meaning**	**Note**	**Error category**	**DP error number**
Header				
0 … 11	Reserved = 0			
Device status				
12^0	Device error (**GF**)	at least one device error has been detected	-	F24, F9
12^1	Group error (**SF**)	at least 1 group error pending.	-	F24
12^2	Bus error (**BF**)	at least 1 bus error pending.	-	F19
12^3	Group warning (**SW**)	at least 1 warning pending.	-	F23
12^4	Group prewarning (**SVW**)	at least 1 group prewarning pending.	-	F23
12^5 ... 13^0	Reserved = 0			
13^1	Configuration error (**KF**)	Memory module not detected; change to configuring mode.	SF*	F24, F27*
13^2	Configuring error (**PF**)	The configuring contains at least 1 error.	SF	F24, F16
13^3	Reserved = 0			
13^4	Wiring error (**VF**)	A wiring error is present.	SF, SF.A	F24, F26
13^5	Logic error (**LF**)	A logic error is pending (e.g., discrepancy or sequence violation).	SF, SF.A	F24, F25
13^6 ... 13^7	Reserved = 0			
14^0	Configuring mode active	Device is in configuring mode.	SE	-
14^1	Test mode active	Device is in test mode.	SE	-
14^2	Safety mode active	Device is in safety mode.	-	-
14^3	User program is active	Device is in test or safety mode. The safety program is executed.	-	-
14^4	User program stopped.	The safety program is executed.	SVW	F23
14^5 ... 14^6	Reserved = 0			
14^7	Operating mode change rejected	The operating status could not be changed.	-	-
15^0	Access path closed	An access path in the device is not open.	-	-
15^1	Access path to fieldbus control is open	Access path via the fieldbus interface is open.	-	-
15^2	Reserved = 0			

DS92 (device messages)				
Byte	**Meaning**	**Note**	**Error category**	**DP error number**
15^3	Access path fieldbus ES tool is open	Access path through the ES tool is open.	-	-
15^4	Reserved = 0			
15^5	Access path to device interface is open	Access path through the device interface is open.	-	-
15^6 ... 15^7	Reserved = 0			
16^0	Disconnect	Access monitoring has detected a communication break.	SW	F23
16^1	Handshake error (**HF**)	Connection monitoring has detected an error.	SF	F24, F27
16^2 ... 16^7	Reserved = 0			
17^0	Device access authorization exists	An access path with a valid password has been opened.	-	-
17^1 ... 17^3	Reserved = 0			
17^4	Password protection for device access is inactive	Password protection for device access is inactive.	-	-
17^5 ... 17^6	Reserved = 0			
17^7	Incorrect password entry	The wrong password was entered	-	-
18^0	Group error from user program (**SF.A**)	At least 1 configured function element has a wiring or logic error.	SF	F24
18^1	Group warning from user program (**SW.A**)	At least 1 configured function element has a group warning.	SW	F23
18^2	Group prewarning from user program (**SVW.A**)	At least 1 configured function element has a group warning.	SVW	F23
18^3 ... 19^7	Reserved = 0			
Configuration status:				
20^0 ... 20^7	Reserved = 0			
21^0	Configuration missing	The system does not contain a valid configuration.	SW	F23
21^1	Configuration not released	The configuration has not been released or the release has been canceled.	-	-
21^2	Configuration released	The configuration has been released.	-	-
21^3	Reserved = 0			
21^4	Release denied due to incorrect configuration CRC	Incorrect configuring CRC, or other incorrect entries, e.g., no time stamp, name or description of company	SF, PF	F24, F16

DS92 (device messages)				
Byte	Meaning	Note	Error category	DP error number
21^5	Release denied, already released	The configuration cannot be released because it has already been released.	-	-
21^6	Release canceled	The release of a configuration has been canceled.	-	-
21^7	Release canceled due to incorrect configuration release CRC	The configuration release has been canceled because the configuration contains errors.	SF, PF	F24, F16
22^0	Reserved = 0			
22^1	Max. size of memory exceeded	The maximum size of the system memory has been exceeded.	SF, PF	F24, F16
22^2	Program cycle time exceeded	The set cycle time has been exceeded.	SF, PF	F24, F16
22^3	Reserved = 0			
22^4	TARGET = ACTUAL configuration	The expanded system configuration matches the target configuration	-	-
22^5	TARGET ≠ ACTUA L configuration (**KF.SI**)	The expanded system configuration does not match the target configuration (e.g., modules swapped)	SF, KF*	F24, F27*
22^6	TARGET≠ACTUAL slot expanded configuration	The expanded system configuration does not match the target configuration (e.g., different number of modules)	SF, PF,KF.SI*	F24, F27*
22^7 ... 23^0	Reserved = 0			
23^1	Invalid parameter value	A parameter in the configuration contains an invalid value.	SF, PF	F24, F16
23^2	Reserved = 0			
23^3	Interconnection rule violated	At least 1 interconnection rule is violated.	SF, PF	F24, F16
23^4	Data structure incorrect	Data has errors, e.g., data structure header or element data block header or element CRC non-matching.	SF, PF	F24, F16
23^5	Factory settings restored	The device contains the factory settings.	-	-
23^6 ... 23^7	Reserved = 0			
24 ... 25	Reserved = 0			
26^0	Memory module not plugged in	A memory module has not been plugged in.	SF, KF	F24, F27
26^1	Memory module defective	The memory module is defective.	SF, KF	F24, F27
26^2	Reserved = 0			

DS92 (device messages)				
Byte	**Meaning**	**Note**	**Error category**	**DP error number**
26^3	Memory module programming successful	The configuration data was successfully saved in the memory module.	-	-
26^4	Programming error	The configuration data could not be saved in the memory module.	SF, KF	F24, F27
26^5	User memory too small	The configuration data do not fit into the configuration memory or onto the memory module.	SF, KF	F24, F27
26^6	Memory module incorrectly organized	Memory module not properly organized	SF, KF	F24, F27
26^7	Memory module deleted	The configuring data has been deleted.	-	-
27^0	Reset implemented	Reset implemented.	-	-
27^1	Reset was not possible	Reset was not possible	-	-
27^2 ... 29^3	Reserved = 0			
29^4	Self-test active	The system is executing a self-test.	-	-
29^5	Self-test OK	The self-test was successful.	-	-
29^6	Self-test error (device error)	A self-test error occurred.	SF, GF	F24, F9
29^7 ... 33	Reserved = 0			
34 ... 35	Incorrect element number	Element number of the first element found in the configuration whose parameters were not accepted by the device: • [0]: no incorrect element exists • [1..32767]: (unsigned int) element no.	-	-
DP fieldbus interface:				
36^0	CPU/master STOP	The DP master is in the STOP state.	-	-
36^1	DP bus error	PROFIBUS error, connection interrupted	BF	F19
36^2	DP parameterization error	Erroneous or incorrect parameterization frame	BF	F19
36^3	DP configuration error	Erroneous or incorrect configuration frame	BF	F19
36^4	DP process data exchange stopped	Process data exchange with DP master stopped.	-	-
36^5	DP communication OK	DP communication OK	-	-
36^6 ... 37^7	Reserved = 0			
38 ... 89	Reserved = 0			

DS92 (device messages)				
Byte	**Meaning**	**Note**	**Error category**	**DP error number**
Diagnosed elements				
90 ... 91	Element number for group error from user program	Element number of the first detected element of the processing sequence for which a group error is pending: • [0]: No error • [1 ... 32.767]: Element no.	-	-
92 ... 93	Element number for group warning from user program	Element number of the first detected element of the processing sequence for which a group error is present: • [0]: No error • [1 ... 32.767]: Element no.	-	-
94 ... 95	Element number for group prewarning from user program	Element number of the first detected element of the processing sequence for which a group error is present: • [0]: No error • [1 ... 32.767]: Element no.	-	-
96 ... 99	Reserved = 0			
100^{0}	Logbook 1 deleted	Logbook 1 (operator errors / device) is empty.	-	-
100^{1}	Logbook 2 deleted	Logbook 2 (operator errors / device) is empty.	-	-
100^{2}	Logbook 3 deleted	Logbook 3 (operator errors / device) is empty.	-	-
100^{3}	Logbook 4 deleted	Logbook 4 (operator errors / device) is empty.	-	-
100^{4}	Logbook 5 deleted	Logbook 5 (operator errors / device) is empty.	-	-
100^{5}	Logbook 6 deleted	Logbook 6 (operator errors / device) is empty.	-	-
100^{6}	Logbook 7 deleted	Logbook 7 (operator errors / device) is empty.	-	-
100^{7}	Logbook 8 deleted	Logbook 8 (operator errors / device) is empty.	-	-
101^{0}	Logbook 9 deleted	Logbook 9 (operator errors / device) is empty.	-	-
101^{1}	Logbook 10 deleted	Logbook 10 (operator errors / device) is empty.	-	-
101^{2}	Logbook 11 deleted	Logbook 11 (operator errors / device) is empty.	-	-
101^{3}	Logbook 12 deleted	Logbook 12 (operator errors / device) is empty.	-	-

DS92 (device messages)				
Byte	**Meaning**	**Note**	**Error category**	**DP error number**
101^4	Logbook 13 deleted	Logbook 13 (operator errors / device) is empty.	-	-
101^5	Logbook 14 deleted	Logbook 14 (operator errors / device) is empty.	-	-
101^6	Logbook 15 deleted	Logbook 15 (operator errors / device) is empty.	-	-
101^7 ... 199	Reserved = 0			

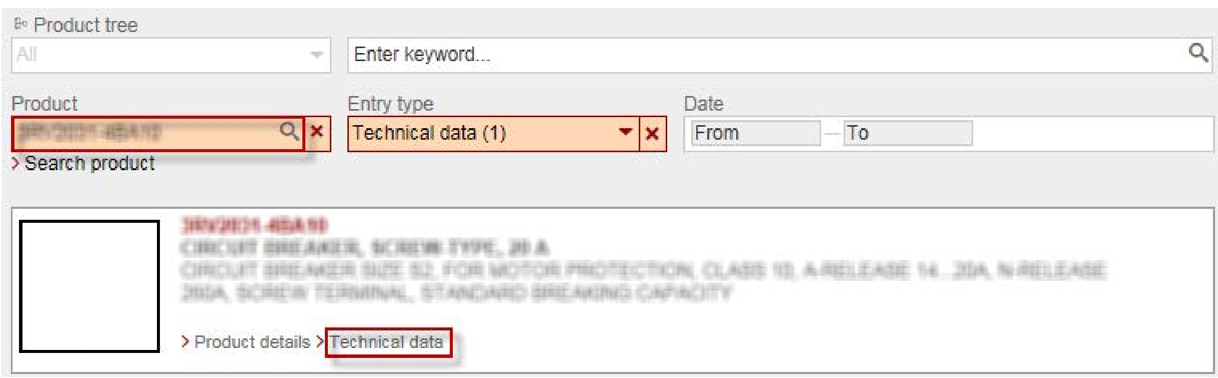
* Message results in a group error depending on the parameterization

10 Technical data

10.1 Data sheet

You can find all the technical data of the product in the Siemens Industry Online Support (https://support.industry.siemens.com/cs/ww/en/ps/).

1. Enter the full article number of the desired device in the "Product" field, and confirm with the Enter key.
2. Click the "Technical data link.



10.2 3SK2 safety relays

Key statement

Order number		3SK2112-1AA10	3SK2122-1AA10	3SK2112-2AA10	3SK2122-2AA10
product brand name		SIRIUS			
Product designation		3SK2 safety relay			
General technical data:					
Product function					
• EMERGENCY STOP function		Yes			
• protective door monitoring		Yes			
• protective door monitoring with tumbler		Yes			
• muting, 2 sensor-parallel		Yes			
• muting, 4 sensor-parallel		Yes			
• muting, 4 sensor-sequential		Yes			
• Monitoring parameterizable		Yes			
• evaluation: electro-sensitive protective equipment		Yes			
• evaluation: selector switch		Yes			
• Pressure-sensitive mat monitoring		Yes			
• evaluation: two-hand operator panel		Yes			
• evaluation: enabling switch		Yes			
• monitored start-up		Yes			
• two-hand control acc. to EN 574		Yes			
Number of function blocks / typical		50			
Insulation voltage / Rated value	V	50			
Consumed current / for rated value of supply voltage					
• without semiconductor output	mA	100	185	100	185
Degree of pollution		3			
Shock resistance		15g / 11 ms			
Vibration resistance / acc. to IEC 60068-2-6		5 ... 500 Hz: 0,75 mm			

Order number		3SK2112-1AA10	3SK2122-1AA10	3SK2112-2AA10	3SK2122-2AA10
Surge voltage resistance / Rated value	V	800			
Switching capacity current / Rated value	A	4			
Switching capacity current / of semiconductor outputs / at DC-13 / at 24 V	A	4			
Relative setting accuracy / of the setting times	%	1			
Protection class IP		IP20			
• of the enclosure		IP20			
• of the terminal		IP20			
Equipment marking					
• acc. to DIN EN 61346-2		K			
• acc. to DIN EN 81346-2		F			
Readback time / maximum	ms	400			
Light test period	ms	3			
Product function / suitable for AS-i Power24V		No			
Product function / Diagnostics with CTT2 slave		No			
Suitability for use					
• Monitoring of floating sensors		Yes			
• Monitoring of non-floating sensors		Yes			
• position switch monitoring		Yes			
• EMERGENCY-OFF circuit monitoring		Yes			
• valve monitoring		Yes			
• opto-electronic protection device monitoring		Yes			
• magnetically operated switch monitoring		Yes			
• proximity switch monitoring		Yes			
• safety-related circuits		Yes			
Suitability for use / for monitoring of optoelectronic protective devices / acc. to IEC 61496-1		Yes			
Operating power / Rated value	W	2.5	4.5	2.5	4.5

Order number		3SK2112-1AA10	3SK2122-1AA10	3SK2112-2AA10	3SK2122-2AA10
Communication/ Protocol:					
Protocol					
• optional / is supported / PROFIBUS DP protocol		Yes			
– Note		when using the DP interface module; 64 bit cyclical data			
• is supported / PROFINET IO protocol		No			
Protocol / is supported / AS-interface protocol		No			
Amount of data / of the cyclic user data					
• for inputs / with PROFIBUS DP	bit	64			
• for outputs / with PROFIBUS DP	bit	64			
Control circuit/ Control:					
Type of voltage		DC			
Type of voltage / of the control supply voltage		DC			
Control supply voltage / Rated value	V	24			
Control supply voltage / 1 / for DC / Rated value	V	24			
Operating range factor control supply voltage rated value / for DC		0.85 ... 1.2			
Inputs/ Outputs:					
Product function					
• Parameterizable inputs		Yes			
• Parameterizable outputs		Yes			
• at the digital outputs / Short-circuit protection		Yes			
Number of inputs					
• safety-related		10	20	10	20
• non-safety-related		0			
Input delay time	ms	0 ... 150			
Type of digital inputs / acc. to IEC 60947-1		Type 1			
Input recording time / at digital input / maximum	ms	60			

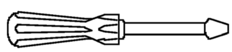
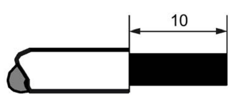
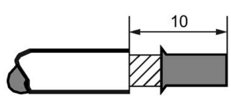
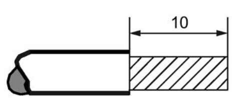
Order number		3SK2112-1AA10	3SK2122-1AA10	3SK2112-2AA10	3SK2122-2AA10
Number of outputs					
• safety-related / 2-channel		2	4	2	4
• for testing contact-based sensors		2	4	2	4
Number of outputs / as contact-affected switching element / safety-related					
• 1-channel		0			
• 2-channel		0			
Number of outputs / as contact-less semiconductor switching element					
• safety-related / 2-channel		2	4	2	4
Design of the contactless switching element / safety-related		P potential			
Recovery time / of the safe outputs	ms	0			
Input voltage / at digital input					
• for DC / Rated value	V	24			
• with signal <0> / for DC	V	-3 ... +5			
• for signal <1> / for DC		15 ... 30			
Input current / at digital input					
• for signal <1> / typical	mA	2.6			
Residual current					
• maximum	mA	0.05			
• at digital output / with signal <0> / maximum	mA	0.1			
Total current / maximum	A	6.5	7	6.5	7
Voltage drop / maximum	V	0.5			
Output current / at digital output / for signal <1> / Rated value	A	4			
Cable length / of the signal cable / to the outputs					
• shielded / maximum	m	1 000			
• unshielded / maximum	m	600			
Installation/ mounting/ dimensions:					
mounting position		any			
Mounting type		Snap-mounted to DIN rail or screw-mounted with additional push-in lug			
Height	mm	100			
Width	mm	22.5	45	22.5	45
Depth	mm	124.5			

Order number		3SK2112-1AA10	3SK2122-1AA10	3SK2112-2AA10	3SK2122-2AA10
Connections/ Terminals:					
Product function					
• removable terminal		Yes			
• removable terminal for control circuit		Yes			
• removable terminal for auxiliary and control circuit		Yes			
Type of electrical connection					
• for auxiliary and control current circuit		screw-type terminals		spring-loaded terminals	
Type of connectable conductor cross-section					
• solid		1x (0.5 ... 2.5 mm²), 2x (1.0 ... 1.5 mm²)		1x (0.5 ... 1.5 mm²), 2x (0.5 ... 1.5 mm²)	
• finely stranded / with core end processing		1x (0.5 ... 2.5 mm²), 2x (0.5 ... 1.0 mm²)		1x (0.5 ... 1.0 mm²), 2x (0.5 ... 1.0 mm²)	
• for AWG conductors					
– solid		1x (20 ... 14), 2x (18 ... 16)		1x (20 ... 16), 2x (20 ... 16)	
– stranded		1x (20 ... 14), 2x (18 ... 16)		1x (20 ... 16), 2x (20 ... 16)	
Connectable conductor cross-section / finely stranded / with core end processing	mm²	0.5 ... 2.5		0.5 ... 1	
AWG number / as coded connectable conductor cross section / solid		20 ... 14		20 ... 16	
AWG number / as coded connectable conductor cross section / stranded		20 ... 14		20 ... 16	
Safety related data:					
Safety Integrity Level (SIL) / acc. to IEC 61508		SIL3			
SIL Claim Limit (subsystem) / acc. to EN 62061		3			
Performance level (PL) / acc. to EN ISO 13849-1		e			
Stop category / acc. to DIN EN 60204-1		0 / 1			
Safe failure fraction (SFF)	%	99			
Average diagnostic coverage level (DCavg)	%	99			
Diagnostics test interval / by internal test function / maximum	ms	1 000 000			

Order number		3SK2112-1AA10	3SK2122-1AA10	3SK2112-2AA10	3SK2122-2AA10
Failure rate [FIT]					
• at rate of recognizable hazardous failures (λdd)	1/s	1 000	1 200	1 000	1 200
• at rate of non-recognizable hazardous failures (λdu)	1/s	10	13	10	13
PFHD / with high demand rate / acc. to EN 62061	1/h	0.00000001	0.000000012	0.00000001	0.000000012
PFDavg / with low demand rate / acc. to IEC 61508		0.000015	0.000018	0.000015	0.000018
MTBF	y	110	90	110	90
Hardware fault tolerance / acc. to IEC 61508		1			
T1 value / for proof test interval or service life / acc. to IEC 61508	y	20			
Protection against electrical shock		finger-safe			
Category / acc. to EN ISO 13849-1		4			
Electromagnetic compatibility:					
EMC emitted interference / acc. to IEC 60947-1		class A			
Conducted interference / due to burst / acc. to IEC 61000-4-4		2 kV (power ports) / 1 kV (signal ports)			
Field-bound parasitic coupling / acc. to IEC 61000-4-3		10 V/m			
Electrostatic discharge / acc. to IEC 61000-4-2		4 kV contact discharge / 8 kV air discharge			
Ambient conditions:					
Installation altitude / at height above sea level / maximum	m	2 000			
Ambient temperature					
• during operation	°C	-25 ... +60			
• during storage	°C	-40 ... +80			
• during transport	°C	-40 ... +80			
Relative humidity / during operation	%	10 ... 95			
Air pressure / acc. to SN 31205	kPa	90 ... 106			

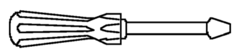
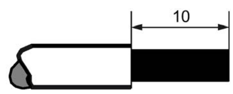
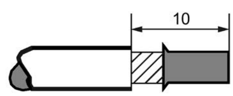
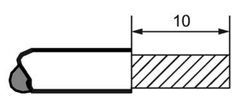
10.3 Connection cross-sections

10.3.1 3SK2 safety relays

	Specification and value in the case of removable terminals with screw-type terminals	**Specification and value in the case of removable terminals with spring-loaded terminals**
Screwdriver 	Cross-tip screwdriver Size: PZ 1 (⌀ 4.5 mm) Torque: 0.6 ... 0.8 Nm	Flat head screwdriver DIN 5264 (0.5 x 3 mm) for raising the terminal springs
Rigid cable 	Maximum number of cables x cable cross-section: 1 x 0.5 … 2.5 mm^2 or 2 x 1.0 … 1.5 mm^2	Maximum number of cables x cable cross-section: 1 x 0.5 … 1.5 mm^2 or 2 x 0.5 ... 1.5 mm^2
Flexible cable with end sleeve/cable lug 	Maximum number of cables x cable cross-section: 1 x 0.5 … 2.5 mm^2 or 2 x 0.5 … 1.0 mm^2	Maximum number of cables x cable cross-section: 1 x 0.5 ... 1.0 mm^2 or 2 x 0.5 … 1.0 mm^2
Flexible cable 	Not allowed	Maximum number of cables x cable cross-section: 1 x 0.5 … 1.5 mm^2 or 2 x 0.5 … 1.5 mm^2
AWG	20 ... 14 18 ... 16	20 ... 16 20 ... 16

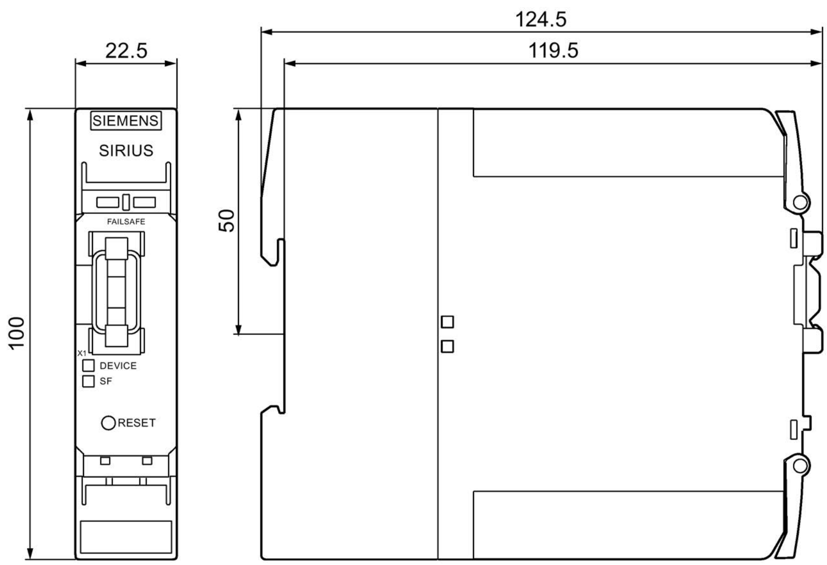
10.3.2 3RK35 DP interface

The following connection data apply dependent on the removable terminal block:

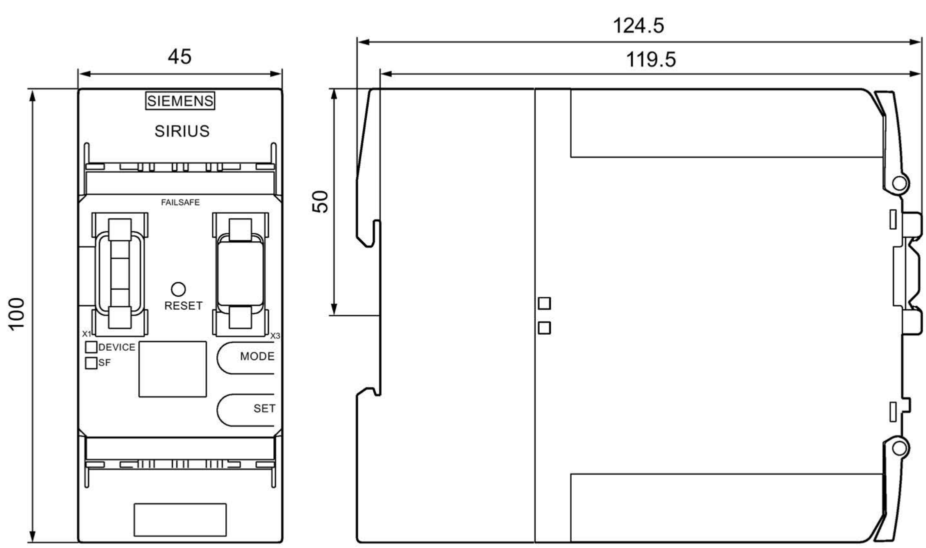
	Specification and value in the case of removable terminal blocks with screw-type terminals	**Specification and value in the case of removable terminal blocks with spring-loaded terminals**
Screwdriver 	Cross-tip screwdriver Size: PZ 2 (⌀ 5 … 6 mm) Torque: 0.8 … 1.2 Nm	Screwdriver Size: 0 or 1 (width to 3 mm) for raising the terminal springs
Rigid cable 	Maximum number of cables x cable cross-section: 1 x 0.5 … 4.0 mm² or 2 x 0.5 … 2.5 mm²	Maximum number of cables x cable cross-section: 2 x 0.25 … 1.5 mm²
Flexible cable with end sleeve/cable lug 	Maximum number of cables x cable cross-section: 1 x 0.5 … 2.5 mm² or 2 x 0.5 … 1.5 mm²	Maximum number of cables x cable cross-section: 2 x 0.25 … 1.5 mm²
Flexible cable 	Not allowed	Maximum number of cables x cable cross-section: 2 x 0.25 … 1.5 mm²

11 Dimension drawings

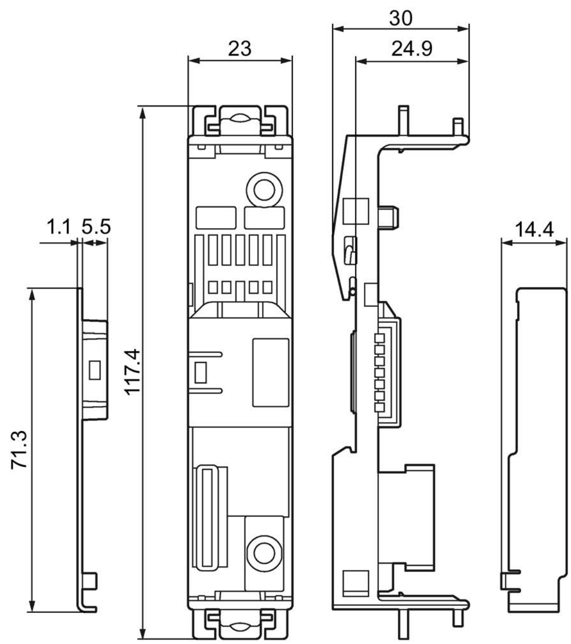
Dimension drawing 3SK2 safety relay (width 22.5 mm)



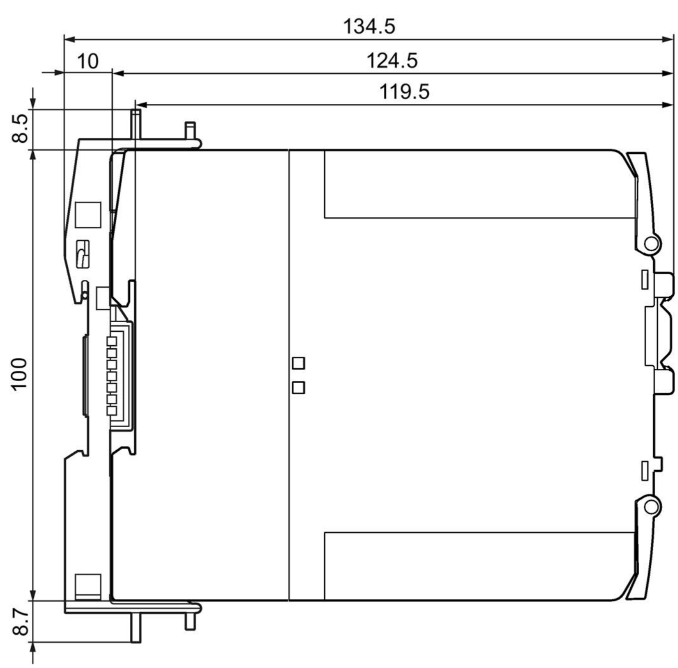
Dimension drawing 3SK2 safety relay (width 45 mm)



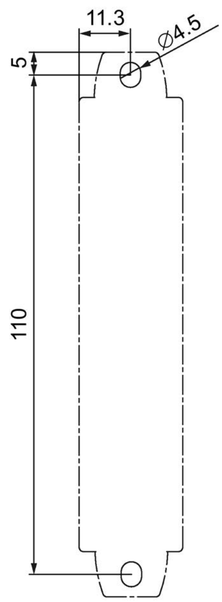
Dimension drawing of 3ZY12 device connector including cover



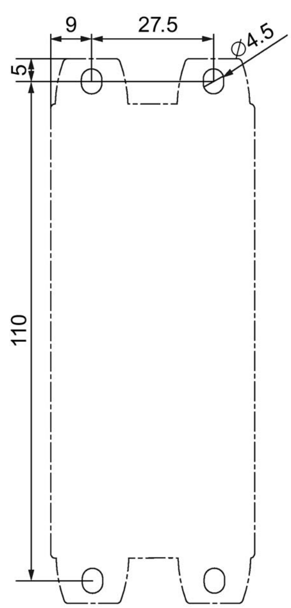
Dimension drawing 3SK2 safety relay mounted on 3ZY12 device connectors



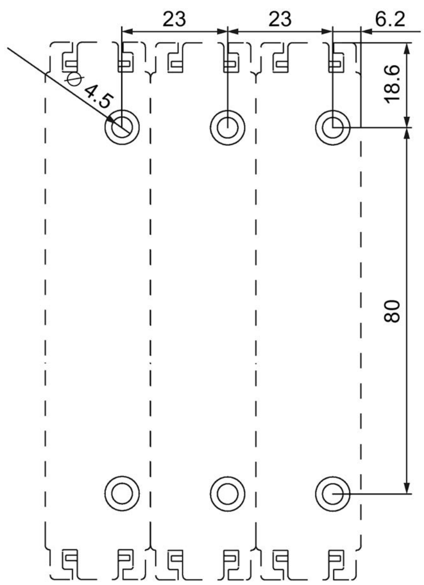
Drilling plan 3SK2 safety relay (width 22.5 mm)



Drilling plan 3SK2 safety relay (width 45 mm)

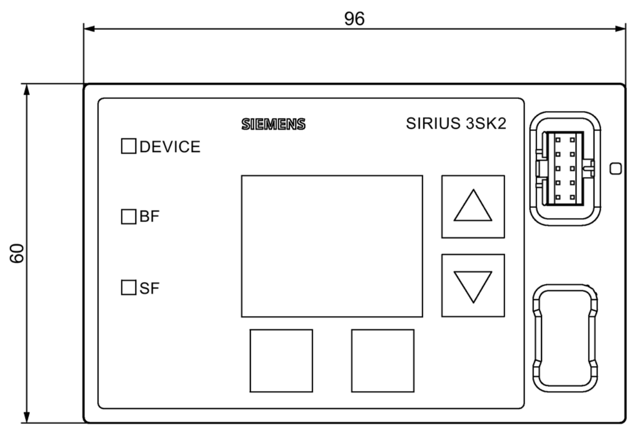


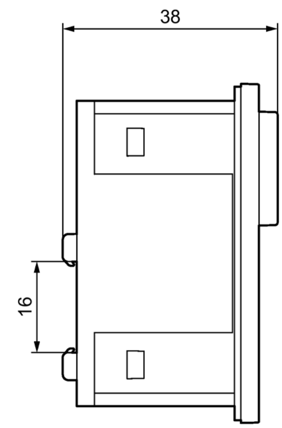
3ZY12 device connector drilling plan



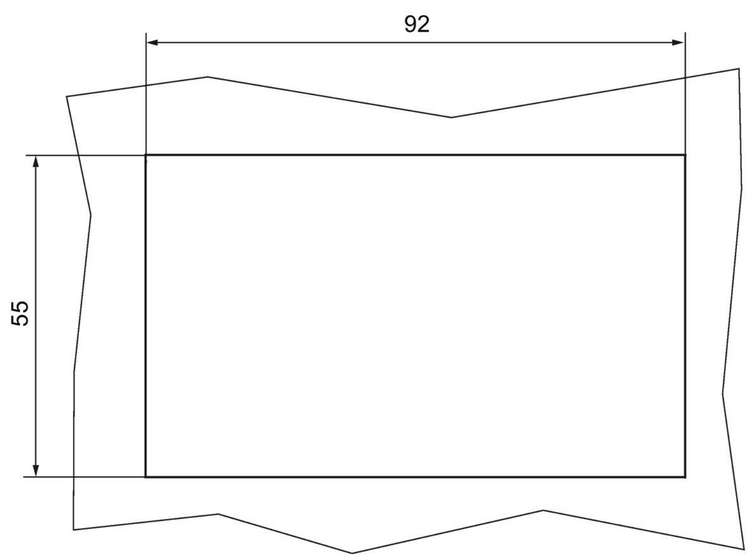
11.1 Diagnostics display

Diagnostics display



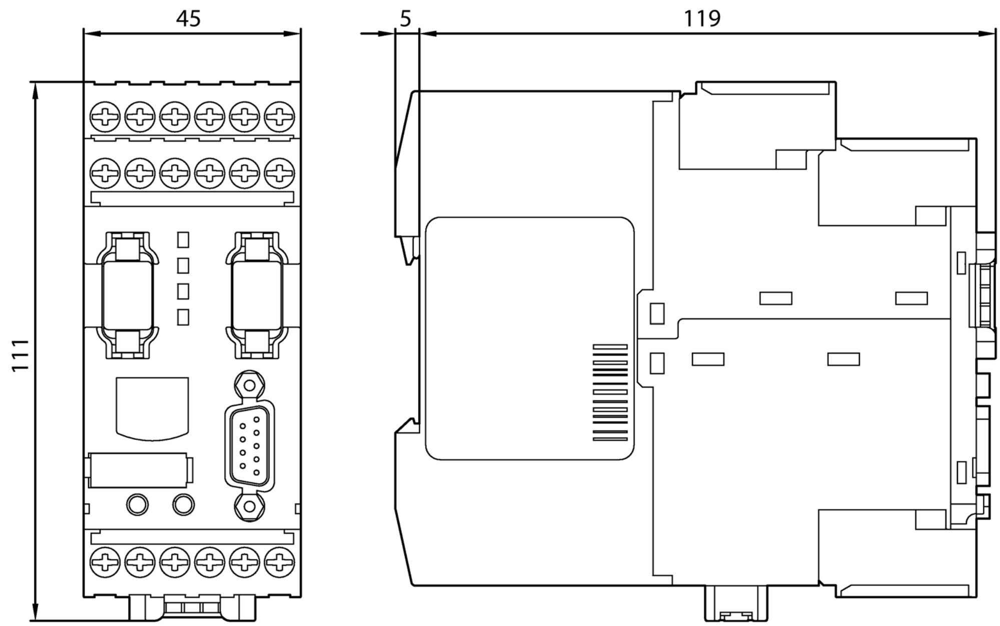


Cut-out for diagnostics display

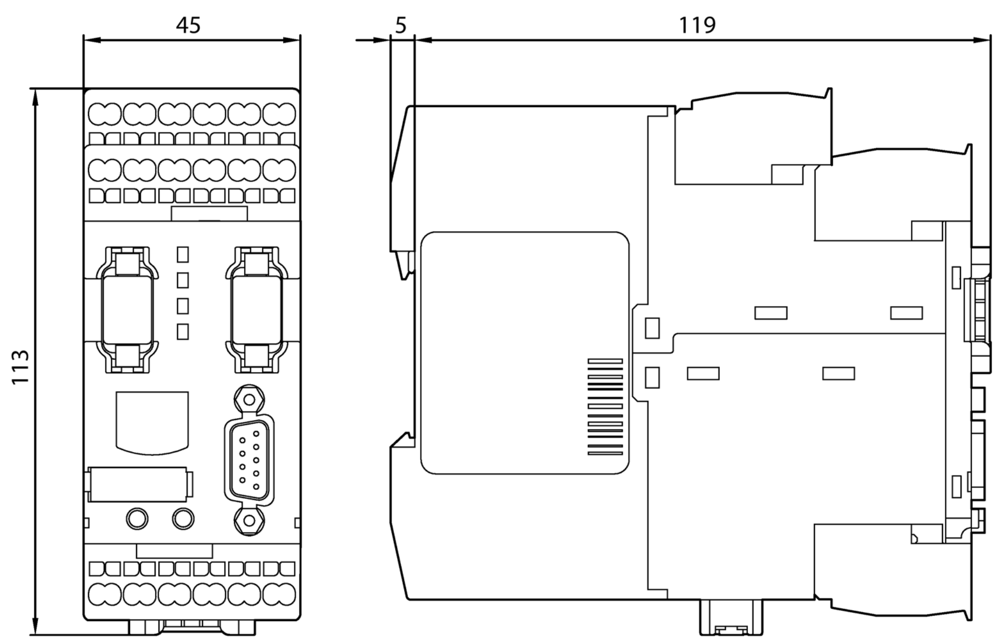


11.2 DP interface

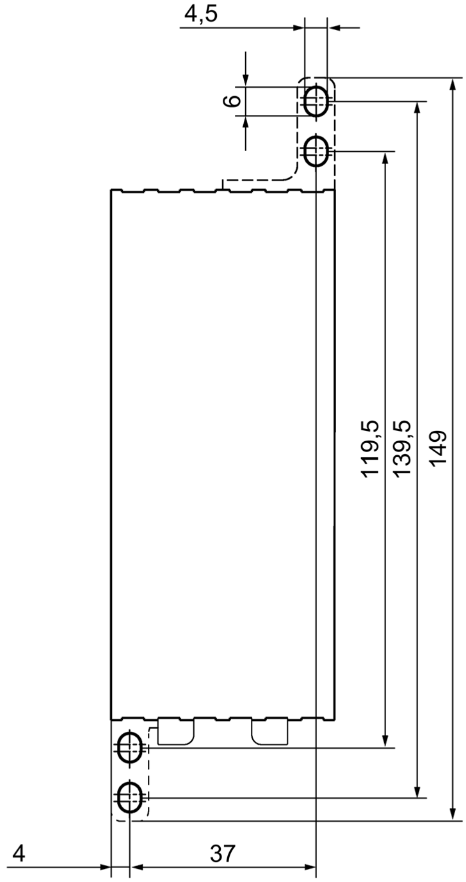
DP interface with screw terminals



DP interface with spring-loaded terminals

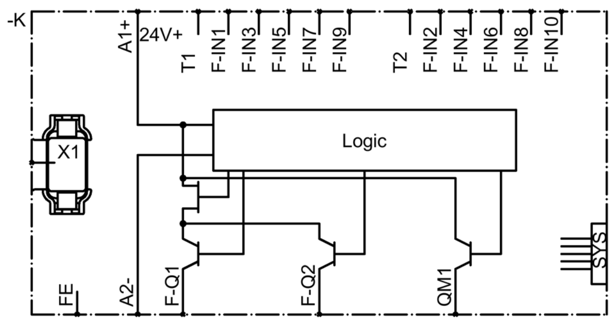


Drilling plan DP interface

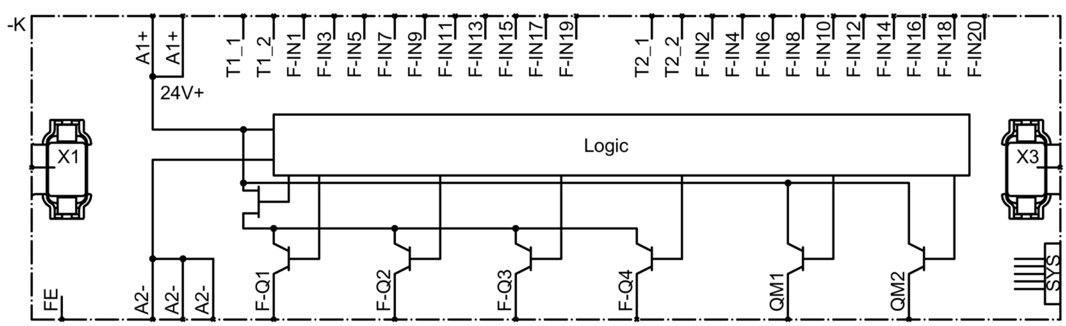


Circuit diagrams 12

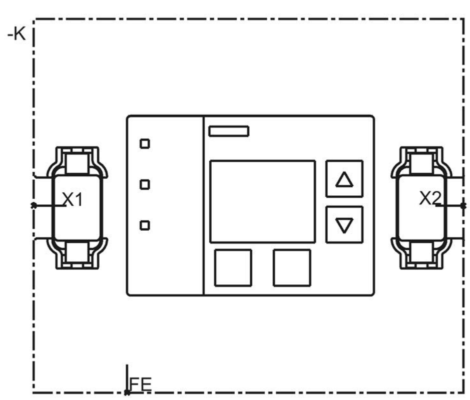
12.1 Circuit diagram 3SK2 safety relay (22.5 mm)



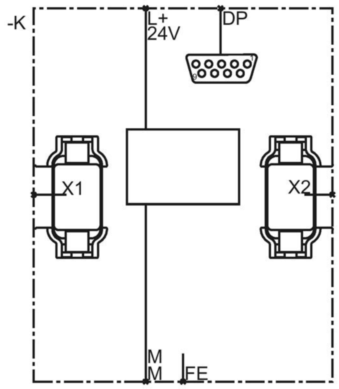
12.2 Circuit diagram 3SK2 safety relay (45 mm)



12.3 Diagnostics display



12.4 DP interface

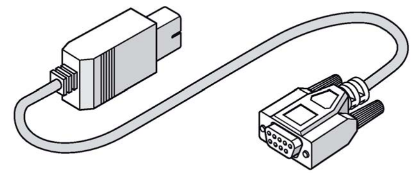
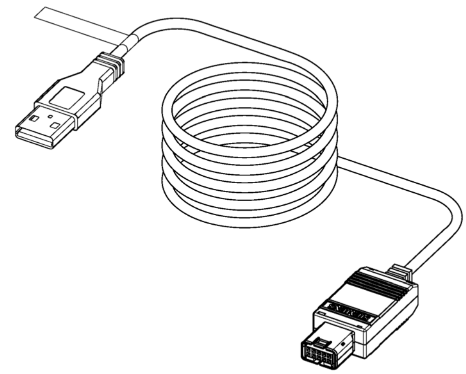
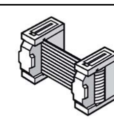
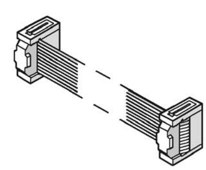
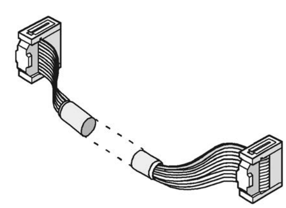
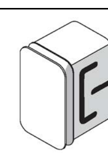


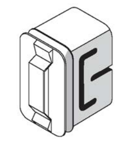
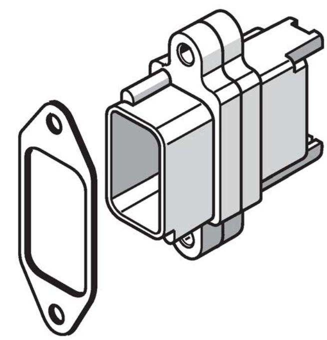
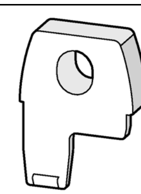
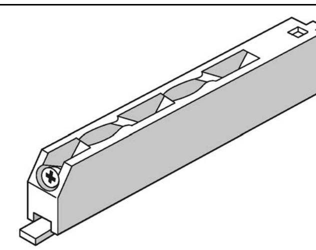
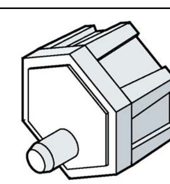
Spare parts/Accessories 13

Accessories

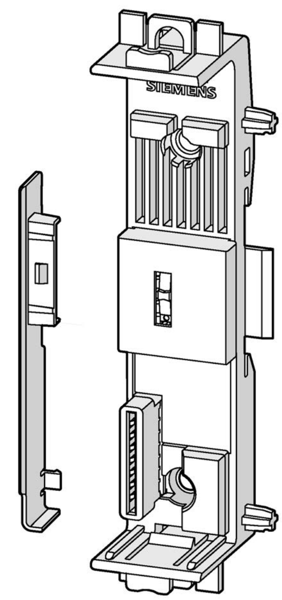
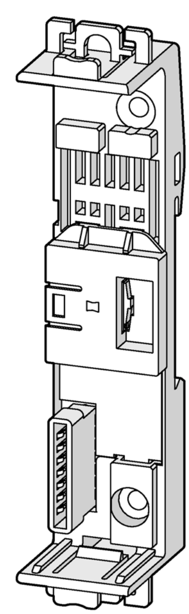
The following components can be ordered as accessories:

Component	Description	Figure
Parameterization and diagnostics software	• The Safety ES software is available in three license variants: Basic, Standard, Premium • The Safety ES software provides a graphical editor (logic diagram) for entering, displaying, and performing diagnostics on the interconnection logic. • The Safety ES software provides the following functionalities: – You use the logic diagram to parameterize the safety functions. – The 3SK2 safety relay is accessed via a PC cable or by means of PROFIBUS-DP and DP interface (optional). – You can also upload an existing configuration from the safety relay to the PC / PG. – The diagnostics functionality of the software enables you to diagnose the safety relay online. – You can force outputs when commissioning the 3SK2 safety relay. • Article number: 3ZS1316-*	

Component	Description	Figure
PC cable and adapter	• Connection cable for exchanging data between the PC / programming device and the 3SK2 safety relay. The connection cable connects the interface of the PC / programming device to the system interface of the 3SK2 safety relay – RS 232 PC cables Article number: 3UF7940-0AA00-0, product version 2 or higher – USB PC cable Article number: 3UF7941-0AA00-0 – USB to serial adapter for connecting an RS 232 PC cable to the USB interface of a PC Article number: 3UF7946-0AA00-0	 
Connection cable to the interface module	• Ribbon cable for data connection • Mechanically-coded and color-coded protection against reverse polarity • 0.025 m ("adjacent") • Article number: 3UF7930-0AA00-0	
Connection cable to the diagnostics display	• Ribbon cable for data connection of 3SK2 safety relay and diagnostics display • Mechanically-coded and color-coded protection against reverse polarity • Max. 2.5 m • Article numbers: – 3UF7931-0AA00-0: 0.1 m, (flat) – 3UF7935-0AA00-0: 0.3 m, (flat) – 3UF7932-0AA00-0: 0.5 m (flat) – 3UF7932-0BA00-0: 0.5 m, (round) – 3UF7937-0BA00-0: 1 m, (round) – 3UF7933-0BA00-0: 2.5 m (round)	Flat:  Round: 
Memory module	• External memory module of the 3SK2 safety relay (45 mm) for storage of configuration data • The slot for the memory module is located on the front of the 3SK2 safety relay • Not relevant to 3SK2 safety relays (22.5 mm) (internal memory) • Article number: 3RK3931-0AA00 **Note:** One memory module is included in the scope of supply of each 3SK2 safety relay (45 mm).	

Component	Description	Figure
System interfaces cover	• Cover for free system interfaces: – Protection against contamination – Compliance with EMC regulations – Seal to protect interface against unauthorized access • Article number: 3UF7950-0AA00-0	
Door adapter	• For bringing out the system interface, e.g., out of a cabinet • Article number: 3UF7920-0AA00-0	
Push-in lugs for wall mounting 3SK2 safety relays	• Push-in lugs for mounting the device on a level surface: – 2 for devices with width 22.5 mm – 4 for devices with width 45 mm • Contents 10 units • Article number: 3ZY1311-0AA00	
Push-in lugs for screw mounting for DP interface	• Fixing lugs for mounting the device on a level surface. – 2 per device • Article number: 3RP1903	
Removable terminals	• 3-pin screw terminals, up to 2 x 1.5 mm² or 1 x 2.5 mm² Article number: 3ZY1131-1BA00 • Spring-type terminals with push-in technology 3-pole, up to 2 x 1.5 mm² Article number: 3ZY1131-2BA00 • Contents 6 units	
Coding pins	• Contents 12 units • Article number: 3ZY1440-1AA00	

3ZY12 device connectors

Description	Description	Figure
Device connectors for 3SK2 safety relays Width 22.5 mm	• The device connector must be provided with a cover (included in the scope of supply of each device termination connector). • The device connector is not required if no devices are connected to the right side of the basic unit. • Article number: 3ZY1212-2GA00	 
Device connector for looping through signals, 22.5 mm wide	• The device connectors for looping through signals are needed to achieve improved cooling. • Article number: 3ZY1212-2AB00	
Device connectors for 3SK2 safety relays Width 45 mm	• The set consists of two device connectors. • The connector with the device interface (front) is fitted on the left. • The connector without the device interface (front) is a device connector for looping through signals and is fitted on the right. • The left connector must be provided with a cover (included in the scope of supply of each device termination connector). • The device connectors are not required if no devices are connected on the right of the basic unit. • Article number: 3ZY1212-4GA01	
Device connectors for 3SK1 safety relays Width 22.5 mm	• The device connector is needed for wireless connection of a 3SK1211 output expansion. • Article number: 3ZY1212-2BA00	
Device termination connectors for 3SK1 safety relay Width 22.5 mm	• The device termination connector is needed for wireless connection of a 3SK1211 output expansion (22.5 mm). • The device termination connector is needed if the output expansion is the last device on the right in the system configuration. The switch must always be set to 1. • Article number: 3ZY1212-2DA00	

Description	Description	Figure
Device termination connector set for 3SK1 safety relay Width > 45 mm	• The device termination connector is needed for wireless connection of an 3SK1213 output expansion (90 mm). • The set consists of two connectors, one device termination connector and one device connector without interface for fastening. On this device termination connector there is no switch that needs to be set. • Article number: 3ZY1212-0FA01	
Device connectors for 3RM1 motor starter Width 22.5 mm	• The device connector is needed for wireless connection of 3RM1 Failsafe motor starters. • Article number: 3ZY1212-2EA00	
Device termination connectors for 3RM1 motor starter Width 22.5 mm	• The device termination connector is needed if the 3RM1 Failsafe motor starter is the last device on the right in the system structure. No switch needs to be set on the device termination connector for 3RM1 Failsafe motor starters. • Article number: 3ZY1212-2FA00	

14 Examples/applications

14.1 User responsibility for system design and function

The products described here were developed to perform safety-related functions as part of an overall installation or machine.

A complete, safety-related system is generally equipped with sensors, evaluation units, and signaling units, and uses reliable shutdown concepts.

It is the responsibility of the manufacturer to ensure that the system or machine is functioning properly as a whole.

Siemens AG, its regional offices, and associated companies (hereinafter referred to as "Siemens") cannot guarantee all the properties of a whole installation or machine that has not been designed by Siemens.

Nor can Siemens assume liability for recommendations that appear or are implied in the following description. No new guarantee, warranty, or liability claims beyond the scope of the Siemens general terms of supply are to be derived or inferred from the following description.

Safety information

WARNING

Hazardous system state due to unverified safety specifications

Can result in death, serious injury, or property damage.
If you use components in your system that do not conform to the safety specifications, safety functions may be deactivated.

The application examples listed in this document are intended only to assist comprehension of the topics covered. For this reason, always check whether the respective application example is actually suitable for your real world application and that it would correspond to the resulting safety requirements. Use the safety characteristics provided for verification for this purpose.

WARNING

Hazardous system state due to unverified components

Can result in death, serious injury, or property damage.

If you use components in your system that do not conform to current legal requirements, safety functions may be deactivated.

The application examples mention components that are not covered by this documentation. Before using any component, check whether its characteristics comply with the current legal requirements for functional safety.

- You can obtain up-to-date information in our Newsletter (Page 26).
- With regard to all application examples, please observe the "Safety information (Page 21)".

14.2 Layout of application examples

Safety function

A safety function consists of the three subfunctions "detecting", "evaluating" and "reacting". Sensors detect the condition of a system, and the 3SK2 safety relay evaluates the sensor signals and controls the actuators such as contactors, valves or frequency converters which then react accordingly. The 3SK2 safety relay also continuously tests and monitors the state of the sensors, the actuators and the associated wiring.

The examples in the following sections focus on one of the two subfunctions "detecting" or "reacting". The second part is implied schematically. You achieve complete safety functions by combining the two parts.

Description

This section lists the most important features of the respective application, and the maximum Safety Integrity Level (SILCL) as per EN 62061 or Performance Level (PL) and Category (Cat.) as per EN ISO 13849-1 that can be achieved.

Application

Here you will find a simplified graphical representation of the components used to implement the safety function. It is split into the "detecting", "evaluating" and "reacting" subsystems.

Circuit diagram

The characteristics of the inputs and outputs shown in the graphic equally apply to the other input and output terminals of the 3SK2 safety relay. The wiring shown can be adapted for all equivalent terminals of the 3SK2 safety relay. The rules from Section "Wiring rules for cross-circuit detection (Page 141)" must be observed.

Logic diagram

The logic is configured with the Safety ES software. To simplify matters, only the respective safety function from the logic diagram of the Safety ES software is shown in the graphic. In practice, several safety functions are often needed on a machine/system. It is also possible to combine several safety-related input/output signals in the logic diagram.

Parameters

The parameters of the functions are set in the Safety ES software. This section only lists the parameters of the software elements that are necessary to obtain the safety-related diagnosis. Depending on the required SILCL or PL, it is necessary to implement fault detection measures in the sensors and actuators. You can find further setting parameters provided by the software elements in the Safety ES (Software) operating manual. See Section "Additional documentation (Page 14)".

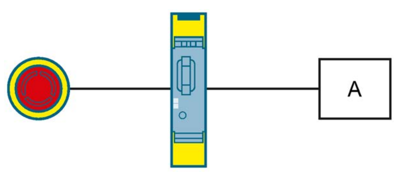
14.3 Connection of sensors

14.3.1 EMERGENCY STOP shutdown up to SILCL 1 or PL c / Cat. 2

Description

- EMERGENCY STOP shutdown
- "Detecting" subsystem up to SILCL 1 as per EN 62061 and PL e / Cat. 2 as per EN ISO 13849-1
- EMERGENCY STOP command device according to EN ISO 13850
- Single-channel sensor interfacing
- Monitored start
- Sensor supply possible via test output or via 24 V DC

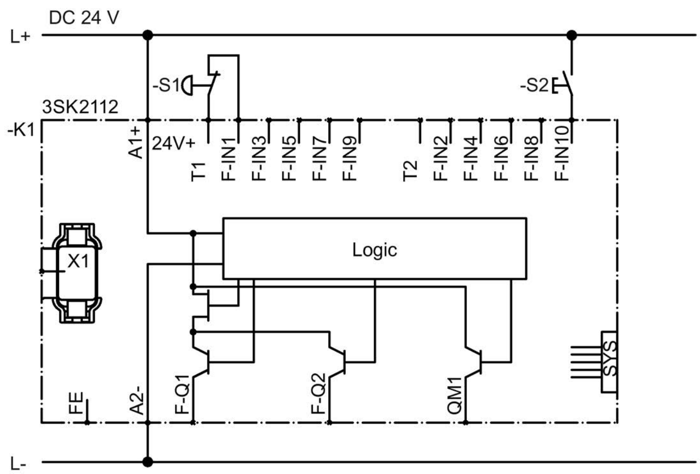
Application



① ② ③

① Detection: EMERGENCY STOP
② Evaluation: 3SK2 safety relay
③ Reaction: actuator A

Circuit diagram

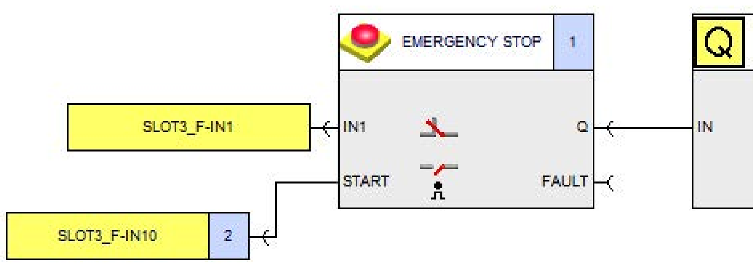


-K1 3SK2 safety relay 22.5 mm

-S1 EMERGENCY STOP (single-channel)

-S2 Start pushbutton

Logic diagram



Parameters of the "EMERGENCY STOP" monitoring function

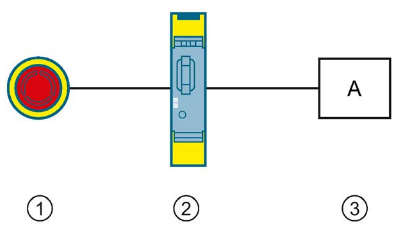
Parameter	Value	Note
Type	Single-channel (NC)	-
IN1	SLOT3_F-IN1	-
Start type	Monitored	-

14.3.2 EMERGENCY STOP shutdown up to SILCL 3 or PL e / Cat. 4

Description

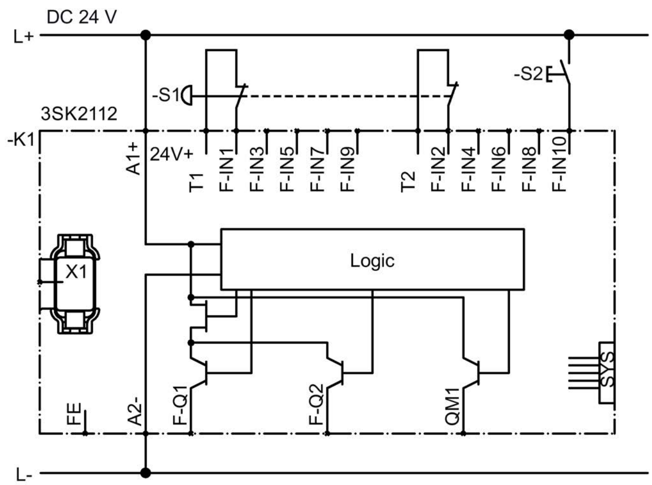
- EMERGENCY STOP shutdown
- "Detecting" subsystem up to SILCL 3 as per EN 62061 and PL e / Cat. 4 as per EN ISO 13849-1
- EMERGENCY STOP command device according to EN ISO 13850
- Two-channel sensor connection
- Discrepancy evaluation between the sensor channels integrated in the "EMERGENCY STOP" monitoring element (5 s)
- Sensor wiring cross-circuit monitoring activated
- Monitored start
- Sensor supply via test outputs

Application



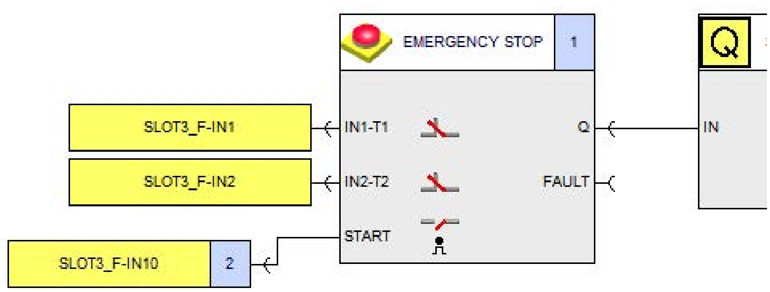
① Detection: EMERGENCY STOP
② Evaluation: 3SK2 safety relay
③ Reaction: actuator A

Circuit diagram



-K1	3SK2 safety relay 22.5 mm
-S1	EMERGENCY STOP (two-channel)
-S2	Start pushbutton

Logic diagram



Parameters of the "EMERGENCY STOP" monitoring function

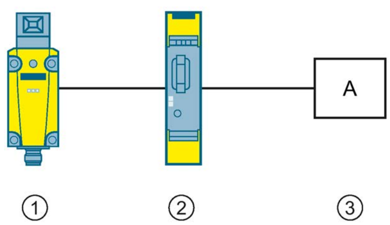
Parameter	Value	Note
Type	Two-channel (NCNC)	-
IN1	SLOT3_F-IN1	-
IN2	SLOT3_F-IN2	-
Cross-circuit detection	✓	-
Start type	Monitored	-

14.3.3 Protective door monitoring up to SILCL 1 or PL c / Cat. 2

Description

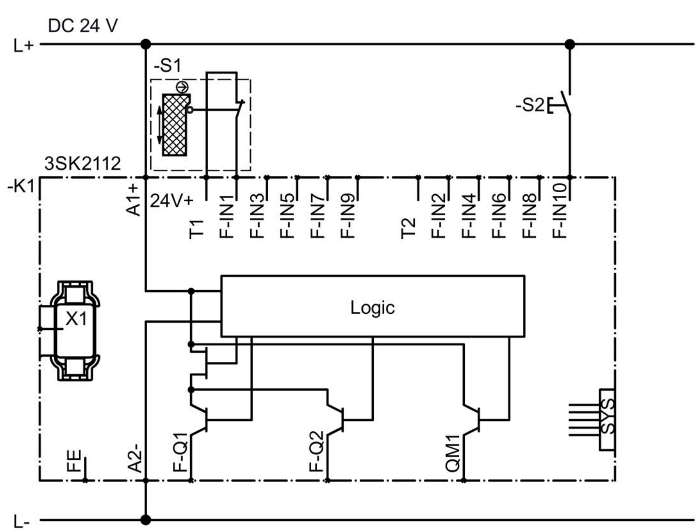
- Protective door monitoring
- "Detecting" subsystem up to SILCL 1 as per EN 62061 and PL e / Cat. 2 as per EN ISO 13849-1
- Single-channel sensor interfacing
- Monitored start in the case of rear-access safety facilities
- Sensor supply possible via test outputs or via 24 V DC

Application



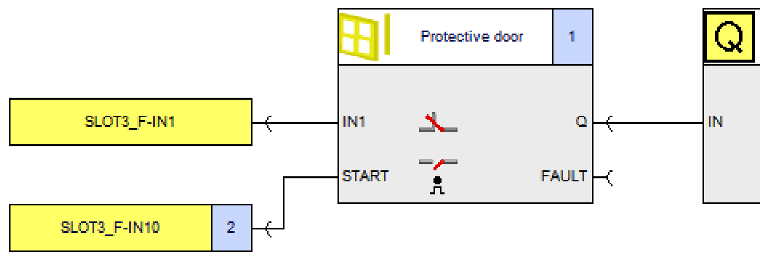
① Detection: 3SE5 position switch
② Evaluation: 3SK2 safety relay
③ Reaction: actuator A

Circuit diagram



-K1 3SK2 safety relay 22.5 mm
-S1 Position switches
-S2 Start pushbutton

Logic diagram



Parameters of the "protective door" monitoring function

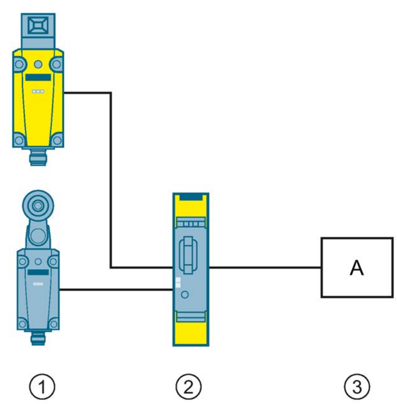
Parameter	Value	Note
Type	Single-channel (NC)	-
IN1	SLOT3_F-IN1	-
Start type	Monitored	The "Automatic" setting is possible for protective facilities that do not offer rear access. This depends on the risk assessment.

14.3.4 Protective door monitoring up to SILCL 3 or PL e / Cat. 4 (electromechanical position switches)

Description

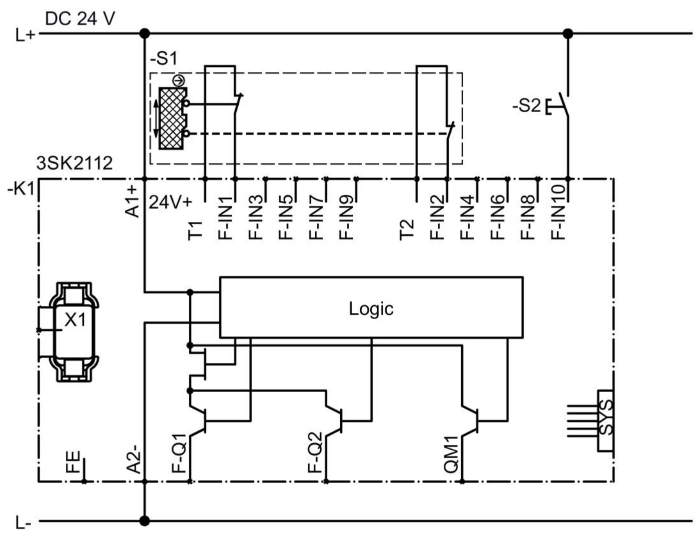
- Protective door monitoring
- "Detecting" subsystem up to SILCL 3 as per EN 62061 and PL e / Cat. 4 as per EN ISO 13849-1
- Redundant sensors
- Discrepancy evaluation between the sensors activated
- Sensor wiring cross-circuit monitoring activated
- Monitored start in the case of rear-access safety facilities
- Sensor supply via test outputs

Application



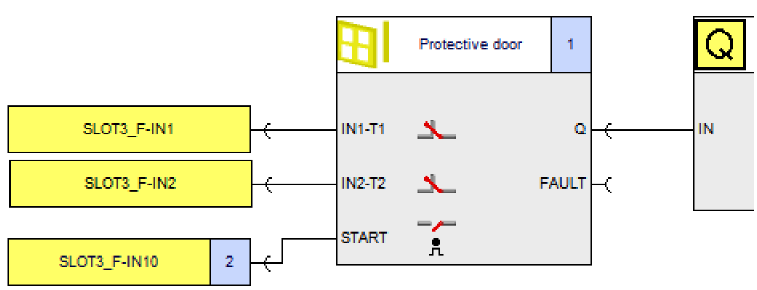
① Detection: 3SE5 position switch
② Evaluation: 3SK2 safety relay
③ Reaction: actuator A

Circuit diagram



-K1	3SK2 safety relay 22.5 mm
-S1	Position switch
-S2	Start pushbutton

Logic diagram



Parameters of the "protective door" monitoring function

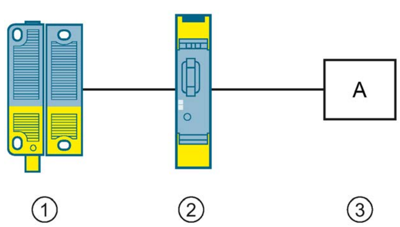
Parameter	Value	Note
Discrepancy monitoring	Between all inputs	-
Discrepancy time infinite	✓	Optional: adjustable discrepancy time for earlier fault detection
Type	Two-channel (NCNC)	NCNO is also possible
IN1	SLOT3_F-IN1	-
IN2	SLOT3_F-IN2	-
Cross-circuit detection	✓	-
Start type	Monitored	The "Automatic" setting is possible for protective facilities that do not offer rear access. This depends on the risk assessment.

14.3.5 Protective door monitoring up to SILCL 3 or PL e / Cat. 4 (electronic position switches)

Description

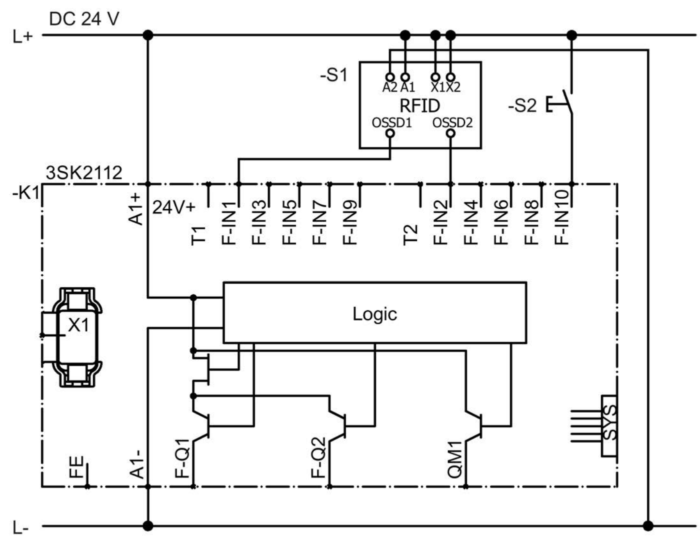
- RFID protective door monitoring
- "Detecting" subsystem up to SILCL 3 as per EN 62061 and PL e / Cat. 4 as per EN ISO 13849-1
- Electro-sensitive position switch with RFID technology certified for SILCL 3/PL e
- Discrepancy evaluation between the sensor inputs activated
- Sensor wiring cross-circuit monitoring deactivated
- Monitored start in the case of rear-access safety facilities
- Sensor supply via 24 V DC

Application



① Detection: Electro-sensitive 3SE6 RFID safety switches
② Evaluation: 3SK2 safety relay
③ Reaction: actuator A

Circuit diagram

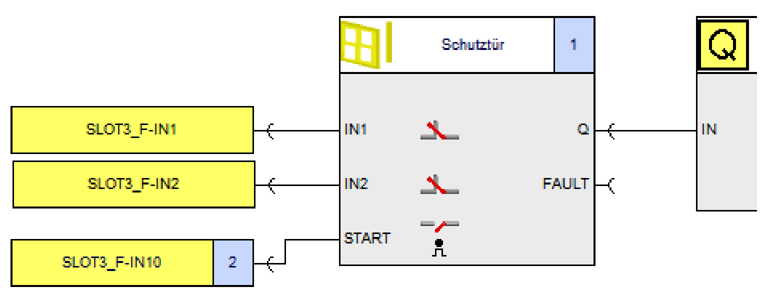


-K1 3SK2 safety relay 22.5 mm

-S1 Electro-sensitive position switch with RFID technology

-S2 Start pushbutton

Logic diagram



Parameters of the "protective door" monitoring function

Parameter	Value	Note
Discrepancy monitoring	Between all inputs	-
Discrepancy time infinite	✓	Optional: adjustable discrepancy time for earlier fault detection
Type	Two-channel (NCNC)	-
IN1	SLOT3_F-IN1	-
IN2	SLOT3_F-IN2	-
Cross-circuit detection	Deactivated	-
Start type	Monitored	The "Automatic" setting is possible for protective facilities that do not offer rear access. This depends on the risk assessment.

14.3.6 Evaluation of ESPE up to SILCL 2 or PL d / Cat. 3 with type 2 light curtains

Description

- Monitoring electro-sensitive protective equipment
- "Detecting" subsystem up to SILCL 2 as per EN 62061 and PL d / Cat. 3 as per EN ISO 13849-1
- Use of a **type 2** ESPE in compliance with IEC 61496
- Use of an ESPE with integrated automatic testing

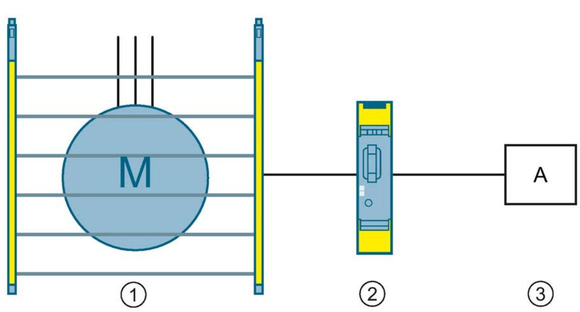
Note

Restrictions for manual or parameterizable testing

Type 2 ESPE with manual or parameterizable testing is **not** supported by the 3SK2 safety relay.

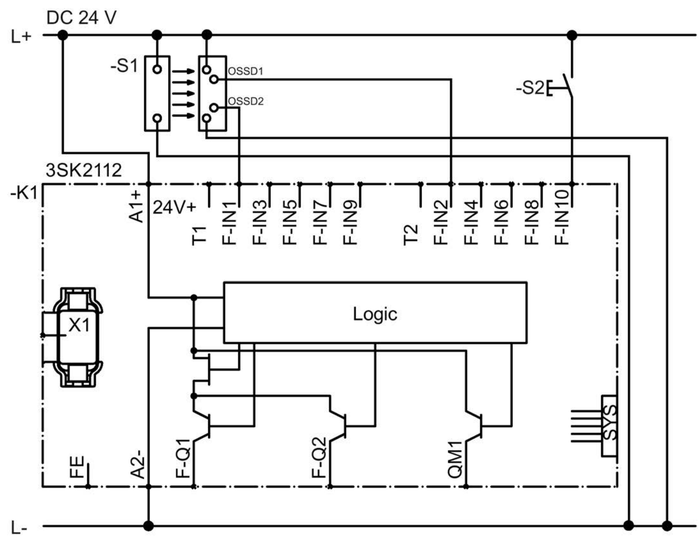
- Certification of sensors according to SILCL 2 as per EN 62061 or PL d / Cat. 3 as per EN ISO 13849-1 required
- Two-channel sensor connection
- Light curtains or arrays or laser scanners are possible
- Sensor wiring cross-circuit monitoring deactivated
- Monitored start in the case of rear-access safety facilities
- Discrepancy evaluation between the sensor channels is integrated in the "ESPE" monitoring function
- Sensor supply via 24 V DC

Application



① Detection: light curtains or arrays or laser scanners (type 2)
② Evaluation: 3SK2 safety relay
③ Reaction: actuator A

Circuit diagram

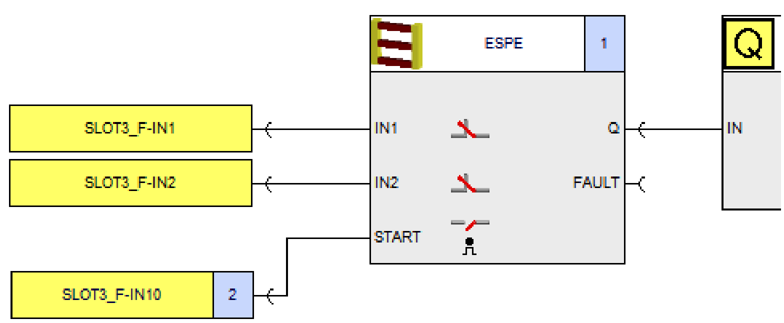


-K1 3SK2 safety relay 22.5 mm

-S1 Light curtain, array or laser scanner

-S2 Start pushbutton

Logic diagram



Parameters of the "electrosensitive protective equipment" monitoring function

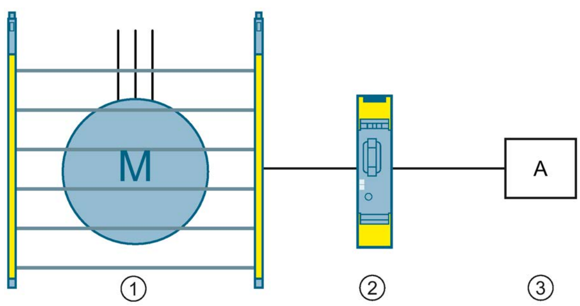
Parameter	Value	Note
Type	Two-channel (NCNC)	-
IN1	SLOT3_F-IN1	-
IN2	SLOT3_F-IN2	-
Cross-circuit detection	Deactivated	-
Start type	Monitored	The "Automatic" setting is possible for protective facilities that do not offer rear access. This depends on the risk assessment.

14.3.7 Evaluation of ESPE up to SILCL 3 or PL e / Cat. 4 with type 4 light curtains

Description

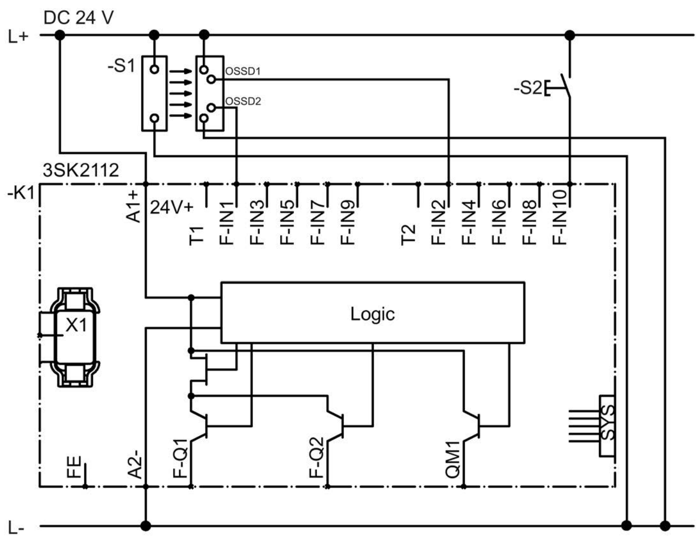
- Monitoring electro-sensitive protective equipment
- "Detecting" subsystem up to SILCL 3 as per EN 62061 and PL e / Cat. 4 as per EN ISO 13849-1
- Use of a **type 4** ESPE in compliance with IEC 61496
- Certification of sensors according to SILCL 3 as per EN 62061 or PL d / Cat. 4 as per EN ISO 13849-1 required
- Light curtains or arrays or laser scanners possible
- Two-channel sensor connection
- Sensor wiring cross-circuit monitoring deactivated
- Monitored start in the case of rear-access safety facilities
- Discrepancy evaluation between the sensor channels is integrated in the "ESPE" monitoring function
- Sensor supply via 24 V DC

Application



① Detection: light curtains or arrays or laser scanners (type 4)
② Evaluation: 3SK2 safety relay
③ Reaction: actuator A

Circuit diagram

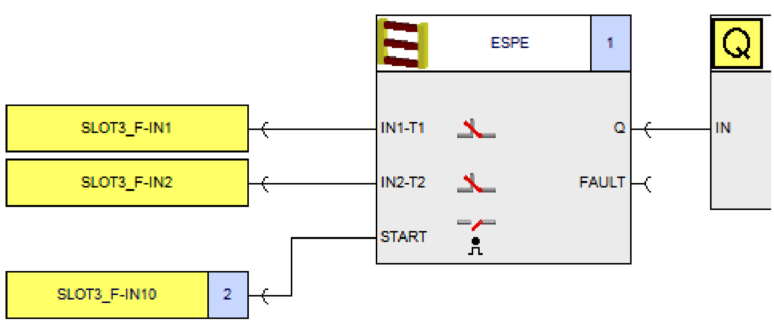


-K1 3SK2 safety relay 22.5 mm

-S1 Light curtain, array or laser scanner

-S2 Start pushbutton

Logic diagram



Parameters of the "electrosensitive protective equipment" monitoring function

Note

ESPE type 4 with floating relay outputs

The wiring rules from Section "Connecting safety-related inputs (Page 144)" in the Subsection "Connection options with test output" apply to ESPE type 4 with floating relay outputs. Activate the "cross-circuit detection" parameter in this case.

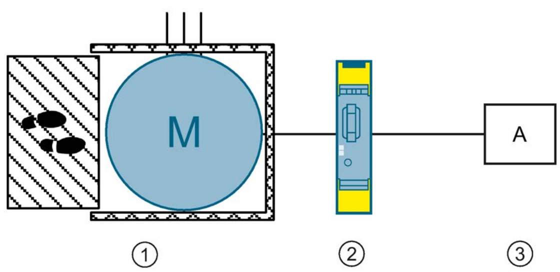
Parameter	Value	Note
Type	Two-channel (NCNC)	-
IN1	SLOT3_F-IN1	-
IN2	SLOT3_F-IN2	-
Cross-circuit detection	Activated	-
Start type	Monitored	The "Automatic" setting is possible for protective facilities that do not offer rear access. This depends on the risk assessment.

14.3.8 Access monitoring with safety shutdown mat (NC contact principle) up to SILCL 3 or PL e / Cat. 4

Description

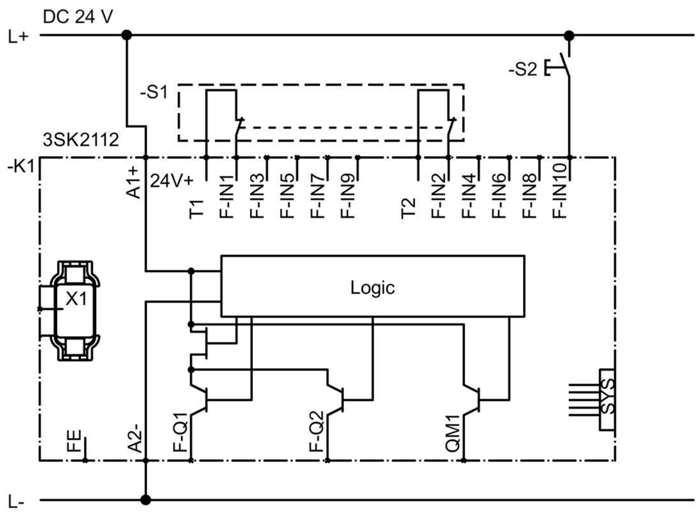
- Access monitoring using a safety shutdown mat (NC contact principle)
- "Detecting" subsystem up to SILCL 3 as per EN 62061 and PL e / Cat. 4 as per EN ISO 13849-1
- Two-channel connection of the safety shutdown mat
- Sensor supply cross-circuit monitoring activated
- Monitored start in the case of rear-access safety facilities
- Sensor supply via test outputs

Application



① Detection: Safety shutdown mat with NC principle
② Evaluation: 3SK2 safety relay
③ Reaction: actuator A

Circuit diagram

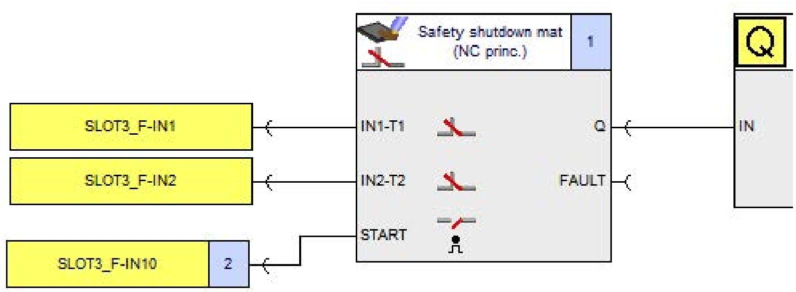


-K1 3SK2 safety relay 22.5 mm

-S1 Safety shutdown mat (NC principle)

-S2 Start pushbutton

Logic diagram



Parameters of the "safety shutdown mat" (NC contact principle) monitoring function

Parameter	Value	Note
Type	Two-channel (NCNC)	-
IN1	SLOT3_F-IN1	-
IN2	SLOT3_F-IN2	-
Cross-circuit detection	✓	-
Start type	Monitored	The "Automatic" setting is possible for protective facilities that do not offer rear access. This depends on the risk assessment.

14.3.9 Access monitoring with safety shutdown mat (cross circuit principle) up to SILCL 3 or PL e / Cat. 4

Description

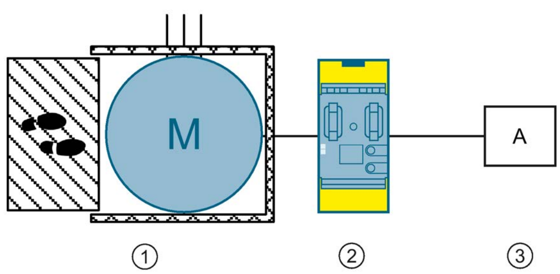
- Access monitoring using a safety shutdown mat (cross-circuit principle)
- "Detecting" subsystem up to SILCL 3 as per EN 62061 and PL e / Cat. 4 as per EN ISO 13849-1
- Two-channel connection of the safety shutdown mat
- Triggering of the safety function by cross-circuit detection (when stepping on the mat)
- Use of test outputs T1_2 and T2_2
- Monitored start in the case of rear-access safety facilities

Note

Use of a second safety shutdown mat with cross-circuit principle

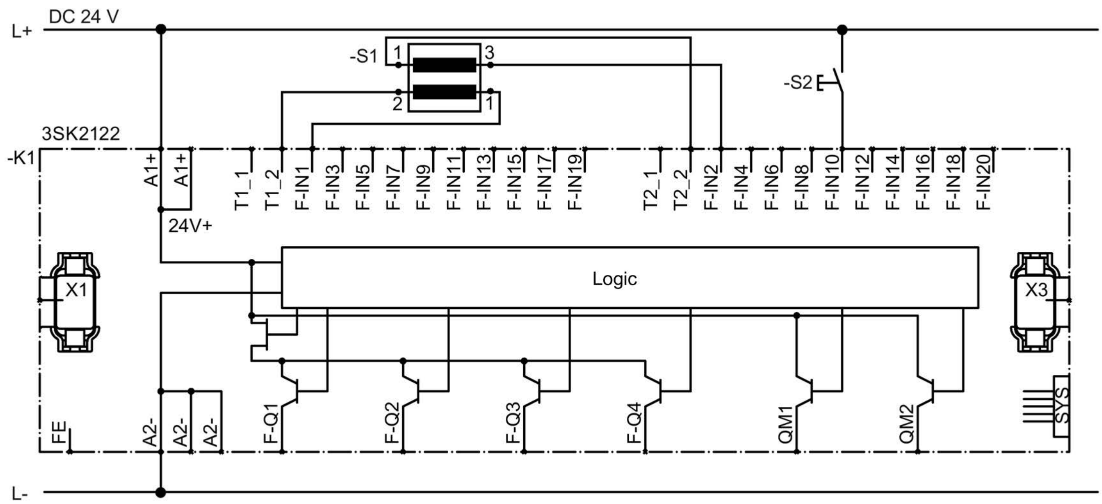
To enable use of a second safety shutdown mat based on the cross-circuit principle and independently of the first safety shutdown mat, this second mat must be connected to the decoupled test outputs T1_1 and T2_1. Then, further sensors can only be used without cross-circuit detection.

Application



① Detection: Safety shutdown mat with cross-circuit principle
② Evaluation: 3SK2 safety relay 45 mm
③ Reaction: actuator A

Circuit diagram

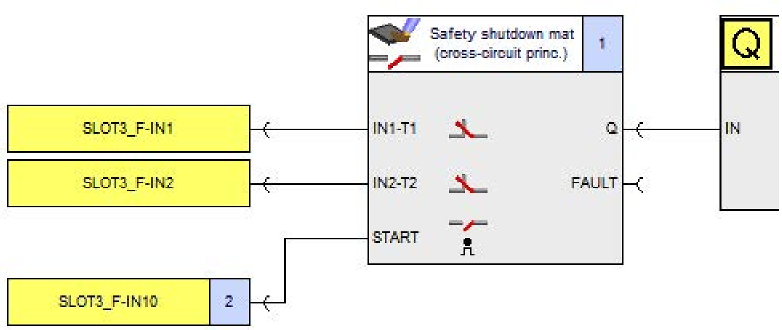


-K1 3SK2 safety relay 45 mm

-S1 Safety shutdown mat (cross-circuit principle)

-S2 Start pushbutton

Logic diagram



Parameters of the "safety shutdown mat (cross-circuit principle)" monitoring function

Parameter	Value	Note
Type	Two-channel (NCNC)	Cannot be changed
IN1	SLOT3_F-IN1	-
IN2	SLOT3_F-IN2	-
Start type	Monitored	The "Automatic" setting is possible for protective facilities that do not offer rear access. This depends on the risk assessment.

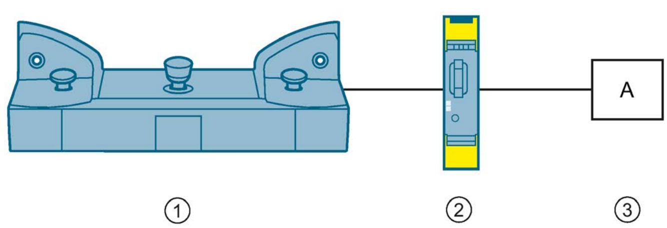
14.3.10 Two-hand operation (type IIIc) up to SILCL 3 or PL e / Cat. 4

14.3.10.1 Input circuit type NONCNONC

Description

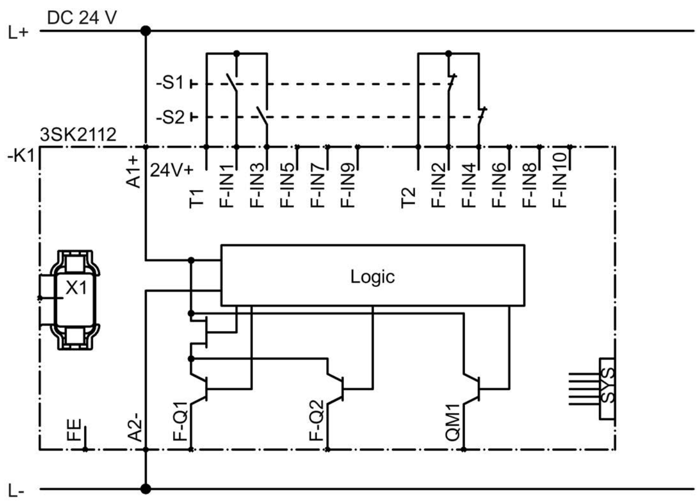
- Safe operation via two-hand operation type IIIc
- "Detecting" subsystem up to SILCL 3 as per EN 62061 and PL e / Cat. 4 as per EN ISO 13849-1
- Type IIIc in accordance with EN574
- Two-channel monitoring of actuators
- Synchronous time between the actuators 0.5 s
- Sensor wiring cross-circuit monitoring activated

Design



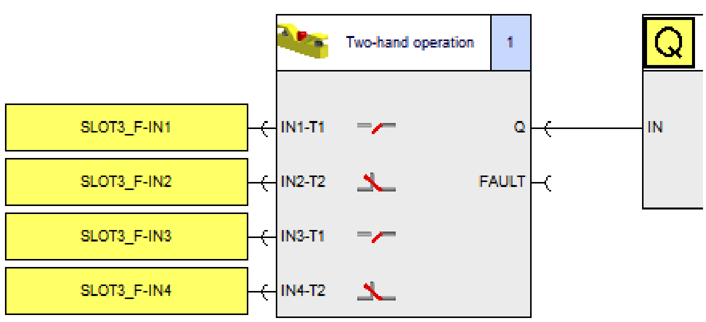
① Detection: Two-hand operation console
② Evaluation: 3SK2 safety relay
③ Reaction: actuator A

Circuit diagram



-K1	3SK2 safety relay 22.5 mm
-S1	Two-hand operation console pushbutton 1
-S2	Two-hand operation console pushbutton 2

Logic diagram



Parameters of the "two-hand operation" monitoring function

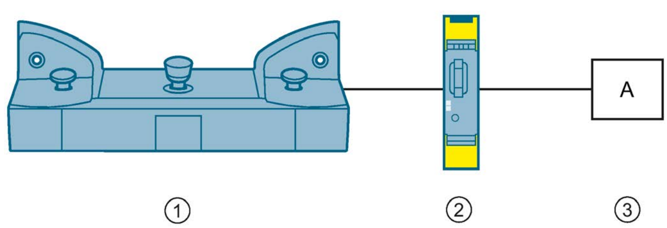
Parameters	Value	Note
Type	four-channel (NONCNONC)	-
IN1	SLOT3_F-IN1	-
IN2	SLOT3_F-IN2	-
IN3	SLOT3_F-IN3	-
IN4	SLOT3_F-IN4	-
Cross-circuit detection	✓	-

14.3.10.2 Input circuit type NONO with cross circuit detection

Description

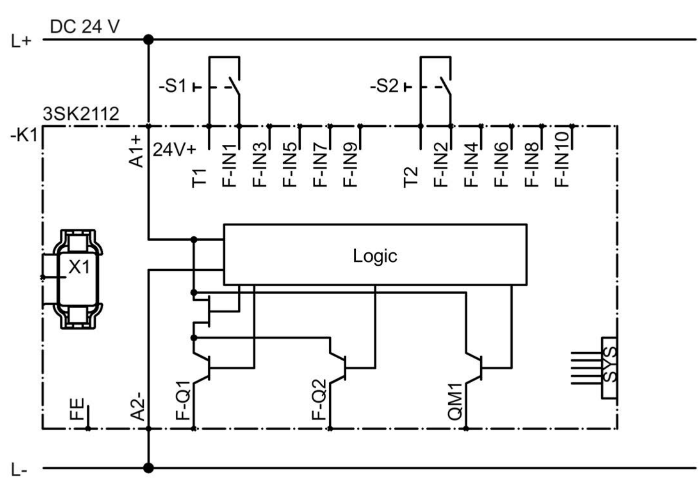
- Safe operation via two-hand operation type IIIc
- "Detecting" subsystem up to SILCL 3 as per EN 62061 and PL e / Cat. 4 as per EN ISO 13849-1
- Type IIIc in accordance with EN574
- Synchronous time between the actuators 0.5 s
- Sensor wiring cross-circuit monitoring activated

Design



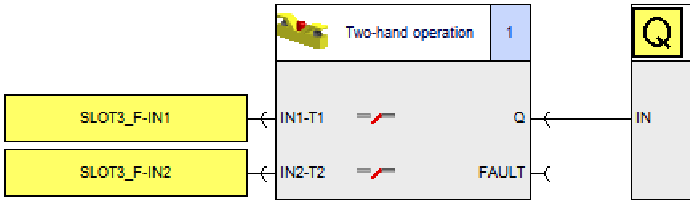
① Detection: Two-hand operation console
② Evaluation: 3SK2 safety relay
③ Reaction: actuator A

Circuit diagram



-K1 3SK2 safety relay 22.5 mm
-S1 Two-hand operation console pushbutton 1
-S2 Two-hand operation console pushbutton 2

Logic diagram



Parameters of the "two-hand operation" monitoring function

Parameters	Value	Note
Type	two-channel (NONO)	-
IN1	SLOT3_F-IN1	-
IN2	SLOT3_F-IN2	-
Cross-circuit detection	✓	-

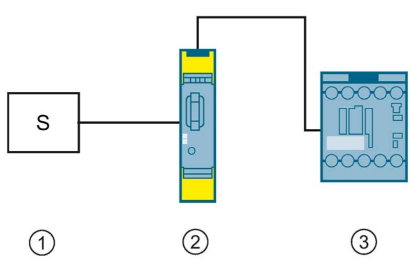
14.4 Connection of actuators

14.4.1 Shutdown via contactor (stop Cat. 0) up to SILCL 1 or PL c / Cat. 2

Description

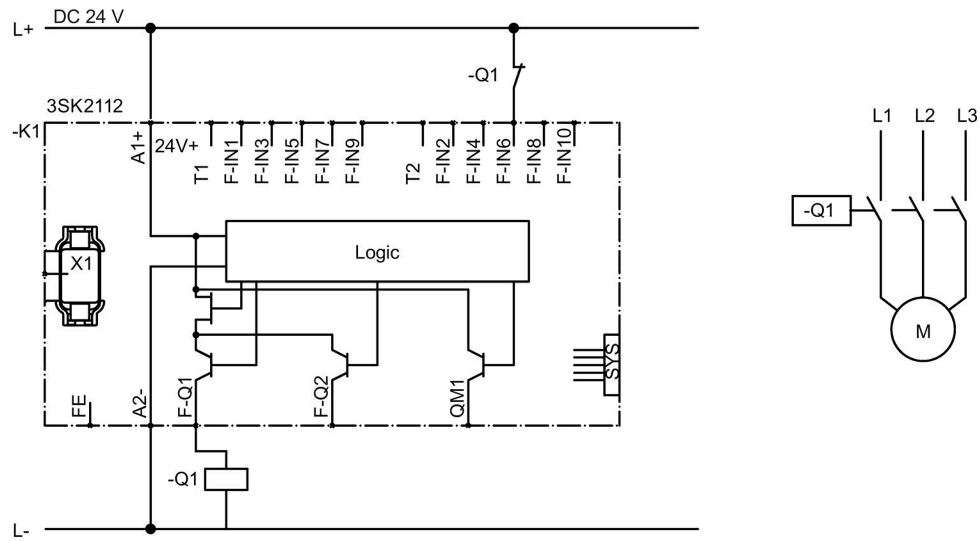
- Shutdown via contactor
- Stop category 0
- "Reacting" subsystem up to SILCL 1 as per EN 62061 and PL c / Cat. 2 as per EN ISO 13849-1
- Single-channel actuator interfacing

Application



① Detection: Sensor S
② Evaluation: 3SK2 safety relay
③ Reaction: 3RT20 contactor

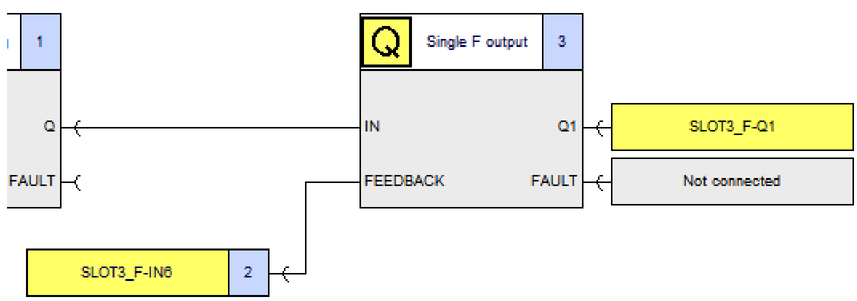
Circuit diagram



-K1 3SK2 safety relay 22.5 mm

-Q1 3RT20 contactor

Logic diagram



Parameters of the "F output" function

Parameter	Value	Note
Output type	Single F output	-
Feedback circuit monitoring 1	For OFF and ON status	-
Switching time [s]	0.090	Default value; Application-dependent adjustment to the actuator, depending on the actuator's response time
Q1	SLOT3_F-Q1	-

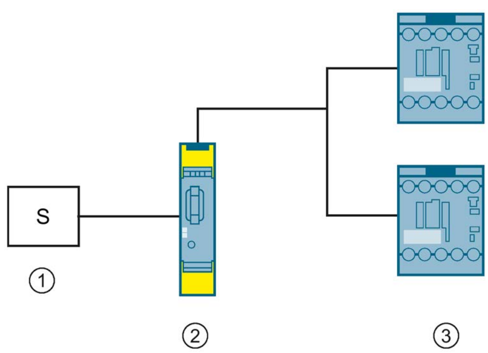
14.4.2 Shutdown via contactor (stop Cat. 0) up to SILCL 3 or PL e / Cat. 4

14.4.2.1 Shutdown via a safety-related output

Description

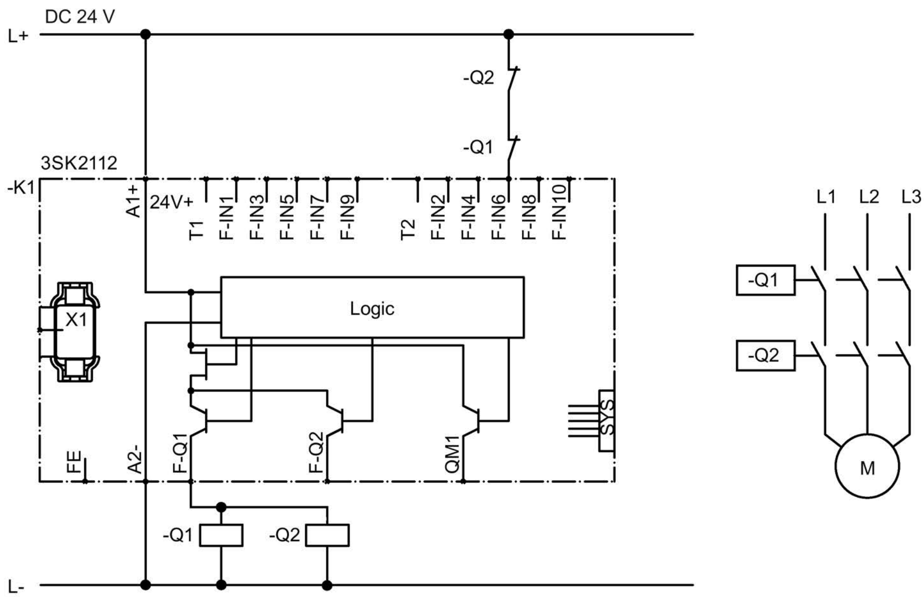
- Shutdown by two contactors via a safety-related output
- Stop category 0
- "Reacting" subsystem up to SILCL 3 as per EN 62061 and PL e / Cat. 4 as per EN ISO 13849-1
- Redundant actuators
- Cross-circuit-proof, short-circuit-to-ground-proof laying in the field or laying in a control cabinet necessary

Application



① Detection: Sensor S
② Evaluation: 3SK2 safety relay
③ Reaction: 3RT20 contactors

Circuit diagram

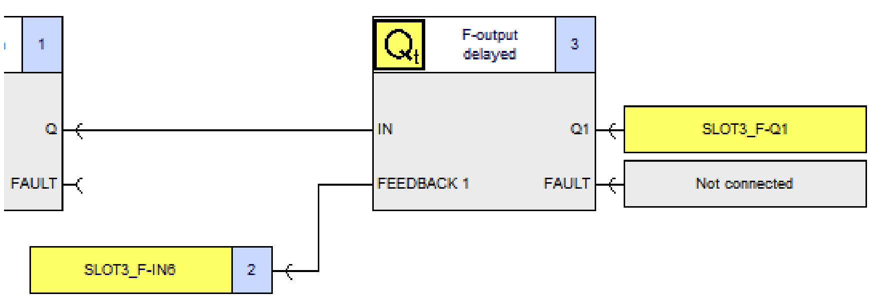


-K1 3SK2 safety relay 22.5 mm

-Q1 3RT20 contactor

-Q2 3RT20 contactor

Logic diagram



Parameters of the "F output delayed" function

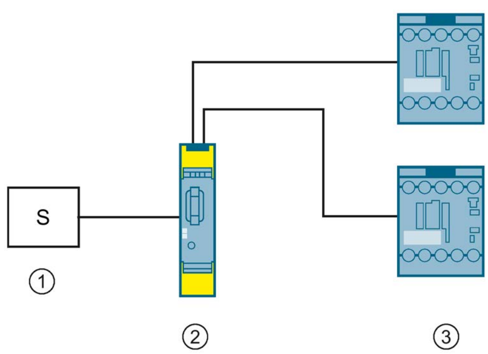
Parameter	Value	Note
Output type	Single F output	-
Feedback circuit monitoring	For OFF and ON status	-
Switching time [s]	0.090	Default value Application-dependent adjustment to the actuator, depending on the actuator's response time
Q1	SLOT3_F-Q1	-
Output circuit Q1 light test	activated	The light test must not be deactivated.

14.4.2.2 Shutdown via two safety-related outputs

Description

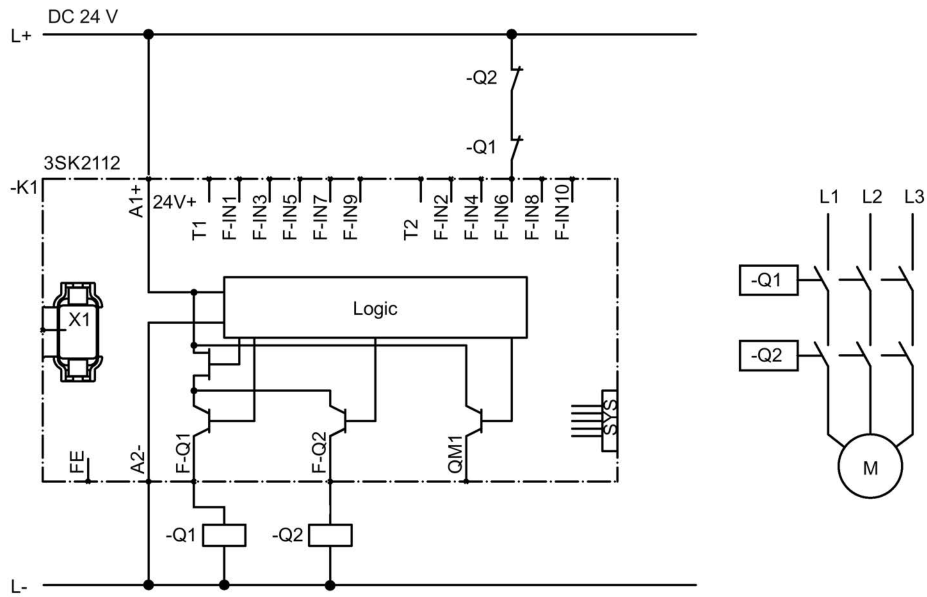
- Shutdown by two contactors via two safety-related outputs
- Stop category 0
- "Reacting" subsystem up to SILCL 3 as per EN 62061 and PL e / Cat. 4 as per EN ISO 13849-1
- Redundant actuators
- Use of two safety-related outputs of the 3SK2 safety relay when actuator cables are laid unprotected in the field

Application



①	Detection: Sensor S
②	Evaluation: 3SK2 safety relay
③	Reaction: 3RT20 contactors

Circuit diagram

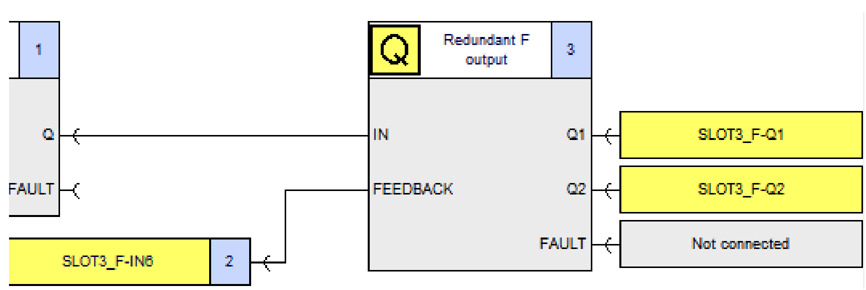


-K1 3SK2 safety relay 22.5 mm

-Q1 3RT20 contactor

-Q2 3RT20 contactor

Logic diagram



Parameters of the "F output" function

Parameter	Value	Note
Output type	Redundant F output	-
Feedback circuit monitoring	For OFF and ON status	-
Switching time [s]	0.090	Default value Application-dependent adjustment to the actuator, depending on the actuator's response time
Q1	SLOT3_F-Q1	-
Q2	SLOT3_F-Q2	-

14.4.3 Shutdown with 3SK1 output expansions (Stop Cat. 0) up to SILCL 3 or PL e / Cat. 4

Description

- Shutdown via two 3SK1 output expansions. Each 3SK1 output expansion is controlled by its own safety-related output from the 3SK2 safety relay
- Stop category 0
- "Reacting" subsystem up to SILCL 3 as per EN 62061 and PL e / Cat. 4 as per EN ISO 13849-1
- Redundant actuators
- Control of the 3SK1 output expansion via 3ZY12 device connector
- Feedback circuit (51-52) of the 3SK1 output expansions in series with the signaling contacts of the downstream actuators

Note

As both output expansions are independent of each another, use of the shared feedback circuit IN1-C is not possible.

- Cross-circuit-proof, short-circuit-to-ground-proof laying in the field or laying in a control cabinet necessary

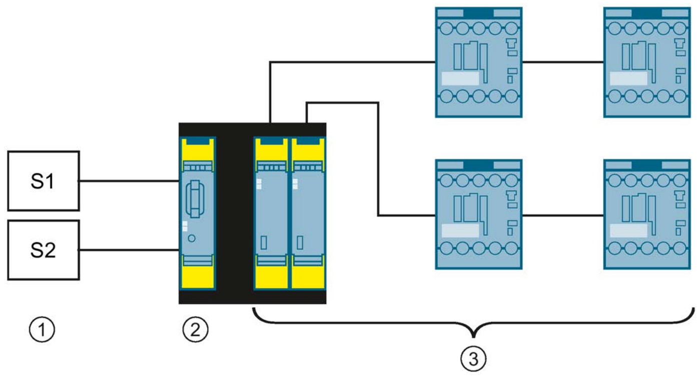
WARNING

Bypassing the Safety Function When Using Device Connectors
Can Cause Death, Serious Injury, or Property Damage.

When operating with a 3SK2 safety relay and 3ZY12 device connectors, the supply voltage for the 3SK1 output expansions is established via the 3ZY12 device connectors.

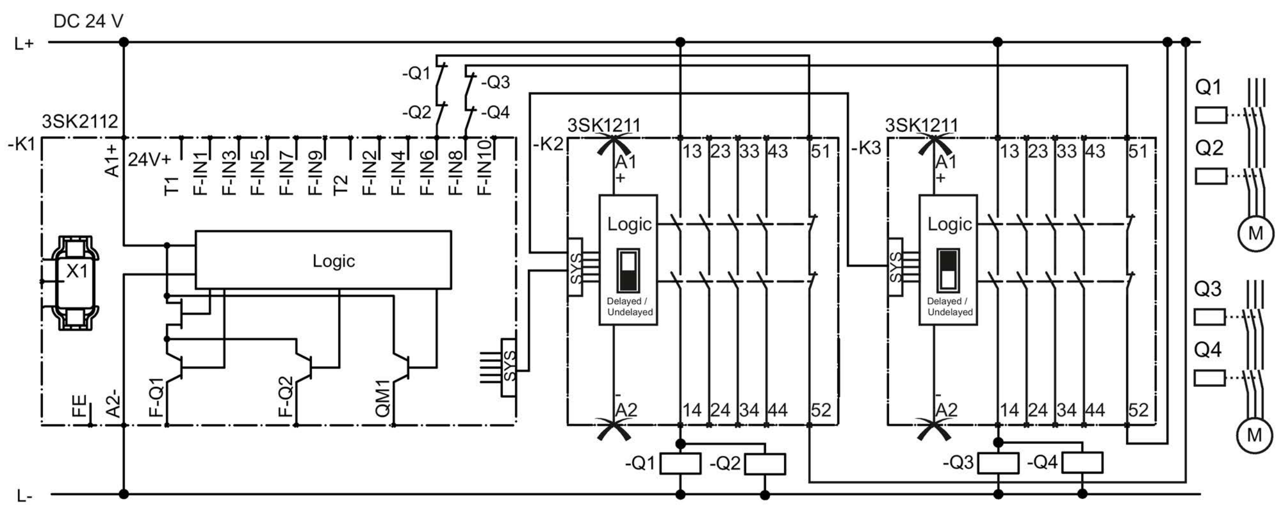
In this case, do not connect anything to terminals A1 and A2 of the 3SK1 output expansions, in order to prevent bypassing of the safety function.

Application



① Detection: two sensors, sensor 1 (S1) and sensor 2 (S2)
② Evaluation: 3SK2 safety relay
③ Reaction: two 3SK1 output expansions and four 3RT20 contactors

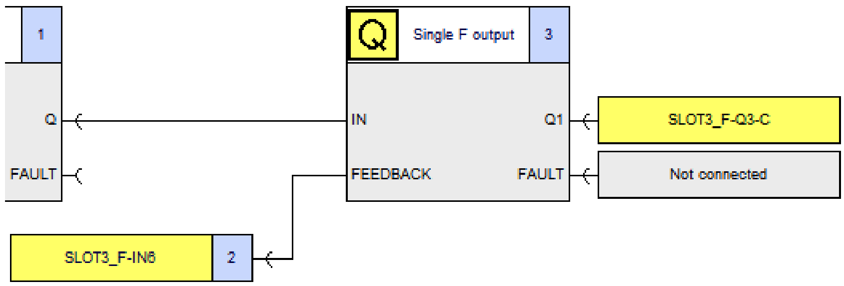
Circuit diagram



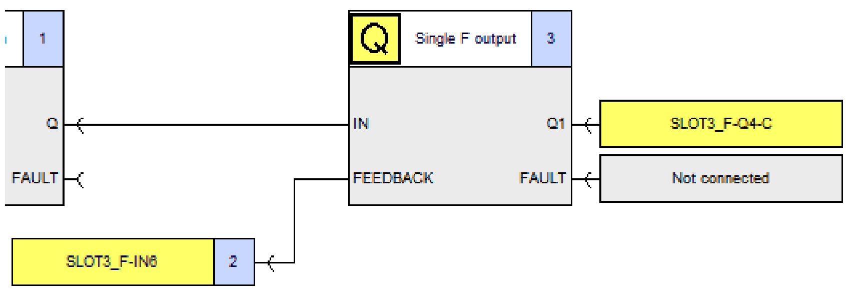
-K1	3SK2 safety relay 22.5 mm
-K2	3SK1211 output expansion (24 V DC) • Switch setting of the slide switch: Undelayed (black area) • Terminal in the logic: SLOT_F-Q3-C
-K3	3SK1211 output expansion (24 V DC) • Switch setting of the slide switch: Delayed (black area) • Terminal in the logic: SLOT_F-Q4-C
-Q1 to -Q4	Contactors

Logic diagram

Control of the 3SK1 output expansion (-K2)



Control of the 3SK1 output expansion (-K3)



Parameters of the "F output" function

Parameter	Value	Note
Output type	Single F output	-
Feedback circuit monitoring	For OFF and ON status	-
Switching time [s]	0.090	Default value Application-dependent adjustment to the actuator, depending on the actuator's response time
3SK1 output expansion (-K2)		
Q1	SLOT3_F-Q3-C	Safety-related output of the 3SK2 safety relay via device connector interface when the slide switch is set to "Undelayed"
3SK1 output expansion (-K3)		
Q1	SLOT3_F-Q4-C	Safety-related output of the 3SK2 safety relay via device connector interface when the slide switch is set to "Delayed"

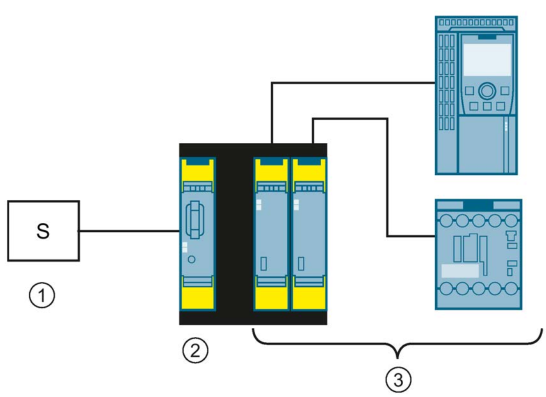
14.4.4 Shutdown with 3SK1 output expansions (Stop Cat. 1) up to SILCL 3 or PL e / Cat. 4

Description

- Shutdown via two 3SK1 output expansions
- Stop category 1
- "Reacting" subsystem up to SILCL 3 as per EN 62061 and PL e / Cat. 4 as per EN ISO 13849-1
- Redundant actuators
- Control of the 3SK1 output expansions via 3ZY12 device connector
- One 3SK1 output expansion shuts down instantaneously and the other after a delay
- Monitoring of the 3SK1 output expansions via the feedback circuit 2 of the device connector

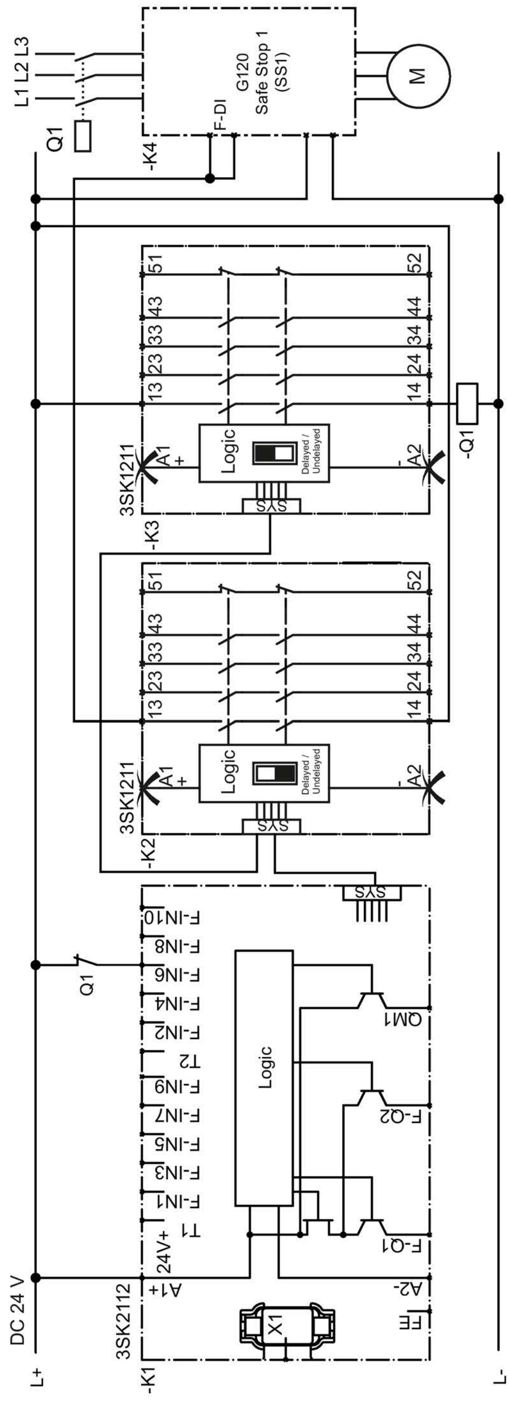
WARNING
Bypassing the Safety Function When Using Device Connectors Can Cause Death, Serious Injury, or Property Damage.
When operating with a 3SK2 safety relay and 3ZY12 device connectors, the supply voltage for the 3SK1 output expansions is established via the 3ZY12 device connectors.
In this case, do not connect anything to terminals A1 and A2 of the 3SK1 output expansions, in order to prevent bypassing of the safety function.

Application



① Detection: Sensor S
② Evaluation: 3SK2 safety relay
③ Reaction: 3SK1 output expansions, 3RT20 contactor and SINAMICS G120 frequency converter

Circuit diagram



-K1 3SK2 safety relay 22.5 mm

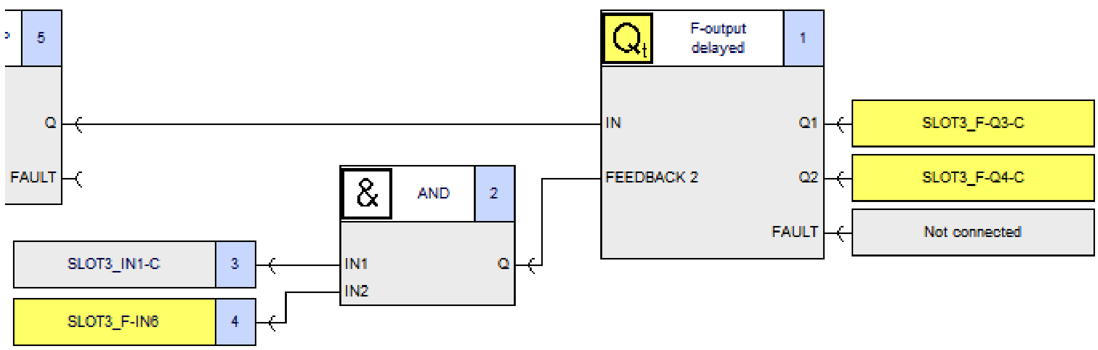
-K2 3SK1211 output expansion (24 V DC)
- Switch setting of the slide switch: Undelayed (black area)
- Terminal in the logic: SLOT_F-Q3-C

-K3 3SK1211 output expansion (24 V DC)
- Switch setting of the slide switch: Delayed (black area)
- Terminal in the logic: SLOT_F-Q4-C

-K4 SINAMICS G120 frequency converters

-Q1 Contactor

Logic diagram



Parameters of the "F output delayed" function

Parameter	Value	Note
Output type	Redundant F output	-
Feedback circuit 1 monitoring	Deactivated	If the feedback contacts of the two actuators are to be monitored with one input, you must use feedback circuit 2.
Feedback circuit 2 monitoring	For OFF and ON status	
Feedback circuit 2 switching time [s]	0,090	Default value Application-dependent adjustment to the actuator, depending on the actuator's response time
Output circuit time-delay (t)-On (Q2-t->Q1) [s]	0,000	Default value Adapt to application
Output circuit time-delay (t)-Off (Q1-t->Q2) [s]	0,000	Default value Adapt to application
Output circuit Q1-Q1	SLOT3_F-Q3-C	Safety-related output of the 3SK2 safety relay via device connector interface when the slide switch is set to "Undelayed"
Output circuit Q1 maximum read-back time [ms]	3,0	Default value Adapt to capacitive load, see Section "Guidelines for capacitive loads (Page 176)"
Output circuit Q1 light test	activated	-
Output circuit Q2-Q2	SLOT3_F-Q4-C	Safety-related output of the 3SK2 safety relay via device connector interface when the slide switch is set to "Delayed"
Output circuit Q2 maximum read-back time [ms]	3,0	Default value Adapt to capacitive load, see Section "Guidelines for capacitive loads (Page 176)"
Output circuit Q2 light test	activated	-

14.4.5 Shutdown of safety-related 3RM1 Failsafe motor starters up to SILCL 3 or PL e / Cat. 4

14.4.5.1 Operational and safety-related switching via 3SK2 safety relay (3ZY12 device connectors)

Description

- Shutdown via 3RM1 Failsafe motor starter
- "Reacting" subsystem up to SILCL 3 as per EN 62061 and PL e / Cat. 4 as per EN ISO 13849-1
- Safety-related control of up to five 3RM1 Failsafe motor starters via 3ZY12 device connectors

Note

As the 3SK1 fail-safe motor starter monitors itself, it does not support an IN1-C feedback circuit signal on the device connector.

- Operational, non-safety-related switching of the 3RM1 Failsafe motor starter through its local input IN1 by means of the 3SK2 safety relay

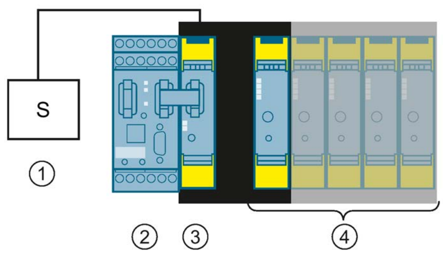
WARNING

Bypassing the Safety Function When Using Device Connectors Can Cause Death, Serious Injury, or Property Damage.

When operating with a 3SK2 safety relay and 3ZY12 device connectors, the supply voltage for 3RM1 Failsafe motor starters is established via the 3ZY12 device connectors.

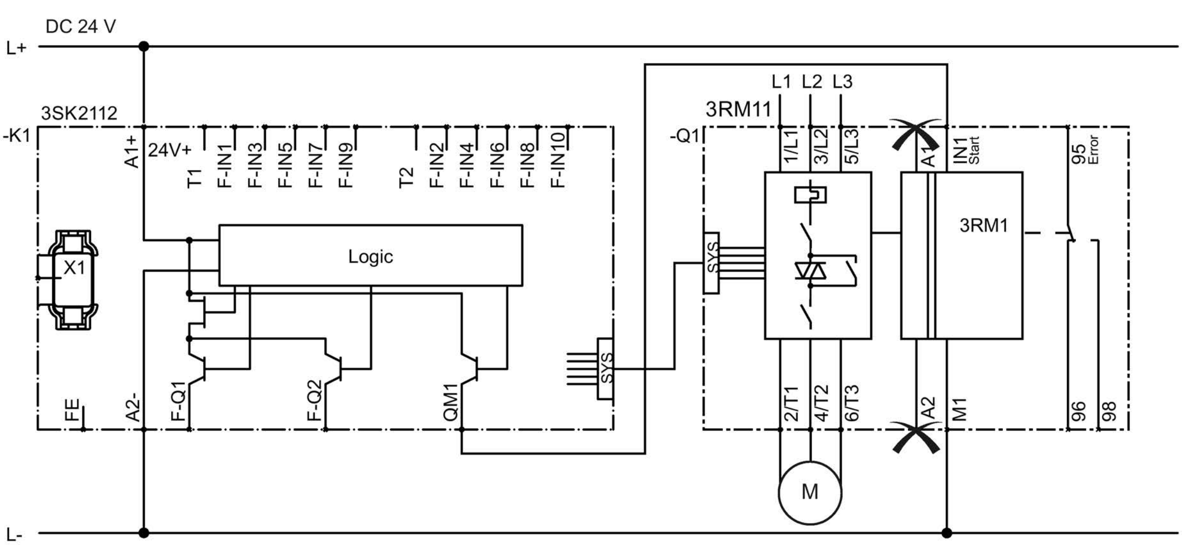
To prevent bypassing of the safety function, do not connect anything to terminals A1 and A2 of the 3RM1 Failsafe motor starters in this case.

Application



①	Detection: Sensor S
②	DP interface
③	Evaluation: 3SK2 safety relay
④	Reaction: up to five 3RM11 Failsafe motor starters (direct-on-line starters)

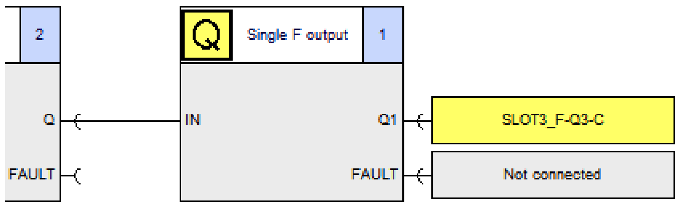
Circuit diagram



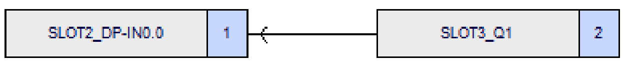
-K1	3SK2 safety relay 22.5 mm
-Q1	3RM11 Failsafe motor starters (direct-on-line starters)

Logic diagram

Safety-related control of 3RM1 Failsafe motor starters



Operational, non-safety-related switching of the 3RM1 Failsafe motor starter



Parameters of the "F output" function

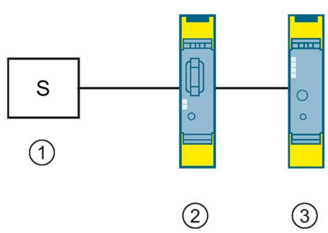
Parameter	Value	Note
Output type	Single F output	-
Feedback circuit monitoring	Deactivated	-
Q1	SLOT3_F-Q3-C	Safety-related output of the 3SK2 safety relay via device connector interface

14.4.5.2 Operational and safety-related switching via 3SK2 safety relay (conventional wiring)

Description

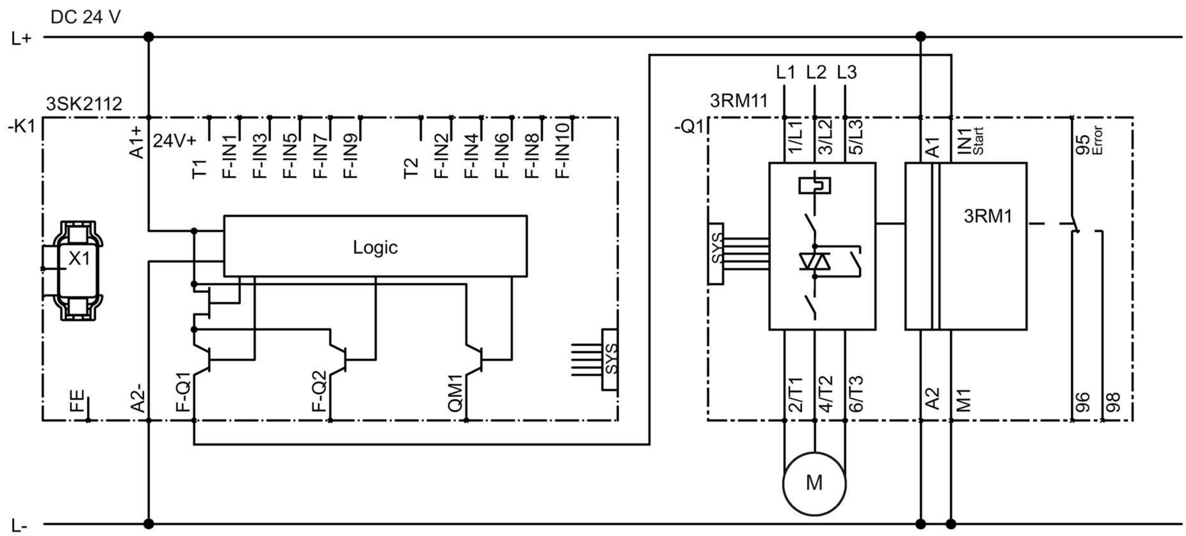
- Shutdown via 3RM1 Failsafe motor starter
- "Reacting" subsystem up to SILCL 3 as per EN 62061 and PL e / Cat. 4 as per EN ISO 13849-1
- Component certified in accordance with EN 62061/EN ISO 13849-1 in the actuator circuit (3RM1 Failsafe motor starter)
- Device supply of the 3RM1 Failsafe motor starter via the terminals A1/A2
- Safety-related switching of the local input of the 3RM1 Failsafe motor starter via fail-safe output of the 3SK2 safety relay
- Suitable for frequently requested safety functions (e.g. on indexing tables)
- No use of device connectors
- Protected laying of signal cables between the 3SK2 safety relay and 3RM1 Failsafe motor starter (in the same control cabinet or in armored conduit)

Application



① Detection: Sensor S
② Evaluation: 3SK2 safety relay
③ Reaction: 3RM11 Failsafe motor starters (direct-on-line starters)

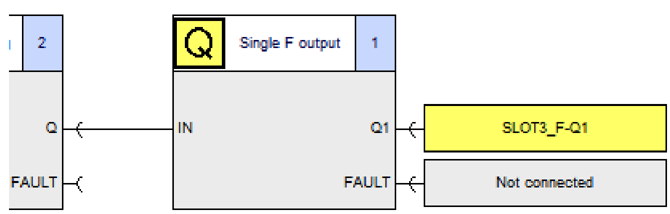
Circuit diagram



-K1 3SK2 safety relay 22.5 mm

-Q1 3RM11 Failsafe motor starters (direct-on-line starters)

Logic diagram



Parameters of the "F output" function

Parameter	Value	Note
Output type	Single F output	-
Feedback circuit monitoring	Deactivated	-
Q1	SLOT3_F-Q1	-

14.4.5.3 Safety-related switching via the 3SK2 safety relay (3ZY12 device connector) and operational switching via PLC

Description

- Shutdown via 3RM1 Failsafe motor starter
- "Reacting" subsystem up to SILCL 3 as per EN 62061 and PL e / Cat. 4 as per EN ISO 13849-1
- Safety-related control of up to five 3RM1 Failsafe motor starters via 3ZY12 device connectors

Note

As the 3SK1 fail-safe motor starter monitors itself, it does not support an IN1-C feedback circuit signal on the device connector.

- Operational, non-safety-related switching of the 3RM1 Failsafe motor starter through its local input IN1 by means of PLC

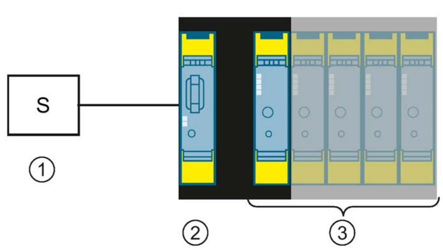
WARNING

**Bypassing the Safety Function When Using Device Connectors
Can Cause Death, Serious Injury, or Property Damage.**

When operating with a 3SK2 safety relay and 3ZY12 device connectors, the supply voltage for 3RM1 Failsafe motor starters is established via the 3ZY12 device connectors.

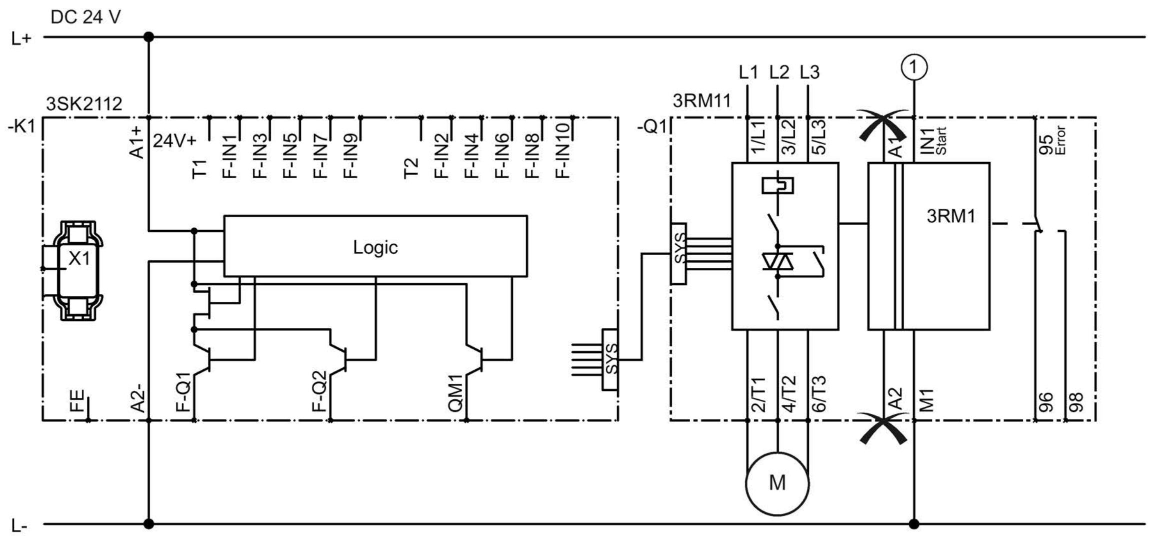
To prevent bypassing of the safety function, do not connect anything to terminals A1 and A2 of the 3RM1 Failsafe motor starters in this case.

Application



① Detection: Sensor S
② Evaluation: 3SK2 safety relay
③ Reaction: up to five 3RM11 Failsafe motor starters (direct-on-line starters)

Circuit diagram

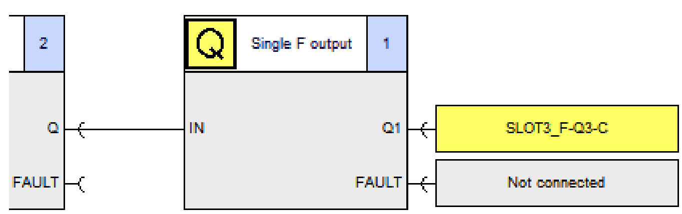


① PLC

-K1 3SK2 safety relay 22.5 mm

-Q1 3RM11 Failsafe motor starters (direct-on-line starters)

Logic diagram



Parameters of the "F output" function

Parameter	Value	Note
Output type	Single F output	-
Feedback circuit monitoring	Deactivated	-
Q1	SLOT3_F-Q3-C	Safety-related output of the 3SK2 safety relay via device connector interface

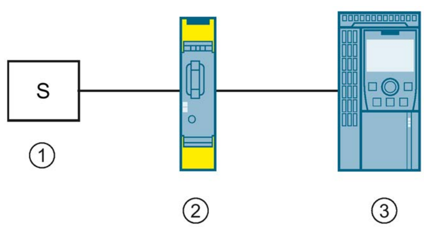
14.4.6 Control of frequency converters up to SILCL 2 and/or PL d / Cat. 3

Description

- Control of frequency converters
- "Reacting" subsystem up to SILCL 2 as per EN 62061 and PL d / Cat. 3 as per EN ISO 13849-1
- Safety-related control of the frequency converter via two safety-related outputs of the 3SK2 safety relay
- The safety function of the frequency converter (e.g. STO, SS1, SS2, SLS) is configured via the converter's software
- Use of two safety-related outputs of the 3SK2 safety relay when actuator cables are laid unprotected in the field.

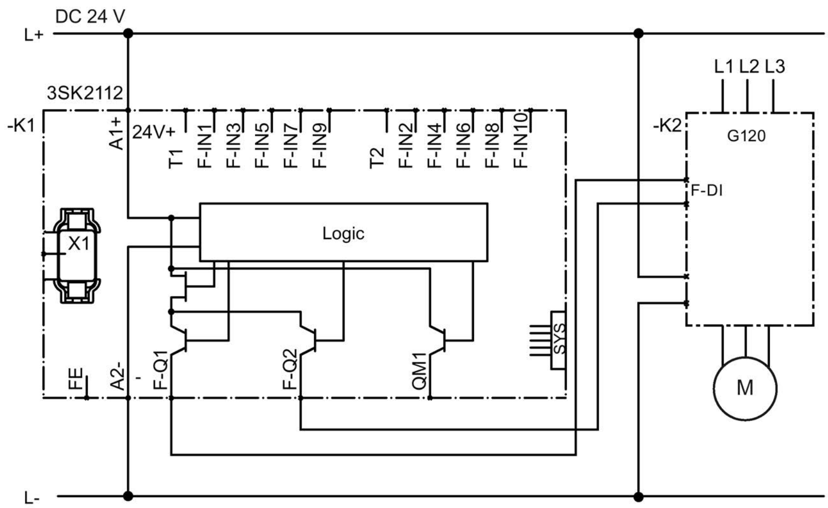
  (In the case of cross-circuit-proof, short-circuit-to-ground-proof laying in the field or in the control cabinet, the frequency converter can be operated at a safety-related output of the 3SK2 safety relay.)

Application



① Detection: Sensor S
② Evaluation: 3SK2 safety relay
③ Reaction: SINAMICS G120 frequency converters

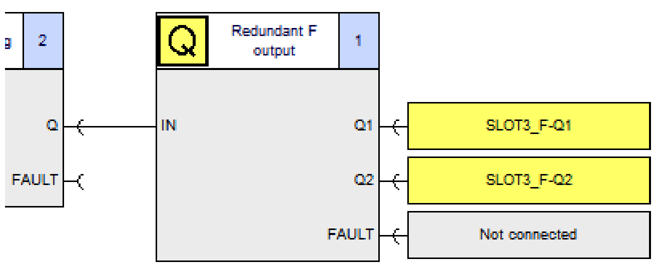
Circuit diagram



-K1 3SK2 safety relay 22.5 mm

-K2 SINAMICS G120C compact inverters

Logic diagram



Parameters of the "F output" function

Parameter	Value	Note
Output type	Redundant F output	-
Feedback circuit monitoring	Deactivated	-
Q1	SLOT3_F-Q1	-
Q2	SLOT3_F-Q2	-

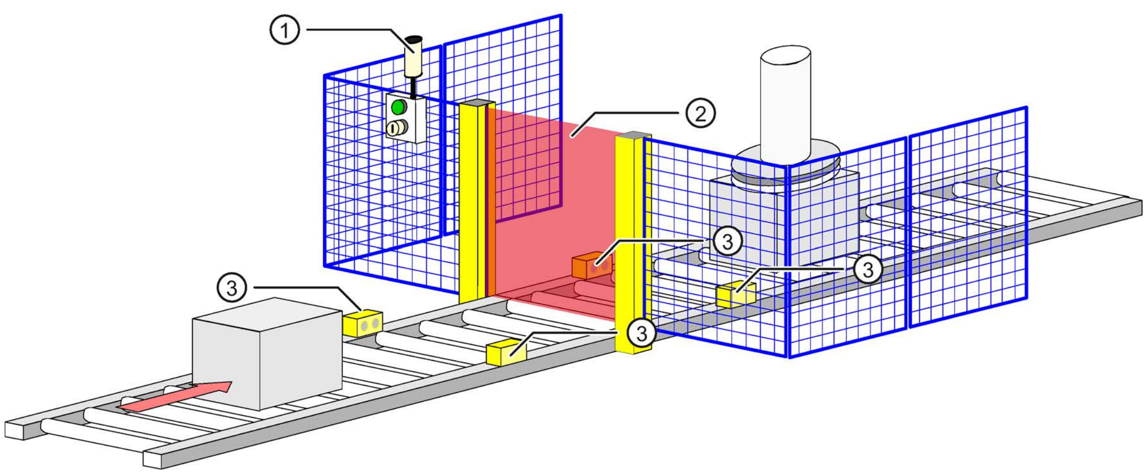
14.5 Complex applications

14.5.1 Muting

Description

If materials have to be conveyed into or out of a hazardous zone for processing, the openings of the access paths can be large enough to enable a person to reach into or enter the hazardous zone. The requirement is to protect persons who may attempt to enter the hazardous zone from harm while allowing the materials to automatically pass unhindered. This is achieved with a special safety circuit that monitors the opening to the hazardous zone with electro-sensitive protective equipment (ESPE) such as a light curtain, and deactivates or "overrides" the protective equipment briefly when the material is conveyed. This safety circuit is known as "muting" and is described in the standard EN 61496-1-A.7. Muting is either already integrated into special light curtains, or it can be implemented via the downstream 3SK2 safety relay evaluation unit.

Application



① Muting indicator light
② Light array
③ Muting sensors

Figure 14-1 Typical muting equipment

Reference

You can find a detailed description of the muting function and its parameterization in the following document:

Link: Muting (http://support.automation.siemens.com/WW/view/en/59847384)

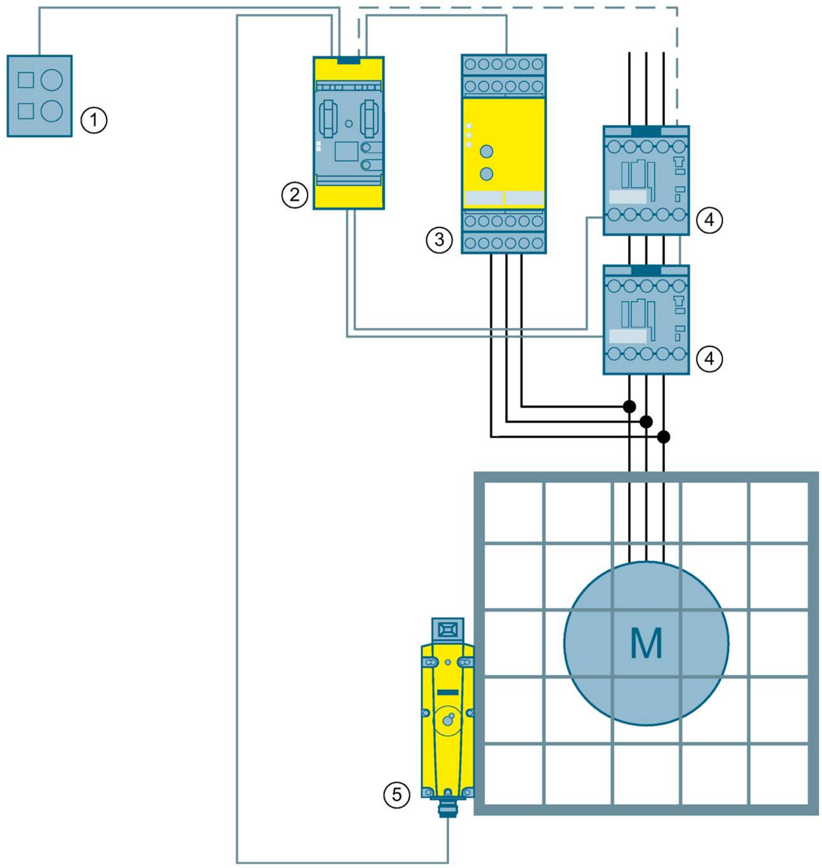
14.5.2 Protective door monitoring with tumbler up to SILCL 2 or PL d / Cat. 3

Description

- Protective door monitoring with tumbler
- SILCL 2 as per EN 62061 and PL d / Cat. 3 as per EN ISO 13849-1

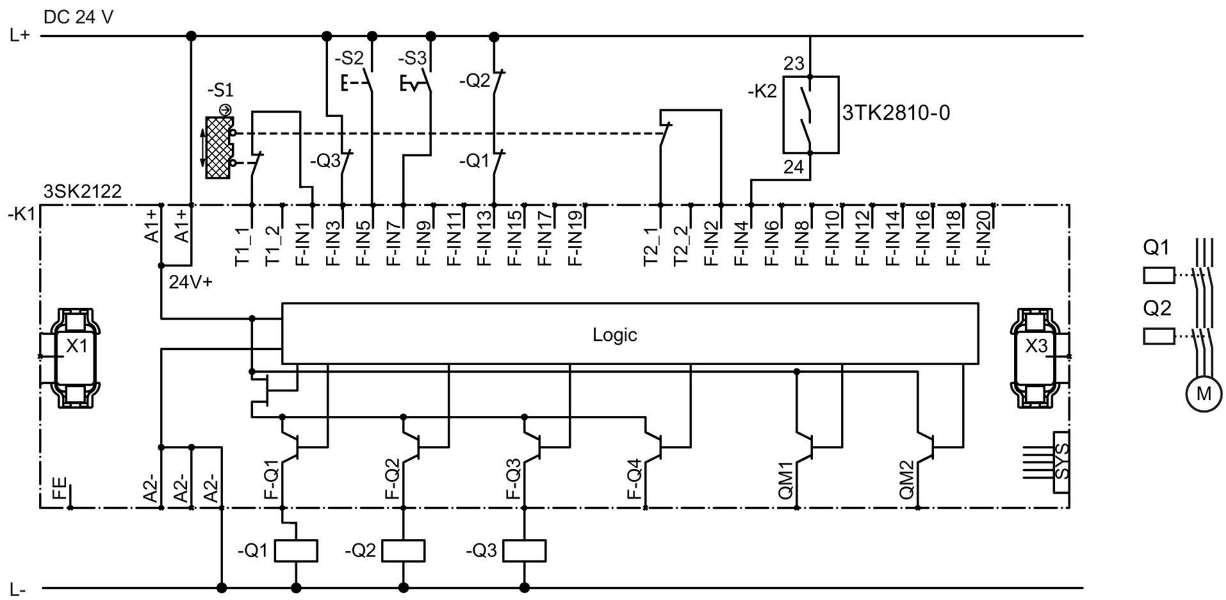
The 3TK2810-0 fail-safe standstill monitor measures a voltage of the coasting motor induced by residual magnetization at three terminals of the stator winding. If the induction voltage falls to zero, this means motor standstill for the device and the output relays are activated. The 3SK2 safety relay monitors this signal from the standstill monitor as well as the 3SE5 position switches. As soon as motor standstill is detected and the button for unlocking is pressed, the tumbler is unlocked and the protective door can be opened. At the same time, the contactors are shut down in a safety-related manner, thus preventing unexpected restarting of the motor. When the door is locked again and the feedback circuit is closed, the Start button can be used to switch on again. EMERGENCY STOP is an additional required safety function that is not considered further here.

Application



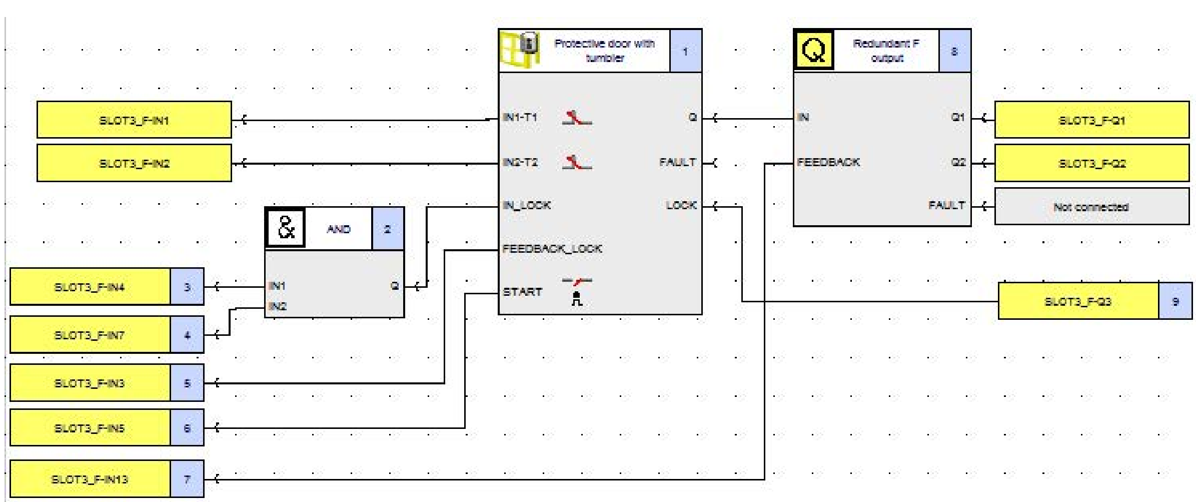
① Starting, unlocking
② Evaluation: 3SK2 safety relay 45 mm
③ Detection: 3TK2810-0 standstill monitors
④ Reaction: 3RT20 contactors
⑤ Detection: 3SE5 position switch

Circuit diagram



-K1	3SK2 safety relay 45 mm
-K2	3TK2810-0 standstill monitors
-S1	3SE5 position switch
-S2	Start
-S3	Unlock
-Q1/-Q2	3RT20 contactors
-Q3	3SE5 tumbler

Logic diagram



Parameters of the "protective door with tumbler" and "F output" function

Protective door with tumbler

Parameter	Value	Note
Discrepancy monitoring	Between all inputs	-
Discrepancy time infinite	✓	Optional: adjustable discrepancy time for earlier fault detection
Type	2-channel (NCNC)	NCNO also possible
IN1	SLOT3_F-IN1	-
IN2	SLOT3_F-IN2	-
Cross-circuit detection	✓	-
Interlock type	Spring locking	or magnetic force, depending on the tumbler's operating principle
Unlocking time [s]	0.000	Unlocking delay between "IN_LOCK" input and "LOCK" output
Feedback circuit monitoring	Activated	Monitors correct functioning of the tumbler unit. In the event of a fault, the "Q" output of the monitoring element is set directly to "zero" or is not enabled.
Feedback circuit switching time [s]	0.090	Default value Adaptation to application
Start type	Monitored	The "Automatic" setting is possible for protective facilities that do not offer rear access. This depends on the risk assessment.

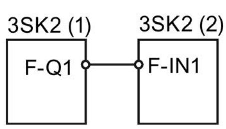
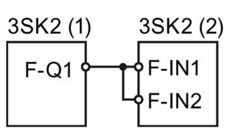
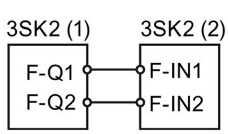
F output

Parameter	Value	Note
Output type	Redundant F output	-
Feedback circuit monitoring	For OFF and ON status	-
Switching time [s]	0.090	Default value Application-dependent adjustment to the actuator, depending on the actuator's response time
Q1	SLOT3_F-Q1	-
Q2	SLOT3_F-Q2	-

14.5.3 Cascading of the 3SK2 safety relay

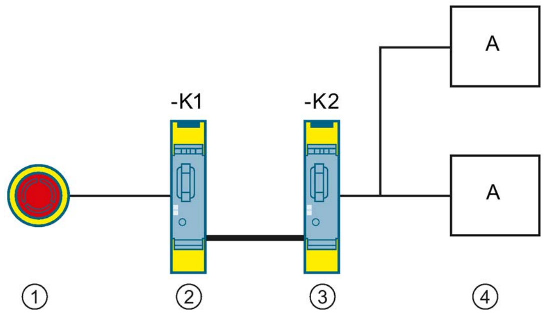
Description

3SK2 safety relays do not possess a safety-related bus connection. If a small number of safety-related signals is to be exchanged between two or more 3SK2 safety relays (e.g. higher-level EMERGENCY STOP commands), the 3SK2 safety relays can be cascaded by means of wiring. The shutdown signal is sent through either one or two channels. The extent to which single-channel wiring is sufficient depends on the required safety level and the laying of cables. Protected laying is required as from safety integrity level (SILCL) 2 or performance level (PL) d. This is ensured if the 3SK2 safety relays are fitted in the same control cabinet or the signal cable is laid in a protected fashion (e.g. in an armored conduit). An external cable fault (current source short circuit) can be ruled out with these measures. If this is not the case, the wiring should be realized in two channels and laid separately.

Architecture	**Laying of signal cables**	**SILCL 1/ PL c**	**SILCL 2/ PL d**	**SILCL 3/ PL e**
Single-channel signal transmission through one output 	Unprotected	✓	-	-
	Protected or in the same control cabinet	✓	✓	-
Two-channel signal transmission through one output 	Unprotected	✓	-	-
	Protected or in the same control cabinet	✓	✓	✓
Two-channel signal transmission through two outputs 	Unprotected	✓	✓[1]	✓[1]
	Protected or in the same control cabinet	✓	✓	✓

[1] Measures must be taken to prevent common cause failures (CCF).

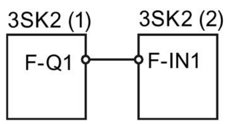
Design



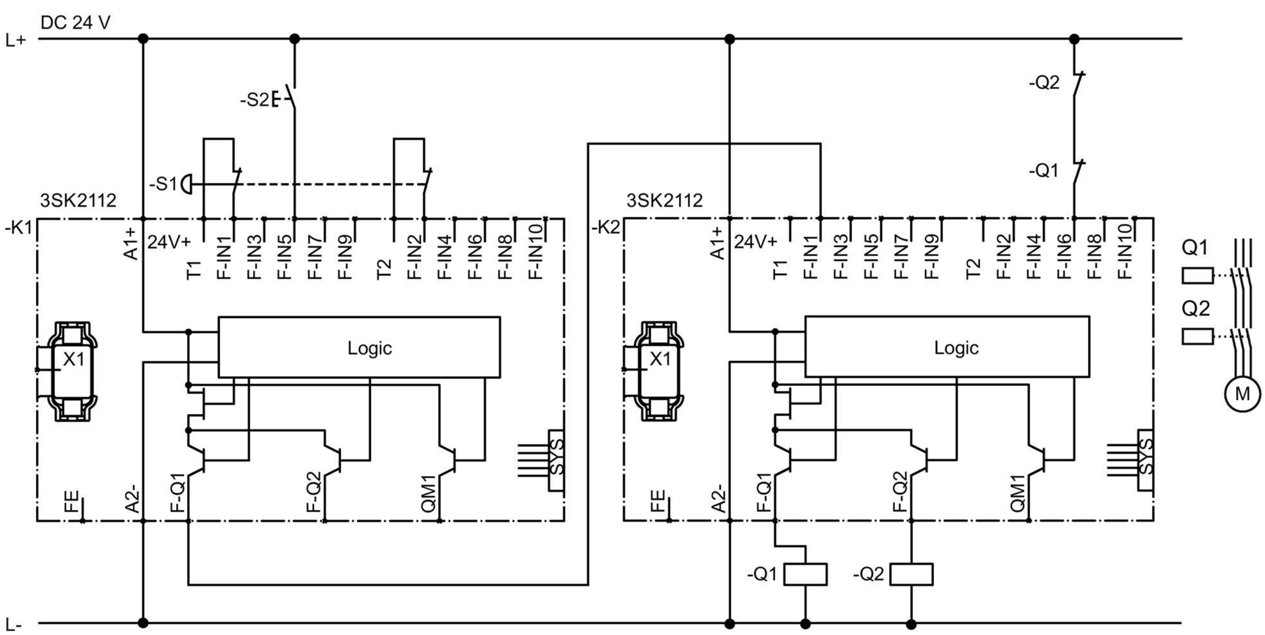
① Detection: EMERGENCY STOP
② Evaluation 1: 3SK2 safety relay
③ Evaluation 2: 3SK2 safety relay
④ Reaction: Actuators

14.5.3.1 Single-channel signal transmission through one output

Description

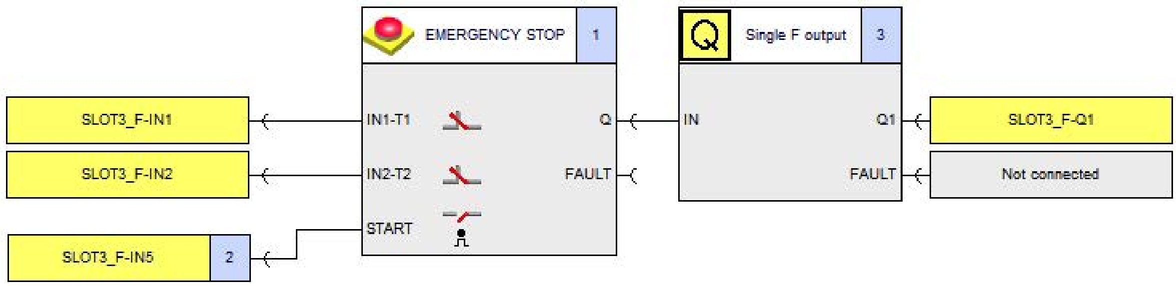
Architecture	Laying of signal cables	SILCL	PL	Category
Single-channel signal transmission through one output 	Unprotected	1	c	2
	Protected or in the same control cabinet	2	d	3

Circuit diagram



-K1	3SK2 safety relay 22.5 mm
-K2	3SK2 safety relay 22.5 mm
-S1	EMERGENCY STOP (two-channel)
-S2	Start
-Q1/-Q2	e.g. 3RT20 contactors

Logic diagram 3SK2 safety relay (-K1)



Parameters of the functions of the 3SK2 safety relay (-K1)

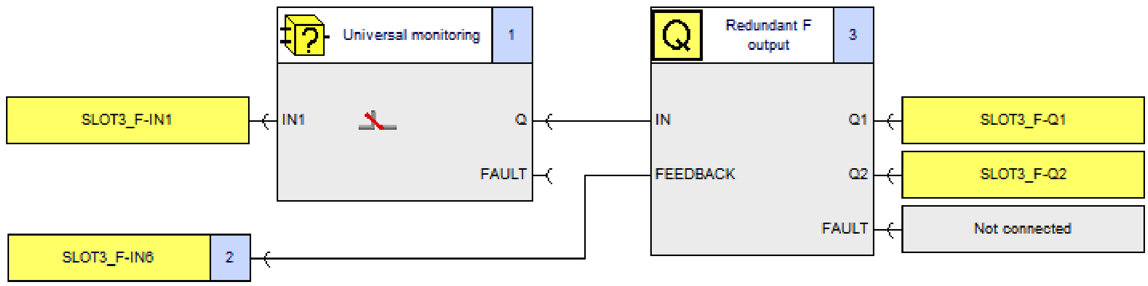
EMERGENCY STOP

Parameters	Value	Note
Type	2-channel (NCNC)	-
IN1	SLOT3_F-IN1	-
IN2	SLOT3_F-IN2	-
Cross-circuit detection	✓	-
Start type	Monitored	-

F output

Parameters	Value	Note
Output type	Single F output	-
Feedback circuit monitoring	Deactivated	-
Q1	SLOT3_F-Q1	-

Logic diagram 3SK2 safety relay (-K2)



Parameters of the functions of the 3SK2 safety relay (-K2)

Universal monitoring

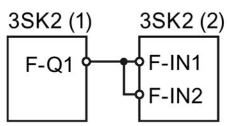
Parameter	Value	Note
Type	1-channel (NC)	-
IN1	SLOT3_F-IN1	-
Cross-circuit detection	Deactivated	-
Start type	Automatic	Local acknowledgement is necessary (by means of monitored start and a separate command point) if the danger zone is not visible.

F output

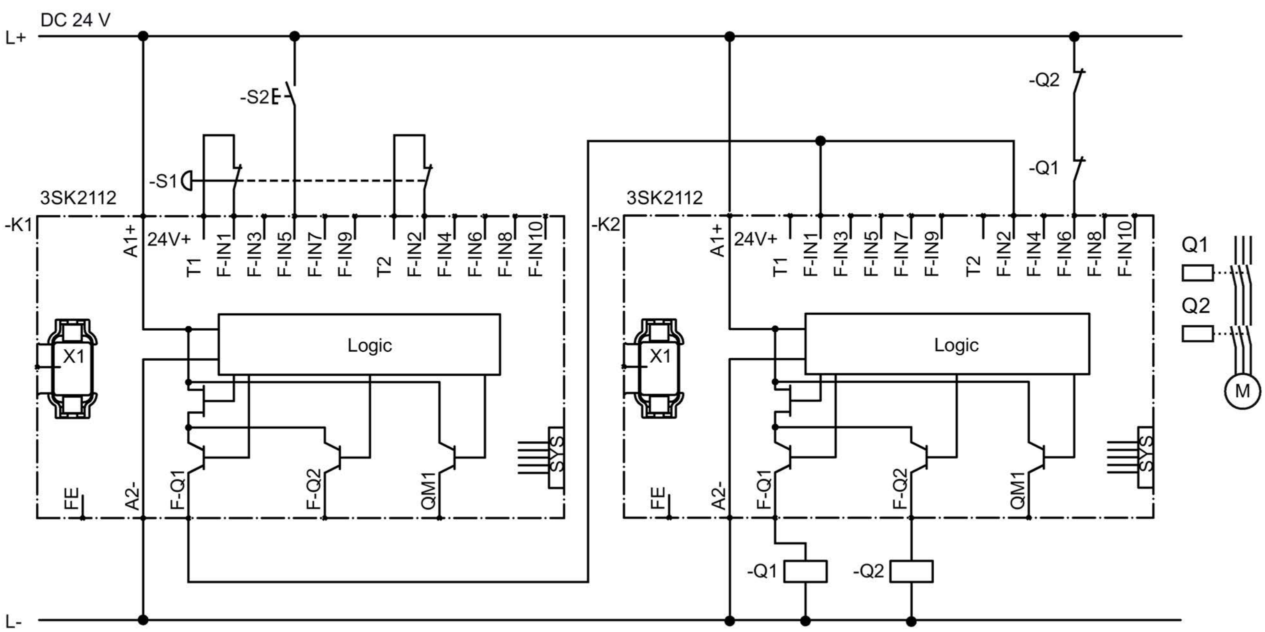
Parameter	Value	Note
Output type	Redundant F output	-
Feedback circuit monitoring	For OFF and ON status	-
Switching time [s]	0.090	Default value Application-dependent adjustment to the actuator, depending on the actuator's response time
Q1	SLOT3_F-Q1	-
Q2	SLOT3_F-Q2	-

14.5.3.2 Two-channel signal transmission through one output

Description

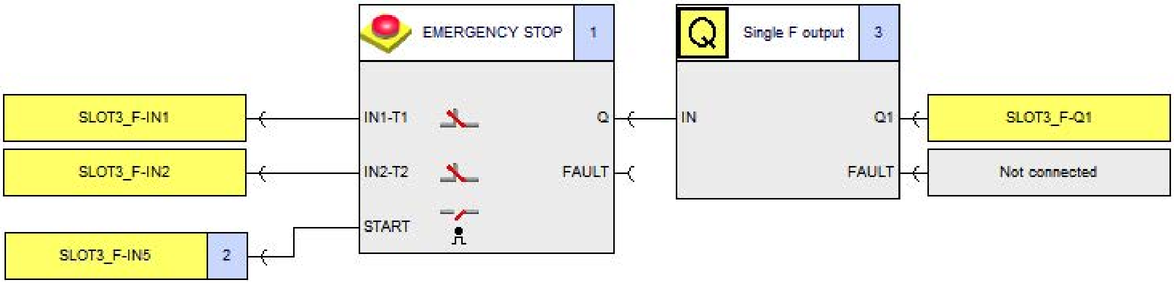
Architecture	Laying of signal cables	SILCL	PL	Category
Two-channel signal transmission through one output 	Unprotected	1	c	2
	Protected or in the same control cabinet	3	e	4

Circuit diagram



-K1	3SK2 safety relay 22.5 mm
-K2	3SK2 safety relay 22.5 mm
-S1	EMERGENCY STOP (two-channel)
-S2	Start
-Q1/-Q2	e.g. 3RT20 contactors

Logic diagram 3SK2 safety relay (-K1)



Parameters of the functions of the 3SK2 safety relay (-K1)

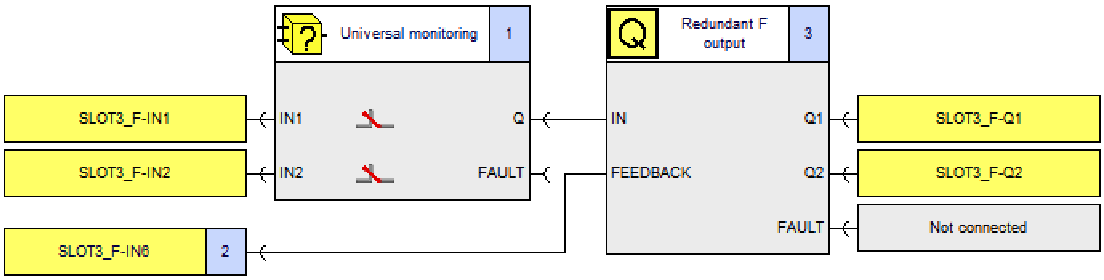
EMERGENCY STOP

Parameters	Value	Note
Type	2-channel (NCNC)	-
IN1	SLOT3_F-IN1	-
IN2	SLOT3_F-IN2	-
Cross-circuit detection	✓	-
Start type	Monitored	-

F output

Parameters	Value	Note
Output type	Single F output	-
Feedback circuit monitoring	Deactivated	-
Q1	SLOT3_F-Q1	-

Logic diagram 3SK2 safety relay (-K2)



Parameters of the functions of the 3SK2 safety relay (-K2)

Universal monitoring

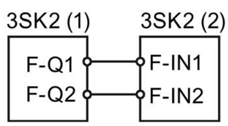
Parameter	Value	Note
Type	Two-channel (NCNC)	-
IN1	SLOT3_F-IN1	-
IN2	SLOT3_F-IN2	-
Cross-circuit detection	Deactivated	-
Start type	Automatic	Local acknowledgement is necessary (by means of monitored start and a separate command point) if the danger zone is not visible.

F output

Parameter	Value	Note
Output type	Redundant F output	-
Feedback circuit monitoring	For OFF and ON status	-
Switching time [s]	0,090	Default value Application-dependent adjustment to the actuator, depending on the actuator's response time
Q1	SLOT3_F-Q1	-
Q2	SLOT3_F-Q2	-

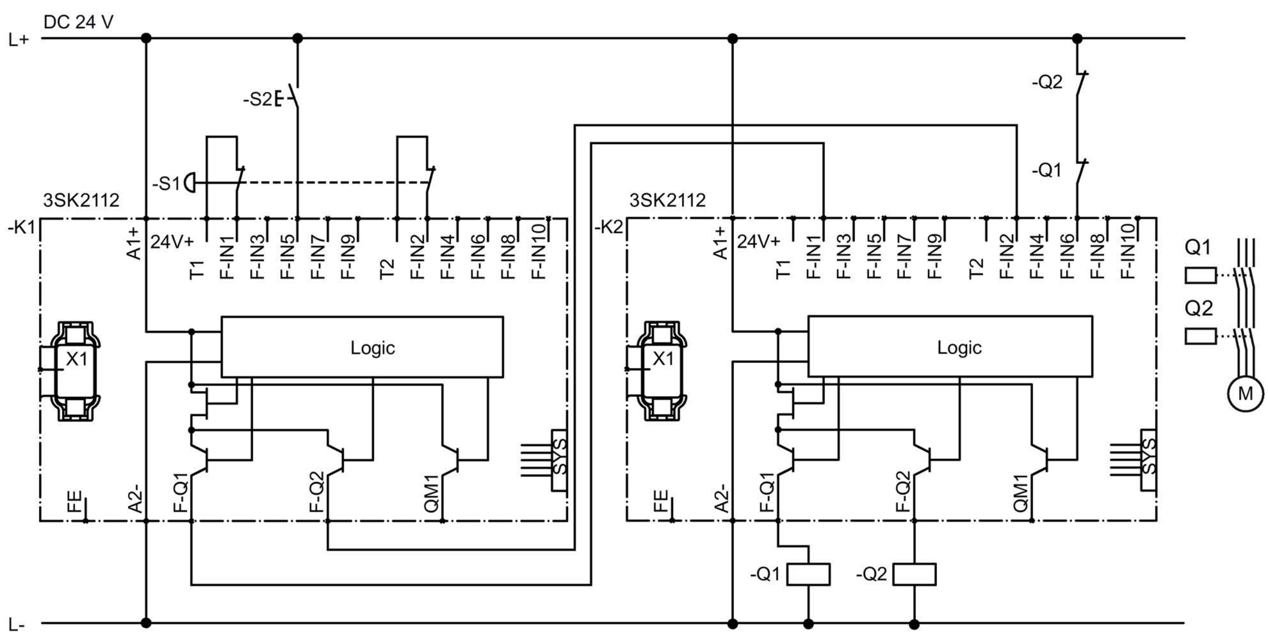
14.5.3.3 Two-channel signal transmission through two outputs

Description

Architecture	Laying of signal cables	SILCL	PL	Category
Two-channel signal transmission through two outputs  	Unprotected	3	e [1)]	4[1)]
	Protected or in the same control cabinet	3	e	4

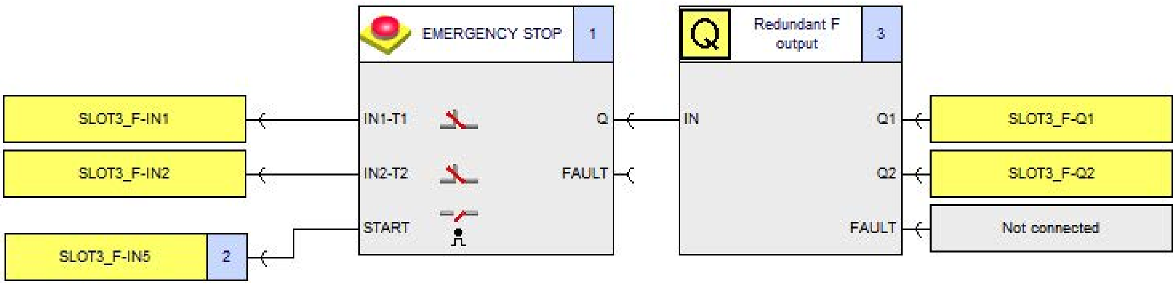
[1)] Measures must be taken to prevent common cause failures (CCF).

Circuit diagram



-K1 3SK2 safety relay 22.5 mm
-K2 3SK2 safety relay 22.5 mm
-S1 EMERGENCY STOP (two-channel)
-S2 Start
-Q1/-Q2 e.g. 3RT20 contactors

Logic diagram 3SK2 safety relay (-K1)



Parameters of the functions of the 3SK2 safety relay (-K1)

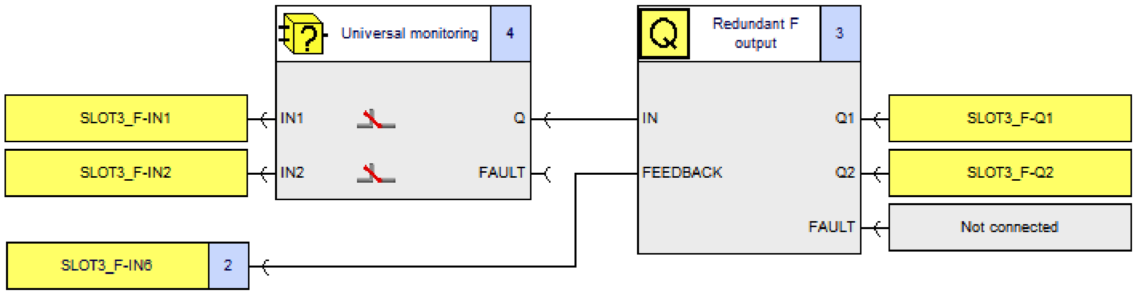
EMERGENCY STOP

Parameter	Value	Note
Type	Two-channel (NCNC)	-
IN1	SLOT3_F-IN1	-
IN2	SLOT3_F-IN2	-
Cross-circuit detection	✓	-
Start type	Monitored	-

F output

Parameter	Value	Note
Output type	Redundant F output	-
Feedback circuit monitoring	Deactivated	-
Q1	SLOT3_F-Q1	-
Q2	SLOT3_F-Q2	-

Logic diagram 3SK2 safety relay (-K2)



Parameters of the functions of the 3SK2 safety relay (-K2)

Universal monitoring

Parameter	Value	Note
Discrepancy monitoring	Between all inputs	-
Discrepancy time infinite	✓	Optional: adjustable discrepancy time for faster fault detection
Type	2-channel (NCNC)	-
IN1	SLOT3_F-IN1	-
IN2	SLOT3_F-IN2	-
Cross-circuit detection	Deactivated	-
Start type	Automatic	Local acknowledgement is necessary (by means of monitored start and a separate command point) if the danger zone is not visible.

F output

Parameter	Value	Note
Output type	Redundant F output	-
Feedback circuit monitoring	For OFF and ON status	-
Switching time [s]	0,090	Default value Application-dependent adjustment to the actuator, depending on the actuator's response time
Q1	SLOT3_F-Q1	-
Q2	SLOT3_F-Q2	-

Glossary

*.sdp file

File for storing parameterization data of a device (switching device parameters) on a programming device / PC. Safety ES projects are saved in files with this extension (*.sdp).

Address

Each device receives an individual address to enable its identification.

Baud rate

The baud rate is the data transfer rate, indicating the number of bits transferred per second (baud rate = bit rate).

Catalog window

View in the Safety ES interface; tree representation of elements that can be dragged and dropped into the work space (in the configuration view: Modules; logical view: Function elements).

Configuration

Defines the configuration of a device or system and the arrangement of the components.

CPU

The central processing unit (CPU) or the main processor is the main processing element of a computer system.

Cross-circuit detection

Current-source short circuit

In the direct voltage system of the safety relays, current-source short circuit means a short circuit between a conductor and a positive potential (+ 5 V or + 24 V).

Cyclic data exchange

Transmission of data between partners. This can be performed without error detection and correction (i.e. datagram) and with error detection and correction (i.e. connection oriented). The user program runs in a recurring program loop, termed a cycle.

Cyclic redundancy check (CRC)

CRC is a test procedure for checking for data corruption. A generator polynomial is used to generate a checksum from the monitored data that then acts as a signature for it. There are different algorithms for calculating the polynomial generator.

Dark period

Dark periods occur during shutdown tests and complete bit pattern tests. Test-related 0 signals are switched from the fail-safe output module to the output bit while the output is active. This output is then briefly disabled (= dark period). A sufficiently slow actuator does not respond to this and remains switched on.

Dark test

A dark test is the brief deactivation of an activated safety-related output of the 3SK2 safety relay to ensure that the output can be deactivated at any time should safety requirements dictate it. To this end, the chosen test pulse is so short that a connected actuator does not shut down as a result.

Data set (DS)

A data set groups together data that belong to a single unit by virtue of logic or content.

DC

Diagnostic coverage

DI

Digital input

Diagnostic test interval

Time between online tests to detect faults in a safety-related system with specified diagnostic coverage level.

Discrepancy monitoring

A two-channel or multi-channel sensor can be monitored for signal discrepancy (= discrepancy monitoring). Discrepancy monitoring is possible with the following monitoring criteria:

- Discrepancy monitoring monitors the values of the input signals when changing from 1->0 or 0->1 at at least one input to check that they are the same after a certain time, the "discrepancy time".
- Discrepancy monitoring monitors the values of the input signals for the simultaneous presence of the value "0".

While a discrepancy error is active, it is impossible to set the function output Q to the value "1".

Discrepancy time

Parameterizable time for the discrepancy analysis.

The discrepancy time monitoring tolerates associated signals not being available at the same time within a defined time window. The signal transmitters are monitored to increase the functional reliability. The signal change of the signal transmitters is checked within the defined time. If this time is exceeded, an enable signal is not output. This type of monitoring is mandatory for a number of protective safety devices.

If the discrepancy time is set too high, the error detection time and error response time will be prolonged to no useful effect. If the discrepancy time is set too low, the availability is reduced to no useful effect because a discrepancy error will be detected even if there is no real error.

DO

Digital output

Element identifier

Parameterizable name for a circuit element.

Element number

Unique and type-independent identification numbers for switching elements that are assigned by the system and can be parameterized.

ESPE (electro-sensitive protective equipment)

Unit comprising devices and/or components that are actuated non-mechanically and that work together for the purpose of detecting the approach or presence of persons. The unit contains at least a detection function, a control/monitoring function, and one or more output signal switching devices.

Examples include light barriers, capacitive, active infrared, ultrasonic, and camera systems. The safety-related control system combined with the ESPE, or the ESPE itself, can additionally contain a second shutdown device, multifunctions, standstill monitoring, start inhibit, restart inhibit, etc.

EUC

Abbreviation for equipment under control

Fault response time (response time in the event of a fault)

The fault response time is the time between detecting a hazardous fault in a system and that system assuming the safe state.

The fault response time of the 3SK2 safety relay depends on whether an output is controlled through one channel or two.

Fault tolerance

Ability of a functional unit to continue executing a required function in the presence of faults or deviations.

Feedback circuit

The feedback circuit of a safety function monitors the connected actuators with positively-driven contacts. The normally closed contacts of the actuators with positively-driven contacts are used to check whether these have assumed their safe state before being activated again.

Forcing

Signal state of an output is set to a fixed value irrespective of the actual signal state value.

This function overwrites a variable (e.g. flag, output) with a defined value. The variable is also write-protected so that this value cannot be changed from any source (including the user program). The value is retained even after the PG has been removed. The write protection can only be removed in error-free operation by calling the "unforce" function and assigning the value defined by the user program to the variable again. In the event of a fault (e.g. connection loss, device fault, etc.), write protection is revoked early.

The "force" function can be used, for example, to set certain outputs to the "ON" state for any length of time during the commissioning phase if the conditions of logic operations of the user program are not fulfilled (for example, because inputs have not yet been wired).

Function / function element

Blocks in the logic diagram of the software (e.g. EMERGENCY STOP function, ESPE, etc.)

FW

Abbreviation for firmware

Group warning

For all device diagnostic buffer entries that can result in internal tripping, a group warning is generated if the relevant message (e.g. unbalance) is set and the associated internal trip signal (e.g. unbalance trip) is not set. This warning is entered in the I/O area. The bit for group errors in the I/O area is not set.

GSD file (device master file)

File that describes the properties of a PROFIBUS DP slave or a PROFINET IO device. Standardized description of a DP standard slave for connection to a higher-level engineering system (e.g. STEP 7).

HFT

Hardware fault tolerance

HW

Abbreviation for hardware

I&M data

Identification and maintenance data. Identification data (I data) is information about the module, some of which is also printed on the module housing.

I data is only read. Maintenance data (M data) is plant-specific information, such as the installation location, installation date, etc. M data is created and written to the module during commissioning. Identification and maintenance data (I&M) is information stored in a module that supports you with

- Checking the system configuration
- Locating modified system hardware
- Troubleshooting a system.

I&M data can be used to identify modules uniquely on the network.

IBS

Abbreviation for commissioning

Input delay

Parameter that is used to suppress interference pulses of 0 ms up to a set input delay time.

The set input delay is subject to a tolerance that can be looked up in the technical data of the module. A long input delay will suppress longer interference pulses; a short delay will suppress shorter interference pulses. The permissible input delay depends on the cable length between the transmitter and module.

Input with a single channel

The safety relay is controlled by means of a single signal transmitter contact or output. Note: With this type of control, the safety equipment can achieve up to Category 2 according to EN ISO 13849-1.

Input with two channels

The safety relay is controlled by means of two signal transmitter contacts or outputs.

Note: With this type of control, the safety equipment can achieve up to Category 4 according to EN ISO 13849-1 if the safety relay has a cross-circuit fault detection function. The two signal transmitters must be part of one item of protective equipment (emergency stop command device, guard). If a two-channel safety relay is controlled through one channel, the signal transmitter contact or output must switch both channels of the safety relay.

Interconnection rule

Rules that have to be followed in creating the safety circuit (logic).

Interlock

According to the standard EN 1088: A mechanical, electrical or another device that has the function of preventing the operation of a machine element under certain specific conditions (usually for as long as the protective door is not closed).

Light test

The light test is understood to consist of brief activation of a deactivated safety-related output to test whether the output is functioning without faults. A sufficiently slow actuator does not respond to this and remains switched off.

Lock (tumbler mechanism)

According to EN 1088, the objective of a tumbler mechanism is to maintain a guard in the closed position. It is also connected to the control so that the machine cannot operate if the guard is not closed and that the guard is kept closed until the risk of injury is no longer present.

Logical input/output terminal

Inputs and outputs whose signals are transferred over a fieldbus system (e.g. PROFIBUS, AS-i) are termed "logical input and output terminals" in the manual.

Maximum read-back time of the dark test

The maximum read-back time of the dark test determines its maximum duration. The restart standby time is also determined by the maximum read-back time. The activation lock must not be canceled again until an output has been detected as having been deactivated.

MSS

Modular Safety System: MSS denotes a modular safety relay product family from SIEMENS.

MTTR

Mean time to restoration: expected time required to achieve restoration.

Muting

Muting is the temporary deactivation or cancellation of a safety function, e.g. light array, that must be passed through.

EN 61946-1:
Override function: Temporary automatic overriding of the protection function with additional sensors to distinguish between people and objects.

Navigation window

Representation in the Safety ES interface; tree structure with which the view shown in the work space can be selected ("Configuration" view, "Logic" view).

Offline project

The safety circuit is provided in the form of a program file and can be opened using the software.

Online project

A safety circuit is present in the safety relay and can be read out using the software.

Output window

View in the software interface in which messages or similar are displayed.

Parameters

Parameters are values that can be used to control the behavior of the devices.

PC cable

The PC cable is used to connect a PC, via its serial interface, for example, to the system interface of a safety relay for device parameterization.

PELV

Protective Extra-Low Voltage. PELV (Protective Extra-Low Voltage, formerly referred to as "protective extra low voltage with safe isolation") offers protection against electric shock. It is dealt with in EN 50178.

PELV power section

Ensures a circuit with a voltage that does not exceed the PELV with safe isolation from other circuits (not PELV circuits). In addition, grounding facilities are provided for PELV circuits and/or their accessible conducting parts.

PFH

Probability of dangerous failure per hour.

PII

Process image input

PIQ

Process Image Output

PLC

Abbreviation for programmable logic controller (e.g. SIMATIC S7)

Process response time

The process response time is synonymous with the process safety time.

Process safety time

The period of time between the failure of the EUC (equipment under control) or of the EUC higher-level control or control system with the potential to cause a dangerous incident, and the time when the response in the EUC must be completed to prevent the occurrence of the dangerous incident (definition from EN 61508-4 3.6.20).

Program cycle time

The program cycle time describes the time in which the safety circuit (PII -> PIQ) is calculated in full once.

Programmable controller (PLC)

Controller whose functionality is defined by a user program stored in the controller. The PLC comprises a CPU, memory, input/output modules and internal bus system. The I/O and the programming language are oriented to control engineering needs.

Programming device (PG)

A PG is a PC that is suitable for use in industry, compact, and portable. Its distinguishing feature is the special hardware and software for programmable controllers (SIMATIC).

Redundant structure

Configuration variant of S7 FH systems in safety operation to increase availability. F-CPU, PROFIBUS-DP, and F I/Os are provided double. In case of a fault, the F I/Os continue to be available.

Reference designation (BMK)

Inputs and outputs or terminals of different devices within a system can be addressed uniquely using the reference designation.

The current reference designations (previously known as equipment identifiers) can be found in EN 61346-2. The standard EN 61346-2 replaces DIN 40719-2 and has been valid since June 1, 2001. The 3-year transition deadline expired on June 1, 2003.

Reliability

In the safety-related sense, the term reliability refers to the probability of hardware component failure. When dealing with software/firmware, we speak of "expectations" here.

Reset

Tripping, i.e. disconnection and prevention of reclosure of an affected output due to a fault (e.g. cross-circuit, discrepancy time violation) can be acknowledged with Reset.

Response time

Time that a system needs to respond at an output after an input variable has been modified. It is therefore the total time between an event and the action, e.g. from terminal to terminal.

The real response time is somewhere between a minimum and a maximum response time. Allowances must be made in the system configuration for the expected maximum response time.

Response time (in error-free operation)

The response time is the time up to which a system responds after a change of an input variable at an output, i.e. the time between the event and the action, e.g. terminal-terminal or sensor-actuator in the event of operational switching.

The response time in error-free operation is calculated in order to define the process in the system. This time is **not** suitable for the determination of safety clearances in the system.

Restart

The device carries out a complete restart as with Power-ON. However, the auxiliary power for the electronics does not have to be switched off; something that is often difficult in practice in the installed state. A restart can be forced by the command "Restart", for example.

Result of logic operation (RLO)

Binary result of a logical combining of several items of data.

S7 routing

The term routing denotes a transition from one subnet to one or several other subnets in a SIMATIC station that possesses interfaces to the applicable subnets.

Routing makes it possible to reach S7 stations online across subnet boundaries using a PG/PC, for example to download user programs or a hardware configuration or to be able to execute testing and diagnostic functions.

You can connect a PG/PC anywhere on the network and establish an online connection to all stations reachable via network transitions.

Safe state

The basis of the safety concept in safety-related systems is that a safe state exists for all process variables that can also be specified by the user. (Substitute value for failed inputs; initial state in the event of a "safety-related incident"). Generally, the safe state signifies signal level = 0 in the case of inputs and deactivation of the output in the case of outputs.

Safety circuit

A safety circuit encompasses the section of a safety system that is located before a safe output and sets this output.

Safety systems

Safety systems are intended to play their role in keeping potential hazards for both people and the environment as low as possible by using suitable technical equipment, without restricting, more than absolutely necessary, industrial production and the use of machines. The protection of man and environment has to be put on an equal footing in all countries by applying rules/regulations that have been internationally harmonized. These regulations are also intended to avoid the distortion of competition due to differing safety requirements in international trade.

Safety-related input/output

An input / output showing a defined residual fault probability or a specific SILCL / PL / Cat., in order to be categorized as "safe".

Safety-related slave

Slave for connecting safety-related sensors, actuators, and other devices.

SC

Abbreviation used for semiconductor. Used in conjunction with inputs and outputs (e.g. "SC outputs").

Sequence monitoring

If at least two function inputs are parameterized on an input element, sequence monitoring is possible. Sequence monitoring monitors the sequence of the remaining input signals in the case of a signal change from 0 -> 1 at an input. The simultaneous response of input signals constitutes a sequence violation. While a sequence error is active, it is impossible to set the function output Q to the value "1".

SFF

Safe failure fraction

Short circuit to ground

Short circuit to ground: A short circuit between a conductor and ground in a DC voltage system.

SIL

Safety integrity level

Startup test

Manually or automatically conducted test of the safety-related evaluation device after the supply voltage has been applied to the safety-related evaluation device.

One example of such a test is manually opening and closing a guard after the supply voltage has been switched on.

STOP category 0

EN 60204-1: Uncontrolled stop by means of immediate power shutdown.

STOP category 1

EN 60204-1: Controlled stop by means of interrupting the power supply when standstill has been reached

Substitute value

Substitute values are, for example, values that are output to the process if signal output modules or signal input modules are defective.

Substitute values are used in the user program instead of a process value. In some cases, the substitute values can be preset. These are values that the outputs or output will output in case of CPU STOP.

On the safety relay, a substitute value can be set as a fixed value for a deactivated function element.

SW

Abbreviation for software

Synchronous operation time

Two input signals are monitored for simultaneity especially at signal change. Any deviation of the signal from the setpoint is tolerated for the duration of the synchronous operation time without a fault being generated.

Target/actual comparison

Comparison of configured and actual system configuration.

Terminal comments

Parameterizable remarks referring to an input or output terminal.

Terminal identifier

Symbolic name for an input or output terminal that can be parameterized.

Test mode

Test mode is used to test and optimize the parameterization of the safety relay. In test mode, it is possible to observe and modify values of function outputs.

Validation

Confirmation based on an inspection and provision of verification that the special requirements for a particular intended use have been met. Validation is the activity that explains that the safety-related system under inspection corresponds to the safety requirements of the safety-related system in all respects of the specification before and after installation.

Verification

Confirmation based on an inspection and provision of verification that the requirements have been met. Verification is the activity that explains in each phase of the relevant safety life cycle through analysis and/or testing that the supplied elements fulfil in every respect the targets and requirements defined for this phase.

Work space

View in the software interface in which the configuration is created.

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