SIEMENS

Industrial Controls

Safety Systems

Modular Safety Systems SIRIUS 3RK3

Manual

Edition 09/2015

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Industrial Controls

Safety systems
SIRIUS 3RK3 Modular Safety System

Manual

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09/2015
NEB926253002000/RS-AB/005

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.

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Qualified Personnel

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

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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.

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3ZX1012-0RK31-1AC1
℗ 09/2015 Subject to change

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About this manual 1

1.1 Purpose of this manual

This manual contains a detailed description of the SIRIUS 3RK3 Modular Safety System (MSS 3RK3 for short) and its components. This manual provides you with the information you require for configuring, commissioning, operating, and diagnosing the MSS 3RK3. A typical safety application will provide you with a clear and practice-oriented introduction to the system.

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 components of the MSS 3RK3 stated below with article numbers:

Component	Article number
3RK3 Basic (central unit)	3RK3111-xAA10
3RK3 Advanced (central unit)	3RK3131-xAC10
3RK3 ASIsafe basic (central unit)	3RK3121-xAC00
3RK3 ASIsafe extended (central unit)	3RK3122-xAC00
4/8F-DI (expansion module)	3RK3211-xAA10
2/4F-DI 1/2F-RO (expansion module)	3RK3221-xAA10
2/4F-DI 2F-DO (expansion module)	3RK3231-xAA10
4F-DO (expansion module)	3RK3242-xAA10
4/8F-RO (expansion module)	3RK3251-xAA10
8DI (expansion module)	3RK3321-xAA10
8DO (expansion module)	3RK3311-xAA10
DP interface (interface module)	3RK3511-xBA10
Diagnostics display	3RK3611-3AA00

x = 1: Version with screw-type terminals:

x = 2: Version with spring-loaded terminals:

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

This manual consists of instructive chapters for reference purposes. The table below contains a list of the most important topics dealt with, along with their associated target groups.

Subject	Target group
Overview	Configuration engineers, planning engineers
Getting Started	Configuration engineers, planning engineers
Description of the hardware: • Mounting / installing / attaching • Connecting / wiring	Configuration engineers, planners, installation engineers, electricians, service and maintenance personnel
Operation (Reaction times, commissioning, tips and tricks, PROFIBUS connection, AS-i connection)	Configuration engineers, commissioning engineers, installation engineers, service and maintenance personnel
Diagnostics / service	Configuration engineers, service and maintenance personnel
Technical data	Configuration engineers
Dimension drawings	Configuration engineers

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 of the manual	Document number
SIRIUS engineering Safety ES V1.0 (software)	3ZX1012-0CS13-1AB1
SIRIUS Safety Integrated application manual	3ZX1012-0SK11-1AB1
SIMATIC NET PROFIBUS Network Manual	C79000-G8900-C124-03
AS-Interface system manual	3RK2703-3AB02-1AA1

Interesting links

- Manuals in Siemens Industry Online Support (https://support.industry.siemens.com/cs/ww/en/ps/man)
- MSS 3RK3 FAQs (http://support.automation.siemens.com/WW/view/en/24706418/133000)
- 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 Siemens Industry App

With the Industry Online Support App, you have access to more than 300,000 documents about all Siemens Industry products, any time and anywhere. Via the article numbers, you have 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 free SIEMENS Industry Support App 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 Definitions

"MSS 3RK3" always refers to all versions of the 3RK3 Modular Safety System.

1.12 History

Product version	New features
10/2008	Initial release
10/2009	New devices: • Expansion modules – 4F-DO – 4/8F-RO – 8DI • Diagnostics display New features of the MSS ES 2008 software: • License variant "Basic" • Extended functionality
08/2011	New devices: • 3RK3 Advanced central unit Integration of the MSS 3RK3 on the AS-i bus New features of the MSS ES 2008 software: • "Premium" license version: • Additional function elements • Extended functionality
06/2012	New devices: • Two new central units with AS-i interface: – 3RK3 ASIsafe basic – 3RK3 ASIsafe extended New features of the MSS ES 2008 software: • Extended functionality
09/2015	New software for all SIRIUS safety relays: • SIRIUS Safety ES The MSS ES 2008 software is superseded by Safety ES:

Product-specific information 2

2.1 General safety notes

Note

SIL 3 to EN 61508:2010
PL e/Cat. 4 per EN ISO 13849-1:2008

The design of the 3RK3 modular safety system allows implementation of applications up to SIL 3 per EN 61508 and PL e/Cat. 4 per EN ISO 13849-1.

WARNING

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

Hazardous voltages can cause electric shock, burns and damage to property.

Turn off and lock out all power supplying the system and device before working on the device.

WARNING

Risk from Conductive Contamination
Can Cause Death, Serious Injury, or Damage to Property.

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 Chapter "Technical data (Page 347)."

NOTICE

Noise immunity/grounding

The following must be grounded in accordance with the regulations in order to ensure noise immunity of the MSS components:

- MSS 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 MSS components, ensure that the components are protected from being electrostatically charged. Changes to the system configuration and wiring are only permissible while the supply voltage is switched off. Connection of MSS 3RK3 central units 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.

2.2 Intended use

WARNING

Can Cause Death, Serious Injury, or Damage to Property.
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

Can Cause Death, Serious Injury, or Damage to Property.
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

Can Cause Death, Serious Injury, or Damage to Property.
Safe state (safety concept)

The basis of the safety concept is that a safe state exists for all process variables. In the case of the MSS 3RK3 modular safety system, 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
Can Cause Death, Serious Injury, or Damage to Property. **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
Can Cause Death, Serious Injury, or Damage to Property **Test interval for safe AS-i input slaves** The calculated failure probabilities for safe transmission of AS-i input slaves is based on an actuation interval of one year. For this reason, all sensors that are recorded using safety-related AS-i input slaves must be actuated at least once every 12 months in order to test their function. If the mechanism of the safety-related AS-i input slaves is used for direct data exchange, a corresponding signal change must also take place here at least once every 12 months, same as for the safety-related AS-i input slaves.

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.siemens.com/industrial-controls/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.

Overview 3

3.1 3RK3 Modular Safety System

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. MSS 3RK3) that evaluate these signals and from 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.

3RK3 Modular Safety System

The 3RK3 Modular Safety System is a software-parameterizable safety relay that can be used to interconnect several safety applications. In this way, you can set shutdown ranges, for example, and freely define other dependencies. The MSS 3RK3 is basically suitable for applications involving two or more safety-related functions.

The MSS 3RK3 reads sensor signals via inputs, combines these signals in software-parameterizable logic, and uses the processed signals to set and reset the outputs to control actuators in a safety-related manner.

Depending on the version of the device and the external connection of sensors and actuators, applications can be implemented at up to SIL 3 in accordance with EN 61508 and PL e/Cat. 4 in accordance with EN ISO 13849-1.

At least one of the following 3RK3 central units and the Safety ES parameterization and diagnostics software are required for every system configuration.

- MSS 3RK3 Basic
- MSS 3RK3 Advanced
- MSS 3RK3 ASIsafe basic
- MSS 3RK3 ASIsafe extended

3RK3 central unit with AS-i interface

The 3RK3 central units with AS-i interface also perform the functions of an AS-i safety monitor. These central units can read in safety-related, standard, AB, and CTT2 data on the AS-i bus, control safety-related outputs on the AS-i bus, and simulate safety-related standard and AB slaves. Diagnosis of the system is possible through the AS-i using the CTT2 protocol. Data can be passed to the controller cyclically/acyclically via AS-i or can be received from it. Safety-related communication between two or more MSS 3RK3s is also possible via AS-Interface (direct data exchange).

The following 3RK3 central units feature an AS-i interface:

- MSS 3RK3 Advanced
- MSS 3RK3 ASIsafe basic
- MSS 3RK3 ASIsafe extended

3RK3 expansion modules

The MSS 3RK3 central units can be optionally combined with 3RK32 and 3RK33 expansion modules.

With the expansion modules, you increase the number of inputs and outputs of the MSS 3RK3 to suit your requirements. The quantity depends on the 3RK3 central unit and the number of sensors and actuators evaluated.

Interface modules for communication via bus systems and integration in TIA

3RK3 central units communicate with higher-level controllers via an optional interface module. In this way, the MSS 3RK3 can, for example, be interfaced to a PLC via PROFIBUS. Fault diagnostics and status information can be passed on cyclically and acyclically.

Via DP interface, the MSS 3RK3 offers the possibility 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 tumbler) as well as fault acknowledgment and starting commands can be sent from the PLC to the MSS 3RK3.

Diagnostics display

Pending messages with detailed information shown as text are displayed on the optional diagnostics display. The diagnostics display enables a time-saving fault detection run of the MSS 3RK3 without connecting 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 MSS 3RK3 features diverse diagnostics options:

- Diagnostics via displays on the device/LEDs
- Diagnostics with Safety ES
- Diagnostics via PROFIBUS (if DP interface is available)
- Diagnostics with diagnostics display
- Diagnostics via AS-Interface (in the case of central units with AS-i interface)

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 Applications

The 3RK3 Modular Safety System is a modular safety relay. Depending on the version of the external wiring with sensors and actuators, applications can be implemented up to SIL3 as per EN 61508 or PL e as per EN ISO 13849-1.

Application areas and use

- The MSS 3RK3 can be implemented in any protective application with three or more safety functions.
- The modular safety relay enables you to interconnect several safety applications with each other. In this way, you can set shutdown ranges, for example, and define other dependencies.
- With suitable safety-related expansion modules, you can adapt the system flexibly to the required safety application.
- With extensive fault diagnostic features and the provision of status information, faults can be quickly located and the commissioning and down times of the system reduced.
- Test operation for support during commissioning. Hier signals can be forced to test the logic processing or system sections already installed. That means that the signals in the logic can be set to 1 or 0, irrespective of the real signal.
- Fault diagnostics and status information can be transferred to higher-level bus systems (e.g., PROFIBUS DP) through an optional interface module.
- The 3RK3 central units with AS-i interface also perform the functions of an AS-i safety monitor. These central units can read in safety-related, standard, AB, and CTT3 data on the AS-i bus, control safe outputs on the AS-i bus, and simulate safety-related standard and AB slaves. Diagnostics of the system is possible through the AS-i using the CTT2 protocol.

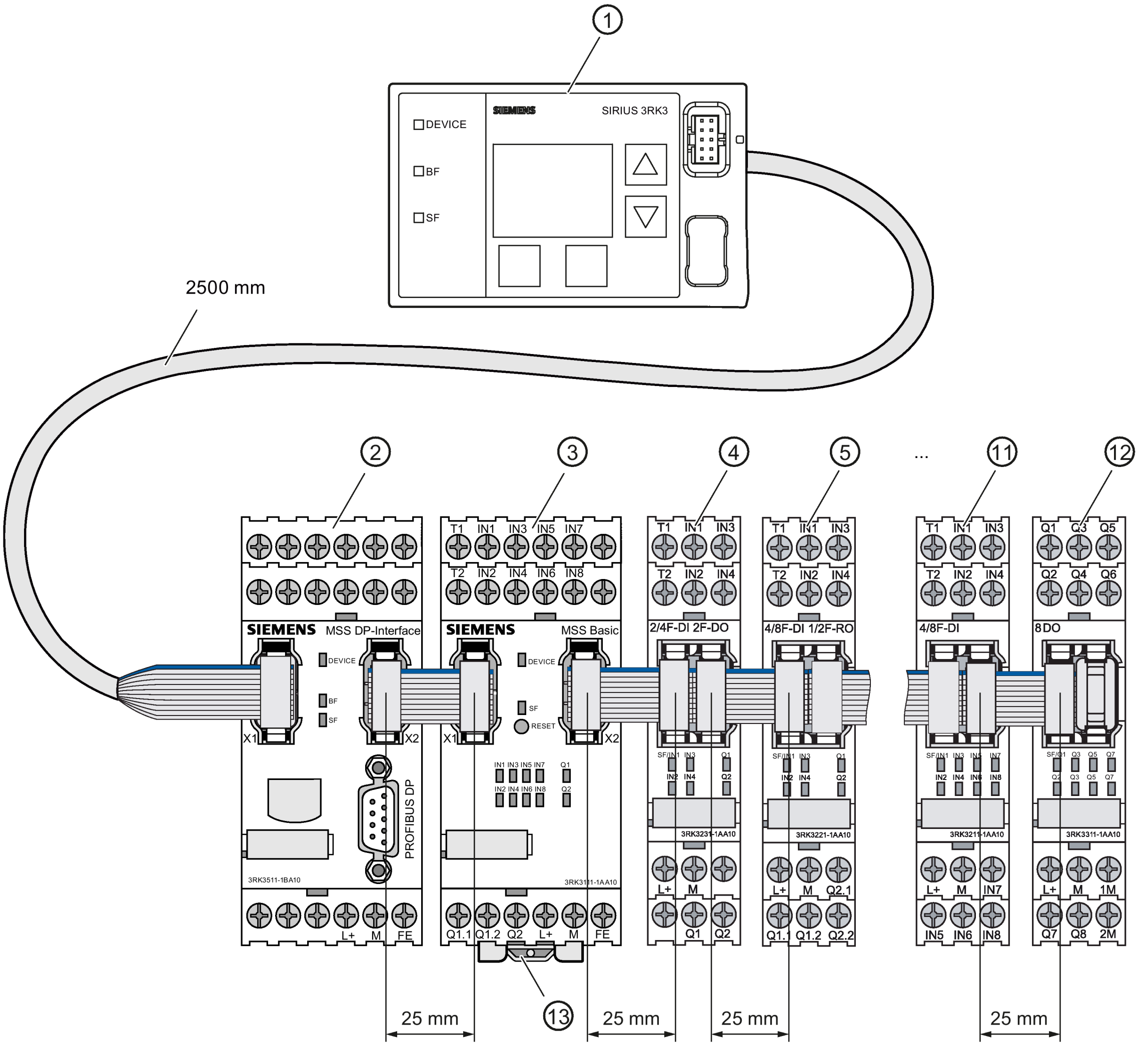
System components

The MSS 3RK3 consists of the following system components:

- Central unit
- Expansion modules
- Interface module
- Diagnostics display
- Parameterization software
- Accessories

3.3 A typical system configuration of the MSS 3RK3 main system

The following diagram shows a typical configuration of the MSS 3RK3 main system with the maximum cable lengths between individual modules. The system consists of a central unit, a number of expansion modules, an interface module, and a diagnostics display.



①	Diagnostics display
②	Interface module
③	Central unit
④ ... ⑫	Expansion modules:

- 0 for MSS 3RK3 ASIsafe basic
- Maximum of 2 for MSS 3RK3 ASIsafe extended
- Maximum of 7 for MSS 3RK3 Basic
- Maximum of 9 for MSS 3RK3 Advanced

⑬ Memory module

Figure 3-1 A typical system configuration of the MSS 3RK3 main system

3.4 A typical configuration of the subsystem with AS-Interface

The following central units can be integrated on the AS-i bus:

- MSS 3RK3 Advanced
- MSS 3RK3 ASIsafe basic
- MSS 3RK3 ASIsafe extended

In doing so the 3RK3 central unit can perform various functions:

- Monitoring of AS-i slaves
- Simulation of AS-i slaves
- Safety-related data exchange with other safety monitors (e.g., with further MSS 3RK3 units with AS-i interface)

Note

MSS 3RK3 bus load

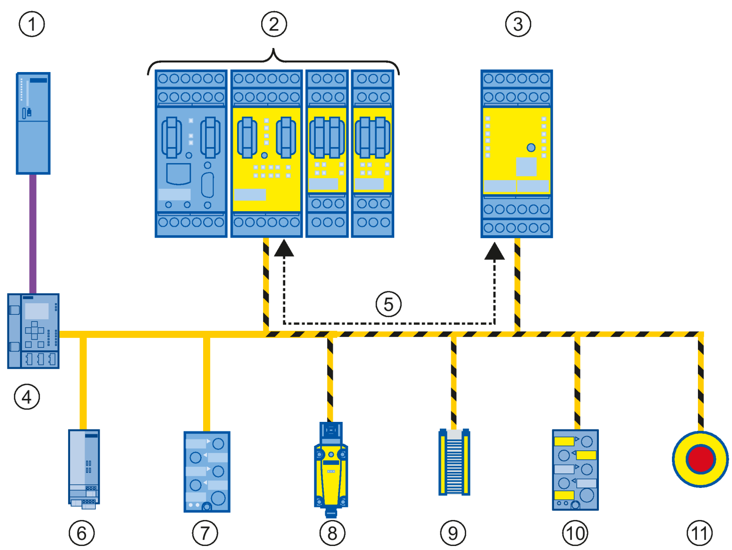
The MSS 3RK3 is always a bus load from an A/B slave on the AS-i bus. This bus load does not depend on how many slaves are simulated by the 3RK3 central unit or whether only AS-i slaves are monitored.

Some typical applications of the MSS 3RK3 with AS-i interface are described below. These examples are all represented with a 3RK3 Advanced central unit.. However, they apply equally to all other central units with AS-i interface. However, you must note the limitations on the number of expansion modules.

Integration of the MSS 3RK3 Advanced as an AS-i monitor on an AS-i bus

The MSS 3RK3 Advanced monitors the various safety-related and non-safety-related AS-i slaves as a safety monitor and exchanges up to 12 safety-related signals bidirectionally with an AS-i safety monitor.

Moreover, the MSS 3RK3 Advanced can mutually independently control up to 12 safety-related AS-i outputs (with up to 4 outputs).



(purple line)	PROFIBUS
(yellow line)	AS-Interface
(yellow/black line)	ASIsafe
①	CPU / PLC (optional)
②	MSS 3RK3 Advanced (The DP interface is optional.)
③	AS-i safety monitor
④	AS-i master
⑤	Data exchange with other safety monitors or MSS 3RK3 units with AS-i interface
⑥	AS-i power section
⑦ ... ⑪	Safety-related and non-safety-related AS-i slaves

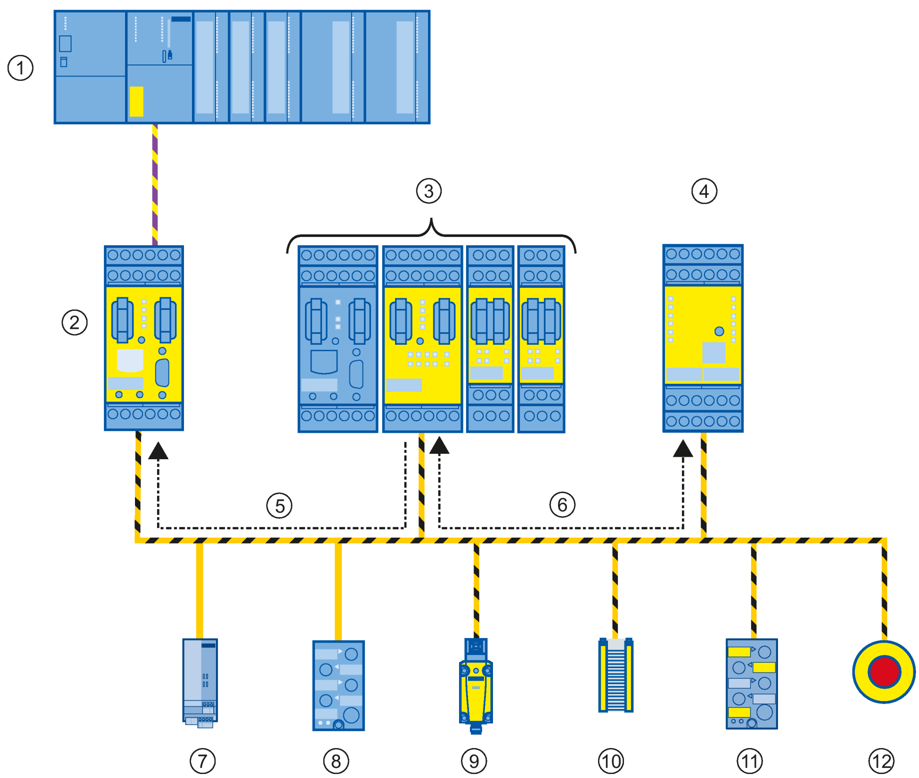
Figure 3-2 A typical system configuration with MSS 3RK3 Advanced as the safety monitor

Integration of the MSS 3RK3 Advanced into a higher-level, fail-safe control

The MSS 3RK3 Advanced monitors the various safety-related and non-safety-related AS-i slaves as a safety monitor and exchanges up to 12 safety-related signals bidirectionally with an AS-i safety monitor.

Moreover, the MSS 3RK3 Advanced can mutually independently control up to 12 safety-related AS-i outputs (with up to 4 outputs).

Up to 12 safety-related signals can be transmitted by the MSS 3RK3 Advanced to an F-PLC over the F-Link.



(yellow line)	AS-Interface
(purple/yellow dashed line)	PROFIBUS with PROFIsafe
(black/yellow dashed line)	ASIsafe
①	F-PLC (optional)
②	DP / AS-i F-Link
③	MSS 3RK3 Advanced (The DP interface is optional)
④	AS-i safety monitor
⑤	Unidirectional data exchange between MSS 3RK3 Advanced and the F-Link
⑥	Data exchange between MSS 3RK3 Advanced and a safety monitor
⑦	AS-i power section
⑧ ... ⑫	Safety-related and non-safety-related AS-i slaves

Figure 3-3 A typical system configuration with MSS 3RK3 Advanced on an F-PLC

3.5 MSS 3RK3 system components

Central units

For each system configuration, you require a 3RK3 central unit that you select appropriately for the specific application (e.g., 3RK3 Basic). For executing the safety functions, the 3RK3 central unit contains the parameterization data in a plug-in memory module. You can optionally connect the expansion modules and the interface module or the diagnostic display to the 3RK3 central unit.

The following table lists the properties of the 3RK3 central units:

Central unit	Inputs / outputs	Maximum number of expansion modules
3RK3 Basic Central unit with safety-related inputs and outputs	• 8 safety-related, freely parameterizable sensor inputs • 1 safety-related two-channel relay output • 1 safety-related two-channel semiconductor output • 2 test outputs for sensor supply and monitoring when used with safety-related sensor inputs	7
3RK3 Advanced Central unit with safety-related inputs and outputs; AS-i connection; Monitor functionality; Simulation of AS-i slaves	• 8 safety-related, freely parameterizable sensor inputs • 1 safety-related two-channel relay output • 1 safety-related two-channel semiconductor output • 2 test outputs for sensor supply and monitoring when used with safety-related sensor inputs • Connection for AS-i bus	9
3RK3 ASIsafe basic Central unit with safety-related inputs and outputs; AS-i connection; Monitor functionality; Simulation of AS-i slaves	• 2 safety-related, freely parameterizable sensor inputs • 6 standard inputs (not safety-related) • 1 safety-related two-channel relay output • 1 safety-related two-channel semiconductor output • 2 test outputs for sensor supply and monitoring when used with safety-related sensor inputs • Connection for AS-i bus	0
3RK3 ASIsafe extended Central unit with safety-related inputs and outputs; AS-i connection; Monitor functionality; Simulation of AS-i slaves	• 4 safety-related, freely parameterizable sensor inputs • 4 standard inputs (not safety-related) • 1 safety-related two-channel relay output • 1 safety-related two-channel semiconductor output • Connection for AS-i bus	2

Expansion modules

You need expansion modules to adapt the MSS 3RK3 to the required application. You thereby supplement the 3RK3 central unit with additional inputs and outputs.

The following table lists the expansion modules and their properties:

Expansion module	Description	Inputs / outputs
4/8F-DI	Safety-related input module	8 safety-related, freely parameterizable sensor inputs
2/4F-DI 1/2F-RO	Safety-related mixed expansion module	4 safety-related, freely parameterizable sensor inputs 2 safety-related single-channel relay outputs
2/4F-DI 2F-DO	Safety-related mixed expansion module	4 safety-related, freely parameterizable sensor inputs 2 safety-related two-channel semiconductor outputs
4F-DO	Safety-related output module	4 safety-related two-channel semiconductor outputs
4/8F-RO	Safety-related output module	8 safety-related single-channel relay outputs
8DI	Standard input module	8 standard inputs (not safety-related)
8 DO	Standard output module	8 standard outputs (not safety-related)

Interface modules

You need interface modules for exchanging data between the MSS 3RK3 and higher-level bus systems (e.g., PROFIBUS DP).

The DP interface has the following characteristics:

- The DP interface constitutes the interface between the MSS 3RK3 and an automation system over PROFIBUS DP.
- The interface module is connected to the 3RK3 central unit.
- A diagnostics display or a PC or programming device can be connected to the interface module.

Diagnostics display

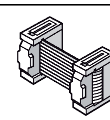
With the diagnostics display, you can monitor and analyze the diagnostics and status data of the MSS 3RK3 and acknowledge errors locally or from a central location.

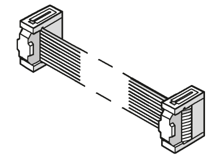
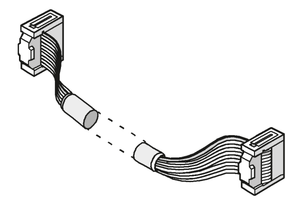
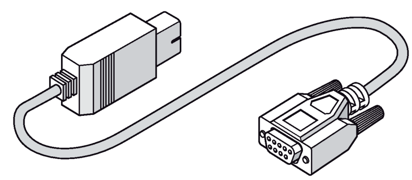
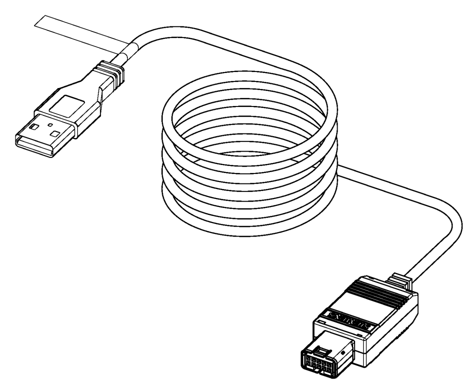
The diagnostics display has the following characteristics:

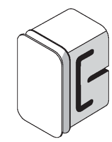
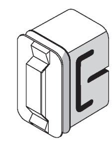
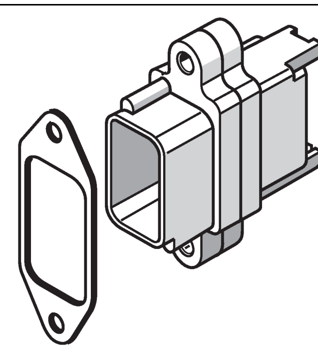
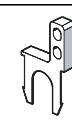
- The diagnostics display shows fault diagnostics and diagnostics information as plaintext on its display.
- The diagnostics display is intended to be installed in a control panel / control cabinet door and is connected to the 3RK3 central unit or, if there is one, to the interface module.
- If required, a PC or programming device can be connected to the diagnostics display.

Accessories

You require the following accessories when using the modules:

Component	Description	Diagram
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 intercon-nection logic. • The Safety ES software provides the following functionalities: – You use the logic diagram to parameterize the safety functions for the MSS 3RK3. – The MSS 3RK3 is accessed for parameter-ization and diagnostics over a PC cable or by means of PROFIBUS-DP and DP inter-face (optional). – You can also upload an existing configura-tion from the 3RK3 central unit to the PC or programming device. – The diagnostics functionality of the soft-ware enables you to diagnose the MSS 3RK3 online. – You can force outputs when commission-ing the MSS 3RK3. • Article number: 3ZS1316-*	
Connection cables	• Ribbon cable for data connection of system components via the system interfaces • Mechanically-coded and color-coded protec-tion against reverse polarity • 0.025 m ("adjacent") • Article number: 3UF7930-0AA00-0	

Component	Description	Diagram
Connection cable to the diagnostics display	• Ribbon cable for the data connection from the 3RK3 central unit to the diagnostic 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: 
PC cable and adapter	• Connection cable for exchanging data between the PC or programming device and the 3RK3 central unit. The connection cable connects the interface of the PC/programming device to the system interface of the 3RK3 central unit. – RS 232 PC cables Article number: 3UF7940-0AA00-0, product version 2 or higher – USB PC cables 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	 

Component	Description	Diagram
Memory module	• External memory module of the 3RK3 central unit for storing configuration data • The slot for the memory module is located on the underside of the 3RK3 central unit • Article number: 3RK3931-0AA00 **Note:** One memory module each is included in the scope of supply of the 3RK3 central unit.	
System interfaces cover	• Cover for free system interfaces: – Protection against dirt – 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 screw fastening	• Fixing lugs for installing the device on a level surface, 2 required per device • Article number: 3RP1903	

3.6 Features and functions of the MSS 3RK3

Features of the 3RK3 central units	MSS 3RK3			
	Basic	Advanced	ASIsafe basic	ASIsafe extended
General characteristics				
Certified acc. to • SIL 3 per EN 61508 • PL e/Cat. 4 per EN ISO 13849-1	✓	✓	✓	✓
Modularity / expansion capability with expansion modules	✓ (max. 7)	✓ (max. 9)	-	✓ (max. 2)
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	8	8	2	4
Test outputs for sensor supply and monitoring	2	2	2	2
Standard inputs	-	-	6	4
Safety-related two-channel relay outputs	1	1	1	1
Safety-related two-channel semiconductor outputs	1	1	1	1
Communication				
Data exchange over PROFIBUS with optional DP interface module	✓	✓	✓	✓
Integration into the automation environment with a GSD on each PROFIBUS-DP master irrespective of the automation system with optional DP interface module	✓	✓	✓	✓
Access with Safety ES				
Configuration and diagnostics through the device interface	✓	✓	✓	✓
Configuration and diagnostics over PROFIBUS	✓	✓	✓	✓
AS-i functionality				
• Simulation of non-safety-related AS-i slaves	-	✓	✓	✓
• Simulation of safety-related AS-i input slaves	-	✓	✓	✓
• Control of safety-related AS-i outputs	-	✓	✓	✓
• Representation of safety-related AS-i outputs	-	✓	✓	✓
• Monitoring of non-safety-related AS-i slaves	-	✓	✓	✓
• Monitoring of safety-related AS-i input slaves	-	✓	✓	✓

Features of the 3RK3 central units	MSS 3RK3			
	Basic	Advanced	ASIsafe basic	ASIsafe extended
Diagnostics				
Diagnostics using LEDs	✓	✓	✓	✓
Diagnostics using Safety ES	✓	✓	✓	✓
Diagnostics using PROFIBUS	✓	✓	✓	✓
Diagnosis using AS-Interface (CTT2 protocol)	-	✓	✓	✓
Diagnostics using the diagnostics display	✓[1]	✓[2]	✓[2]	✓[2]

[1] Product version E01 and higher of the diagnostics display

[2] Product version E03 or FW version V1.1.x and higher of the diagnostics display

Function elements in the logic diagram	MSS 3RK3			
	Basic	Advanced	ASIsafe basic	ASIsafe extended
Cell functions				
• Input cell	✓	✓	✓	✓
• Output cell	✓	✓	✓	✓
Monitoring functions				
• Monitoring Universal	-	✓	✓	✓
• EMERGENCY STOP	✓	✓	✓	✓
• ESPE (electro-sensitive protective equipment)	✓	✓	✓	✓
• Safety shutdown mat (NC principle)	✓	✓	✓	✓
• Safety shutdown mat (cross-circuit principle)	✓	✓	✓	✓
• Protective door	✓	✓	✓	✓
• Protective door with lock	-	✓	✓	✓
• Enabling 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	-	✓	✓	✓

Function elements in the logic diagram	MSS 3RK3			
	Basic	Advanced	ASIsafe basic	ASIsafe extended
Control functions				
• Device command	✓	✓	✓	✓
Logic functions				
• AND	✓	✓	✓	✓
• OR	✓	✓	✓	✓
• XOR	✓	✓	✓	✓
• NAND	✓	✓	✓	✓
• NOR	✓	✓	✓	✓
• NEGATION (NEG)	✓	✓	✓	✓
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	-	✓	✓	✓

3.7 Safety systems - General information

3.7.1 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.

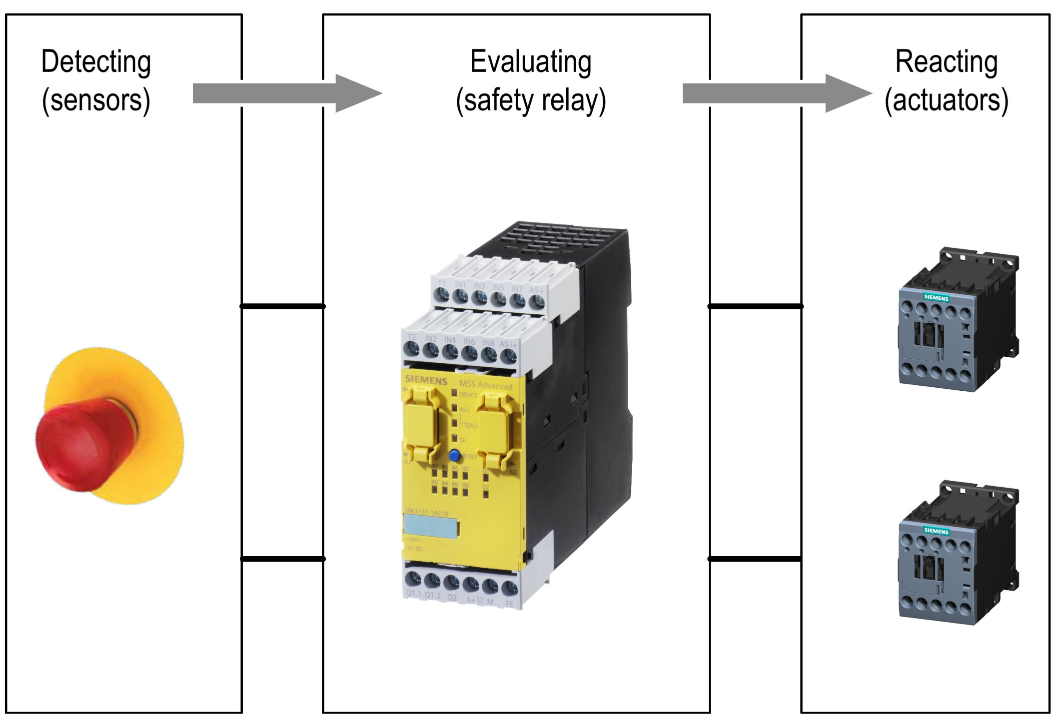
Evaluating (safety relay):

- 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



3.7.2 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.

3.7.3 Basic terminology

3.7.3.1 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).

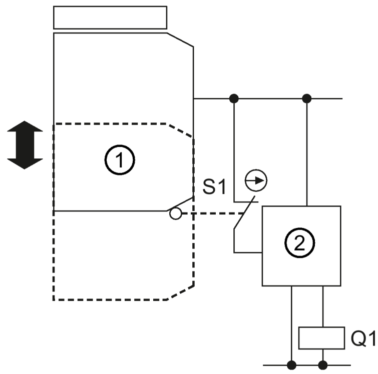
The simplest form of redundancy is **two-channel redundancy.**

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.

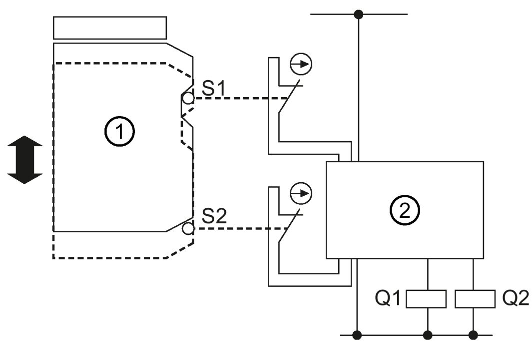
Note

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 3-4 Single-channel safety-related control system



① Mechanical position switches
② Safety relay

Figure 3-5 Two-channel safety-related control system

3.7.3.2 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).

3.7.3.3 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.

3.7.3.4 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.

3.7.3.5 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.

3.7.3.6 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.

3.7.3.7 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 47)
- Manual start (Page 47)
- Monitored start (Page 48)

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.

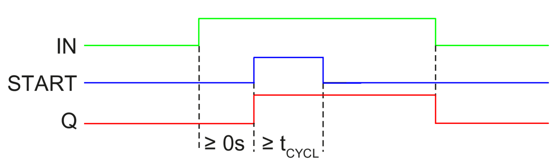


Figure 3-6 Start function "Manual start"

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.

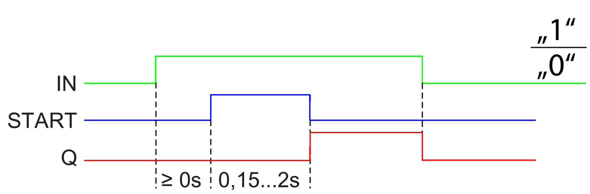


Figure 3-7 Start function "Monitored start"

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.

3.7.3.8 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 151).

3.7.3.9 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.

3.7.3.10 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).

3.7.3.11 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.

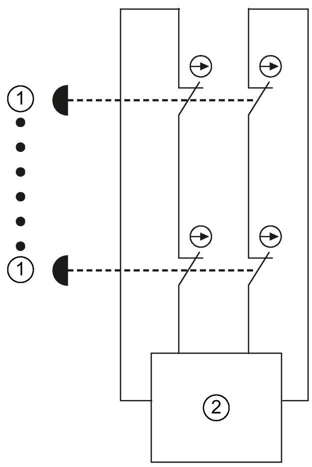
Possible startup testing applications:

- 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)

3.7.4 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.

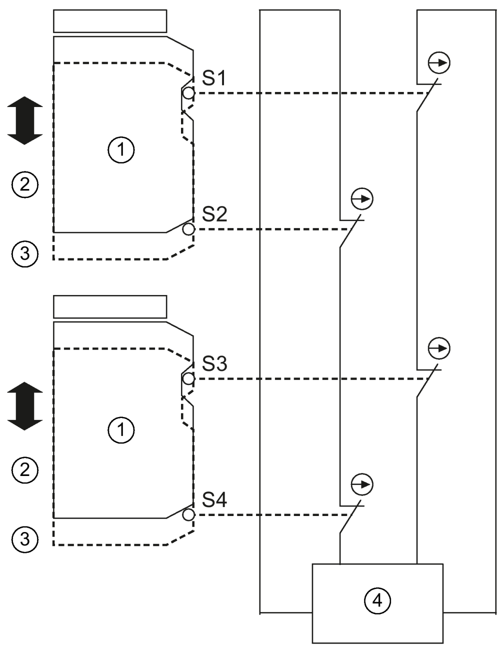


① EMERGENCY STOP
② Safety relay

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

Getting started with MSS 3RK3 Basic 4

4.1 Introduction

This chapter provides a step-by-step guide to commissioning a Modular Safety System 3RK3 (MSS 3RK3) using an example demonstrating **how to protect a metalworking press**.

The essential steps for commissioning the MSS 3RK3 are as follows:

1. Installation
2. Wiring
3. Configuring
4. Function test

4.2 Hardware and software requirements

To commission the MSS 3RK3 in this example, you will need the following hardware and software components:

Number	Device	Article number
1	3RK3 Basic central unit	3RK3111-1AA10
1	Expansion module 2/4 F-DI 2 F-DO	3RK3231-1AA10
1	24V PELV power supply unit	6ES73071EA00-0AA0
1	Light curtain (ESPE)	-
1	Pushbutton (NO contact)	3SB3801-0DD3
1	EMERGENCY STOP control device	3SB3801-0EG3
1	Two-hand operator panel	3SB3863-4BB
2	Contactors	3RT1015-1BB42
1	0.025 m connection cable	3UF7930-0AA0-0
1	PC cable	3UF7940-0AA00-0, product version 2
1	Safety ES (software)	3ZS1316-*

To configure the modules, you need a programming device or PC with MS Windows XP Professional SP2/SP3 or MS Windows 7 Ultimate/Professional/Enterprise 32-bit operating system (SP3 and higher: 64-bit). You will find additional information in the attached README file of the software.

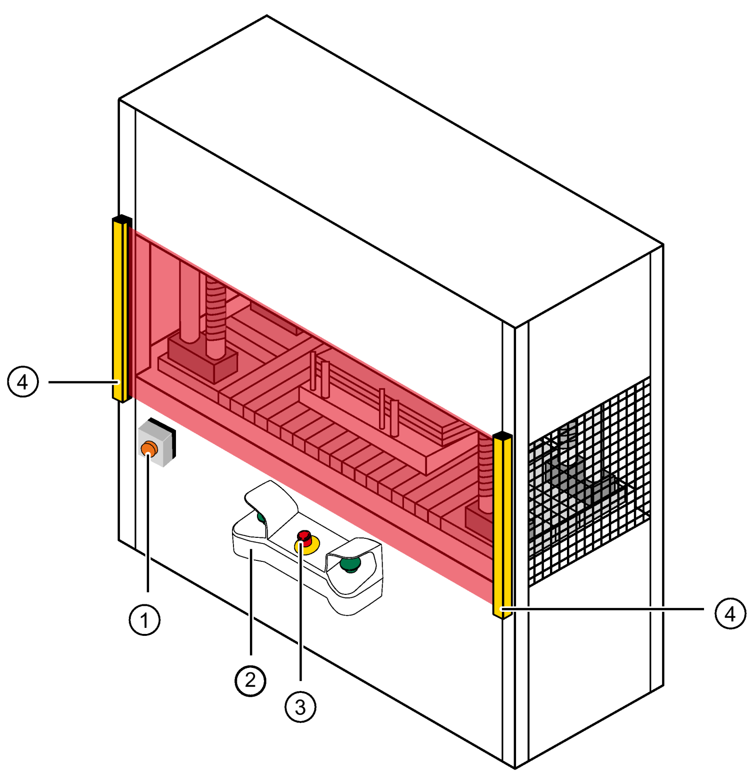
4.3 Task and structure of the example

Protecting a metalworking press

- The hazardous area is protected by permanent isolating protective equipment.
- The insertion point is additionally protected by electrosensitive protective equipment (ESPE).
- The working stroke of the press is triggered with a two-hand operator panel. If the zone protected by the electrosensitive protective equipment is entered during operation, or if the EMERGENCY STOP is activated, the press drive is immediately switched off (stop category 0).
- The press starts once the protective zone of the ESPE has been enabled and the two-hand operator panel has been actuated.

Note

To enable switch-on by two-hand operation, the start pushbutton must be pressed after unlocking the pressed EMERGENCY STOP.



①	Start pushbutton
②	Two-hand operator panel
③	EMERGENCY STOP control device
④	Light curtain (ESPE)

Figure 4-1 Typical system configuration

4.4 Installation of the MSS 3RK3 Basic

Installation

Step	Activity
1	Hang the device on the mounting rail or screw it onto a level surface using the fixing lugs.
2	Establish a connection between the 3RK3 Basic central unit (interface X2) and the expansion module (interface X1) by means of a connection cable (0.025 m).

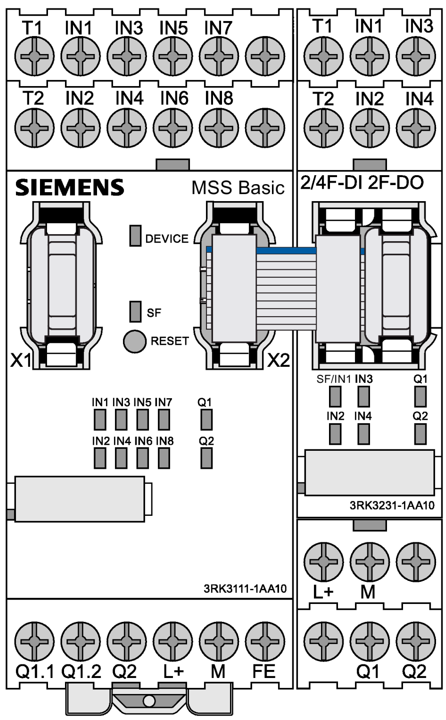


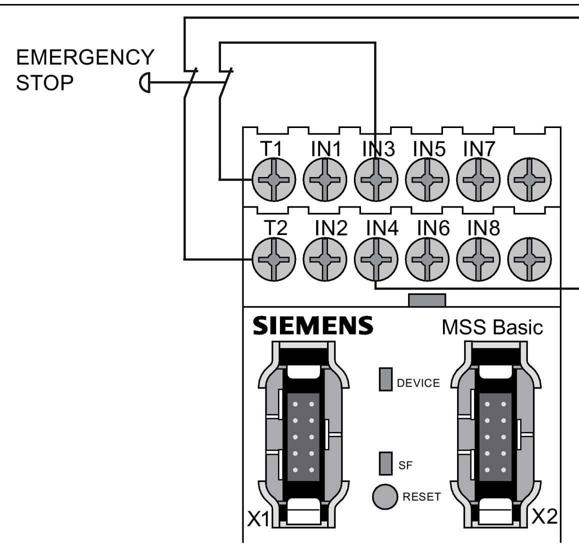
Figure 4-2 MSS 3RK3 configuration

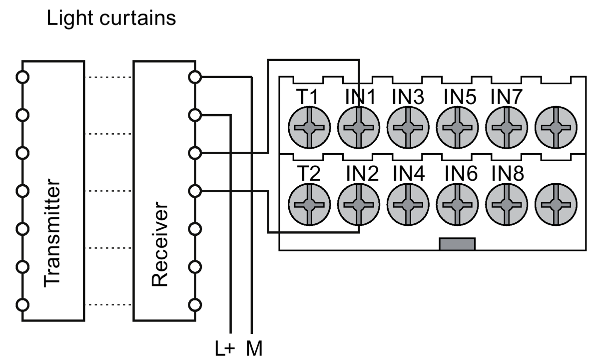
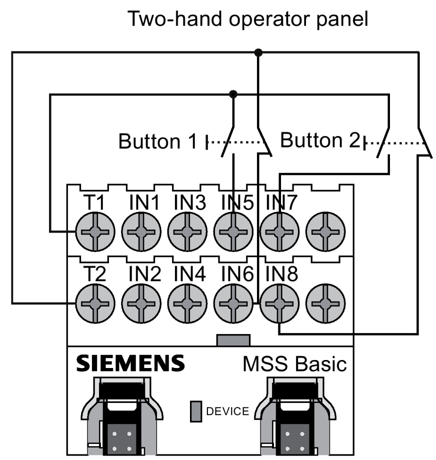
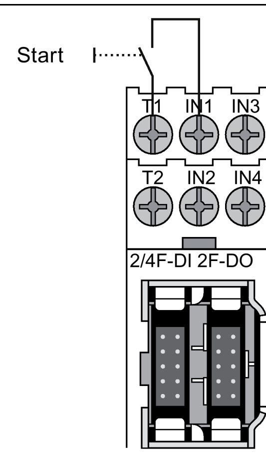
4.5 Wiring of the MSS 3RK3 Basic

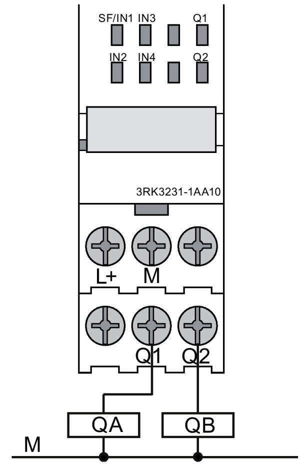
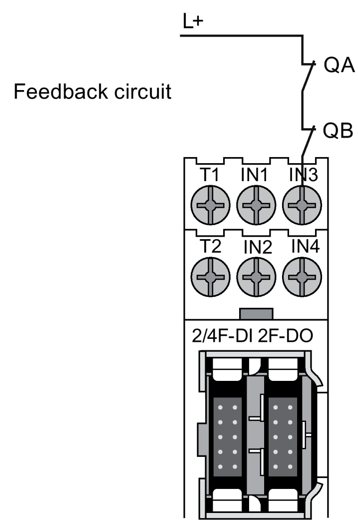
Wiring

Note

All components, including the light curtain, must be operated on the same power supply.

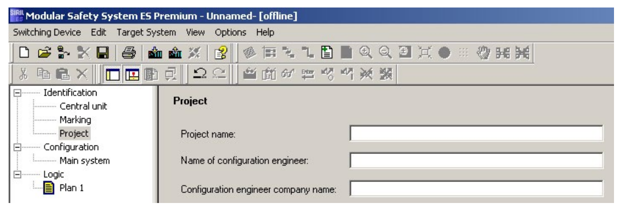
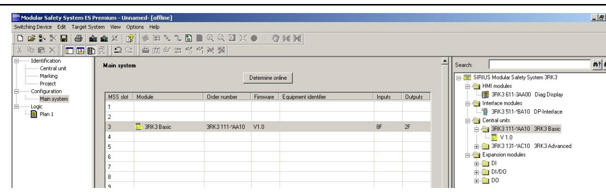
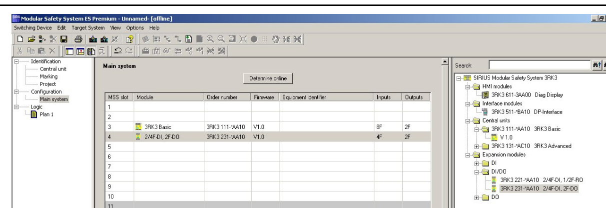
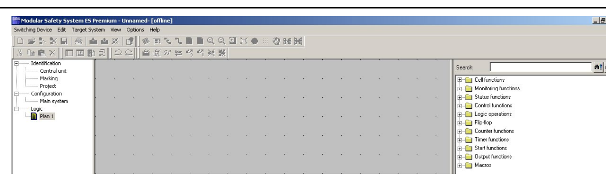
Step	Action	Result
1	Connect the 3RK3 Basic central unit to the power supply with: • + 24 V to terminal L+ • Ground to terminal M • Ground to terminal FE	The 3RK3 Basic central unit is supplied with power.
2	Connect the expansion module 2/4 F-DI 2F-DO to the power supply with: • + 24 V to terminal L+ • Ground to terminal M	The expansion module 2/4 F-DI 2F-DO is supplied with power.
3	Connect the light curtain to the power supply. **Note:** Please refer here to the operating instructions for the light curtain.	The light curtain is supplied with power.
4	Connect the EMERGENCY STOP control device to the 3RK3 Basic central unit, with: • NC 1: Terminal T1/IN3 • NC 2: Terminal T2/IN4	

<table>
<tr><th>Step</th><th>Action</th><th>Result</th></tr>
<tr><td>5</td><td>Connect the light curtain to the 3RK3 Basic central unit, with
Output 1 of the light curtain: Terminal IN1
Output 2 of the light curtain: Terminal IN2
Note:
Please refer here to the operating instructions for the light curtain.</td><td>
</td></tr>
<tr><td>6</td><td>Connect the two-hand operator panel to the 3RK3 Basic central unit, with:
NC pushbutton 1: Terminal T2/IN6
NO pushbutton 1: Terminal T1/IN5
NC pushbutton 2: Terminal T2/IN8
NO pushbutton 2: Terminal T1/IN7</td><td>
</td></tr>
<tr><td>7</td><td>Connect the Start pushbutton on the expansion module 2/4 F-DI 2F-DO, with:
NO contact: Terminal T1/IN1</td><td>
</td></tr>
</table>

<table>
<tr><th>Step</th><th>Action</th><th>Result</th></tr>
<tr><td>8</td><td>Connect the contactors QA and QB on the expansion module 2/4 F-DI 2F-DO, with:
Contactor / coil QA: Terminal Q1
Contactor / coil QB: Terminal Q2</td><td>
</td></tr>
<tr><td>9</td><td>Connect the feedback circuit of the contactors QA and QB on the expansion module 2/4 F-DI 2F-DO, with:
Contactor / NC QA / QB: Terminal IN3</td><td>
</td></tr>
</table>

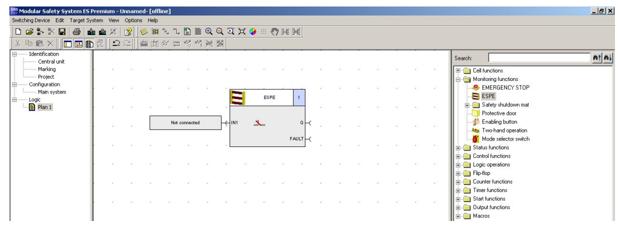
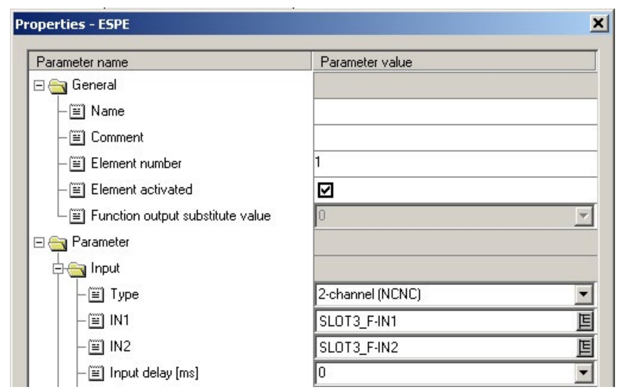
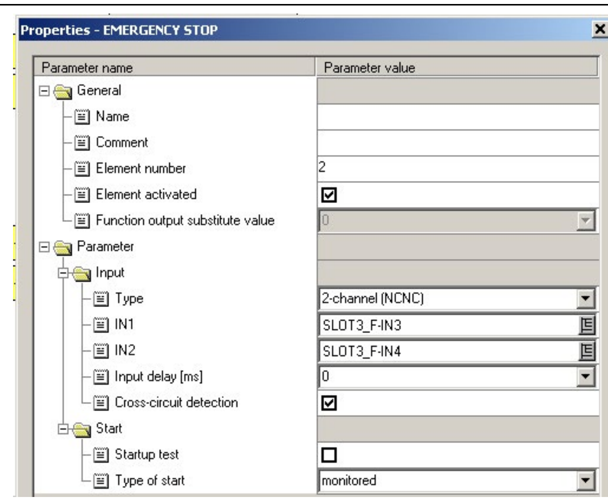
4.6 Configuration of the MSS 3RK3 Basic

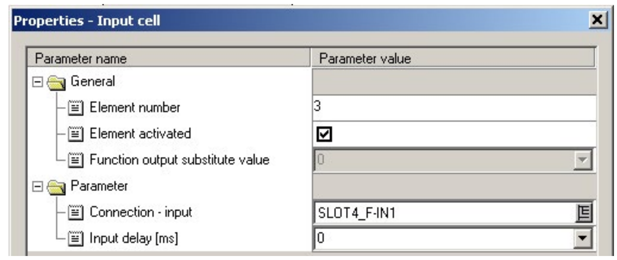
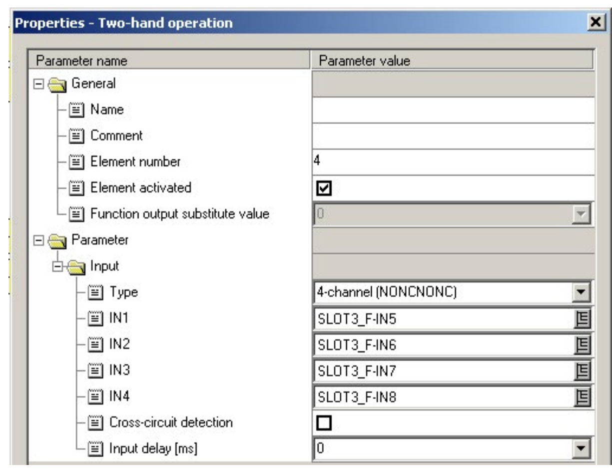
Configuration

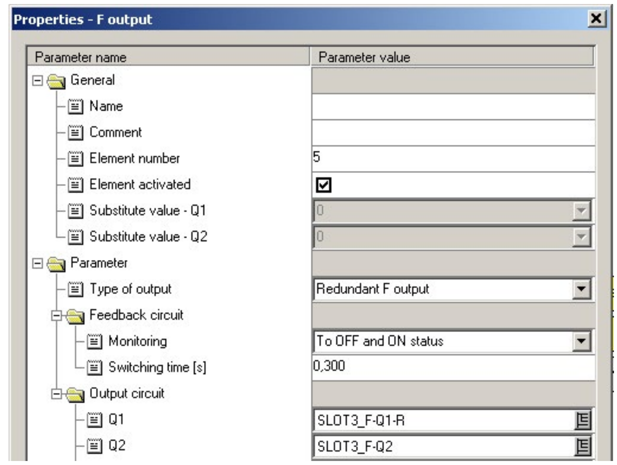
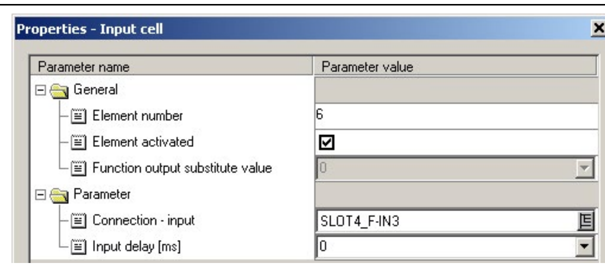
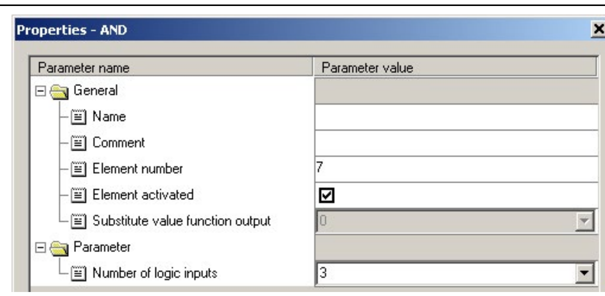
Step	Activity	Result
1	Switch on your PC/PG. Install the Safety ES software. Administrator rights are required here.	The Safety ES software is installed on your computer.
2	Start the Safety ES software and choose "Switching device" > "New..." > "Safety relays" > "SIRIUS Modular Safety System 3RK3."	Install the Safety ES software.
3	Connect the 3RK3 Basic central unit to your PC / PG using the PC cable.	The MSS 3RK3 is connected to the PC / PG.
4	On the left of the navigation window, select the "Identification" directory and then the "Project" subdirectory.	
5	Make entries in the following lines of the work space: • Project name • Name of configuration engineer • Configuration engineer's company name	
6	On the left of the navigation window, select the "Configuration" directory and then the "Main system" subdirectory.	
7	Drag the 3RK3 Basic central unit from the catalog window to the first green-illuminated row in the work space for the hardware configuration.	
8	Drag the 2/4 F-DI 2F-DO expansion module from the catalog window to the next empty row (under the 3RK3 central unit added in Step 7) in the work space for the hardware configuration.	
9	On the left of the navigation window, select the "Logic" directory and then the "Diagram 1" subdirectory.	

4.7 Creating the safety program

Parameter assignment

Step	Activity	Result
1	• Drag the "ESPE" element from the "Monitoring functions" folder to the work space.	
2	• Open the "Properties - ESPE" dialog box by double-clicking the block. • Select the following in the "Parameter > Input" directory: – The "Type" parameter, and define this as "2-channel (NCNC)". – The "IN1" parameter, and connect this to "SLOT3_F-IN1". – The "IN2" parameter is automatically set to "SLOT3_F-IN2". • Close the window by clicking "OK".	
3	• Drag the "EMERGENCY STOP" element from the "Monitoring functions" folder into the work space. • Open the "Properties - EMERGENCY STOP" dialog box by double-clicking the block. • Select the following in the "Parameter > Input" directory: – The "Type" parameter, and define this as "2-channel (NCNC)". – The "IN1" parameter, and connect this to "SLOT3_F-IN3". – The "IN2" parameter is automatically set to "SLOT3_F-IN4". – Activate cross-circuit detection. • Select the following in the "Parameter > Start" directory: – The "Type of start" parameter, and define this as "Monitored". • Close the window by clicking "OK".	

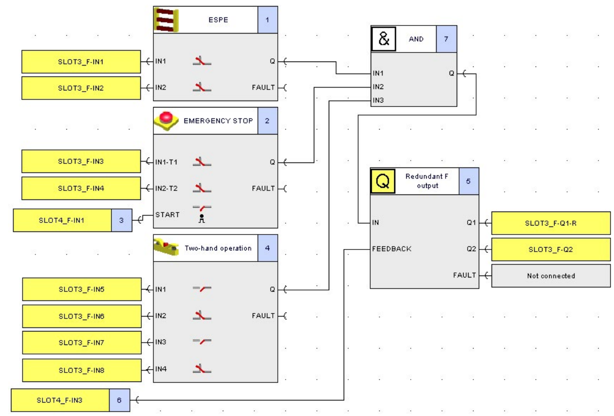
Step	Activity	Result
4	• Drag the "Input cell" element from the "Cell functions" folder into the work space. This cell function is required for acknowledging the EMERGENCY STOP control device. • Open the "Properties - Input cell" dialog box by double-clicking the block. • Select the following in the "Parameter" directory: – The "Connection - input" parameter, and connect this to "SLOT4_F-IN1". • Close the window by clicking "OK".	
5	• Drag the "Two-hand operation" element from the "Monitoring functions" folder into the work space. • Open the "Properties - Two-hand operation" dialog box by double-clicking the block. • Select the following in the "Parameter > Input" directory: – The "Type" parameter, and define this as "4-channel (NONCNONC)". – The "IN1" parameter, and connect this to "SLOT3_F-IN5". – The "IN2" parameter is automatically set to "SLOT3_F-IN6". – The "IN3" parameter, and connect this to "SLOT3_F-IN7". – The "IN4" parameter is automatically set to "SLOT3F-IN8". – Activate cross-circuit detection • Close the window by clicking "OK".	

Step	Activity	Result
6	• Drag the "F output" element from the "Output functions" > "Switching output" folder to the work space. • Open the "Properties - F output" dialog box by double-clicking the block. • Select the following in the directory "Parameter" > "Type of output: Redundant F output". • Select the following in the "Parameter" > "Feedback circuit" directory: – The "Monitoring" parameter, and define this as "To OFF and ON status". • Select the following in the "Parameter" > "Output circuit" directory: – The "Q1" parameter, and connect this to "SLOT4-F-Q1". – The "Q2" parameter, and connect this to "SLOT4-F-Q2". • Close the window by clicking "OK".	
7	• Drag the "Input cell" element from the "Cell functions" folder into the work space. This cell function is required for monitoring the feedback circuit. • Open the "Properties - Input cell" dialog box by double-clicking the block. • Select the following in the "Parameter" directory: – The "Connection - input" parameter, and apply this to "SLOT4_F-IN3". • Close the window by clicking "OK".	
8	• Drag the "AND" element from the "Logic operations" folder into the work space. • Open the "Properties - AND" dialog box by double-clicking the block. • Select the following in the "Parameter" directory: – The "Number of logic inputs" parameter, and define this as "3". • Close the window by clicking "OK".	

<table>
<tr><th>Step</th><th>Activity</th><th>Result</th></tr>
<tr><td>9</td><td>

- Connect outputs "Q" of the monitoring functions with inputs "IN" of the AND function element by drag and drop.
- Connect the output "Q" of the AND function with the input "IN" of the F output.
- Connect the output of the input cell "SLOT4_F-IN3" with the input "FEEDBACK" (feedback circuit) of the F output.
- Connect the output of the input cell "SLOT4_F-IN1" with the input "Start" of the EMERGENCY STOP monitoring function.

</td><td rowspan="2">



</td></tr>
<tr><td>10</td><td>For a clearer display, choose "Edit" > "Realign graphic".</td></tr>
</table>

4.8 Function test of the MSS 3RK3 Basic

Download to 3RK3 Basic central unit

Step	Action	Result
1	Switch on the power supply.	The safety relay executes a self-test.
2	Choose "Edit" > "Check consistency".	If no message is displayed in the output window, the test was successful.
3	Choose "Target system" > "Load to switching device" and confirm the memory dialog with "Yes".	The "Save switching device as" dialog box opens.
4	Save the project.	The "Load to switching device" dialog box opens.
5	Set the interface via which you have access to the device (e.g., COM1) and confirm with "OK".	The configuration data is now downloaded. A message is displayed on completion of the download.
6	Confirm with "OK".	You are now online in configuring mode.
7	Choose "Target system" > "Test mode" and confirm the message "Activate test mode" with "Yes".	The "Change password for test mode" dialog box opens.
8	Assign a new password and confirm it. The default password is 0000.	The MSS 3RK3 changes from configuring mode to test mode.

Testing the functions

The MSS 3RK3 can be switched to "test mode" so that the full function test can be conducted. Outputs of function elements can be forced in this operating mode.

You can create printouts of the configuration to help you in the function test by choosing "Target system" > "Prepare configuration test".

Step	Action	Result
1	Check whether the EMERGENCY STOP has been unlocked and the protective field of the ESPE is free.	-
2	Press the Start button.	-
3	Press both buttons of the two-hand operator panel simultaneously.	The contactors QA and QB pick up.
4	Press EMERGENCY STOP.	If the two-hand operator panel is pressed again, contactors QA and QB do not pick up.
5	Unlock the EMERGENCY STOP and press the Start button.	The "EMERGENCY STOP" function element is acknowledged.
6	Place a suitable object in the protection zone of the ESPE.	If the two-hand operator panel is pressed again while the light curtain is interrupted, contactors QA and QB do not pick up.

Configuration release

Step	Action	Result
1	Select the menu command "Target system" > "Go offline".	The offline configuration is opened.
2	Choose "Target system" > "Approve configuration".	The "Approve configuration" dialog box is opened, thereby confirming that the configuration test has been performed properly.
3	Set the interface via which you have access to the device (e.g., COM1) and confirm with "OK".	The "Approve configuration" dialog box opens.
4	Enter the name and approving company and confirm with "OK".	The "Approve configuration" dialog box opens. The configuration has been successfully approved.
5	Acknowledge the message with "OK".	The printout of the release information is created.

Note

If the report could not be printed when the project was released, e.g., because no printer was available, the printout must be created at the latest by the time of acceptance by selecting "Options" > "Release information...".

Safety mode

Step	Action	Result
1	Establish an online connection with the MSS 3RK3 using the "Switching device" > "Open online" or "Target system" > "Load to PC" menu command.	The Set interface dialog box appears.
2	Set the interface and confirm with "OK".	The project opens online.
3	Activate the menu command "Target system" > "Safety mode".	The message "Activate safety mode" appears.
4	Confirm with "Yes".	The MSS 3RK3 switches to safety mode without password protection.

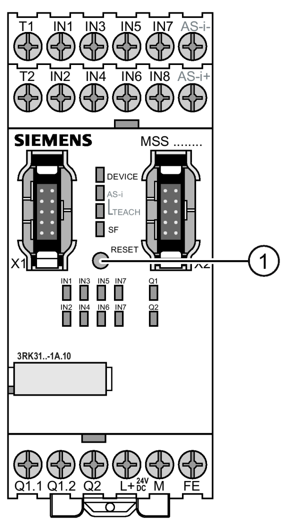
Description of the hardware 5

5.1 Description of the individual modules

5.1.1 General information on 3RK3 central units

The application for 3RK3 central units are safety-related control functions. A 3RK3 central unit is required for each system configuration. The 3RK3 central unit contains the configuring data in an external memory module, and it handles all control tasks.

5.1.2 Operating elements on the 3RK3 central unit



① RESET button

Figure 5-1 Operator controls

RESET button

The 3RK3 central units have a RESET button on the front with the following functions:

- Acknowledging messages
- Restoring the basic factory settings
- Transfer of the code tables for central units with AS-i interface

Safety ES software

The 3SK3 MSS is parameterized with the Safety ES software, see Chapter "3RK3 Modular Safety System (Page 25)."

5.1.3 3RK3 Basic central unit

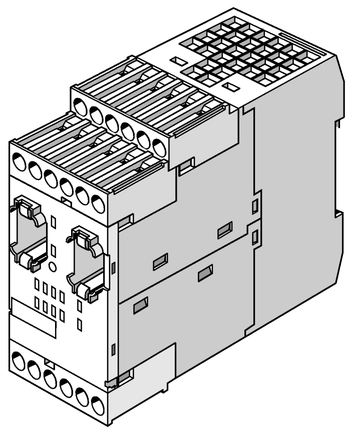


Figure 5-2 3RK3 Basic central unit

Properties

The 3RK3 Basic central unit is the basic component of an MSS 3RK3 configuration for safety-related control functions. It can be used up to SIL 3 per EN 61508 and PL e/Cat. 4 per EN ISO 13849-1.

- The 3RK3 Basic central unit can be parameterized using Safety ES.
- An additional interface module (e.g. DP interface) can be used to exchange process data with a PLC. Diagnostics data of the MSS 3RK3 is also transmitted to the PLC.
- The 3RK3 central unit is supplied with a memory module (sealable with central unit or control cabinet).
- Up to 7 expansion modules can be connected to the 3RK3 Basic central unit.
- Connection of the diagnostics display is possible as an option for time-saving diagnostics.

Inputs and outputs

The 3RK3 Basic central unit has the following inputs and outputs:

- 8 safety-related, freely parameterizable sensor inputs
- 1 safety-related two-channel relay output
- 1 safety-related two-channel semiconductor output
- 2 test outputs for sensor supply and monitoring when used with safety-related sensor inputs

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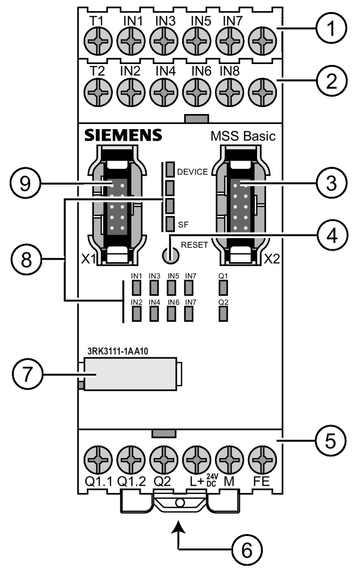
Note

Safety-related outputs

If you use the safety-related outputs with 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.

Structure of the 3RK3 Basic central unit

Front view	No.	Meaning
	①	Removable terminal block D
	②	Removable terminal block C
	③	Connection for expansion module (X2)
	④	RESET button
	⑤	Removable terminal block A
	⑥	Connection of a memory module (X3, sealable)
	⑦	Label
	⑧	Display LEDs
	⑨	Connection of PC or programming device, interface module, diagnostics display (X1)

Internal circuit diagram

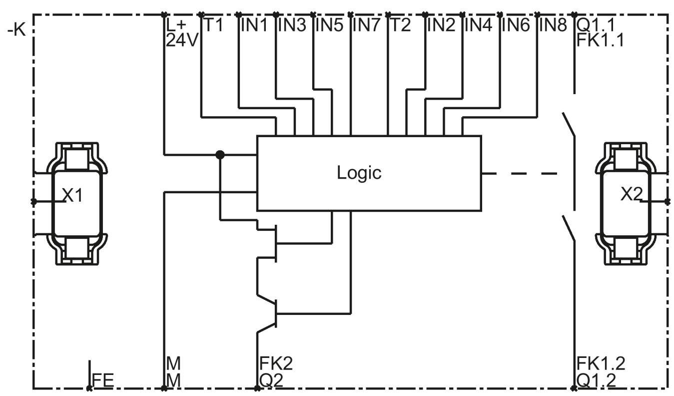


Figure 5-3 MSS 3RK3 Basic internal circuit diagram

Terminal names of the 3RK3 Basic central unit

Terminal	Meaning	Description
T1	Test output for inputs IN1, IN3, IN5, IN7	• Test outputs with different test signals • Connection for sensor contacts for detecting cross-circuits
T2	Test output for inputs IN2, IN4, IN6, IN8	
IN1 ... IN8	Safety-related sensor inputs	Terminal for safety sensors Combinations for two-channel connection: • IN1 with IN2 • IN3 with IN4 • IN5 with IN6 • IN7 with IN8
Q1.1, Q1.2	Safety-related relay output	Isolated two-channel output for connecting actuators
Q2	Safety-related semiconductor output	Two-channel output for connecting actuators
L+	Power supply	24 V DC
M	Ground	Ground to 24 V DC
FE	Functional ground	Shielding, equipotential bonding

Interfaces of the 3RK3 Basic central unit

Interface	Meaning	Description
X1	System interface	Connection of PC or programming device, interface module, diagnostics display
X2	Interface	Interface for connecting expansion modules (e.g., I/O modules)
X3	External memory module	Slot for external memory module with parameterization data The memory module is sealable with the 3RK3 central unit or the control cabinet.

Operator controls of the 3RK3 Basic central unit

Element	Meaning	Description
RESET button	• Error acknowledgment • Factory setting	• Confirm the acknowledgeable errors with this button. • Refer to Chapter "Restoring factory settings (Page 335)"

Displays of the 3RK3 Basic central unit

Element	Meaning
DEVICE	Device status
SF	Group error
IN1 ... IN8	Status of the sensor inputs
Q1, Q2	Status of the safety-related outputs

Connecting inputs and outputs

You will find further information on connecting inputs and outputs in Chapter "Wiring rules for inputs and outputs (Page 123)."

5.1.3.1 Startup / self-test of the MSS 3RK3 Basic

Once the power supply has been applied, the MSS 3RK3 runs a self-test. During the self-test phase, all the LEDs on the MSS 3RK3 central unit light up for two seconds (lamp test). Two-color LEDs light up yellow. The 3RK3 Basic central unit then loads the configuration from the external memory module and checks whether a valid configuration or parameterization is stored and automatically switches to safety mode (DEVICE LED lights up green).

Configuring mode

The 3RK3 Basic central unit enters configuring 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 modules could not be parameterized (the SF LED lights up red)
- The existing configuration has not been released.
- The memory module is missing or defective. In this case, only diagnostics of the MSS 3RK3 is possible (DEVICE LED flashes red, SF LED lights up red).

5.1.4 3RK3 Advanced central unit

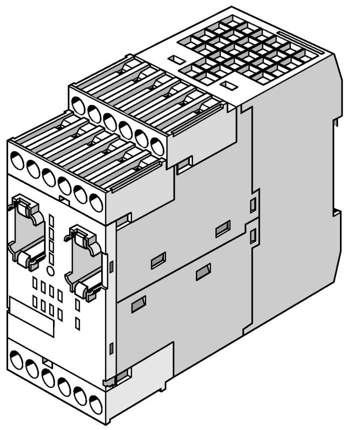


Figure 5-4 3RK3 Advanced central unit

Properties

The 3RK3 Advanced central unit is a basic component of an MSS 3RK3 configuration for safety-related control functions with use of AS-Interface. As an AS-i monitor, the 3RK3 Advanced central unit can monitor sensor inputs in the lower fieldbus level and also shut down safety circuits through its outputs. It can be used up to SIL 3 per EN 61508 and PL e/Cat. 4 per EN ISO 13849-1.

- The 3RK3 Advanced central unit can be parameterized using Safety ES.
- An additional interface module (e.g., DP interface) can be used to exchange process data with a PLC. Diagnostic data of the MSS 3RK3 are also transmitted to the PLC.
- The 3RK3 central unit is supplied with a memory module (sealable with central unit or control cabinet).
- Up to 9 expansion modules can be connected to the 3RK3 Advanced central unit.
- Connection of the diagnostics display is possible as an option for time-saving diagnostics.
- Connection to AS-Interface is possible for safety-related and non-safety-related data exchange.

Inputs and outputs

The 3RK3 Advanced central unit has the following inputs and outputs:

- 8 safety-related, freely parameterizable sensor inputs
- 1 safety-related two-channel relay output
- 1 safety-related two-channel semiconductor output
- 2 test outputs for sensor supply and monitoring when used with safety-related sensor inputs

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Note

Safety-related outputs

If you use the safety-related outputs with 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.

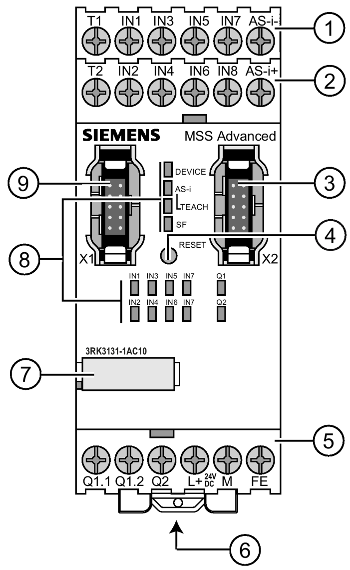
MSS 3RK3 Advanced on the AS-i bus

The MSS 3RK3 Advanced can perform various functions on the AS-i bus:

- Simulation of up to 4 non-safety-related AS-i slaves
- Simulation of up to 12 safety-related AS-i input slaves
- Control of up to 12 safety-related AS-i outputs
- Display of up to 31 safety-related AS-i outputs
- Monitoring of up to 14 non-safety-related AS-i slaves
- Monitoring of up to 31 safety-related AS-i input slaves

You will find further information in Chapter "Connecting to the AS-i master via AS-Interface (Page 188)."

Structure of the 3RK3 Advanced central unit

<table>
<tr><th>Front view</th><th>No.</th><th>Meaning</th></tr>
<tr><td rowspan="9"></td><td>①</td><td>Removable terminal block D</td></tr>
<tr><td>②</td><td>Removable terminal block C</td></tr>
<tr><td>③</td><td>Connection for expansion module (X2)</td></tr>
<tr><td>④</td><td>RESET button</td></tr>
<tr><td>⑤</td><td>Removable terminal block A</td></tr>
<tr><td>⑥</td><td>External memory module (X3; sealable)</td></tr>
<tr><td>⑦</td><td>Label</td></tr>
<tr><td>⑧</td><td>Display LEDs</td></tr>
<tr><td>⑨</td><td>Connection of PC or programming device, interface module, diagnostics display (X1)</td></tr>
</table>

Internal circuit diagram

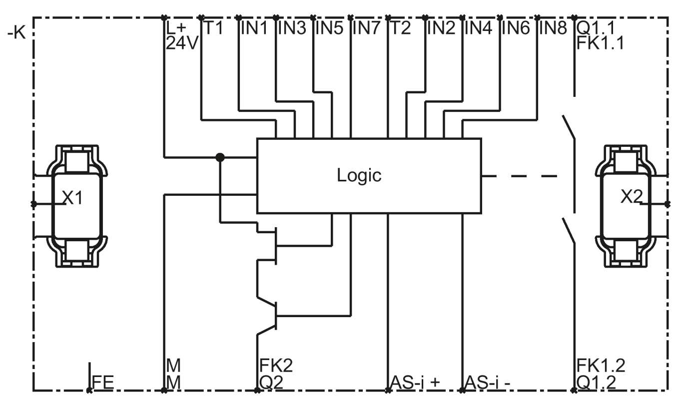


Figure 5-5 MSS 3RK3 Advanced internal circuit diagram

Terminal names of the 3RK3 Advanced central unit

Terminal	Meaning	Description
T1	Test output for inputs IN1, IN3, IN5, IN7	• Test outputs with different test signals • Connection for sensor contacts for detecting cross-circuits
T2	Test output for inputs IN2, IN4, IN6, IN8	
IN1 ... IN8	Safety-related sensor inputs	Terminal for safety sensors Combinations for two-channel connection: • IN1 with IN2 • IN3 with IN4 • IN5 with IN6 • IN7 with IN8
Q1.1, Q1.2	Safety-related relay output	Isolated two-channel output for connecting actuators
Q2	Safety-related semiconductor output	Two-channel output for connecting actuators
AS-i+, AS-i-	AS-i terminals	Connection of the AS-i cable
L+	Power supply	24 V DC
M	Ground	Ground to 24 V DC
FE	Functional ground	Shielding, equipotential bonding

Interfaces of the 3RK3 Advanced central unit

Interface	Meaning	Description
X1	System interface	Connection of PC or programming device, interface module, diagnostics display
X2	Interface	Interface for connecting expansion modules (e.g., I/O modules)
X3	External memory module	Slot for external memory module with parameterization data The memory module is sealable with the 3RK3 central unit or the control cabinet.

Operator controls of the 3RK3 Advanced central unit

Element	Meaning	Description
RESET button	• Error acknowledgment • Factory setting • Application of code sequences	• Confirm the acknowledgeable errors with this button • Refer to Chapter "Restoring factory settings (Page 335)" • Refer to Chapter "Teaching the code sequences (Page 194)"

Displays of the 3RK3 Advanced central unit

Element	Meaning
DEVICE	Device status
AS-i	AS-i error
TEACH	Status of the teaching of code sequences
SF	Group error
IN1 ... IN8	Status of the sensor inputs
Q1, Q2	Status of the safety-related outputs

Connecting inputs and outputs

You will find further information on connecting inputs and outputs in Chapter "Wiring rules for inputs and outputs (Page 123)."

5.1.4.1 Startup / self-test of the MSS 3RK3 Advanced

Initially, startup is performed very much like startup of the MSS 3RK3 Basic, as described in Chapter "Startup / self-test of the MSS 3RK3 Basic (Page 71)." The AS-i function is activated during startup, depending on the configuration.

If no AS-i bus is detected within 30 s during startup, the MSS 3RK3 Advanced switches to safety mode. The missing AS-i slaves are then processed with substitute value "0" in the logic. (AS-i-BF-LED flashes red)

If safety-related AS-i slaves have been detected on the AS-i bus whose code sequence has not been acquired by teaching or whose code sequence does not match the existing code sequence, these are processed with the substitute value "0" in the interconnection logic. (AS-i-BF-LED flashes red)

If no AS-i is configured, the AS-i functionality and the AS-i-BF LED are not processed.

Configuring mode

The 3RK3 Advanced central unit enters configuring 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)

Note

Actual AS-i structure ≠ target AS-i structure

If the actual AS-i structure deviates from the target structure, substitute values will be used for the AS-i slaves affected and the MSS 3RK3 Advanced will change to safety mode after startup.

- The modules could not be parameterized (the SF LED lights up red)
- The existing configuration has not been released.
- The memory module is missing or defective. In this case, only diagnostics of the MSS 3RK3 is possible (DEVICE LED flashes red, SF LED lights up red).

Simulated slaves in configuration mode

If simulated AS-i slaves are contained in the configuration, they will already be simulated on the AS-i bus in configuration mode. The process data of the simulated slaves in configuration mode are always zero.

If the AS-i bus does not exist or if no data traffic is detected on the AS-i bus by the master, simulation of these AS-i slaves is not possible. (AS-i LED flashes red)

If configuration mode is entered by ending safety mode or test mode, the AS-i functionality remains, that is, the simulated slaves remain active on the AS-i bus. Teaching of safety-related AS-i slaves also remains active. Only when a new configuration is loaded onto the device will the period for transmission stop the simulation of AS-i slaves and it will not be started again until the new configuration has been evaluated and accepted.

5.1.5 3RK3 ASIsafe basic central unit

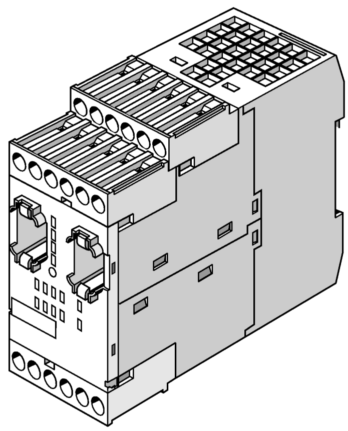


Figure 5-6 3RK3 ASIsafe basic central unit

Properties

The 3RK3 ASIsafe central unit is a basic component of an MSS 3RK3 configuration for safety-related control functions with use of AS-Interface. As an AS-i monitor, the 3RK3 ASIsafe basic central unit can monitor sensor inputs in the lower fieldbus level and also shut down safety circuits through its outputs. It can be used up to SIL 3 per EN 61508 and PL e/Cat. 4 per EN ISO 13849-1.

- The 3RK3 ASIsafe basic central unit can be parameterized using Safety ES.
- An additional interface module (e.g., DP interface) can be used to exchange process data with a PLC. Diagnostic data of the MSS 3RK3 are also transmitted to the PLC.
- The 3RK3 central unit is supplied with a memory module (sealable with central unit or control cabinet).
- Connection of the diagnostics display is possible as an option for time-saving diagnostics.
- Connection to AS-Interface is possible for safety-related and non-safety-related data exchange.

Note

No expansion modules can be connected to the 3RK3 ASIsafe basic central unit.

Inputs and outputs

The 3RK3 ASIsafe basic central unit has the following inputs and outputs:

- 2 safety-related, freely parameterizable sensor inputs
- 6 standard inputs
- 1 safety-related two-channel relay output
- 1 safety-related two-channel semiconductor output
- 2 test outputs for sensor supply and monitoring when used with safety-related sensor inputs

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Note

Safety-related outputs

If you use the safety-related outputs with 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.

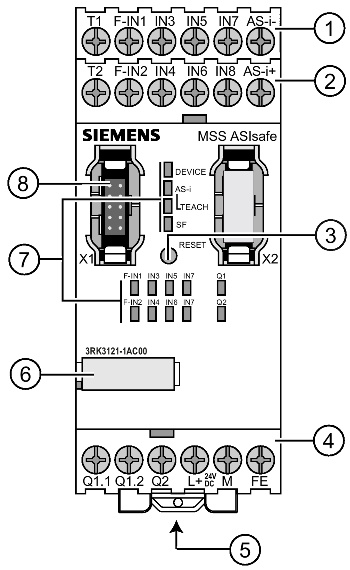
MSS 3RK3 ASIsafe basic on the AS-i bus

The MSS 3RK3 ASIsafe basic can perform various functions on the AS-i bus:

- Simulation of up to 4 non-safety-related AS-i slaves
- Simulation of up to 8 safety-related AS-i input slaves
- Simulation of up to 8 safety-related AS-i output slaves
- Display of up to 31 safety-related AS-i outputs
- Monitoring of up to 14 non-safety-related AS-i slaves
- Monitoring of up to 31 safety-related AS-i input slaves

You will find further information in Chapter "Connecting to the AS-i master via AS-Interface (Page 188)."

Structure of the 3RK3 ASIsafe basic central unit

Front view	No.	Meaning
	①	Removable terminal block D
	②	Removable terminal block C
	③	RESET button
	④	Removable terminal block A
	⑤	External memory module (X3; sealable)
	⑥	Label
	⑦	Display LEDs
	⑧	Connection of PC or programming device, interface module, diagnostics display (X1)

Internal circuit diagram

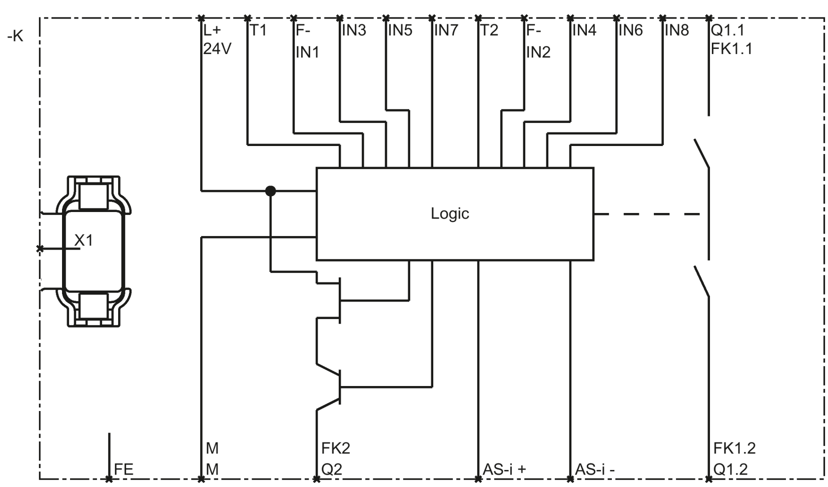


Figure 5-7 MSS 3RK3 ASIsafe basic internal circuit diagram

Terminal designations of the 3RK3 ASIsafe basic central unit

Terminal	Meaning	Description
T1	Test output for input F-IN1	• Test outputs with different test signals • Connection for sensor contacts for detecting cross-circuits
T2	Test output for input F-IN2	
F-IN1 ... F-IN2	Safety-related sensor inputs	Terminal for safety sensors Combinations for two-channel connection: • F-IN1 with F-IN2
IN3 ... IN8	Standard inputs	Connection for sensors (non-safety-related)
Q1.1, Q1.2	Safety-related relay output	Isolated two-channel output for connecting actuators
Q2	Safety-related semiconductor output	Two-channel output for connecting actuators
AS-i+, AS-i-	AS-i terminals	Connection of the AS-i cable
L+	Power supply	24 V DC
M	Ground	Ground to 24 V DC
FE	Functional ground	Shielding, equipotential bonding

Interfaces of the 3RK3 ASIsafe basic central unit

Interface	Meaning	Description
X1	System interface	Connection of PC or programming device, interface module, diagnostics display
X3	External memory module	Slot for external memory module with parameterization data The memory module is sealable with the 3RK3 central unit or the control cabinet.

Operator controls of the 3RK3 ASIsafe basic central unit

Element	Meaning	Description
RESET button	• Error acknowledgment • Factory setting • Application of code sequences	• Confirm the acknowledgeable errors with this button • Refer to Chapter "Restoring factory settings (Page 335)" • Refer to Chapter "Teaching the code sequences (Page 194)"

Displays of the 3RK3 ASIsafe basic central unit

Element	Meaning
DEVICE	Device status
AS-i	AS-i error
TEACH	Status of the teaching of code sequences
SF	Group error
F-IN1, F-IN2	State of the safety-related sensor inputs
IN3 ... IN8	State of the standard inputs
Q1, Q2	State of the safety-related outputs

Connecting inputs and outputs

You will find further information on connecting inputs and outputs in Chapter "Wiring rules for inputs and outputs (Page 123)."

5.1.5.1 Startup/self-test of the MSS 3RK3 ASIsafe basic

The startup process is similar to the startup of the MSS 3RK3 Advanced, as described in Chapter "Startup / self-test of the MSS 3RK3 Advanced (Page 77)."

5.1.6 3RK3 ASIsafe extended central unit

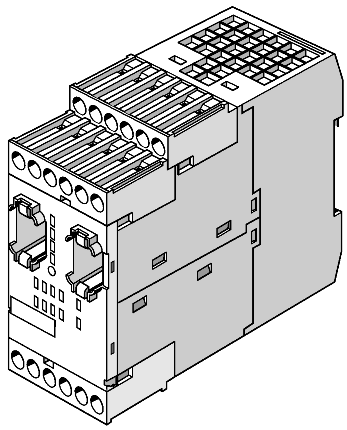


Figure 5-8 3RK3 ASIsafe extended central unit

Properties

The 3RK3 ASIsafe extended central unit is a basic component of an MSS 3RK3 configuration for safety-related control functions with use of AS-Interface. As an AS-i monitor, the 3RK3 ASIsafe extended central unit can monitor sensor inputs in the lower fieldbus level and also shut down safety circuits through its outputs. It can be used up to SIL 3 per EN 61508 and PL e/Cat. 4 per EN ISO 13849-1.

- The 3RK3 ASIsafe extended central unit can be parameterized using Safety ES.
- An additional interface module (e.g., DP interface) can be used to exchange process data with a PLC. Diagnostic data of the MSS 3RK3 are also transmitted to the PLC.
- The 3RK3 central unit is supplied with a memory module (sealable with central unit or control cabinet).
- Up to 2 expansion modules can be connected to the 3RK3 extended central unit.
- Connection of the diagnostics display is possible as an option for time-saving diagnostics.
- Connection to AS-Interface is possible for safety-related and non-safety-related data exchange.

Inputs and outputs

The 3RK3 ASIsafe extended central unit has the following inputs and outputs:

- 4 safety-related, freely parameterizable sensor inputs
- 4 standard inputs
- 1 safety-related two-channel relay output
- 1 safety-related two-channel semiconductor output
- 2 test outputs for sensor supply and monitoring when used with safety-related sensor inputs

---

Note

Safety-related outputs

If you use the safety-related outputs with 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.

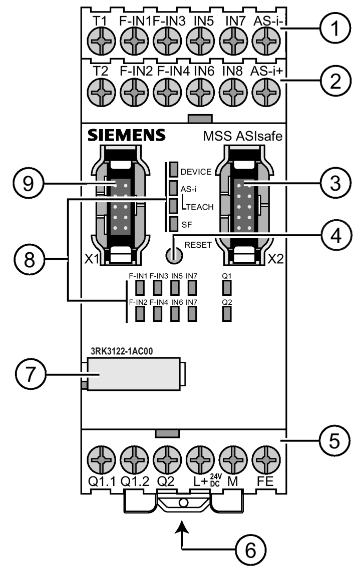
MSS 3RK3 ASIsafe extended on the AS-i bus

The MSS 3RK3 ASIsafe extended can perform various functions on the AS-i bus:

- Simulation of up to 4 non-safety-related AS-i slaves
- Simulation of up to 10 safety-related AS-i input slaves
- Control of up to 10 safety-related AS-i outputs
- Display of up to 31 safety-related AS-i outputs
- Monitoring of up to 14 non-safety-related AS-i slaves
- Monitoring of up to 31 safety-related AS-i input slaves

You will find further information in Chapter "Connecting to the AS-i master via AS-Interface (Page 188)."

Structure of the 3RK3 ASIsafe extended central unit

Front view	No.	Meaning
	①	Removable terminal block D
	②	Removable terminal block C
	③	Connection for expansion module (X2)
	④	RESET button
	⑤	Removable terminal block A
	⑥	External memory module (X3; sealable)
	⑦	Label
	⑧	Display LEDs
	⑨	Connection of PC or programming device, interface module, diagnostics display (X1)

Internal circuit diagram

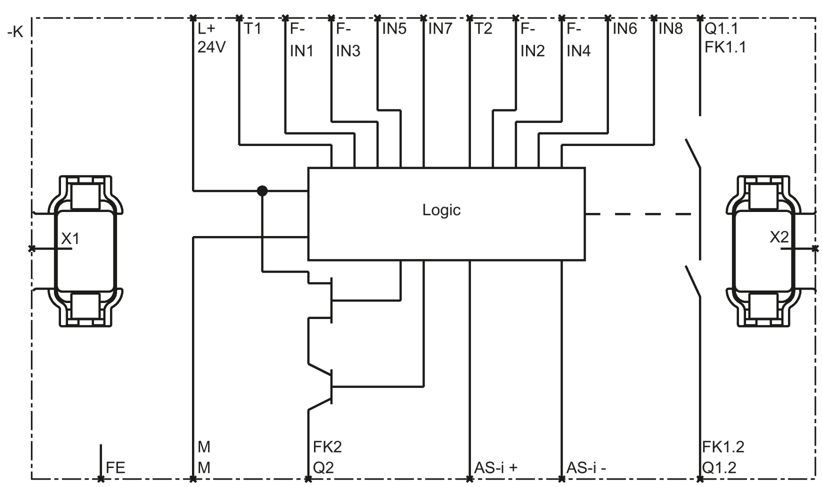


Figure 5-9 MSS 3RK3ASIsafe extended internal circuit diagram

Terminal designations of the 3RK3 ASIsafe extended central unit

Terminal	Meaning	Description
T1	Test output for inputs F-IN1, F-IN3	• Test outputs with different test signals • Connection for sensor contacts for detecting cross-circuits
T2	Test output for inputs F-IN2, F-IN4	
F-IN1 ... F-IN4	Safety-related sensor inputs	Terminal for safety sensors Combinations for two-channel connection: • F-IN1 with F-IN2 • F-IN3 with F-IN4
IN5 ... IN8	Standard inputs	Connection for sensors (non-safety-related)
Q1.1, Q1.2	Safety-related relay output	Isolated two-channel output for connecting actuators
Q2	Safety-related semiconductor output	Two-channel output for connecting actuators
AS-i+, AS-i-	AS-i terminals	Connection of the AS-i cable
L+	Power supply	24 V DC
M	Ground	Ground to 24 V DC
FE	Functional ground	Shielding, equipotential bonding

Interfaces of the 3RK3 ASIsafe extended central unit

Interface	Meaning	Description
X1	System interface	Connection of PC or programming device, interface module, diagnostics display
X2	Interface	Interface for connecting expansion modules (e.g., I/O modules)
X3	External memory module	Slot for external memory module with parameterization data The memory module is sealable with the 3RK3 central unit or the control cabinet.

Operator controls of the 3RK3 ASIsafe extended central unit

Element	Meaning	Description
RESET button	• Error acknowledgment • Factory setting • Application of code sequences	• Confirm the acknowledgeable errors with this button • Refer to Chapter "Restoring factory settings (Page 335)" • Refer to Chapter "Teaching the code sequences (Page 194)"

Displays of the 3RK3 ASIsafe extended central unit

Element	Meaning
DEVICE	Device status
AS-i	AS-i error
TEACH	Status of the teaching of code sequences
SF	Group error
F-IN1 ... F-IN4	Status of the sensor inputs
IN5 ... IN8	State of the standard inputs
Q1, Q2	Status of the safety-related outputs

Connecting inputs and outputs

You will find further information on connecting inputs and outputs in Chapter "Wiring rules for inputs and outputs (Page 123)."

5.1.6.1 Startup/self-test of the MSS 3RK3 ASIsafe extended

The startup process is similar to the startup of the MSS 3RK3 Advanced, as described in Chapter "Startup / self-test of the MSS 3RK3 Advanced (Page 77)."

5.1.7 General information on expansion modules

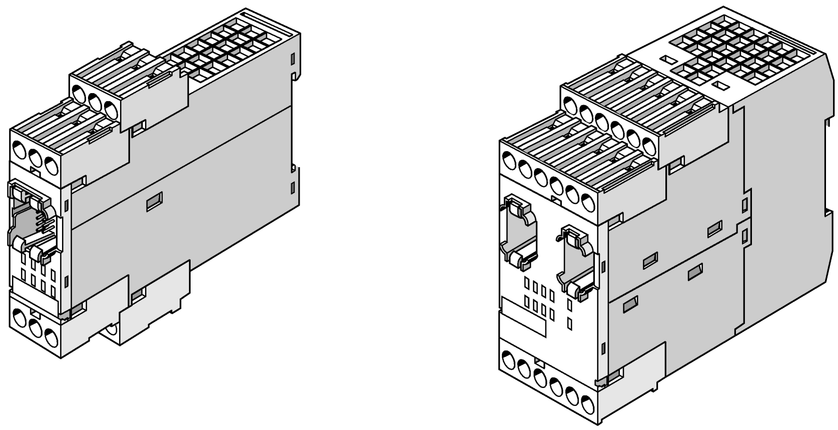


Figure 5-10 Expansion modules of the MSS 3RK3

Application

The expansion modules provide additional inputs and outputs for a 3RK3 central unit. The precondition for the use of expansion modules is always connection to a 3RK3 central unit and the corresponding software version Safety ES.

5.1.8 Startup/self-test of the expansion modules

Once the power supply has been applied, all the devices perform a self-test. During this phase, the LEDs of the 3RK3 central unit and the expansion modules light up (lamp test). When the system has powered up, the self-test is complete, and the device is in safety or test mode, the LEDs light up in accordance with the pending signals.

5.1.9 Expansion module 4/8F-DI

Properties

With the expansion module 4/8F-DI, the 3RK3 central unit can be expanded with further safety-related inputs. It can be used up to SIL 3 per EN 61508 and PL e/Cat. 4 per EN ISO 13849-1.

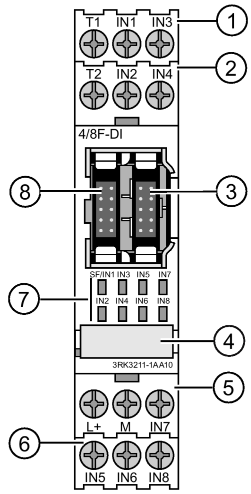
- Parameterization is performed using the 3RK3 central unit with Safety ES software.
- Additional expansion modules can be connected to the expansion module 4/8F-DI.

Inputs and outputs

The expansion module 4/8F-DI has the following inputs and outputs:

- 8 safety-related, parameterizable sensor inputs
- 2 test outputs for sensor supply and monitoring when used with safety-related sensor inputs

Design of the expansion module 4/8F-DI:

Front view	No.	Meaning
	①	Removable terminal block D
	②	Removable terminal block C
	③	Interface (X2)
	④	Label
	⑤	Removable terminal block A
	⑥	Removable terminal block B
	⑦	Display LEDs
	⑧	Interface (X1)

Internal circuit diagram

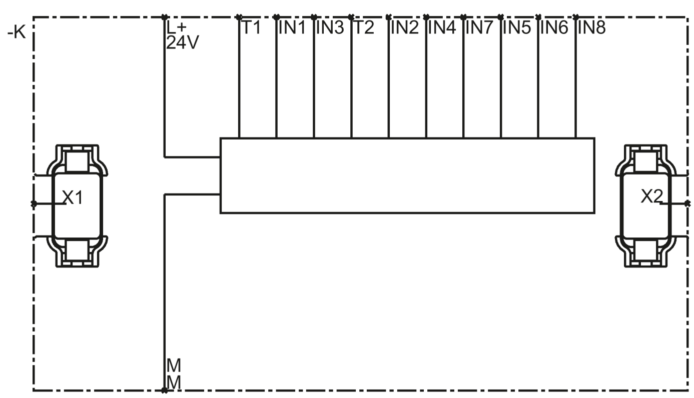


Figure 5-11 EM 4/8F-DI internal circuit diagram

Terminal designations of the expansion module 4/8F-DI:

Terminal	Meaning	Description
T1	Test output for inputs IN1, IN3, IN5, IN7	• Test outputs with different test signals • Connection for sensor contacts for detecting cross-circuits
T2	Test output for inputs IN2, IN4, IN6, IN8	
IN1 ... IN8	Safety-related sensor inputs	Terminal for safety sensors Combinations for two-channel connection: • IN1 with IN2 • IN3 with IN4 • IN5 with IN6 • IN7 with IN8
L+	Power supply	24 V DC
M	Ground	Ground to 24 V DC

Interfaces of the expansion module 4/8F-DI:

Interface	Meaning	Description
X1	Interface	Connection of central unit/expansion module
X2	Interface	Connection of expansion module

Displays of the expansion module 4/8F-DI

Element	Meaning
SF / IN1	Group error / status of the sensor input
IN2 ... IN8	Status of the sensor inputs

Connecting inputs and outputs

You will find further information on connecting inputs and outputs in Chapter "Wiring rules for inputs and outputs (Page 123)."

5.1.10 Expansion module 2/4F-DI 1/2F-RO

Properties

With the 2/4F-DI 1/2F-RO expansion module, the 3RK3 central unit can be expanded with further safety-related inputs and outputs. To achieve SIL 3 per EN 61508 or PL e / Cat. 4 per EN ISO 13849-1, you must interconnect 2 relay outputs in a logic combination.

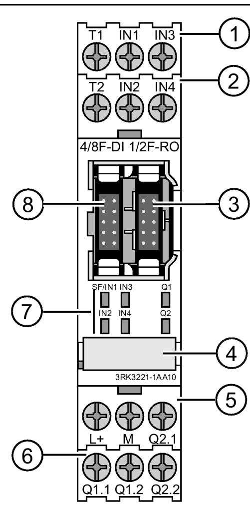
- Parameterization is performed using the 3RK3 central unit with Safety ES software.
- Additional expansion modules can be connected to the expansion module 2/4F-DI 1/2F-RO.

Inputs and outputs

The expansion module 2/4F-DI 1/2F-RO has the following inputs and outputs:

- 4 safety-related, freely parameterizable sensor inputs
- 2 safety-related single-channel relay outputs
- 2 test outputs for sensor supply and monitoring when used with safety-related sensor inputs

Design of the expansion module 2/4F-DI 1/2F-RO

Front view	No.	Meaning
	①	Removable terminal block D
	②	Removable terminal block C
	③	Interface (X2)
	④	Label
	⑤	Removable terminal block A
	⑥	Removable terminal block B
	⑦	Display LEDs
	⑧	Interface (X1)

Internal circuit diagram

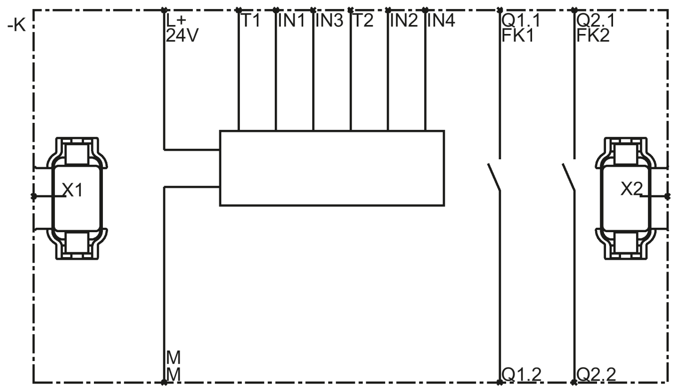


Figure 5-12 2/4F-DI 1/2F-RO internal circuit diagram

Terminal designations of the expansion module 2/4F-DI 1/2F-RO

Terminal	Meaning	Description
T1	Test output for inputs IN1, IN3	• Test outputs with different test signals • Connection for sensor contacts for detecting cross-circuits
T2	Test output for inputs IN2, IN4	
IN1 ... IN4	Safety-related sensor inputs	Terminal for safety sensors Combinations for two-channel connection: • IN1 with IN2 • IN3 with IN4
Q1.1, Q1.2	Safety-related relay output	Isolated output for connecting actuators
Q2.1, Q2.2	Safety-related relay output	
L+	Power supply	24 V DC
M	Ground	Ground to 24 V DC

Interfaces of the expansion module 2/4F-DI 1/2F-RO

Interface	Meaning	Description
X1	Interface	Connection of central unit/expansion module
X2	Interface	Connection of expansion module

Displays of the expansion module 2/4F-DI 1/2F-RO

Element	Meaning
SF / IN1	Group error / status of the sensor input
IN2, IN3, IN4	Status of the sensor inputs
Q1, Q2	State of the relay outputs

Connecting inputs and outputs

You will find further information on connecting inputs and outputs in Chapter "Wiring rules for inputs and outputs (Page 123)."

5.1.11 Expansion module 2/4F-DI 2F-DO

Properties

With the 2/4F-DI 2F-DO expansion module, the 3RK3 central unit can be expanded with further safety-related inputs and outputs. It can be used up to SIL 3 per EN 61508 and PL e/Cat. 4 per EN ISO 13849-1.

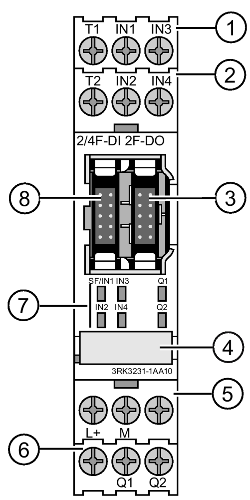
- Parameterization is performed using the 3RK3 central unit with Safety ES software.
- Additional expansion modules can be connected to the expansion module 2/4F-DI 2F-DO.

Inputs and outputs

The expansion module 2/4F-DI 2F-DO has the following inputs and outputs:

- 4 safety-related, freely parameterizable sensor inputs
- 2 safety-related two-channel semiconductor outputs
- 2 test outputs for sensor supply and monitoring when used with safety-related sensor inputs

Design of the expansion module 2/4F-DI 2F-DO

Front view	No.	Meaning
	①	Removable terminal block D
	②	Removable terminal block C
	③	Interface (X2)
	④	Label
	⑤	Removable terminal block A
	⑥	Removable terminal block B
	⑦	Display LEDs
	⑧	Interface (X1)

Internal circuit diagram

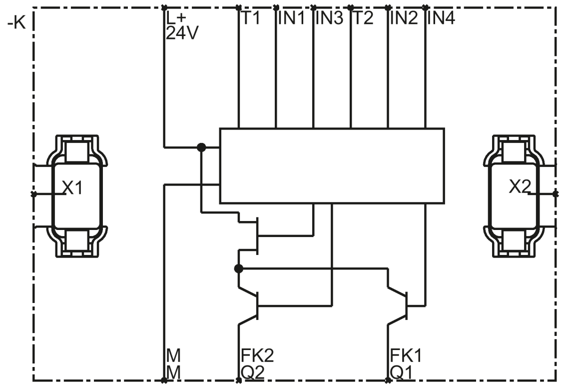


Figure 5-13 2/4F-DI 2F-DO internal circuit diagram

Terminal designations of the expansion module 2/4F-DI 2F-DO

Terminal	Meaning	Description
T1	Test output for inputs IN1, IN3	• Test outputs with different test signals • Connection for sensor contacts for detecting cross-circuits
T2	Test output for inputs IN2, IN4	
IN1 ... IN4	Safety-related sensor inputs	Terminal for safety sensors Combinations for two-channel connection: • IN1 with IN2 • IN3 with IN4
Q1, Q2	Safety-related semiconductor outputs	Two-channel semiconductor outputs for connecting actuators
L+	Power supply	24 V DC
M	Ground	Ground to 24 V DC

Interfaces of the expansion module 2/4F-DI 2F-DO

Interface	Meaning	Description
X1	Interface	Connection of central unit/expansion module
X2	Interface	Connection of expansion module

Displays of the expansion module 2/4F-DI 2F-DO

Element	Meaning
SF / IN1	Group error / status of the sensor input
IN2, IN3, IN4	Status of the sensor inputs
Q1, Q2	State of semiconductor outputs

Connecting inputs and outputs

You will find further information on connecting inputs and outputs in Chapter "Wiring rules for inputs and outputs (Page 123)."

5.1.12 Expansion module 4F-DO

Properties

With the expansion module 4F-DO, the 3RK3 central unit can be expanded with further safety-related outputs. It can be used up to SIL 3 per EN 61508 and PL e/Cat. 4 per EN ISO 13849-1.

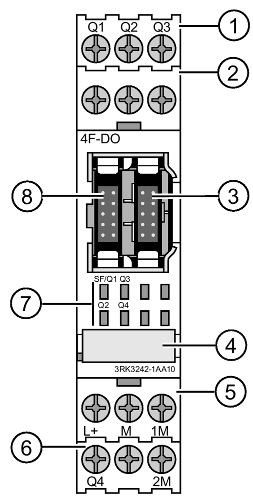
- Parameterization is performed using the 3RK3 central unit with Safety ES software.
- Additional expansion modules can be connected to the expansion module 4F-DO.

Inputs and outputs

The 4F-DO expansion module has the following outputs:

- 4 safety-related two-channel semiconductor outputs

Structure of the expansion module 4F-DO

Front view	No.	Meaning
	①	Removable terminal block D
	②	Removable terminal block C
	③	Interface (X2)
	④	Label
	⑤	Removable terminal block A
	⑥	Removable terminal block B
	⑦	Display LEDs
	⑧	Interface (X1)

Internal circuit diagram

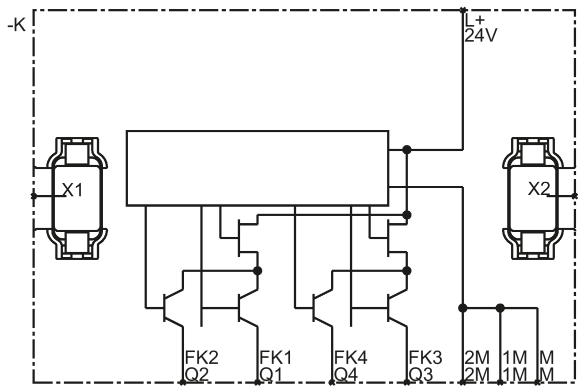


Figure 5-14 4F-DO internal circuit diagram

Terminal designations of the expansion module 4F-DO

Terminal	Meaning	Description
Q1, Q2, Q3, Q4	Safety-related semiconductor outputs	Two-channel semiconductor outputs for connecting actuators
L+	Power supply	24 V DC
M, 1M, 2M	Ground	Ground to 24 V DC

Interfaces of the expansion module 4F-DO

Interface	Meaning	Description
X1	Interface	Connection of central unit/expansion module
X2	Interface	Connection of expansion module

Displays of the expansion module 4F-DO

Element	Meaning
SF/Q1	Group error / state of the semiconductor outputs
Q2, Q3, Q4	State of the semiconductor outputs

Connecting inputs and outputs

You will find further information on connecting inputs and outputs in Chapter "Wiring rules for inputs and outputs (Page 123)."

5.1.13 Expansion module 4/8F-RO

Properties

With the expansion module 4/8F-RO, the 3RK3 central unit can be expanded with further safety-related outputs. To achieve SIL 3 per EN 61508 or PL e / Cat. 4 per EN ISO 13849-1, you must interconnect 2 relay outputs in a logic combination.

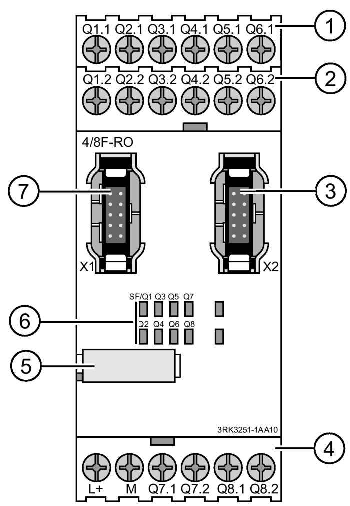
- Parameterization is performed using the 3RK3 central unit with Safety ES software.
- Additional expansion modules can be connected to the expansion module 4/8F-RO.

Inputs and outputs

The 4/8F-RO expansion module has the following inputs and outputs:

- 8 safety-related single-channel relay outputs

Design of the expansion module 4/8F-RO

Front view	No.	Meaning
	①	Removable terminal block D
	②	Removable terminal block C
	③	Interface (X2)
	④	Removable terminal block A
	⑤	Label
	⑥	Display LEDs
	⑦	Interface (X1)

Internal circuit diagram

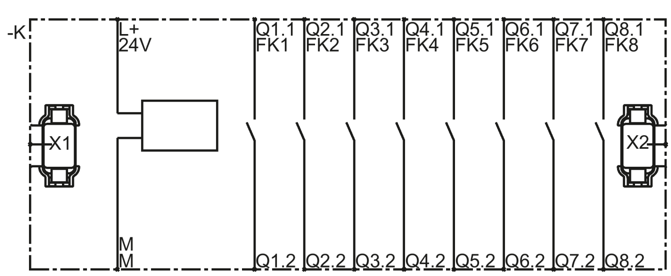


Figure 5-15 4/8F-RO internal circuit diagram

Terminal designations of the 4/8F-RO expansion module

Terminal	Meaning	Description
Q1.1, Q1.2	Safety-related relay output	Isolated output for connecting actuators
Q2.1, Q2.2	Safety-related relay output	
Q3.1, Q3.2	Safety-related relay output	
Q4.1, Q4.2	Safety-related relay output	
Q5.1, Q5.2	Safety-related relay output	
Q6.1, Q6.2	Safety-related relay output	
Q7.1, Q7.2	Safety-related relay output	
Q8.1, Q8.2	Safety-related relay output	
L+	Power supply	24 V DC
M	Ground	Ground to 24 V DC

Interfaces of the expansion module 4/8F-RO

Interface	Meaning	Description
X1	Interface	Connection of central unit/expansion module
X2	Interface	Connection of expansion module

Operator controls and displays of the expansion module 4/8F-RO

Element	Meaning
SF/Q1	Group error / state of the relay output
Q2 ...Q8	State of the relay outputs

Connecting inputs and outputs

You will find further information on connecting inputs and outputs in Chapter "Wiring rules for inputs and outputs (Page 123)."

5.1.14 Expansion module 8DI

Properties

With the 8DI expansion module, the 3RK3 central unit can be expanded by further (non-safety-related) inputs. The 8DI expansion module supplements a 3RK3 central unit.

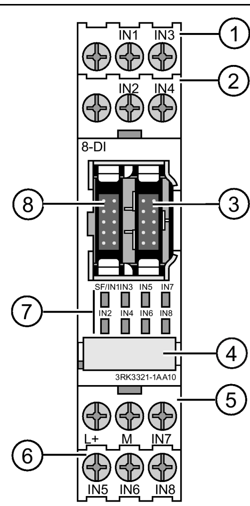
- Parameterization is performed using the 3RK3 central unit with Safety ES software.
- It is suitable as an input module with non-safety-related sensor inputs, e.g. for:
  - Displaying process statuses for operational switching.
  - Detecting start buttons.
- Additional expansion modules can be connected to the expansion module 8DI.

Inputs and outputs

The 8DI expansion module has the following inputs:

- 8 sensor inputs (non-safety-related)

Design of the expansion module 8-DI

Front view	No.	Meaning
	①	Removable terminal block D
	②	Removable terminal block C
	③	Interface (X2)
	④	Label
	⑤	Removable terminal block A
	⑥	Removable terminal block B
	⑦	Display LEDs
	⑧	Interface (X1)

Internal circuit diagram

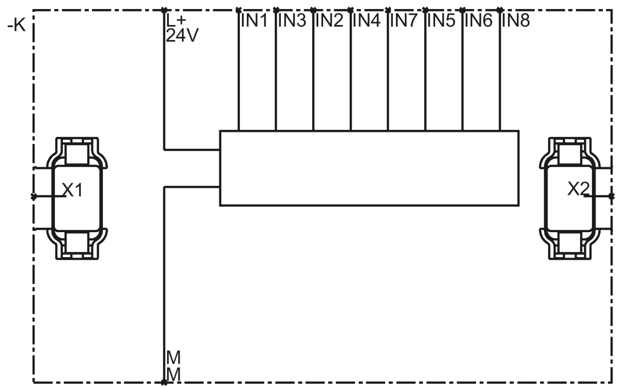


Figure 5-16 8-DI internal circuit diagram

Terminal designations of the expansion module 8-DI

Terminal	Meaning	Description
IN1 ... IN8	Sensor inputs	Connection for sensors
L+	Power supply	24 V DC
M	Ground	Ground to 24 V DC

Interfaces of the expansion module 8-DI

Interface	Meaning	Description
X1	Interface	Connection of central unit/expansion module
X2	Interface	Connection of expansion module

Displays of the expansion module 8-DI

Element	Meaning
SF / IN1	Group error / status of the sensor input
IN2 ... IN8	State of the sensor inputs

Connecting inputs and outputs

You will find further information on connecting inputs and outputs in Chapter "Wiring rules for inputs and outputs (Page 123)."

5.1.15 Expansion module 8DO

Properties

With the 8DO expansion module, the 3RK3 central unit can be expanded by further (non-safety-related) outputs. It is suitable as an output module with non-safety-related outputs, e.g. for messages.

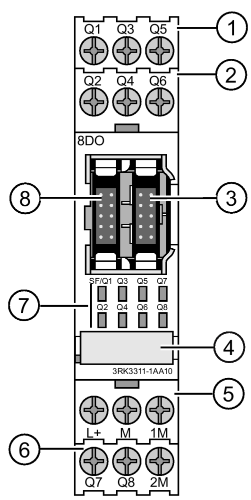
- Parameterization is performed using the 3RK3 central unit with Safety ES software.
- Additional expansion modules can be connected to the expansion module 8DO.

Inputs and outputs

The 8DO expansion module has the following outputs:

- 8 standard semiconductor outputs (non-safety-related)

Design of the expansion module 8DO



Front view	No.	Meaning
	①	Removable terminal block D
	②	Removable terminal block C
	③	Interface (X2)
	④	Label
	⑤	Removable terminal block A
	⑥	Removable terminal block B
	⑦	Display LEDs
	⑧	Interface (X1)

Internal circuit diagram

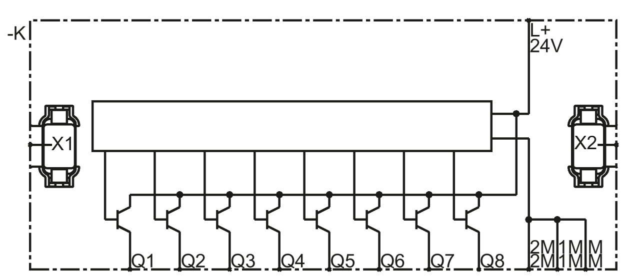


Figure 5-17 8DO internal circuit diagram

Terminal designations of the expansion module 8DO

Terminal	Meaning	Description
Q1 ...Q8	Semiconductor outputs	Standard semiconductor outputs (non-safety-related)
L+	Power supply	24 V DC
M, 1M, 2M	Ground	Ground to 24 V DC

System interfaces of the expansion module 8DO

Interface	Meaning	Description
X1	Interface	Connection of central unit/expansion module
X2	Interface	Connection of expansion module

Displays of the expansion module 8DO

Element	Meaning
SF/Q1	Group error / state of the semiconductor output
Q2 ...Q8	State of the semiconductor outputs (non-safety-related)

Connecting inputs and outputs

You will find further information on connecting inputs and outputs in Chapter "Wiring rules for inputs and outputs (Page 123)."

5.1.16 3RK35 DP interface module

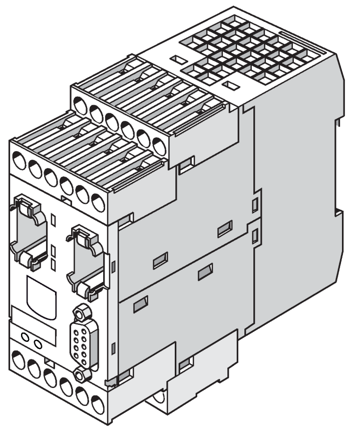


Figure 5-18 DP interface module

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.

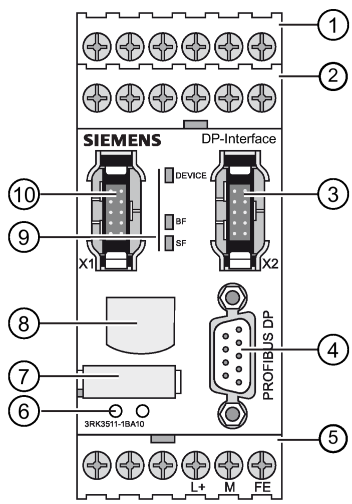
  Both options can be used at the same time.
- The DP interface supports DPV1 and DPV0 mode.

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	Button (SET / MODE)
	⑦	Label
	⑧	LCD display
	⑨	Display LEDs
	⑩	System interface (X1)

Internal circuit diagram

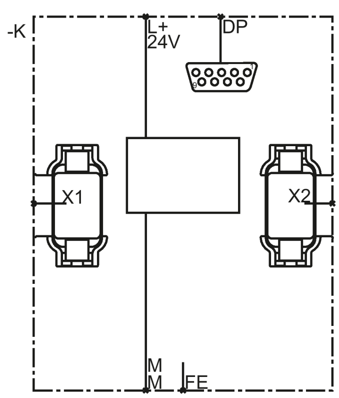


Figure 5-19 DP interface internal circuit diagram

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 182)".
MODE	Operating the display	

Display elements of the DP interface module

Element	Meaning
DEVICE	Status
BF	Bus error
SF	Group error

5.1.17 3RK36 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).

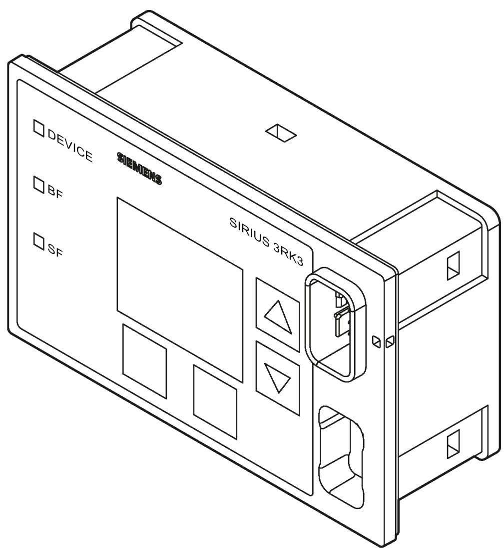


Figure 5-20 Diagnostics display

Note

3SK2 safety relays

These 3SK2 safety relays are supported by the diagnostics display from product version E04 and firmware version V1.2.x and higher.

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

These 3RK3 central units are supported by the diagnostics display with product version E03 and firmware version V1.1.x and higher.

MSS 3RK3 Basic

MSS 3RK3 Basic is supported by the diagnostics display with product version E01 and higher.

Note

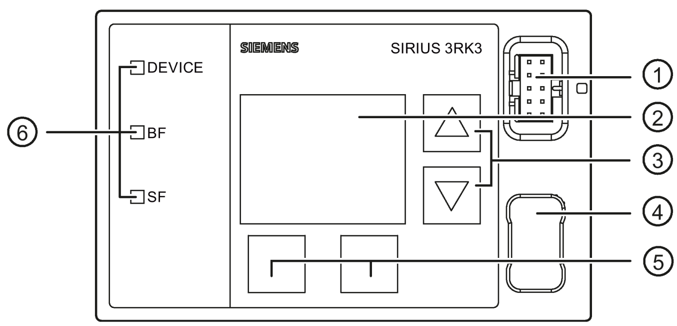
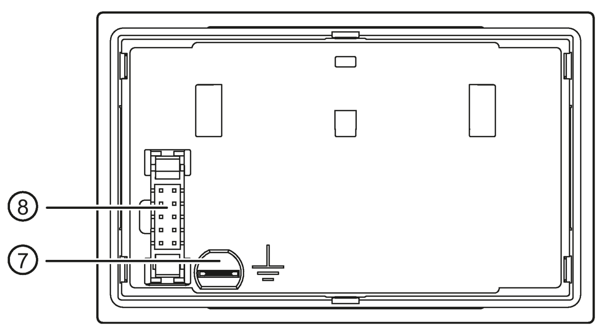
Communication via PROFIBUS and diagnostics display

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

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.

[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. In addition, it is shown by selecting menu command "Display settings / Identification". (see also Section "Display settings (Page 331)")

Design of the diagnostics display

<table>
<tr><th>View</th><th>No.</th><th>Meaning</th></tr>
<tr><td rowspan="7">Front view

</td><td>①</td><td>System interface (X1)</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>Rear view:
</td><td>⑧</td><td>System interface (X2)</td></tr>
</table>

Internal circuit diagram

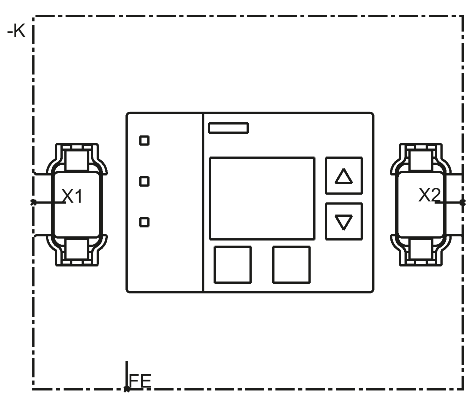


Figure 5-21 Diagnostic display internal circuit diagram

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 314)".

5.2 Mounting / installing / attaching

5.2.1 General information

Safety information

WARNING

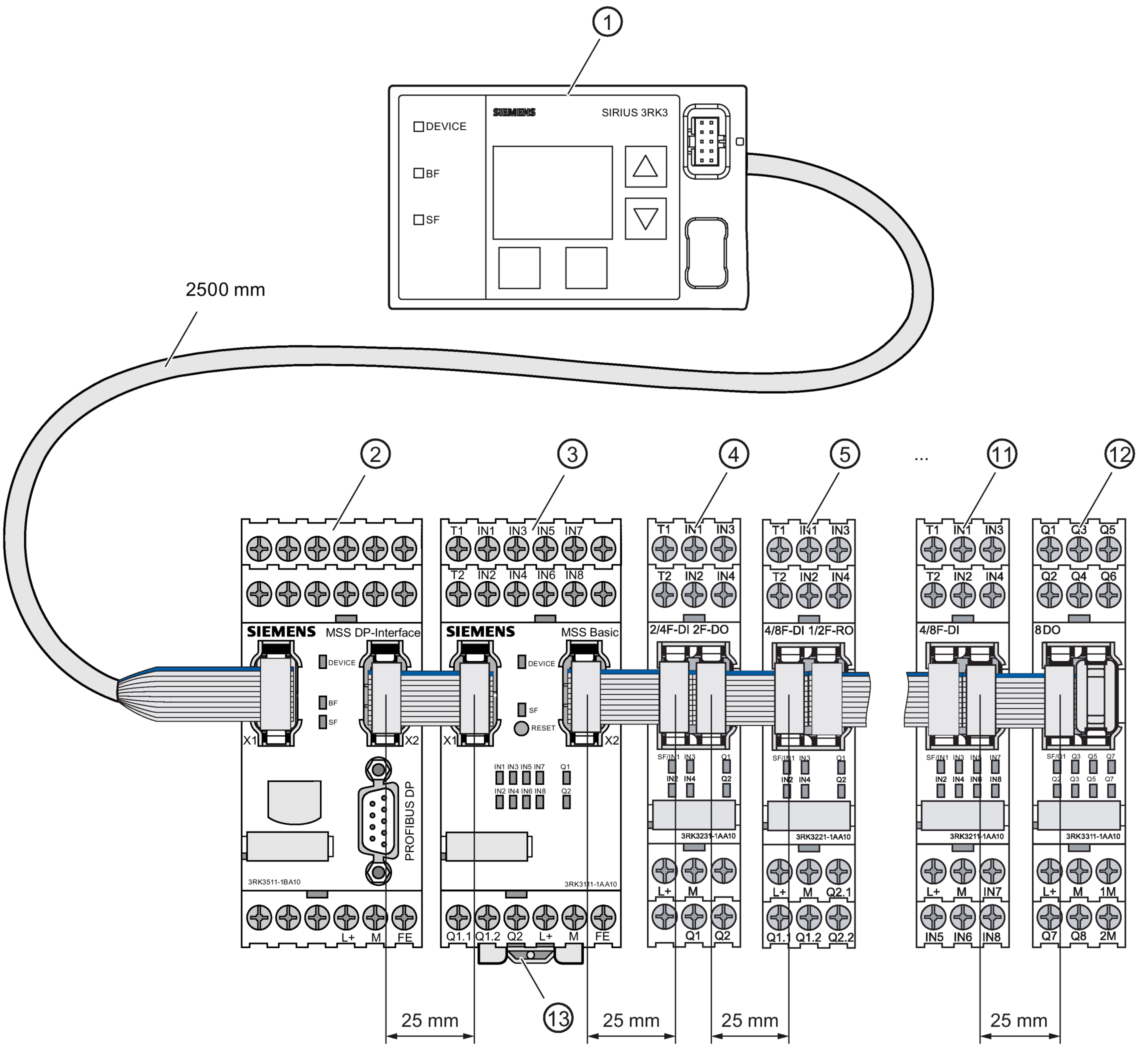
Hazardous Voltage
Can Cause Death, Serious Injury, or Damage to Property.

Hazardous voltages can cause electric shock, burns and damage to property.

Turn off and lock out all power supplying the system and device before working on the device.

Cable lengths

During installation, pay attention to the maximum cable lengths to be complied with between the modules:



①	Diagnostics display
②	Interface module
③	Central unit
④ ... ⑫	Expansion modules

- 0 for MSS 3RK3 ASIsafe basic
- Maximum of 2 for MSS 3RK3 ASIsafe extended
- Maximum of 7 for MSS 3RK3 Basic
- Maximum of 9 for MSS 3RK3 Advanced

⑨ Memory module

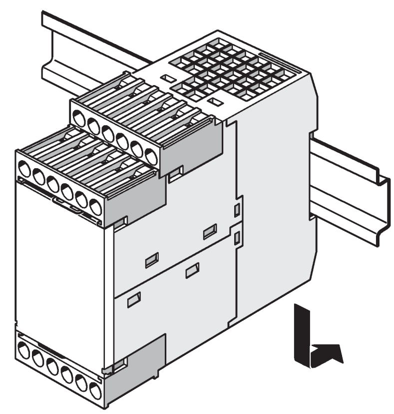
Figure 5-22 Maximum cable lengths of the MSS 3RK3

5.2.2 Mounting the central unit, expansion module, or interface module on a DIN 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 "General technical data (Page 348)."

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.	

5.2.3 Mounting the central unit, expansion module, or interface module on a level surface

Requirements

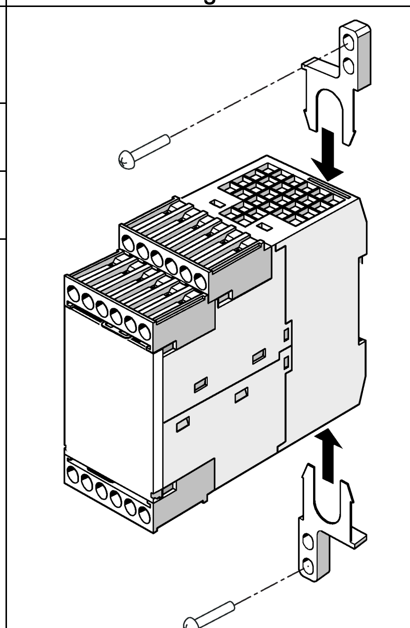
Please note the following requirements for mounting on a level surface:

- Please observe the information about the mounting position in Section "General technical data (Page 348)".
- 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 "Dimension drawings (Page 367)".
- 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 "MSS 3RK3 system components (Page 34)".

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.	

5.2.4 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.

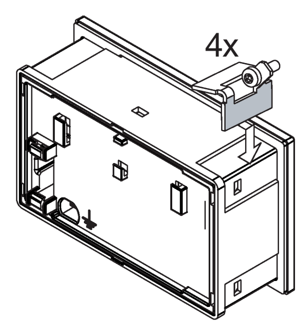
Note

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.	

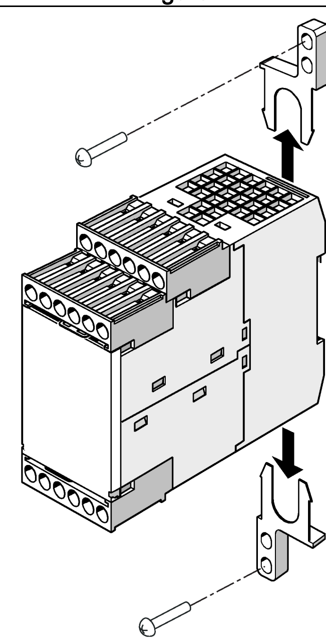
5.2.5 Removing the central unit, expansion module, or interface module from a level surface

⚠ 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.	

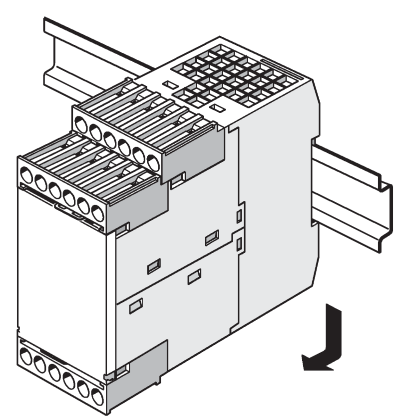
5.2.6 Removing the central unit, expansion module, or interface module from a DIN rail

⚠ 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

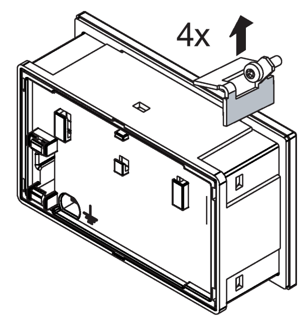
Step	Instructions	Figure
1	Pull the device down until the lower half can be pulled away from the DIN rail.	
2	Pull the lower half of the device away from the DIN rail.	
3	Lift the device from the upper edge of the DIN rail.	

5.2.7 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.	

5.3 Connecting / wiring

5.3.1 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.

NOTICE

Protection against electrostatic charge

Unused system interfaces must be closed using system interface covers; see Chapter "MSS 3RK3 system components (Page 34)."

Note

All components, including the light curtain, must be operated on the same power supply.

Note

Sealing system interfaces

To protect against unauthorized access, you can secure the system interfaces of the 3RK3 central unit using the system interface cover, sealing wire and crimp seal.

Note

Wiring rules and options for connecting inputs and outputs

You can find further information on wiring rules and possibilities of connecting inputs and outputs in the Chapter "Wiring rules for inputs and outputs (Page 123)."

5.3.2 Wiring rules for inputs and outputs

5.3.2.1 Safety information

DANGER

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

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 SIL 2/3 per IEC 61508 or PL d/e per EN ISO 13849-1, a fault exclusion such as a short-circuit to a power cable or ground is required. This can be implemented, for example, within a 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.

5.3.2.2 Guidelines for wiring the MSS 3RK3

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.

Cross-circuit detection

To ensure reliable cross-circuit detection, note the following points when wiring the individual devices:

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 only be connected to a single (expansion) module.
4. A two-channel sensor must be connected to test outputs T1/T2 to ensure cross-circuit detection.
   If a cross-circuit is detected, this applies to the entire module.
5. Test output T1 must always be combined with an odd-numbered sensor input (IN1, IN3, IN5, IN7).
6. Test output T2 must always be combined with an even-numbered sensor input (IN2, IN4, IN6, IN8).
7. Non-floating sensors cannot be connected to test outputs T1/T2. Cross-circuit detection of non-floating sensors with a safety relay is therefore not possible. These sensors must be able to monitor and evaluate themselves and also the cable 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. For this reason, the cables for the two buttons must be routed separately to prevent a cross-circuit (in two-hand operation, for example).
9. If a safety shutdown mat (cross-circuit principle) is connected to a device, 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.
10. Since a cross-circuit is a fault that requires acknowledgment, a cross-circuit that has been rectified must be acknowledged by resetting.

Wiring sensors

Chapters "Connecting safety-related inputs (Page 127)" and "Connecting non-safety-related inputs (Page 129)" describe how to connect the sensors to the safety relay.

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 has solid-state outputs, cross-circuit detection must be deactivated. • If the ESPE has floating contacts, only the sensor line between the safety relay and the ESPE is tested when cross-circuit detection is activated. The light barrier is not tested.
Safety shutdown mat (NC principle)	can be set to on/off	-
Safety shutdown mat (cross-circuit principle)	ON	With this monitoring function, a cross-circuit is not a fault, but complies with the safety requirement. A cross-circuit is not therefore evaluated as a fault and does not need to 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 and T2.
Protective door	can be set to on/off	-
Protective door with lock	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 operator controls	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	-

Outputs

1. If outputs are used as two-channel outputs, the two outputs do not have to be on the same device.
2. Safety-related semiconductor outputs can be used for safety-related shutdown to SIL 3 per EN 61508 and PL e / Cat. 4 per EN ISO 13849-1 if the cables are installed in a protected manner or routed inside the cabinet.

Wiring actuators

Chapters "Connecting safety-related semiconductor outputs (Page 130)," "Connecting safety-related relay outputs (Page 131)," and "Connecting non-safety-related outputs (Page 134)" describe how to connect the actuators to the safety relay.

5.3.2.3 Connecting safety-related inputs

Single- and two-channel sensors

To achieve the required performance level or SIL, single-channel or two-channel interconnection of the inputs of the MSS 3RK3 is possible. The following connection options are available:

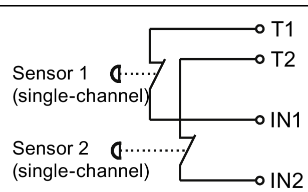
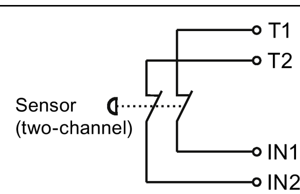
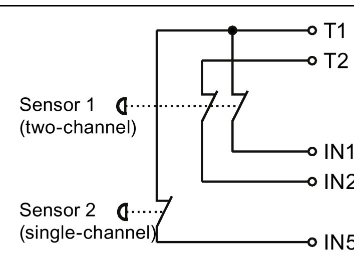
- In the case of single-channel connection, only one input terminal is assigned for each sensor.
- In the case of two-channel connection, two input terminals are assigned for each sensor. Both single-channel and two-channel sensors can be interconnected on a single 3RK3 central unit or expansion module. The number of connectable sensors thus varies according to the connection options. Up to 4 two-channel sensors or 8 single-channel sensors can be connected to the 3RK3 central unit.
- 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.

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 test output for IN1, 3, 5, 7

T2 test output for IN2, 4, 6, 8

IN1 ... IN5 sensor inputs

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

Note

SIL 3 per EN 61508 or PL e/Cat. 4 per EN ISO 13849-1

The following conditions must be met to achieve SIL 3 per EN 61508 or PL e/Cat. 4 per EN ISO 13849-1:

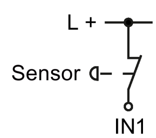
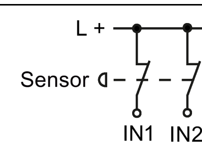
- The two-channel sensor is connected to a test output pair on the 3RK3 central unit in compliance with the wiring rules (Page 124).
- Cross-circuit detection of the applicable safety function is activated in Safety ES.

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)

1 single-channel sensor	1 two-channel sensor
	

IN1, IN2 sensor inputs

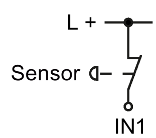
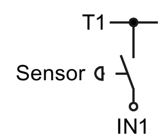
5.3.2.4 Connecting non-safety-related inputs

Non-safety-related sensors

The 8DI expansion module has 8 non-safety-related sensor inputs. All other 3RK3 modules only have safety-related inputs. Therefore, these inputs are also used for non-fail-safe signals (e.g. fault acknowledgment).

Non-safety-related signals such as start buttons can be supplied on modules with test outputs not only in a non-floating implementation via L+ but also via the test outputs T1 / T2, just like single-channel sensors.

Connection possibility

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

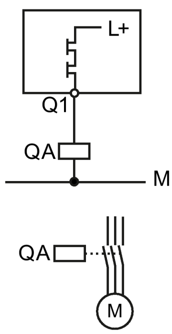
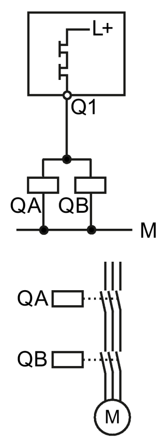
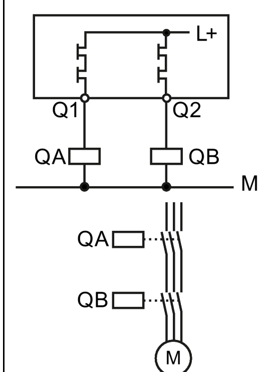
IN1 sensor input

5.3.2.5 Connecting safety-related semiconductor outputs

Semiconductor outputs

Internally, safety-related semiconductor outputs always have a two-channel structure. Each of these outputs can therefore be used for applications up to SIL 3 per EN 61508 or PL e per 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

Q1, Q2 safety-related semiconductor outputs

Note

***)SIL 2/3 per EN 61508 or PL d/e per EN ISO 13849-1**

To achieve SIL 2/3 per IEC 61508 or PL d/e per EN ISO 13849-1, a fault exclusion such as a short-circuit to a power cable or ground is required. This can be implemented, for example, within a 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 further information in Chapter "Requirements for actuators (Page 173)."

5.3.2.6 Connecting safety-related relay outputs

Relay outputs

Safety-related outputs of the 3RK3 central units are configured with two channels; those of the expansion modules, with one channel.

To achieve SIL 2 / 3 per EN 61508 or PL d / e (Cat. 4) per EN ISO 13849-1 of the expansion modules, two relay outputs must be interconnected in a logic combination.

WARNING

Overload

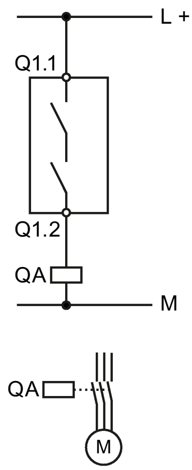
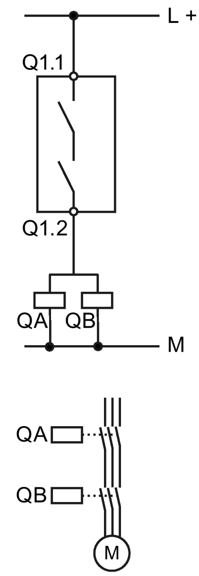
The relay contacts may weld if an overload occurs. The system cannot then shut down. To prevent relay contact welding, the switched loads must be protected accordingly, see Chapter "Technical data (Page 347)."

Note

Protection 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 further information in Chapter "Requirements for actuators (Page 173)."

Connection options for the 3RK3 central units

<table>
<tr><th>Single-channel actuator wiring</th><th>Two-channel actuator wiring via
1 safety-related output*)</th></tr>
<tr><td>
</td><td>
</td></tr>
</table>

QA/QB contactors

Q1.1, Q1.2 safety-related relay outputs

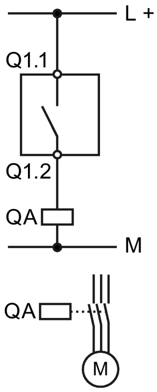
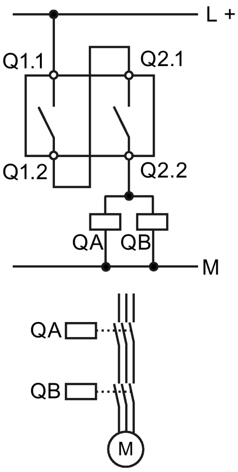
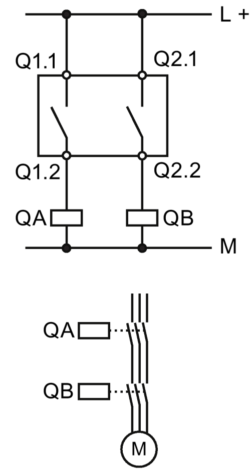
Note

***)SIL 2/3 per EN 61508 or PL d/e per EN ISO 13849-1**

To achieve SIL 2/3 per IEC 61508 or PL d/e per EN ISO 13849-1, a fault exclusion such as a short-circuit to a power cable or ground is required. This can be implemented, for example, within a 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.

Connection options for the 2/4F-DI, 1/2F-RO, and 4/8F-RO expansion modules

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

Qx.1, Qx.2 safety-related relay outputs

Note

***)SIL 2/3 per EN 61508 or PL d/e per EN ISO 13849-1**

To achieve SIL 2/3 per IEC 61508 or PL d/e per EN ISO 13849-1, a fault exclusion such as a short-circuit to a power cable or ground is required. This can be implemented, for example, within a cabinet and by installing the connection cables in such a way that they are protected.

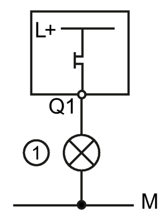
If this is not possible, the actuators must be wired via two safety-related outputs; see the right-hand image. For this purpose, separate cables must be laid to actuators/contactors. In the associated function element "F output," the output type "F output redundant" must be chosen.

5.3.2.7 Connecting non-safety-related outputs

Signaling outputs

The 8DO expansion module has 8 non-safety-related semiconductor 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 semiconductor output

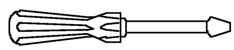
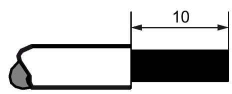
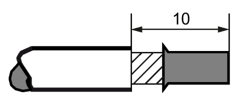
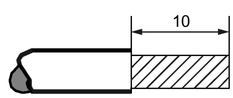
Note

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 further information in Chapter "Requirements for actuators (Page 173)."

5.3.3 Connection data for terminal blocks

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

5.3.4 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

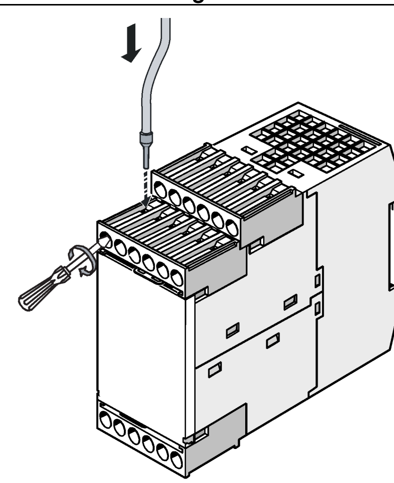
Functional ground - protective ground conductor

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

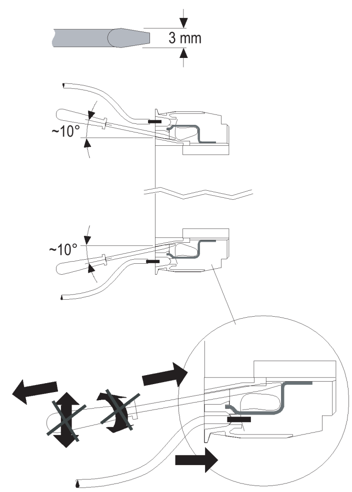
Requirements

- 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 Connection data for terminal blocks (Page 135).

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.	

5.3.5 Connecting the system interfaces

⚠ 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

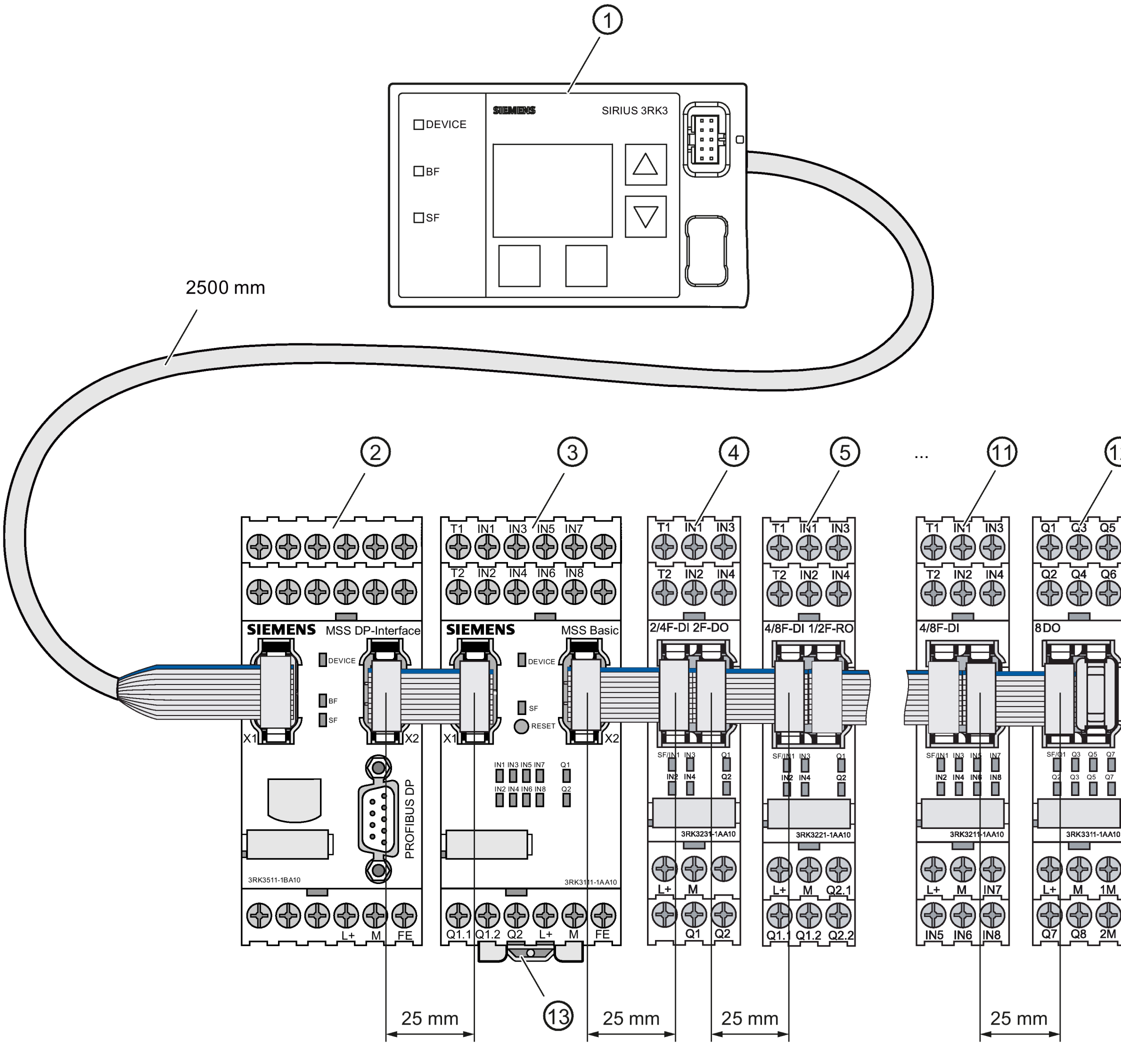
Connection cables

- MSS components are connected through the system interfaces using connection cables.
- The connection cables are available as adjacent versions (0.025 m). Connection cables up to max. 2.5 m in length are available for connecting to the diagnostics display.

Note

Reverse polarity protection

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



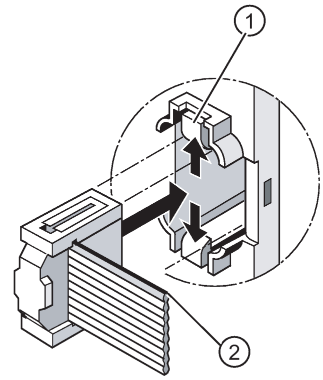
①	Diagnostics display
②	Interface module
③	Central unit
④ ... ⑫	Expansion modules:

- Maximum of 7 for MSS 3RK3 Basic
- Maximum of 9 for MSS 3RK3 Advanced
- 0 for MSS 3RK3 ASIsafe basic
- Maximum of 2 for MSS 3RK3 ASIsafe extended

⑬	Memory module

Figure 5-23 Maximum cable lengths of the MSS 3RK3

Procedure for connecting the system interfaces

Step	Operating instruction	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.	

5.3.6 Connecting a diagnostics display

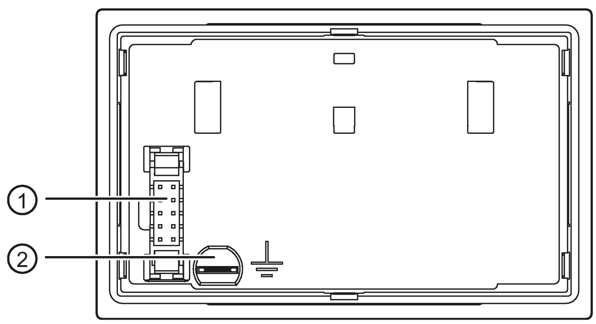
Connections on the rear

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.

Every diagnostics display has three connections:



① System interface X2
② Functional ground

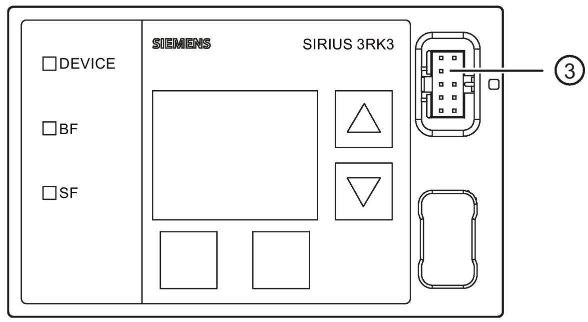
The rear is normally not accessible if the diagnostics display is installed. The connection cable from the safety relay / interface module is connected to the system interface X2 ② there. The diagnostics display also has to be grounded at the functional ground ①.

You will find additional information in Section "Grounding (Page 150)".

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.

NOTICE
EMC measures 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.

5.3.7 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

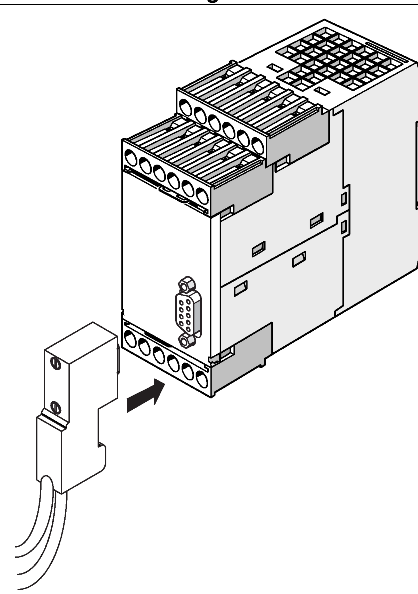
Tel.: +49 721 / 9658 590
Fax: +49 721 / 9658 589
Internet (http://www.profibus.com)
guidelines, article no. 2.111

See also "SIMATIC NET PROFIBUS Network Manual (http://support.automation.siemens.com/WW/view/de/35222591/0/en)"

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.	

5.3.8 Connecting the AS-i bus

Requirements

The MSS 3RK3 can only be connected to the following central units on the AS-i bus:

- 3RK3 Advanced
- 3RK3 ASIsafe basic
- 3RK3 ASIsafe extended

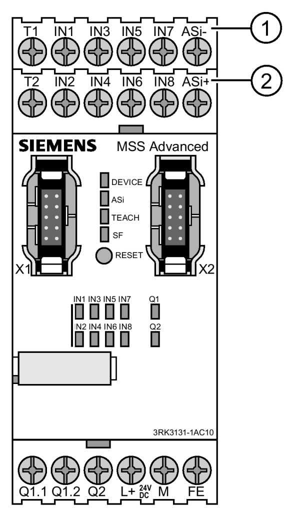
When connecting the AS-i cables, pay attention to the general information in Chapter "Connecting terminal blocks (Page 136)."

Note

Bus load of MSS 3RK3

The MSS 3RK3 is always a bus load from an A/B slave on the AS-i bus. This bus load does not depend on how many slaves are simulated by the 3RK3 central unit or whether only AS-i slaves are monitored.

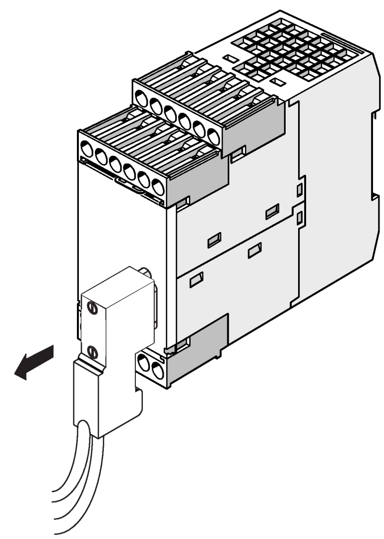
How to connect to the AS-i bus

Step	Operating instruction	Figure
1	Connect AS-Interface to the AS-i terminals ① / ② on the 3RK3 central unit. The blue conductor of the AS-i cable is connected to the terminal "ASi-" ① and the brown conductor to the terminal "ASi+" ②.	

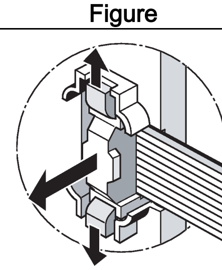
5.3.9 Disconnecting

⚠ 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

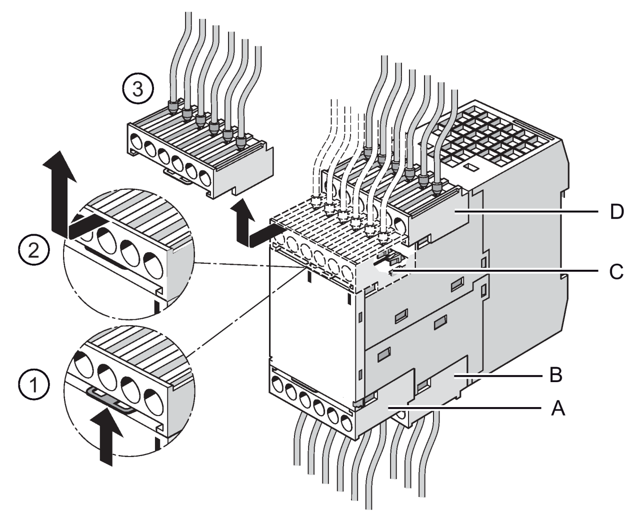
Step	Instructions	Figure
1	Press the locking element apart and then pull the connection cable out of the connector slot of the system interface.	

Removing terminal blocks from the device

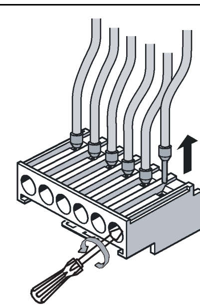
Note

Order of removal

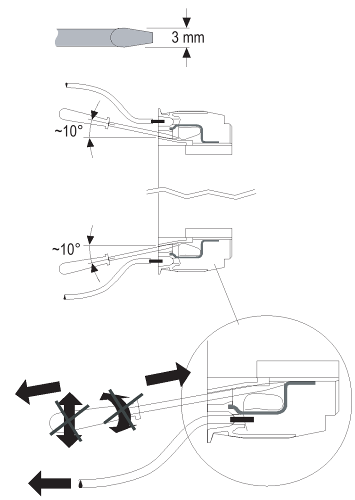
Remove terminal block A before terminal block B, and C before D.

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.	

5.3.10 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

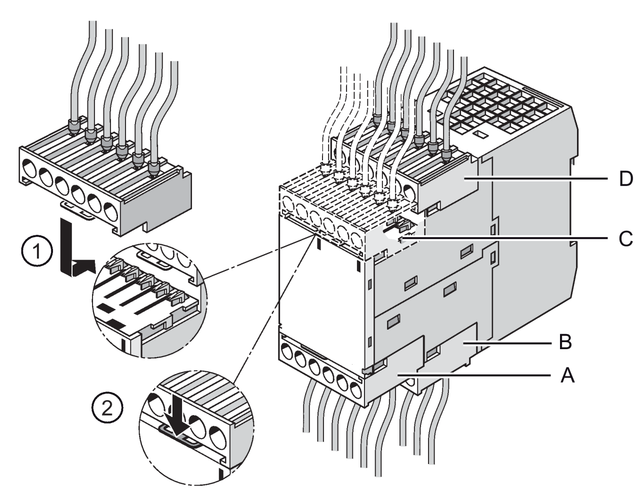
Removable terminal blocks are mechanically coded to prevent polarity reversal

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.	

5.3.11 Inserting and sealing the memory module

Memory module

The memory module is included in the scope of delivery of the 3RK3 central unit. Program the memory module in the 3RK3 central unit that is connected to a configuring PC or programming device.

Inserting and sealing the memory module

Note

The memory module must only be connected/disconnected when the 3RK3 central unit is disconnected from the power supply.

Connect the memory module to the interface on the underside of the 3RK3 central unit ①. Engage the locking mechanisms ②. Make sure that the memory module is positioned correctly on the 3RK3 central unit.

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 3RK3 central unit

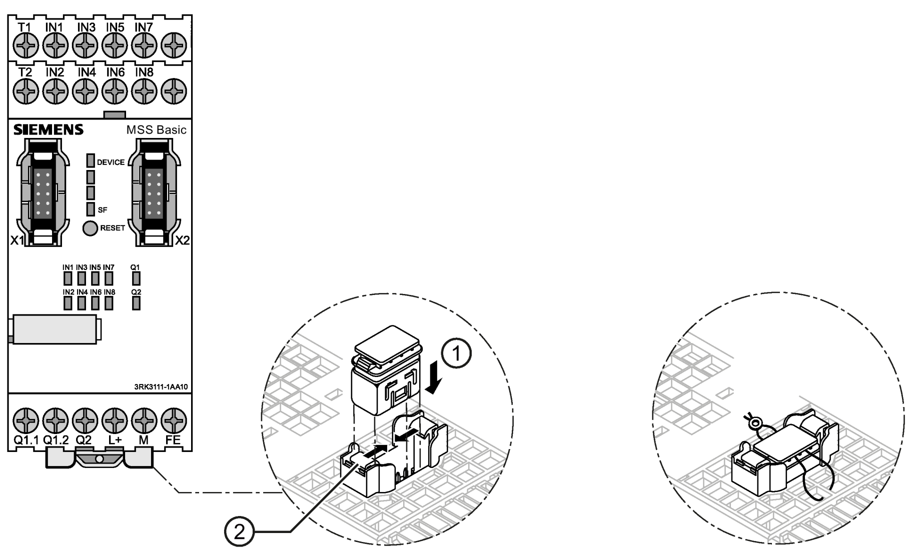


Figure 5-24 Connecting the memory module

Note on the memory module

If you connect a memory module to a 3RK3 Basic, Advanced, ASIsafe basic or ASIsafe extended central unit on which a configuration was released by a different safety relay, this cancels the configuration release. In this case, adapt the configuration, upload it to the device and release it.

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.

5.3.12 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.

Operation 6

6.1 Response times

6.1.1 Notes and definitions

Reaction time (in error-free operation)

The reaction time is the time until a system responds at the output after a change of an input variable, i.e. the time between the event and the action, e.g. terminal to terminal or sensor to actuator for operational switching.

The reaction time in error-free operation is calculated to define the process in the system. This time is **not** suitable for the determining safety distances in the system.

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

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

The fault reaction time of the MSS 3RK3 depends on whether a safety-related output is controlled through one channel or two.

Verification of reaction 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 the safety function has been requested.

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

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

Note

Field bus signals

If field bus signals are logically combined, runtime synchronism must be considered. It is the responsibility of the manufacturer to ensure that the system or machine is functioning properly as a whole.

Relevant times

When calculating the reaction times of the MSS 3RK3, the following times configured in the Safety ES must be considered:

- Program cycle time of the central unit
  - Without AS-i interface (3RK3 Basic): 10 ... 60 ms
  - With AS-i interface (3RK3 Advanced, 3RK3 ASIsafe basic, and 3RK3 ASIsafe extended):

	Program cycle time		
	3RK3 Advanced	**3RK3 ASIsafe basic**	**3RK3 ASIsafe extend-ed**
AS-i interface activated	15 ... 60 ms	15 ... 60 ms	15 ... 60 ms
AS-i interface deactivated	10 ... 60 ms	10 ... 60 ms	10 ... 60 ms

- Relevant input delay times for monitoring functions and input cells at the inputs of the expansion modules
- Relevant timer functions in the logic (timer)

6.1.2 Reaction time of the logic (in error-free operation)

Calculation

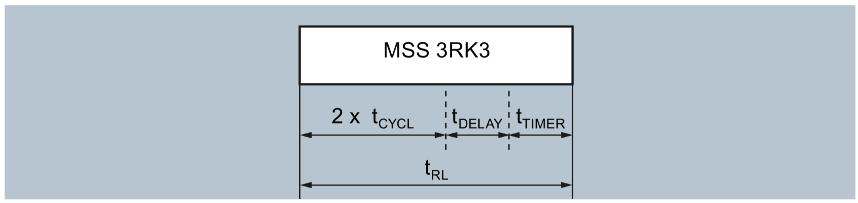


Figure 6-1 Reaction time of the logic (in error-free operation)

Reaction time of the logic (in error-free operation)	$t_{RL} = (2 \times t_{CYCL}) + t_{DELAY} + t_{TIMER}$

Formula	Description
t_{RL}	Reaction time of the logic (in error-free operation)
t_{CYCL}	Program cycle time of the MSS 3RK3
t_{DELAY}	Input delay for monitoring functions and input cells at the inputs
t_{TIMER}	Timer functions in the logic (timer)

6.1.3 Fault reaction time of the logic (single-channel actuator circuit)

Calculation

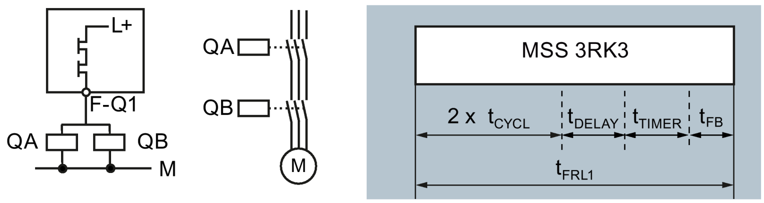


Figure 6-2 Fault reaction time of the logic for a single-channel actuator circuit

Fault reaction time of the logic (for a single-channel actuator circuit)	$t_{FRL1} = (2 \times t_{CYCL}) + t_{DELAY} + t_{TIMER} + t_{FB}$

For- mula	Description	
t_{FRL1}	Fault reaction time of the logic for a single-channel shutdown	
t_{CYCL}	Program cycle time of the MSS 3RK3	
t_{DELAY}	Input delay for monitoring functions and input cells at the inputs	
t_{TIMER}	Timer functions in the logic (timer)	
t_{FB}	Max. read-back time of the safety-related outputs:	
	• MSS central units (Basic / Advanced)	1 ms
	• 2/4 F-DI 2F-DO expansion module	1 ms
	• 4F-DO expansion module	5 ms

6.1.4 Fault reaction time of the logic (two-channel actuator circuit)

Calculation

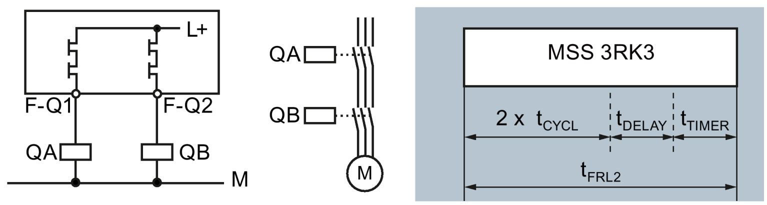


Figure 6-3 Fault reaction time of the logic for a two-channel actuator circuit

Fault reaction time of the logic (two-channel actuator circuit)	$t_{FRL2} = (2 \times t_{CYCL}) + t_{DELAY} + t_{TIMER}$

Formula	Description
t_{FRL2}	Fault reaction time of the logic (two-channel actuator circuit)
t_{CYCL}	Program cycle time of the MSS 3RK3
t_{DELAY}	Input delay for monitoring functions and input cells at the inputs
t_{TIMER}	Timer functions in the logic (timer)

6.1.5 Reaction times "sensor - actuator"

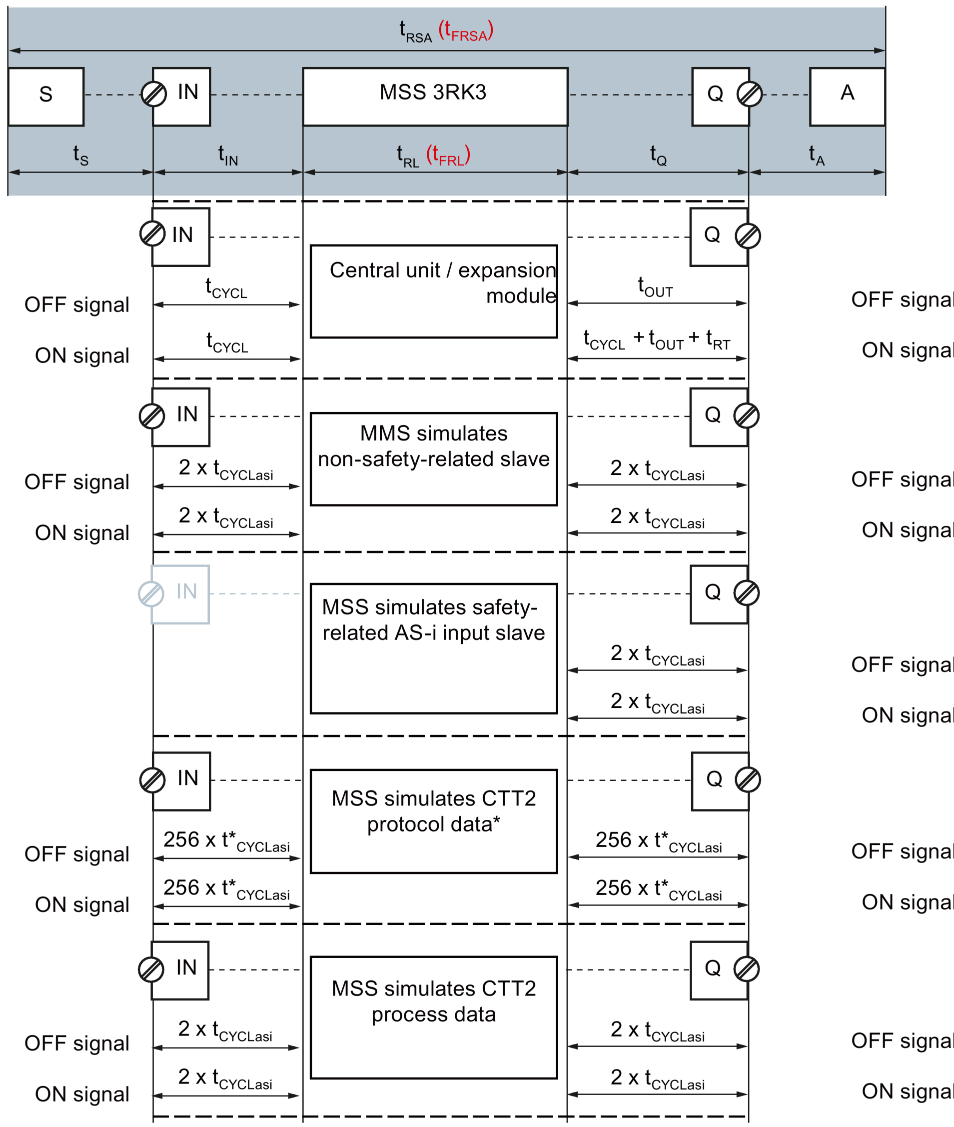
Dependencies

The total reaction times of the MSS 3RK3 depend on the functions that the MSS 3RK3 performs in each case. In both graphics below, all times that can occur are shown in compact form.

These times are dependent on two factors:

- Type of terminals used to connect the sensor or actuator to the logic of MSS 3RK3, e.g. terminal on the device or via AS-i bus
- Signal change:
  - "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).

Calculation



* This reaction time only applies if transmission of the cyclic data is not delayed by acyclic data transfer. In this case, the reaction time of input terminals t_{IN} or the reaction time of the output terminals t_Q is 256 x $t_{CYCLasi}$ + 16 s.

Figure 6-4 Reaction times "sensor - actuator" - Part 1

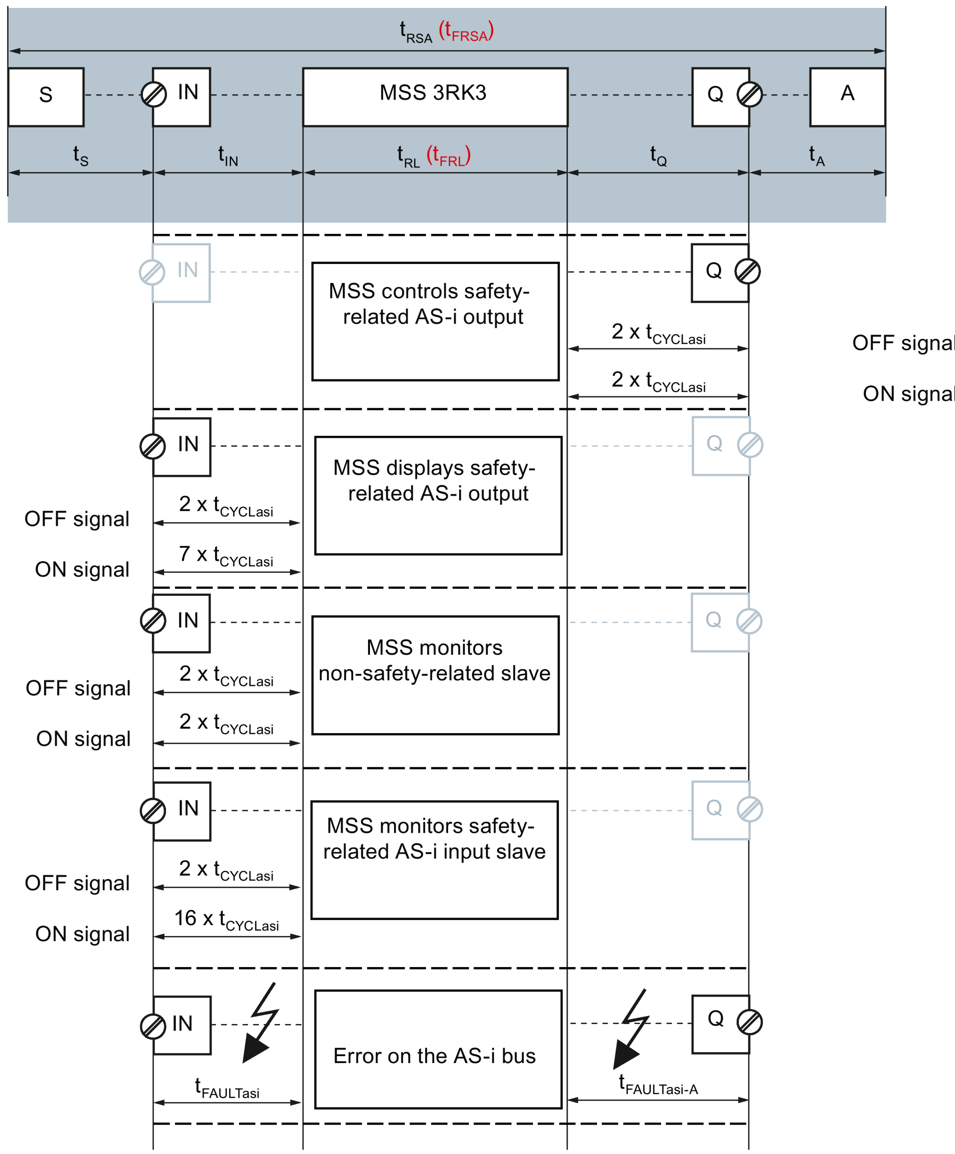


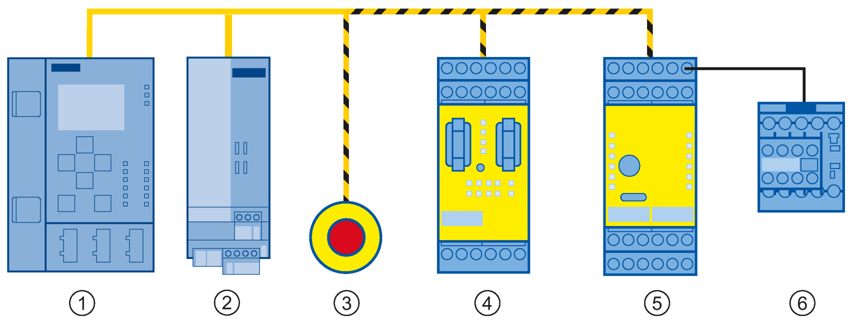
Figure 6-5 Reaction times "sensor - actuator" - Part 2

Reaction time "sensor - actuator" (in error-free operation)	$t_{RSA} = t_S + t_{IN} + t_{RL} + t_Q + t_A$
Fault reaction time "sensor - actuator"	$t_{FRSA} = t_S + t_{IN} + t_{FRL} + t_Q + t_A$

Formula	Explanation
S	Sensor (provides an OFF or ON signal)
IN	Input terminal
Q	Output terminal
A	Actuator
t_{RSA}	Reaction time of the system from a sensor **(S)** to an actuator **(A)** (in error-free operation)
t_{FRSA}	Fault reaction time of the system from a sensor **(S)** to an actuator **(A)**
t_{S}	For the reaction 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 MSS 3RK3; depending on the signal
t_{RL}	For the reaction time of the logic of the MSS 3RK3, see Chapter "Reaction time of the logic (in error-free operation) (Page 153)"
t_{FRL}	For the fault reaction time of the logic of the MSS 3RK3, see Chapters "Fault reaction time of the logic (single-channel actuator circuit) (Page 154)" and "Fault reaction time of the logic (two-channel actuator circuit) (Page 155)"
t_{DELAY}	Input delay for monitoring functions and input cells at the inputs
t_{TIMER}	Timer functions in the logic (timer)
t_{Q}	Transmission duration from the logic of the MSS 3RK3 to the output terminal **(Q);** depending on the signal; for values, see the graphic above
t_{A}	For the reaction of the actuator **(A)** including the time until the signal has been received and processed by the actuator, see the actuator documentation
t_{CYCL}	Program cycle time of the MSS 3RK3, configured in Safety ES
$t_{CYCLasi}$	AS-i cycle time, max. 5 ms
t_{OUT}	Reaction time of the output terminal on the expansion module (EM Q) • Semiconductor outputs: 10 ms • Relay outputs: 20 ms
t_{RT}	Restart standby time of the • safe outputs: 420 ms • non-safety-related outputs: 0 ms
$t_{FAULTasi}$	Reaction time of the MSS 3RK3 in case of an error on the AS-i bus: Max. 32 ms
$t_{FAULTasi-A}$	Reaction time of the AS-i actuator in case of an error on the AS-i bus: see the documentation of the AS-i actuator

6.1.6 Examples of the total response time with MSS 3RK3 Advanced

Example 1



① AS-i master
② AS-i power section
③ Fail-safe AS-i EMERGENCY STOP
④ MSS 3RK3 Advanced
⑤ Safety-related AS-i output
⑥ Contactor

Figure 6-6 Configuration MSS 3RK3 Advanced - example 1

This case considers the signal flow from a safety-related AS-i sensor (AS-i EMERGENCY STOP) to a safety-related AS-i output. The EMERGENCY STOP transmits an OFF signal to the MSS 3RK3 Advanced. The MSS 3RK3 monitors this safety-related AS-i input slave. After taking input delay times and timer functions in the logic into account, the MSS 3RK3 Advanced transmits a signal to the safety-related AS-i output that shuts down the system. In this way, MSS 3RK3 controls a safety-related AS-i output.

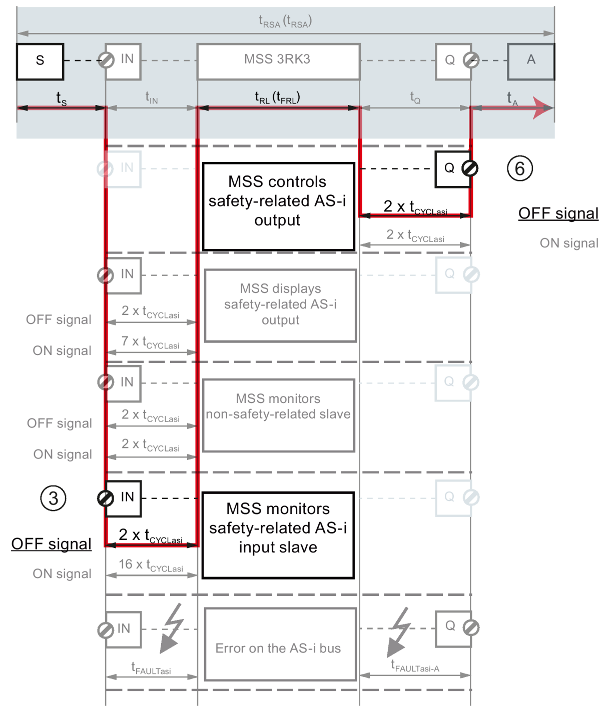


Figure 6-7 Signal flow of example 1

The reaction times are calculated as follows:

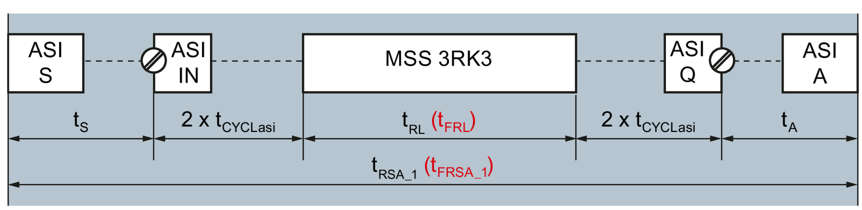
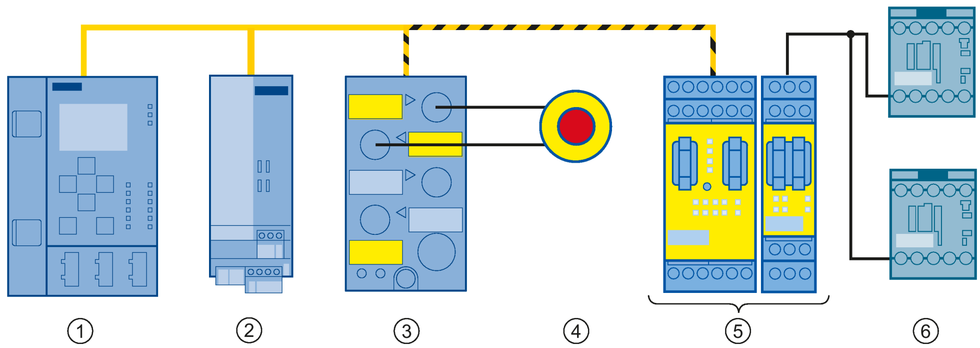


Figure 6-8 Reaction times MSS 3RK3 Advanced - example 1

Reaction time "sensor - actuator" (in error-free operation)	$t_{RSA\_1} = t_S + (2 \times t_{CYCLasi}) + t_{RL} + (2 \times t_{CYCLasi}) + t_A$ $= t_S + (4 \times t_{CYCLasi}) + t_{RL} + t_A$
Fault reaction time "sensor - actuator"; for AS-i output signal identical to t_{RSA_1}	$t_{FRSA\_1} = t_{RSA\_1}$ $t_{RL} = t_{FRL}$

Formula	Description
t_{RSA_1}	Reaction time "sensor - actuator" in error-free operation
t_{FRSA_1}	Fault reaction time "sensor - actuator"; for AS-i output signal identical to t_{RSA_1}
t_S	For the reaction time of the AS-i sensor (ASI S), see the documentation of the sensor.
$t_{CYCLasi}$	AS-i cycle time, max. 5 ms • Transmission duration from signal acquisition on the safety-related AS-i input slave (ASI IN) to the logic of the MSS 3RK3 • Transmission duration from the logic of the MSS 3RK3 to the input terminal on the safety-related AS-i output (ASI Q)
t_{RL}	Reaction time of the logic of the MSS 3RK3 in error-free operation
t_{FRL}	Fault reaction time of the logic of the MSS 3RK3; for AS-i output signal identical to t_{RL}
t_A	Reaction time of the AS-i output (ASI A), see the documentation of AS-i output

Example 2



① AS-i master
② AS-i power section
③ Safety-related AS-i input slave
④ Fail-safe EMERGENCY STOP
⑤ MSS 3RK3 Advanced
⑥ Contactors

Figure 6-9 Configuration MSS 3RK3 Advanced - example 2

This case considers the signal flow from an EMERGENCY STOP on a safety-related AS-i input slave to an actuator (contactor) via the output terminal of an expansion module.

The EMERGENCY STOP transmits an OFF signal to the input slave. The slave transfers the signal via the AS-i bus in a safety-related manner. MSS 3RK3 monitors this safety-related AS-i input slave and processes the information in the logic. After taking input delay times and timer functions in the logic into account, the MSS 3RK3 Advanced opens the contactors of the system down via a safety-related output.

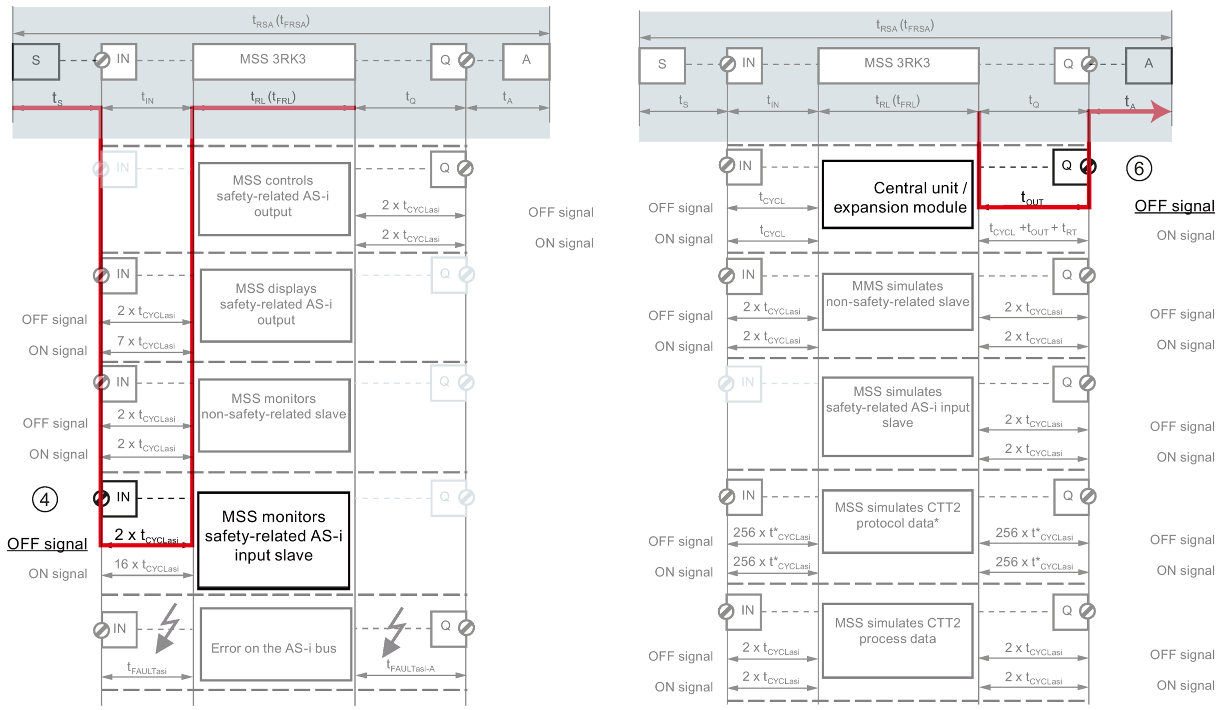


Figure 6-10 Signal flow of example 2

The reaction times are calculated as follows:

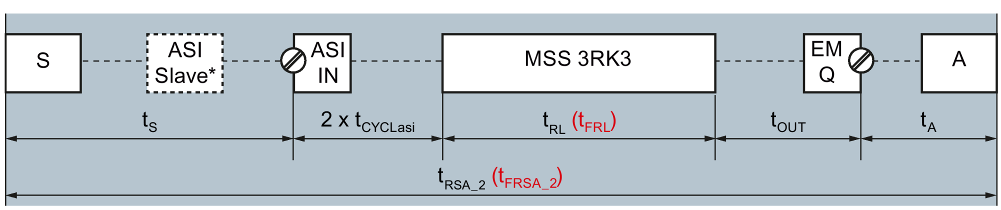


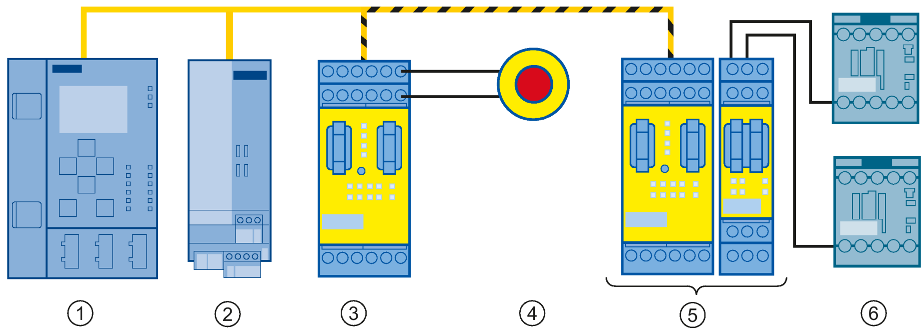
Figure 6-11 Reaction times MSS 3RK3 Advanced - example 2

*The AS-i slave only has to be considered if the utilized slave does not forward the changed input signal directly to the bus and its signal processing thus contributes to the system reaction time. Refer to the documentation of the input slave for the appropriate value.

Reaction time "sensor - actuator"	$t_{RSA\_2} = t_S + (2 \times t_{CYCLasi}) + t_{RL} + t_{OUT} + t_A$
"Sensor - actuator" fault reaction time; for a single-channel actuator wiring not equal to t_{RSA_2}	$t_{FRSA\_2} = t_{RSA\_2} + t_{FB}$

<table>
<tr><th>Formula</th><th colspan="2">Description</th></tr>
<tr><td>t_{RSA_2}</td><td colspan="2">Reaction time "sensor - actuator" in error-free operation</td></tr>
<tr><td>t_{FRSA_2}</td><td colspan="2">"Sensor - actuator" fault reaction time; for a single-channel actuator wiring not equal to t_{RSA_2}</td></tr>
<tr><td>t_S</td><td colspan="2">For the reaction time of the sensor (S), see the documentation of the sensor.
(If an immediate response cannot be assumed for the AS-i slave, the reaction time of the AS-i slave must also be considered at this point. Note also example 3.)</td></tr>
<tr><td>$t_{CYCLasi}$</td><td colspan="2">Transmission duration of the signals evaluated by the AS-i input slave (ASI IN) via the AS-i bus up until the logic of the MSS 3RK3:
AS-i cycle time, max. 5 ms</td></tr>
<tr><td>t_{RL}</td><td colspan="2">Reaction time of the logic of the MSS 3RK3 in error-free operation</td></tr>
<tr><td>t_{FRL}</td><td colspan="2">Fault reaction time of the logic of the MSS 3RK3; for single-channel actuator wiring not equal to t_{RL}</td></tr>
<tr><td>t_{OUT}</td><td colspan="2">Transmission duration from the logic of the MSS 3RK3 to the output terminal on the expansion module (EM Q)
• Semiconductor outputs: 10 ms
• Relay outputs: 20 ms</td></tr>
<tr><td>t_A</td><td colspan="2">For the reaction time of the actuator (A), see the documentation of the actuator</td></tr>
<tr><td rowspan="4">t_{FB}</td><td colspan="2">Max. read-back time of the safety-related outputs:</td></tr>
<tr><td>• MSS 3RK3 central units</td><td>1 ms</td></tr>
<tr><td>• 2/4 F-DI 2F-DO expansion module</td><td>1 ms</td></tr>
<tr><td>• 4F-DO expansion module</td><td>5 ms</td></tr>
</table>

Example 3



① AS-i master
② AS-i power section
③ MSS 3RK3 Advanced No. 1
④ Fail-safe EMERGENCY STOP
⑤ MSS 3RK3 Advanced No. 2
⑥ Contactors

Figure 6-12 Configuration MSS 3RK3 Advanced - example 3

This case considers the signal flow from an EMERGENCY STOP on an input of an MSS 3RK3 Advanced via the AS-i bus (direct data exchange) to another MSS 3RK3 Advanced and then to an actuator (contactor) via the output terminal of an expansion module.

The EMERGENCY STOP transmits an OFF signal to the first MSS 3RK3 Advanced. This unit processes the signal in its logic. After taking input delay times and timer functions in the logic into account, it forwards the information to the AS-i bus via a simulated AS-i input slave. The second MSS 3RK3 monitors this safety-related AS-i input slave and, in turn, processes the information in its logic. After taking input delay times and timer functions in the logic into account, the second MSS 3RK3 Advanced opens the contactors of the system via two safety-related outputs.

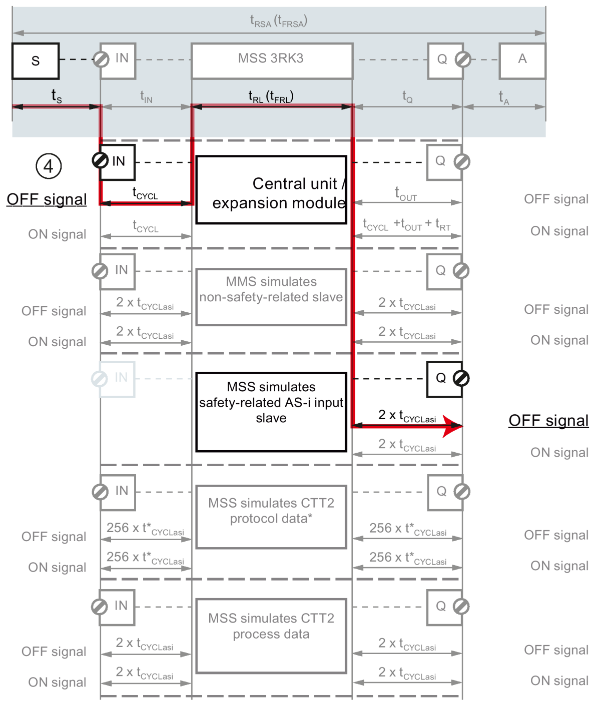


Figure 6-13 Signal flow of example 3 for MSS 3RK3 Advanced No. 1

The reaction times of subsystem 1 are calculated as follows:

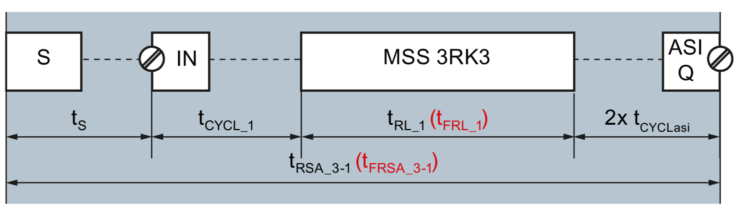


Figure 6-14 Reaction times MSS 3RK3 Advanced No. 1 - example 3

Reaction time "sensor - actuator" (in error-free operation) Subsystem 1	$t_{RSA\_3\text{-}1} = t_S + t_{CYCL\_1} + t_{RL\_1} + (2x\ t_{CYCLasi})$
Fault reaction time "sensor - actuator"; for AS-i output signal identical to t_{RSA_1} Subsystem 1	$t_{FRSA\_3\text{-}1} = t_{RSA\_3\text{-}1}$ $t_{RL} = t_{FRL}$

Formula	Description
t_{RSA_3-1}	Reaction time "sensor - actuator" in error-free operation; only subsystem 1 is considered.
t_{FRSA_3-1}	Fault reaction time "sensor - actuator"; only subsystem 1 is considered; for AS-i output signal identical to t_{RSA_3-1}
t_S	Reaction time of the sensor (EMERGENCY STOP), see the documentation of the sensor.
t_{CYCL_1}	Set cycle time of MSS 3RK3 Advanced No. 1 When AS-i is used, values between 15 ms and 60 ms can be set.
t_{RL}	Reaction time of the logic of the MSS 3RK3 in error-free operation
t_{FRL}	Fault reaction time of the logic of the MSS 3RK3; for AS-i output signal identical to t_{RL}
$t_{CYCLasi}$	AS-i cycle time, max. 5 ms

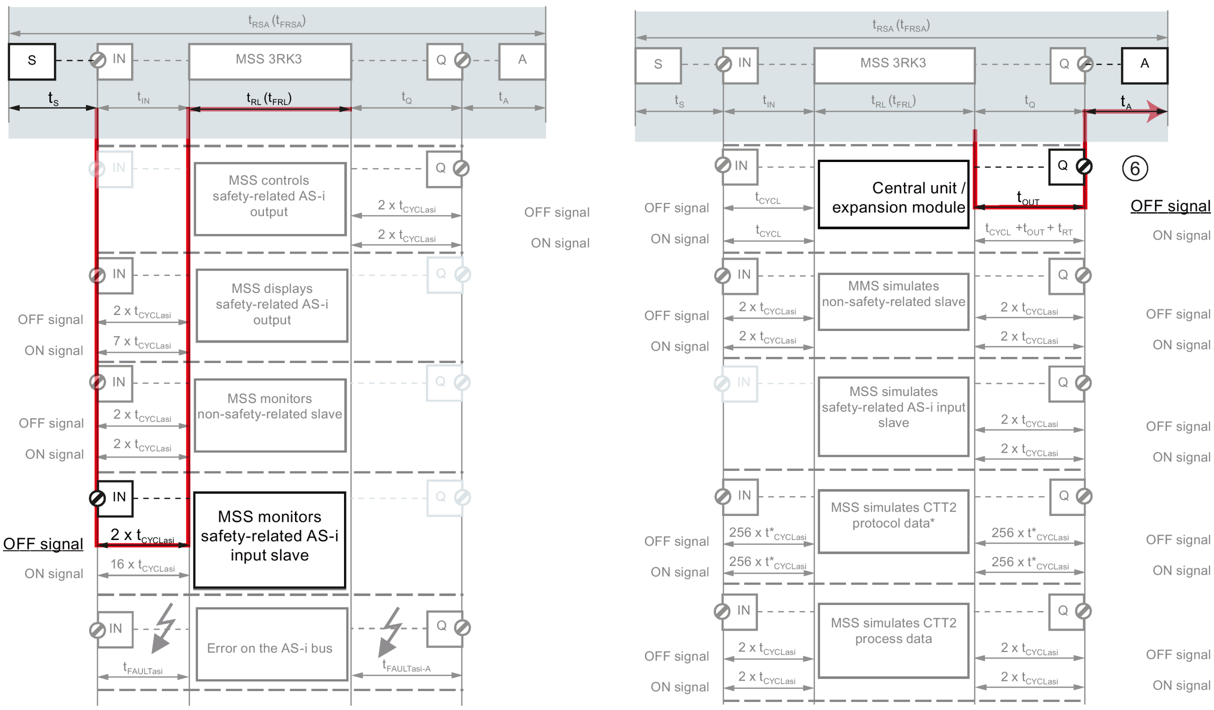


Figure 6-15 Signal flow of example 3 for MSS 3RK3 Advanced No. 2

The reaction times of subsystem 2 are calculated as follows:

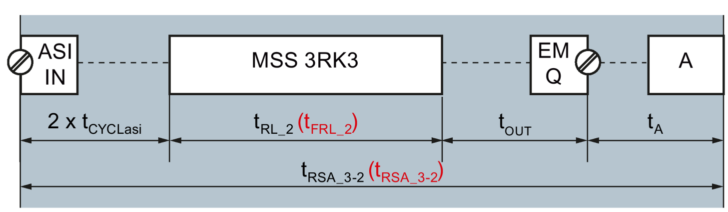


Figure 6-16 Reaction times MSS 3RK3 Advanced No. 2 - example 3

Reaction time "sensor - actuator" in error-free operation "sensor - actuator" (in error-free operation) Subsystem 2	$t_{RSA\_3-2} = (2x\ t_{CYCLasi}) + t_{RL\_2} + t_{OUT} + t_A$
Fault reaction time "sensor - actuator"; for two-channel actuator wiring identical to t_{RSA_1} Subsystem 2	$t_{FRSA\_3-1} = t_{RSA\_3-1}$ $t_{RL} = t_{FRL}$

Formula	Description
t_{RSA_3-2}	Reaction time "sensor - actuator" in error-free operation; only subsystem 2 is considered.
t_{FRSA_3-2}	Fault reaction time "sensor - actuator"; only subsystem 2 is considered; for two-channel actuator wiring identical to t_{RSA_1}
t_{RL}	Reaction time of the logic of the MSS 3RK3 in error-free operation
t_{FRL}	Fault reaction time of the logic of the MSS 3RK3, for two-channel actuator wiring identical to t_{RL}
$t_{CYCLasi}$	AS-i cycle time, max. 5 ms
t_A	For the reaction time of the actuator (A), see the documentation of the actuator

The total reaction times are calculated as follows:

To calculate the total reaction times from the sensor up to the actuator, the two partial reaction times must be added. Because no sensor or actuator hangs between the two MSS 3RK3 units, t_S and t_A do not have to be considered at this point.

Note

Note that t_{CYCL} and t_{RL} may differ for the two systems. They must each be assigned to the correct system.

Reaction time "sensor - actuator" (in error-free operation)	$t_{RSA\_3} = t_{RSA\_3-1} + t_{RSA\_3-2}$
Fault reaction time "sensor - actuator"	$t_{FRSA\_3} = t_{FRSA\_3-1} + t_{FRSA\_3-2}$

6.1.7 Parameterizing in Safety ES

Parameterizing the program cycle time t_{CYCL} of the MSS 3RK3 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 3RK3 central unit.
2. Enter a value for "Program cycle time [ms]" that is suitable for the scope of your configuration in the "Central unit properties - MSS Slot 3" dialog box.
   – 3RK3 Basic: 10 ... 60 ms
   – 3RK3 Advanced/ 3RK3 ASIsafe basic/ 3RK3 ASIsafe extended: 15 ... 60 ms
   (With deactivated AS-Interface: 10 ... 60 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 reaction time
can cause death, serious injury, or damage to property.

If the input delay increases, the reaction time of the safety program increases.

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, MSS 3RK3 rounds the input delay time to an integer multiple of the program cycle time for safety reasons and Safety ES outputs a warning. If you use safety-related AS-i input terminals, the smallest settable input delay time is 50 ms.

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

Reaction time when powering down

Not every delay time has to be considered in the reaction time of the MSS 3RK3 For example, for calculating of the reaction 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, MSS 3RK3 rounds the delay time to an integer multiple of the program cycle time for safety reasons and Safety ES outputs a warning.

6.2 Selection of sensors and actuators

6.2.1 Requirements for sensors

6.2.1.1 Minimum actuating duration at the inputs

Design of sensors

The minimum actuating duration at the input of the MSS 3RK3 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 MSS 3RK3

t_{CYCL} Program cycle time of the MSS 3RK3

Note

Minimum actuating duration of AS-i sensors

The minimum actuating duration of the AS-i sensors depends on the AS-i slave used.

6.2.2 Requirements for actuators

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 Chapters "Dark test (Page 173)" and "Guidelines for capacitive loads (Page 174)."

Inductive load

The outputs of the MSS 3RK3 do not feature internal inductive interference protection. If inductive loads are operated at the solid-state outputs of the MSS 3RK3, they must be provided with inductive interference protection; see Chapter "Guidelines for inductive loads (Page 174)."

6.2.2.1 Dark test

Dark test

The dark test is the brief deactivation of an activated safety-related output of the MSS 3RK3 to ensure that the output can be deactivated at any time in the event of a safety requirement. To this end, the chosen test pulse is so short that a connected actuator does not shut down as a result. The dark test is repeated cyclically

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. An output must not be reactivated until it has been detected as having been deactivated.

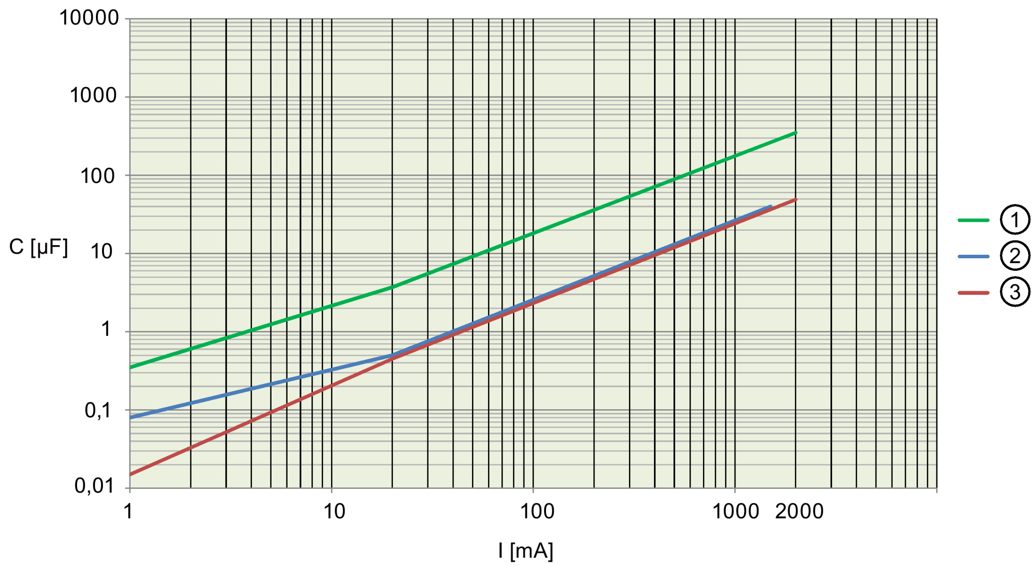
Maximum read-back time

The maximum read-back time is different on different devices:

Device	Maximum read-back time
MSS 3RK3 central units	1 ms
2/4 F-DI 2F-DO expansion module	1 ms
4F-DO expansion module	5 ms

6.2.2.2 Guidelines for capacitive loads

The following figure shows the maximum capacitive load C [µF] at load current I [mA] at the safety-related outputs for different MSS 3RK3 modules.



①	3RK3 central units
	2/4F-DI 2F-DO expansion module
②	4F-DO E01 expansion module
③	4F-DO expansion module as of E02

6.2.2.3 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

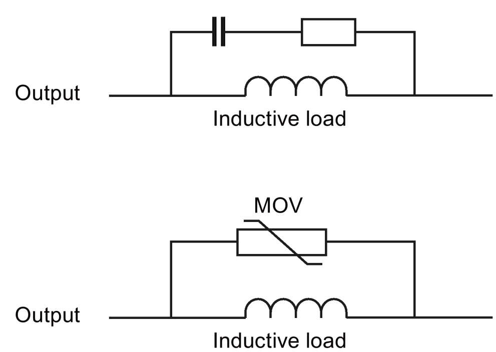
Increasing the Fault Reaction Time
Can Cause Death, Serious Injury, or Property Damage.

Note that the (fault) reaction 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.

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.	Example: Protective circuit for an inductive load 

6.3 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 13)".

6.3.1 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).

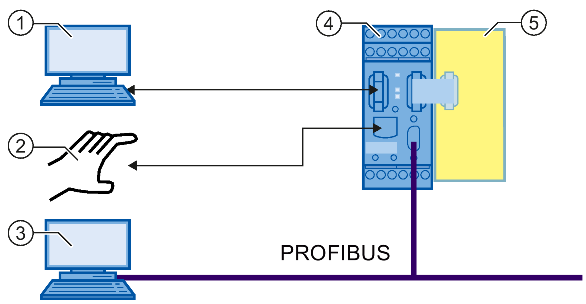
6.4 Integrating into DP master systems

6.4.1 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 6-17 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 13)". 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 185)".

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.

6.4.2 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.

6.4.3 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

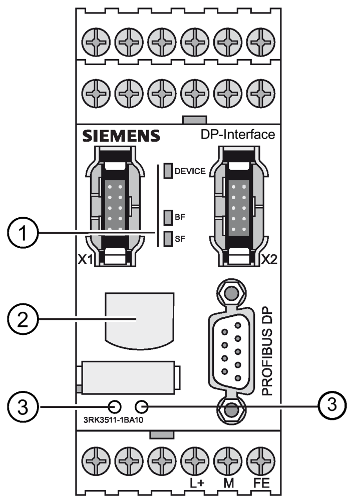
Once the PROFIBUS connection has been restored, the safety relay will work with the real values again.

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.

6.4.4 Operating the 3RK35 DP interface

6.4.4.1 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 6-18 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

6.4.4.2 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.

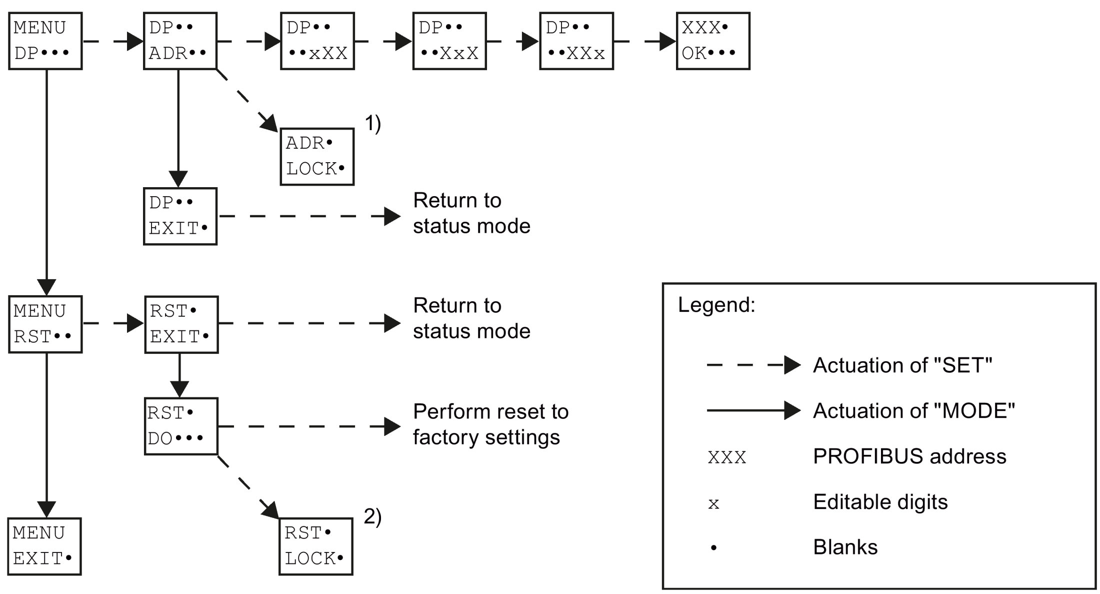
6.4.4.3 Menu of the DP interface

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 185)
- Restoring factory settings (Page 187)

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 6-19 DP interface menu

6.4.4.4 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.

6.4.4.5 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.

6.5 Connecting to the AS-i master via AS-Interface

6.5.1 3RK3 central unit with AS-i interface

Three central units with an AS-i interface are available for integrating the 3RK3 modular safety system on the AS-i bus.

- 3RK3 Advanced
- 3RK3 ASIsafe basic
- 3RK3 ASIsafe extended

Note

Name

References to "MSS 3RK3" or "3RK3 central units" in Chapter "Central unit with AS-i interface" always mean "MSS 3RK3 with AS-i interface" and "3RK3 central units with AS-i interface". Exceptions are explicitly identified.

The differences between these 3RK3 central units are listed in the table:

Feature	3RK3 ASIsafe basic	3RK3 ASIsafe extended	3RK3 Advanced
Safety-related, freely parameterizable sensor inputs	2	4	8
Standard inputs	6	4	0
Safety-related two-channel relay outputs	1	1	1
Safety-related two-channel semiconductor outputs	1	1	1
Expansion modules	0	2	9
Max. number of simulated safety-related AS-i slaves	8	10	12
DP interface	Yes	Yes	Yes
Diagnostics module	Yes	Yes	Yes

Note

Examples

The examples in this chapter are all represented with a 3RK3 Advanced central unit. However, they apply equally to all other central units with AS-i interface. However, you must note the limitations on the number of expansion modules.

6.5.2 Communication of MSS 3RK3 with AS-i interface

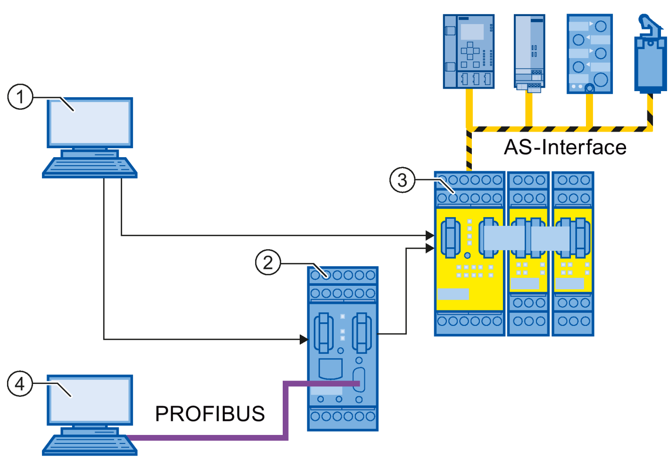
Requirements

The MSS 3RK3 is an AS-i safety monitor and/or an AS-i slave on the AS-i bus. You therefore additionally need an AS-i master and an AS-i power section on the AS-i bus to operate the AS-i network. MSS 3RK3 also supports conventional AS-i components as well as AS-i Power24V components.

Before the MSS 3RK3 can participate in AS-i communication, it must be informed by means of configuration in the Safety ES as to which AS-i slaves on the AS-i line are relevant for MSS 3RK3 and which AS-i slaves the MSS 3RK3 is to represent/simulate.

Communication

Unlike MSS 3RK3 Basic, the 3RK3 central units with AS-i interface can be connected to an AS-i bus. Otherwise, the same interfaces are available as on the MSS 3RK3 Basic.



① PC or programming device via device interface on MSS 3RK3 with AS-i interface or DP interface

② DP interface

③ MSS 3RK3 with connection to the AS-Interface

④ PC or programming device over PROFIBUS and DP-Interface

Figure 6-20 Communication of MSS 3RK3 Advanced

Reference

You will find further information on AS-Interface in " AS-Interface system manual (edition 11/2008) with expansions (edition 09/2010 - for displaying and configuring see Entry ID 44365425) (http://support.automation.siemens.com/WW/view/en/26250840)."

6.5.3 ASIsafe

The ASIsafe (AS-Interface Safety at Work) concept allows the integration of safety-related components in an AS-Interface network. The use of safety-related AS-i input slaves, safety monitors and safety-related AS-i outputs enables the transfer and evaluation of safety-related data and the safety-related control of actuators on the bus level.

ASIsafe principle of operation

Safety-related signals from sensors (8 x 4-bit code sequences)

Each safety-related AS-i input slave has its own, unique 8 x 4-bit code sequence to be able to transmit safety-related signals to a safety monitor. These code sequences must be made known to the MSS 3RK3 by teaching. The integrated safety monitor listens in to the 8 x 4-bit code sequences of all safety-related AS-i input slaves as a passive participant and evaluates them safely.

You will find more information about teaching code sequences in Chapter "Teaching the code sequences (Page 194)."

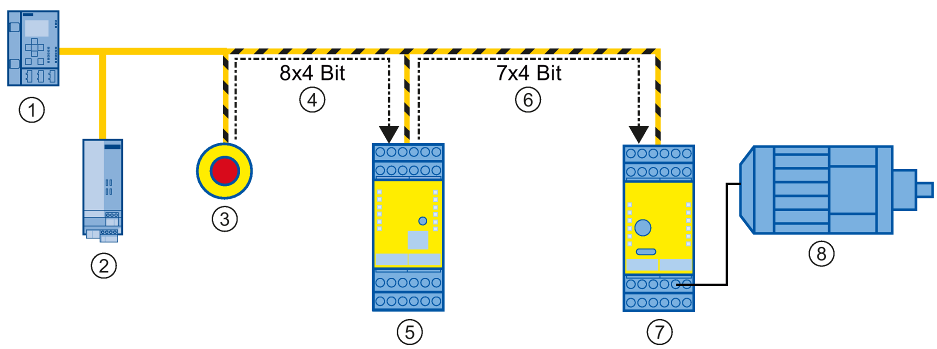
Safety-related signals to actuators (7 x 4-bit code sequences)

These safety-related signals are transmitted to the safety-related AS-i outputs as 7 x 4-bit code sequences. For this purpose, the safety monitor simulates a safety-related AS-i slave with an AS-i address and a special 7 x 4-bit code sequence. The safety-related output listens out for this 7 x 4-bit code sequence without having an address assigned to it, that is, it behaves like a monitor. The safety-related output evaluates the 7 x 4-bit code sequences and switches the connected actuators on or off as required.

Example

The graphic shows a typical structure of an AS-i-Bus. A safety monitor monitors the 8 x 4-bit code sequences of an EMERGENCY-STOP (safety-related AS-i input slave) and evaluates the safety information. A safety-related AS-i slave is integrated in the safety monitor. This slave controls a safety-related AS-i output using 7 x 4 bit sequences. The safety-related AS-i output responds to the address of the integrated slave and switches the system on or off based on the safety information using an actuator.

An MSS 3RK3 with AS-i interface can perform any function of these safe AS-i components:



① AS-i master
② AS-i power section
③ Safety-related AS-i input slave
④ Transmission of the 8 x 4 bit-code sequences
⑤ AS-i-safety monitor with integrated safety-related AS-i slave
⑥ Transmission of the 7 x 4 bit-code sequences
⑦ Safety-related AS-i output
⑧ Actuator

Figure 6-21 Example ASIsafe

An MSS 3RK3 with AS-i interface can perform the functions of the components "safety-related AS-i input slave" ③, "AS-i safety monitor with integrated safety-related AS-i Slave" ⑤, and "safety-related AS-i output" ⑦ in the AS-i network.

Reference

You will find more information about ASIsafe and safety-related AS-i outputs in the "AS-Interface System Manual (11/2008 Edition) with Supplements (09/2010 Edition)." (http://support.automation.siemens.com/WW/view/en/26250840)

6.5.4 Addressing and configuring AS-i components in Safety ES

Configuration of real AS-i slaves

In Safety ES, the real AS-i slaves are communicated to the MSS 3RK3 in the subsystem (navigation window). The hardware catalog contains all supported SIEMENS AS-i components. Just like in the main system they can be dragged into the work space and have their AS-i address assigned. Using the universal modules, the profiles of AS-i slaves can be defined independently of their manufacturers.

Alternately, it is also possible to determine the expanded configuration of the AS-Interface in the subsystem online: The actual configuration, that is, the hardware configuration of the AS-i subslot expanded configuration can be applied by clicking the "Determine online" button. The result will depend on the master and slaves used. You will find further information in the Operating Manual *SIRIUS engineering Safety ES V1.0 (Software)*, see Chapter "Additional documentation (Page 13)."

Configuration and addressing of simulated AS-i slaves

The addresses of the simulated non-safety-relevant AS-i slaves can be freely assigned. The AS-i slave addresses are assigned in the Safety ES in the properties for the 3RK3 central unit. This is also where the profile of the simulated slave is selected. The simulated slaves are displayed in italics in the subsystem.

Note

The addresses cannot be changed during runtime because it would require modification of the configuration data. That is why no addressing and no address changes can be performed on the MSS 3RK3 using the addressing device.

Configuring the safety logic

The parameterizable safety logic of the MSS 3RK3 with AS-i interface allows the following signals to be interconnected in Safety ES via input and output terminals:

- Inputs and outputs of expansion modules, if supported by the 3RK3 central unit
- Inputs and outputs of the DP interface
- Inputs and outputs of real, non-safety-related AS-i slaves
- Inputs and outputs of real, safety-related AS-i slaves
- Inputs and outputs of simulated, non-safety-related AS-i slaves
- Inputs and outputs of simulated, safety-related AS-i slaves

6.5.5 Overview of possible incoming and outgoing AS-i signals

The information that can be read by the AS-i bus or written to the AS-i bus is displayed in the logic interconnection in the Safety ES software through terminals.

Note

Terminal list in Safety ES

For an overview of all terminals configured in Safety ES, you can have them displayed as a list: "Options" > "Terminal list"

Terminal designation input cells in Safety ES	Explanation	Function of MSS 3RK3
ASI#xx(AB)_INc	Sensor input	Monitoring of non-safety-related AS-i slaves
ASI#xx(AB)_Qc	Output (master call)	
ASI#xx(AB)_Qc*	Master call to the channel that is not part of the slave profile	
ASi#xx_F-IN1&2	Sensor value: Safety-related signal from the code sequence of a two-channel sensor	Monitoring of safety-related AS-i input slaves
ASi#xx_F-INc	Input terminal signal of the ASIsafe input slave for the monitoring functions. If monitoring function "AS-i 2F-DI" is used: Monitoring function "AS-i 2F-DI" is used instead of an input cell if you want to diagnose both the input terminal signals of the ASIsafe input slave.	
ASI#xx_F-OUTc	Signal, for example, from an AS-i safety monitor or from another MSS 3RK3	Representation of a safety-related AS-i output
ASI#xx_AUXm	Modulated, non-safety-related auxiliary control signal	
Slot3_ASI#xx(AB)-Qc	Master call from AS-i master to the simulated non-safety-related AS-i slave of the MSS 3RK3	Simulation of non-safety-related AS-i slaves
Slot3_ASI#xx-Qy.z	Master call from AS-i master to the simulated non-safety-related AS-i slave (CTT2) of the MSS 3RK3	

Function of MSS 3RK3	Explanation	Terminal designation output cells in Safety ES
Simulation of non-safety-related AS-i slaves	Sensor signal from MSS 3RK3 to AS-i master: Non-safety-related AS-i output data range of the simulated AS-i slave designates "non-safety-related" output	Slot3_ASI#xx(AB)-Sc
	Sensor signal from MSS 3RK3 to AS-i master: Determines bit position in CTT2 frame for device diagnostics (see Chapter "Diagnosis using AS-Interface (CTT2 protocol) (Page 285)").	Slot3_ASI#xx-Sy.z
Simulation of safety-related AS-i input slaves	Sensor signal from MSS 3RK3 to AS-i master that can be evaluated by an AS-i safety monitor	Slot3_ASI#xx-F-S1&2
Setting/resetting of safety-related AS-i outputs	Sensor signal from MSS 3RK3 to AS-i master that can be evaluated by an AS-i output.	Slot3_ASI#xx-F-Qc

m: Auxiliary signal 1 or 2

xx: AS-i address

(AB): A or B can be entered here if the monitored slave is an A/B slave. This identifier is omitted for standard slaves. MSS 3RK3 supports only standard slaves for CTT2.

c: Channel number of AS-i slave process image

c*: The process image of the master call may contain more channels than the slave profile of the corresponding AS-i slave. The channels addressed here are not processed on the AS-i slave but can be used for special solutions.

y.z: Defines bit position in CTT2 frame

6.5.6 Teaching the code sequences

6.5.6.1 Code sequences

Code sequences of safety-related AS-i input slaves

Code sequences are acquired by a safety monitor As soon as the MSS 3RK3 with AS-i interface detects that at least one safety-related AS-i input slave requires processing, the monitor functionality is automatically started. That is possible both during startup and after transmission of a new configuration in configuring mode. Teaching of 8 x 4 bit code sequences is therefore possible in configuring mode, safety mode and test mode.

Code sequences of safety-related AS-i outputs

As part of the development of safety-related AS-i outputs new 7 x-4 bit code sequences have been added to the 8 x 4 bit code sequences of the safety-related AS-i input slaves. These code sequences which uniquely apply to the safety-related AS-i outputs do not have to be retaught but are specified for every possible address on the AS-i bus.

6.5.6.2 Teaching code sequences

To be able to monitor safety-related AS-i input slaves, they must be made known to the system. This means that the code sequences of all safety-related AS-i input slaves located on the AS-i bus must be known so that they can be identified as safety-related information on the AS-i bus. The process of recording, checking, and storing these code sequences is referred to as "teaching code sequences."

Determining the actual expanded configuration on the AS-i bus and comparing it with the target configuration

The actual expanded configuration on the AS-i bus can only be determined once the AS-i master has completed its power-up phase and all AS-i slaves on the bus have been addressed correctly and are active. The MSS 3RK3 with AS-i interface determines all slaves. The list of recognized safety-related slaves is derived from this information. Finally, a check is made to see whether matching code sequences exist for all safety-related AS-i input slaves.

Note

Important requirement

During the teaching process the contacts of the safety-related AS-i input slaves must be closed at least once to allow the code sequences to be retaught.

If the contacts are not closed, calculation continues in the logic diagram with the substitute value "0." The current status of the AS-i slaves is displayed in the "Target system" > "Learn ASIsafe code tables" dialog box in Safety ES.

Once the actual expanded configuration has been determined, it is compared with the predefined target configuration. AS-i slaves that were not found or that have been stored with a non-matching code sequence are calculated in the logic processing with the substitute value "0." For all others, the current process value is fed into the logic. Then the MSS 3RK3 enters safety mode.

Automatic teaching of code sequences in the background

Irrespective of the current operating status, code sequence teaching is started in the background if the code sequence table is empty or incomplete.

In the following cases, the code sequences are not taught:

- During power-up
- During switchover from safety mode to configuring mode due to an error
- When the system stops
- If the factory settings apply

LED display during teaching of code sequences

LED	Behavior	Explanation
DEVICE	yellow/green/flickering green	Device in configuring mode/safety mode/test mode
AS-i	flashing red	AS-i bus not ok, code table incomplete
TEACH	yellow flashing	Teaching of code sequences in progress
SF	off	No error

Note

Missing code sequences are not interpreted as configuration errors.

LED display when code sequences are complete

LED	Behavior	Explanation
DEVICE	yellow/green/flickering green	Device in configuring mode/safety mode/test mode
AS-i	off	AS-i bus ok, code table complete
TEACH	yellow	The code sequences have been recorded and checked and can now be stored.
SF	off	No error

Apply code tables

The code sequence table can be transferred into the memory of the MSS 3RK3 in three different ways:

- Pressing the RESET button for 3 s
- Pressing the "Apply code tables" button in the "Target system" > "ASIsafe code tables" dialog box in Safety ES
- Controlling a device command function element with the "Adopt code tables" command

The TEACH-LED goes off after the code sequences have been successfully stored.

If saving was started by pressing the reset button, this button can now be released

After completion of the teach process, the device remains in its operating state. In test or safety mode, the real values of the safety-related AS-i input slaves are now used in the logic.

The code sequences are stored in the memory module. No reteaching of code sequences is therefore necessary when devices are replaced.

Note

Deleting code sequences

The stored code sequences are deleted by restoring the factory settings or clearing the memory module.

Note

Applying the actual expanded configuration on the AS-i bus

When the code sequence table is stored, the actual state of all safety-related AS-i slaves on the AS-i bus is applied irrespective of the target configuration that is configured. For example, an existing code table of a previously taught safety-related AS-i slave is deleted for the address of a non-safety-related slave.

LED display after successful teaching of code sequences

LED	Behavior	Explanation
DEVICE	yellow/green/flickering green	Device in configuring mode/safety mode/test mode
AS-i	off	AS-i bus ok, all safety-related AS-i slaves have been taught
TEACH	off	Teaching over
SF	off	No error

6.5.6.3 Canceling teaching of code sequences

Teaching can be canceled in two ways, for example, if not enough time is available to complete teaching of code sequences:

- Cancel without storage in buffer with power OFF

  In this case no code sequences are saved, i.e., the code sequences will have to be retaught completely the next time the device is started up.

- Cancel with storage in buffer

  The taught code sequences are saved. Any missing code sequences can be taught when the device is next started up. The actual status of the AS-i slaves can be read out to ascertain which AS-i slaves still require teaching of code sequences.

  Code sequence teaching can be canceled by:

  – Pressing the RESET buttons for 3 s

  – Pressing the "Apply code tables" button in the "Target system" > "ASIsafe code tables" dialog box in Safety ES

  – Controlling a device command function element with the "Adopt code tables" command

LED display after canceling teaching of code sequences

LED	Behavior	Explanation
DEVICE	yel-low/green/flickering green	Device in configuring mode/safety mode/test mode
AS-i	flashing red	AS-i bus ok, but no code sequences or missing code sequences
TEACH	yellow flashing	Teaching continues
SF	Off	No group error

6.5.6.4 Missing / incorrect code sequences

Missing code sequences

If a code sequence for a safety-related AS-i slave is missing from the code sequence table, it is calculated by the logic processing with the substitute value "0" in safety mode and in test mode.

Note

While the code sequences are being taught, all input contacts of the safety-related AS-i slaves must be actuated so that all code sequences can be determined. The resulting code sequence is checked for correctness. As soon as all code sequences have been determined, they are checked for uniqueness.

Incorrect code sequences

Note

Important requirement

During the teaching process the contacts of the safety-related AS-i input slaves must be closed at least once to allow the code sequences to be retaught.

If the contacts are not closed, calculation continues in the logic diagram with the substitute value "0." The current status of the AS-i slaves is displayed in the "Target system" > "Learn ASIsafe code tables" dialog box in Safety ES.

Safety-related AS-i input slaves and safety-related AS-i outputs can be distinguished using the IO code. However, as this cannot be monitored on the AS-i bus by the monitor, the MSS 3RK3 with AS-i interface analyzes the incoming code sequences and recognizes the different safety-related slave types based on the identified code sequence type. The MSS 3RK3 interprets the data of the safety-related AS-i input slaves as code sequences based on its configuring and the detected ID code. If a comparison with the taught code sequence fails, for example, due to the replacement of an input slave with another type, the safety-related AS-i slave in question is calculated in the interconnection logic using the substitute value "0."

Note

Incorrect code sequence table during startup

During startup, the MSS 3RK3 with AS-i interface checks the consistency of the code sequence tables stored in the device. If any of the code sequences are shown to be invalid, all the stored code sequences are rejected and all safety-related AS-i input slaves on the bus have to be retaught. The code sequence table might be invalid, for example, if the voltage supply of the device failed during storage of the code sequence table.

Error during teaching of code sequences

If there are errors in a received code sequence or the code sequence table is not clear, the device remains in teach phase until it is successful. Code sequence errors are indicated by a red AS-i LED that lights up and can be more precisely defined with the Safety ES software.

Note

Incorrect code sequences and an unclear code sequence table are not interpreted as a configuration error and do not generate a group error (SF).

Double code sequences on the AS-i bus

If the code sequence that a newly inserted safety-related AS-i slave outputs is identical to an existing code sequence, the substitute value "0" is used for both slaves.

Error on replacement of a safety-related AS-i slave

During a routine replacement of a safety-related AS-i slave, the yellow-lit TEACH-LED of the MSS 3RK3 indicates that new code sequences have been detected and can be applied. There are cases where new code sequences cannot be taught:

- Replacement of a safety-related AS-i slave with a non-safety-related AS-i slave

  If a safety-related AS-i slave is replaced by a non-safety-related AS-i slave, this is detected by the MSS 3RK3 and the substitute value "0" for this AS-i slave will be retained and the taught code sequence of the removed safety-related AS-i slave will be deleted.
- Incorrect code sequence when replacing a safety-related AS-i slave

  If the replaced AS-i slave sends an incorrect code sequence, it cannot be used. The TEACH-LED does not light up or flash.

WARNING

Additional safety-related AS-i slave on AS-i bus

For safety reasons, the code sequences of all safety-related slaves must be known to every monitor on the AS-i bus. If an additional safety-related AS-i input slave is added to the AS-i bus, the code sequence of this slave must be taught or every MSS 3RK3 or safety monitor located on the AS-i bus, irrespective of whether or not this new safety-related AS-i slave is monitored by the corresponding MSS 3RK3 or safety monitor.

Acknowledging a code sequence error

When a new slave with a correct new code sequence has been inserted, the existing code sequence error must be acknowledged with the RESET button. Only then can the new code sequence be stored.

6.5.7 Functions of the MSS 3RK3 on the AS-i bus

6.5.7.1 Functions of the MSS 3RK3 on the AS-i bus

The MSS 3RK3 with AS-i interface can perform various functions on the AS-i bus:

- Simulation of slaves
  - Simulation of non-safety-related AS-i slaves

    The MSS 3RK3 with AS-i interface can simulate up to 4 non-safety-related AS-i slaves.
  - Simulation of safety-related AS-i slaves

    The MSS 3RK3 with AS-i interface can simulate safety-related AS-i slaves and perform one of the following functions on the AS-i bus in each case:
    - Simulation of safety-related AS-i input slaves
    - Setting/resetting of safety-related AS-i outputs

    The MSS 3RK3 ASIsafe basic can simulate up to 8 safety-related AS-i slaves.

    The MSS 3RK3 ASIsafe extended can simulate up to 10 safety-related AS-i slaves.

    The MSS 3RK3 Advanced can simulate up to 12 safety-related AS-i slaves.
- Representation of safety-related AS-i outputs

  The MSS 3RK3 with AS-i interface can represent up to 31 safety-related AS-i outputs on the AS-i bus, where each of these AS-i outputs can have up to 4 safety-related output functions.
- Monitoring slaves

  The MSS 3RK3 with AS-i interface is configured as an AS-i safety monitor and can monitor and evaluate all frames on the AS-i bus.
  - Monitoring of non-safety-related AS-i slaves

    MSS 3RK3 evaluates up to 14 non-safety-related AS-i slaves.
  - Monitoring of safety-related AS-i input slaves

    MSS 3RK3 evaluates up to 31 safety-related AS-i input slaves.

Note

Maximum expanded configuration of the AS-Interface

Up to 31 standard addresses can be assigned on an AS-i bus. Once all standard addresses are assigned, maximum 4 safety monitors without an address can be additionally installed.

If fewer than 31 standard addresses are assigned, an additional safety monitor or another AS-i component without an address (e.g., ground fault monitoring modules) can be installed for every unassigned standard address.

You will find further information in the "AS-Interface System Manual (11/2008 edition) with Supplements (09/2010 edition) (http://support.automation.siemens.com/WW/view/de/26250840/0/en)."

Note

MSS 3RK3 bus load

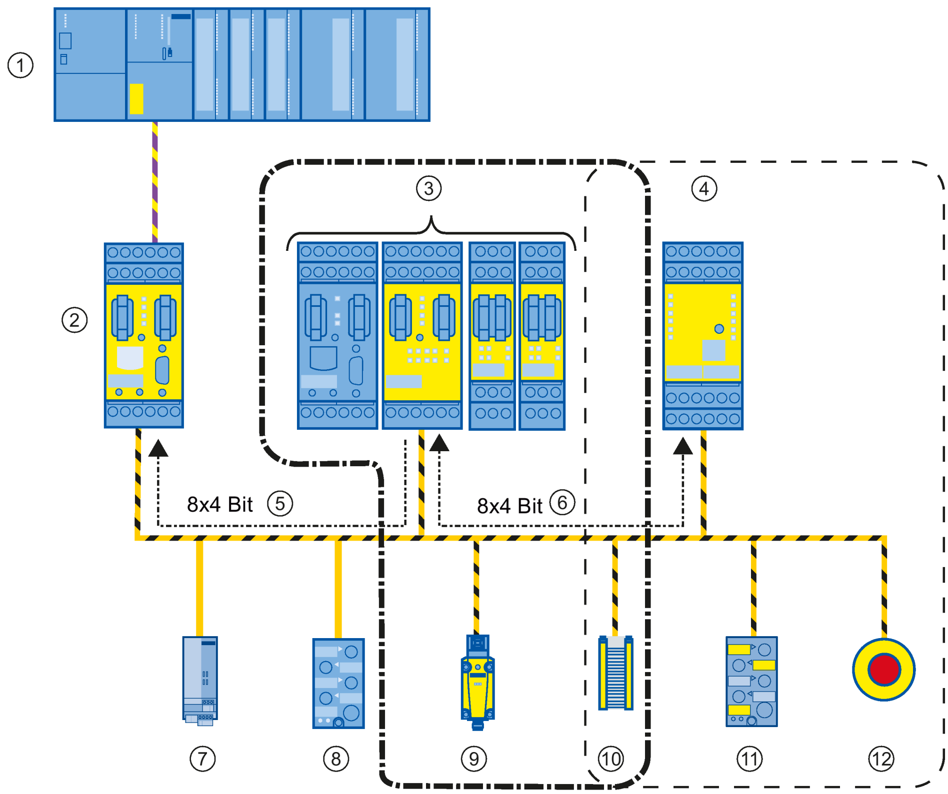
The MSS 3RK3 is always a physical bus load from an A/B slave on the AS-i bus. This bus load does not depend on how many slaves can be simulated by the MSS 3RK3 or whether only AS-i slaves are monitored.

Reference

Examples of various applications of the MSS 3RK3 with AS-i interface and combinations can be found in the following chapter.

6.5.7.2 Safety-related data exchange, for example, in multiple subnetworks

Combination of multiple MSS 3RK3 units with AS-i interface in various subnets.



(yellow line)	AS-Interface
(purple/yellow line)	PROFIBUS with PROFIsafe
(yellow/black line)	ASIsafe
①	F-PLC
②	DP/AS-i F-Link
③	MSS 3RK3 Advanced monitors ⑨ and ⑩
④	AS-i-safety-related monitor monitors ⑩, ⑪, and ⑫
⑤	Unidirectional data exchange from the MSS 3RK3 Advanced to the F-Link
⑥	Data exchange between MSS 3RK3 Advanced and the safety monitor
⑦	AS-i power section
④ ... ⑫	Safety-related and non-safety-related AS-i slaves

Figure 6-22 AS-Interface with different subnetworks

It is possible to operate multiple AS-i devices with monitor functionality on one AS-i line. That way, they can monitor different groups of AS-i slaves on the same AS-i line (subnets) that contain no restrictions, that is, the groups may contain the same AS-i slaves, or only subsets, or no common AS-i slaves. The individual 3RK3 central units with AS-i interface can also monitor one another and communicate with one another.

Note

Exchange of up to 12 safety-related signals

The MSS 3RK3 with AS-i interface can simulate multiple safety-related AS-i slaves on the AS-i bus. These can be either safety-related input slaves for controlling an F-link or safety monitors, or safety-related output slaves for controlling safety-related AS-i outputs or a combination of the two.

The number of simulated safety-related AS-i slaves depends on the type of central unit:

- The MSS 3RK3 ASIsafe basic can simulate up to 8 safety-related AS-i slaves.
- The MSS 3RK3 ASIsafe extended can simulate up to 10 safety-related AS-i slaves.
- The MSS 3RK3 Advanced can simulate up to 12 safety-related AS-i slaves.

6.5.7.3 Simulated AS-i slaves

AS-i slave function - simulated slaves

Simulated slaves are required for transmitting bit information to other devices on the AS-i bus, for example, to the safety monitor or to an additional MSS 3RK3 unit with AS-i interface. In principle, they have the same properties as real slaves, in particular regarding their AS-i address, process data exchange, terminal identifiers, and equipment identifier (BMK).

The following must be noted for simulated slaves:

- The MSS 3RK3 does not monitor its own simulated AS-i slaves with its monitoring function.

  Where values from output terminals of simulated slaves are used again as an input in the logic, the input value is not derived using the monitor function but the value of the output terminal is used. This means that the value will be available to the safety logic in the next processing cycle of the MSS 3RK3. There are no asynchronous dependencies between the cycle time of the MSS 3RK3 and the cycle time of the AS-i bus.

- Simulated AS-i slaves are also visible on the AS-i bus outside safety mode and test mode.

  However, only zeros are returned as output values in configuration mode. All received input values are ignored.

  One exception to this is the simulated AS-i slave with CTT2 profile, as this is used for device diagnostics of the MSS 3RK3 and therefore supplies correct diagnostics data using the CTT2 protocol in configuration mode, too.

  You will find additional information in Chapter "Diagnosis using AS-Interface (CTT2 protocol) (Page 285)."

- Downloading a new configuration

  No AS-i slaves are simulated while a new configuration is being downloaded. Therefore no simulated slaves are visible. Only after the correctness of the configuration has been evaluated are the AS-i slaves in the new configuration simulated on the bus again.

6.5.7.4 Simulation of non-safety-related AS-i slaves

An MSS 3RK3 with AS-i interface can identify itself as a slave on the AS-i bus. For this, a maximum of 4 non-safety-related standard slaves or a maximum of 4 A/B slaves are simulated on the bus. One of these AS-i slaves can be configured as a CTT2 diagnostics slave.

The following non-safety-related slaves can be simulated:

- Standard slaves type S-7.F.F (Std 4I/4O)
- A/B slaves type S-7.A.E (A/B 4I/3O)
- CTT2 diagnostic slave type S-7.5.5 (CTT2 + 2I/2O)

With a simulated non-safety-related AS-i slave, master calls to the simulated slave can be incorporated in the safety logic and signals sent to the master.

CTT2 slave

With a simulated CTT2 slave, diagnostic data can be exchanged with the AS-i master via the CTT2 protocol (message and control data). The CTT2 slave also has 2 non-fail-safe inputs and outputs.

Terminal designation in Safety ES

Input terminals for non-safety-related signals can have input signals of the simulated slaves assigned to them in the interconnection logic in Safety ES.

Terminal designation in the input cell	Explanation
SLOT3_ASI#xx(AB)_Qc	Master call from AS-i master to simulated non-safety-related AS-i slave of the MSS 3RK3
SLOT3_ASI#xx_Qy.z	Master call (CTT2 protocol) from AS-i master to simulated non-safety-related AS-i slave (CTT2) of the MSS 3RK3 (see Chapter "Diagnosis using AS-Interface (CTT2 protocol) (Page 285)")

Output terminals for non-safety-related signals can be configured as output signals of the simulated slaves in the interconnection logic in Safety ES.

Terminal designation in the output cell	Explanation
SLOT3_ASI#xx(AB)-Sc	Sensor signal from MSS 3RK3 to AS-i master: Non-safety-related AS-i output data range of the simulated AS-i slave designates "non-safety-related" output
SLOT3_ASI#xx-Sy.z	Signal from simulated CTT2 slave of MSS 3RK3 to AS-i master (see Chapter "Diagnosis using AS-Interface (CTT2 protocol) (Page 285)").

xx: AS-i address

(AB): A or B can be entered here if the monitored slave is an A/B slave. This identifier is omitted for standard slaves. MSS 3RK3 supports only standard slaves for CTT2.

c: Channel number of AS-i slave process image

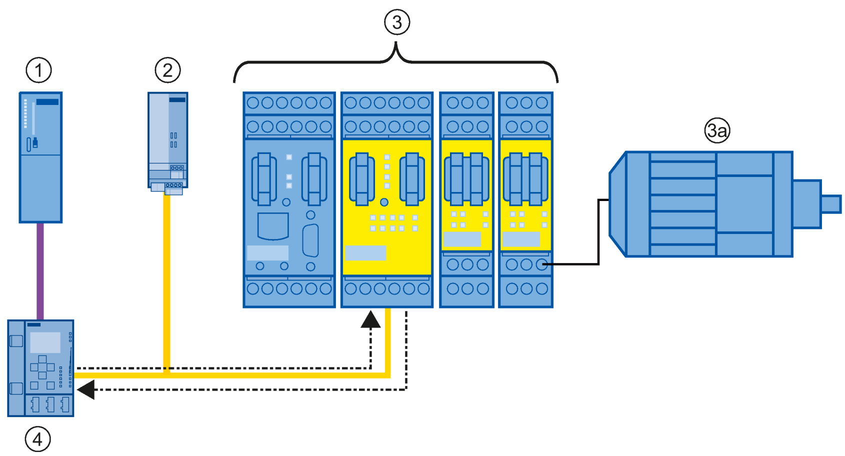
y.z: Defines bit position in CTT2 frame

Note

The signals of the output cells can be included in the logic again through input cells.

Example

The MSS 3RK3 Advanced simulates a non-safety-related AS-i slave on the AS-i bus. The signals from and to the master can be fed into and processed in the logic of the MSS 3RK3 Advanced. The sensor signals from the simulated, non-safety-related AS-i slaves to the master are output to the AS-i bus through the output terminals in the logic.



①	CPU/PLC
②	AS-i power section
③	MSS 3RK3 Advanced (AS-i address #01) with connected motor (3a)
④	AS-i master

Figure 6-23 Simulation of non-safety-related AS-i slaves

In this case, the input and output terminals of the logic diagram in Safety ES have the following designations:

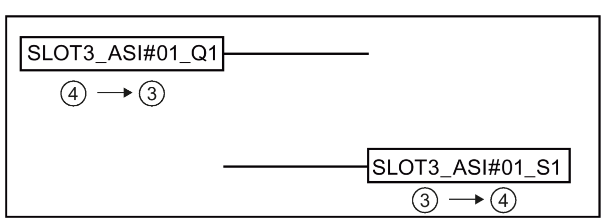


Figure 6-24 Simulation of non-safety-related AS-i slaves in the logic diagram

6.5.7.5 Simulation of safety-related AS-i input slaves

An MSS 3RK3 with AS-i interface can simulate safety-related AS-i input slaves on the AS-i bus in order to send safety-related signals to the AS-i bus:

- The MSS 3RK3 ASIsafe basic can simulate up to 8 safety-related AS-i input slaves.
- The MSS 3RK3 ASIsafe extended can simulate up to 10 safety-related AS-i input slaves.
- The MSS 3RK3 Advanced can simulate up to 12 safety-related AS-i input slaves.

These signals can be monitored and evaluated by other safety monitors.

Note

Exchange of safety-related signals

If safety-related output slaves for controlling safety-related AS-i outputs are simulated simultaneously, the number of simulated safety-related AS-i input slaves are reduced accordingly.

Terminal designation in Safety ES

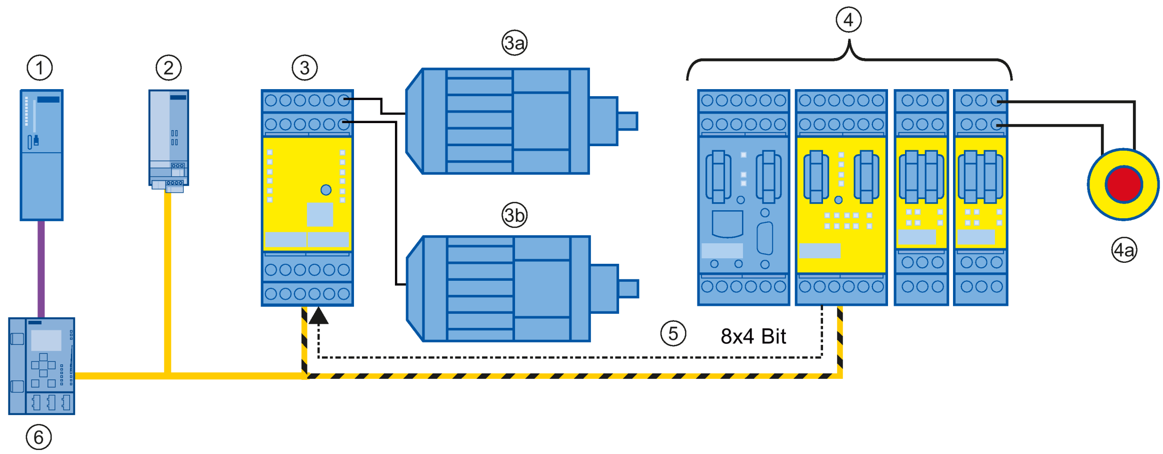
The input signals of the expansion modules of the MSS 3RK3 can be wired in the interconnection logic in Safety ES to logical terminals, which provide their values as simulated safety-related AS-i input slaves on the AS-i bus.

Terminal designation of the output cell	Explanation
SLOT3_ASI#xx-F-S1&2	Sensor signal from MSS 3RK3 to AS-i master that can be evaluated by an AS-i safety monitor

xx: AS-i address

Example

The MSS 3RK3 Advanced simulates a safety-related AS-i input slave on the AS-i bus. The signals of terminals of the expansion modules can be entered in the logic of the MSS 3RK3 Advanced as AS-i signals on the AS-i bus. A safety monitor, for example, an AS-i safety monitor, can evaluate these signals and shut down the motors safely.



① CPU/PLC
② AS-i power section
③ As-i safety monitor with connected motors on Q1/Q2
④ MSS 3RK3 Advanced (AS-i address #01) with emergency stop on IN1/IN2
⑤ Data exchange between MSS 3RK3 Advanced and the AS-i safety monitor
⑥ AS-i master

Figure 6-25 Simulation of safety-related AS-i input slaves

In this case, the input and output terminals of the logic diagram in Safety ES have the following designations:

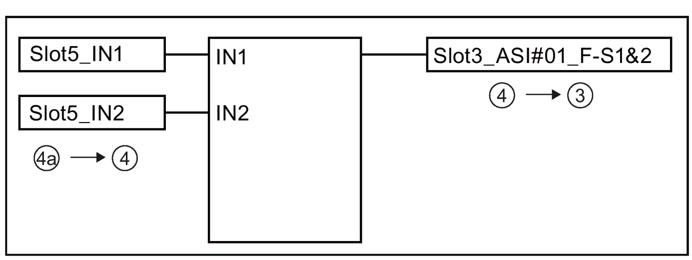


Figure 6-26 Simulation of safety-related AS-i input slaves in the logic diagram

6.5.7.6 Control of safety-related AS-i outputs

The MSS 3RK3 with AS-i interface can control safety-related AS-i outputs. Safety-related AS-i output slaves are simulated on the AS-i bus for this purpose.

- The MSS 3RK3 ASIsafe basic can simulate up to 8 safety-related AS-i output slaves.
- The MSS 3RK3 ASIsafe extended can simulate up to 10 safety-related AS-i output slaves.
- The MSS 3RK3 Advanced can simulate up to 12 safety-related AS-i output slaves.

These AS-i output slaves are each assigned an AS-i address to which the safety-related AS-i output being set or reset responds.

Note

Exchange of safety-related signals

If safety-related AS-i input slaves are simulated simultaneously, the number of simulated safety-related AS-i output slaves for controlling safety-related AS-i outputs is reduced accordingly.

Safety-related AS-i outputs can be set or reset using the "AS-i1..4F-DO" output function and "Output cell" cell function.

Up to four fail-safe signals can be transmitted for each AS-i address using output functions "AS-i1..4F-DO." At any one time, only one of these fail-safe signals may be active.

If the output is set and reset using the "Output cell" cell function, only the first of the four fail-safe signals can be used.

7 x 4 bit code sequences of the safety-related AS-i output slaves

These slaves send 7 x 4 bit code sequences, which are permanently assigned for each address, on the address configured for this. The safety-related AS-i outputs to be set and reset behave like safety monitors and monitor the address assigned to them on the AS-i bus.

Non-safety-related auxiliary control signals (AUX1/AUX2)

In addition to the safety-related control signals (code sequences) of the AS-i outputs, non-safety-related auxiliary control signals (AUX1, AUX2) can also be transmitted. These are used, for example, to acknowledge a restart inhibit or to release errors at AS-i outputs. Additional information can be found in the relevant documentation of the safety-related AS-i output.

The auxiliary control signals AUX1 and AUX2 are defined as pulses. That is why these terminals must not be used for static signals. This pulse is generated as soon as an edge change from zero to one is detected at the respective AUX input (an edge change from one to zero is not taken into consideration).

If a simultaneous edge change is detected for both inputs, the pulse for AUX2 is output after the pulse for AUX1.

Interconnection in the logic diagram

The AS-i outputs are set or reset in the interconnection logic either by means of an "output cell" (Q1 only) or by means of the function element "AS-i 1..4F-DO."

Terminal designation in Safety ES

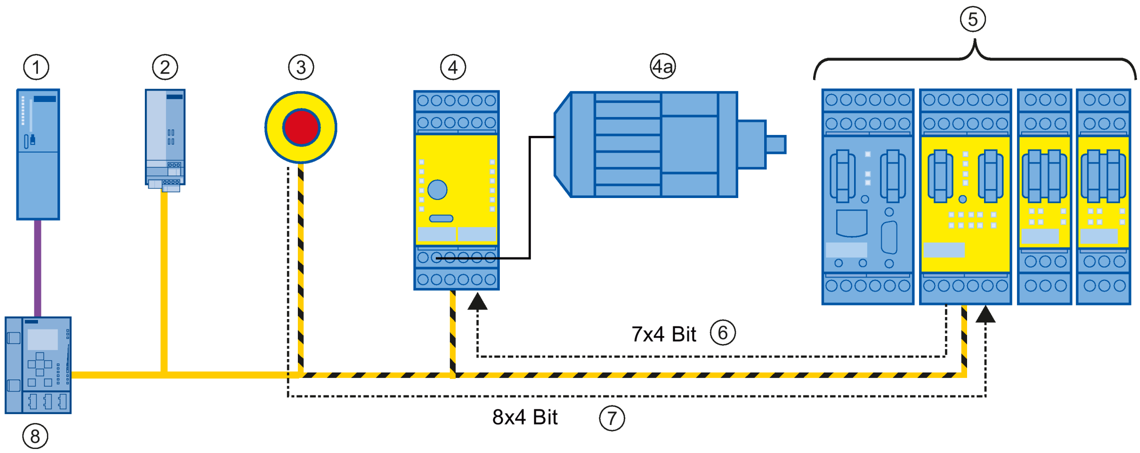
Terminal designation BMK.OUT	Explanation
SLOT3_ASI#xx-F-Qc	Sensor signal from MSS 3RK3 to AS-i master that can be evaluated by an AS-i output.

xx: AS-i address

c: Number of the output (1 ... 4)

Example

The MSS 3RK3 monitors the safety-related AS-i input slave "EMERGENCY STOP" and sets and resets the safety-related AS-i output, which switches the motor off.



① CPU/PLC
② AS-i power section
③ Safety-related AS-i input slave (AS-i address #01)
④ Safety-related AS-i output (responds to AS-i address #02) with motor (4a) connected to Q1
⑤ MSS 3RK3 Advanced sets and resets the AS-i output at address #02
⑥ Data exchange between MSS 3RK3 Advanced and the safety-related AS-i output
⑦ Data exchange between safety-related AS-i input slave and MSS 3RK3 Advanced
⑧ AS-i master

Figure 6-27 Setting/resetting of safety-related AS-i output

In this case, the input and output terminals of the logic diagram in Safety ES have the following designations:

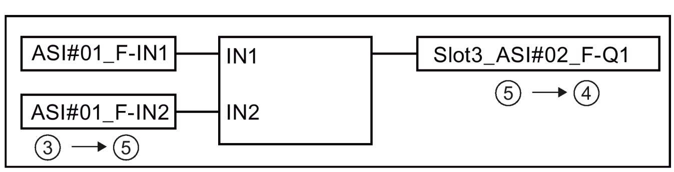


Figure 6-28 Setting/resetting of safety-related AS-i output in the logic diagram

Note

Setting/resetting of a safety-related AS-i output

If a safety-related AS-i output is set and reset using the "Output cell" cell function, only the first of the four fail-safe signals can be used.

You can use output function "AS-i1..4F-DO" to interconnect multiple outputs of a safety-related AS-i output or auxiliary signals (AUX) and to monitor the switching status.

Another method of interconnecting the signals in the logic is demonstrated below:

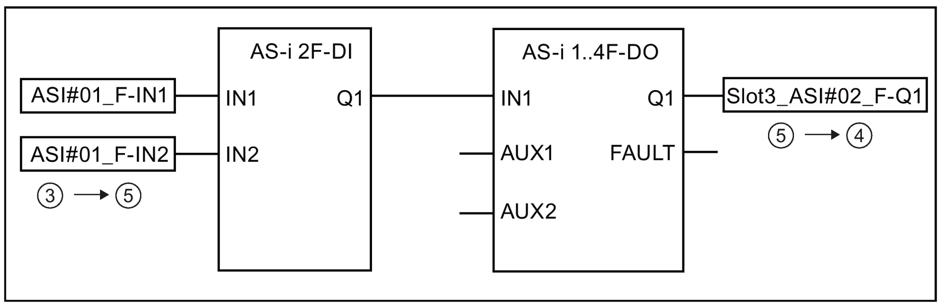


Figure 6-29 Controlling safety-related AS-i outputs using function element AS-i 1..4F-DO

6.5.7.7 Representation of safety-related AS-i outputs

The MSS 3RK3 with AS-i interface can represent a maximum of 31 safety-related AS-i outputs. Safety-related AS-i outputs do not have an explicit address on the AS-i bus. A safety-related AS-i output behaves like a safety monitor that responds to a 7 x 4 bit code sequence of an AS-i address. In this way, actuators can be switched safely.

Switching response of safety-related output signals

No zero signal has to be transferred in order to switch between two output signals of an AS-i output slave. The active output stays on until the full code sequence of another output of this output slave has been received. If an error occurs while the new code sequences are being transmitted or if a zero sequence is transmitted, all outputs will be deactivated.

Terminal designation in Safety ES

The signal source (e.g., a safety monitor or an additional MSS 3RK3 with AS-i interface) transmits a 7 x 4-bit code sequence depending on the AS-i address, which is received and evaluated by the MSS 3RK3. The input values are available for processing on the logical terminals in the logic and can be configured as required in the Safety ES. In this way, the MSS 3RK3 controls its own outputs. The terminal designations of the input cells for this are as follows:

Terminal designation of the input cells	Explanation
ASI#xx_F-OUTc	Signal, for example, from an AS-i safety monitor V3.0 or from another MSS 3RK3 with AS-i interface
ASI#xx_AUXm	Modulated, non-safety-related auxiliary control signal

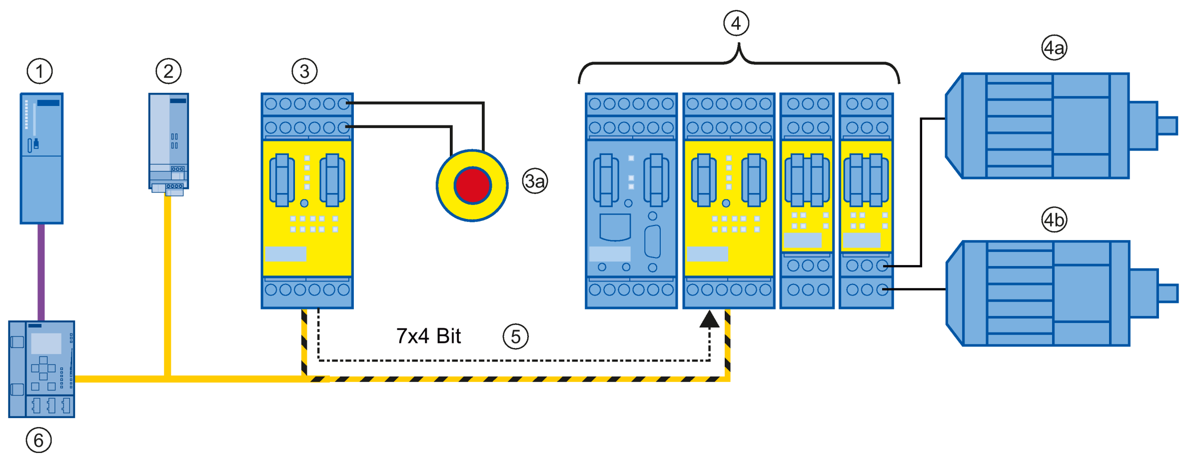
m: Auxiliary signal 1 or 2

xx: AS-i address

c: Channel number of the AS-i slave process image, here the identifier OUT is selected as it is not a sensor value but a preprocessed signal.

Example

The left MSS 3RK3 Advanced responds to an EMERGENCY STOP and passes a signal for a safety-related AS-i output to the right-hand MSS 3RK3 Advanced. The right-hand MSS 3RK3 Advanced behaves like a safety-related AS-i output and can read and process the signal. Both motors are shut down safely through a safety-related output of an expansion module.



① CPU/PLC
② AS-i power section
③ MSS 3RK3 Advanced (controlling a safety-related AS-i output slave on AS-i address #01) with connected EMERGENCY STOP
④ MSS 3RK3 Advanced (safety-related AS-i output slave monitors AS-i address #01; no AS-i address is assigned) with motors connected to Q1/Q2
⑤ Data exchange between MSS 3RK3 Advanced ③ and MSS 3RK3 Advanced ④
⑥ AS-i master

Figure 6-30 MSS 3RK3 Advanced as a safety-related AS-i output

In this case, the input and output terminals of the logic diagram in Safety ES of the right-hand MSS 3RK3 Advanced have the following designations:

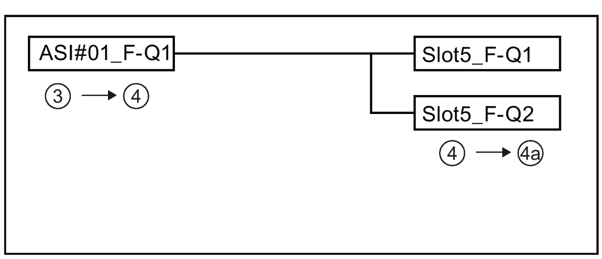


Figure 6-31 Evaluation of safety-related AS-i output in the logic diagram

6.5.7.8 MSS 3RK3 Advanced as the safety monitor

Function

The MSS 3RK3 with AS-i interface also performs the function of a safety monitor. The safety monitor is at the heart of ASIsafe. It monitors the information transmitted through the AS-Interface (master call, response from AS-i slave).

Note

Minimum expanded configuration of the AS-i bus

At least four AS-i slaves must be connected to the AS-i bus to ensure that the safety-related AS-i input slaves are correctly evaluated. It does not matter whether the additional slaves are safety-related or standard slaves. If fewer than four real AS-i slaves exist, the other slaves that are needed can be simulated by MSS 3RK3.

Evaluation in the logic of the MSS 3RK3

The evaluation of the information produces the values in the input cells. These are subsequently further processed in the processing logic of the MSS 3RK3.

To be able to interconnect a non-safety-related AS-i slave, the "Monitor non safe I/O" checkbox must be selected in the subsystem (navigation window) in the properties of the AS-i slave.

The signals of a safety-related AS-i input slave are composed partly of safety-related signals and partly of non-safety-related signals. To be able to interconnect the non-safety-related information of a safety-related slave, the "Monitor non safe I/O" checkbox must be selected in the subsystem (navigation window) in the properties of the slave, like for the non-safety-related slave.

Note

Simulated AS-i slaves

Where values from output terminals of simulated slaves are used again as an input in the logic, the input value is not derived using the monitor function but the value of the output terminal is used. This means that the value will be available to the safety logic in the next processing cycle of the MSS 3RK3. There are no asynchronous dependencies between the cycle time of the MSS 3RK3 and the cycle time of the AS-i bus.

Reference

You will find additional information on ASIsafe on the Internet (http://support.automation.siemens.com/WW/view/en/12834652/133300).

6.5.7.9 Monitoring of non-safety-related AS-i slaves

The MSS 3RK3 with AS-i interface can monitor up to 14 non-safety-related AS-i slaves of type "standard slave," "A/B slave," or "CTT3 slave." In this way, non-safety-related signals that are exchanged between the master and the non-safety-related AS-i slaves can be fed into the logic of the MSS 3RK3.

The following CTT3 profiles are supported:

- IO-Code 0x7, ID-Code 0xA, ID2-Code 0x7 (S-7.A.7):

  A/B slave with 4-bit input and 4-bit output image
- IO-Code 0x7, ID-Code 0xA, ID2-Code 0xA (S-7.A.A):

  A/B slave with 8-bit input and 8-bit output image

Note

Further AS-i slave profiles:

All slave profiles that are not supported are interpreted as "4I / 4O standard slaves" or as "4I / 3O A/B slaves."

Terminal designation in Safety ES

Signals from the AS-i master to the AS-i slave (Q) or from the AS-i slave to the AS-i master (IN) can be incorporated in the interconnection logic via an input cell and interconnected in the Safety ES.

Note

To be able to interconnect a non-safety-related AS-i slave, the "Monitor non safe I/O" checkbox must be selected in the subsystem (navigation window) in the properties of the slave.

The designations of the input cells for this are as follows:

Terminal designation in the input cell	Explanation
ASI#xx(AB)_INc	Sensor input
ASI#xx(AB)_Qc	Output (master call)
ASI#xx(AB)_Qc*	Master call to the channel that is not part of the slave profile

xx: AS-i address

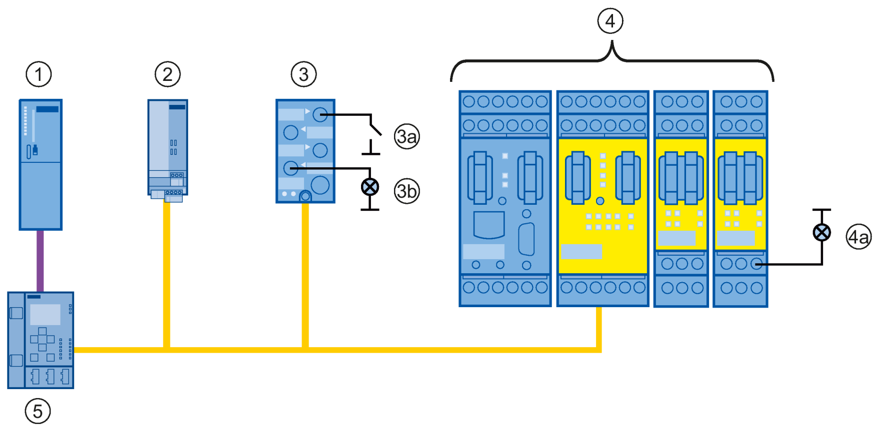
(AB): A or B can be entered here if the monitored slave is an A/B slave. This identifier is omitted for standard slaves.

c: Channel number of AS-i slave process image

c*: The process image of the master call may contain more channels than the slave profile of the corresponding AS-i slave. The channels addressed here are not processed on the AS-i slave but can be used in the logic.

Example

The MSS 3RK3 Advanced monitors a non-safety-related AS-i slave. A release and an indicator light are connected to this AS-i slave. The data traffic between the AS-i master and the non-safety-related AS-i slave can be fed into the logic of the MSS 3RK3 Advanced and processed. An additional indicator light is connected via an expansion module.



1 CPU/PLC
2 AS-i power section
3 Non-safety-related AS-i slave (AS-i address #01) with release (3a) connected to IN1 and indicator light (3b) to Q4
4 MSS 3RK3 Advanced with additional indicator light (4a) on expansion module (slot 5) connected to Q2
5 AS-i master

Figure 6-32 Evaluation of a non-safety-related AS-i slave

In this case, the input and output terminals of the logic diagram in Safety ES have the following designations:

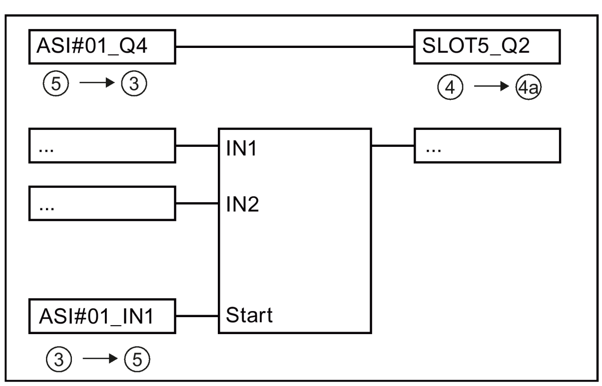


Figure 6-33 Evaluation of the non-safety-related AS-i slave in the logic diagram

6.5.7.10 Monitoring of safety-related AS-i input slaves

The MSS 3RK3 with AS-i interface can monitor up to 31 safety-related AS-i input slaves. These can be simulated by real input slaves or by other devices such as additional MSS 3RK3 units with AS-i interface, safety monitors, etc.

Terminal designation in Safety ES

Signals from the safety-related AS-i input slave to the AS-i master (IN) can be incorporated into the interconnection logic as in input and configured in Safety ES.

If the AS-i input slave also has non-safety-related outputs, these master calls to the AS-i slave (Q) can also be monitored and incorporated in the logic.

The terminal designations of the input cells and the monitoring function "AS-i 2F-DI" for this are named:

Terminal designation in the input cell	Explanation
ASi#xx_F-IN1&2	Sensor value: Safety-related signal from the code sequence of a two-channel sensor
ASi#xx_F-INc	Input terminal signal of the ASIsafe input slave for the monitoring functions. If monitoring function "AS-i 2F-DI" is used: The monitoring function "AS-i 2F-DI" is used instead of an input cell if you want to diagnose both of the input terminal signals of the ASIsafe input slave.

xx: AS-i address

c: Number of the safety-related input

Note

Non-safety-related data with combined AS-i slaves

The signals of combined AS-i slaves with safety-related AS-i inputs and standard AS-i outputs are composed partly of safety-related signals and partly of non-safety-related signals. To be able to interconnect the non-safety-related information of these slaves, the "Monitor non safe I/O" check box must be selected as for the non-safety-related slave in the subsystem (navigation window) in the properties of the slave.

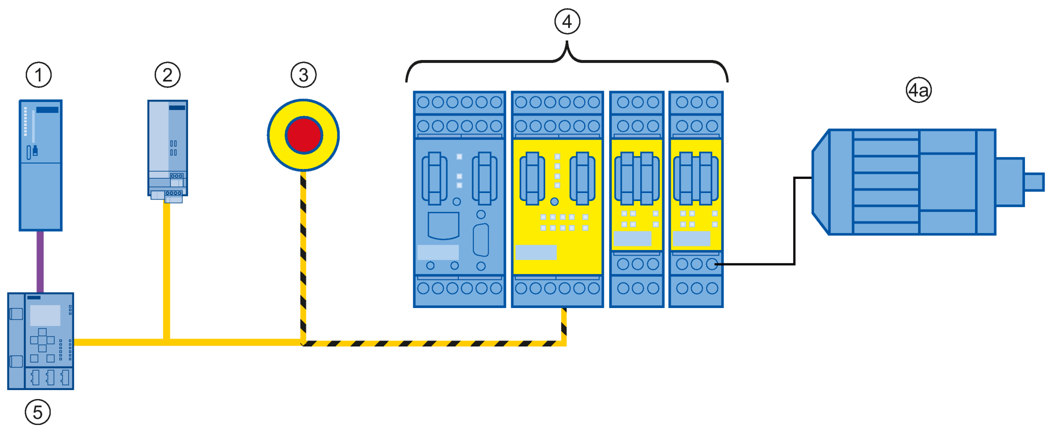
Note

Single-channel use of safety-related AS-i input slaves

The safety-related AS-i input slaves have two inputs that cannot be used independently of each other, so that a safety-related AS-i input slave can only be used in two channels. If a safety-related AS-i input slave is nevertheless to be used in one channel only, the second input must be bridged or assigned two single-channel sensors so that the entire code sequence can be viewed.

Example 1

The MSS 3RK3 Advanced monitors the AS-i EMERGENCY STOP, a safety-related AS-i input slave. The safe data traffic can be fed into the logic of the MSS 3RK3 Advanced through input cells and processed. A motor is shut down safely through a safety-related output of an expansion module.



① CPU/PLC
② AS-i power section
③ Safety-related AS-i input slave (AS-i address #02)
④ MSS 3RK3 Advanced with motor (4a) connected to Q2
⑤ AS-i master

Figure 6-34 Evaluation of a safety-related AS-i input slave

In this case, the input and output terminals of the logic diagram in Safety ES have the following designations:

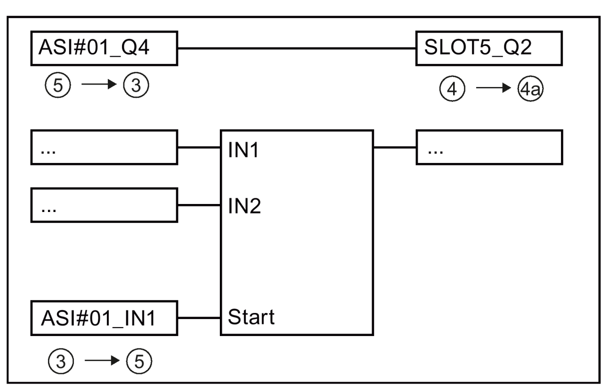


Figure 6-35 Evaluation of the safety-related AS-i input slave in the logic diagram

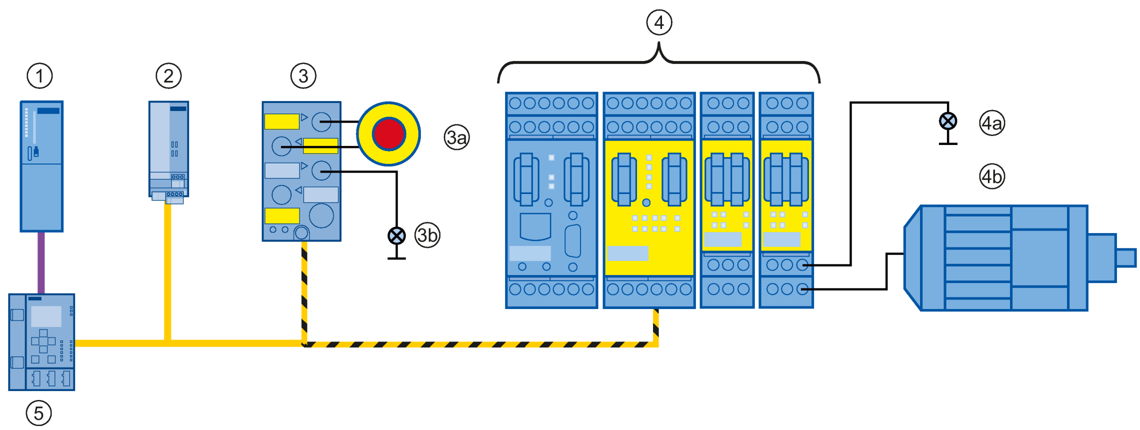
Example 2

The MSS 3RK3 Advanced monitors the safety-related AS-i input slave to whose inputs an EMERGENCY STOP is connected. An indicator light is connected to a standard output of the AS-i slave, which is switched by the AS-i master. The MSS 3RK3 Advanced acquires the status of the indicator light with "monitoring standard slaves" functionality. This status can be fed into the logic of the MSS 3RK3 Advanced via input cells.

Note

The standard output can only be interconnected in the logic if the "Monitor non safe I/O" checkbox is selected in the subsystem in the slave properties.

The motor of the system is safely shut down through a safety-related output of an expansion module and a further indicator light indicates release of the EMERGENCY STOP.



① CPU/PLC
② AS-i power section
③ Safety-related AS-i input slave (AS-i address #02) with standard outputs
An EMERGENCY STOP is connected to the safety-related inputs (IN1/IN2), and an indicator light is connected to the standard output (OUT1)
④ MSS 3RK3 Advanced with connected indicator light (4a) to Q4 and motor (4b) to Q2
⑤ AS-i master

Figure 6-36 Evaluation of a safety-related AS-i input slave

In this case, the input and output terminals of the logic diagram in Safety ES have the following designations:

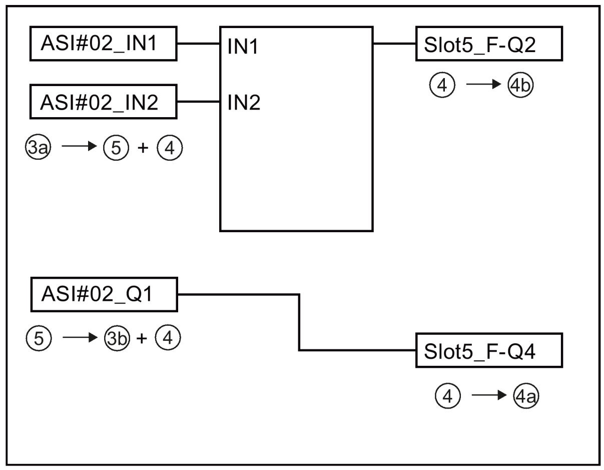


Figure 6-37 Evaluation of the safety-related AS-i input slaves and of the standard outputs in the logic diagram

6.5.8 Behavior on failure of AS-i components

6.5.8.1 Acknowledgement behavior

Responses in the event of an error

On failure of a component on the AS-i bus, calculation in the logical processing is always performed with the substitute value "0."

⚠ WARNING
Hazardous Voltage **Can Cause Death, Serious Injury, or Damage to Property.** **Recovery of an AS-i slave after failure** As soon as the failed AS-i slave returns to the AS-i bus, its real value is immediately processed in the logic and the corresponding partial path of the logic is active again. To prevent this, you must activate the "Startup test" parameter for the relevant function elements in Safety ES, or secure the system by other suitable means.

For the monitoring functions (e.g. EMERGENCY STOP), a startup test is required on recovery of the safety-related slaves if any have been parameterized in the function element.

On failure of an AS-i component, the AS-i-LED flashes red and a warning is generated.

If errors are pending on the AS-i bus (e.g. code sequence errors), the AS-i-LED lights up red. The error must be acknowledged once it has been rectified.

6.5.8.2 Failure of an AS-i slave

The AS-i master cyclically scans all AS-i addresses to ascertain whether new slaves have been added. These scans are detected and evaluated by the AS-i monitor functionality. In this way, the MSS 3RK3 can determine what slaves are on the bus and can independently detect the absence of an AS-i slave on the bus or the absence of the monitored AS-i subnet.

Substitute value on missing slave/erroneous code sequence

If the MSS 3RK3 detects that a configured AS-i slave is missing, or that a safety-related AS-i slave is transmitting an erroneous code sequence, the logic processing at the relevant terminals continues with the substitute value "0" for the terminals affected.

It is possible to ascertain which slaves are missing or defective by reading out the actual status of the AS-i slaves by online diagnostics in Safety ES.

Note

If the missing or defective AS-i slave is a device that is not contained in the configuration of the MSS 3RK3, there is no response.

Recovery of an AS-i slave

When the removed safety-related AS-i slave (identical code sequence) is reinserted or when a non-safety-related slave is plugged in with the corresponding slave profile, work is resumed with the received process value.

For the monitoring elements (e.g., EMERGENCY STOP), a startup test is required on recovery of the safety-related slaves if any have been parameterized in the function element.

6.5.8.3 Failure of the AS-i bus

Entering safety mode even without the AS-i bus

When the system enters safety or test mode, if it is detected that the AS-i bus is not running or is missing completely, the system enters safety mode nevertheless. This can take up to 30 s. In this case, the process values of all configured AS-i slaves are assigned the substitute value "0."

Failure of the total AS-i bus

In protection or test mode, the device evaluates the bus failure as a TARGET ≠ ACTUAL error, but remains in safety mode. Calculation continues with the substitute value "0" for all AS-i slaves.

Note

Simulated AS-i slaves

On bus failure, the substitute value 0 is assumed for all slaves at the input of the logic in safety or test mode.

Where values from output terminals of simulated slaves are used again as an input in the logic, the input value is not derived using the monitor function but the value of the output terminal is used. In this case, no substitute value is assumed.

Recovery / switch-on of the AS-i bus while safety mode is running

If the AS-i bus is switched on in safety or test mode or recovers after a failure, the substitute values of the AS-i slaves are shut down and the received process image is transferred.

Because this procedure can be performed without informing the user and can therefore result in safety-critical conditions, "restart" of the AS-i bus is controlled so that a startup test (if configured) is performed in the input elements of the logic not only on entering safety mode but also on the transition from the substitute value to the real value.

You will find additional information in Chapter " Failure of an AS-i slave (Page 225)."

7 Diagnostics / service

Diagnostics options

A number of methods are available for diagnosing errors:

- Diagnostics with Safety ES
- Diagnostics with LEDs
- Diagnostics using PROFIBUS
- Diagnostics with diagnostics display
- Diagnosis using AS-Interface (CTT2 protocol)

7.1 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 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.
   - The diagnostics display shows which signals are active at which terminals (1 / 0 / fault).
   - Acknowledge the message on the diagnostics display after resolving the cause.
2. Troubleshooting with LEDs
   - You can see by IN-LEDs at which terminal an error signal is pending and what state the signal has (1, 0)
   - By the configuration documents, you can see which element (sensor) is causing the fault.
3. Troubleshooting with Safety ES
   - Safety ES offers you detailed diagnostics of all elements with a locally connected PG / PC.

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.
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.
3. Troubleshooting via CTT2 protocol
   - Via a simulated CTT2 slave that is interconnected in the logic of the MSS 3RK3, you can transfer messages to a AS-i master.

7.2 Diagnostics concept

The diagnostics concept of the MSS 3RK3 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.

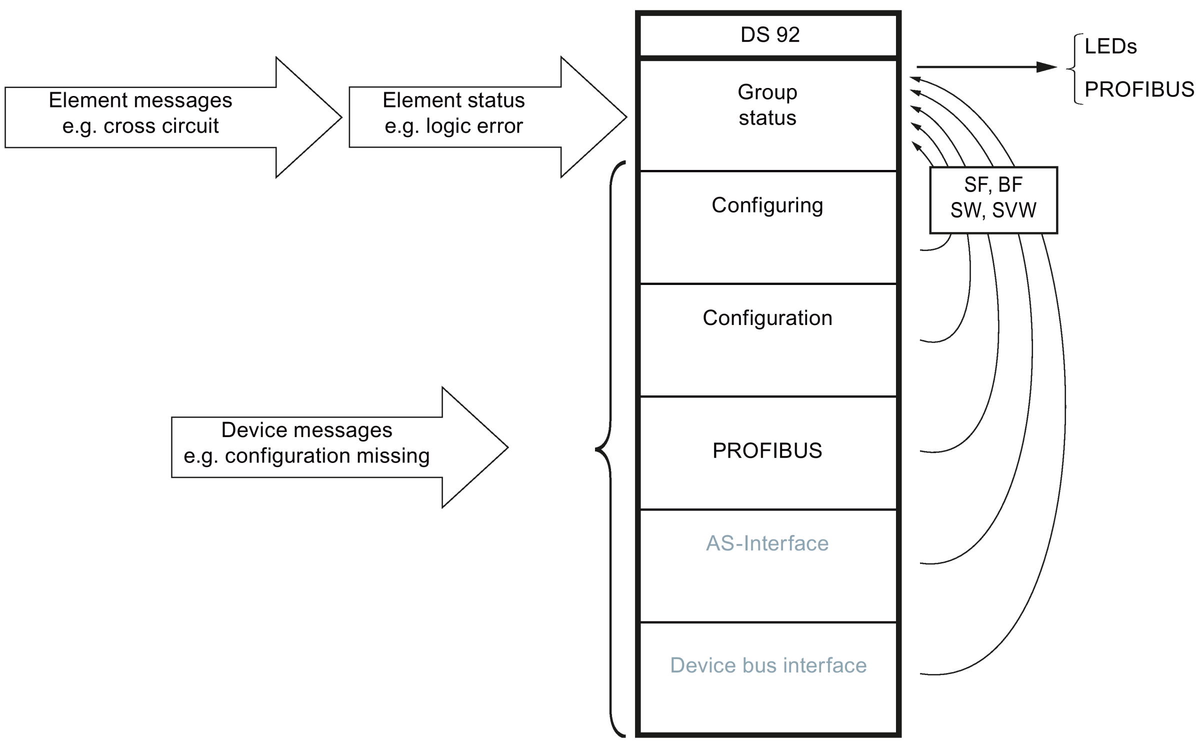


Figure 7-1 MSS 3RK3 diagnostics concept

7.2.1 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 Acknowledgment/Restart**
> **Can Cause Death, Serious Injury, or Damage to Property.**
>
> After fault acknowledgment/restart, the system immediately resumes operation with the values specified by the control, and outputs are activated if the power-on condition is fulfilled.
>
> 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.
- The LEDs of the real inputs on the MSS 3RK3 to which the error refers also indicate the error by a green flashing LED.

7.2.2 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 modules is not possible. The cause of such an error is either internal system error or a defective 3RK3 central unit.

This error category can occur in any operating mode.

Display on the central unit		Remedy
LED	**Display**	
DEVICE	Red	The 3RK3 central unit can only exit the system stop by means of a restart initiated by switching the power supply off and on. If the error is still present after the system has restarted, you must replace the 3RK3 central unit. **Exception:** In the event of overvoltage or undervoltage, the device LED and SF LED do not light up:
SF	red	

Note

Diagnostics not possible

In this state, no diagnostics information can be queried.

System error

If a system error occurs, the 3RK3 central unit switches from safety or test mode into a safe state (configuring mode) and switches off all the outputs. Communication with the expansion modules continues, however, ensuring that status and diagnostics messages can still read out. The causes of such errors are device errors on modules connected to the central unit (e.g., expansion module defective), configuration errors, and bus errors. If an expansion module has caused this error, the SF LED of the affected expansion module lights up.

<table>
<tr><th colspan="2">Display on the central unit</th><th rowspan="2">Remedy</th></tr>
<tr><th>LED</th><th>Display</th></tr>
<tr><td>DEVICE</td><td>• flashing red (in safety mode)
• yellow (in test mode)</td><td rowspan="2">• 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.</td></tr>
<tr><td>SF</td><td>red</td></tr>
</table>

Logic or wiring error

A logic or wiring error does not cause the mode to change; the 3RK3 central unit 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):

<table>
<tr><th colspan="2">Display on the central unit</th><th rowspan="2">Remedy</th></tr>
<tr><th>LED</th><th>Display</th></tr>
<tr><td>DEVICE</td><td>Depending on the operating state</td><td rowspan="3">Resolve the cause and then acknowledge the error with reset.</td></tr>
<tr><td>SF</td><td>red</td></tr>
<tr><td colspan="2">The warning is signaled when the LEDs of the corresponding inputs start flashing.</td></tr>
</table>

- **Logic error**

  (e.g., discrepancy time violation, violation of a signal sequence):

<table>
<tr><th colspan="2">Display on the central unit</th><th rowspan="2">Remedy</th></tr>
<tr><th>LED</th><th>Display</th></tr>
<tr><td>DEVICE</td><td>Depending on the operating state</td><td rowspan="3">Acknowledgment is not necessary. When the logic is correct, the error is automatically canceled.</td></tr>
<tr><td>SF</td><td>flashing red</td></tr>
<tr><td colspan="2">The warning is signaled when the LEDs of the corresponding inputs start flashing.</td></tr>
</table>

- **Group warning (for MSS 3RK3 Basic only)**

  (e.g., wait for startup test)

Display on the central unit		Remedy
LED	**Display**	
DEVICE	Depending on the operating state	Acknowledgment is not necessary. When the logic is correct, the warning is automatically canceled.
SF	-	
The warning is signaled when the LEDs of the corresponding inputs start flashing.		

- **Group prewarning (not in the case of MSS 3RK3 Basic)**

  (e.g., wait for startup test)

Display on the central unit		Remedy
LED	**Display**	
DEVICE	Depending on the operating state	Acknowledgment is not necessary. When the logic is correct, the warning is automatically canceled.
SF	-	
The warning is signaled when the LEDs of the corresponding inputs start flashing.		

  (e.g., safety sensor triggered)

Display on the central unit		Remedy
LED	**Display**	
DEVICE	Depending on the operating state	Acknowledgment is not necessary. When the logic is correct, the warning is automatically canceled.
SF	-	
The LEDs of the relevant inputs do not light up.		

Parameterization or configuration error

This category of error only occurs in configuring mode. This error is caused if the configuration is either not available or is incorrect, for example.

Display on the central unit		Remedy
LED	Display	
DEVICE	Yellow	Acknowledgment is not necessary. When the parameterization is correct, the error is automatically canceled.
SF	red	

Handshake error

This category of error only occurs in test mode. This error is caused by an interruption in the connection between the Safety ES and the MSS 3RK3. The MSS 3RK3 changes from test mode to configuring mode.

Display on the central unit		Remedy
LED	Display	
DEVICE	Yellow	Acknowledgment is not necessary. The error is automatically canceled when a connection is re-established.
SF	red	

7.3 Diagnostics with LEDs

Requirements

When performing diagnosis of the MSS 3RK3 via LEDs, you must observe all the LEDs on every module. The interpretation of the errors depends on how the function element is wired to the inputs.

To be able to diagnose an error, it must be known which function element is wired to the flashing IN inputs.

LED response

The following table shows the possible cause of error for a particular LED response on the function elements:

<table>
<tr><th colspan="2">LED response</th><th rowspan="2">Sensor connected to responding IN inputs</th><th rowspan="2">Meaning/Causes</th></tr>
<tr><th>SF-LED on central unit</th><th>Input LEDs on central unit or expansion module</th></tr>
<tr><td rowspan="7">red</td><td rowspan="7">The IN LEDs of a sensor are flashing green.</td><td>• Monitoring Universal
• EMERGENCY STOP
• ESPE
• Protective door
• Safety shutdown mat with NC principle
• Two-hand operation
• Enabling button</td><td>• Cross-circuit at input x</td></tr>
<tr><td>• Protective door with lock</td><td>• Cross-circuit at input x
• Protective door opened when interlock was active</td></tr>
<tr><td>• Safety shutdown mat with cross-circuit principle</td><td>• Wire break at input x
• Short circuit to P at input x</td></tr>
<tr><td>• Mode selector switch</td><td>• Invalid operating mode selection</td></tr>
<tr><td>• Muting functions
Note:
To allow diagnosis by LED, only function elements with one input and one output can be interconnected between the input cell and the function input.</td><td>• Muting indicator light defective</td></tr>
<tr><td>• Output functions
Note:
To allow diagnosis by LED, only function elements with one input and one output can be interconnected between the input cell and the function input.</td><td>• Feedback circuit signal and switching status do not match
In case of inconsistencies, the output function immediately switches off all its outputs.</td></tr>
</table>

<table>
<tr><th colspan="2">LED response</th><th rowspan="2">Sensor connected to responding IN inputs</th><th rowspan="2">Meaning/Causes</th></tr>
<tr><th>SF-LED on central unit</th><th>Input LEDs on central unit or expansion module</th></tr>
<tr><td rowspan="8">flashing red</td><td rowspan="6">The IN LEDs of a sensor are flashing green.</td><td>• Monitoring Universal
• EMERGENCY STOP
• ESPE
• Protective door
• Safety shutdown mat with NC principle</td><td>• Discrepancy condition violated
For further information, see Safety ES</td></tr>
<tr><td>• Two-hand operation</td><td>• Discrepancy condition violated
Other meanings for Advanced/ASIsafe:
• Pushbutton stuck
• Do not release both pushbuttons
For further information, see Safety ES</td></tr>
<tr><td>• Enabling button</td><td>• Discrepancy condition violated
Other meanings for Advanced/ASIsafe:
• Pushbutton stuck
For further information, see Safety ES</td></tr>
<tr><td>• Protective door with lock</td><td>• Discrepancy condition violated
• Interlock not possible because the protective door is open</td></tr>
<tr><td>• Muting functions</td><td>• Discrepancy condition sensor pair x not fulfilled</td></tr>
<tr><td>--</td><td>• Muting functions</td><td>• Max. muting time exceeded</td></tr>
<tr><td>Basic: The IN LEDs of a sensor are flashing green.
Advanced/ASIsafe: The sensor that triggered the sequence violation is flashing green.</td><td>• Monitoring Universal
• Protective door
• Protective door with lock</td><td>• Sequence condition not fulfilled
The sequence condition was not fulfilled in accordance with the parameter assignment.</td></tr>
<tr><td>One or more IN LEDs flashing green.
The error was detected at this input.</td><td>• Muting functions</td><td>• Sequence condition not fulfilled (muting)
The sequence condition was not fulfilled in accordance with the parameter assignment.</td></tr>
</table>

LED response		Sensor connected to responding IN inputs	Meaning/Causes
SF-LED on central unit	Input LEDs on central unit or expansion module		
--	The IN LEDs of a sensor are flashing green.	• Monitoring Universal • EMERGENCY STOP • ESPE • Protective door • Protective door with lock • Safety shutdown mat with NC principle • Safety shutdown mat with cross-circuit principle	• Startup test required When startup test is parameterized, this message is set at every change to safety/test mode and at every change from substitute value to real value and remains set until the connected sensor is actuated at least once. After the sensor has been operated correctly this message is automatically reset.
	The IN LEDs of a sensor are off.	• Monitoring Universal • EMERGENCY STOP • ESPE • Protective door • Protective door with lock • Safety shutdown mat with NC principle	• Safety sensor triggered The safety sensor has been actuated. This message is automatically reset if the value "1" is present for all function inputs monitored (set as part of configuring).

Note

SF on the expansion module lights up red

The cause of errors that result in a red-lit SF-LED on the expansion module are explained in Chapter ""SF" on the expansion module lights up red (Page 238)."

Note

Response of IN LEDs

The way the IN LEDs flash depends on the signal that is present at the input:

- Input signal present: 1.75 s ON/0.25 s OFF
- Input signal not present: 0.75 s ON/1.25 s OFF

7.3.1 "SF" on the expansion module lights up red

Error during startup

After power-up, the modules of the MSS 3RK3 respond as follows:

LED display on the faulty EM	LED display on the following EMs	LED display on the central unit	Meaning / Remedy
• "SF" lights up red • "IN" or "Q" are off	• "SF" lights up yellow • "IN" or "Q" lights up green	• "SF" lights up red • "DEVICE" lights up yellow	**Interruption on the system bus** Interruption in the connection **upstream of** the faulty expansion module with the red "SF" LED. Check the connection cables.
• "SF" lights up red • "IN" or "Q" are off	• "SF" lights up yellow • "IN" or "Q" Lights up green	• "SF" lights up red • "DEVICE" flashes red	The first EM downstream from the 3RK3 central unit on which the "SF" LED lights up is defective and must be replaced.

Error during test mode

In test mode, the modules of the MSS 3RK3 respond as follows:

LED display on the faulty EM	LED display on the following EMs	LED display on the central unit	Meaning / Remedy
• "SF" lights up red • "IN" or "Q" are off	• "SF" lights up red • "IN" or "Q" are off	• "SF" lights up red • "DEVICE" lights up yellow	**Interruption on the system bus** Interruption in the connection **upstream of** the expansion module with the red "SF" LED. Check the connection cables.
• "SF" lights up red • "IN" or "Qx" are off	• "SF" are off • "IN" or "Q" are off	• "SF" lights up red • "DEVICE" lights up yellow	The first EM on which the "SF" LED lights up is defective and must be replaced.

Error in safety mode

In safety mode, the modules of the MSS 3RK3 respond as follows:

LED display on the faulty EM	LED display on the following EMs	LED display on the central unit	Meaning / Remedy
• "SF" lights up red • "IN" or "Q" are off	• "SF" lights up red • "IN" or "Q" are off	• "SF" lights up red • "DEVICE" flashes red	**Interruption on the system bus** Interruption in the connection **upstream of** the expansion module with the red "SF" LED. Check the connection cables.
• "SF" lights up red • "IN" or "Qx" are off	• "SF" are off • "IN" or "Q" are off	• "SF" lights up red • "DEVICE" flashes red	The first EM on which the "SF" LED lights up is defective and must be replaced.

7.3.2 LEDs on the modules

7.3.2.1 Displays on the 3RK3 Basic central unit

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 Chapter "Restoring factory settings (Page 335)"
	red	System stop (e.g. wiring error) The system stop can only be exited by means of a restart after switching the power supply off and on. If the fault is still present after the system has restarted, you must replace the 3RK3 central unit.
	red flashing 0.5 Hz (ratio 1:1)	Error in configuration (e.g. wrong expansion module configured)
	flickering red	See Chapter "Restoring factory settings (Page 335)"
SF	off	No group error
	red	Group fault[1]that requires acknowledgment (wiring, communication, parameterization or configuration error)
	red flashing 0.5 Hz (ratio 1:1)	Self-acknowledging group fault (logic error) (e.g. discrepancy time violation, violation of a signal sequence)
IN1, IN2, IN3, IN4, IN5, IN6, IN7, IN8	off	Input signal not present
	green	Input signal present
	green flashing (1.75 s on / 0.25 s off)	Error detected (cross-circuit at input / wirebreak / short-circuit to power cable / discrepancy error / feedback circuit error / sequence error / error during startup test) Input signal present
	green flashing (0.75 s on / 1.25 s off)	Error detected (cross-circuit at input / wirebreak / short-circuit to power cable / discrepancy error / feedback circuit error / sequence error / error during startup test) Input signal not present
Q1, Q2	off	Output signal not present
	green	Output signal present

[1] Please note the safety information below.

WARNING

**System Restart After Fault Acknowledgment/Restart
Can Cause Death, Serious Injury, or Damage to Property.**

After fault acknowledgment/restart, the system immediately resumes operation with the values specified by the control, and outputs are activated if the power-on condition is fulfilled.

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 further information on the LED display during startup in Chapter "Startup / self-test of the MSS 3RK3 Basic (Page 71)"

7.3.2.2 Displays on the 3RK3 Advanced central unit

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; user program not released; no user program)
	yellow flashing 0.5 Hz (ratio 1:1)	Factory settings restored
	flickering yellow	See Chapter "Restoring factory settings (Page 335)"
	red	System stop (e.g. wiring error) The system stop can only be exited by means of a restart after switching the power supply off and on. If the fault is still present after the system has restarted, you must replace the 3RK3 central unit.
	red flashing 0.5 Hz (ratio 1:1)	Error in configuration (e.g. memory module removed during operation)
	flickering red	See Chapter "Restoring factory settings (Page 335)"
AS-i	off	AS-i bus OK, code table complete
	red	AS-i bus OK, but code sequence error
	red flashing 0.5 Hz (ratio 1:1)	AS-i bus not OK, code table either missing or incomplete; TARGET ≠ ACTUAL AS-i configuration
TEACH	off	Code sequences complete
	flashing yellow	Teaching of code sequences in progress
	yellow	Teaching of code sequences successfully completed, code sequence tables can now be applied
SF	off	No group error
	red	Group fault[1)]that requires acknowledgment (wiring, communication, parameterization or configuration error)
	red flashing 0.5 Hz (ratio 1:1)	Self-acknowledging group fault (logic error) (e.g. discrepancy time violation, violation of a signal sequence)

LED	Display	Explanation
IN1, IN2, IN3, IN4, IN5, IN6, IN7, IN8	off	Input signal not present
	green	Input signal present
	green flashing (1.75 s on / 0.25 s off)	Error detected (cross-circuit at input / wirebreak / short-circuit to power cable / discrepancy error / feedback circuit error / sequence error / error during startup test) Input signal present
	green flashing (0.75 s on / 1.25 s off)	Error detected (cross-circuit at input / wirebreak / short-circuit to power cable / discrepancy error / feedback circuit error / sequence error / error during startup test) Input signal not present
Q1, Q2	off	Output signal not present
	green	Output signal present

[1] Please note the safety information below.

WARNING

System Restart After Fault Acknowledgment/Restart
Can Cause Death, Serious Injury, or Damage to Property.

After fault acknowledgment/restart, the system immediately resumes operation with the values specified by the control, and outputs are activated if the power-on condition is fulfilled.

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 further information on the LED display during startup in Chapter "Startup / self-test of the MSS 3RK3 Advanced (Page 77)"

7.3.2.3 Displays on the 3RK3 ASIsafe basic central unit

LED	Display	Description
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; user program not released; no user program)
	yellow flashing 0.5 Hz (ratio 1:1)	Factory settings restored
	flickering yellow	See Chapter "Restoring factory settings (Page 335)"
	red	System stop (e.g. wiring error) The system stop can only be exited by means of a restart after switching the power supply off and on. If the fault is still present after the system has restarted, you must replace the 3RK3 central unit.
	red flashing 0.5 Hz (ratio 1:1)	Error in configuration (e.g. memory module removed during operation)
	flickering red	See Chapter "Restoring factory settings (Page 335)"
AS-i	Off	AS-i bus OK, code table complete
	red	AS-i bus OK, but code sequence error
	red flashing 0.5 Hz (ratio 1:1)	AS-i bus not OK, no or incomplete code table; SET ≠ TARGET AS-i expansion
TEACH	Off	Code sequences complete
	Flashing yellow	Teaching of code sequences in progress
	yellow	Teaching of code sequences successfully completed, code sequence tables can now be applied
SF	Off	No group error
	red	Group fault[1)]that requires acknowledgment (wiring, communication, parameterization or configuration error)
	red flashing 0.5 Hz (ratio 1:1)	Self-acknowledging group fault (logic error) (e.g. discrepancy time violation, violation of a signal se-quence)

LED	Display	Description
F-IN1, F-IN2	Off	Input signal not present
	green	Input signal present
	green flashing (1.75 s ON/0.25 s OFF)	Error detected (cross-circuit at input / wirebreak / short-circuit to power cable / discrepancy error / feedback circuit error / sequence error / error during startup test) Input signal present
	green flashing (0.75 s ON/1.25 s OFF)	Error detected (cross-circuit at input / wirebreak / short-circuit to power cable / discrepancy error / feedback circuit error / sequence error / error during startup test) Input signal not present
IN3, IN4, IN5, IN6, IN7, IN8	Off	Input signal not present
	green	Input signal present
	green flashing (1.75 s ON/0.25 s OFF)	Error detected (feedback circuit error/sequence error) Input signal present
	green flashing (0.75 s ON/1.25 s OFF)	Error detected (feedback circuit error/sequence error) Input signal not present
Q1, Q2	Off	Output signal not present
	green	Output signal present

[1] Please note the safety information below.

WARNING

System Restart After Fault Acknowledgment/Restart
Can Cause Death, Serious Injury, or Damage to Property.

After fault acknowledgment/restart, the system immediately resumes operation with the values specified by the control, and outputs are activated if the power-on condition is fulfilled.

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 further information on the LED display during startup in Chapter "Startup / self-test of the MSS 3RK3 Advanced (Page 77)"

7.3.2.4 Displays on the 3RK3 ASIsafe extended central unit

LED	Display	Description
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; user program not released; no user program)
	yellow flashing 0.5 Hz (ratio 1:1)	Factory settings restored
	flickering yellow	See Chapter "Restoring factory settings (Page 335)"
	red	System stop (e.g. wiring error) The system stop can only be exited by means of a restart after switching the power supply off and on. If the fault is still present after the system has restarted, you must replace the 3RK3 central unit.
	red flashing 0.5 Hz (ratio 1:1)	Error in configuration (e.g. memory module removed during operation)
	flickering red	See Chapter "Restoring factory settings (Page 335)"
AS-i	Off	AS-i bus OK, code table complete
	red	AS-i bus OK, but code sequence error
	red flashing 0.5 Hz (ratio 1:1)	AS-i bus not OK, code table either missing or incomplete; TARGET ≠ ACTUAL AS-i configuration
TEACH	Off	Code sequences complete
	Flashing yellow	Teaching of code sequences in progress
	yellow	Teaching of code sequences successfully completed, code sequence tables can now be applied
SF	Off	No group error
	red	Group fault[1)]that requires acknowledgment (wiring, communication, parameterization or configuration error)
	red flashing 0.5 Hz (ratio 1:1)	Self-acknowledging group fault (logic error) (e.g. discrepancy time violation, violation of a signal sequence)
F-IN1, F-IN2, F-IN3, F-IN4	Off	Input signal not present
	green	Input signal present
	green flashing (1.75 s ON/0.25 s OFF)	Error detected (cross-circuit at input / wirebreak / short-circuit to power cable / discrepancy error / feedback circuit error / sequence error / error during startup test) Input signal present
	green flashing (0.75 s ON/1.25 s OFF)	Error detected (cross-circuit at input / wirebreak / short-circuit to power cable / discrepancy error / feedback circuit error / sequence error / error during startup test) Input signal not present

LED	Display	Description
IN5, IN6, IN7, IN8	Off	Input signal not present
	green	Input signal present
	green flashing (1.75 s ON/0.25 s OFF)	Error detected (feedback circuit error/sequence error) Input signal present
	green flashing (0.75 s ON/1.25 s OFF)	Error detected (feedback circuit error/sequence error) Input signal not present
Q1, Q2	Off	Output signal not present
	green	Output signal present

WARNING

**System Restart After Fault Acknowledgment/Restart
Can Cause Death, Serious Injury, or Damage to Property.**

After fault acknowledgment/restart, the system immediately resumes operation with the values specified by the control, and outputs are activated if the power-on condition is fulfilled.

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 further information on the LED display during startup in Chapter "Startup / self-test of the MSS 3RK3 Advanced (Page 77)"

7.3.2.5 Displays on the expansion module 4/8F-DI

LED	Display	Explanation
SF / IN1	off	Input signal not present
	green	Input signal present
	green flashing (1.75 s on / 0.25 s off)	Error detected (cross-circuit at input / wirebreak / short-circuit to power cable / discrepancy error / feedback circuit error / sequence error / error during startup test) Input signal present
	green flashing (0.75 s on / 1.25 s off)	Error detected (cross-circuit at input / wirebreak / short-circuit to power cable / discrepancy error / feedback circuit error / sequence error / error during startup test) Input signal not present
	red	Device defective or error on the system bus (see also Chapter ""SF" on the expansion module lights up red (Page 238)")
IN2, IN3, IN4, IN5, IN6, IN7, IN8	off	Input signal not present
	green	Input signal present
	green flashing (1.75 s on / 0.25 s off)	Error detected (cross-circuit at input / wirebreak / short-circuit to power cable / discrepancy error / feedback circuit error / sequence error / error during startup test) Input signal present
	green flashing (0.75 s on / 1.25 s off)	Error detected (cross-circuit at input / wirebreak / short-circuit to power cable / discrepancy error / feedback circuit error / sequence error / error during startup test) Input signal not present

7.3.2.6 Displays on expansion module 2/4F-DI 1/2F-RO

LED	Display	Explanation
SF / IN1	off	Input signal not present
	green	Input signal present
	green flashing (1.75 s on / 0.25 s off)	Error detected (cross-circuit at input / wirebreak / short-circuit to power cable / discrepancy error / feedback circuit error / sequence error / error during startup test) Input signal present
	green flashing (0.75 s on / 1.25 s off)	Error detected (cross-circuit at input / discrepancy error / feedback circuit error / sequence error / error during startup test) Input signal not present
	red	Device defective or error on the system bus (see also Chapter ""SF" on the expansion module lights up red (Page 238)")
IN2, IN3, IN4,	off	Input signal not present
	green	Input signal present
	green flashing (1.75 s on / 0.25 s off)	Error detected (cross-circuit at input / wirebreak / short-circuit to power cable / discrepancy error / feedback circuit error / sequence error / error during startup test) Input signal present
	green flashing (0.75 s on / 1.25 s off)	Error detected (cross-circuit at input / wirebreak / short-circuit to power cable / discrepancy error / feedback circuit error / sequence error / error during startup test) Input signal not present
Q1, Q2	off	Output signal not present
	green	Output signal present

7.3.2.7 Displays on expansion module 2/4F-DI 2F-DO

LED	Display	Explanation
SF / IN1	off	Input signal not present
	green	Input signal present
	green flashing (1.75 s on / 0.25 s off)	Error detected (cross-circuit at input / wirebreak / short-circuit to power cable / discrepancy error / feedback circuit error / sequence error / error during startup test) Input signal present
	green flashing (0.75 s on / 1.25 s off)	Error detected (cross-circuit at input / wirebreak / short-circuit to power cable / discrepancy error / feedback circuit error / sequence error / error during startup test) Input signal not present
	red	Device defective or error on the system bus (see also Chapter ""SF" on the expansion module lights up red (Page 238)")
IN2, IN3, IN4,	off	Input signal not present
	green	Input signal present
	green flashing (1.75 s on / 0.25 s off)	Error detected (cross-circuit at input / wirebreak / short-circuit to power cable / discrepancy error / feedback circuit error / sequence error / error during startup test) Input signal present
	green flashing (0.75 s on / 1.25 s off)	Error detected (cross-circuit at input / wirebreak / short-circuit to power cable / discrepancy error / feedback circuit error / sequence error / error during startup test) Input signal not present
Q1, Q2	off	Output signal not present
	green	Output signal present

7.3.2.8 Displays on expansion module 4F-DO

LED	Display	Explanation
SF / Q1	off	Output signal not present
	green	Output signal present
	red	Device defective or error on the system bus (see also Chapter ""SF" on the expansion module lights up red (Page 238)")
Q2, Q3, Q4,	Off	Output signal not present
	Green	Output signal present

7.3.2.9 Displays on expansion module 4/8F-RO

LED	Display	Explanation
SF / Q1	off	Output signal not present
	green	Output signal present
	red	Device defective or error on the system bus (see also Chapter ""SF" on the expansion module lights up red (Page 238)")
Q2, Q3, Q4, Q5, Q6, Q7, Q8	off	Output signal not present
	green	Output signal present

7.3.2.10 Displays on expansion module 8DI

LED	Display	Explanation
SF / IN1	Off	Input signal not present
	Green	Input signal present
	Red	Device defective or error on the system bus (see also Chapter ""SF" on the expansion module lights up red (Page 238)")
IN2, IN3, IN4, IN5, IN6, IN7, IN8	Off	Input signal not present
	Green	Input signal present

7.3.2.11 Displays on expansion module 8DO

LED	Display	Explanation
SF / Q1	off	Output signal not present
	green	Output signal present
	red	Device defective or error on the system bus (see also Chapter ""SF" on the expansion module lights up red (Page 238)")
Q2, Q3, Q4, Q5, Q6, Q7, Q8	off	Output signal not present
	green	Output signal present

7.3.2.12 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 187)"
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.)

7.3.2.13 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.)

7.3.3 LED response for various element functions

7.3.3.1 Monitoring Universal

The table below lists all the messages and corresponding LED responses to the "Monitoring Universal" function element.

Message	Meaning	LED response	
		SF-LED on central unit	Input LEDs on central unit or expansion module
Startup test required	This message is set in a parameterized startup test on each restart and each time the substitute value is changed to a real value until the connected sensor is actuated at least once. After the sensor has been operated correctly this message is automatically reset.	-	The IN LEDs of the sensor are flashing green.
Sequence condition not fulfilled	The sequence condition was not fulfilled in accordance with the parameter assignment. This message is automatically reset if the value "0" is detected for all function inputs monitored.	flashes red	The IN LEDs of the sensor are flashing green.
Discrepancy condition violated	is set if: • After the discrepancy time has elapsed, the signal states at the inputs monitored are different • The signal states of the inputs monitored had not all previously been reset simultaneously to the value "0" when they are set to "1"	flashes red	The IN LEDs of the sensor are flashing green.
Safety sensor triggered	The safety sensor has been actuated. This message is automatically reset if the value "1" is present for all function inputs monitored (set as part of configuring).	-	The IN LEDs of the sensor are off. The IN2-LED is green on input type NCNO.
Cross-circuit at input x	A cross-circuit was detected at input x.	red	The IN LEDs of the sensor are flashing green.
Start signal duration invalid	Only with start type "Monitored start": The start signal time monitoring element detected a violation.	-	-
Start condition not fulfilled	is set if: • A sensor test was not executed in the case of an active startup test function • A discrepancy condition violation is present • The value "1" is not present simultaneously at all available (parameterized) function inputs (IN1, ...) • A signal sequence violation is present • A cross-circuit is present in the case of cross-circuit monitoring	-	-

7.3.3.2 EMERGENCY STOP

The table below lists all the messages and corresponding LED responses to the "EMERGENCY STOP" function element.

Message	Meaning	LED response	
		SF-LED on central unit	Input LEDs on central unit or expansion module
Startup test required	This message is set in a parameterized startup test on each restart and each time the substitute value is changed to a real value until the connected sensor is actuated at least once.	-	The IN LEDs of the sensor are flashing green.
Discrepancy condition violated	is set if: • After the discrepancy time has elapsed, the signal states at the inputs monitored are different • The signal states of the inputs monitored had not all previously been reset simultaneously to the value "0" when they are set to "1"	flashes red	The IN LEDs of the sensor are flashing green.
Safety sensor triggered	The safety sensor has been actuated. This message is automatically reset if the value "1" is present for all function inputs monitored (set as part of configuring).	-	The IN LEDs of the sensor are off.
Cross-circuit at input x	A cross-circuit was detected at input x.	red	The IN LEDs of the sensor are flashing green.
Start signal duration invalid	Only with start type "Monitored start": The start signal time monitoring element detected a violation.	-	-
Start condition not fulfilled	is set if: • A sensor test was not executed in the case of an active startup test function • A discrepancy condition violation is present • The value "1" is not present simultaneously at all available (parameterized) function inputs (IN1, ...) • A cross-circuit is present in the case of cross-circuit monitoring	-	-

7.3.3.3 ESPE

The table below lists all the messages and corresponding LED responses to the "ESPE" function element.

Message	Meaning	LED response	
		SF-LED on central unit	Input LEDs on central unit or expansion module
Startup test required	This message is set in a parameterized startup test on each restart and each time the substitute value is changed to a real value until the connected sensor is actuated at least once.	-	The IN LEDs of the sensor are flashing green.
Discrepancy condition violated	is set if: • The signal states of the inputs monitored had not all previously been reset simultaneously to the value "0" when they are set to "1"	flashes red	The IN LEDs of the sensor are flashing green.
Safety sensor triggered	The safety sensor has been actuated. This message is automatically reset if the value "1" is present for all function inputs monitored (set as part of configuring).	-	The IN LEDs of the sensor are off.
Cross-circuit at input x	A cross-circuit was detected at input x.	red	The IN LEDs of the sensor are flashing green.
Start signal duration invalid	Only with start type "Monitored start": The start signal time monitoring element detected a violation.	-	-
Start condition not fulfilled	is set if: • A sensor test was not executed in the case of an active startup test function • A discrepancy condition violation is present • The value "1" is not present simultaneously at all available (parameterized) function inputs (IN1, ...) • A cross-circuit is present in the case of cross-circuit monitoring	-	-

7.3.3.4 Protective door

The table below lists all the messages and corresponding LED responses to the "Protective Door" function element.

Message	Meaning	LED response	
		SF-LED on central unit	**Input LEDs on central unit or expansion module**
Startup test required	This message is set in a parameterized startup test on each restart and each time the substitute value is changed to a real value until the connected sensor is actuated at least once.	-	The IN LEDs of the sensor are flashing green.
Sequence condition not fulfilled	The sequence condition was not fulfilled in accordance with the parameter assignment.	flashes red	**Basic:** The IN LEDs of the sensor are flashing green. **Advanced/ASIsafe:** The sensor that triggered the sequence violation is flashing.
Discrepancy condition violated	is set if: • After the discrepancy time has elapsed, the signal states at the inputs monitored are different • The signal states of the inputs monitored had not all previously been reset simultaneously to the value "0" when they are set to "1"	flashes red	The IN LEDs of the sensor are flashing green.
Safety sensor triggered	The safety sensor has been actuated. This message is automatically reset if the value "1" is present for all function inputs monitored (set as part of configuring).	-	The IN LEDs of the sensor are off. The IN2-LED is green on input type NCNO.
Cross-circuit at input x	A cross-circuit was detected at input x.	Red	The IN LEDs of the sensor are flashing green.
Start signal duration invalid	Only with start type "Monitored start": The start signal time monitoring element detected a violation.	-	-
Start condition not fulfilled	is set if: • A sensor test was not executed in the case of an active startup test function • A discrepancy condition violation is present • The value "1" is not present simultaneously at all available (parameterized) function inputs (IN1, ...) • A signal sequence violation is present • A cross-circuit is present in the case of cross-circuit monitoring	-	-

7.3.3.5 Protective door with lock

The table below lists all the messages and corresponding LED responses to the "Protective Door with Lock" function element.

Message	Meaning	LED response	
		SF-LED on central unit	**Input LEDs on central unit or expansion module**
Startup test required	This message is set in a parameterized startup test on each restart and each time the substitute value is changed to a real value until the connected sensor is actuated at least once.	-	The IN LEDs of the sensor are flashing green.
Sequence condition not fulfilled	The sequence condition was not fulfilled in accordance with the parameter assignment.	flashes red	The sensor that triggered the sequence violation is flashing.
Discrepancy condition violated	is set if: • After the discrepancy time has elapsed, the signal states at the inputs monitored are different • The signal states of the inputs monitored had not all previously been reset simultaneously to the value "0" when they are set to "1"	flashes red	The IN LEDs of the sensor are flashing green.
Safety sensor triggered	The safety sensor has been actuated. This message is automatically reset if the value "1" is present for all function inputs monitored (set as part of configuring).	-	The IN LEDs of the sensor are off. The IN2-LED is green on input type NCNO.
Protective door closed	The protective door is closed.	-	The IN LEDs of the sensor are green. The IN2-LED is off on input type NCNO.
Lock engaged	The lock is engaged.	-	-
Lock released	The lock is released	-	-
Cross-circuit at input x	A cross-circuit was detected at input x.	red	The IN LEDs of the sensor are flashing green.
Start signal duration invalid	Only with start type "Monitored start": The start signal time monitoring element detected a violation.	-	-
Start condition not fulfilled	is set if: • A sensor test was not executed in the case of an active startup test function • A discrepancy condition violation is present • The value "1" is not present simultaneously at all available (parameterized) function inputs (IN1, ...) • A signal sequence violation is present • A cross-circuit is present in the case of cross-circuit monitoring	-	-
Start override active	The start override time is running.	-	-

Message	Meaning	LED response	
		SF-LED on central unit	Input LEDs on central unit or expansion module
Feedback circuit signal and switching status do not match	The feedback circuit signal does not match the interlock status	red	The corresponding IN LED of the input that is connected on the FEEDBACK_LOCK function input flashes green if in the logic there is no more than one negation between the element input and the input cell.
Protective door opened when interlock was active	The protective door opened when interlock was active.	red	The corresponding IN LEDs of the sensor (protective door monitoring) are flashing green.
Interlock not possible because the protective door is open	Interlock not possible because the protective door is open.	flashes red	The corresponding IN LEDs of the sensor (protective door monitoring) are flashing green.

7.3.3.6 Safety shutdown mat with NC principle

The table below lists all the messages and corresponding LED responses to the "Safety shutdown mat with NC principle" function element.

Message	Meaning	LED response	
		SF-LED on central unit	**Input LEDs on central unit or expansion module**
Startup test required	This message is set in a parameterized startup test on each restart and each time the substitute value is changed to a real value until the connected sensor is actuated at least once.	-	The IN LEDs of the sensor are flashing green.
Discrepancy condition violated	is set if: • The signal states of the inputs monitored had not all previously been reset simultaneously to the value "0" when they are set to "1"	flashes red	The IN LEDs of the sensor are flashing green.
Safety sensor triggered	The safety sensor has been actuated. This message is automatically reset if the value "1" is present for all function inputs monitored (set as part of configuring).	-	The IN LEDs of the sensor are off.
Cross-circuit at input x	A cross-circuit was detected at input x.	red	The IN LEDs of the sensor are flashing green.
Start signal duration invalid	Only with start type "Monitored start": The start signal time monitoring element detected a violation.	-	-
Start condition not fulfilled	is set if: • A sensor test was not executed in the case of an active startup test function • A discrepancy condition violation is present • The value "1" is not present simultaneously at all available (parameterized) function inputs (IN1, ...) • A cross-circuit is present in the case of cross-circuit monitoring	-	-

7.3.3.7 Safety shutdown mat with cross-circuit principle

The table below lists all the messages and corresponding LED responses to the "Safety shutdown mat with cross-circuit principle" function element.

Message	Meaning	LED response	
		SF-LED on central unit	Input LEDs on central unit or expansion module
Startup test required	This message is set in a parameterized startup test on each restart and each time the substitute value is changed to a real value until the connected sensor is actuated at least once.	-	The IN LEDs of the sensor are flashing green.
Safety sensor triggered	The safety sensor has been actuated. This message is automatically reset if the value "1" is present for all function inputs monitored (set as part of configuring).	-	The IN LEDs of the sensor are off.
Wire break at input x	A wire break was detected at input x.	red	The IN LEDs of the sensor are flashing green.
Short circuit to P at input x	A short-circuit to P was detected at input x.	red	The IN LEDs of the sensor are flashing green.
Start signal duration invalid	Only with start type "Monitored start": The start signal time monitoring element detected a violation.	-	-
Start condition not fulfilled	is set if: • A sensor test was not executed in the case of an active startup test function • The value "1" is not present simultaneously at all available (parameterized) function inputs (IN1, ...) • A cross-circuit is present	-	-

7.3.3.8 Two-hand operation

The table below lists all the messages and corresponding LED responses to the "two-hand operation" function element.

Message	Meaning	LED response	
		SF-LED on central unit	Input LEDs on central unit or expansion module
Discrepancy condition violated	is set if: • After the discrepancy time has elapsed, the signal states at the inputs monitored are different within one or between to two pushbuttons. • The signal states of the inputs monitored had not all previously been reset simultaneously to the value "0" when they are set to "1"	flashes red	The IN LEDs of the sensor are flashing green.
Cross-circuit at input x	A cross-circuit was detected at input x.	red	The IN LEDs of the sensor are flashing green.
Start condition not fulfilled	is set if: • If both pushbuttons were not pressed "synchronously," that is, they were pressed with a time offset greater than 0.5 s • A discrepancy condition violation is present • The value "1" is not present simultaneously at IN1 ... 2 / 4 • A cross-circuit is present	-	-
Pushbutton stuck (not in the case of 3RK3 Basic)	The pushbutton is stuck.	flashes red	The IN LEDs of the sensor are flashing green.
Do not release both pushbuttons simultaneously (not in the case of 3RK3 Basic)	The two pushbuttons were not released simultaneously.	flashes red	The IN LEDs of the sensor are flashing green.

7.3.3.9 Enabling button

The table below lists all the messages and corresponding LED responses to the "enabling button" function element.

Message	Meaning	LED response	
		SF-LED on central unit	**Input LEDs on central unit or expansion module**
Discrepancy condition violated	is set if: • The signal states of the inputs monitored had not all previously been reset simultaneously to the value "0" when they are set to "1"	flashes red	The IN LEDs of the sensor are flashing green.
Enabling button OFF	The enabling button has the status OFF.	-	-
Enabling button ON	The enabling button has the status ON.	-	-
Cross-circuit at input x	A cross-circuit was detected at input x.	red	The IN LEDs of the sensor are flashing green.
Start condition not fulfilled	is set if: • A discrepancy condition violation is present • The value "1" is not present simultaneously at all available (parameterized) function inputs (IN1, ...) • A cross-circuit is present	-	-
Pushbutton stuck (not in the case of 3RK3 Basic)	The pushbutton is stuck.	flashes red	The IN LEDs of the sensor are flashing green.

7.3.3.10 Mode selector switch

The table below lists all the messages and corresponding LED responses to the "Mode Selector Switch" function element.

Message	Meaning	LED response	
		SF-LED on central unit	Input LEDs on central unit or expansion module
Switchover time exceeded	The "1 out of 2...5 selection monitoring" has detected the value "0" at all inputs after the contact switchover time has elapsed.	-	-
Invalid operating mode selection	The "1 out of 2...5 selection monitoring" has detected after the contact switchover time has elapsed: The value "1" is present at more than one input.	red	The IN LEDs of the sensor are flashing green.

7.3.3.11 Muting functions

The table below lists all the messages and corresponding LED responses to the "Muting" function element.

Message	Meaning	LED response	
		SF-LED on central unit	Input LEDs on central unit or expansion module
Muting operation active	Muting mode is activated.	-	-
Muting operation not active	Muting mode is not activated.	-	-
Muting restart possible	Muting mode was not terminated correctly, i.e. at least one muting sensor is still being triggered.	flashes red	The corresponding IN-LED of the muting display lamp flashes green if only single-channel elements (negation) have been placed between the input cell and the element input in the logic.
Restart signal duration invalid	The "Muting restart possible" message is set and, the first time the RESTART button is pressed, the expected operating sequence does not follow.	flashes red	The corresponding IN-LED of the muting display lamp flashes green if only single-channel elements (negation) have been placed between the input cell and the element input in the logic.
Protective field not free	The value "0" is present at the "FREE" function input.	-	-
System not running	The value "1" is present at the "STOP" function input.	-	-
Start muting condition not met	Not all conditions for operational starting of muting using muting sensors are met.	-	-
Max. muting time exceeded	Muting operation terminated because "max. muting time" expired.	flashes red	-
Discrepancy condition sensor pair x not fulfilled	A discrepancy violation was detected in the signals of muting sensor pair x.	flashes red	The corresponding IN LEDs of the sensors are flashing green.
Sequence condition not fulfilled	The sequence condition was not observed.	flashes red	The LED(s) on whose input the error was detected are flashing green.
Muting display lamp defective	The muting display lamp - monitoring function has detected an error.	red	The corresponding IN-LED of the muting display lamp flashes green if only single-channel elements (negation) have been placed between the input cell and the element input in the logic.

7.3.3.12 Output functions

The table below lists all the messages and corresponding LED responses to the "standard output" and "F output" function elements.

Message	Meaning	LED response	
		SF-LED on central unit	**Input LEDs on central unit or expansion module**
Output x active	Function output 1 is switched on.	-	-
Feedback circuit signal and switching status do not match	The signal at the feedback circuit input does not match the switching status of the function outputs. The output function immediately deactivates all its outputs in case of inconsistencies.	red	The corresponding IN LED of the sensor flashes green if there is no more than one negation between the element input and the input cell in the logic.
Start condition not fulfilled	is set if: • there is a feedback circuit error when feedback circuit monitoring is activated. • the value "0" is pending at the function input (IN).	-	-
Start signal duration invalid	Only with start type "Monitored start": The start signal time monitoring element detected a violation.	-	-

7.3.3.13 Messages for AS-i 1...4F-DO

The table below lists all the messages and corresponding LED responses to the "AS-i1..4F-DO" function element.

Message	Meaning	LED response	
		SF-LED on central unit	Input LEDs on central unit or expansion module
Output x active	Function output x is switched on.	-	-
Feedback circuit signal x and switching status do not match	The signal at feedback circuit input x and the switching status of the corresponding function output x do not match. In case of inconsistencies, the output function immediately switches off all its outputs.	red	The corresponding IN LED of the sensor flashes green if there is no more than one negation between the element input and the input cell in the logic.
Invalid output selection	The value "1" was detected on more than one input IN1 ... 4 by the "1 out of 4 - selection monitoring."	flashing red	The corresponding IN LEDs of the sensors are flashing green.
Start condition not fulfilled	is set if: • there is a feedback circuit error when feedback circuit monitoring is active. • the logic error "Invalid output selection" is pending. • The value "1" is not present simultaneously at all available (parameterized) function inputs (IN1, ...).	-	-
Auxiliary control signal x sent	The auxiliary control signal x was transmitted completely by the code sequence that is currently active.	-	-
Start signal duration invalid	Only with start type "Monitored start": The start signal time monitoring element detected a violation.	-	-

7.4 Diagnostics using PROFIBUS

7.4.1 Using data sets

Note

Diagnostics block

An MSS-specific diagnostics block is available for diagnostics using PROFIBUS. You will find more information on the Internet under FAQs (http://support.automation.siemens.com/WW/view/de/40631654).

Required knowledge

This section is aimed at the following target groups:

- Configuration engineers
- 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
Central unit	0 / 1	System diagnostics	Read
DP interface			
Central 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 central 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 only 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"):

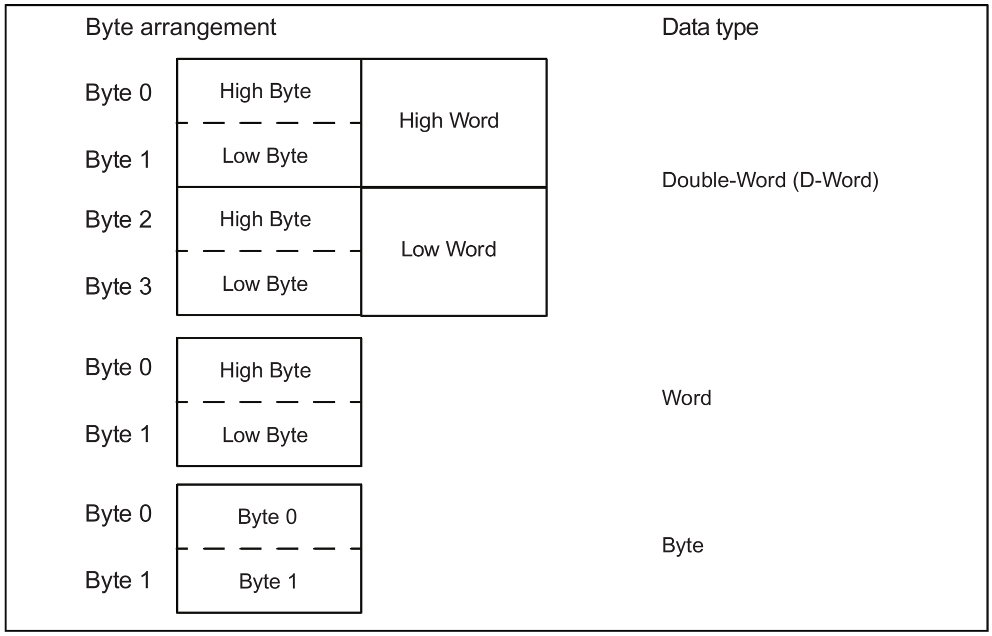


Figure 7-2 Byte arrangement

Additional information

You will find further information about the SFCs and SFBs

- Reference manual "System Software for S7-300/400, System and Standard Functions"
- In the STEP7 online help

7.4.2 Structure of the diagnostics frame

Diagnostics concept via PROFIBUS

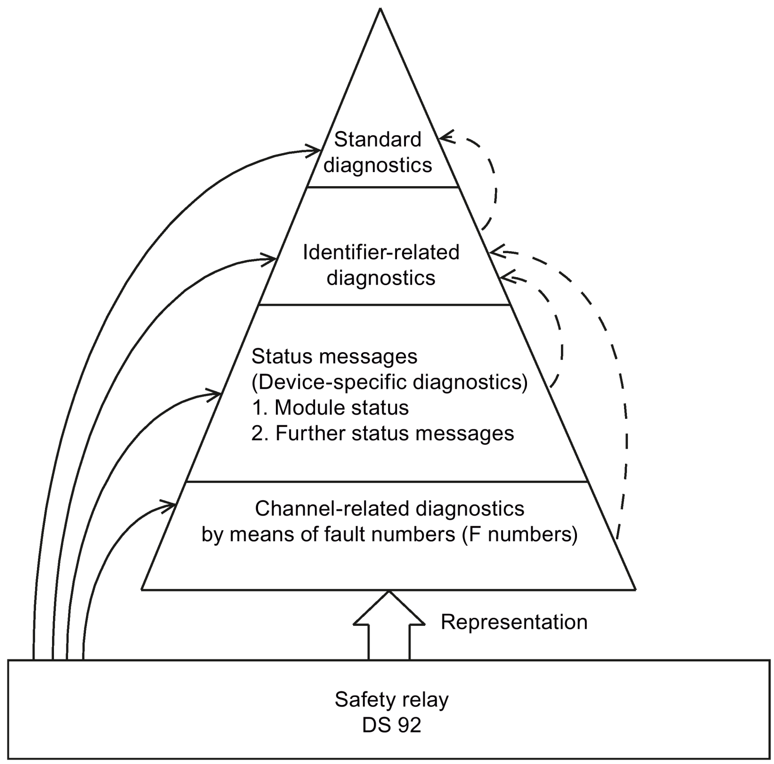


Figure 7-3 Diagnostics pyramid

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 MSS 3RK3 uses the following error numbers:

Note

Difference between the 3RK3 central units

The error numbers of the 3RK3 central units are not all identical.

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	• Device error • Self-test error	Replace 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 (not in the case of MSS 3RK3 Basic) • Data structure incorrect (not in the case of MSS 3RK3 Basic)	• Correct configuring • Update engineering software
19	Communication error	Bus error: • Error on PROFIBUS • Error on AS-i bus (MSS 3RK3 Basic only) • Multiple ASIsafe code tables (not for MSS 3RK3 Basic) • ASIsafe 8x4-bit code sequence errors (not for MSS 3RK3 Basic) • ASIsafe 7x4-bit code sequence errors (not for MSS 3RK3 Basic) • Error on the system interface • Handshake error (MSS 3RK3 Basic)	• Check bus systems • Check device configuration

DP error numbers			
Error no.	Description	Explanation	Remedy
23	Actuator warning	Group warning (MSS 3RK3 Basic) or group prewarning (MSS 3RK3 Advanced, MSS 3RK3 ASIsafe) from the user program	Eliminate cause of warning and acknowledge
24	Actuator disconnection	Group error: • Error in configuration • Configuring error • Protocol error on a safety-related bus (not for MSS 3RK3 Basic) • 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 (not in the case of MSS 3RK3 Basic) • Data structure incorrect (not in the case of MSS 3RK3 Basic) • Memory module not plugged in • Memory module defective • Programming error • Memory module too small • Self-test error (device error) • Multiple ASIsafe code tables (not for MSS 3RK3 Basic) • ASIsafe 8x4-bit code sequence errors (not for MSS 3RK3 Basic) • ASIsafe 7x4-bit code sequence errors (not for MSS 3RK3 Basic) • 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	• 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 (not in the case of MSS 3RK3 Basic) • Handshake error • TARGET≠ACTUAL configuration • TARGET≠ACTUAL slot expanded configuration • Memory module defective • Programming error • System interface configuration error	Eliminate cause of error

7.4.3 Data set 0

7.4.3.1 General data set 0

This DS is available for both the 3RK3 central unit and the DP interface. DS0 in the 3RK3 central unit can be queried through DP slot number 1 on the PROFIBUS slot model, and DS0 in the DP interface can be queried through DP slot number 0.

7.4.3.2 Data set 0 in 3RK3 central unit

The content of DS0 for the 3RK3 central unit is described below:

Byte	Meaning	Note
0^0	Module fault	SF on 3RK3 central unit
0^1	Internal error	Device error on 3RK3 central unit
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 for MSS 3RK3 because diagnostics information is available via DS92
1^6	Diagnostic interrupt from substitute	Not set by MS 3RK3.
1^7	Reserved=0	
2^0	No user module / user module incorrect	Configuration error in MSS 3RK3 TARGET / ACTUAL
2^1	Communication fault	Bus error or safety protocol error
2^2	[0]: RUN mode [1]: STOP mode	RUN: MSS 3RK3 in safety/test mode STOP: MSS 3RK3 in configuring mode
2^3	Time monitoring	Cycle time violation of MSS 3RK3
2^4 ... 2^6	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	

7.4.3.3 Data set 0 in DP interface

The content of DS0 for DP interface is described below:

Coding	Meaning	Note
0^0	Module fault	SF on expansion module
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 for MSS 3RK3 because no diagnostics information is 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	

7.4.4 Data set 1

7.4.4.1 Data set 1 in the 3RK3 central unit

The content of DS1 for the 3RK3 central unit 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 ... 8^0	Reserved=0
8^1	Short-circuit
8^2	Undervoltage
8^3	Overvoltage
8^4	Overload
8^5	Overtemperature
8^6	Line break
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	No encoder or load voltage
10^2	Fuse faulty
10^3	Reserved=0
10^4	Ground error
10^5	Reference channel error
10^6	Process alarm lost
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

7.4.4.2 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

7.4.5 Data set 92

All device-specific messages and information about the individual device function states are collected centrally and stored in the message memory of the 3RK3 central unit. 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**	**3RK3 Basic**		**3RK3 Advanced 3RK3 ASIsafe**	
			Error category	**DP error number**	**Error category**	**DP error number**
Header						
0 … 11	Reserved = 0					
Device status						
12^0	Device error (GF/DEVICE)	Device defective	GF	F9	GF	F9
12^1	Group error (SF)	at least 1 group error pending.	SF	F24	SF	F24
12^2	Bus error (BF)	at least 1 bus error pending.	BF	F19	BF	F19
12^3	Group warning (SW)	at least 1 warning pending.	SW	F23	SW	F23
12^4	Group prewarning (SVW)	at least 1 group prewarning pending.	-		SVW	F23
12^5 ... 13^0	Reserved = 0					
13^1	Configuration error (**KF**)	Memory module not detected; change to configuring mode.	SF	F24, F27	SF	F24, F27
13^2	Configuring error (**PF**)	The configuring contains at least 1 error.	SF	F24, F16	SF	F24, F16
13^3	Safety protocol error (**SPF**)	Protocol error at a safety-related bus, e.g., ASIsafe	-	-	SF	F24, F27
13^4	Wiring error (**VF**)	A wiring error is present.	SF	F24, F26	SF	F24, F26
13^5	Logic error (**LF**)	A logic error is pending (e.g., discrepancy or sequence violation).	SF	F24, F25	SF	F24, F25
13^6 ... 13^7	Reserved = 0					
14^0	Configuring mode active	Device is in configuring mode.	✓		✓	
14^1	Test mode active	Device is in test mode.	✓		✓	
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	-
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.	✓		✓	

DS92 (device messages)						
Byte	**Meaning**	**Note**	**3RK3 Basic**		**3RK3 Advanced 3RK3 ASIsafe**	
			Error category	**DP error number**	**Error category**	**DP error number**
15^2	Reserved = 0					
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	-	SW	-
16^1	Handshake error	Connection monitoring has detected an error.	SF	F24, F19	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 has not been activated.	✓		✓	
17^5 ... 17^6	Reserved = 0					
17^7	Incorrect password entry	The wrong password was entered	✓		✓	
18^0	Group error from user program	At least 1 configured function element has a wiring or logic error.	SF	F24	SF	F24
18^1	Group warning from user program	At least 1 configured function element has a group warning.	SW	F23	-	
18^2	Group prewarning from user program	At least 1 configured function element has a group warning.	-		SVW	-
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	-	SW	-
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					

DS92 (device messages)						
Byte	**Meaning**	**Note**	**3RK3 Basic**		**3RK3 Advanced 3RK3 ASIsafe**	
			Error category	**DP error number**	**Error category**	**DP error number**
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	F24, F16	SF, PF	F24, F16
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	F24, F16	SF, PF	F24, F16
22^0	Max. number of elements exceeded	The max. no. of system elements has been exceeded.	SF	F24, F8	SF, PF	F24, F8
22^1	Max. memory size exceeded	The maximum size of the system memory has been exceeded.	SF	F24, F8	SF, PF	F24, F8
22^2	Program cycle time exceeded	The set cycle time has been exceeded.	SF	F24, F8	SF, PF	F24, F8
22^3	Reserved = 0					
22^4	TARGET = ACTUAL configuration	The expanded system configuration matches the target configuration	✓		✓	
22^5	TARGET≠ACTUAL configuration	The expanded system configuration does not match the target configuration (e.g., modules swapped)	SF	F24, F27	SF, PF	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	F24, F27	SF, PF	F24, F27
22^7	TARGET≠ACTUAL subslot expanded configuration	The expanded configuration of the AS-i system does not match the configuration (e.g., different number of AS-i slaves)	-		✓	
23^0	Reserved = 0					
23^1	Invalid parameter value	A parameter in the configuration contains an invalid value.	SF	F24, F16	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

DS92 (device messages)						
Byte	Meaning	Note	3RK3 Basic		3RK3 Advanced 3RK3 ASIsafe	
			Error category	DP error number	Error category	DP error number
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	F24, F26	SF, KF	F24, F26
26^1	Memory module defective	The memory module is defective.	SF	F24, F27	SF, KF	F24, F27
26^2	Reserved = 0					
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	F24, F27	SF, KF	F24, F27
26^5	User memory too small	The configuration data does not fit into the configuration memory or onto the memory module.	SF	F24, F7	SF, KF	F24, F7
26^6	Reserved = 0					
26^7	Memory module deleted	The configuring data has been deleted.	✓		✓	
27^0	Reset performed	Reset has been performed.	✓		✓	
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.	GF	F24, F9	GF, SF	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	BF	F19
36^2	DP parameterization error	Erroneous or incorrect parameterization frame	✓		BF	-

DS92 (device messages)						
Byte	**Meaning**	**Note**	**3RK3 Basic**		**3RK3 Advanced** **3RK3 ASIsafe**	
			Error category	**DP error number**	**Error category**	**DP error number**
36^3	DP configuration error	Erroneous or incorrect configuration frame	✓		BF	-
36^4	DP process data exchange stopped	Process data exchange with DP master stopped.	✓		✓	
36^5	DP communication OK	DP communication is OK	✓		✓	
36^6 ... 37^7	Reserved = 0					
AS-i fieldbus interface						
38^0	AS-i bus error	AS-i data exchange interrupted, substitute values in process image	-		BF	F19
38^1	AS-i parameterization error	Simulated slave is not incorporated in the communication of the AS-i master	-		BF	F19
38^2	AS-i configuration error	In addition, the AS-i address of the affected AS-i slave with the lowest address is entered in byte 39. For example, set for TARGET ≠ ACTUAL subslot expanded configuration	-		BF	-
38^3 ... 38^4	Reserved = 0					
38^5	AS-i communication OK	AS-i communication is OK	-		✓	
38^6 ... 38^7	Reserved = 0					
39	Incorrect AS-i address	AS-i address of AS-i slave identified as faulty by the device • [0x00]: no AS-i address exists • Bit 0... 4: address 1 ... 31[1 ... 31] • Bit 5: A address [0] B address [1] • Bit 6: Standard slave [0] A/B slave [1] • Bit 7: reserved [0]	-		BF	-
40 ... 43						
44^0	AS-i slave function active	At least one AS-i slave is being simulated	-		✓	
44^1 ... 44^7	Reserved = 0					
45	Reserved = 0					
46^0	AS-i monitor function active	At least one AS-i slave is being monitored	-		✓	
46^1 ... 47	Reserved = 0					

DS92 (device messages)						
Byte	Meaning	Note	3RK3 Basic		3RK3 Advanced 3RK3 ASIsafe	
			Error category	DP error number	Error category	DP error number
ASIsafe:						
48^0	ASIsafe 8x4-bit code sequence monitor active	At least one safety-related AS-i slave is being monitored	-		✓	
48^1	ASIsafe 7x4-bit code sequence generator active	At least one safety-related AS-i output is being monitored	-		✓	
48^2	ASIsafe 8x4-bit code sequence generator active	At least one safety-related AS-i sensor is being simulated	-		✓	
48^3	ASIsafe 7x4-bit code sequence monitor active	At least one safety-related AS-i output is being simulated	-		✓	
48^4 ... 48^7	Reserved = 0					
49^0	ASIsafe code tables missing	ASIsafe code tables are missing. In addition, the (lowest) AS-i address is entered in byte 50	-		✓	
49^1	Multiple ASIsafe code tables	More than one ASIsafe code table exists. In addition, the (lowest) AS-i address is entered in byte 50.	-		SPF	F24, F19
49^2	ASIsafe code tables new	A new correct code sequence was received for at least one AS-i F slave. In addition, the (lowest) AS-i address is entered in byte 50.	-		✓	
49^3	ASIsafe code tables known	Code tables have been taught and stored in the memory module.	-		✓	
49^4	ASIsafe 8x4-bit code sequence error	Error occurred while evaluating input slaves. In addition, the AS-i address is entered in byte 50.	-		SF, SPF	F24, F19
49^5	ASIsafe code table teaching active	ASIsafe code table teaching is active	-		✓	
49^6 ... 49^7	Reserved = 0					
50	AS-i address with 8x4-bit code sequence problem	Lowest AS-i address in which an 8x4-bit code sequence problem occurred. Code sequence problems are: Priority 1: ASIsafe code tables multiple byte: 49^1 Priority 2: ASIsafe 8x4-bit code sequence error byte: 49^4 Priority 3: ASIsafe code tables missing byte: 49^0 Priority 4: ASIsafe code tables new byte: 49^2	-		✓	

DS92 (device messages)						
Byte	Meaning	Note	3RK3 Basic		3RK3 Advanced 3RK3 ASIsafe	
			Error category	DP error number	Error category	DP error number
51^0	ASIsafe 7x4-bit code sequence error	Error in 7x4-bit code sequences (MSS 3RK3 as safety-related AS-i output). In addition, the AS-i address is entered in byte 52.	-		SF, SPF	F24, F19
51^1 ... 51^7	Reserved = 0					
52	AS-i address with 7x4-bit code sequence problem	A problem has occurred on a safety-related AS-i output	-		✓	
53 ... 57	Reserved = 0					
Device bus interface: (SC = System Interface)						
58^0	SC bus error	Communication error	SF, BF	F24, F19	SF, BF	F24, F19
58^1	SC parameterization error	Error occurred during the transfer of parameters to expansion module.	✓		BF	-
58^2	SC configuration error	An expansion module cannot be addressed, or an unaddressed expansion module is installed.	SF	F24, F27	SF, BF	F24, F27
58^3	SC process data exchange stopped	Expansion modules are not involved in cyclic data exchange (e.g., system in configuring mode)	✓		✓	
58^4	SC communication OK	Expansion modules in cyclic data exchange	✓		✓	
58^5 ... 89	Reserved = 0					
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]: for now error • [1 ... 32,767]: element no.	-		✓	
92 ... 93	Reserved = 0					
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]: for now error • [1 ... 32,767]: element no.	-		✓	
96 … 199	Reserved = 0					

✓: Supported

-: Not supported

7.5 Diagnosis using AS-Interface (CTT2 protocol)

7.5.1 Diagnostics concept using the CTT2 protocol

For the 3RK3 central units with AS-interface, the diagnostics concept of the MSS 3RK3 Basic is supplemented to include diagnostics of elements via AS-Interface using the CTT2 protocol. For this purpose, the MSS 3RK3 simulates a CTT2 slave, which is interconnected in the logic. The diagnostics concept using the CTT2 protocol is shown in the following graphic: The device messages result in an entry in the cyclic data, the message data. The acyclic data can then be read out using a command. In these acyclic data, all elements are entered with their pending messages.

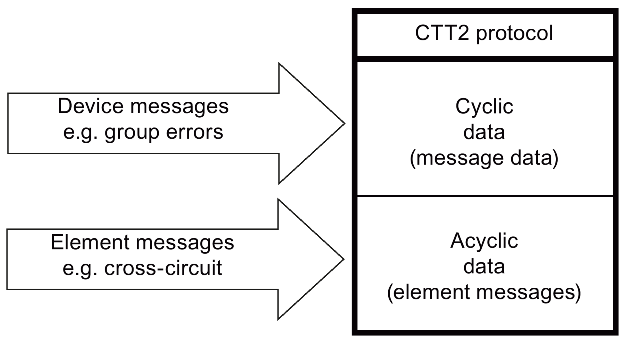


Figure 7-4 Diagnostics concept of MSS 3RK3 with AS-i interface using CTT2

7.5.2 Diagnostics using the CTT2 protocol

Diagnostics over an AS-i CTT2 channel provides access to the elements that have an error or whose safety sensor has been triggered. Device diagnostics using AS-i is possible with a simulated AS-i slave of type CTT2. This is able to process AS-i frames of type "Combined Transaction Type 2."

Because both the cyclic and the acyclic "CTT2 data" are transmitted over the same CTT2 channel, the cyclic CTT2 data transmission from the AS-i master is interrupted for transmission of the acyclic CTT2 data and resumed by the AS-i master automatically after acyclic data transmission has been completed.

Cyclic CTT2 data transmission

The cyclic CTT2 data transmission provides 8 bytes of input data and 8 bytes of output data per AS-i standard slave, which are cyclically exchanged over the CTT2 channel between the AS-i master and the AS-i slaves. Message data are sent by the AS-i slave to the AS-i master and control data are sent by the AS-i master to the AS-i slave.

For the simulated CTT2 slave of the MSS 3RK3, the message data consist of 2 bytes of diagnostics data and 6 bytes of freely interconnectable signals that can be interconnected in the logic via terminals. The diagnostic data signal the status and the operating state of the MSS 3RK3 to a higher-level control.

The MSS 3RK3 can be acknowledged with RESET via the control data.

The transmission duration of the cyclic data transmission depends on the number of AS-i slaves and can be up to 1.31 s.

Acyclic CTT2 data transmission

The cyclic CTT2 data transmission can be interrupted by the acyclic data transmission to permit a precise diagnosis of the individual elements. In this way, function elements with errors and function elements with prewarnings can be read out.

The acyclic CTT2 data transmission consists of up to 200 bytes of input and output data.

The transmission duration of the acyclic data transmission depends on the number of AS-i slaves and can be up to 16 s.

7.5.3 Cyclic data

Message data:

For diagnostics purposes, the device provides message data through a simulated AS-i slave with a CTT2 channel via the cyclic CTT2 data transmission channel. These message data are a subset of data set 92. The following messages can be diagnosed:

Byte	Process data block "device diagnostics"		Note
	Description	**DS92**	
0^0	Device error	12^0: device error	Device diagnostics messages Bit=[0]: Message not set Bit=[1]: Message set
0^1	Group error	12^1: group error	
0^2	Bus error	12^2: bus error	
0^3	Group warning	12^3: group warning	
0^4	Group prewarning	12^4: group prewarning	
0^5	TARGET≠ACTUAL	ORing of: 22^5: TARGET≠ACTUAL configuration 22^6: TARGET≠ACTUAL slot expanded configuration 22^7: TARGET≠ACTUAL subslot ex-panded configuration	
0^6	Group error code tables/sequences	ORing of: 49^0: code tables missing 49^1: multiple code tables 49^4: 8x4bit code sequence error 51^0: 7x4bit code sequence error	
0^7	Reserved = 0	[0]: fix	
1^0	Configuring mode active	14^0: configuring mode active	
1^1	Test mode active	14^1: test mode active	
1^2	Safety mode active	14^2: safety mode active	
1^3	User program is active	14^3: user program is active	
1^4 ... 1^7	Reserved = 0	[0]: fix	
2^0 ... 7^7	SLOT3_ASI#xx-S2.0 SLOT3_ASI#xx-S7.7	-	Signal from simulated CTT2 slave of MSS 3RK3 to AS-i master

xx: AS-i address

Note

Substitute values on failure of a slave

Depending on the AS-i master used, on failure of the AS-i bus or CTT2 slave different substitute values are generated by the master and transferred to the controller (0x7FFF or 0x0000). This must be considered in the programming of the controller because otherwise messages will be interpreted that are not present. The same applies to the freely interconnectable protocol data (SLOT3_ASI#xx-Sy.z).

If the corresponding master is used, the input data are checked word by word for the value 0x7FFF. If the value 0x7FFF is received, the value 0x0000 must be used in the program.

The corresponding substitute value response can be taken from the documentation of the master.

The data in the MSS are not affected by this. The substitute value 0x00 is always generated in this case.

Control data:

Through a simulated AS-i slave with a CTT2 channel, an AS-i master or a controller connected to it can write data to the safety relay. The following data can be written to the safety relay through the cyclic CTT2 data transmission channel:

Byte	Process data block "control data device"		Note
	Description	Description	
0^0	Reset	[->]: On pos. edge 0 -> 1, the command is executed once. [0,1]:constant value: does not cause command processing	Device commands
0^1 ... 1^7	Reserved=0	[0]: fix	
2^0 ... 7^7	SLOT3_ASI#xx-Q2.0 SLOT3_ASI#xx-Q7.7	-	Master call (CTT2 protocol) from AS-i master to simulated non-safety-related AS-i slave (CTT2) of the MSS 3RK3

xx: AS-i address

7.5.4 Acyclic data transmission with function block

The process of transferring CTT2 data from the CPU to AS-i master is dependent on the master. The sequence is described below by way of example based on the DP/AS-i link Advanced. If you are working with SIEMENS AS-i masters and SIMATIC S7 controllers, FC ASI_3422, for example, offers a user-friendly command interface.

Note

This FC ASi_3422 is not supported by all SIEMENS AS-i masters. You will find additional information in the documentation of the FC ASi_3422.

If you are not using the FC ASi_3422, refer to the documentation of the master used and the following chapter on CTT2..

Command interface block FB ASI_CTRL for AS-i master

Calling the command interface block FB ASI_CTRL enables you to both transfer commands and accept response data. The FB ASI_CTRL administers the calls Write_data_record and Read_data_record autonomously

When the command interface is called using command 44_H, a byte string can be used to send a CTT2 request to the AS-i master. The master forwards the string bytes to the AS-i slave address specified in the transmit buffer. The AS-i master determines the number of string bytes to be sent to the AS-i slave (number depends on the data set to be transferred) on the basis of byte 2 of the transmit buffer (number of string bytes).

The addressed AS-i slave responds to the CTT2 request with a CTT2 response. The AS-i master communicates this response as a byte string in the receive buffer. The structure of the CTT2 request or CTT2 response (code, index, etc.) begins with string byte 1 in each case and is not dependent on the master.

The extended process image with the addressed AS-i slave is not transferred while string transfers to the AS-i are taking place.

Depending on the type of protocol, the process of transmitting a data set to a slave may take up to 19 s:

- Read DS3: up to 17 s
- Write DS3: up to 2 s

Reference

You will find further details in the Internet (http://support.automation.siemens.com/WW/view/en/22710305).

7.5.5 CTT2 data exchange

Using CTT2 code 29 ($1D_H$), data sets can be read out from the AS-i through the CTT2 channel while carrying useful data. The read request must be acknowledged positively (= CTT2 code $5D_H$) or negatively (= CTT2 code $9D_H$) by the AS-i slave within a certain time. Transmission of the data set requested by the AS-i slave with the specified length is evaluated as a positive acknowledgment.

Diagnostics with CTT2 codes

The "Write/Read a data set" command is provided in the transmit buffer. The first three bytes (command header) contain the command code, slave address, and number of CTT2 bytes. The CTT2 data set follows this. The CTT2 data set starts with the CTT2 command code, the data set number, and the data set length, followed by the data set bytes DS byte 0 to DS byte 13.

The DP command interface for the AS-i master accepts the data set bytes and forwards them to the addressed slave. These data are transmitted using the CTT2 protocol. MSS 3RK3 processes the CTT2 data set and prepares the requested data and answers using the CTT2 protocol. The AS-i master accepts the response and forwards it to the receive buffer of the CPU via the DP command interface. The response is decoded in the receive buffer of the CPU and the program is executed accordingly.

The following responses are possible:

- $5D_H$: Transmission without error (see Chapter "Element messages (Page 298)")
- $9D_H$: Transmission with error, (CTT2 code that is not supported, see Chapter "Error codes "CTT2 error code" (Page 295)")
- $5A_H$: Transmission with error (CTT2 error data set error, see Chapter "Error codes "CTT2 error code" (Page 295)")

1. Example of transmission without error

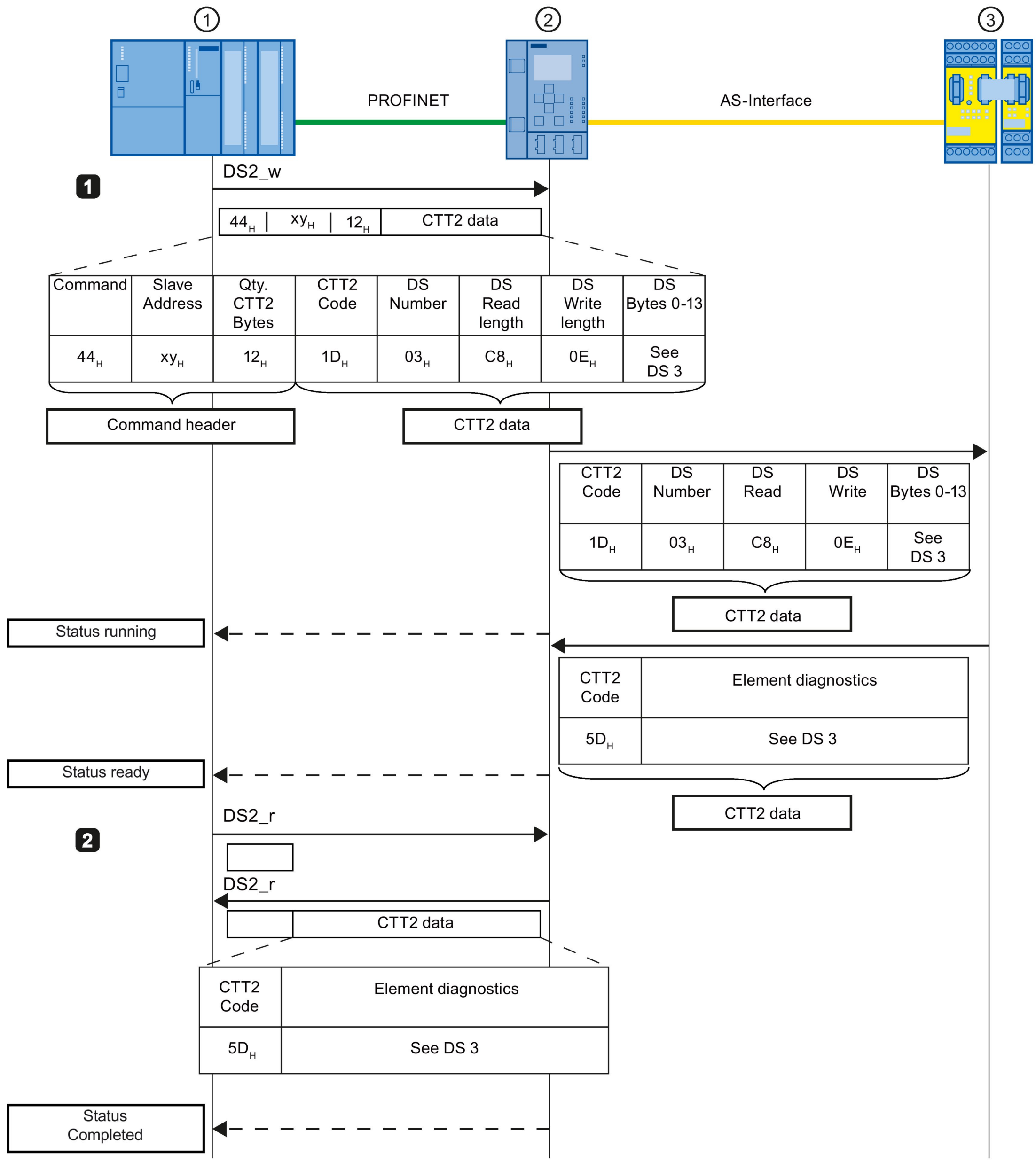
The first example below demonstrates the writing of a data set using data set DS3 "Command interface: Element accesses," with error-free transmission.

2. Example of transmission with error because of incorrect DS number

The second example below demonstrates the writing of a data set using data set DS3 "Command interface: element accesses" when there is a transmission error due to incorrect data set number (DS 4).

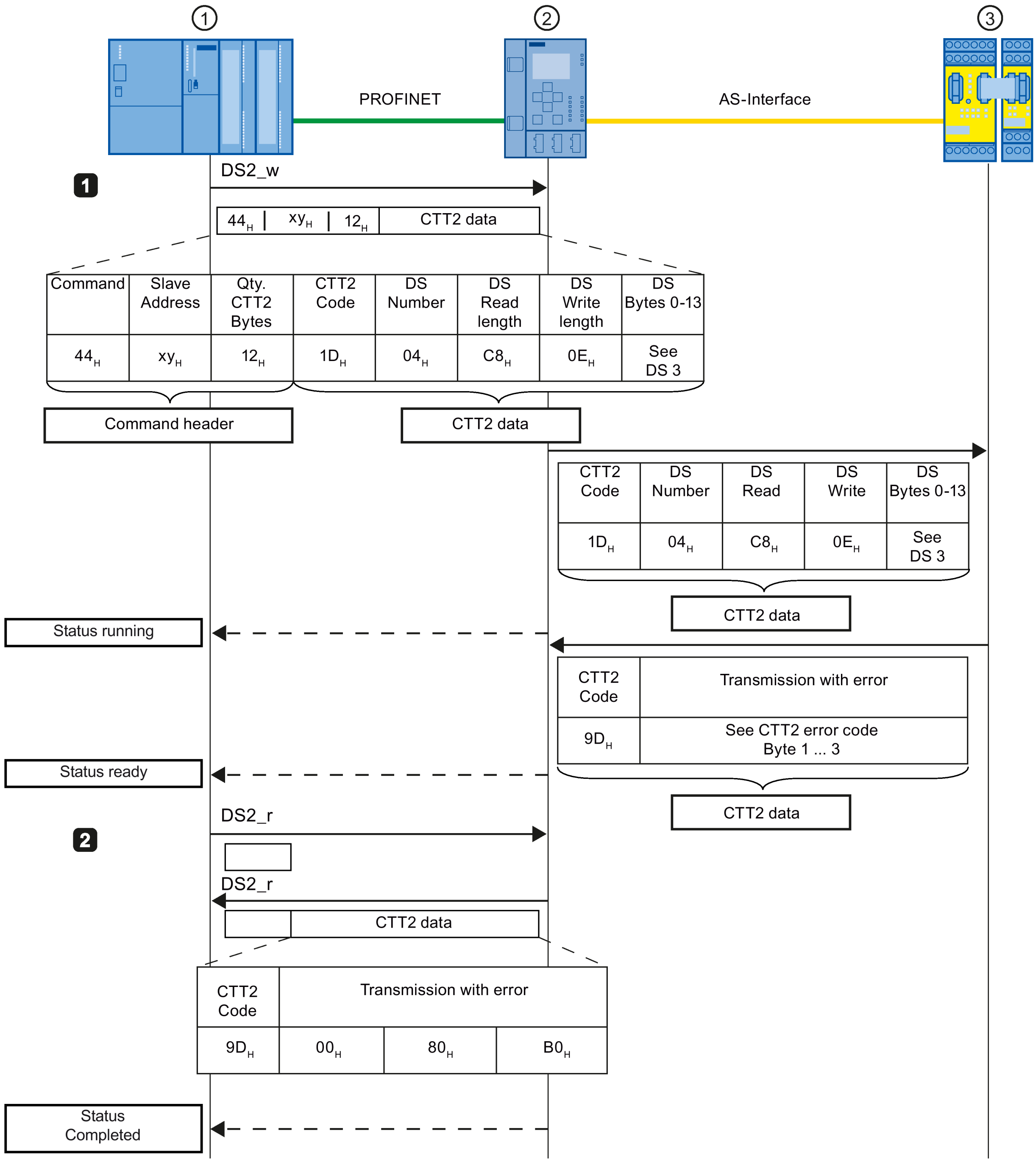
3. Example of transmission with error because of incorrect CTT2 code

The third example below demonstrates the writing of a data set using data set DS3 "Command interface: element accesses" when an unknown CTT2 code ($1E_H$) has been rejected:



① F-PLC
② AS-i master
③ MSS 3RK3 with AS-i interface
1 Write DS2
2 Read DS2

Figure 7-5 Example of transmission without error



① F-PLC

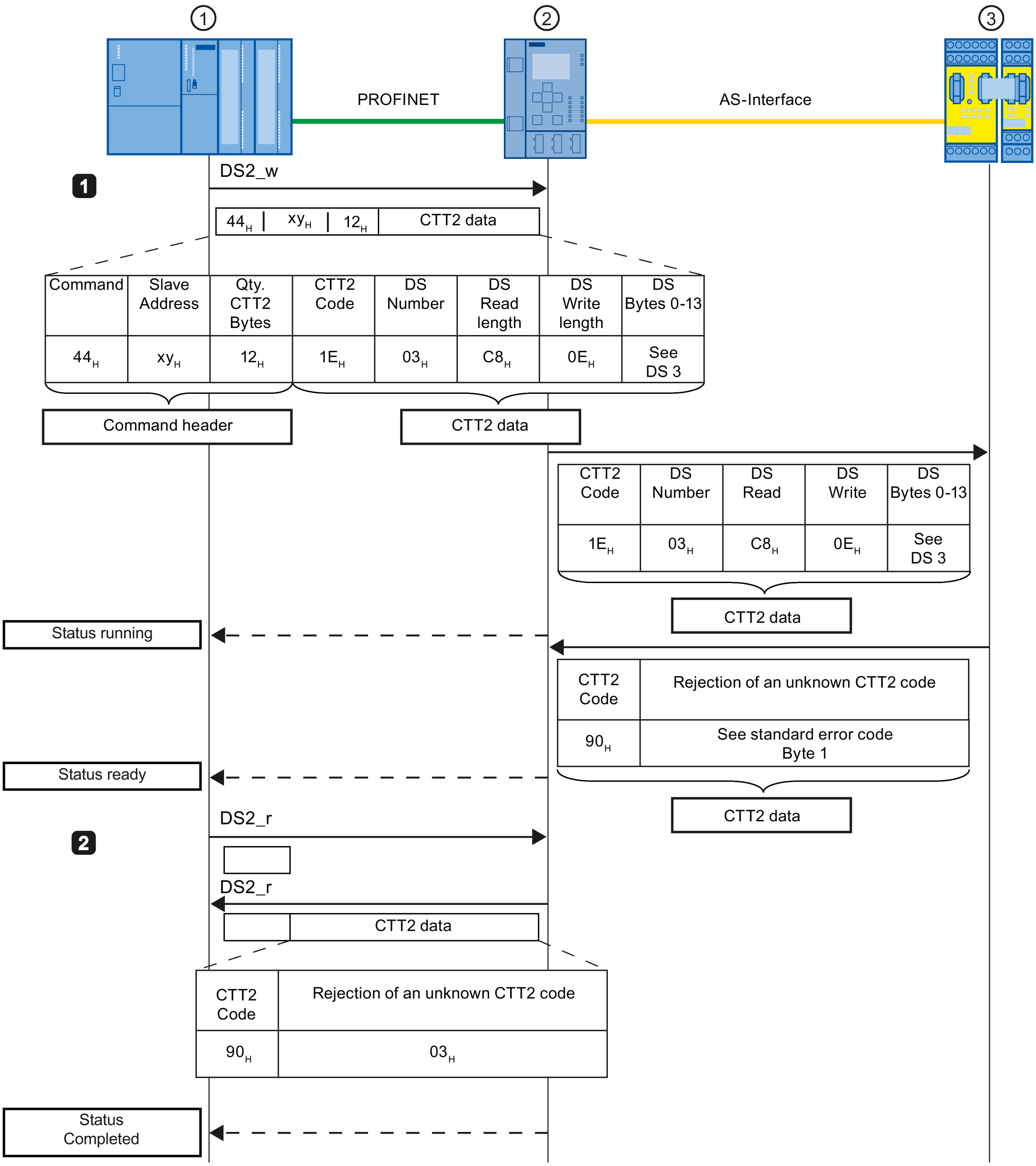
② AS-i master

③ MSS 3RK3 with AS-i interface

1 Write DS2

2 Read DS2

Figure 7-6 Example of transmission with error because of incorrect DS number



① F-PLC

② AS-i master

③ MSS 3RK3 with AS-i interface

1 Write DS2

2 Read DS2

Figure 7-7 Example of transmission with error because of incorrect CTT2 code

7.5.6 Structure of the transfer protocol

CTT2 codes and feedback messages (request/response)

The CTT2 slave supports the following CTT2 codes and feedback messages for transferring data sets:

Code	Meaning according to AS-i spec. V3.0	Followed by
144_{dec} (90_H)	Read response not OK	Standard error code
29_{dec} ($1D_H$)	Exchange request	index, read length, write length, write data
93_{dec} ($5D_H$)	Exchange request OK	read data
157_{dec} ($9D_H$)	Exchange request not OK	Standard error code, data set error code

index: Data set number; for MSS 3RK3 always 3

read length: expected returned data; $C8_H$

write length: length of the data to be written $0E_H$

write data: data to be transmitted, see Chapter "Diagnostics using the CTT2 protocol (Page 296)"

This CTT2 data structure is defined in the AS-i specification V3.0 and therefore has the same structure for all AS-i masters. The various manufacturers of AS-i masters use different mechanisms for transferring this CTT2 data to the master, however (command interface or comparable methods). Please refer to the user documentation for the AS-i master for detailed information on this.

The complete transmission protocol consists of the master-specific component of the protocol and the non-master-specific CTT2 data.

Acyclic CTT2 data transmission (code 29_{dec} ($1D_H$))

The acyclic CTT2 data transmission makes precise diagnostics of the individual elements possible. If an event is signaled through the cyclic diagnostics data, the cyclic CTT2 data transmission can be interrupted. The AS-i Master can read all messages of the elements with errors or a prewarning. The command is entered in DS3 to distinguish which error type is pending. You will find additional information in Chapter " Reading / writing data set 3 (Page 296)."

CTT2 code	Data set	Command	Byte
exchange 29_{dec}	DS3 - command interface "element accesses"	Elements with errors: Read messages	52_H
		Elements with prewarnings: Read messages	72_H

7.5.7 Error codes "CTT2 error code"

If a data set is transferred with an error or rejected by the MSS 3RK3, the negative acknowledgment is accompanied by an "error code" explaining the reason for the negative acknowledgment.

Byte 1	Byte 2	Byte 3
Standard error code	Data set error code	

Figure 7-8 Error code

Standard error code (CTT2 transmission error)

CTT2 error	Meaning
0	No error, pay attention to the data set error code
2	Impermissible length
3	Request not implemented

MSS 3RK3 data set error code

DS error	Error message	Possible causes	Remedial measures
0000_H	No error, pay attention to the standard error code		
$80B0_H$	Unknown data set number	• DS no. not supported by device	• None, since the device does not recognize this data set no.
$80B1_H$	Incorrect data set length when writing	• DS length ≠ specified DS length	• Change DS length to match specified length and send DS again
$80B4_H$	Incorrect data set length when reading	• DS length ≠ specified DS length	• Request DS with the correct length
$80B6_H$	Device has rejected data transfer	• Due to incorrect mode • Data set is read-only • Parameter change not permissible in current device/system operating mode	Check whether • The correct mode is set on the device for the data sent • A data set that can only be read is to be written • A parameter has been changed even though it may only be changed in a particular operating mode

DS error	Error message	Possible causes	Remedial measures
$80B7_H$	Invalid value range	• Value is not in the valid range	• Correct the value and transmit again.
$80B8_H$	Invalid parameter	• Incorrect/invalid parameter values were received	• Read out diagnosis DS 92 and ascertain the incorrect parameter using the "number of the parameter with error." • Change the parameter value to a valid one and resend.

7.5.8 Diagnostics using the CTT2 protocol

7.5.8.1 Reading / writing data set 3

Writing data set 03

The following table shows the structure of Writing data set 03:

Byte	Value	Explanation
0 ... 3	21_H / 00_H / 00_H / 00_H	Data set header
4 ... 5	$0A_H$ / 00_H	Data structure length
6 ... 7	00_H / 00_H	Start position
8 ... 9	00_H / 00_H	Data structure CRC
10	Command	• 51_H: The messages of the elements with errors are read • 71_H: The messages of the elements with prewarnings are read
11 ... 12	Fix 00_H	All elements that have a message are read.
13	Reserved = 0	

Reading data set 03

The following table shows the structure of Reading data set 03:

Byte	Value	Explanation
0 ... 3	00_H / 00_H / 00_H / 00_H	Data set header
4 ... 5	Variable	Data structure length
6 ... 7	00_H / 00_H	Start position
8 ... 9	CRC	Data structure CRC
10 ... 11	Number of the elements with a message	Number of elements with an error or a prewarning, depending on what was requested.
12 - x	1. Element data block	Net (useful) data: The structure of the element data blocks is written in Chapter "Structure of the element data blocks (Page 297)."
x+1 to x+y	2. Element data block	

7.5.8.2 Structure of the element data blocks

The following table shows the structure of the element data block:

Byte	Value	Explanation
Data block header		
0 ... 1	Element data block length	The length of the element data block, including the data block header
2 … 3	Element number	The element number is assigned by the Safety ES according to the configuration sequence.
4 … 5	Function element	This object contains a number that uniquely identifies the function element, see Table below.
Useful data		
6	Data 1	Net (useful) data: All pending messages about the element are entered here.
7 to 5+x-1	Data 2 to x-1	
5+x	Data x	

Number		Function element
Decimal	Hexadecimal	
4001	$0FA1_H$	Monitoring Universal
4010	$0FAA_H$	EMERGENCY STOP
4020	$0FB4_H$	ESPE
4030	$0FBE_H$	Protective door
4031	$0FBF_H$	Protective door with lock
4040	$0FC8_H$	Safety shutdown mat with NC principle
4041	$0FC9_H$	Safety shutdown mat with cross-circuit principle
4050	$0FD2_H$	Two-hand operation
4060	$0FDC_H$	Acknowledgment button
4070	$0FE6_H$	Mode selector switch
12540	$30FC_H$	Counter functions
12550	3106_H	Timer functions
12560	3110_H	Start functions
13002	$32CA_H$	Muting functions
16501	4075_H	Switching output
17002	$426A_H$	AS-i 1...4F-DO

7.5.8.3 Element messages

Messages for Monitoring Universal

The following table shows the messages with the associated byte arrangement in the element data block of the "Monitoring Universal" function element.

Byte position	Message	Meaning	Element status	Cyclic data
6^0	Startup test required	This message is set in a parameterized startup test on each restart and each time the substitute value is changed to a real value until the connected sensor is actuated at least once. After the sensor has been operated correctly this message is automatically reset.	SVW	SVW
6^1	Sequence condition not fulfilled	The sequence condition was not fulfilled in accordance with the parameter assignment. This message is automatically reset if a correct sequence / the value "0" is detected at all function inputs monitored.	Logic error	SF
6^2	Discrepancy condition violated	is set if: • After the discrepancy time has elapsed, the signal states at the inputs monitored are different • The signal states of the inputs monitored had not all previously been reset simultaneously to the value "0" when they are set to "1"	Logic error	SF
6^3	Safety sensor triggered	The safety sensor has been actuated. This message is automatically reset if the value "1" is pending at all function inputs IN1 ... 4 monitored.	SVW	SVW
6^4 ... 6^7	Reserved=0			
7^0	Cross-circuit at input 1	A cross-circuit was detected at input 1.	Wiring error	SF
7^1 ... 7^3	Reserved=0			
7^4	Cross-circuit at input 2	A cross-circuit was detected at input 2.	Wiring error	SF
7^5 ... 7^7	Reserved=0			
8^0	Start signal duration invalid	Only with start type "Monitored start": The start signal time monitoring element detected a violation.	--	-

Byte position	Message	Meaning	Element status	Cyclic data
8^1	Start condition not fulfilled	is set if: • A sensor test was not executed in the case of an active startup test function • A discrepancy condition violation is present • The value "1" is not present simultaneously at all available (parameterized) function inputs (IN1, ...) • A signal sequence violation is present • A cross-circuit is present in the case of cross-circuit monitoring	-	-
8^2 ... 8^7	Reserved=0			

EMERGENCY STOP messages

The following table shows the messages with the associated byte arrangement in the element data block of the "EMERGENCY STOP" function element.

Byte position	Message	Meaning	Element status	Cyclic data
0^0	Startup test required	This message is set in a parameterized startup test on each restart and each time the substitute value is changed to a real value until the connected sensor is actuated at least once.	SVW	SVW
0^1	Reserved=0			
0^2	Discrepancy condition violated	is set if: • After the discrepancy time has elapsed, the signal states at the inputs monitored are different • The signal states of the inputs monitored had not all previously been reset simultaneously to the value "0" when they are set to "1"	Logic error	SF
0^3	Safety sensor triggered	The safety sensor has been actuated.	SVW	SVW
0^4 ... 0^7	Reserved=0			
1^0	Cross-circuit at input 1	A cross-circuit was detected at input 1.	Wiring error	SF
1^1 ... 1^3	Reserved=0			
1^4	Cross-circuit at input 2	A cross-circuit was detected at input 2.	Wiring error	SF
1^5 ... 1^7	Reserved=0			
2^0	Start signal duration invalid	Only with start type "Monitored start": The start signal time monitoring element detected a violation.	-	-
2^1	Start condition not fulfilled	is set if: • A sensor test was not executed in the case of an active startup test function • A discrepancy condition violation is present • The value "1" is not present simultaneously at all available (parameterized) function inputs (IN1, ...) • A cross-circuit is present in the case of cross-circuit monitoring	-	-
2^2 ... 2^7	Reserved=0			

Messages for ESPE

The following table shows the messages with the associated byte arrangement in the element data block of the "ESPE" function element.

Byte position	Message	Meaning	Element status	Cyclic data
6^0	Startup test required	This message is set in a parameterized startup test on each restart and each time the substitute value is changed to a real value until the connected sensor is actuated at least once.	SVW	SVW
6^1	Reserved = 0			
6^2	Discrepancy condition violated	is set if: • The signal states of the inputs monitored had not all previously been reset simultaneously to the value "0" when they are set to "1"	Logic error	SF
6^3	Safety sensor triggered	The safety sensor has been actuated.	SVW	SVW
6^4 ... 6^7	Reserved=0			
7^0	Cross-circuit at input 1	A cross-circuit was detected at input 1.	Wiring error	SF
7^1 ... 7^3	Reserved=0			
7^4	Cross-circuit at input 2	A cross-circuit was detected at input 2.	Wiring error	SF
7^5 ... 7^7	Reserved=0			
8^0	Start signal duration invalid	Only with start type "Monitored start": The start signal time monitoring element detected a violation.	-	-
8^1	Start condition not fulfilled	is set if: • A sensor test was not executed in the case of an active startup test function • A discrepancy condition violation is present • The value "1" is not present simultaneously at all available (parameterized) function inputs (IN1, ...) • A cross-circuit is present in the case of cross-circuit monitoring	-	-
8^2 ... 8^7	Reserved=0			

Messages for protective door

The following table shows the messages with the associated byte arrangement in the element data block of the "protective door" function element.

Byte position	Message	Meaning	Element status	Cyclic data
6^0	Startup test required	This message is set in a parameterized startup test on each restart and each time the substitute value is changed to a real value until the connected sensor is actuated at least once.	SVW	SVW
6^1	Sequence condition not fulfilled	The sequence condition was not fulfilled in accordance with the parameter assignment.	Logic error	SF
6^2	Discrepancy condition violated	is set if: • After the discrepancy time has elapsed, the signal states at the inputs monitored are different • The signal states of the inputs monitored had not all previously been reset simultaneously to the value "0" when they are set to "1"	Logic error	SF
6^3	Safety sensor triggered	The safety sensor has been actuated.	SVW	SVW
6^4 ... 6^7	Reserved=0			
7^0	Cross-circuit at input 1	A cross-circuit was detected at input 1.	Wiring error	SF
7^1 ... 7^3	Reserved=0			
7^4	Cross-circuit at input 2	A cross-circuit was detected at input 2.	Wiring error	SF
7^5 ... 7^7	Reserved=0			
8^0	Start signal duration invalid	Only with start type "Monitored start": The start signal time monitoring element detected a violation.	-	-
8^1	Start condition not fulfilled	is set if: • A sensor test was not executed in the case of an active startup test function • A discrepancy condition violation is present • The value "1" is not present simultaneously at all available (parameterized) function inputs (IN1, ...) • A signal sequence violation is present • A cross-circuit is present in the case of cross-circuit monitoring	-	-
8^2 ... 8^7	Reserved=0			

Message for protective door with lock

The following table shows the messages with the associated byte arrangement in the element data block of the "protective door with lock" function element.

Byte position	Message	Meaning	Element status	Cyclic data
6^0	Startup test required	This message is set in a parameterized startup test on each restart and each time the substitute value is changed to a real value until the connected sensor is actuated at least once.	SVW	SVW
6^1	Sequence condition not fulfilled	The sequence condition was not fulfilled in accordance with the parameter assignment.	Logic error	SF
6^2	Discrepancy condition violated	is set if: • After the discrepancy time has elapsed, the signal states at the inputs monitored are different • The signal states of the inputs monitored had not all previously been reset simultaneously to the value "0" when they are set to "1"	Logic error	SF
6^3	Safety sensor triggered	The safety sensor has been actuated.	SVW	SVW
6^4	Protective door closed	The protective door is closed.	-	-
6^5	Reserved=0			
6^6	Lock engaged	The lock is engaged.	-	-
6^7	Lock released	The lock is released.	-	-
7^0	Cross-circuit at input 1	A cross-circuit was detected at input 1.	Wiring error	SF
7^1 ... 7^3	Reserved=0			
7^4	Cross-circuit at input 2	A cross-circuit was detected at input 2.	Wiring error	SF
7^5 ... 7^7	Reserved=0			
8^0	Start signal duration invalid	Only with start type "Monitored start": The start signal time monitoring element detected a violation.	-	-
8^1	Start condition not fulfilled	is set if: • A sensor test was not executed in the case of an active startup test function • A discrepancy condition violation is present • The value "1" is not present simultaneously at all available (parameterized) function inputs (IN1, ...) • A signal sequence violation is present • A cross-circuit is present in the case of cross-circuit monitoring	-	-

Byte position	Message	Meaning	Element status	Cyclic data
8^2	Start override active	The start override time is running.	-	-
8^3 ... 9^3	Reserved=0			
9^4	Feedback circuit signal and switching status do not match	The feedback circuit signal does not match the interlock status	Wiring error	SF
9^5	Protective door opened when lock was active	The protective door opened when lock was active.	Wiring error	SF
9^6	Locking not possible be-cause the protective door is open	Locking not possible because the protective door is open.	Logic error	SF
9^7	Reserved=0			

Messages for safety shutdown mat (NC principle)

The following table shows the messages with the associated byte arrangement in the element data block of the "safety shutdown mat with NC principle" function element.

Byte position	Message	Meaning	Element status	Cyclic data
6^0	Startup test required	This message is set in a parameterized startup test on each restart and each time the substitute value is changed to a real value until the connected sensor is actuated at least once.	SVW	SVW
6^1	Reserved = 0			
6^2	Discrepancy condition violated	is set if: • The signal states of the inputs monitored had not all previously been reset simultaneously to the value "0" when they are set to "1"	Logic error	SF
6^3	Safety sensor triggered	The safety sensor has been actuated.	SVW	SVW
6^4 ... 6^7	Reserved=0			
7^0	Cross-circuit at input 1	A cross-circuit was detected at input 1.	Wiring error	SF
7^1 ... 7^3	Reserved=0			
7^4	Cross-circuit at input 2	A cross-circuit was detected at input 2.	Wiring error	SF
7^5 ... 7^7	Reserved=0			
8^0	Start signal duration invalid	Only with start type "Monitored start": The start signal time monitoring element detected a violation.	-	-
8^1	Start condition not fulfilled	is set if: • A sensor test was not executed in the case of an active startup test function • A discrepancy condition violation is present • The value "1" is not present simultaneously at all available (parameterized) function inputs (IN1, ...) • A cross-circuit is present in the case of cross-circuit monitoring	-	-
8^2 ... 8^7	Reserved=0			

Messages for safety shutdown mat (cross-circuit principle)

The following table shows the messages with the associated byte arrangement in the element data block of the "safety shutdown mat with cross-circuit principle" function element.

Byte position	Message	Meaning	Element status	Cyclic data
6^0	Startup test required	This message is set in a parameterized startup test on each restart and each time the substitute value is changed to a real value until the connected sensor is actuated at least once.	SVW	SVW
6^1 ... 6^2	Reserved=0			
6^3	Safety sensor triggered	The safety sensor has been actuated.	SVW	SVW
6^4 ... 6^7	Reserved=0			
7^0	Wire break at input 1	A cross-circuit was detected at input 1.	Wiring error	SF
7^1	Short circuit to P at input 1	A short-circuit to P was detected at input 1.	Wiring error	SF
7^2 ... 7^3	Reserved=0			
7^4	Wire break at input 2	A cross-circuit was detected at input 2.	Wiring error	SF
7^5	Short circuit to P at input 2	A short-circuit to P was detected at input 2.	Wiring error	SF
7^6 ... 7^7	Reserved=0			
8^0	Start signal duration invalid	Only with start type "Monitored start": The start signal time monitoring element detected a violation.	-	-
8^1	Start condition not fulfilled	is set if: • A sensor test was not executed in the case of an active startup test function • The value "1" is not present simultaneously at all available (parameterized) function inputs (IN1, ...) • A cross-circuit is present	-	-
8^2 ... 8^7	Reserved=0			

Messages for two-hand operation

The following table shows the messages with the associated byte arrangement in the element data block of the "two-hand operation" function element.

Byte position	Message	Meaning	Element status	Cyclic data
$6^0 \ldots 6^1$	Reserved=0			
6^2	Discrepancy condition violated	is set if: • After the discrepancy time has elapsed, the signal states at the inputs monitored are different within one or between to two pushbuttons. • The signal states of the inputs monitored had not all previously been reset simultaneously to the value "0" when they are set to "1"	Logic error	SF
6^3	Bushbutton stuck	The pushbutton is stuck.	Logic error	SF
6^4	Do not release both pushbuttons	The two pushbuttons were not released simultaneously.	Logic error	SF
$6^5 \ldots 6^7$	Reserved=0			
7^0	Cross-circuit at input 1	A cross-circuit was detected at input 1.	Wiring error	SF
$7^1 \ldots 7^3$	Reserved=0			
7^4	Cross-circuit at input 2	A cross-circuit was detected at input 2.	Wiring error	SF
$7^5 \ldots 8^0$	Reserved=0			
8^1	Start condition not fulfilled	is set if: • If both pushbuttons were not pressed "synchronously," that is, they were pressed with a time offset greater than 0.5 s • A discrepancy condition violation is present • The value "1" is not present simultaneously at IN1 ... 2 / 4 • A cross-circuit is present	-	-
$8^2 \ldots 8^7$	Reserved=0			
9^0	Cross-circuit at input 3	A cross-circuit was detected at input 3.	Wiring error	SF
$9^1 \ldots 9^3$	Reserved=0			
9^4	Cross-circuit at input 4	A cross-circuit was detected at input 4.	Wiring error	SF
$9^5 \ldots 9^7$	Reserved=0			

Messages for enabling button

The following table shows the messages with the associated byte arrangement in the element data block of the "enabling button" function element.

Byte position	Message	Meaning	Element status	Cyclic data
6^0 ... 6^1	Reserved=0			
6^2	Discrepancy condition violated	is set if: The signal states of the inputs monitored had not all previously been reset simultaneously to the value "0" when they are set to "1"	Logic error	SF
6^3	Bushbutton stuck	One pushbutton on the operating console is stuck.	Logic error	SF
6^4	Enabling button OFF	The enabling button has the status OFF.	-	-
6^5	Enabling button ON	The enabling button has the status ON.	-	-
6^6 ... 6^7	Reserved=0			
7^0	Cross-circuit at input 1	A cross-circuit was detected at input 1.	Wiring error	SF
7^1 ... 7^3	Reserved=0			
7^4	Cross-circuit at input 2	A cross-circuit was detected at input 2.	Wiring error	SF
7^5 ... 8^0	Reserved=0			
8^1	Start condition not fulfilled	is set if: • A discrepancy condition violation is present • The value "1" is not present simultaneously at all available (parameterized) function inputs (IN1, ...) • A cross-circuit is present	-	-
8^2 ... 8^7	Reserved=0			

Messages for mode selector switch

The following table shows the messages with the associated byte arrangement in the element data block of the "mode selector switch" function element.

Byte position	Message	Meaning	Element status	Cyclic data
6^0	Reserved=0			
6^1	Switchover time exceeded	The "1 out of 2...5 selection monitoring" has detected the value "0" at all inputs after the contact switchover time has elapsed.	-	-
6^2	Invalid operating mode selection	The "1 out of 2...5 selection monitoring" has detected after the contact switchover time has elapsed: The value "1" is present at more than one input.	Wiring error	SF
6^3 ... 8^7	Reserved=0			

Messages for the muting functions

The following table shows the messages with the associated byte arrangement in the element data block of the "muting" function element.

Byte position	Message	Meaning	Element status	Cyclic data
6^0	Muting operation active	Muting mode is activated.	-	-
6^1	Muting operation not active	Muting mode is not activated.	-	-
6^2	Muting restart possible	Muting mode was not terminated correctly, i.e. at least one muting sensor is still being triggered.	-	-
6^3	Restart signal duration invalid	The "Muting restart possible" message is set and, the first time the RESTART button is pressed, the expected operating sequence does not follow.	-	-
6^4	Protective field not free	The value "0" is present at the "FREE" function input.	-	-
6^5	System not running	The value "1" is present at the "STOP" function input.	-	-
6^6	Start muting condition not met	Not all conditions for operational starting of muting using muting sensors are met.	-	-
6^7	Max. muting time exceeded	Muting operation terminated because "max. muting time" expired.	Logic error	SF
7^0	Discrepancy condition sensor pair 1 violated	A discrepancy violation was detected in the signals of muting sensor pair 1.	Logic error	SF
7^1	Discrepancy condition sensor pair 2 violated	A discrepancy violation was detected in the signals of muting sensor pair 2.	Logic error	SF
7^2	Sequence condition not fulfilled	The sequence condition was not observed.	Logic error	SF
7^3	Reserved=0			
7^4	Muting display lamp defective	The muting display lamp - monitoring function has detected an error.	Wiring error	SF
7^5 ... 7^7	Reserved=0			

Messages for output functions

The following table shows the messages with the associated byte arrangement in the element data block of the "switching output" function element.

Byte position	Message	Meaning	Element status	Cyclic data
6^0	Output 1 active	Function output 1 is switched on.	-	-
6^1 ... 6^2	Reserved=0			
6^3	Output 2 active	Function output 2 is switched on.	-	-
6^4 ... 6^5	Reserved=0			
6^6	Feedback circuit signal and switching status do not match	The message at the feedback circuit input does not match the switching status of the function outputs. The output function immediately deactivates all its outputs in case of inconsistencies.	Wiring error	SF
6^7 ... 7^2	Reserved=0			
7^3	Start condition not fulfilled	is set if: • there is a feedback circuit error when feedback circuit monitoring is activated. • the value "0" is pending at the function input (IN).	-	-
7^4 ... 7^6	Reserved=0			
7^7	Start signal duration invalid	Only with start type "Monitored start": The start signal time monitoring element detected a violation.	-	-

Messages for AS-i 1..4F-DO

The following table shows the messages with the associated byte arrangement in the element data block of the "AS-i 1...4F-DO" function element.

Byte position	Message	Meaning	Element status	Cyclic data
6^0	Output 1 active	Function output 1 is switched on.	-	-
6^1	Output 2 active	Function output 2 is switched on.	-	-
6^2	Output 3 active	Function output 3 is switched on.	-	-
6^3	Output 4 active	Function output 4 is switched on.	-	-
6^4	Feedback circuit signal 1 and switching status do not match	The signal at feedback circuit input 1 and the switching status of function output 1 do not match. In case of inconsistencies, the output function immediately switches off all its outputs.	Wiring error	SF
6^5	Feedback circuit signal 2 and switching status do not match	The signal at feedback circuit input 2 and the switching status of function output 2 do not match. In case of inconsistencies, the output function immediately switches off all its outputs.	Wiring error	SF
6^6	Feedback circuit signal 3 and switching status do not match	The signal at feedback circuit input 3 and the switching status of function output 3 do not match. In case of inconsistencies, the output function immediately switches off all its outputs.	Wiring error	SF
6^7	Feedback circuit signal 4 and switching status do not match	The signal at feedback circuit input 4 and the switching status of function output 4 do not match. In case of inconsistencies, the output function immediately switches off all its outputs.	Wiring error	SF
7^0	Invalid output selection	The value "1" was detected on more than one input IN1 ... 4 by the "1 out of 4 - selection monitoring."	Logic error	SF
7^1 ... 7^2	Reserved=0			
7^3	Start condition not fulfilled	is set if: • there is a feedback circuit error when feedback circuit monitoring is active. • the logic error "Invalid output selection" is pending. • The value "1" is not present simultaneously at all available (parameterized) function inputs (IN1, ...).	-	-
7^4	Auxiliary control signal 1 transmitted*	Auxiliary control signal 1 was transmitted with value "1."	-	-
7^5	Auxiliary control signal 2 transmitted*	Auxiliary control signal 2 was transmitted with value "2."	-	-
7^6	Reserved=0			
7^7	Start signal duration invalid	Only with start type "Monitored start": The start signal time monitoring element detected a violation.	-	-

* The message is active if the auxiliary signal has been transmitted and a "1" is present at the corresponding auxiliary signal input of the element.

7.5.8.4 Element status

The following table explains each element status with the associated byte position element data block:

Byte position	Message	Meaning / Remedy	DS 92
6^0	At least one function output active	At least one function output is active.	-
6^1	Function element ready and waiting for a start signal	The function element is ready and is waiting for a start signal.	-
6^2	Timer is active	Is set if at least one of the timers identified with the clock icon is running. The input delay time is an exception to this because this timer is always active.	-
6^3	Function element waiting for startup test	A startup test is required for the corresponding function element. Read the element messages.	-
6^4	Logic error	At least one logic error is pending, e.g.: • Discrepancy error • Sequence error Read the element messages.	Logic error
6^5	Wiring error	At least one wiring error is pending, e.g.: • Cross-circuit fault Read the element messages.	Wiring error
6^6 ... 6^7	Reserved=0		
7^0	(Element) group error	There is at least one error message among the element messages. Read the element messages.	SF from user program
7^1	(Element) group warning	There is at least one warning message among the element messages. Read the element messages.	SW from user program
7^2	(Element) group prewarning	There is at least one prewarning message among the element messages. Read the element messages.	SVW from user program
7^3 ... 7^4	Reserved=0		
7^5	Substitute input value active	At least one input terminal has failed, e.g. because of: • Module / terminal is missing / defective • Module / terminal is incorrectly configured • Code sequence error • Missing code table If an element has multiple input terminals, work continues with the substitute value for the failed terminal only. The real value is used for all the other input terminals. Read the element messages.	-
7^6 ... 7^7	reserved		
8^0 to x^7	reserved		

7.6 Diagnostics with diagnostics display

7.6.1 Diagnostics display

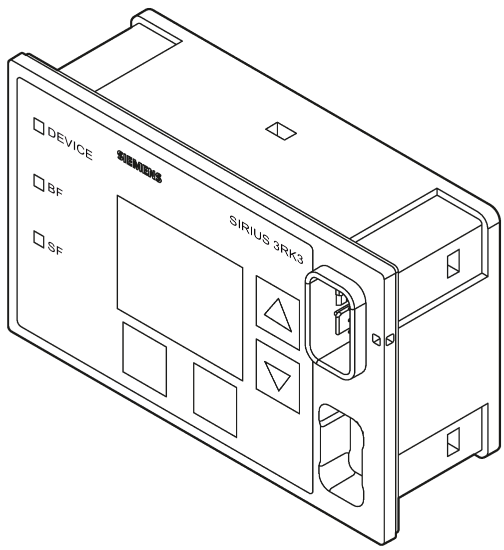


Figure 7-9 Diagnostics display

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

These 3SK2 safety relays are supported by the diagnostics display from product version E04 and firmware version V1.2.x and higher.

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

These 3RK3 central units are supported by the diagnostics display with product version E03 and firmware version V1.1.x and higher.

MSS 3RK3 Basic

MSS 3RK3 Basic is supported by the diagnostics display with product version E01 and higher.

Note

Communication via PROFIBUS and diagnostics display

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

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.

[1)] The firmware version can be read at the startup of the display or at the bottom left when the display is disabled. In addition, it is shown by selecting menu command "Display settings / Identification". (see also Section "Display settings (Page 331)")

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).

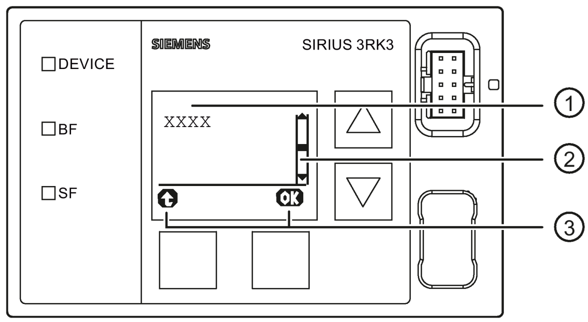
NOTICE
Damage to property
The diagnostics display must only be removed or connected when the system is de-energized.

"Park position" for cover

The cover can be "parked" on the front of the diagnostics display under the system interface.

7.6.2 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)

7.6.3 Operator controls and displays on the diagnostics display

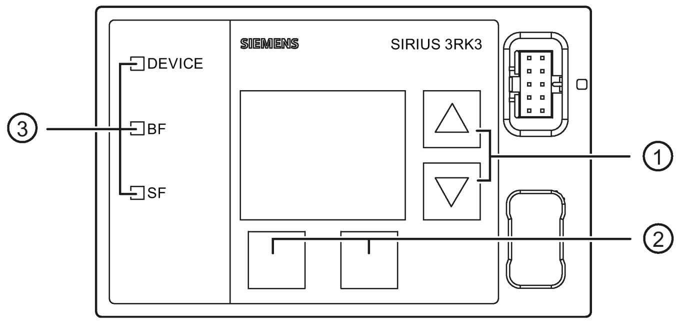


Figure 7-10 Display and operating elements on the diagnostics display

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 "Displays on diagnostic display (Page 252)".

7.6.4 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).

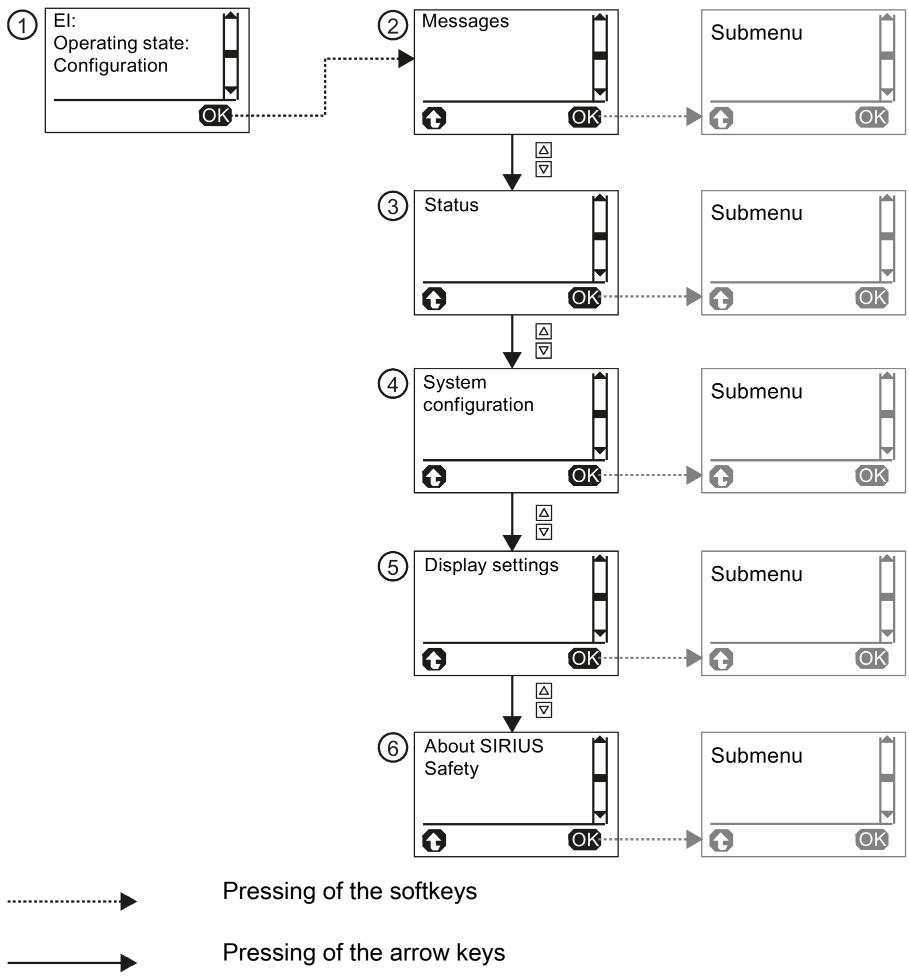


Figure 7-11 First level of the menu of the diagnostics display

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 320)"

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 324)"

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 328)"

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 331)"

About SIRIUS Safety ⑥

The menu option "About SIRIUS Safety" provides more information on the safety relay.

7.6.4.1 Messages

The "Messages" menu option provides an overview of all current pending error messages and warnings for the entire system.

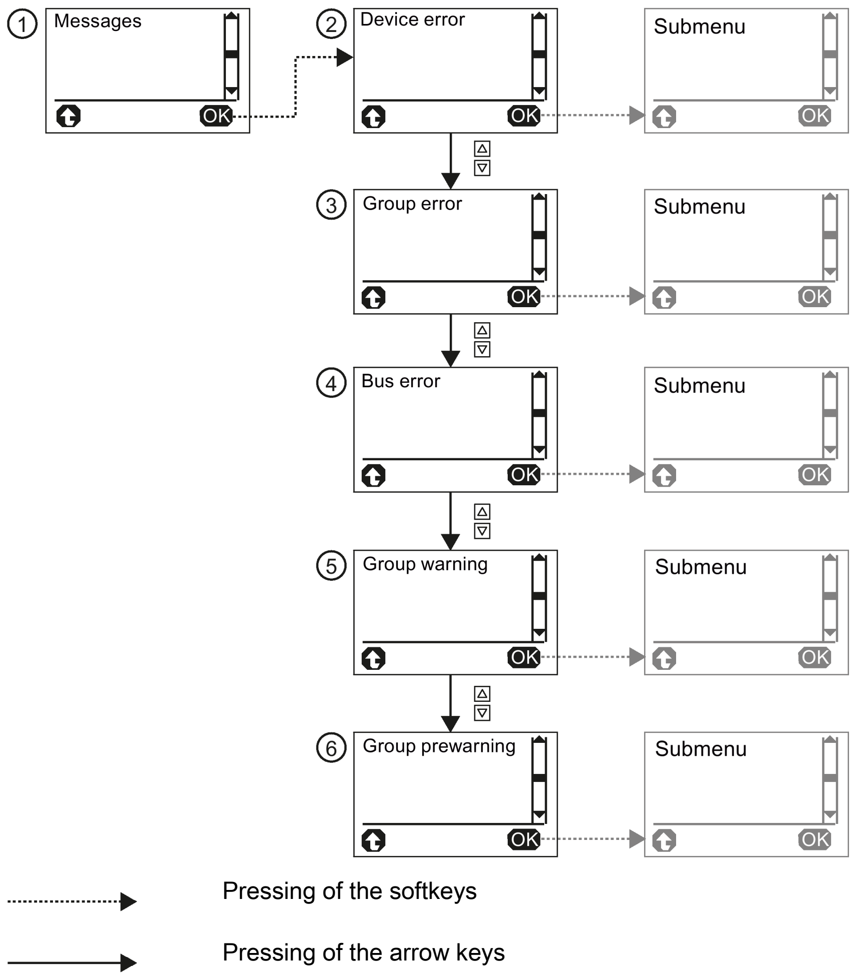


Figure 7-12 Second level of the menu of the diagnostics display - "Messages" menu option

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 • 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	• Multiple ASIsafe code tables • ASIsafe 8x4-bit code sequence error • ASIsafe 7x4-bit code sequence error
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	Communication via the device bus interface is interrupted.
SC configuration error	The actual configuration of an existing communication connection does not match the target configuration. This resulted in an error.
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.

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	Communication via the AS-i interface is interrupted.
ASi parameterization error	An error occurred during parameterization for an existing communication connection.
ASi configuration error	The actual configuration of an existing communication connection does not match the target configuration. This resulted in an error.
SC bus error	Communication via the device bus interface is interrupted.
SC parameterization error	An error occurred during parameter assignment for an existing communication connection.
SC configuration error	The actual configuration of an existing communication connection does not match the target configuration. This resulted in an error.

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.

7.6.4.2 Status

Selection of the individual functions

The status display makes a distinction between input elements ②, output elements ③, and other elements ④.

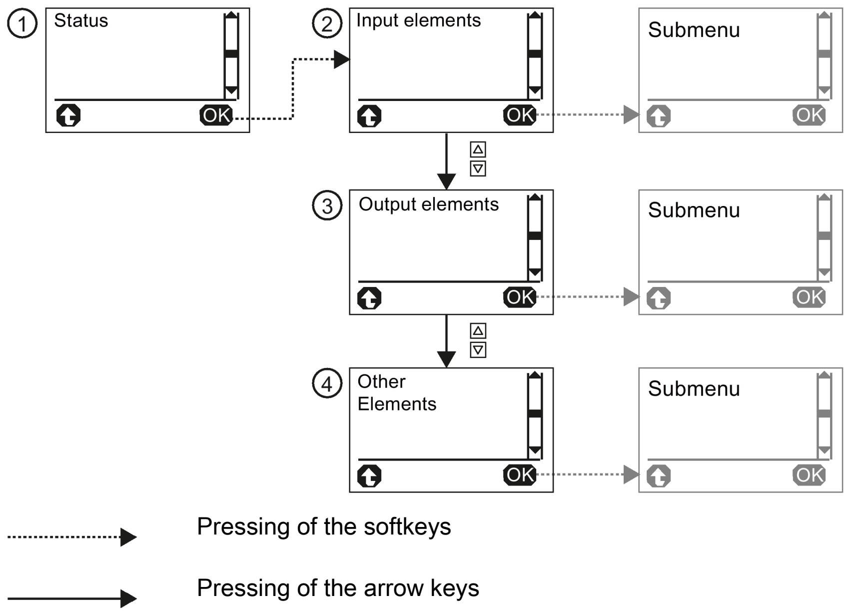


Figure 7-13 Second level of the menu of the diagnostics display - "Status" menu option

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

7.6.4.3 System configuration

Structure of the menu

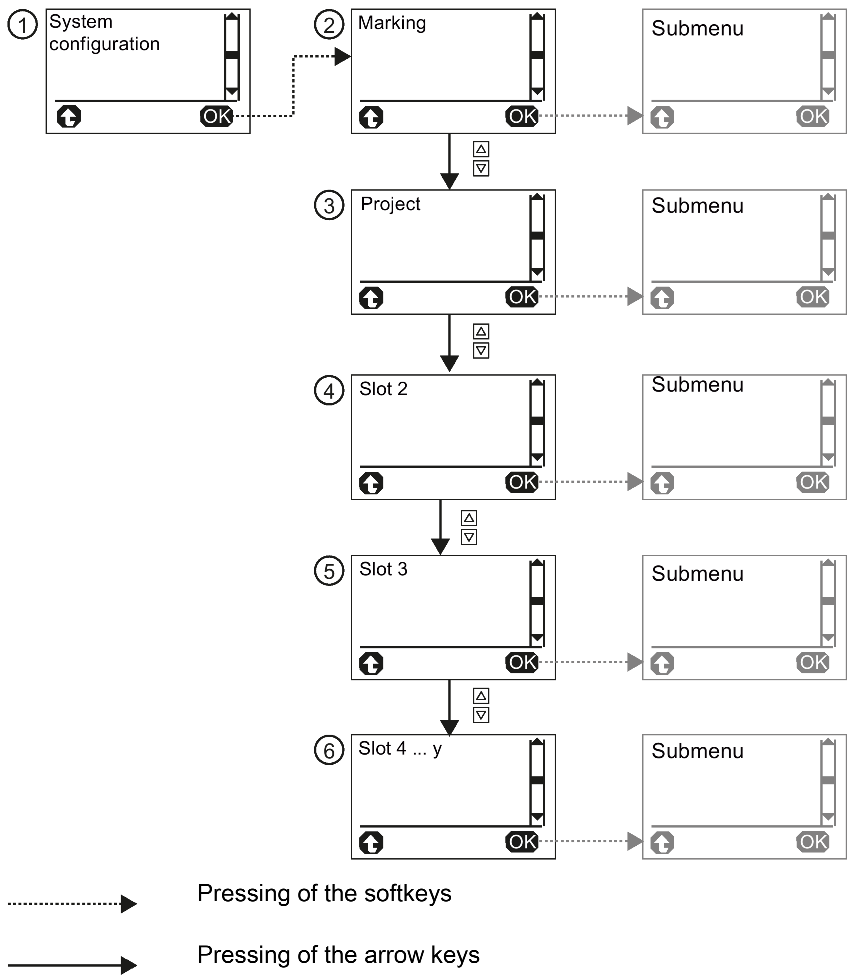


Figure 7-14 Second level of the menu of the diagnostics display - "System configuration" menu option

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

7.6.4.4 Display settings

All settings affecting the diagnostics display can be made via the display settings.

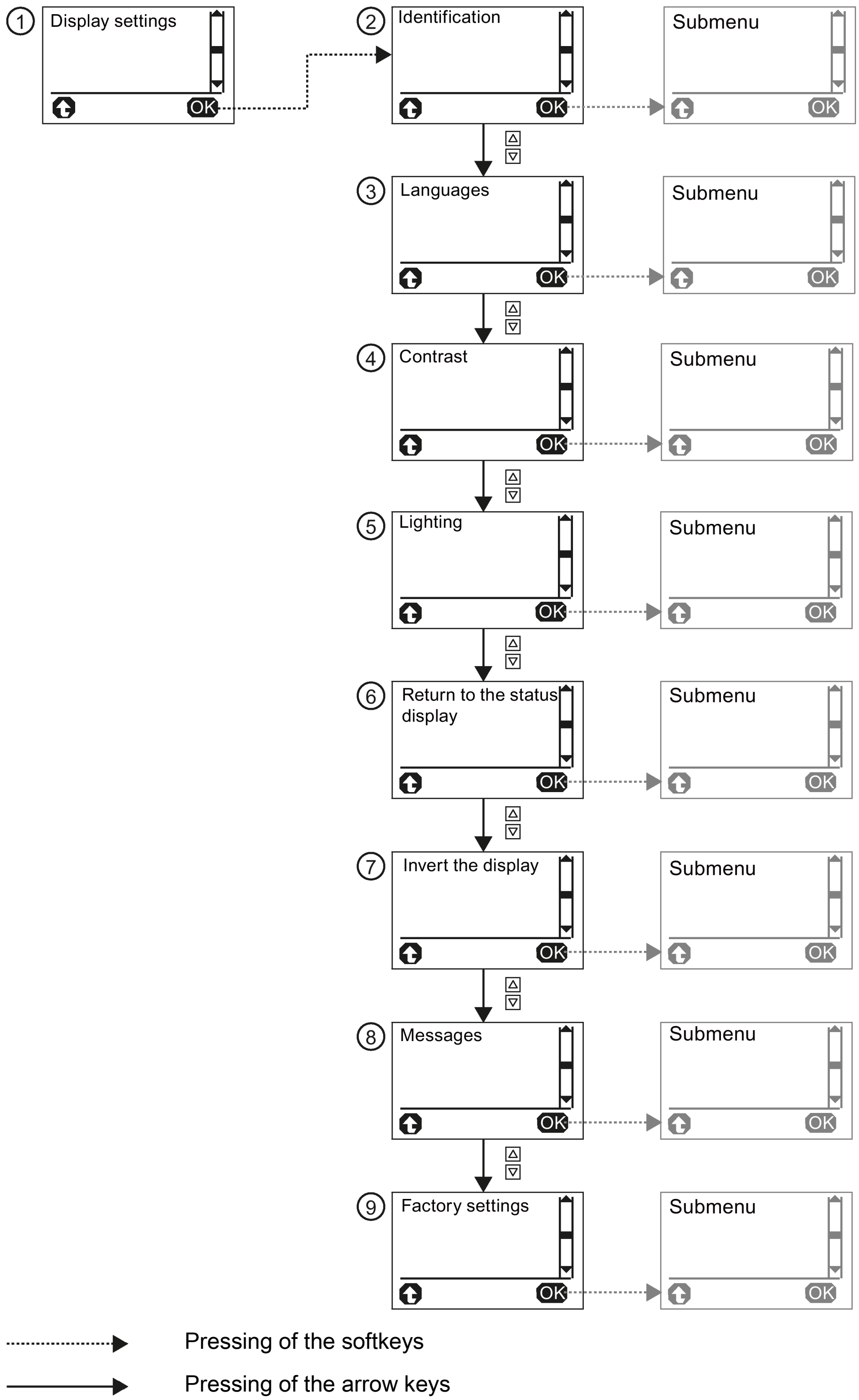


Figure 7-15 Second level of the menu of the diagnostics display - "Display settings" menu option

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).

7.7 Restoring factory settings

Procedure

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 3RK3 central unit automatically restarts and switches to configuring mode.

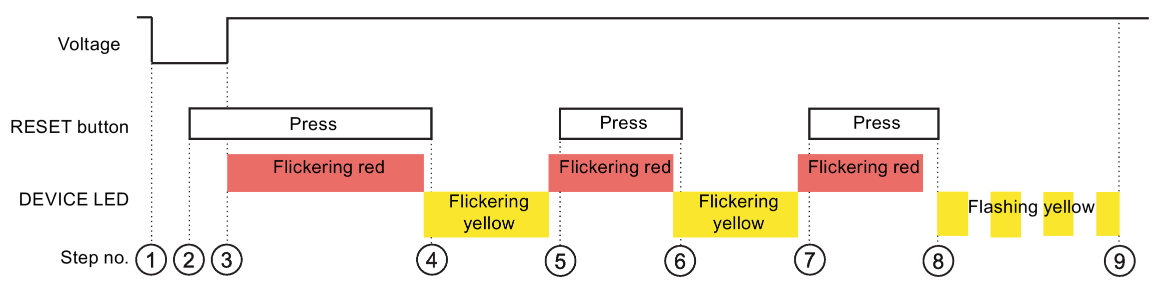


Figure 7-16 Factory settings

Result

When the factory settings are restored, all the LEDs on the inputs and outputs light up.

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

- All configuring information in the internal memory of the 3RK3 central unit is deleted.
- If the external memory module is plugged in, all the existing data is deleted.
- The DP address is deleted and set to DP address 126.
- For 3RK3 central units with AS-i interface, the saved code sequence table is also deleted.

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 Chapter "Display settings (Page 331)."

Note

Factory settings for DP interface

The factory settings for the DP interface can also be restored; see Chapter "Restoring factory settings (Page 187)."

7.8 Module 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 Damage to Property.

Before starting work, therefore, disconnect the system and devices from the power supply.

WARNING

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

When replacing a module, you do not need to re-wire it. The terminal blocks can be disconnected from the defective module and then connected to the new module.

Replacing the central unit

Note

Data loss

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

1. Disconnect the defective 3RK3 central unit.
2. Remove the defective 3RK3 central unit.
3. Remove the memory module with the device configuration.
4. Install the new 3RK3 central unit.
5. Connect the module.
6. Insert the memory module with the existing configuration data.

Note

Do not connect a memory module with released configuration to a 3RK3 central unit of another type.

The released configuration on the memory module depends on the 3RK3 central unit. For example, the configuration released on an MSS 3RK3 Basic cannot be interpreted by an MSS 3RK3 Advanced, or vice versa. The same applies to all other 3RK3 central units. When the memory module is plugged into a 3RK3 central unit of another type, the configuration release is canceled. The configuration may have to be adapted and released again.

WARNING

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

After the supply voltage has been applied, the new 3RK3 central unit checks whether the expanded 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 expansion modules/DP interface

Note

Only replace a defective module with a module of an identical type.

---

1. Disconnect the defective module at the terminals.
2. Remove the defective module.
3. Install the new module.
4. Connect the module.

WARNING

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

After the supply voltage has been applied, the new 3RK3 central unit checks whether the expanded 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.

7.9 Replacement of AS-i components

7.9.1 Replacement of an AS-i slave during running operation

Behavior of the MSS 3RK3 in case of a defective AS-i slave:

An AS-i slave is considered faulty or defective if it is no longer addressed by the AS-i master. MSS 3RK3 detects this configuration error and uses the substitute value "0" in the interconnection logic.

Replacement of a non-safety-related slave

> **WARNING**
>
> **Hazardous Voltage**
> **Can Cause Death, Serious Injury, or Damage to Property.**
> **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)

If a non-safety-related slave of the same type is plugged in at the corresponding address and if MSS 3RK3 detects that this slave matches the data in the configuration of the target expanded configuration, the configuration error will automatically be reset. The sensor value is input to the logic processing again instead of the substitute value.

Replacing a safety-related AS-i slave

⚠ WARNING
Hazardous Voltage **Can Cause Death, Serious Injury, or Damage to Property.** **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)

Addressing the new slave

If the newly inserted, safety-related AS-i slave already has the correct address, it is enough to close the contacts on the safety-related AS-i slave in order for the MSS 3RK3 to be able to receive the new code sequence.

If the new safety-related AS-i slave has to be included on the bus by the AS-i master, it is first necessary to wait for the autoadressing phase of the AS-i master. During the autoaddressing phase, the new AS-i slave is addressed through address "0." This is not monitored by the MSS 3RK3. The system does not detect the new AS-i slave until it is provided with a correct address.

Teaching the new code sequences

If a safety-related AS-i slave is replaced, the MSS 3RK3 detects that the code sequence transmitted by the AS-i slave is not contained in the code sequence table. This initially results in the substitute value "0" being used in the interconnection logic for this slave.

Note

Important requirement

Before the code sequences are taught, both contacts of the safety-related AS-i input slaves must be closed to enable the code sequences to be taught.

If the contacts are not closed, calculation in the logic diagram continues with the substitute value "0." The current status of the AS-i slave is displayed in the "Learn ASIsafe code tables" dialog box in Safety ES.

If MSS 3RK3 has ascertained after a monitoring period has elapsed that the new code sequence is unique, the TEACH-LEDs will indicate that the new code sequence can be used instead of the originally used code sequence. The new code sequence is applied and saved if you press the RESET button for 3 s or use the "Apply learned AS-i code tables" command.

Table 7- 1 LED display during teaching of code sequences

LED	Display	Explanation
DEVICE	green	Device in safety mode
	flickering green	Device in test mode
AS-i	flashing red	Other code sequence on the AS-i bus
TEACH	yellow flashing	Teaching of code sequences active: The code sequences are being taught.
SF	off	No group error

Table 7- 2 LED display if the code tables can be applied

LED	Display	Explanation
DEVICE	green	Device in safety mode
	flickering green	Device in test mode
AS-i	flashing red	Other code sequence on the AS-i bus
TEACH	yellow	Code sequences can be applied
SF	off	No group error

You will find further information in Chapter "Teaching the code sequences (Page 194)."

7.9.2 Replacing an AS-i slave in different subnetworks

Behavior of the MSS 3RK3

> **WARNING**
>
> **Hazardous Voltage**
> **Can Cause Death, Serious Injury, or Damage to Property.**
> **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)

To ensure that the code sequences are unique, the code sequences of all safety-related AS-i slaves on every device must be saved with monitor functionality. If a safety-related AS-i slave of another subnet is replaced, the code sequence will change. This is detected by each AS-i monitor on the AS-i bus and it is treated just like an AS-i slave of the same subnet. When it lights up yellow, the TEACH-LED on the MSS 3RK3 indicates that a new code sequence has been detected that can be applied.

Applying the new code sequence

The new code sequence can be applied and saved by pressing the reset button for 3 s or by pressing the "Adopt code tables" button in the "Target system" > "ASIsafe code tables" dialog box in Safety ES. The code sequence of MSS 3RK3 is applied and saved in this way.

Table 7- 3 LED display on replacement of an AS-i slave in different subnets in safety mode

LED	Display	Explanation
DEVICE	green	Device in safety mode
AS-i	off	Another code sequence in another subnet is not evaluated as an error
TEACH	yellow	Code sequences can be applied
SF	off	No group error

You will find further information in Chapter "Teaching the code sequences (Page 194)."

7.9.3 Replacement of multiple AS-i slaves during running operation

> **WARNING**
>
> **Hazardous Voltage**
> **Can Cause Death, Serious Injury, or Damage to Property.**
> **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)

When multiple defective AS-i slaves are replaced, the defective AS-i slaves can be replaced by any new slaves if they are of the same type and have already been assigned the same address.

If the new AS-i slaves have not yet been addressed, each must be addressed in succession through an AS-i master with the autoadressing function to apply them to the system.

In the case of safety-related AS-i input slaves, the sensor must be operated once to teach the new code sequence. Non-safety-related slaves are interpreted according to the configuration.

Automatic teaching of code sequences in the background

The transmitted code sequences are learned in the background by the system. The TEACH-LED light up yellow when all code sequences have been taught. The code sequences of all taught slaves can be saved in the code sequence table by pressing the reset button for 3 s or by pressing the "Adopt code tables" button in the "Target system" > "ASIsafe code tables" dialog box in Safety ES.

You will find further information in Chapter "Teaching the code sequences (Page 194)."

7.9.4 Additional AS-i slave in running operation

Additional non-safety-related AS-i slave

An additional non-safety-related slave on the AS-i bus is ignored.

Additional safety-related AS-i slave

WARNING

Additional safety-related AS-i slave on AS-i bus

For safety reasons, the code sequences of all safety-related slaves must be known to every monitor on the AS-i bus. If an additional safety-related AS-i slave is added to the AS-i bus, the code sequence of this slave must be taught on every MSS 3RK3 or safety monitor located on the AS-i bus, irrespective of whether or not this new safety-related AS-i slave is monitored by the respective MSS 3RK3 or safety monitor.

Consider the following when adding a further safety-related slave:

- If a new safety-related AS-i slave is connected to the AS-i bus and its contacts are closed, the MSS 3RK3 detects a new code sequence, the AS-i BF-LED flashes red, and the TEACH-LED lights up yellow. The code sequence table can be transferred into the memory of the MSS 3RK3 in three different ways:
  - Pressing the RESET buttons for 3 s
  - Pressing the "Apply code tables" button in the "Target system" > "ASIsafe code tables" dialog box in Safety ES
  - Controlling a device command function element with the "Adopt code tables" command

  The TEACH-LED goes off after the code sequences have been successfully stored.
- As long as the contacts of the safety-related input slave are not closed, it will be ignored by the MSS 3RK3.
- As soon as teaching in the background has detected that the code sequence that provides a newly inserted safety-related AS-i slave is identical to an existing slave, the substitute value "0" will be used for both slaves.

You will find additional information in Chapter "Teaching the code sequences (Page 194)."

7.9.5 Replacement of MSS 3RK3 with AS-i interface

Replacement of all 3RK3 central units is identical. Because the code sequences are stored on the memory module, the code sequences do not have to be taught as new.

Reference

You will find a description of how to replace the 3RK3 central units in Chapter "Module replacement (Page 337)."

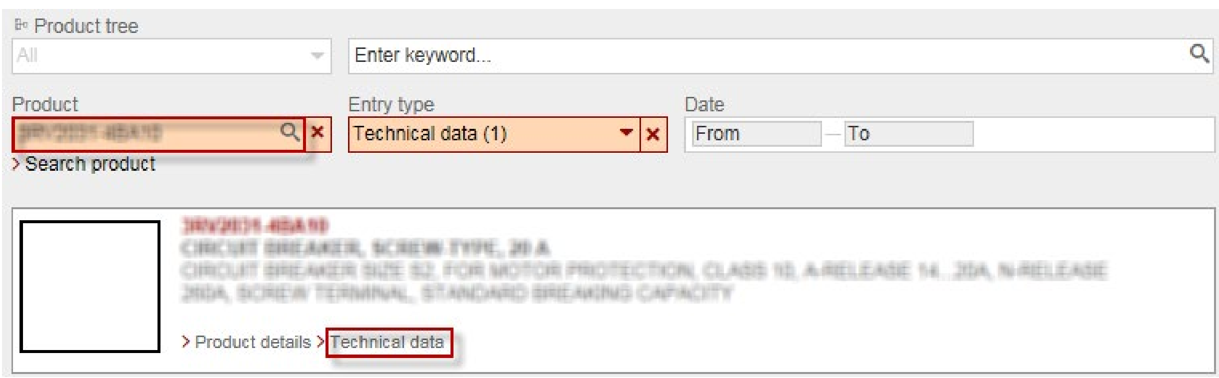
Technical data

8

8.1 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/16392/td).

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.



8.2 General technical data

Table 8- 1

Device data	
Shock resistance (half-sine pulse)	15 g/11 ms
Shock-hazard protection to DIN EN 60529	IP20
Pollution degree	2
Permitted mounting position	Vertical mounting surface (+10°/ -10°)
Minimum clearances	for heat dissipation by convection from the devices: 25 mm from the ventilation openings (top and bottom)
Ambient conditions	
Ambient temperature during operation	-20 ... +60°C[1)]
Ambient temperature during storage	-40 ... +85°C[2)]
Installation altitude	max. 2000 m above sea level
Pressure	70 ... 106 kPa; < 90 kPa with restrictions
Relative humidity	10 % .... 95 %
Safety data	
SIL claim limit SIL CL in accordance with EN 61508	3
Performance Level PL in accordance with EN ISO 13849-1	e
Safety category in accordance with EN ISO 13849-1	4
Requirement class to EN 574	III C
Proof-Test Interval T1	20 years
Setting accuracy of times	± 0.6 %
Environmental data	
EMC EMC emitted interference	according to IEC 60947-5-1 Severity level A (industry)
Vibrations in accordance with EN 60068-2-6 • Frequency • Amplitude	 5 ... 500 Hz 0.75 mm

1) Diagnostics display: 0 ... 60 °C

2) Diagnostics display: -20 ... 70 °C

8.3 3RK3 Basic central unit

Technical data of the 3RK3 Basic

Device data	
Number of sensor inputs (1-channel), safety-related	8
Number of test outputs	2
Number of outputs	1 safety-related two-channel semiconductor output 1 safety-related two-channel semiconductor output
Height • Screw terminals • Spring-loaded terminals	 111 mm 113 mm
Width	45 mm
Depth	124 mm
Weight	300 g
Typical number of function elements to be processed[1)]	250
Electrical data	
Supply voltage/ rated control supply voltage Us	Device power supply via power supply unit in ac-cordance with IEC 60 536 protection class III (SELV or PELV) 24 V DC
Operating range	0.85 to 1.15 x Us
Rated insulation voltage U_i	300 V
Rated impulse voltage U_{imp}	2.5 kV[2)]
Total power consumption	185 mA + 1.5 A semiconductor output
Rated power at Us	4.5 W
Utilization category in accordance with EN 60947-5-1 (relay outputs) • AC-15 at 230 V • DC-13 at 24 V (semiconductor outputs) • DC-13 at 24 V	 2 A 1 A 1.5 A; short-circuit-proof up to 10 A
Resetting time[3)] of the safety-related outputs t_{RT}	420 ms
Mechanical durability[4)]	10 x 10^6 switching cycles (relay)
Max. switching frequency z at rated operational current	1000 1/h
Conventional thermal current I_{th} (relay/semiconductor)	2/1.5 A
Max. protection of relay contacts with fuses NH type 3NA, DIAZED type 5SB, NEOZED type 5SE • Operating class gL/gG • Operating class quick response	 4 A 6 A

Safety data according to EN ISO 13849-1	
Probability of a dangerous failure per hour (PFH_D)	5.14×10^{-9} 1/h
Probability of a dangerous failure on demand (PFD)	1.28×10^{-5}
Characteristic values for cables	
Max. permissible cable resistance	100 Ω
Max. permissible cable length from device to sensor (for CU 1.5 mm^2 and 150 nF/km)	1000 m (i.e., max. total cable length of 2000 m)
Max. permissible cable capacitance	330 nF
Dark period semiconductor outputs	< 1 ms

1) The number of function elements that can be processed by one MSS 3RK3 depends on the type of function elements.

2) Protective separation, reinforced insulation 4 kV between input circuit and output contact current paths.

3) Time from instant an output is switched off to the instant the output reaches a state that permits it to be switched on again.

4) The mechanical durability may be reduced, depending on the contact load.

8.4 3RK3 Advanced central unit

Technical data of the 3RK3 Advanced

Device data	
Number of sensor inputs (1-channel), safety-related	8
Number of test outputs	2
Number of outputs	1 safety-related two-channel semiconductor output 1 safety-related two-channel semiconductor output
Height • Screw terminals • Spring-loaded terminals	 111 mm 113 mm
Width	45 mm
Depth	124 mm
Weight	300 g
Typical number of function elements to be processed[1)]	250
Electrical data	
Supply voltage/ rated control supply voltage Us	Device power supply via power supply unit in accordance with IEC 60 536 protection class III (SELV or PELV) 24 V DC
Operating range	0.85 to 1.15 x Us
Rated insulation voltage U_i	300 V
Rated impulse voltage U_{imp}	2.5 kV[2)]
Total power consumption	185 mA + 1.5 A semiconductor output
Rated power at Us	4.5 W
Utilization category in accordance with EN 60947-5-1 (relay outputs) • AC-15 at 230 V • DC-13 at 24 V (semiconductor outputs) • DC-13 at 24 V	 2 A 1 A 1.5 A; short-circuit-proof up to 10 A
Resetting time[3)] of the safety-related outputs t_{RT}	420 ms
Mechanical durability[4)]	10 x 10^6 switching cycles (relay)
Max. switching frequency z at rated operational current	1000 1/h
Conventional thermal current I_{th} (relay/semiconductor)	2/1.5 A
Max. protection of relay contacts with fuses NH type 3NA, DIAZED type 5SB, NEOZED type 5SE • Operating class gL/gG • Operating class quick response	 4 A 6 A

Safety data according to EN ISO 13849-1	
Probability of a dangerous failure per hour (PFH_D)	2.8 x 10^{-9} 1/h (without use of AS-i) 3.8 x 10^{-9} 1/h (with use of AS-i)
Probability of a dangerous failure on demand (PFD)	1.7 x 10^{-4}
Characteristic values for cables	
Max. permissible cable resistance	100 Ω
Max. permissible cable length from device to sensor (for CU 1.5 mm^2 and 150 nF/km)	1000 m (i.e., max. total cable length of 2000 m)
Max. permissible cable capacitance	330 nF
Dark period semiconductor outputs	< 1 ms
AS-Interface data	
AS-i voltage	18.5 V DC ... 31.6 V DC
AS-i power consumption	< 45 mA
AS-i bus load	like A/B slave
AS-i slave profiles (simulated slaves)	• S-7 F.F (4I/4O): standard slave (max. 4) • S-7 A.E (4I/3O): AB slave (max. 4) • S-6 B.D: safety-related output slave for controlling a safety-related AS-i output (maximum of 12) • S-0 B.F: safety-related input slave for AS-i link (maximum of 12) • S-7 5.5: (standard CTT2 + 2I/2O) CTT2 slave for transmission of diagnostics information (maximum of 1)
Number of devices per AS-Interface line	In the maximum configuration of the AS-Interface network in which 31 standard addresses are used, you can install up to four additional safety monitors without addresses. If fewer than 31 standard addresses are used, a further monitor can be installed for each unused standard address. If you install additional nodes without an address (e.g., ground fault monitoring modules), this reduces the number of safety monitors that can be installed accordingly. When repeaters are used, this definition applies to each segment.

1) The number of function elements that can be processed by one MSS 3RK3 depends on the type of function elements.

2) Protective separation, reinforced insulation 4 kV between input circuit and output contact current paths.

3) Time from instant an output is switched off to the instant the output reaches a state that permits it to be switched on again.

4) The mechanical durability may be reduced, depending on the contact load.

8.5 3RK3 ASIsafe basic central unit

Technical data of the 3RK3 ASIsafe basic

Device data	
Number of sensor inputs (1-channel), safety-related	2
Number of standard inputs	6
Number of test outputs	2
Number of outputs	1 safety-related two-channel semiconductor output 1 safety-related two-channel semiconductor output
Height • Screw terminals • Spring-loaded terminals	 111 mm 113 mm
Width	45 mm
Depth	124 mm
Weight	300 g
Typical number of function elements to be processed[1)]	250
Electrical data	
Supply voltage/ rated control supply voltage Us	Device power supply via power supply unit in accordance with IEC 60 536 protection class III (SELV or PELV) 24 V DC
Operating range	0.85 to 1.15 x Us
Rated insulation voltage U_i	300 V
Rated impulse voltage U_{imp}	2.5 kV[2)]
Total power consumption	185 mA + 1.5 A semiconductor output
Rated power at Us	4.5 W
Utilization category in accordance with EN 60947-5-1 (relay outputs) • AC-15 at 230 V • DC-13 at 24 V (semiconductor outputs) • DC-13 at 24 V	 2 A 1 A 1.5 A; short-circuit-proof up to 10 A
Resetting time[3)] of the safety-related outputs t_{RT}	420 ms
Mechanical durability[4)]	10 x 10^6 switching cycles (relay)
Max. switching frequency z at rated operational current	1000 1/h
Conventional thermal current I_{th} (relay/semiconductor)	2/1.5 A
Max. protection of relay contacts with fuses NH type 3NA, DIAZED type 5SB, NEOZED type 5SE • Operating class gL/gG • Operating class quick response	 4 A 6 A

Safety data according to EN ISO 13849-1	
Probability of a dangerous failure per hour (PFH_D)	2.8 x 10^{-9} 1/h (without use of AS-i) 3.8 x 10^{-9} 1/h (with use of AS-i)
Probability of a dangerous failure on demand (PFD)	1.7 x 10^{-4}
Characteristic values for cables	
Max. permissible cable resistance	100 Ω
Max. permissible cable length from device to sensor (for CU 1.5 mm^2 and 150 nF/km)	1000 m (i.e., max. total cable length of 2000 m)
Max. permissible cable capacitance	330 nF
Dark period semiconductor outputs	< 1 ms
AS-Interface data	
AS-i voltage	18.5 V DC ... 31.6 V DC
AS-i power consumption	< 45 mA
AS-i bus load	like A/B slave
AS-i slave profiles (simulated slaves)	• S-7 F.F (4I/4O): standard slave (max. 4) • S-7 A.E (4I/3O): AB slave (max. 4) • S-6 B.D: safety-related output slave for controlling a safety-related AS-i output (maximum of 8) • S-0 B.F: Safety-related input slave for AS-i link (maximum of 8) • S-7 5.5: (standard CTT2 + 2I/2O) CTT2 slave for transmission of diagnostics information (maximum of 1)
Number of devices per AS-Interface line	In the maximum configuration of the AS-Interface network in which 31 standard addresses are used, you can install up to four additional safety monitors without addresses. If fewer than 31 standard addresses are used, a further monitor can be installed for each unused standard address. If you install additional nodes without an address (e.g., ground fault monitoring modules), this reduces the number of safety monitors that can be installed accordingly. When repeaters are used, this definition applies to each segment.

1) The number of function elements that can be processed by one MSS 3RK3 depends on the type of function elements.

2) Protective separation, reinforced insulation 4 kV between input circuit and output contact current paths.

3) Time from instant an output is switched off to the instant the output reaches a state that permits it to be switched on again.

4) The mechanical durability may be reduced, depending on the contact load.

8.6 3RK3 ASIsafe extended central unit

Technical data of the 3RK3 ASIsafe extended

Device data	
Number of sensor inputs (1-channel), safety-related	4
Number of standard inputs	4
Number of test outputs	2
Number of outputs	1 safety-related two-channel semiconductor output 1 safety-related two-channel semiconductor output
Height • Screw terminals • Spring-loaded terminals	 111 mm 113 mm
Width	45 mm
Depth	124 mm
Weight	300 g
Typical number of function elements to be processed[1)]	250
Electrical data	
Supply voltage/ rated control supply voltage Us	Device power supply via power supply unit in accordance with IEC 60 536 protection class III (SELV or PELV) 24 V DC
Operating range	0.85 to 1.15 x Us
Rated insulation voltage U_i	300 V
Rated impulse voltage U_{imp}	2.5 kV[2)]
Total power consumption	185 mA + 1.5 A semiconductor output
Rated power at Us	4.5 W
Utilization category in accordance with EN 60947-5-1 (relay outputs) • AC-15 at 230 V • DC-13 at 24 V (semiconductor outputs) • DC-13 at 24 V	 2 A 1 A 1.5 A; short-circuit-proof up to 10 A
Resetting time[3)] of the safety-related outputs t_{RT}	 420 ms
Mechanical durability[4)]	10 x 10^6 switching cycles (relay)
Max. switching frequency z at rated operational current	1000 1/h
Conventional thermal current I_{th} (relay/semiconductor)	2/1.5 A
Max. protection of relay contacts with fuses NH type 3NA, DIAZED type 5SB, NEOZED type 5SE • Operating class gL/gG • Operating class quick response	 4 A 6 A

Safety data according to EN ISO 13849-1	
Probability of a dangerous failure per hour (PFH_D)	2.8×10^{-9} 1/h (without use of AS-i) 3.8×10^{-9} 1/h (with use of AS-i)
Probability of a dangerous failure on demand (PFD)	1.7×10^{-4}
Characteristic values for cables	
Max. permissible cable resistance	100 Ω
Max. permissible cable length from device to sensor (for CU 1.5 mm^2 and 150 nF/km)	1000 m (i.e., max. total cable length of 2000 m)
Max. permissible cable capacitance	330 nF
Dark period semiconductor outputs	< 1 ms
AS-Interface data	
AS-i voltage	18.5 V DC ... 31.6 V DC
AS-i power consumption	< 45 mA
AS-i bus load	like A/B slave
AS-i slave profiles (simulated slaves)	• S-7 F.F (4I/4O): standard slave (max. 4) • S-7 A.E (4I/3O): AB slave (max. 4) • S-6 B.D: safety-related output slave for controlling a safety-related AS-i output (maximum of 10) • S-0 B.F: Safety-related input slave for AS-i link (maximum of 10) • S-7 5.5: (standard CTT2 + 2I/2O) CTT2 slave for transmission of diagnostics information (maximum of 1)
Number of devices per AS-Interface line	In the maximum configuration of the AS-Interface network in which 31 standard addresses are used, you can install up to four additional safety monitors without addresses. If fewer than 31 standard addresses are used, a further monitor can be installed for each unused standard address. If you install additional nodes without an address (e.g., ground fault monitoring modules), this reduces the number of safety monitors that can be installed accordingly. When repeaters are used, this definition applies to each segment.

1) The number of function elements that can be processed by one MSS 3RK3 depends on the type of function elements.

2) Protective separation, reinforced insulation 4 kV between input circuit and output contact current paths.

3) Time from instant an output is switched off to the instant the output reaches a state that permits it to be switched on again.

4) The mechanical durability may be reduced, depending on the contact load.

8.7 EM 4/8F-DI

Technical data of the expansion module 4/8F-DI

Device data	
Number of sensor inputs (1-channel), safety-related	8
Number of test outputs	2
Height • Screw terminals • Spring-loaded terminals	102 mm 105 mm
Width	22.5 mm
Depth	124 mm
Weight	160 g
Electrical data	
Supply voltage/ rated control supply voltage Us	24 V DC
Operating range	0.85 to 1.15 x Us
Rated insulation voltage U_i	50 V
Rated impulse voltage U_{imp}	500 V
Total power consumption	60 mA
Rated power at Us	1.5 W
Safety data according to EN ISO 13849-1	
Probability of a dangerous failure per hour (PFH_d)	1.89×10^{-9} 1/h
Probability of a dangerous failure on demand (PFD)	4.29×10^{-6}
Characteristic values for cables	
Max. permissible cable resistance	100 Ω
Max. permissible cable length from device to sensor (for CU 1.5 mm^2 and 150 nF/km)	1000 m
Max. permissible cable capacitance	330 nF

8.8 EM 2/4F-DI 1/2F-RO

Technical data of the expansion module 2/4F-DI 1/2F-RO

Device data	
Number of sensor inputs (1-channel), safety-related	4
Number of test outputs	2
Number of outputs	2 safety-related single-channel relay outputs
Height • Screw terminals • Spring-loaded terminals	 102 mm 105 mm
Width	22.5 mm
Depth	124 mm
Weight	160 g
Electrical data	
Supply voltage/ rated control supply voltage Us	24 V DC
Operating range	0.85 to 1.15 x Us
Rated insulation voltage U_i	300 V
Rated impulse withstand voltage U_{imp}	2.5 kV[1)]
Total power consumption	85 mA
Rated power at Us	2.0 W
Utilization category in accordance with EN 60947-5-1 (relay outputs) • AC 15 at 230 V • DC 13 at 24 V	 2 A 1 A
Resetting time[2)] of the safety-related outputs t_{RT}	 420 ms
Mechanical durability	10 x 10^6 switching cycles
Max. switching frequency z at rated operational current	1000 1/h
Conventional thermal current I_{th}	2 A
Output contacts protected with fuses NH type 3NA, DIAZED type 5SB, NEOZED type 5SE • Operating class gL/gG • Operating class quick response	 4 A 6 A

Safety data according to EN ISO 13849-1	
Probability of a dangerous failure per hour (PFH_d)	3.79 x 10^{-9} 1/h
Probability of a dangerous failure on demand (PFD)	5.85 x 10^{-6}
Characteristic values for cables	
Max. permissible cable resistance	100 Ω
Max. permissible cable length from device to sensor (for CU 1.5 mm^2 and 150 nF/km)	1000 m
Max. permissible cable capacitance	330 nF

1) Protective separation, reinforced insulation 4 kV between input circuit and output contact current paths.

2) Time from instant an output is switched off to the instant the output reaches a state that permits it to be switched on again.

8.9 EM 2/4F-DI 2F-DO

Technical data of the expansion module 2/4F-DI 2F-DO

Device data	
Number of sensor inputs (1-channel), safety-related	4
Number of test outputs	2
Number of outputs	2 safety-related two-channel semiconductor outputs
Height • Screw terminals • Spring-loaded terminals	 102 mm 105 mm
Width	22.5 mm
Depth	124 mm
Weight	160 g
Electrical data	
Supply voltage/ rated control supply voltage Us	24 V DC
Operating range	0.85 to 1.15 x Us
Rated insulation voltage U_i	50 V
Rated impulse withstand voltage U_{imp}	500 V
Total power consumption	85 mA + 1.2 A per semiconductor output
Rated power at Us	2.0 W
Utilization category in accordance with EN 60947-5-1 (semiconductor outputs) • 13 V DC at 24 V DC	 1.2 A; short-circuit-proof up to 10 A
Resetting time[1)] of the safety-related outputs t_{RT}	420 ms
Max. switching frequency z at rated operational current	1000 1/h
Conventional thermal current I_{th}	1.2 A
Safety data according to EN ISO 13849-1	
Probability of a dangerous failure per hour (PFH_d)	2.70×10^{-9} 1/h
Probability of a dangerous failure on demand (PFD)	8.34×10^{-6}
Characteristic values for cables	
Max. permissible cable resistance	100 Ω
Max. permissible cable length from device to sensor (for CU 1.5 mm² and 150 nF/km)	1000 m
Max. permissible cable capacitance	330 nF
Dark period semiconductor outputs	< 1 ms

1) Time from instant an output is switched off to the instant the output reaches a state that permits it to be switched on again.

8.10 EM 4F-DO

Technical data of the expansion module 4F-DO

Device data	
Number of outputs	4 safety-related two-channel semiconductor outputs
Height • Screw terminals • Spring-loaded terminals	 102 mm 105 mm
Width	22.5 mm
Depth	124 mm
Weight	135 g
Electrical data	
Supply voltage/ rated control supply voltage Us	24 V DC
Operating range	0.85 to 1.15 x Us
Rated insulation voltage U_i	50 V
Rated impulse withstand voltage U_{imp}	500 V
Total power consumption	100 mA + 2 A per semiconductor output
Rated power at Us	4.8 W
Utilization category in accordance with EN 60947-5-1 (semiconductor outputs) • DC 13 at 24 V	 2 A; short-circuit-proof up to 10 A
Resetting time[1)] of the safety-related outputs t_{RT}	420 ms
Max. switching frequency z at rated operational current	1000 1/h
Conventional thermal current I_{th}	2 A
Safety data according to EN ISO 13849-1	
Probability of a dangerous failure per hour (PFH_d)	3.18×10^{-9} 1/h
Probability of a dangerous failure on demand (PFD)	2.20×10^{-5}
Dark period semiconductor outputs	< 1 ms

1) Time from instant an output is switched off to the instant the output reaches a state that permits it to be switched on again.

8.11 EM 4/8F-RO

Technical data of the expansion module 4/8F-RO

Device data	
Number of outputs	8 safety-related single-channel relay outputs
Height • Screw terminals • Spring-loaded terminals	 102 mm 105 mm
Width	45 mm
Depth	124 mm
Weight	400 g
Electrical data	
Supply voltage/ rated control supply voltage Us	24 V DC
Operating range	0.85 to 1.15 x Us
Rated insulation voltage U_i	300 V
Rated impulse withstand voltage U_{imp}	2.5 kV[1)]
Total power consumption	140 mA
Rated power at Us	3.0 W
Utilization category in accordance with EN 60947-5-1 (relay outputs) • AC 15 at 230 V • DC 13 at 24 V	 2 A 1 A
Resetting time[2)] of the safety-related outputs t_{RT}	420 ms
Mechanical durability	10 x 10^6 switching cycles
Max. switching frequency z at rated operational current	360 1/h
Conventional thermal current I_{th}	3 A
Output contacts protected with fuses NH type 3NA, DIAZED type 5SB, NEOZED type 5SE • Operating class gL/gG • Operating class quick response	 4 A 6 A
Safety data according to EN ISO 13849-1	
Probability of a dangerous failure per hour (PFH_d)	7.15 x 10^{-9} 1/h
Probability of a dangerous failure on demand (PFD)	4.36 x 10^{-5}

1) Protective separation, reinforced insulation 4 kV between input circuit and output contact current paths.

2) Time from instant an output is switched off to the instant the output reaches a state that permits it to be switched on again.

8.12 EM 8DI

Technical data of the expansion module 8DI

Device data	
Number of standard inputs	8
Height • Screw terminals • Spring-loaded terminals	 102 mm 105 mm
Width	22.5 mm
Depth	124 mm
Weight	125 g
Electrical data	
Supply voltage/ rated control supply voltage Us	24 V DC
Operating range	0.85 to 1.15 x Us
Rated insulation voltage U_i	50 V
Rated impulse voltage U_{imp}	500 V
Total power consumption	78 mA
Rated power at Us	1.9 W
Characteristic values for cables	
Max. permissible cable resistance	100 Ω
Max. permissible cable length from device to sensor (for CU 1.5 mm^2 and 150 nF/km)	1000 m
Max. permissible cable capacitance	330 nF

8.13 EM 8DO

Technical data of the expansion module 8DO

Device data	
Number of standard outputs	8
Height • Screw terminals • Spring-loaded terminals	 102 mm 105 mm
Width	22.5 mm
Depth	124 mm
Weight	160 g
Electrical specifications	
Supply voltage / rated control supply voltage Us	24 V DC
Work area	0.85 to 1.15 x Us
Rated insulation voltage U_i	50 V
Rated impulse withstand voltage U_{imp}	500 V
Total power consumption	60 mA + 0.5 A per semiconductor output
Rated power at Us	1.5 W
Utilization category to EN 60947-4-1 (semiconductor outputs) • DC 13 at 24 V	 0.5 A; short-circuit-proof up to 10 A
Max. switching frequency z at rated operational current	1000 1/h
Conventional thermal current I_{th}	0.5 A

8.14 DP interface module

Technical data of the DP interface module

Device data	
Height • Screw terminals • Spring-loaded terminals	 111 mm 113 mm
Width	45 mm
Depth	124 mm
Weight	approx. 270 g
Electrical specifications	
Power supply / rated control supply voltage Us (to IEC 61131-2)	24 V DC
Work area	0.85 to 1.15 x Us
Rated insulation voltage U_i	50 V
Rated impulse voltage U_{imp}	500 V
Total power consumption	100 mA
Rated power at U_s	2.4 W

8.15 Diagnostics display

Technical data of the diagnostics display

Device data	
Height	60 mm
Width	96 mm
Depth	44 mm
Weight	91 g
Electrical specifications	
Supply voltage / rated control supply voltage U_S	via a connection cable from the 3RK3 central unit U_s = 24 V DC
Work area	0.85 to 1.15 x U_s
Rated insulation voltage U_i	50 V
Rated impulse voltage U_{imp}	500 V
Total power consumption	24 mA
Rated power at U_S	0.6 W

8.16 Memory module

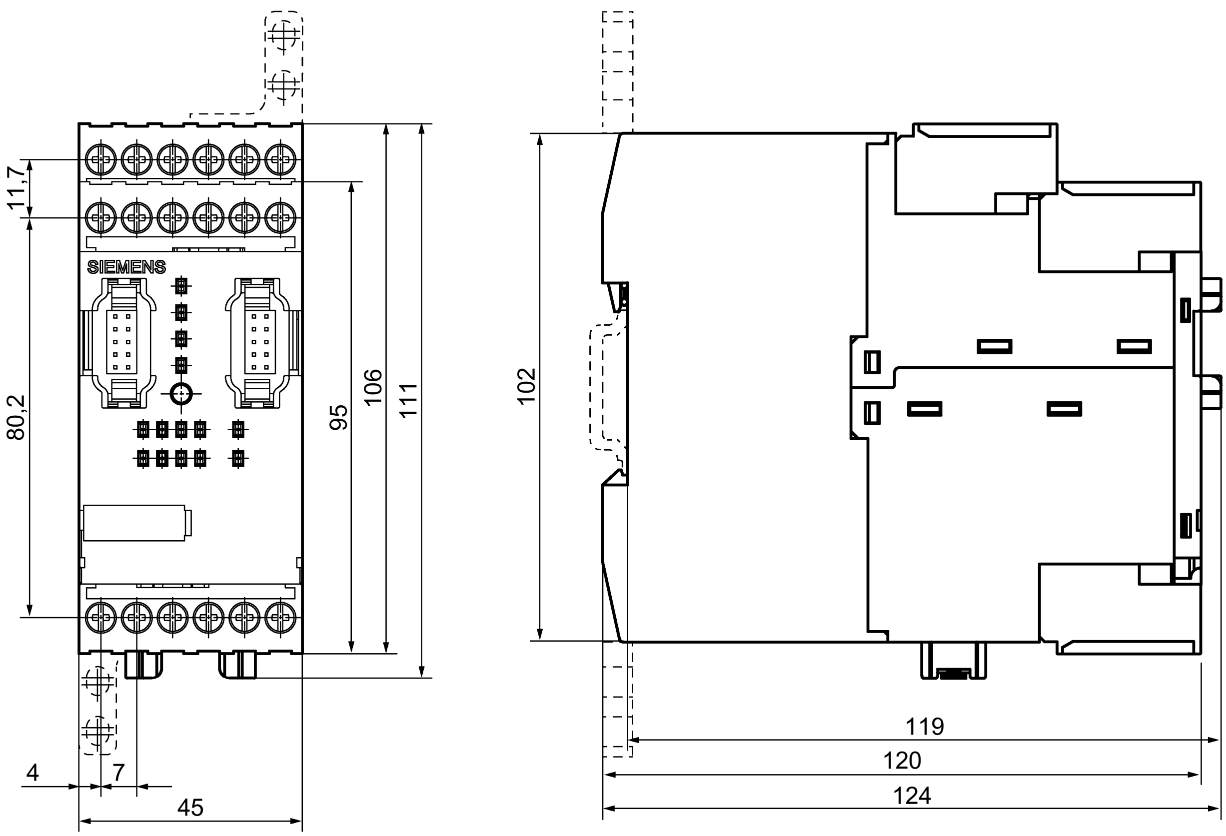
Technical data of the memory module

Device data	
Electronic supply	From the 3RK3 central unit
EEPROM	
Data storage	> 40 years
Deletion/write cycles	100 000

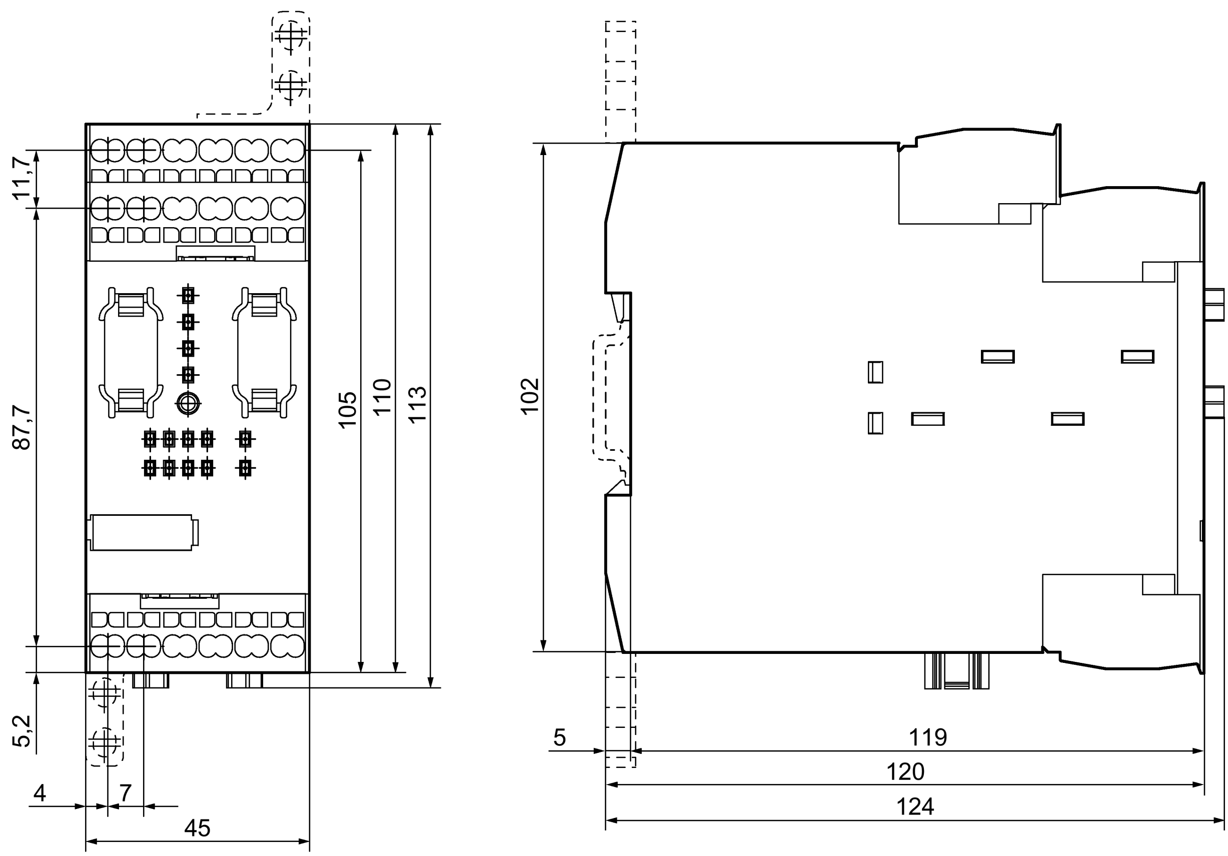
Dimension drawings

9

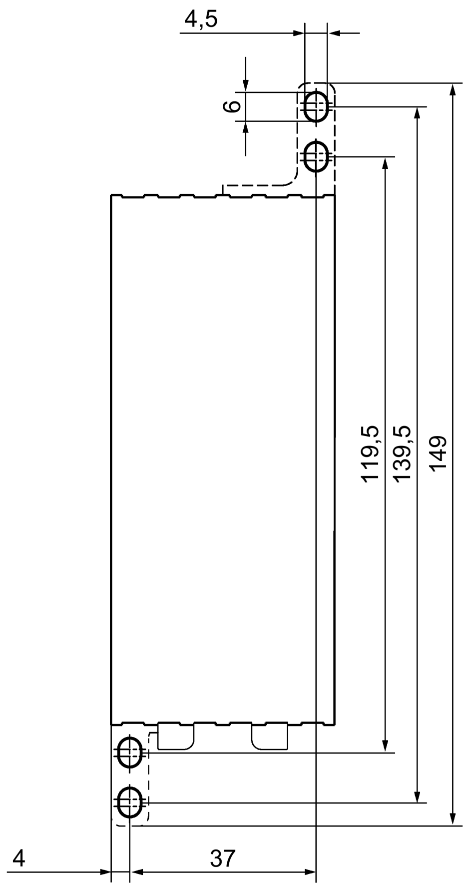
Dimension drawing of 45-mm enclosure with screw-type terminals



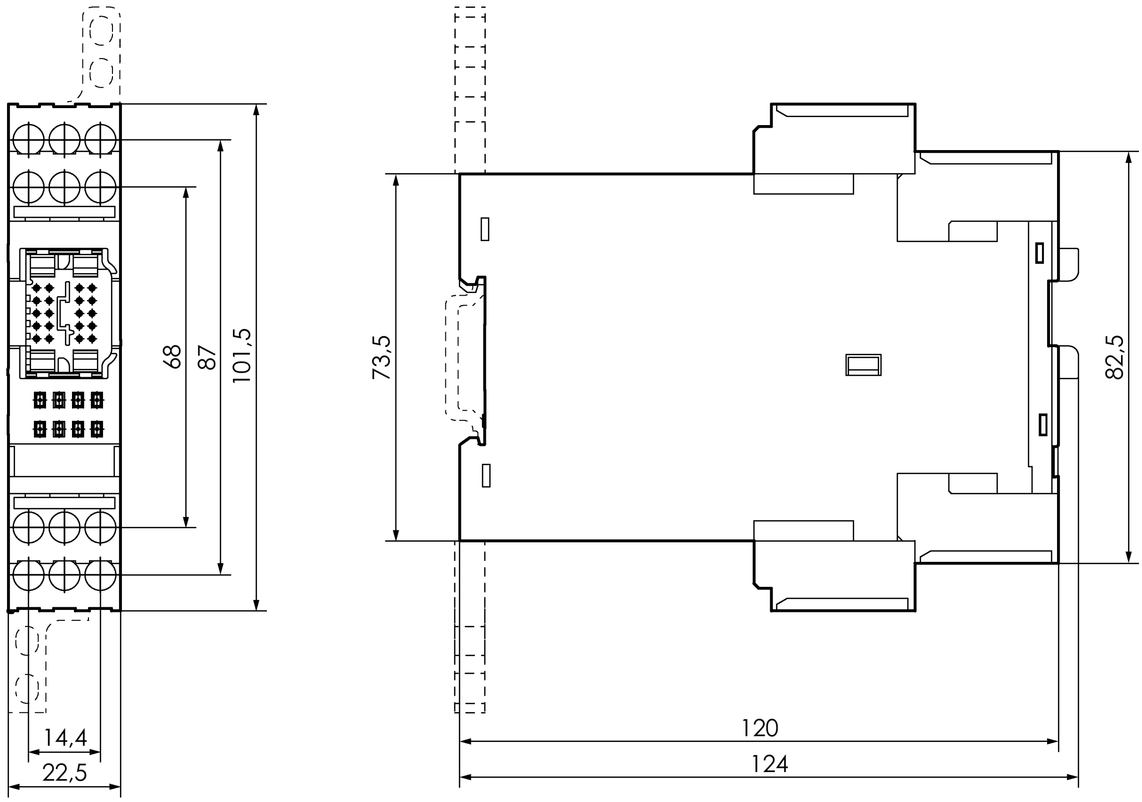
Dimension drawing of 45-mm enclosure with spring-loaded terminals



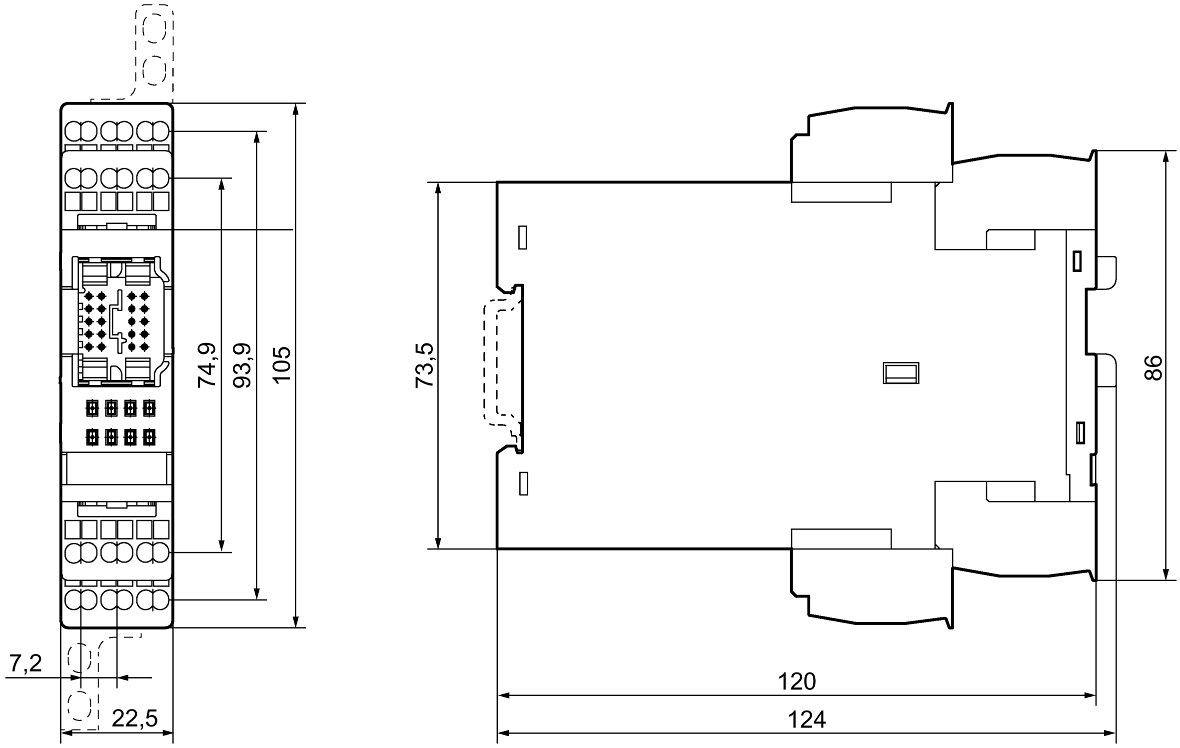
Drilling plan for 45-mm enclosure



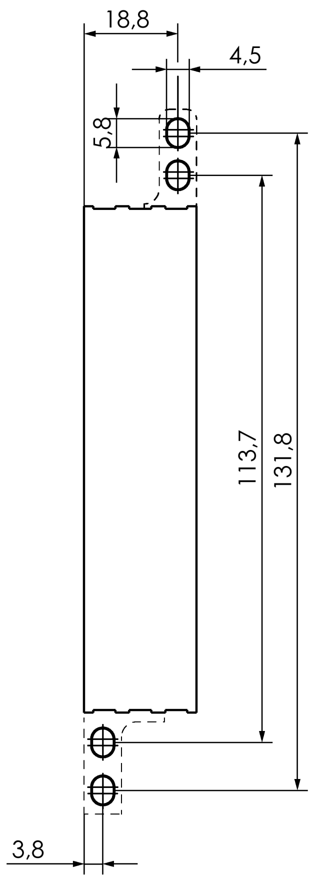
Dimension drawing: Enclosure 22.5 mm with screw terminals



Dimension drawing of 22.5-mm enclosure with spring-loaded terminals

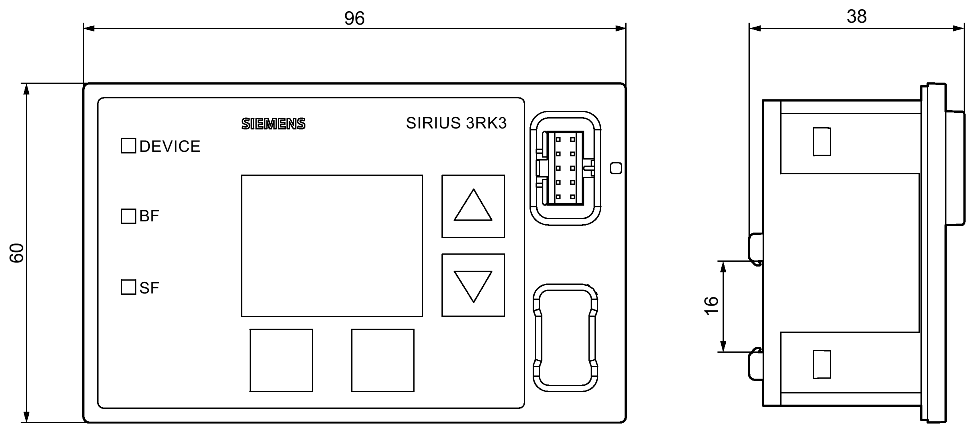


Drilling plan for 22.5-mm enclosure

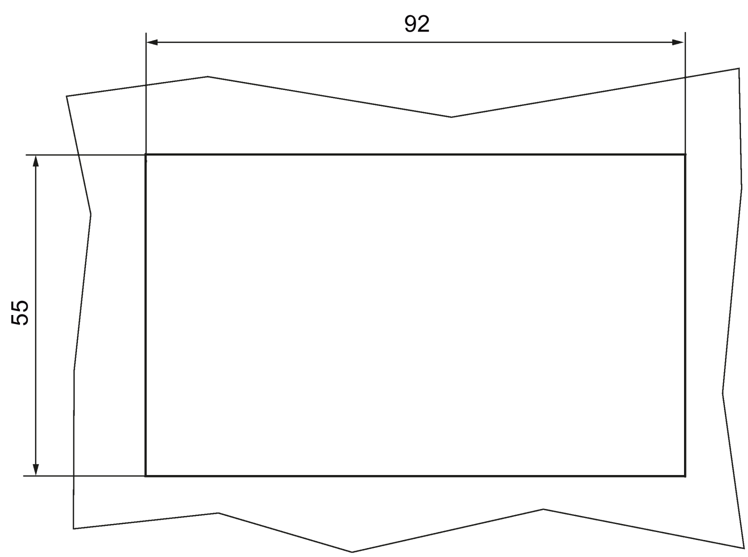


9.1 Diagnostics display

Diagnostics display

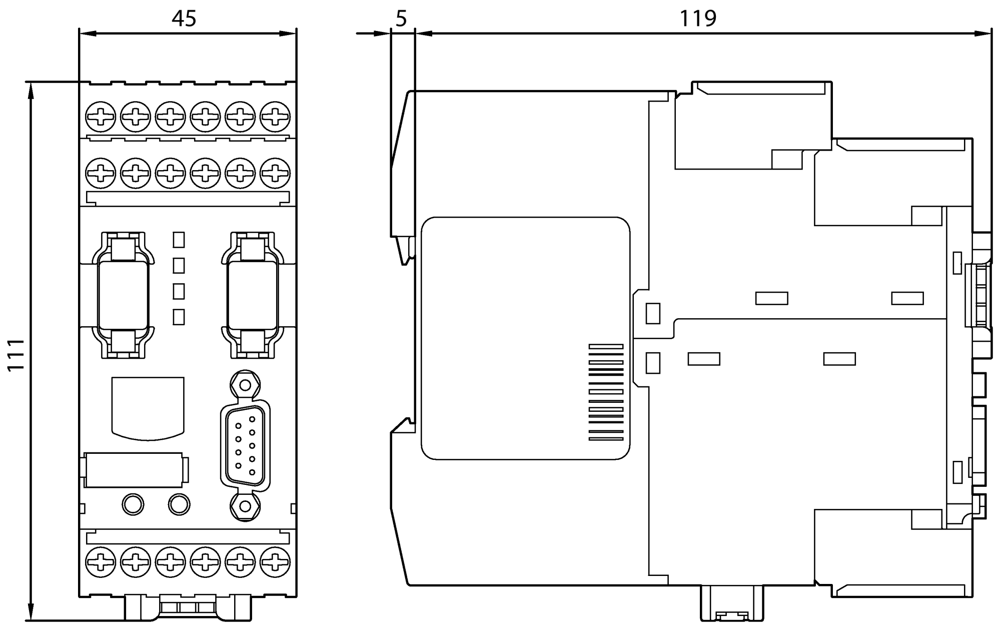


Cut-out for diagnostics display

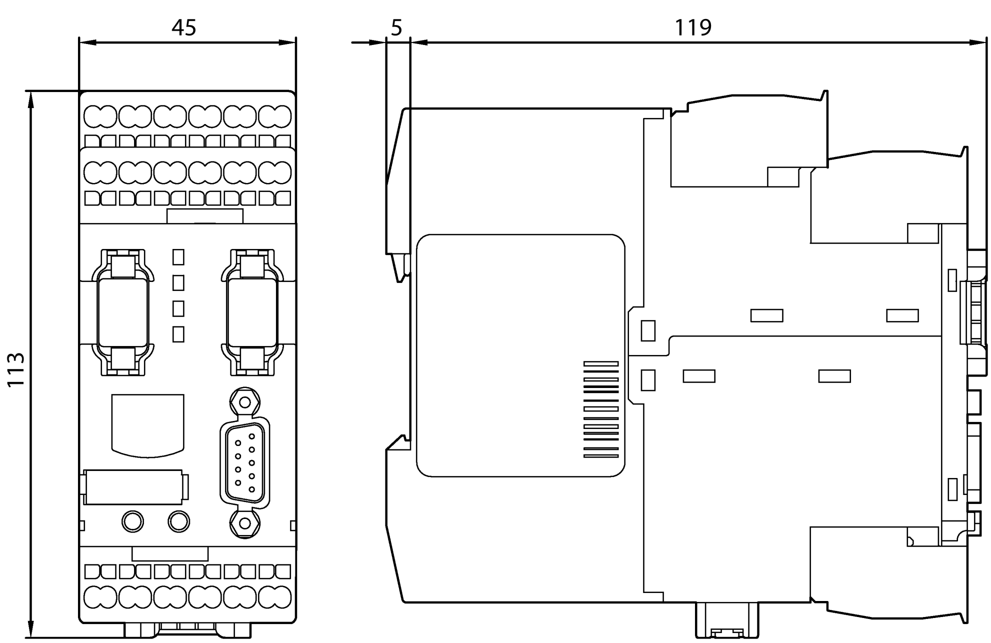


9.2 DP interface

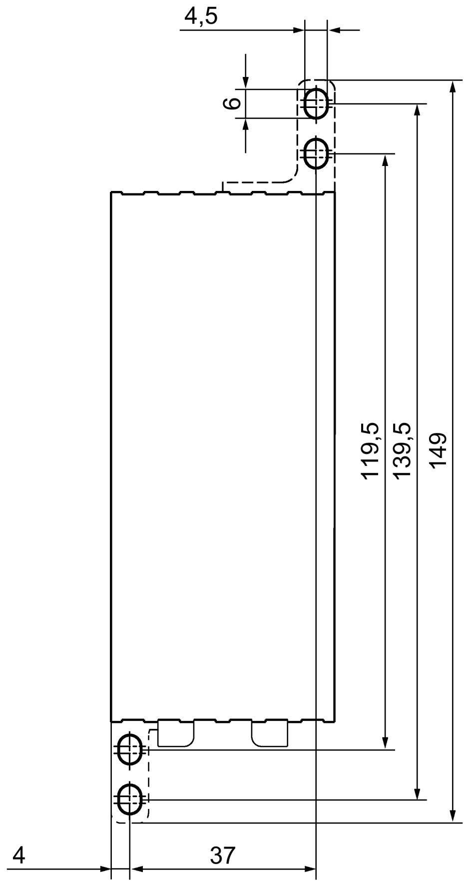
DP interface with screw terminals



DP interface with spring-loaded terminals



Drilling plan DP interface



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