

VIPA System SLIO

SM-S | 02x-1SD00 | Instructions

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Safety Digital I/O - SM-S 02x

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1 General

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Every effort has been made to ensure that the information contained in this document was complete and accurate at the time of publishing. Nevertheless, the authors retain the right to modify the information.

This customer document describes all the hardware units and functions known at the present time. Descriptions may be included for units which are not present at the customer site. The exact scope of delivery is described in the respective purchase contract.

CE Conformity Declaration

Hereby, VIPA GmbH declares that the products and systems are in compliance with the essential requirements and other relevant provisions. Conformity is indicated by the CE marking affixed to the product.

Conformity Information

For more information regarding CE marking and Declaration of Conformity (DoC), please contact your local VIPA customer service organization.

Machinery directive

The system SLIO safety modules of this manual meet all the requirements of the machinery directive 2006/42/EG.

Certification

The product SLIO safety signal module was developed and certified according to the standards specified at "Approvals, directives, standards" in chapter "Safety".

It is suited for use in applications up to category 4 / PL e of EN ISO 13849-1 and SIL 3 of EN 62061 and IEC 61508.

Test report number: 968/M 387.01/14

Certificate number: 01/205/5301/13

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1.2 About this manual**Objective and contents**

This manual is the translation of the original instructions!

This manual describes the System SLIO safety signal modules from VIPA. It contains a description of the structure, project engineering and deployment. This manual is relevant for:

| Product | Order number | as of HW state: |
|-------------------|--------------|-----------------|
| SDI 4xDC 24V | 021-1SD00 | 2 |
| SDO 4xDC 24V 0.5A | 022-1SD00 | 2 |

Target audience

The manual is targeted at users who have a background in automation technology.

Structure of the manual

The manual consists of chapters. Every chapter provides a self-contained description of a specific topic.

Guide to the document The following guides are available in the manual:

- An overall table of contents at the beginning of the manual
- References with page numbers

Availability The manual is available in:

- printed form, on paper
- in electronic form as PDF-file (Adobe Acrobat Reader)

Icons Headings Important passages in the text are highlighted by following icons and headings:

**DANGER!**

Immediate danger to life and limb of personnel and others.
Non-compliance will cause death or serious injury.

**WARNING!**

Hazardous situation to life and limb of personnel and others.
Non-compliance may cause death or serious injury.

**CAUTION!**

Hazardous situation to life and limb of personnel and others. Non-compliance may cause slight injuries.
This symbol is also used as warning of damages to property.

**NOTICE!**

Designates a possibly harmful situation. Non-compliance can damage the product or something in its environment.



Supplementary information and useful tips.

Liability Limitation

All data and notes in these instructions were prepared with consideration to the statutory standards and regulations, the present state of technology, as well as our many years of knowledge and experience.

The manufacturer accepts no liability for damage caused because:

- Non-compliance with the instructions
- Non-specified use
- Use of untrained personnel

The actual scope of delivery can, by special designs, deviate from the explanations and presentations given here, because of the utilization of additional order options, or because of the most recent technical changes.

The user is responsible for the execution of service and commissioning according to the safety instructions of the prevailing standards and other relevant national and local instructions concerning conductor dimensioning and protection, earthing, disconnectors, overcurrent protection and so on.

For damages, which result from the mounting or from the connection, the one is liable, who has carried out the mounting or the installation.

We have checked the contents of this manual for agreement with the hardware and software described. Since deviations cannot be precluded entirely, we cannot guarantee full agreement. However, the data in this manual are reviewed regularly. Necessary corrections are included in subsequent editions.

Suggestions for improvement are welcomed.

For damage, which results from missing or insufficient knowledge of the manual, any liability of the manufacturer is impossible.

Therefore, the operator is recommended to have the instruction of the persons concerned confirmed in writing.

Modifications or functional alternations on the product are not allowed due to safety reasons. Any modification on the product not explicitly authorized by the manufacturer will result in loss of any liability claims to the vendor. The same applies if non authorized parts or equipment are used.

Copyright

This manual is to be treated confidentially. It has been provided only for the personnel, which use the product. The transfer of this document to third parties without the authorization in writing of the vendor is prohibited.



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Use of this manual

This safety manual contains information for the intended use of the system SLIO safety signal modules.

Knowledge of regulations and the proper technical implementation of the safety instructions detailed in this manual performed by qualified personnel are prerequisites for safely planning, engineering, programming, installing and starting up the system SLIO safety modules as well as for ensuring safety during their operation and maintenance.

↳ *Chapter 1.8 'Education of the personnel' on page 14*

VIPA GmbH will not be held liable for severe personal injuries, damage to property or the surroundings caused by any of the following: unqualified personnel working on or with the devices, de-activation or bypassing of safety functions, or failure to comply with the instructions detailed in this manual.

VIPA safety components and systems have been developed, manufactured and tested in compliance with the pertinent safety standards and regulations. They may only be used for the intended applications under the specified environmental conditions.

They must be used only as specified in environmental descriptions and be connected only to approved external devices.

The manual contains safety instructions, description of the modules and information about life cycle.

Applicable documentation

In the safety signal module components of other manufacturers are possibly integrated. For these purchased parts of the respective manufacturers risk evaluations were carried out. The conformity of the constructions to the valid European and national regulations was declared by the according manufacturer.

Warranty conditions

The warranty conditions by be found in the "General terms and conditions" on the homepage and in the catalog of VIPA GmbH.

1.3 Safety information

Applications conforming with specifications

The System SLIO is constructed and produced for:

- communication and process control
- general control and automation applications
- industrial applications
- operation within the environmental conditions specified in the technical data
- installation into a cubicle with degree of protection IP54 or better

The modules have been engineered and designed exclusively for the intended use described in this documentation.

The modules are intended used if you consider all references and information of this manual.



WARNING!

Danger by non intended use!

Every application in excess of the intended use and/or other use of the product, can lead to hazardous situations.



DANGER!

This device is not certified for applications in

- in explosive environments (EX-zone)

To prevent hazards and ensure optimum performance, no changes, modifications or conversions may be made to the product that have not been expressly approved by the manufacturer.

Documentation

Every person working with the product must have read and understood the operating instructions before carrying out any work.

The manual must be available to all personnel in the

- project design department
- installation department
- commissioning
- operation

**CAUTION!**

The following conditions must be met before using or commissioning the components described in this manual:

- Hardware modifications to the process control system should only be carried out when the system has been disconnected from power!
- Installation and hardware modifications only by properly trained personnel.
- The national rules and regulations of the respective country must be satisfied (installation, safety, EMC ...)

**DANGER!**

To prevent hazards and ensure optimum performance, no changes, modifications or conversions may be made to the product that have not been expressly approved by the manufacturer.

Maintenance

If you keep the prescribed environmental conditions (see technical data) the corresponding safety module is maintenance-free.

Spare parts

Please use only original spare parts of the VIPA GmbH.

**WARNING!**

Incorrect or faulty spare parts can cause damage, malfunction or failure as well as affect security.

Shipping

For shipping always use the original packaging.

Disposal

National rules and regulations apply to the disposal of the unit!

1.4 Safety Information for Users

Handling of electrostatic sensitive modules

VIPA modules make use of highly integrated components in MOS-Technology. These components are extremely sensitive to over-voltages that can occur during electrostatic discharges. The following symbol is attached to modules that can be destroyed by electrostatic discharges.



The Symbol is located on the module, the module rack or on packing material and it indicates the presence of electrostatic sensitive equipment. It is possible that electrostatic sensitive equipment is destroyed by energies and voltages that are far less than the human threshold of perception. These voltages can occur where persons do not discharge themselves before handling electrostatic sensitive modules and they can damage components thereby, causing the module to become inoperable or unusable. Modules that have been damaged by electrostatic discharges can fail after a temperature change, mechanical shock or changes in the electrical load. Only the consequent implementation of protection devices and meticulous attention to the applicable rules and regulations for handling the respective equipment can prevent failures of electrostatic sensitive modules.

Measurements and alterations on electrostatic sensitive modules

When you are conducting measurements on electrostatic sensitive modules you should take the following precautions:

- Floating instruments must be discharged before use.
- Instruments must be grounded.



CAUTION!

Personnel and instruments should be grounded when working on electrostatic sensitive modules.

1.5 Intended use

General

The product is exclusively designed and constructed for the intended use described in this manual. The product is intended used if all the notes and information of this manual are considered.



WARNING!

Danger by not intended use!

Each use of the product, which differs to the intended use can lead to dangerous situations.

Therefore

- Use the product only intended.
- Use the product only together with the recommended components.
- Consider all the data in this manual.
- Ensure that only qualified personnel work with/at the product.
↳ *Chapter 1.8 'Education of the personnel' on page 14*
- Ensure during configuration that the product is operated within its specifications.
- Ensure that the power supply corresponds to the given specifications.
- Only use the product in a technically perfect condition.
- Only use the product in combination with approved components.
- Only use the product in an area of second type (industrial area). The product was developed such as this fulfils the requirements of the category C3. For operation an approved power supply (SELV/PELV) is necessary. Here With the usage of the product in an area of first type, category C2/C1 (living-, business and trade without an interstage transformer directly at a public low-voltage-system) the cabinet builder has to reduce the emission (conducted and radiated) by special measure steps, which are to be demonstrated, since it can come without any additional measures to EMC disturbances. Whether a products described here reaches category C2/C1 with additional measures, cannot be ensured.

Changes and modifications at the product

To avoid endangerments and to ensure the optimal power neither changes nor modifications may be made at the product, which are not specially approved by the manufacturer.

1.6 Responsibility of the user

General

The product is used in the commercial range. The user of the product is subject of the statutory duties to work safety. In addition to the safety instructions in this manual, for the usage environment of the product valid safety, accident prevention and environmental protection regulations must be adhered.

- The user must be informed about the valid industrial safety regulations and determine in an endangerment evaluation additionally dangers, which arise as a result of the special conditions for the product on the place of operation. This is to be transcribed with working instructions for the operation of the product.
- These working instructions must be kept in direct environment of the product and accessible at any time for people, which work with the product.
- The working instructions must fully be adhered.
- The product is only to be operated in a technically flawless condition.

1.7 Protective devices

Protection

The place of installation of the safe field bus modules must comply for devices according to IP20.

1.8 Education of the personnel



WARNING!

Risk of injury resulting from insufficient qualification!

Improper use can cause considerable personal injury and material damage.

Therefore: The special activities may only be executed by personnel nominated by the respective chapters.

1.8.1 Qualification

In the manual the following qualifications for different activities are defined:

Operating personnel

The automation system may only be operated by persons, which are trained, instructed and authorized. Troubleshooting, maintenance, cleaning, maintenance and replacement must be performed only by skilled or trained personnel. These persons have to know the instruction manual and have to act accordingly. Commissioning and training should only be performed by qualified personnel.

Qualified personnel

These are electrical engineers and electricians of the customer or third party, which are authorized by the manufacturer and which have learned installation and commissioning by the manufacturer and are allowed to ground, mark and install electrical circuits and devices in accordance to the standard safety technology. Qualified personnel is trained and instructed according to the corresponding valid standards in safety technology in the care and use of appropriate safety equipment.

1.9 Personal protective equipment

General

During work, the wearing of personal protective equipment is needed to minimize health hazards.

- Always wear the necessary protective equipment for the corresponding job.
- For your own safety regard the signs, which are in your work space.

Work clothing



is close-fitting clothing with low tensile strength, with tight sleeves and without a protruding part. Depending on the application it should be prevented, that the carrier gets serious injured or is exposed to health risk during work. For reasons of injury no jewellery like rings and chains should be worn.

Protective helmet



for protection against falling and flying objects.

Safety shoes



for protection against falling heavy objects.

Protective gloves



to protect hands from friction abrasions, punctures or injuries, as well as from contact with hot objects.

**Wear at special works:
Eye protector**

to protect eyes from flying parts and liquid splashes.

1.10 Special hazards

General

In the following section the residual risks are listed. Regard the listed safety warnings here and the notes in the whole manual to reduce health hazards and to avoid dangerous situations.

Electric current**DANGER!****Risk of death by electric current!**

Contact with live parts is immediate danger to life. Damage of the insulation or of components can be danger to life.

Therefore: Immediately turn off the power supply when the insulation is damaged. Work on the electrical system only by qualified personnel. Always power-off and secure the electrical system during the work on it.

Risk by residual energy**DANGER!****Risk of death by electric current!**

After disconnecting the device from main voltage, parts such as power connections should only be touched when the capacitors are discharged in the device.

Therefore: Regard discharge time of the capacitors, do not touch live parts before. Regard corresponding instructions on the device. If you have connected additional capacitors on the link, the discharge of the link can last considerably longer. In this case you have to determine the required waiting period or even to measure whether the device is free of voltage.

Moved objects**WARNING!****Risk of injury from moving parts!**

Rotary respectively linear moved parts can cause serious injuries.

Therefore: Do not touch moving parts during operation. Do not open the cover during operation. The mechanical residual energy depends on the application. Driven components rotate respectively move for a certain time even after switching off the power supply. Here serve for suited safety devices.

1.11 Fire fighting

**DANGER!****Risk of death by electric current!**

Risk of an electrical shock when using a conducting fire fighting medium.



Therefore use the following fire fighting medium:

ABC powder / CO₂

1.12 Electrical safety

General

The System SLIO Safety is designed according to IEC61131-2 for degree of pollution 2. This means only non-conductive pollution may occur during operation. Temporary conductivity by condensation is only allowed when the module is out of operation.

**WARNING!****Risk of injury from conductive pollution!**

During the operation there is no conductive pollution allowed.

Therefore: Before the system is installed check and guarantee if necessary by additional measures that the degree of pollution 2 is not exceeded (e.g. installation in a cubicle with degree of protection IP54 or better).

Note to the power supply

**WARNING!****Risk of injury by electric current!**

There may only devices be connected to the module, which have a safe separation of the 230V power. The power supply to generate 24V power must correspond to the requirements for PELV/SELV according to EN 50178.

1.13 Safety facilities



WARNING!

Risk of death by non-functioning safety facilities!

Safety facilities serve for maximum safety during operation. Even if by safety facilities working process become complicated, its never allowed to circumvent them. The security is guaranteed only when the safety facilities are intact.

Therefore: Before beginning the work check whether the safety facilities are installed properly and functional.

1.14 Behavior with dangers and accidents

Preventive measures

- Always be prepared for accidents or fire!
- First-aid equipment (first aid kit, blankets etc.) and keep fire extinguisher handy.
- Make Personal with accident message, first-aid and rescue mechanisms familiar.

In case of emergency: act correctly

- Set immediately the device with emergency stop out of operation.
- Initiate first-aid measures.
- Rescue persons from the danger zone.
- Inform responsible on-site.
- Alarm medical and / or fire department.
- Make free the access routes for emergency vehicles.

1.15 Sign-posting



WARNING!

Danger of injury by illegible symbols

In course of time stickers and symbols on the equipment can get dirty or otherwise become unrecognizable.

Therefore: Please hold all the safety warnings and operation instructions on the device in always well readable condition.

1.15.1 Signs

The following symbols and signs are in the work space. They refer to the direct environment in which they are attached.

Electrical voltage

In the such marked work space only qualified personnel may work. Unauthorized may not touch the marked equipment.

**DANGER!****Danger of life by electrical power!**

Time for discharge > 1 Minute

Stored electrical charge

Therefore: Consider discharge time of capacitor and do not touch live parts before. Consider appropriate instructions on the device. If you have connected additional capacitors at DC, the discharge of the DC link can last longer. In this case you have to determine respectively to measure the required waiting time whether the device is free of voltage.

1.16 Safety hints

The modules of the System SLIO represent the current state of the art and fulfill the valid safety regulations and the appropriate harmonized, European standards (EN)

For the user additionally is valid the:

- relevant rules for the prevention of accidents
- EG directives or other country-specific regulations
- generally accepted safety rules
- general ESD regulations

Disturbances of any kind or other damage must be reported to a responsible person. Protective and safety equipment must not be circumvented or bypassed. Dismounted protective equipment must be mounted and functionally tested before a restart. The modules are to be secured against misuse or accidental use. Original mounted signs, labels, stickers are to be always considered and be held in a readable condition.

1.17 Functional safety - safety relevant parameters**General**

This chapter describes characteristics associated to functional safety. In according to IEC 61508 safety means that the residual error probability of the whole system below the standard limits. In accordance to the whole system internal safety-relevant device errors must be detected and be led to a safe condition.

Safety relevant parameters

The values here refer to the modules of this manual. Safety relevant characteristics may always be found in the according manuals of the modules.

Functional safety - safety relevant parameters

**Characteristics SDI
4xDC 24V**


| Characteristics according to IEC 61508 | Meaning |
|--|--|
| PFH = $0.25 * 10^{-9}/h$ | Probability of failure per Hour: Probability of danger failure per hour. |
| PFDavg = $2.14 * 10^{-5}$ | Probability of Failure on Demand average: Average of probability of failure on demand. |
| SFF according SIL 3 | Safe Failure Fraction: Fraction of failure, which lead to a safe state. |

| Characteristics according to DIN EN ISO 13849-1 | Meaning |
|---|---|
| MTTFd: high | Mean Time To dangerous Failure |
| DCavg: high | Diagnostic Coverage average |
| Device life: 20 Years | During the expected life of the device of up to 20 years, no proof test is required. After this interval, the system SLIO safety module must be decommissioned and sent back to the vendor. |

**Characteristics SDO
4xDC 24V, 0.5A**

| Characteristics according to IEC 61508 | Meaning |
|--|--|
| PFH = $0,22 * 10^{-9}/h$ | Probability of failure per Hour: Probability of danger failure per hour. |
| PFDavg = $1,85 * 10^{-5}$ | Probability of Failure on Demand average: Average of probability of failure on demand. |
| SFF according SIL 3 | Safe Failure Fraction: Fraction of failure, which lead to a safe state. |

| Characteristics according to DIN EN ISO 13849-1 | Meaning |
|---|---|
| MTTFd: high | Mean Time To dangerous Failure: |
| DCavg: high | Diagnostic Coverage average: |
| Device life: 20 Years | During the expected life of the device of up to 20 years, no proof test is required. After this interval, the system SLIO safety module must be decommissioned and sent back to the vendor. |

 **CAUTION!** If the user calculates his safety application with the specified data for e.g. 10 years, the safety controller is to be decommissioned and sent back to the vendor at the end of its lifetime. A proof test cannot be established by the user.

1.18 Approvals, directives, standards

Conformity and approval

| | | |
|------------|------------|--|
| Conformity | | |
| CE | 2014/35/EU | EMC directive |
| | 2014/30/EU | Machinery directive |
| others | | |
| RoHS | 2011/65/EU | Restriction of the use of certain hazardous substances |

Protection of persons and device protection

| | | |
|---------------------------------------|------------|-----------------------------------|
| Type of protection | - | IP20 |
| Electrical isolation | | |
| to the field bus | - | electrically isolated |
| to the process level | - | electrically isolated |
| Insulation resistance | EN 61131-2 | - |
| Insulation voltage to reference earth | | |
| Inputs / outputs | - | AC / DC 50V, test voltage AC 500V |
| Protective measures | - | against short circuit |

Environmental conditions to EN 61131-2

| | | |
|---------------------------------|---------------|---|
| Climatic | | |
| Storage / transport | EN 60068-2-14 | -25...+70°C |
| Operation | | |
| Horizontal installation hanging | EN 61131-2 | 0...+60°C |
| Horizontal installation lying | EN 61131-2 | 0...+55°C |
| Vertical installation | EN 61131-2 | 0...+50°C |
| Air humidity | EN 60068-2-30 | RH1 (without condensation, rel. humidity 10... 95%) |
| Pollution | EN 61131-2 | Degree of pollution 2 |
| Installation altitude max. | - | 2000m |
| Mechanical | | |
| Oscillation | EN 60068-2-6 | 1g, 9Hz ... 150Hz |
| Shock | EN 60068-2-27 | 15g, 11ms |

Mounting conditions

| | | |
|-------------------|---|--|
| Mounting place | - | In the control cabinet (IP54 or better) |
| Mounting position | - | Horizontal hanging ↗ <i>Chapter 3.4.3 'Mounting Proceeding' on page 79</i> |

| EMC | Standard | Comment | |
|-----------------------|--------------|---------------------------|---|
| Emitted interference | EN 61000-6-4 | Class A (Industrial area) | |
| Noise immunity zone B | EN 61000-6-2 | Industrial area | |
| | | EN 61000-4-2 | ESD 8kV at air discharge (degree of severity 3), 4kV at contact discharge (degree of severity 2), |
| | | EN 61000-4-3 | HF field immunity (casing) 80MHz ... 1000MHz, 10V/m, 80% AM (1kHz) 1,4GHz ... 2,0GHz, 3V/m, 80% AM (1kHz) 2GHz ... 2,7GHz, 1V/m, 80% AM (1kHz) |
| | | EN 61000-4-6 | HF conducted 150kHz ... 80MHz, 10V, 80% AM (1kHz) |
| | | EN 61000-4-4 | Burst, degree of severity 3 |
| | | EN 61000-4-5 | Surge, installation class 3 * |

Due to the high-energetic single pulses with Surge an appropriate external protective circuit with lightning protection elements like conductors for lightning and over-voltage is necessary.

Example of lightning protection conductors

| Application | Vendor | Article | Description |
|---------------------------------------|--------|------------------------------------|---|
| Feed | Dehn | BLITZDUCTOR VT BVT AVD 24 | External Lightning protection (DC24V/10A) |
| Digital inputs, test pulse outputs | Dehn | DEHNconnect RK DCO RK ME 24 | External Lightning protection (DC24V/0.5A) |
| Digital outputs | Dehn | DEHNconnect RK DCO RK D 5 24 | External Lightning protection (DC24V/10A) |
| PROFIBUS interface | Dehn | BLITZDUCTOR XT BXT ML2 BD HFS 5 | External Lightning protection (RS485/5V) |
| PROFINET interface | Dehn | DEHNpatch DPA M CLE RJ45B 48 | External Lightning protection (RJ45/48V) |

Approvals, directives, standards

Norms and standards

| | |
|-----------------------|---|
| DIN EN 61508 part 1-7 | Functional safety of electrical/electronic/programmable electronic safety-related systems |
| DIN EN ISO 13849-1 | Safety of machinery: Safety-related parts of control systems |
| DIN EN 61784-3 | Functional safety field buses - General rules and profile definitions |
| DIN EN 60204-1 | Electrical equipment of machines |
| DIN EN 61131-2 | Programmable logic controllers, part 2: Equipment requirements and tests |
| DIN EN 61000-4-11 | Mains voltage variation |
| Row SN 29500 | Failure rate, component, expected value, reliability |
| DIN EN 61496-1 | Electro sensitive protective equipment |

Requirements to clearance / creep-age current distances and system power supply

| | |
|----------------|--|
| DIN EN 61131-2 | The definition of clearance and creep-age current distances takes place in accordance to EN 61131-2. For the safe field bus coupler over-voltage category 2 and degree of pollution 2 are basis. |
| DIN EN 13849 | The acceptance of error exclusions for short-circuits between neighbouring conductor or for short-circuits between neighbouring components must be avoided as far as possible by suitable circuit and layout measures. If an error exclusion is inevitable, measures are to be used in accordance with EN 13849 part of 2. |
| DIN EN 50178 | The device is developed for operation on 24V power supplies, which correspond to the PELV-/SELV regulations in accordance to EN 50178. |
| DIN EN 61508 | The normative requirements of the 61508 (increased EMC requirements and requirements concerning isolation) are to be fulfilled also for the common voltage circuit of the SLIO system. |
| DIN EN 50178 | So that the electrical values for extra-low voltage with safe separation cannot be exceeded on the safe field bus coupler, for the system 24V power supplies are exclusively used, which correspond to the PELV /SELV regulations in accordance with EN 50178. |
| | In order to protect the safe field bus couplers against over-voltage, a suitable over-voltage protection is provided. |
| DIN EN 60204-1 | The 24V power supply must keep the voltage interrupt according to EN 60204-1. |

Requirements for environmental and EMC testing

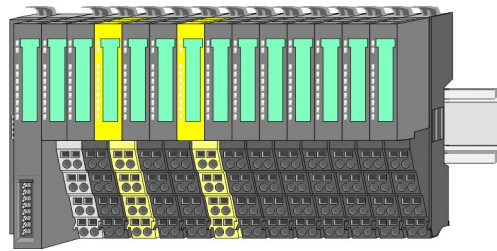
| | |
|-------------------------|---|
| DIN EN 61131-2 | Programmable logic controllers, part 2: Equipment requirements and tests |
| DIN EN 62061 Appendix E | For the EMC immunity tests, the increased requirements according to appendix E of EN 62061 are applied. |

2 Product description

2.1 System conception

Overview

System SLIO is a modular automation system for assembly on a 35mm mounting rail. By means of the peripheral modules with 2, 4 or 8 channels this system may properly be adapted matching to your automation tasks. The wiring complexity is low, because the supply of the DC 24V power section is integrated to the backplane bus and defective modules may be replaced with standing wiring. By deployment of the power modules in contrasting colors within the system, further isolated areas may be defined for the DC 24V power section supply, respectively the electronic power supply may be extended with 2A.

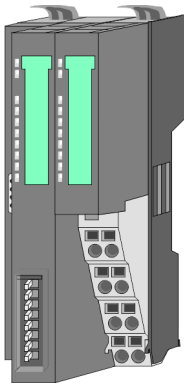


Components

The System SLIO consists of the following components:

- Bus coupler
- Periphery modules
- Power modules
- Accessories

Bus coupler



With a bus coupler bus interface and power module is integrated to one casing. With the bus interface you get access to a subordinated bus system. Via the integrated power module for power supply the bus interface is supplied as well as the electronic of the connected periphery modules. The DC 24 power section supply for the linked periphery modules is established via a further connection. By installing of up to 64 periphery modules at the bus coupler, these are electrically connected, this means these are assigned to the backplane bus, the electronic modules are power supplied and each periphery module is connected to the DC 24V power section supply.

Bus coupler for System SLIO safety modules

The System SLIO safety modules of this manual can be used with the following bus coupler:

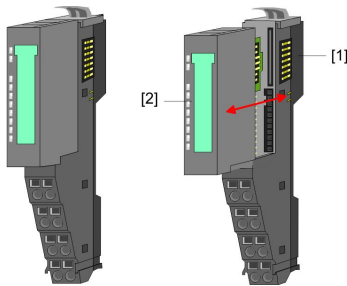
- 053-1DP00 - PROFIBUS DP: Firmware V1.3.0 and up and GSD file (SLIO) V223 and up
- 053-1PN00 - PROFINET: Firmware V1.1.7 and up and GSDML file (SLIO) V116 and up

Configuration of the System SLIO safety modules

The System SLIO Safety modules are configured by means of the *VIPA Safety CRC Tool*. This tool can be accessed in the SIMATIC Manager from version V5.4. To completely carry out the configuration there, from version 5.4 an additional program package *S7 Distributed Safety* from Siemens is necessary. Starting from Version 1.1.0.9 of the *VIPA Safety CRC Tool* the configuration in the Siemens TIA Portal V13 is supported.

Periphery modules

Each periphery module consists of a *terminal* and an *electronic* module.



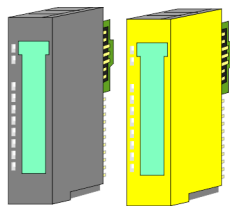
- 1 Terminal module
- 2 Electronic module

Terminal module



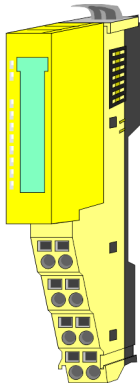
The *terminal* module serves to carry the electronic module, contains the backplane bus with power supply for the electronic, the DC 24V power section supply and the staircase-shaped terminal for wiring. Additionally the terminal module has a locking system for fixing at a mounting rail. By means of this locking system your SLIO system may be assembled outside of your switchgear cabinet to be later mounted there as whole system.

Electronic module



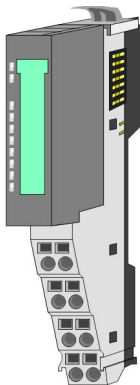
The functionality of a SLIO periphery module is defined by the *electronic* module, which is mounted to the terminal module by a sliding mechanism. With an error the defective module may be exchanged for a functional module with standing installation. At the front side there are LEDs for status indication. For simple wiring each module shows a corresponding connection diagram at the front and at the side.

Safety periphery modules



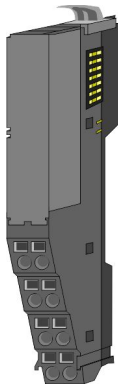
According to structure and dimensions the *safety periphery modules* correspond to the standard periphery modules of the System SLIO. For better recognition the color of the safety modules is yellow. Please consider that the safety electronic module may only be used at an yellow terminal module! The operation with mechanical compatible terminal modules is not allowed.

Power modules



In the System SLIO the power supply is established by *power modules*. These are either integrated to the bus coupler or may be installed between the periphery modules. Depending on the power module isolated areas of the DC 24V power section supply may be defined respectively the electronic power supply may be extended with 2A. For better recognition the color of the power modules are contrasting to the periphery modules.

Clamp modules



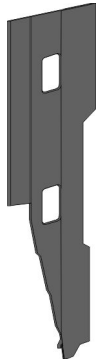
A *clamp module* is a distributor module. According to the module GND respectively DC 24V of the power section supply may be accessed by the clamp connectors. The backplane bus is looped through the module. So this module has no module ID, but influences the maximum number of modules to be connected.

Accessories



Shield bus carrier

The shield bus carrier serves to carry the shield bus (10mm x 3mm) to connect cable shields. Shield bus carriers, shield bus and shield fixings are not in the scope of delivery. They are only available as accessories. The shield bus carrier is mounted underneath the terminal of the terminal module. With a flat mounting rail for adaptation to a flat mounting rail you may remove the spacer of the shield bus carrier.

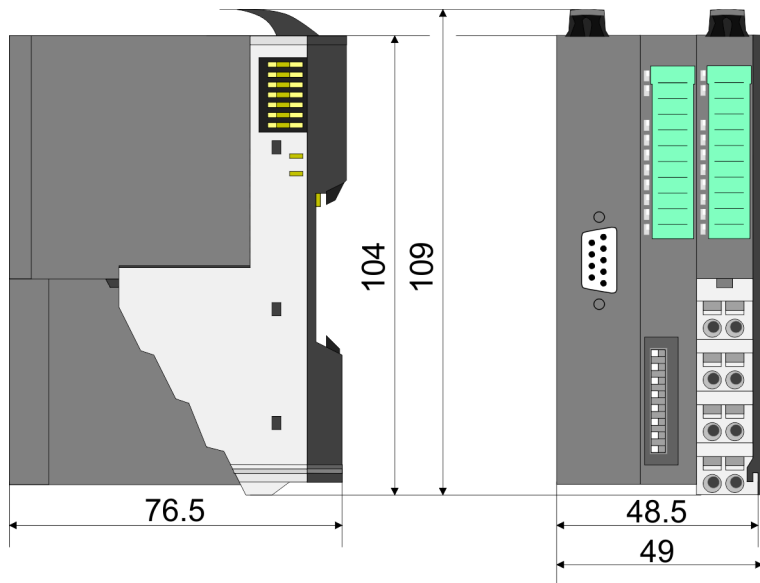


Bus cover

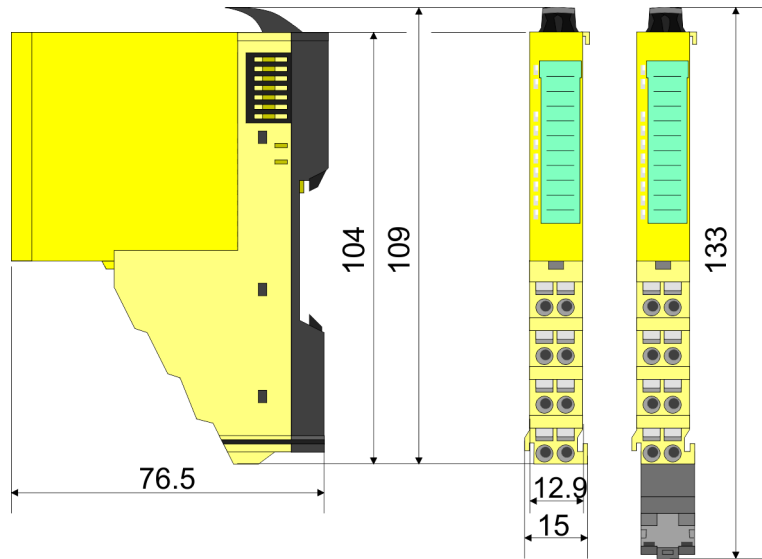
With each bus coupler, to protect the backplane bus connectors, there is a mounted bus cover in the scope of delivery. You have to remove the bus cover of the bus coupler before mounting a SLIO module. For the protection of the backplane bus connector you always have to mount the bus cover at the last module of your system again. If this is a clamp module, for adaptation the upper part of the bus cover can be cut off.

2.2 Dimensions

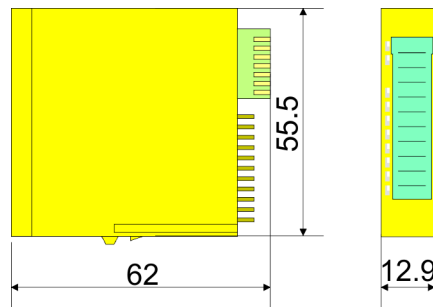
Dimensions bus coupler



Dimensions periphery module (here Safety)



Dimensions electronic module (here Safety)



Dimensions in mm

The dimensions of the System SLIO safety modules are identical to those of the System SLIO standard modules.

2.3 SDI 4xDC 24V - Operating and display elements

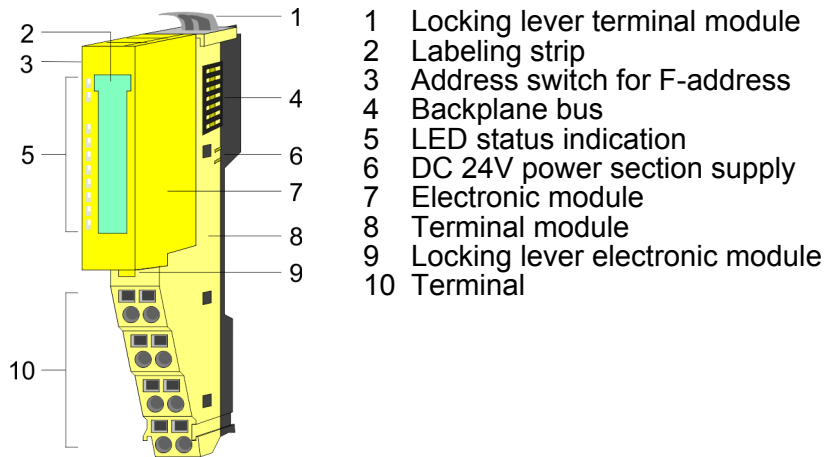
Description

The electronic module collects the binary control signals from the process level and transmits them isolated to the central bus system. It has 4 channels and their status is monitored via LEDs.

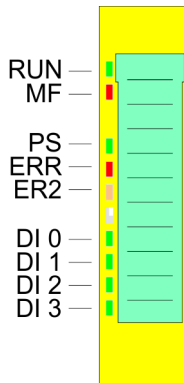
Properties

- 4 digital Inputs isolated to the backplane bus
- Status indication of the channels via LEDs
- Safety module with automatic disconnection in case of error according to IEC 61508 SIL3 and EN ISO 13849-1, Cat.4/PLe

Structure



Status indication



| RUN | MF | Description |
|-------|-----|---|
| green | red | |
| | | |
| • | ○ | Bus communication is OK Module status is OK |
| • | • | Bus communication is OK Module status reports an error |
| ○ | • | Bus communication is not possible Module status reports an error |
| ○ | ○ | Error at bus power supply |
| B | B | Error in configuration |

on: • | off: ○ | blinking with 0.5Hz: B

| LED | Color | Description | |
|------|------------|-------------|--|
| PS | green | • | PROFIsafe communication in data exchange |
| | | BB | Safety parametrization expected |
| | | B | Error - acknowledgement expected |
| | | ○ | Module initialization is running |
| ERR | red | • | Permanent fail-safe condition |
| | | C | Blink code ↗ 'ERR LED' on page 33 |
| ERR2 | yellow | C | Blink code ↗ 'ER2 LED' on page 33 |
| | | B | Requesting fail-safe state |
| DI x | green | • | Digital input is triggered |

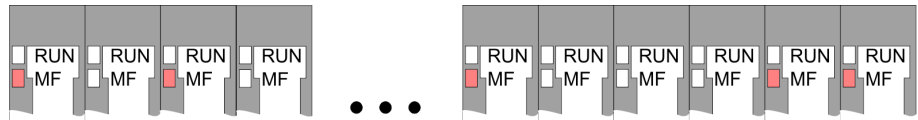
on: • | off: ○ | blinking with 0.5Hz: B | blinking with 2Hz: BB | Blink code: C

RUN and MF LED

Each module has the LEDs RUN and MF on its front side. Errors or incorrect modules may be located by means of these LEDs.

In the following illustrations flashing LEDs are marked by ☼.

Sum current of the electronic power supply exceeded

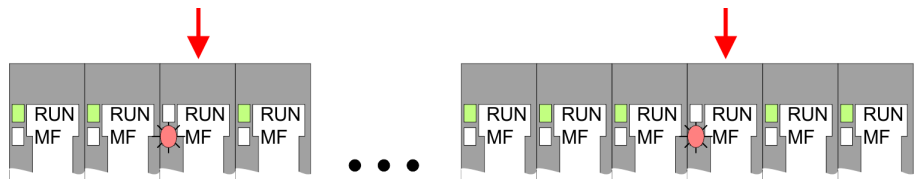


Behaviour: After PowerON the RUN LED of each module is off and the MF LED of each module is sporadically on.

Cause: The maximum current for the electronic power supply is exceeded.

Remedy: As soon as the sum current of the electronic power supply is exceeded, always place the power module 007-1AB10. ↪ Chapter 3.6 'Wiring' on page 88

RUN and MF LED - Error in configuration

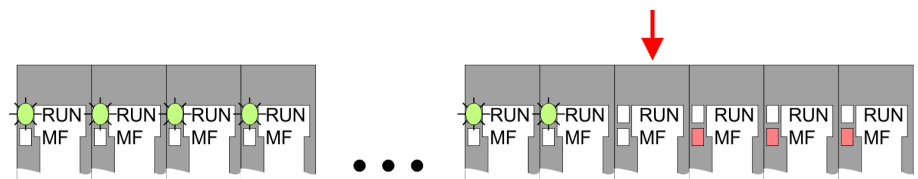


Behaviour: After PowerON the MF LED of one module respectively more modules flashes. The RUN LED remains off.

Cause: At this position a module is placed, which does not correspond to the configured module.

Remedy: Match configuration and hardware structure.

RUN and MF LED - Module failure



Behaviour: After PowerON all of the RUN LEDs up to the defective module are flashing. With all following modules the MF LED is on and the RUN LED is off.

Cause: The module on the right of the flashing modules is defective.

Remedy: Replace the defective module.

ERR LED

The LED is permanently on at a critical error, which led into a permanent fail-safe state, which may not be acknowledged.

On error like short-circuit, cross-circuit and so on, the ERR LED shows an error by the following blink behaviour. The LED gets off for 2s. Then it shows the following code 1 ... 6 by blinking with 1Hz:

Blink code

| Blinking | Error | External error |
|----------|---|----------------|
| 1x | Short-circuit within a channel | yes |
| 2x | Cross-circuit error between 2 channels | yes |
| 3x | Discrepancy error between 2 channels | yes |
| 4x | --- | --- |
| 5x | Other errors | no |
| 6x | F-address was changed ↪ <i>Chapter 3.3 'Setting the F-address' on page 75</i> | no |

After the blink code the LED gets off for 2s and then starts again with the code output. Normally an *external error* is caused by wiring respectively by a connected sensor. Please check also your parameters for the sensor.

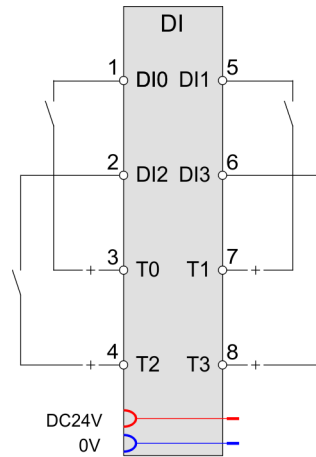
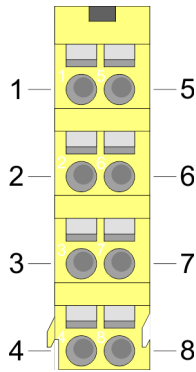
ER2 LED

If an external error was reported by the ERR LED, the LED ER2 indicates the faulty channel by the following blink code:

- The ER2 LED gets off for 2s.
- Then it indicates the number of the faulty channel by blinking with 1Hz. Here it is valid blinking 1x...4x means channel DI 0 ... 3.
- After the blink code the LED gets off for 2s and then starts again with the code output.
- If there are more errors pending, only the 1. recognized error is indicated.
- If the LED blinks with 0.5Hz the safety control system requests a fail-safe state of the System SLIO safety module. But there is no error on the System SLIO safety module. This request may occur, for example after a brief interrupt of the communication and may be acknowledged. ↪ *'Error acknowledgement' on page 144*

Terminal

For wires with a core cross-section of 0.08mm² up to 1.5mm².

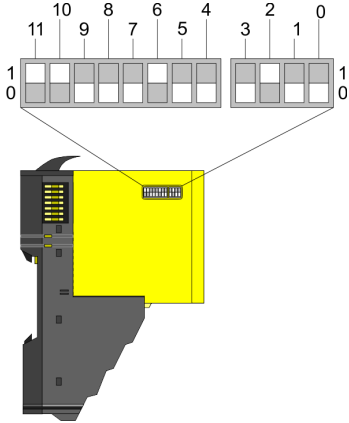


| Pos. | Function | Type | Description |
|------|----------|------|--------------------|
| 1 | DI 0 | I | Digital input DI 0 |
| 2 | DI 2 | I | Digital input DI 2 |
| 3 | T0 | O | Clock output T0 |
| 4 | T2 | O | Clock output T2 |
| 5 | DI 1 | I | Digital input DI 1 |
| 6 | DI 3 | I | Digital input DI 3 |
| 7 | T1 | O | Clock output T1 |
| 8 | T3 | O | Clock output T3 |

I: Input, O: Output

Address switch for F-address

The F-address is to be configured by the F-address switch at the VIPA safety module and additionally in the master system e.g. hardware configurator. The F-address is to be set by the F-address switch besides on the safety module. Only if the F-address set in the hardware configurator accords to the setting of the F-address switch, it is possible to operate!



| Pos. | Value | Example | |
|------|-------|---------|--------------------------------|
| | | State | Address |
| 0 | 1 | 1 | 1+2+32+512=547 Address: 547 |
| 1 | 2 | 1 | |
| 2 | 4 | 0 | |
| 3 | 8 | 0 | |
| 4 | 16 | 0 | |
| 5 | 32 | 1 | |
| 6 | 64 | 0 | |
| 7 | 128 | 0 | |
| 8 | 256 | 0 | |
| 9 | 512 | 1 | |
| 10 | 1024 | 0 | |
| 11 | 2048 | 0 | |



When the module is installed, the F-address switch may not be accessed!

To set the F-address on the safety module the (electronic) module is to be demounted before as described at "Demounting and module exchange". ↪ Chapter 3.5 'Demounting and module exchange' on page 84

2.4 SDI 4xDC 24 V - Process Image

Input/Output area - PROFIsafe-V2-Mode

The safety DI module occupies 5 data bytes each in the input and output image of the superordinate safety PLC system. The data to be sent and received are stored in the input and output byte 0 ... 4.

Input area

| Addr. | Name | Byte | Input data |
|-------|-----------|------|--|
| +0 | PII | 0 | PROFIsafe Inputs <ul style="list-style-type: none"> ■ Bit 0: DI 0 ■ Bit 1: DI 1 ■ Bit 2: DI 2 ■ Bit 3: DI 3 ■ Bit 7 ... 4: reserved |
| +1 | PII_STAT | 1 | PROFIsafe Status |
| +2 | PII_RN | 2 | PROFIsafe CRC2 byte 2 |
| +3 | PII_CRC_H | 3 | PROFIsafe CRC2 byte 1 |
| +4 | PII_CRC_L | 4 | PROFIsafe CRC2 byte 0 |

Output area

| Addr. | Name | Bytes | Output data |
|-------|-----------|-------|-----------------------|
| +0 | PIQ | 0 | reserved |
| +1 | PIQ_CTRL | 1 | PROFIsafe Control |
| +2 | PIQ_RN | 2 | PROFIsafe CRC2 byte 2 |
| +3 | PIQ_CRC_H | 3 | PROFIsafe CRC2 byte 1 |
| +4 | PIQ_CRC_L | 4 | PROFIsafe CRC2 byte 0 |

2.5 SDI 4xDC 24V - Parameter record set

2.5.1 Parameter data

Record set 81h (iParameter) This record set is once transferred during start-up by the standard parameter telegram.

Parameter

| Name | Type | Description / range of values | Default |
|--|--------|---|---------|
| Parameter change mode | Bit | 0: normal parameter record set 1: Parameter change F-address | 0 |
| Behavior after channel errors | Bit | 0: Passivate the entire module | 0 (fix) |
| Activation diagnostic interrupt | Bit | 0: deactivated 1: activated This bit is not safety-related. | 1 |
| Channel 0, 1: Activation | Bit | 0: deactivated 1: activated | 1 |
| Channel 0, 1: Input smoothing time in ms | UINT16 | Condition: Channel 0, 1 Activation is "activated" 1-1000 | 1 |
| Channel 0, 1: Test pulse activation | Bit | Condition: Channel 0, 1 Activation is "activated" 0: activated 1: deactivated The test pulse activation also switches on the short-circuit and cross-circuit recognition. | 0 |
| Channel 0, 1: Evaluation of the inputs | Bit | Condition: Channel 0, 1 Activation is "activated" 0: 1-channel 1: 2-channel | 1 |
| Channel 0, 1: Signal polarity | Bit | Condition: Channel 0, 1 Activation is "activated" Condition: Channel 0, 1 Evaluation of the inputs is "2-channel" 0: equivalent 1: antivalent | 0 |
| Channel 0, 1: Discrepancy time in ms | UINT16 | Condition: Channel 0, 1 Activation is "activated" Condition: Channel 0, 1 Evaluation of the inputs is "2-channel" 1-30000 | 20 |

| Name | Type | Description / range of values | Default |
|--|--------|--|---------|
| Channel 0, 1: Discrepancy error (re-integration after discrepancy error) | Bit | Condition: Channel 0, 1 Activation is "activated" Condition: Channel 0, 1 Evaluation of the inputs is "2-channel" 0: Test 0-signal required 1: Test 0-Signal not required | 0 |
| Channel 2, 3: Activation | Bit | 0: deactivated 1: activated | 1 |
| Channel 2, 3: Input smoothing time in ms | UINT16 | Condition: Channel 2, 3 Activation is "activated" 1-1000 | 1 |
| Channel 2, 3: Test pulse activation | Bit | Condition: Channel 2, 3 Activation is "activated" 0: activated 1: deactivated The test pulse activation also switches on the short-circuit and cross-circuit recognition. | 0 |
| Channel 2, 3: Evaluation of the inputs | Bit | Condition: Channel 2, 3 Activation is "activated" 0: 1-channel 1: 2-channel | 1 |
| Channel 2, 3: Signal polarity | Bit | Condition: Channel 2, 3 Activation is "activated" Condition: Channel 2, 3 Evaluation of the inputs is "2-channel" 0: equivalent 1: antivalent | 0 |
| Channel 2, 3: Discrepancy time in ms | UINT16 | Condition: Channel 2, 3 Activation is "activated" Condition: Channel 2, 3 Evaluation of the inputs is "2-channel" 1-30000 | 20 |
| Channel 2, 3: Discrepancy error (re-integration after discrepancy error) | Bit | Condition: Channel 2, 3 Activation is "activated" Condition: Channel 2, 3 Evaluation of the inputs is "2-channel" 0: Test 0-signal required 1: Test 0-Signal not required | 0 |

Parameter change mode

For a valid parameterization this parameter must be set to 0 (default value). If the F-address of a System SLIO safety module is to be changed, the F-address in the memory of the module can be erased by setting this parameter. ↪ *Chapter 3.3 'Setting the F-address' on page 75*

Behavior after channel errors

If the SDI module detects an error at one of the input channels (e.g. short circuit), then the whole System SLIO safety module is passivated. Here, the module provides the safety control system as long with the fail-safe value 0 for the inputs until the error is fixed and acknowledged. ↪ *'Error acknowledgement' on page 144*

Activation diagnostic interrupt

Here you activate res. de-activate the diagnostic interrupt function. With a set diagnostic interrupt bit in case of an error a diagnostic interrupt message is sent to the upper master system. There the diagnostics message can further be processed. More may be found in the manual of the master system.

Channel activation

- With the *channel activation* channel groups may be activated or deactivated. With *channel activation* = 1 the corresponding channel group is in "standard operation".
- Deactivated channel groups (*channel activation* = 0) permanently provide a logical 1 during the cyclic data exchange as input information to the safety control system as long as the module is not passivated. This serves to bridge non-existing sensors e.g. during commissioning or variations of machines, without adjustment of the safety program in the safety control system.

**CAUTION!**

Deactivation of channel groups represents a potentially dangerous condition!

The usage of the *channel activation* must be taken into account during planning and constructing the safety program!

Input smoothing time

Errors on the input signals can be suppressed by specifying an *input smoothing time*. This is used for debouncing sensors. If there is an active safety sensor connected to an input, which tests the wired lines by test pulses, then the *input smoothing time* must always be greater than the max. test pulse length of the sensor. Please also refer to the "Connection examples". ↪ *Chapter 3.7 'Connection examples' on page 96*



The input smoothing time is included in the calculation of the max. system response time! ↪ *Chapter 2.11 'Response time' on page 64*

Test pulse activation

- When using sensors with mechanical or electromechanical contacts, to detect a short circuit to DC 24V, for each channel group a test pulse can be activated. For test pulse output each System SLIO safety module has a DC 24V power supply output for each channel group.
- When activated (*test pulse activation* = 0) the DC 24V power supply output is shortly set to 0V at defined intervals. Here the return of the test pulse is observed by each input channel, provided the sensor is currently closed. Here wiring errors or short and cross circuits can be detected.
- This function is to be deactivated (*test pulse activation* = 1) if there is an active sensor (e.g. light array) connected to the input with integrated electronic and semiconductor output. Here the active sensor serves for the observation of the connected lines by generating the test pulse to check the switch-off ability. Here the input smoothing time of the corresponding safety input must be greater than the test pulse length of the output of the safety sensor (vendor information). Please also refer to the "Connection examples". ↪ *Chapter 3.7 'Connection examples' on page 96*

Evaluation of the inputs

Here for each channel group you can set the evaluation of the inputs as 1-channel or 2-channel evaluation:

- With "1-channel" evaluation one sensor with one output is connected to one channel.
- With "2-channel" evaluation one sensor with one output is connected to one channel. Here the sensor supplies by both connectors the same signal state. With "2-channel" evaluation more short and cross circuits may be detected as with "1-channel" evaluation. This kind of 2-channel connection allows to achieve higher safety levels like SIL 3 and PL e. Please also refer to the "Connection examples". ↪ *Chapter 3.7 'Connection examples' on page 96*

Signal polarity

With the parameter signal polarity with 2-channel evaluation the inputs of your System SLIO safety module may be adapted to the signal polarity of your sensor. The 1. channel always supplies the current input signal of the sensor. Independent of the signal polarity, in the safety control system the resulted input value (corresponds to the polarity of the 1. channel) is passed to both input bits of a channel group.

- With *equivalent* signal polarity the 2. channel supplies the same value as the 1. channel.
- With an *antivalent* signal polarity the signal is inverted by the 2. channel of the sensor. Antivalent signals are found e.g. at connecting safety doors. By this way simple manipulations can be prevented.

Discrepancy time

- During the switching operation of 2-channel sensors, temporarily both channels do not supply the same signal state. With the *discrepancy time* you can set the time until both channels have valid values after switching.
- If the discrepancy time is exceeded, the System SLIO safety module gets to fail-safe state.
- It is valid for electrical and electromechanical sensors:
Discrepancy to be set = real signal discrepancy (switch and bounce time of the sensor) + set *Input smoothing time* + 7 ms
- It is valid for active sensors with semiconductor output (and own test pulse generation):
Discrepancy to be set = real signal discrepancy + set *Input smoothing time* * 3 + 4 ms



Please consider with mechanical sensors and increasing abrasion by e.g. contact bounce, the discrepancy time increases and this is reported as error by the System SLIO safety module.

In this case, in order to avoid failure of a sensor, during operation a defective sensor must immediately be changed!

Re-integration after discrepancy error

This parameter allows you to define how you can acknowledge a discrepancy error.

- With 0 of this parameter, a discrepancy error can only be acknowledged when the sensor supplies 0 signal. For example, an emergency stop switch must be pressed.
- With 1 of this parameter, a discrepancy error can only be acknowledged when both sensors supply a valid signal state (depending on the parametrization equivalent or antivalent).

↪ *'Error acknowledgement' on page 144*

2.5.2 Overview PROFIsafe F parameters

| F Parameter | Description | Default | | | | |
|-------------------|---|---------------|--------------|-------------------|------------|------------|
| F_SIL | <p>The parameter <i>F_SIL</i> specifies the required safety integrity class of the SLIO safety module.</p> <p>The SLIO safety module supports up to SIL3.</p> | SIL 3 | | | | |
| F_CRC_Length | <p>The parameter <i>F_CRC_Length</i> specifies the length of the CRC2 key to be used in the PROFIsafe telegram.</p> <p>The required length depends on the length of the user data to be transferred. Valid combinations are:</p> <table border="1"> <tr> <td>F_Par_Version</td> <td>F_CRC_Length</td> </tr> <tr> <td>PROFIsafe-V2-Mode</td> <td>3-Byte-CRC</td> </tr> </table> | F_Par_Version | F_CRC_Length | PROFIsafe-V2-Mode | 3-Byte-CRC | 3-Byte-CRC |
| F_Par_Version | F_CRC_Length | | | | | |
| PROFIsafe-V2-Mode | 3-Byte-CRC | | | | | |
| F_Block_ID | <p><i>F_Block_ID</i> specifies the format of the F parameter set.</p> <p>Value 1 indicates that <i>F_iPar_CRC</i> is a part of the F parameters.</p> | 1 | | | | |
| F_Par_Version | <p><i>F_Par_Version</i> specifies the PROFIsafe version to be used for communication.</p> <p>The System SLIO safety module supports with PROFIBUS and PROFINET PROFIsafe-V2-mode and uses the version specified by this parameter:</p> <table border="1"> <tr> <td>F_Par_Version</td> </tr> <tr> <td>V2-mode</td> </tr> </table> | F_Par_Version | V2-mode | V2-mode | | |
| F_Par_Version | | | | | | |
| V2-mode | | | | | | |
| F_Source_Add | <p><i>F_Source_Add</i> specifies the PROFIsafe source address. To prevent incorrect parameterization, the address of the configuration tool is automatically assigned and cannot be changed. The Parameter can accept values from 1 to 65534.</p> | 2000 | | | | |
| F_Dest_Add | <p><i>F_Dest_Add</i> specifies the PROFIsafe destination address of the SLIO safety module. For <i>F_Dest_Add</i> values from 1 to 4095 can be selected. Each address value may appear in the system once, which is accessed by the safety PLC.</p> <p>To establish the PROFIsafe communication the parameter value must match the setting of the F-address of the SLIO safety module, which is set by the DIP switch. ↪ Chapter 3.3 'Setting the F-address' on page 75</p> | 200 | | | | |

| F Parameter | Description | Default |
|-------------|---|---------|
| F_WD_Time | <p>The parameter <i>F_WD_Time</i> determines the monitoring time for the PROFI-safe communication between F controller and System SLIO safety module.</p> <p>At least on valid PROFI-safe telegram must be exchanged between the safe PLC and the SLIO safety module within the monitoring time.</p> <p>If this condition is not met, the safe PLC or the SLIO safety module initiates a safe state.</p> <p>The monitoring time must be selected, so that telegram execution times are tolerated, but an interruption in the connection is detected quickly enough. ↪ <i>'Calculating the F_WD_Time' on page 44</i></p> <p>Below you can find information about the calculation.</p> <p>The monitoring time can be specified in steps of 1 ms. The possible range of value (1 to 65535 ms) is specified by the device description file (GSD/GSDML).</p> | 150 |
| F_iPar_CRC | <p>The parameter <i>F_iPar_CRC</i> specifies a comparison value for the CRC value via the iParameter (<i>iPar_CRC</i>). The PROFI-safe data exchange only starts when the value for <i>F_iPar_CRC</i> and the <i>iPar_CRC</i> match.</p> <p>After confirmation of the set parameters the CRC (<i>iPar-CRC</i>) is calculated and displayed by the VIPA Safety CRC-Tool.</p> <p>This value must be entered with the configuration tool of the safe PLC to the F parameter of the SLIO safety module.</p> | 0 |

Calculating the F_WD_Time

Thus the running PROFIsafe watchdog in the SLIO safety modules is reset periodically, that this does not release, the following cyclically data flow (circulation of a token) is to be considered:



The time required for this can be regarded as the full circulation time of a token. Thus the minimum PROFIsafe monitoring time to be configured results in:

$$T_{PSTO} = T_{Slave} + T_{BUS} + T_{CI} + T_{BUS} + T_{Slave} + T_{DAT}$$

$$T_{PSTO} = 2 * T_{Slave} + 2 * T_{BUS} + T_{CI} + T_{DAT}$$

| Component | Time | Meaning | from |
|-----------------------------|-------------|---|--|
| System SLIO safety module | T_{PSTO} | Configured PROFIsafe monitoring time (<i>F_WD_Time</i>) | refer to the formula above |
| Bus coupler | T_{Slave} | Max. response time of the decentralized peripheral system = max. delay by the bus coupler and the backplane bus | Documentation of the decentralized periphery system (for System SLIO PROFIBUS and PROFINET < 2ms) |
| Field bus | T_{Bus} | Response time of the field bus | T_{TR} at PROFIBUS res. T_{WD} at PROFINET |
| Either Field bus (PROFIBUS) | T_{TR} | max. target rotation time for the DP master system | Object properties of the DP master system, bus parameters in the HW configuration. |
| Or Field bus (PROFINET) | T_{WD} | threshold monitoring of the PROFINET IO device | Value from the object properties of the PROFINET IO device Tab "IO cycle", in HW config. If there is no threshold monitoring time configured for the IO device, instead of this you can take the given refresh time multiplied with 3. The refresh time can be found in the HW config. at object properties of the PROFINET IO system. |

| Component | Time | Meaning | from |
|--------------------|-----------|--|--|
| F-PLC / F-Logic | T_{CI} | Configured cycle time the F-runtime group is called | Configured timing (cycle time) for calling the F-runtime group. By processing of higher priority interrupts, by communication load, or by testing and commissioning functions, the distance between the start times can increase. The influence of these factors can be determined from the documentation and configuration of the standard system itself and then added to the value determined here. |
| SLIO safety module | T_{DAT} | max. acknowledge time of the F periphery (Device Acknowledgement Time) | 8ms |

2.6 SDI 4xDC 24V - Technical data

| | |
|---|------------------|
| Order no. | 021-1SD00 |
| Type | SM 021 |
| Module ID | 0C41 2E00 |
| Current consumption/power loss | |
| Current consumption from backplane bus | 95 mA |
| Power loss | 0.8 W |
| Technical data digital inputs | |
| Number of inputs | 4 |
| Cable length, shielded | 330 m |
| Cable length, unshielded | 330 m |
| Rated load voltage | - |
| Current consumption from load voltage L+ (without load) | 2 mA |
| Rated value | DC 20.4...28.8 V |
| Input voltage for signal "0" | DC 0...5 V |
| Input voltage for signal "1" | DC 11...28.8 V |
| Input voltage hysteresis | - |
| Frequency range | - |
| Input resistance | - |
| Input capacitance | 100 nF |
| Input current for signal "1" | 3 mA |
| Connection of Two-Wire-BEROs possible | ✓ |

| | |
|---|--------------------------------|
| Order no. | 021-1SD00 |
| Max. permissible BERO quiescent current | 1.5 mA |
| Input delay of "0" to "1" | parameterizable 1ms - 1s |
| Input delay of "1" to "0" | parameterizable 1ms - 1s |
| Number of simultaneously utilizable inputs horizontal configuration | 4 |
| Number of simultaneously utilizable inputs vertical configuration | 4 |
| Input characteristic curve | IEC 61131-2, type 3 |
| Initial data size | 4 Bit |
| Status information, alarms, diagnostics | |
| Status display | green LED per channel |
| Interrupts | yes, parameterizable |
| Process alarm | no |
| Diagnostic interrupt | yes, parameterizable |
| Diagnostic functions | yes, parameterizable |
| Diagnostics information read-out | possible |
| Module state | green LED |
| Module error display | red LED |
| Channel error display | red ERR-LED and yellow ER2-LED |
| Isolation | |
| Between channels | - |
| Between channels of groups to | - |
| Between channels and backplane bus | ✓ |
| Insulation tested with | DC 500 V |
| Safety | |
| Safety protocol | PROFIsafe V2 |
| Safety requirements | SIL CL 3, PL e, Kat 4 |
| Secure user address | 1 - 4095 |
| Watchdog | parameterizable 10ms - 1s |
| Two channels | Each 2 of 4 inputs switchable |
| Test pulse outputs | 4 |
| Datasizes | |
| Input bytes | 5 |
| Output bytes | 5 |
| Parameter bytes | 44 |
| Diagnostic bytes | 20 |
| Housing | |

| | |
|---------------------------------|----------------------------|
| Order no. | 021-1SD00 |
| Material | PC / PPE GF10 |
| Mounting | Profile rail 35 mm |
| Mechanical data | |
| Dimensions (WxHxD) | 12.9 mm x 109 mm x 76.5 mm |
| Weight | 60 g |
| Environmental conditions | |
| Operating temperature | 0 °C to 60 °C |
| Storage temperature | -25 °C to 70 °C |
| Certifications | |
| UL certification | yes |
| KC certification | yes |



Please consider that the signal increase of the sensor signals for signal on and signal off must have a slope of at least 13V/s, otherwise an error could be detected by the mutual monitoring of the microcontrollers!



Please note that the electrical input stage of safe digital inputs of a System SLIO safety module may affect the test pulses of connected devices (sensors) with OSSD outputs. If the OSSD outputs are of the type "open collector", the input capacitance, which is specified in the technical data here, must be considered as a load capacitance in addition to the cable capacitance. You can find the maximum permissible load capacitance of the sensor in its technical data. If the actual load capacitance is higher than the permitted, then the sensor will falsely detect a short circuit to 24V and switch to a safe state, i.e. these sensors can not be operated on the System SLIO safety module. At OSSD outputs of the type "push-pull" the specified input capacitance of the test pulses of the sensor are not relevant.

2.7 SDO 4xDC 24V 0.5A - Operating and display elements

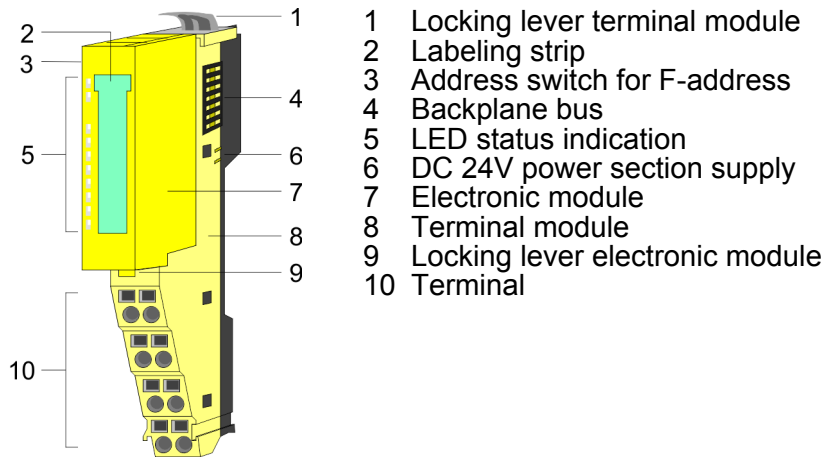
Description

The electronic module accepts binary control signals from the central bus system and transfers them to the process level via outputs. It has 4 channels and their status is monitored via LEDs.

Properties

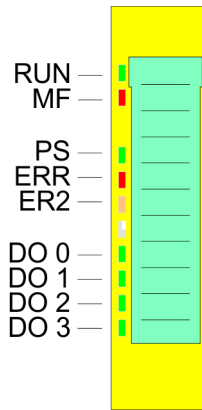
- 4 digital outputs isolated to the backplane bus
- Status indication of the channels via LEDs
- Safety module with automatic disconnection in case of error according to IEC 61508 SIL3 and EN ISO 13849-1, Cat.4/PLe

Structure



- 1 Locking lever terminal module
- 2 Labeling strip
- 3 Address switch for F-address
- 4 Backplane bus
- 5 LED status indication
- 6 DC 24V power section supply
- 7 Electronic module
- 8 Terminal module
- 9 Locking lever electronic module
- 10 Terminal

Status indication



| RUN | MF | Description |
|-------|-----|---|
| green | red | |
| ● | ○ | Bus communication is OK Module status is OK |
| ● | ● | Bus communication is OK Module status reports an error |
| ○ | ● | Bus communication is not possible Module status reports an error |
| ○ | ○ | Error at bus power supply |
| B | B | Error in configuration |

on: ● | off: ○ | blinking with 0.5Hz: B

| LED | Color | Description | |
|------|--------|-------------|--|
| PS | green | ● | PROFIsafe communication in data exchange |
| | | BB | Safety parametrization expected |
| | | B | Error - acknowledgement expected |
| | | ○ | Module initialization is running |
| ERR | red | ● | Permanent fail-safe condition |
| | | C | Blink code ↪ 'ERR-LED' on page 51 |
| ERR2 | yellow | C | Blink code ↪ 'ER2 LED' on page 51 |
| | | B | Requesting fail-safe state |
| DO x | green | ● | Digital output is triggered |

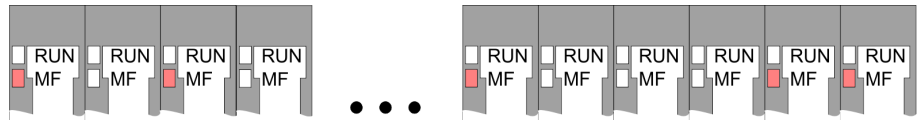
on: ● | off: ○ | blinking with 0.5Hz: B | blinking with 2Hz: BB | Blink code: C

RUN and MF LED

Each module has the LEDs RUN and MF on its front side. Errors or incorrect modules may be located by means of these LEDs.

In the following illustrations flashing LEDs are marked by ☼.

Sum current of the electronic power supply exceeded

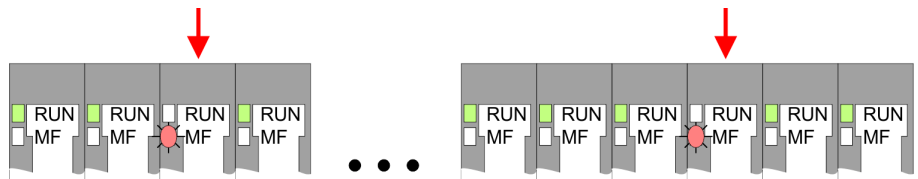


Behaviour: After PowerON the RUN LED of each module is off and the MF LED of each module is sporadically on.

Cause: The maximum current for the electronic power supply is exceeded.

Remedy: As soon as the sum current of the electronic power supply is exceeded, always place the power module 007-1AB10. [Chapter 3.6 'Wiring' on page 88](#)

RUN and MF LED - Error in configuration

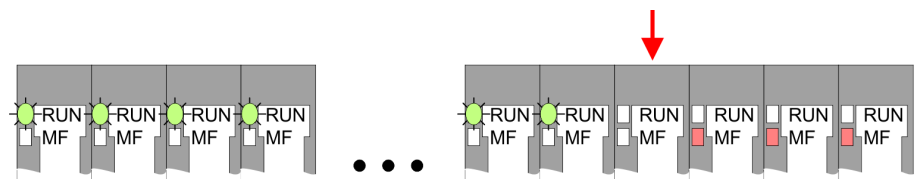


Behaviour: After PowerON the MF LED of one module respectively more modules flashes. The RUN LED remains off.

Cause: At this position a module is placed, which does not correspond to the configured module.

Remedy: Match configuration and hardware structure.

RUN and MF LED - Module failure



Behaviour: After PowerON all of the RUN LEDs up to the defective module are flashing. With all following modules the MF LED is on and the RUN LED is off.

Cause: The module on the right of the flashing modules is defective.

Remedy: Replace the defective module.

ERR-LED

The LED is permanently on at a critical error, which led into a permanent fail-safe state, which may not be acknowledged.

On error like short-circuit, cross-circuit and so on, the ERR LED shows an error by the following blink behaviour. The LED gets off for 2s. Then it shows the following code 1 ... 6 by blinking with 1Hz:

Blink code

| Blinking | Error | External error |
|----------|--|----------------|
| 1x | Short-circuit within a channel | yes |
| 2x | Cross-circuit error between 2 channels | yes |
| 3x | Wire break error on currents < 30mA ↳ Chapter 2.9 'SDO 4xDC 24V 0.5A - Parameter record set' on page 55 | yes |
| 4x | Read back error output part | yes |
| 5x | Other errors | no |
| 6x | F-address was changed ↳ Chapter 3.3 'Setting the F-address' on page 75 | no |

- After the blink code the LED gets off for 2s and then starts again with the code output. Normally an *external error* is caused by wiring respectively by a connected sensor. Please check also your parameters for the actuator.
- The system SLIO safety output module monitors the actual state of the output voltage level monitoring with the setpoint state (control).
- If there is a difference between the setpoint state and the actual state detected, a read back error is reported.
This can either mean that the output is "1" state, although it should have "0" state (points to a separate power supply) or the output has "0" state, although it should have "1" state (points to an external short circuit or an internal hardware malfunction).
In this case of error please check the external wiring and the configured test pulse length. If they are OK and the error occurs several times in succession, then the module is defective and you have to proceed as described at "Repair". ↳ Chapter 3.14 'Repair' on page 120

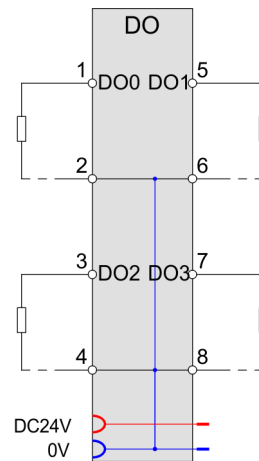
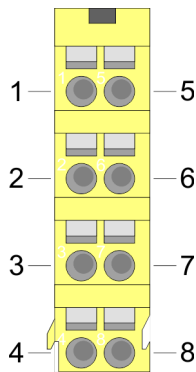
ER2 LED

If an external error was reported by the ERR LED, the LED ER2 indicates the faulty channel by the following blink code:

- The ER2 LED gets off for 2s.
- Then it indicates the number of the faulty channel by blinking with 1Hz. Here it is valid blinking 1x...4x means channel DO 0 ... 3.
- After the blink code the LED gets off for 2s and then starts again with the code output.
- If there are more errors pending, only the 1. recognized error is indicated.
- If the LED blinks with 0.5Hz the safety control system requests a fail-safe state of the System SLIO safety module. But there is no error on the System SLIO safety module. This request may occur, for example after a brief interrupt of the communication and may be acknowledged.

Terminal

For wires with a core cross-section of 0.08mm² up to 1.5mm².

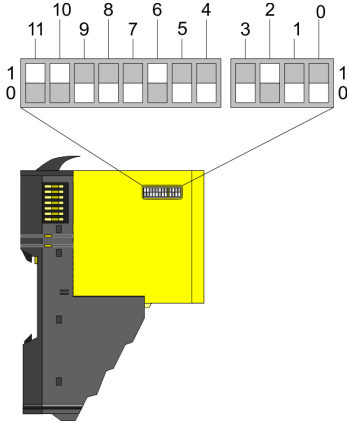


| Pos. | Function | Type | Description |
|------|----------|------|---------------------|
| 1 | DO 0 | O | Digital output DO 0 |
| 2 | 0V | O | GND for actuator |
| 3 | DO 2 | O | Digital output DO 2 |
| 4 | 0V | O | GND for actuator |
| 5 | DO 1 | O | Digital output DO 1 |
| 6 | 0V | O | GND for actuator |
| 7 | DO 3 | O | Digital output DO 3 |
| 8 | 0V | O | GND for actuator |

I: Input, O: Output

Address switch for F-address

The F-address is to be configured by the F-address switch at the VIPA safety module and additionally in the master system e.g. hardware configurator. The F-address is to be set by the F-address switch besides on the safety module. Only if the F-address set in the hardware configurator accords to the setting of the F-address switch, it is possible to operate!



| Pos. | Value | Example | |
|------|-------|---------|--------------------------------|
| | | State | Address |
| 0 | 1 | 1 | 1+2+32+512=547 Address: 547 |
| 1 | 2 | 1 | |
| 2 | 4 | 0 | |
| 3 | 8 | 0 | |
| 4 | 16 | 0 | |
| 5 | 32 | 1 | |
| 6 | 64 | 0 | |
| 7 | 128 | 0 | |
| 8 | 256 | 0 | |
| 9 | 512 | 1 | |
| 10 | 1024 | 0 | |
| 11 | 2048 | 0 | |



When the module is installed, the F-address switch may not be accessed!

To set the F-address on the safety module the (electronic) module is to be demounted before as described at "Demounting and module exchange". ↪ Chapter 3.5 'Demounting and module exchange' on page 84

2.8 SDO 4xDC 24V 0.5A - Process Image

Input/Output area - PROFIsafe-V2-Mode

The safety DO module occupies 5 data bytes each in the input and output image of the superordinate safety PLC system. The safety PROFIsafe data to be sent and received are stored in the input and output byte 0 ... 4.

Input area

| Addr. | Name | Byte | Input data |
|-------|-----------|------|-----------------------|
| +0 | PII | 0 | reserved |
| +1 | PII_STAT | 1 | PROFIsafe Status |
| +2 | PII_RN | 2 | PROFIsafe CRC2 byte 2 |
| +3 | PII_CRC_H | 3 | PROFIsafe CRC2 byte 1 |
| +4 | PII_CRC_L | 4 | PROFIsafe CRC2 byte 0 |

Output area

| Addr. | Name | Bytes | Output data |
|-------|-----------|-------|---|
| +0 | PIQ | 0 | PROFIsafe outputs <ul style="list-style-type: none"> ■ Bit 0: DO 0 ■ Bit 1: DO 1 ■ Bit 2: DO 2 ■ Bit 3: DO 3 ■ Bit 7 ... 4: reserved |
| +1 | PIQ_CTRL | 1 | PROFIsafe Control |
| +2 | PIQ_RN | 2 | PROFIsafe CRC2 byte 2 |
| +3 | PIQ_CRC_H | 3 | PROFIsafe CRC2 byte 1 |
| +4 | PIQ_CRC_L | 4 | PROFIsafe CRC2 byte 0 |

2.9 SDO 4xDC 24V 0.5A - Parameter record set

2.9.1 Parameter data

Record set 81h (iParameter)

This record set is once transferred during start-up by the standard parameter telegram.

Parameter

| Name | Type | Description / Range of values | Default |
|---------------------------------|------|--|---------|
| Parameter change mode | Bit | 0: normal parameter record set 1: Parameter change F-address | 0 |
| Diagnostic interrupt | Bit | 0: deactivated 1: activated This bit is not safety-related. | 1 |
| Channel 0, 1: * Activation | Bit | 0: deactivated 1: activated | 1 |
| Channel 0, 1: Activation mode | Bit | Condition: Channel 0, 1 Activation is "activated" 0: 1-channel 1: 2-channel | 1 |
| Channel 0: Wire break detection | Bit | Condition: Channel 0, 1 Activation is "activated" 0: deactivated 1: activated This bit is not safety-related. | 0 |
| Channel 1: Wire break detection | Bit | Condition: Channel 0, 1 Activation is "activated" 0: deactivated 1: activated This bit is not safety-related | 0 |
| Channel 2, 3: * Activation | Bit | 0: deactivated 1: activated | 1 |
| Channel 2, 3: Activation mode | Bit | Condition: Channel 2, 3 Activation is "activated" 0: 1-channel 1: 2-channel | 1 |
| Channel 2: Wire break detection | Bit | Condition: Channel 2, 3 Activation is "activated" 0: deactivated 1: activated This bit is not safety-related. | 0 |

| Name | Type | Description / Range of values | Default |
|---------------------------------------|--------|---|---------|
| Channel 3: Wire break detection | Bit | Condition: Channel 2, 3 Activation is "activated" 0: deactivated 1: activated This bit is not safety-related | 0 |
| Channel 0: Test pulse time in μ s | UINT16 | Condition: Channel 0, 1 Activation is "activated" Various values selectable (e.g. 500 μ s, 750 μ s, 1ms, ... ,10ms) | 500 |
| Channel 1: Test pulse time in μ s | UINT16 | Condition: Channel 0, 1 Activation is "activated" Various values selectable (e.g. 500 μ s, 750 μ s, 1ms, ... ,10ms) | 500 |
| Channel 2: Test pulse time in μ s | UINT16 | Condition: Channel 2, 3 Activation is "activated" Various values selectable (e.g. 500 μ s, 750 μ s, 1ms, ... ,10ms) | 500 |
| Channel 3: Test pulse time in μ s | UINT16 | Condition: Channel 2, 3 Activation is "activated" Various values selectable (e.g. 500 μ s, 750 μ s, 1ms, ... ,10ms) | 500 |

*) The deactivation of channel groups deviates from the "standard mode" and represents a potentially dangerous condition.

Parameter change mode

For a valid parametrization this parameter must be set to 0 (default value). If the F-address of a System SLIO safety module is to be changed, the F-address in the memory of the module can be erased by setting this parameter. ↪ *Chapter 3.3 'Setting the F-address' on page 75*

Activation diagnostic interrupt

Here you activate res. de-activate the diagnostic interrupt function. With a set diagnostic interrupt bit in case of an error a diagnostic interrupt message is sent to the upper master system. There the diagnostics message can further be processed. More may be found in the manual of the master system.

Channel activation

- With the *channel activation* channel groups may be activated or deactivated. With *channel activation* = 1 the corresponding channel group is in "standard operation".
- Deactivated channel groups (*channel activation* = 0) permanently provide a logical 0 as output signal, independent from the defined signal of the safety control system. This can be useful during the first start-up.

**NOTICE!**

Deactivation of channel groups represents a potentially dangerous condition!

Activation mode

Here you can specify for each channel group, if the outputs of the safety output module are controlled by the safety system individually (*1-channel*) or in pairs (*2-channel*). The paired control option simplifies the creation of the safety logic in the safety controller. Please consider that regardless of the type of the activation mode, in the System SLIO safety module, each output is always 2-channel driven and switched off (double PP switching)

- With *1-channel* 1 or 2 actuators with one input are connected to one channel. Here respectively one bit is used to control an output. By means of 2-channel actuators, a higher safety level like SIL3 or PLe can be achieved, if you can exclude the errors cross-circuit or external power supply or there is a superior shut-down on error.
- With *2-channel* a 2-channel actuator with 2 inputs or 2 actuators with respectively 1 input are connected to a channel group. Here bit 0 switches the outputs DO 0 and DO 1 respectively bit 2 switches the outputs DO 2 and DO 3. Here the actuator / actuators get the output signal via both channels. Errors in cross circuits and external power supply at the channel group can be identified and controlled, if this relates to only one of the two lines. This enables to achieve higher safety levels like SIL 3 and PLe.
[↪ Chapter 3.7.2 'Connection examples for digital safety outputs' on page 101](#)

**NOTICE!**

In case of error with a switched-off output, a short-time turn-on pulse with a max. length of the error detection time can occur.

The error detection time is $6\text{ms} + 2 \times \text{test pulse length}$.

Wire break detection

If this parameter is set, the System SLIO safety module observes the outputs with output state 1, whether there is a min. current of 10mA... 30mA. By this way a line break can be detected. Here the System SLIO safety module gets to fail-safe state and the outputs are switched off.

**CAUTION!**

This function must not be used as safety function. This means a safety function must not depend on this function.

Test pulse length

Each output with “1” state is continuously observed whether this can still be switched off. Here wiring errors e.g. short circuit to DC 24V and errors within the System SLIO safety module can be detected. The *test pulse length* must be set depending on cable capacitance and the load current.



If the test pulse length is too long, a connected actuator may briefly switch off during the test pulse, or if there is another security device connected, this can recognize a 0-signal and turn off incorrectly!

If the test pulse length is too short, the System SLIO safety module reports an error, because here it is not possible for the module to test the switch-off ability of an output. Then the module reports "short circuit".

Orientation values for the *test pulse length*

| Load current | Cable length (capacity, resistor) | Test pulse length to be configured |
|--------------|-----------------------------------|------------------------------------|
| 2 | 100 m (30 nF, up to 6.7 Ohm) | 2500 µs |
| 2 mA | 333 m (100 nF, up to 22.4 Ohm) | 3500 µs |
| 2 mA | 1000 m (300 nF, up to 67 Ohm) | 6000 µs |
| 5 mA | 100 m (30 nF, up to 6.7 Ohm) | 2000 µs |
| 5 mA | 333 m (100 nF, up to 22.4 Ohm) | 2500 µs |
| 5 mA | 1000 m (300 nF, up to 67 Ohm) | 4000 µs |
| > 25 mA | 100 m (30 nF, up to 6.7 Ohm) | 1000 µs |
| > 25 mA | 333 m (100 nF, up to 22.4 Ohm) | 1000 µs |
| > 25 mA | 1000 m (300 nF, up to 67 Ohm) | 1500 µs |

2.9.2 Overview PROFIsafe F parameters

| F Parameter | Description | Default | | | | |
|-------------------|--|---------------|--------------|-------------------|------------|------------|
| F_SIL | <p>The parameter <i>F_SIL</i> specifies the required safety integrity class of the SLIO safety module.</p> <p>The SLIO safety module supports up to SIL3.</p> | SIL 3 | | | | |
| F_CRC_Length | <p>The parameter <i>F_CRC_Length</i> specifies the length of the CRC2 key to be used in the PROFIsafe telegram.</p> <p>The required length depends on the length of the user data to be transferred. Valid combinations are:</p> <table border="1"> <tr> <td>F_Par_Version</td> <td>F_CRC_Length</td> </tr> <tr> <td>PROFIsafe-V2-Mode</td> <td>3-Byte-CRC</td> </tr> </table> | F_Par_Version | F_CRC_Length | PROFIsafe-V2-Mode | 3-Byte-CRC | 3-Byte-CRC |
| F_Par_Version | F_CRC_Length | | | | | |
| PROFIsafe-V2-Mode | 3-Byte-CRC | | | | | |
| F_Block_ID | <p><i>F_Block_ID</i> specifies the format of the F parameter set.</p> <p>Value 1 indicates that <i>F_iPar_CRC</i> is a part of the F parameters.</p> | 1 | | | | |
| F_Par_Version | <p><i>F_Par_Version</i> specifies the PROFIsafe version to be used for communication.</p> <p>The System SLIO safety module supports with PROFIBUS and PROFINET PROFIsafe-V2-mode and uses the version specified by this parameter:</p> <table border="1"> <tr> <td>F_Par_Version</td> </tr> <tr> <td>V2-mode</td> </tr> </table> | F_Par_Version | V2-mode | V2-mode | | |
| F_Par_Version | | | | | | |
| V2-mode | | | | | | |
| F_Source_Add | <p><i>F_Source_Add</i> specifies the PROFIsafe source address. To prevent incorrect parameterization, the address of the configuration tool is automatically assigned and cannot be changed. The Parameter can accept values from 1 to 65534.</p> | 2000 | | | | |
| F_Dest_Add | <p><i>F_Dest_Add</i> specifies the PROFIsafe destination address of the SLIO safety module. For <i>F_Dest_Add</i> values from 1 to 4095 can be selected. Each address value may appear in the system once, which is accessed by the safety PLC.</p> <p>To establish the PROFIsafe communication the parameter value must match the setting of the F-address of the SLIO safety module, which is set by the DIP switch. ↪ <i>Chapter 3.3 'Setting the F-address' on page 75</i></p> | 200 | | | | |

| F Parameter | Description | Default |
|-------------|---|---------|
| F_WD_Time | <p>The parameter <i>F_WD_Time</i> determines the monitoring time for the PROFIsafe communication between F controller and System SLIO safety module.</p> <p>At least on valid PROFIsafe telegram must be exchanged between the safe PLC and the SLIO safety module within the monitoring time.</p> <p>If this condition is not met, the safe PLC or the SLIO safety module initiates a safe state.</p> <p>The monitoring time must be selected, so that telegram execution times are tolerated, but an interruption in the connection is detected quickly enough. ↪ <i>'Calculating the F_WD_Time' on page 44</i></p> <p>Below you can find information about the calculation.</p> <p>The monitoring time can be specified in steps of 1 ms. The possible range of value (1 to 65535 ms) is specified by the device description file (GSD/GSDML).</p> | 150 |
| F_iPar_CRC | <p>The parameter <i>F_iPar_CRC</i> specifies a comparison value for the CRC value via the iParameter (<i>iPar_CRC</i>). The PROFIsafe data exchange only starts when the value for <i>F_iPar_CRC</i> and the <i>iPar_CRC</i> match.</p> <p>After confirmation of the set parameters the CRC (<i>iPar-CRC</i>) is calculated and displayed by the VIPA Safety CRC-Tool.</p> <p>This value must be entered with the configuration tool of the safe PLC to the F parameter of the SLIO safety module.</p> | 0 |

Calculating the F_WD_Time

Thus the running PROFIsafe watchdog in the SLIO safety modules is reset periodically, that this does not release, the following cyclically data flow (circulation of a token) is to be considered:



The time required for this can be regarded as the full circulation time of a token. Thus the minimum PROFIsafe monitoring time to be configured results in:

$$T_{PSTO} = T_{Slave} + T_{BUS} + T_{CI} + T_{BUS} + T_{Slave} + T_{DAT}$$

$$T_{PSTO} = 2 * T_{Slave} + 2 * T_{BUS} + T_{CI} + T_{DAT}$$

| Component | Time | Meaning | from |
|-----------------------------|-------------|---|--|
| System SLIO safety module | T_{PSTO} | Configured PROFIsafe monitoring time (<i>F_WD_Time</i>) | refer to the formula above |
| Bus coupler | T_{Slave} | Max. response time of the decentralized peripheral system = max. delay by the bus coupler and the backplane bus | Documentation of the decentralized periphery system (for System SLIO PROFIBUS and PROFINET < 2ms) |
| Field bus | T_{Bus} | Response time of the field bus | T_{TR} at PROFIBUS res. T_{WD} at PROFINET |
| Either Field bus (PROFIBUS) | T_{TR} | max. target rotation time for the DP master system | Object properties of the DP master system, bus parameters in the HW configuration. |
| Or Field bus (PROFINET) | T_{WD} | threshold monitoring of the PROFINET IO device | Value from the object properties of the PROFINET IO device Tab "IO cycle", in HW config. If there is no threshold monitoring time configured for the IO device, instead of this you can take the given refresh time multiplied with 3. The refresh time can be found in the HW config. at object properties of the PROFINET IO system. |

| Component | Time | Meaning | from |
|--------------------|-----------|--|--|
| F-PLC / F-Logic | T_{CI} | Configured cycle time the F-runtime group is called | Configured timing (cycle time) for calling the F-runtime group. By processing of higher priority interrupts, by communication load, or by testing and commissioning functions, the distance between the start times can increase. The influence of these factors can be determined from the documentation and configuration of the standard system itself and then added to the value determined here. |
| SLIO safety module | T_{DAT} | max. acknowledge time of the F periphery (Device Acknowledgement Time) | 8ms |

2.10 SDO 4xDC 24V 0.5A - Technical data

| | |
|---|------------------|
| Order no. | 022-1SD00 |
| Type | SM 022 |
| Module ID | 0C81 1E00 |
| Current consumption/power loss | |
| Current consumption from backplane bus | 75 mA |
| Power loss | 1 W |
| Technical data digital outputs | |
| Number of outputs | 4 |
| Cable length, shielded | 1000 m |
| Cable length, unshielded | 600 m |
| Rated load voltage | DC 20.4...28.8 V |
| Current consumption from load voltage L+ (without load) | 15 mA |
| Total current per group, horizontal configuration, 40°C | 2 A |
| Total current per group, horizontal configuration, 60°C | - |
| Total current per group, vertical configuration | - |
| Output current at signal "1", rated value | 0.5 A |
| Output delay of "0" to "1" | 100 µs |
| Output delay of "1" to "0" | 175 µs |
| Minimum load current | - |
| Lamp load | 5 W |

| | |
|---|--------------------------------|
| Order no. | 022-1SD00 |
| Parallel switching of outputs for redundant control of a load | not possible |
| Parallel switching of outputs for increased power | not possible |
| Actuation of digital input | ✓ |
| Switching frequency with resistive load | max. 50 Hz |
| Switching frequency with inductive load | max. 0.5 Hz |
| Switching frequency on lamp load | max. 10 Hz |
| Internal limitation of inductive shut-off voltage | L+ (-45 V) |
| Short-circuit protection of output | yes, electronic |
| Trigger level | 1.7 A |
| Number of operating cycle of relay outputs | - |
| Switching capacity of contacts | - |
| Output data size | 4 Bit |
| Status information, alarms, diagnostics | |
| Status display | green LED per channel |
| Interrupts | yes, parameterizable |
| Process alarm | no |
| Diagnostic interrupt | yes, parameterizable |
| Diagnostic functions | yes, parameterizable |
| Diagnostics information read-out | possible |
| Supply voltage display | green LED |
| Group error display | red SF LED |
| Channel error display | red ERR-LED and yellow ER2-LED |
| Isolation | |
| Between channels | - |
| Between channels of groups to | - |
| Between channels and backplane bus | ✓ |
| Insulation tested with | DC 500 V |
| PWM data | |
| PWM channels | - |
| PWM time basis | - |
| Period length | - |
| Minimum pulse width | - |
| PtP communication | - |
| Safety | |
| Safety protocol | PROFIsafe V2 |

Response time

| | |
|---------------------------------|--------------------------------|
| Order no. | 022-1SD00 |
| Safety requirements | SIL CL 3, PL e, Kat 4 |
| Secure user address | 1 - 4095 |
| Watchdog | parameterizable 10ms - 1s |
| Two channels | Each 2 of 4 outputs switchable |
| Test pulse length | parameterizable 500µs - 10ms |
| Circuit monitoring | ✓ |
| Datasizes | |
| Input bytes | 5 |
| Output bytes | 5 |
| Parameter bytes | 44 |
| Diagnostic bytes | 20 |
| Housing | |
| Material | PC / PPE GF10 |
| Mounting | Profile rail 35 mm |
| Mechanical data | |
| Dimensions (WxHxD) | 12.9 mm x 109 mm x 76.5 mm |
| Weight | 60 g |
| Environmental conditions | |
| Operating temperature | 0 °C to 60 °C |
| Storage temperature | -25 °C to 70 °C |
| Certifications | |
| UL certification | yes |
| KC certification | yes |

2.11 Response time

General

The response times of the System SLIO safety modules are listed below. The response time of the safety modules is included in the calculation of the fail-safe system response time.

Response time safety digital inputs

The response time specifies the time between a signal transition at the digital input and the reliable availability of the safety message frame on the backplane bus.

Response time safety digital outputs

The response time specifies the interval between the receipt of a safety message from the backplane bus and the signal transition at the digital output.

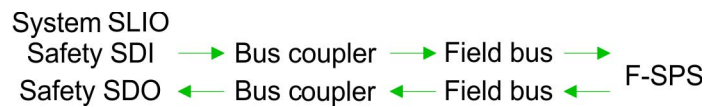
Maximum response time of the system

These response times are required for plant design. Hereby you can determine whether the maximum error tolerance time of a process is not exceeded. Here, the following cases are to be distinguished, which are described below:

- Error-free case
- Existing error
- Arbitrary run times at single errors

2.11.1 Error-free case

In error-free case it is assumed that none of the monitoring time is exceeded and the transition of the signal of the input connector of a System SLIO safety IN to the output connector of the safety SLIO OUT is considered:



Max expected response time in error-free case

$$T_{\max NF} = TE_{GL} + TE_{WCDT} + TE_{Slave} + TE_{BUS} + T_{CI} + T_{FPROG} + TA_{BUS} + TA_{Slave} + TA_{WCDT}$$

For plant design sensor and actuator run times are to be taken into account:

$$T_{\max NFSA} = T_{SensorDly} + T_{\max NF} + T_{ActuatorDly}$$

2.11.2 Existing error

Possible single errors

If there is an error it is assumed that a monitoring time is exceeded and a error reaction is released. Possible reasons could be errors of the system, wrong listed run time in the documentation of the standard system or a extension of the calculated value of the run time, by changing the configuration of the standard system. In case of no error the total response time increases by the maximum duration of the possible single errors:

- Discrepancy error in the System SLIO safety SDI. Here, the discrepancy time must be considered in addition: (TE_{DIS})
- A single error occurs in the System SLIO safety SDI. Here the possibly larger max. response time during an error (TE_{OFDT}) is to be considered with the max. response time in error-free case (TE_{WCDT}) : $(TE_{OFDT} - TE_{WCDT})$
- Once or permanent interrupted communication between System SLIO safety SDI and the safety control. Here the PROFIsafe monitoring time of the System SLIO safety SDI and the configured cyclic time of the safety controller must be considered: $(TE_{PSTO} + T_{CI})$
- Once or permanent interrupted communication between System SLIO safety SDO and the safety control respectively failure of the safety control. Here the PROFIsafe monitoring time of the System SLIO safety SDO and Acknowledge time of the System SLIO safety SDO must be considered: $(TA_{PSTO} + TA_{DAT})$
- A single error occurs in the System SLIO safety SDO. Here the possibly larger max. response time during an error (TE_{OFDT}) is to be considered with the max. response time in error free case (TA_{WCDT}) : $(TA_{OFDT} - TA_{WCDT})$

Response time > Arbitrary run times at single errors

Max. response time on error

$$T_{\max\text{OF}} = T_{\max\text{NF}} + \text{MAX}((T_{\text{E_DIS}}), (T_{\text{E_OFDT}} - T_{\text{E_WCDT}}), (T_{\text{E_PSTO}} + T_{\text{CI}}), (T_{\text{A_PSTO}} + T_{\text{A_DAT}}), (T_{\text{A_OFDT}} - T_{\text{A_WCDT}}))$$

For plant design sensor and actuator run times are to be taken into account:

$$T_{\max\text{OFSA}} = T_{\text{SensorDLY}} + T_{\max\text{OF}} + T_{\text{ActuatorDLY}}$$

2.11.3 Arbitrary run times at single errors

Times to be considered

At arbitrary run times of the standard system in addition to an existing error, it is assumed that the values of all the relevant run times lie nearby the limit of the monitored times.

- The max processing time to and in the System SLIO safety SDI: $(T_{\text{E_GL}} + T_{\text{E_DIS}} + T_{\text{E_WCDT}} + T_{\text{E_PSTO}})$
- The smallest of the possible monitoring times, from this moment the defined behaviour of an error is: $(\text{MIN}(T_{\text{E_PSTO}}, T_{\text{CI_MAX}}, T_{\text{A_PSTO}}))$
- The max. processing time to and in the System SLIO safety SDO: $(T_{\text{A_WCDT}} + T_{\text{A_PSTO}})$
- The possibly increased processing times in case of an error within the System SLIO safety modules, here but only the larger of them, because it is assumed that there is a single error: $(\text{MAX}((T_{\text{E_OFDT}} - T_{\text{E_WCDT}}), (T_{\text{A_OFDT}} - T_{\text{A_WCDT}})))$
- For the entire process chain a good PROFIsafe telegram could be sent before to the System SLIO safety SDI or -SDO. Here the largest of the two timeouts must be considered: $(\text{MAX}(T_{\text{E_PSTO}}, T_{\text{A_PSTO}}))$

Max. response time at arbitrary run times at one error

$$\begin{aligned} T_{\max} &= T_{\text{E_GL}} + T_{\text{E_DIS}} + T_{\text{E_WCDT}} + T_{\text{E_PSTO}} \\ &+ \text{MIN}(T_{\text{E_PSTO}}, T_{\text{CI_MAX}}, T_{\text{A_PSTO}}) \\ &+ T_{\text{A_WCDT}} + T_{\text{A_PSTO}} \\ &+ \text{MAX}((T_{\text{E_OFDT}} - T_{\text{E_WCDT}}), (T_{\text{A_OFDT}} - T_{\text{A_WCDT}})) \\ &+ \text{MAX}(T_{\text{E_PSTO}}, T_{\text{A_PSTO}}) \end{aligned}$$

For plant design sensor and actuator run times are to be taken into account:

$$T_{\max\text{SA}} = T_{\text{SensorDLY}} + T_{\max} + T_{\text{ActuatorDLY}}$$

Response time > Arbitrary run times at single errors

Designations**Abbreviations sorted by components**

| Components | Time *) | Description | From |
|---|--|--|--|
| Sensor | $T_{\text{SensorDLY}}$ | Delay time of the sensor | Documentation sensor |
| System SLIO Safety SDI | TE_{GL} | Input smoothing time of the inputs of the SLIO safety SDI | Configuration of the F periphery, matched to the sensor used. |
| System SLIO Safety SDI | TE_{DIS} | With two-channel evaluation discrepancy time otherwise 0 | Configuration of the F periphery, matched to the sensor used. |
| System SLIO Safety SDI Safety SDO | TE_{WCDDT} TA_{WCDDT} | Max. response time in error-free case (Worst Case Delay Time) | 11ms |
| System SLIO Safety SDI Safety SDO | TE_{OFDDT} TA_{OFDDT} | Max. response time at one error (One Fault Delay Time) | 11ms |
| System SLIO Safety SDI Safety SDO | TE_{DAT} TA_{DAT} | max. acknowledge time of the F periphery (Device Acknowledgement Time) | 8ms |
| System SLIO Safety SDI Safety SDO | TE_{PSTO} TA_{PSTO} | Configured PROFIsafe monitoring time (ProfiSafeTimeOut) | PROFIsafe monitoring time of the HW-config. |
| Bus coupler | TE_{Slave} TA_{Slave} | Max. response time of the decentralized periphery system = max. delay by the coupler and the backplane bus | Documentation of the decentralized periphery system (for System SLIO PROFIBUS and PROFINET < 2ms) |
| Field bus (PROFIBUS) | TE_{TR} TA_{TR} | Max. target rotation time for the DP master system | Object properties of the DP master system, bus parameters in HW config. |
| Field bus (PROFINET) | TE_{WD} TA_{WD} | Threshold monitoring time of the PROFINET IO device | <p>Values of the object properties of the PROFINET IO device at tab "IO cycle", in HW configuration.</p> <p>If there is no threshold monitoring time configured for the IO device, instead of this you can take the given refresh time multiplied with 3.</p> <p>The refresh time can be found in the HW config. at object properties of the PROFINET IO system.</p> |

Response time > Arbitrary run times at single errors

| Components | Time *) | Description | From |
|---------------------------|-------------------|---|---|
| F-SPS / F-Logic | T_{CI} | Configured cycle time the F-runtime group is called | Configured timing (cycle time) for calling the F-runtime group. By processing of higher priority interrupts, by communication load, or by testing and commissioning functions, the distance between the start times can increase. The influence of these factors can be determined from the documentation and configuration of the standard system itself and then added to the value determined here. |
| F-SPS / F-Logic | T_{CI_MAX} | Cycle monitoring time the F-runtime group is called | Configured monitoring time of the F cycle time (= Parameter "Max. cycle time of the F-runtime in ms" in the dialog "F-Runtime groups") |
| F-SPS / F-Logik | T_{FPROG} | Run time of the F-runtime group (of the safety program) | max. runtime of the F-runtime group |
| Actuator | $T_{ActuatorDLY}$ | Delay time of the actuator | Documentation of the actuator |
| Entire inputs, outputs | T_{maxNF} | Response time in error-free case (maxNoFault) | Refer to the formula \varnothing 'Max expected response time in error-free case' on page 65 |
| Entire sensors, actuator | $T_{maxNFSA}$ | Response time in error free case (maxNoFaultSensor-Aktor) | Refer to the formula \varnothing 'Max expected response time in error-free case' on page 65 |
| Entire inputs, outputs | T_{maxOF} | Response time at one error (maxOneFault) | Refer to the formula \varnothing 'Max. response time on error' on page 66 |
| Entire sensors, actuators | $T_{maxOFSA}$ | Response time at one error (maxOneFaultSensorAktor) | Refer to the formula \varnothing 'Max. response time on error' on page 66 |
| Entire inputs, outputs | T_{max} | Response time at one error (maxOneFault) | Refer to the formula \varnothing 'Max. response time at arbitrary run times at one error' on page 66 |
| Entire sensors, actuators | T_{maxSA} | Response time at one error (maxOneFaultSensorAktor) | Refer to the formula \varnothing 'Max. response time at arbitrary run times at one error' on page 66 |

*) "E" or "A" behind "T" corresponds input or output.

2.12 Compatibility list

Sensors

The System SLIO safety input module was successfully tested with the following sensors:

- SICK L41S-11MA1A Single-beam photoelectric safety switch
- SICK ES21-SA10E1 Emergency stop pushbutton
- SICK i10-PA213 Safety position switch
- SICK miniTwin4 Safety light curtain
- SICK T4000-E0101K Safety switch

Actuators

The System SLIO safety output module was successfully tested with the following actuators:

- Pilz Safety switch device PNOZ X2.7P



You can also use sensors and actuators from other producers, which have the properties suitable for the application and the corresponding type examination.

Controllers

The System SLIO safety input and output modules were successfully tested with the following controllers:

- Siemens IM151-8F PN/DP CPU
(6ES7151-8FB00-0AB0, product version 3, FW 2.7.1)
- Siemens CPU315F-2 PN/DP
(6ES7315-2FH13-0AB0, product version 4, FW 2.6.7)
- Siemens CPU317F-2 PN/DP
(6ES7317-2FK14-0AB0, product version 2, FW 3.1.1)

3 Deployment

3.1 Planning of a safety-related control system

General

In the planning phase the complete definition of the safety function(s) takes place. Besides the risk evaluation the planning contains the detailed definition of all system components, the definition of the system parameters, the detailed installation and wiring of the components.

**DANGER!**

A careful executed planning serves for avoidance of errors. Errors in safety-related machines can lead to irreversible injuries and to death.

**CAUTION!**

In the phase of planning the "Check list planning" is to be used. ↪ *Appendix 'Checklist planning' on page 147*

Risk evaluation

The risk evaluation shows the risk, which can come from a machine and which plant components must be equipped with safety equipment. Due to the safety measures the residual risk is reduced to an acceptable level.

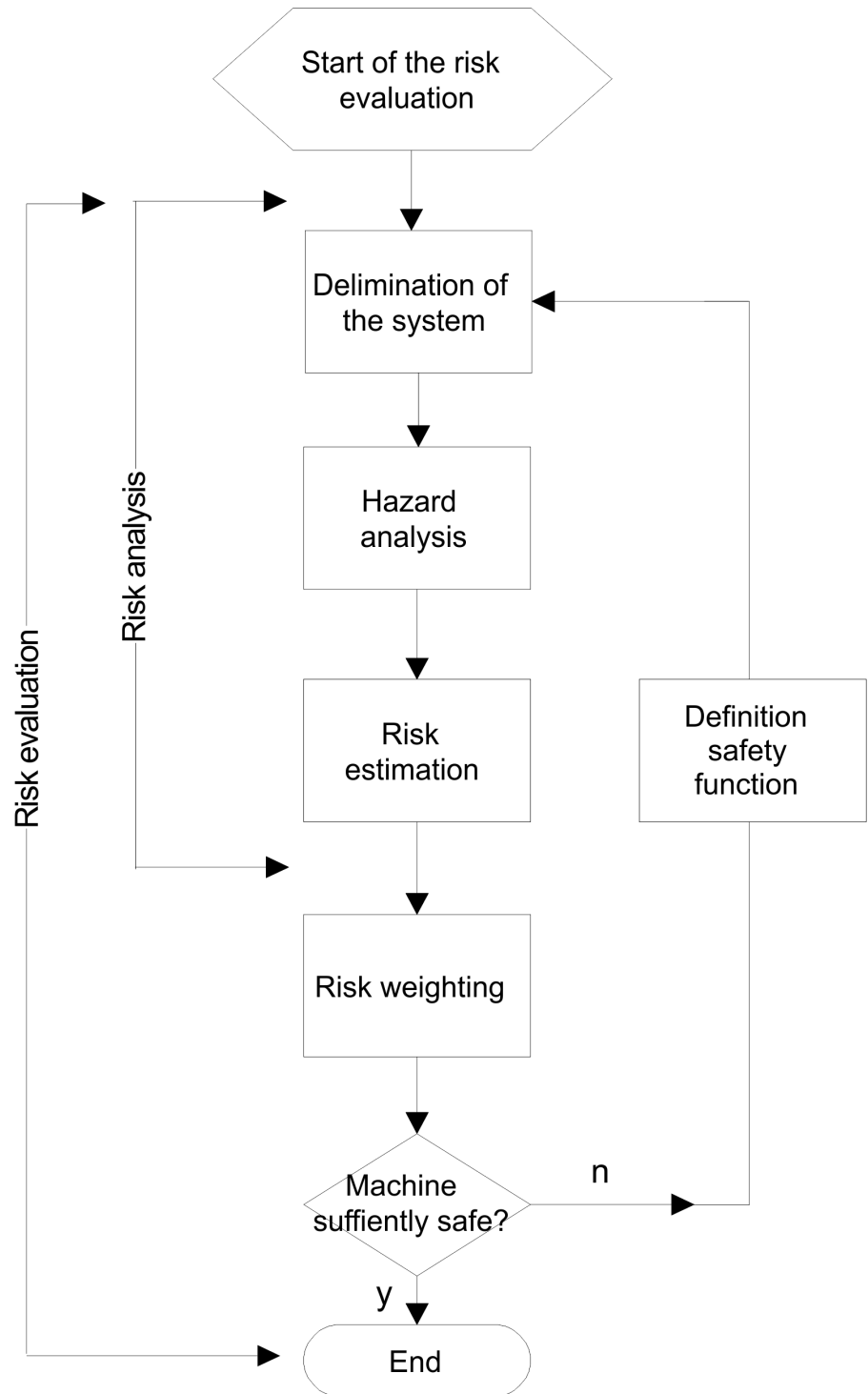
**CAUTION!**

As a manufacturer of machine you are obliged under the machinery directive to execute a risk evaluation to identify all hazards associated with the machine and reduce the residual risk to an acceptable minimum.

**CAUTION!**

The risk evaluation must necessarily be conducted in the planning phase and before realization and conversion works.

Sequence of a risk evaluation in accordance to DIN EN ISO 12100-1 and EN ISO 14121



Installation and wiring diagram

In the phase of planning an installation and a wiring diagram for the total safety system are to be created. It contains all system components and their wiring.

**CAUTION!**

Please consider a separation of high- and low-voltage signals in the installation and wiring diagram for the exclusion of cross- or short circuits to potentials > 60V.

This can be achieved for the System SLIO by a separate installation and appropriate isolation.

With the production of the wiring diagram valid standards and guidelines are to be considered for the proper installation of lines.

Determining the device parameters

The available safety parameters can be found in the chapter "Product description" ↗ *Chapter 2 'Product description' on page 25.*

The parameters of further standard modules can be found in the according user manual.

**CAUTION!**

In the phase of planning a list of parameters to be adjusted is to be created with a determination of the individual parameters and their verification.

Sequence of the phase of planning

The system is planned according to the respective need of the plant or machine. The components available for the control technology are more described at "Installation" further down. Before the commissioning of a module the following must be checked and ensured:

- Compatibility of the modules (↗ *Chapter 2.12 'Compatibility list' on page 69* and technical data).
- Sufficient supply of the control system by attached power supplies, respectively attached safety components.

3.2 Installation guidelines

General

The installation guidelines contain information about the interference free deployment of the System SLIO. There is the description of the ways, interference may occur in your PLC, how you can make sure the electromagnetic compatibility (EMC), and how you manage the isolation.

What does EMC mean?

Electromagnetic compatibility (EMC) means the ability of an electrical device, to function error free in an electromagnetic environment without being interfered respectively without interfering the environment.

All System SLIO components are developed for the deployment in industrial environments and meets high demands on the EMC. Nevertheless you should project an EMC planning before installing the components and take conceivable interference causes into account.

Possible interference causes

Electromagnetic interferences may interfere your control via different ways:

- Electromagnetic fields (RF coupling)
- Magnetic fields with power frequency
- Bus system
- Power supply
- Protected earth conductor

Depending on the spreading medium (lead bound or lead free) and the distance to the interference cause, interferences to your control occur by means of different coupling mechanisms.

There are:

- galvanic coupling
- capacitive coupling
- inductive coupling
- radiant coupling

Basic rules for EMC

In the most times it is enough to take care of some elementary rules to guarantee the EMC. Please regard the following basic rules when installing your PLC.

- Take care of a correct area-wide grounding of the inactive metal parts when installing your components.
 - Install a central connection between the ground and the protected earth conductor system.
 - Connect all inactive metal extensive and impedance-low.
 - Please try not to use aluminium parts. Aluminium is easily oxidizing and is therefore less suitable for grounding.
- When cabling, take care of the correct line routing.
 - Organize your cabling in line groups (high voltage, current supply, signal and data lines).
 - Always lay your high voltage lines and signal respectively data lines in separate channels or bundles.
 - Route the signal and data lines as near as possible beside ground areas (e.g. suspension bars, metal rails, tin cabinet).
- Proof the correct fixing of the lead isolation. ↪ *'Isolation of conductors' on page 74*
 - Data lines must be laid isolated.
 - Analog lines must be laid isolated. When transmitting signals with small amplitudes the one sided laying of the isolation may be favourable.
 - Lay the line isolation extensively on an isolation/protected earth conductor rail directly after the cabinet entry and fix the isolation with cable clamps.
 - Make sure that the isolation/protected earth conductor rail is connected impedance-low with the cabinet.
 - Use metallic or metallised plug cases for isolated data lines.

- In special use cases you should appoint special EMC actions.
 - Consider to wire all inductivities with erase links.
 - For lightening cabinets you should avoid luminescent lamps.
- Create a homogeneous reference potential and ground all electrical operating supplies when possible.
 - Please take care for the targeted employment of the grounding actions. The grounding of the PLC serves for protection and functionality activity.
 - Connect installation parts and cabinets with the System SLIO in star topology with the isolation/protected earth conductor system. So you avoid ground loops.
 - If there are potential differences between installation parts and cabinets, lay sufficiently dimensioned potential compensation lines.

Isolation of conductors

Electrical, magnetically and electromagnetic interference fields are weakened by means of an isolation, one talks of absorption. Via the isolation rail, that is connected conductive with the rack, interference currents are shunt via cable isolation to the ground. Here you have to make sure, that the connection to the protected earth conductor is impedance-low, because otherwise the interference currents may appear as interference cause.

When isolating cables you have to regard the following:

- If possible, use only cables with isolation tangle.
- The hiding power of the isolation should be higher than 80%.
- Normally you should always lay the isolation of cables on both sides. Only by means of the both-sided connection of the isolation you achieve high quality interference suppression in the higher frequency area. Only as exception you may also lay the isolation one-sided. Then you only achieve the absorption of the lower frequencies. A one-sided isolation connection may be convenient, if:
 - the conduction of a potential compensating line is not possible.
 - analog signals (some mV respectively μA) are transferred.
 - foil isolations (static isolations) are used.
- With data lines always use metallic or metallised plugs for serial couplings. Fix the isolation of the data line at the plug rack. Do not lay the isolation on the PIN 1 of the plug bar!
- At stationary operation it is convenient to strip the insulated cable interruption free and lay it on the isolation/protected earth conductor line.
- To fix the isolation tangles use cable clamps out of metal. The clamps must clasp the isolation extensively and have well contact.
- Lay the isolation on an isolation rail directly after the entry of the cable in the cabinet. Lead the isolation further on to the System SLIO module and don't lay it on there again!



CAUTION!

Please regard at installation!

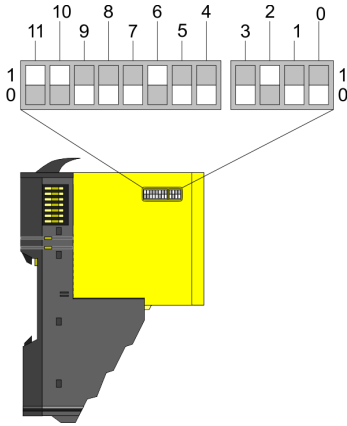
At potential differences between the grounding points, there may be a compensation current via the isolation connected at both sides.

Remedy: Potential compensation line

3.3 Setting the F-address

Address switch for F-address

The F-address is to be configured by the F-address switch at the VIPA safety module and additionally in the master system e.g. hardware configurator. The F-address is to be set by the F-address switch besides on the safety module. Only if the F-address set in the hardware configurator accords to the setting of the F-address switch, it is possible to operate!



| Pos. | Value | Example | |
|------|-------|---------|--------------------------------|
| | | State | Address |
| 0 | 1 | 1 | 1+2+32+512=547 Address: 547 |
| 1 | 2 | 1 | |
| 2 | 4 | 0 | |
| 3 | 8 | 0 | |
| 4 | 16 | 0 | |
| 5 | 32 | 1 | |
| 6 | 64 | 0 | |
| 7 | 128 | 0 | |
| 8 | 256 | 0 | |
| 9 | 512 | 1 | |
| 10 | 1024 | 0 | |
| 11 | 2048 | 0 | |



When the module is installed, the F-address switch may not be accessed!

To set the F-address on the safety module the (electronic) module is to be demounted before as described at "Demounting and module exchange". ↪ Chapter 3.5 'Demounting and module exchange' on page 84

- **Before setting take the field bus coupler of circuit!**
- **F-address must be unique!**
 - F-addresses from 1 to 4095 may be set.
 - Each F-address must be unique in the communication network of the safety PLC!
- **Only use suitable tools for the setting!**
 - The switching elements of the F-address switch must be set only with a suitable tool like a screwdriver or a clockmaker.
 - In no case should pressure be exerted on the switching elements.
- **Setting the F-address via safety parameter dialog**
 - In addition the F-address setting of the F-address switch must be configured by the safety parameter dialog of the master system.

3.3.1 Changing the F-address

The following 2 steps are required to change the F-address:

- Changing an existing F-address at the module
- Changing the F-address in the hardware configuration



For this please consider the hints below at "Demounting and module exchange". ↪ Chapter 3.5 'Demounting and module exchange' on page 84

3.3.1.1 Changing an existing F-address at the module

If you want to change the F-address of a System SLIO module, which just operates with a valid configuration, there are the following options to initiate the change process:

- At the module by means of the F-address switch
- Start the Siemens SIMATIC Manager.

At the module via the F-address switch

With the following approach the System SLIO safety module is to be powered off and to demounted.

- 1.** ▶ Switch off the DC 24V power supply of your System SLIO safety module.
- 2.** ▶ Demount the System SLIO safety module.
- 3.** ▶ Switch all the DIP switches of the F-address switch to 0 position.
- 4.** ▶ Mount the System SLIO safety module.
- 5.** ▶ Switch on the DC 24V power supply for the System SLIO safety module.
- 6.** ▶ Please wait for about 5s and switch the DC 24V power supply for the System SLIO module off again. Hereby the internal F-address memory of the System SLIO safety module is cleared.
- 7.** ▶ Demount the System SLIO safety module.
- 8.** ▶ Switch the F-address switch to the wished F-address.
- 9.** ▶ Mount the System SLIO safety module.
- 10.** ▶ Switch on again the DC 24V power supply for the System SLIO safety module.

Online via the Siemens SIMATIC Manager

With the following approach the System SLIO safety module is to be powered off and to demounted.

1. ▶ Switch off the DC 24V power supply of your System SLIO safety module.
2. ▶ Demount the System SLIO safety module.
3. ▶ Switch the F-address switch to the wished F-address.
4. ▶ Mount the System SLIO safety module.
5. ▶ Switch on the DC 24V power supply for the System SLIO safety module.
6. ▶ Start the Siemens SIMATIC Manager with your project.
7. ▶ Open in the Siemens hardware configurator by a double-click to the properties dialog of your System SLIO safety module.
8. ▶ Set the parameter *Parameter change mode*.
9. ▶ Close the Siemens properties dialog.
10. ▶ For the validation of the parameters, click at the System SLIO safety module and choose *'context menu → Start device tool → VIPA Safety CRC-Tool'*.
11. ▶ Examine the validation. Here the re-generation of the safety program is not necessary. ↪ *Chapter 3.9 'Deployment with PROFIBUS' on page 110*, ↪ *Chapter 3.10 'Deployment with PROFINET' on page 115*
12. ▶ Translate and transfer your project to your CPU.
13. ▶ Re-open the properties dialog of the System SLIO safety module and reset the parameter *parameter change mode*.
14. ▶ Examine the validation with re-generation of the safety program. This always includes the verification of the F-address of the module, which is set by the DIP switches.
15. ▶ Translate and transfer your project to your CPU.

3.3.1.2 Changing the F-address in the hardware configuration

For the following approach, it is assumed that the wished F-address is set and the System SLIO safety module is mounted.

1. ▶ Open the hardware configuration with your project.
2. ▶ Open the properties dialog of the System SLIO safety module, whose address you want to change.
3. ▶ Switch to the tab *'PROFIsafe'*.
4. ▶ Enter at *'F_Dest_Add'* your F-address.
5. ▶ Close the properties dialog with [OK]. Save and translate your hardware project and transfer it into your CPU. Then you can close the hardware configurator.
6. ▶ Open in the Siemens SIMATIC Manager the dialog *'Edit safety program'*. "Generate" your safety program and "upload" it into your CPU.
 - ⇒ The program is now executable with the new F-address.

3.4 Installation



CAUTION!

In the phase of installation the "Check list Installation" of the appendix is to be used. ↪ *Appendix 'Checklist installation' on page 148*

- Make sure that the installation is complete in accordance with the installation and wiring plan.
- Make sure that you bring a supply voltage separation in the wiring in accordance to SELV / PELV.
- After the installation make a visual inspection and check all components for visible damages.
- Check the system for wiring errors.
- Check the tensile strength of the electrical terminal and screw connections.
- Ensure the installation and wiring in accordance to valid standards and guidelines.
- Make sure that the environmental characteristics of the system, which are described in chapter 2, are not exceeded. ↪ *Chapter 2.6 'SDI 4xDC 24V - Technical data' on page 45*, ↪ *Chapter 2.10 'SDO 4xDC 24V 0.5A - Technical data' on page 62*
- Make sure that the type of safety system is sufficient.
- Make sure that the safety system will not be damaged by moving parts or working in the environment of the installed safety components.
- Make sure that the system components do not get in contact to aggressive media (e.g. acid, leaches, gear oil).

3.4.1 Requirements to the operating personnel

Qualified personnel are persons who, based on their education, experiences, instructions about valid standards and regulations, accident prevention regulations and operation conditions, are authorized by the plant safety executive manager to execute the required actions and to recognize and avoid potential hazards. The required qualifications for this duty are e.g.:

- Training or instruction in accordance with the standards of the safety engineering in care and use of appropriate safety equipment.



DANGER!

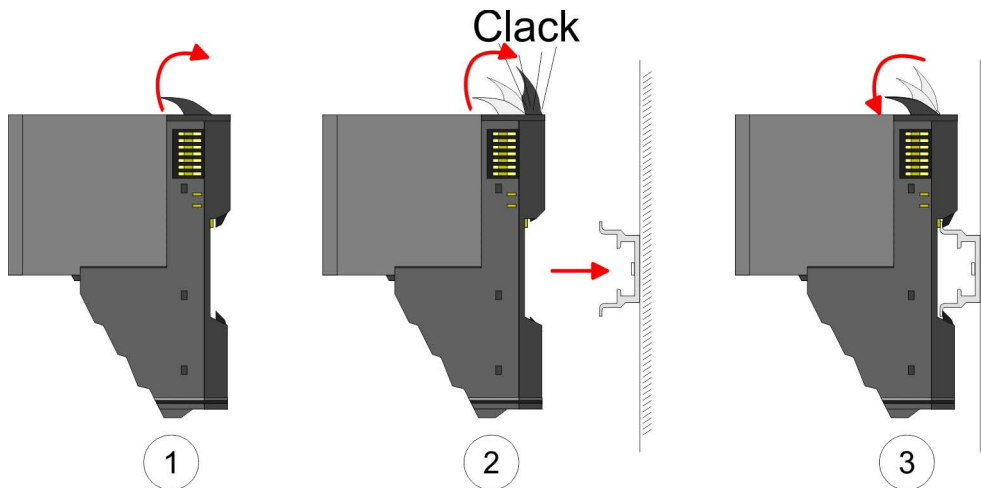
Risk of life by electrical current!

Devices and the environment in the switch gear cabinet can remain at dangerous potentials.

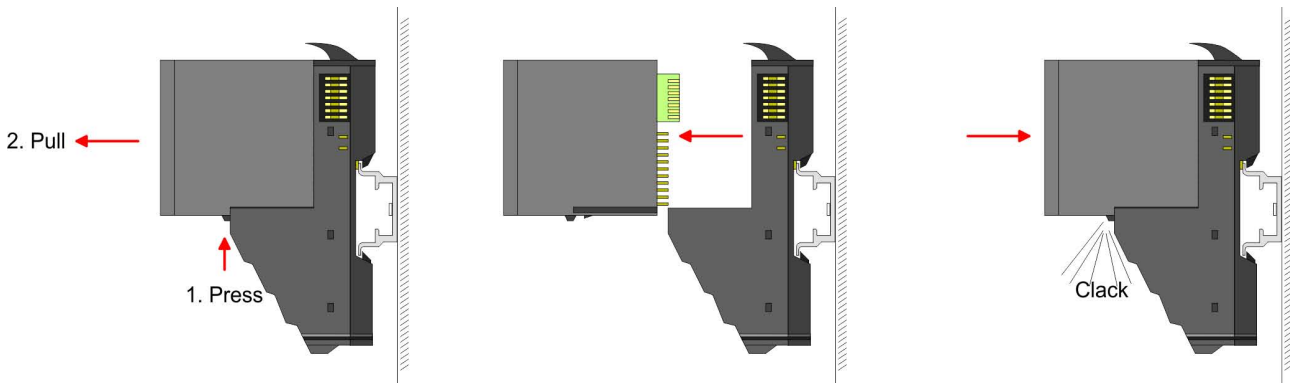
- For this before you start with work make sure that the device and the environment are off circuit.
- Observe the relevant safety regulations when handling with high-voltage devices.
- Make sure that only qualified personnel installs this module.

3.4.2 Functional principle

There is a locking lever at the top side of the terminal module. For mounting and demounting this locking lever is to be turned upwards until this engages audible. For mounting plug the module to the module installed before and push the module to the mounting rail guided by the strips at the upper and lower side of the module. The module is fixed to the mounting rail by pushing downward the locking lever. The modules may either separately be mounted to the mounting rail or as block. Here is to be considered that each locking lever is opened.



For the exchange of a electronic module, the electronic module may be pulled forward after pressing the unlocking lever at the lower side of the module. For installation plug the electronic module guided by the strips at the lower side until this engages audible to the terminal module.

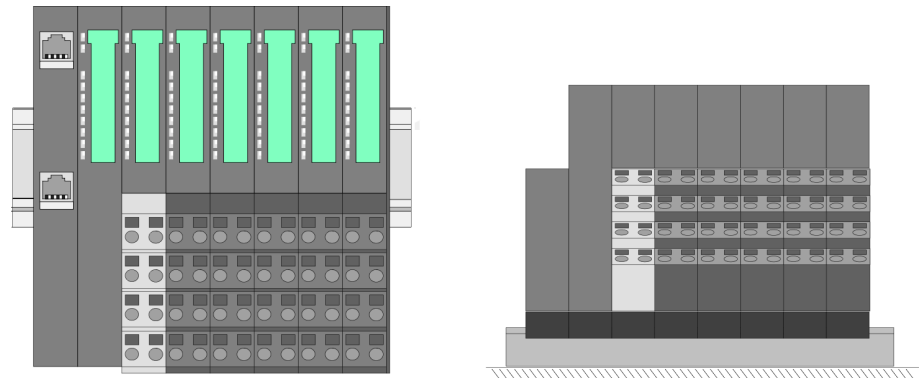


3.4.3 Mounting Proceeding

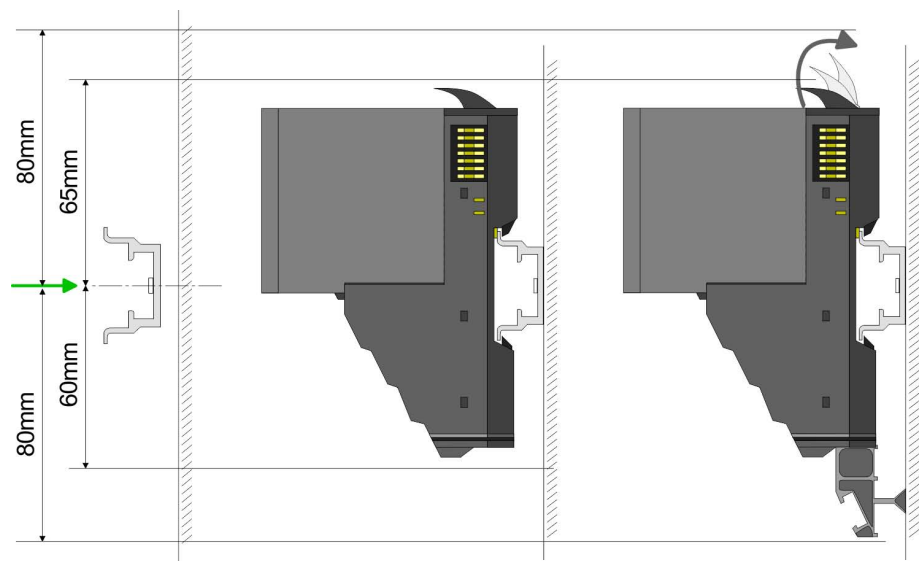
The modules were directly be mounted to the mounting rail and so connected to the backplane bus and the power supply for the electronic and power section. Up to 64 modules may be mounted. Please consider here that the sum current of the electronic power supply does not exceed the maximum value of 3A. By means of the power module 007-1AB10 the current of the electronic power supply may be expanded with 2A. More about this may be found at "Wiring".
 ↪ Chapter 3.6 'Wiring' on page 88

Possibilities

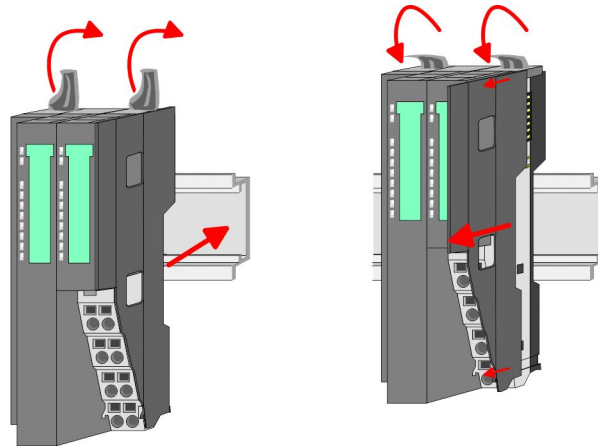
Horizontal hanging or lying



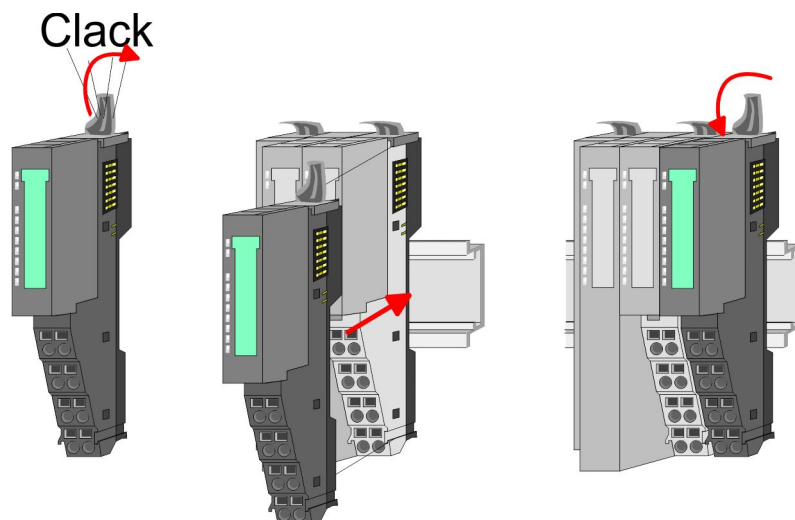
Mounting mounting rail



➤ Mount the mounting rail! Please consider that a clearance from the middle of the mounting rail of at least 80mm above and 60mm below, respectively 80mm by deployment of shield bus carriers, exist.

**Mounting head module
(e.g. bus coupler)**

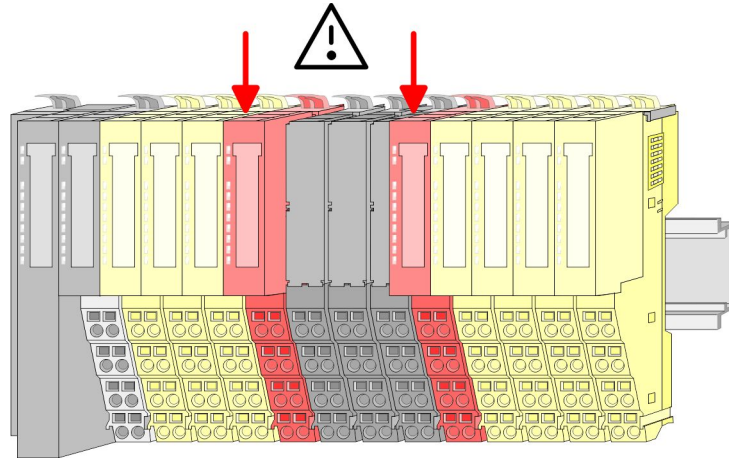
1. Start at the left side with the head module (e.g. bus coupler). For this turn both locking lever upwards, put the head module to the mounting rail and turn both locking lever downward.
2. Before mounting the periphery modules you have to remove the bus cover at the right side of the Head module by pulling it forward. Keep the cover for later mounting.

**Mounting periphery
modules**

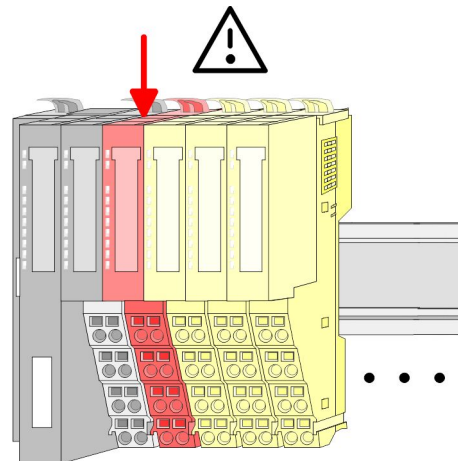
- Mount the periphery modules you want.

Characteristics when installing System SLIO safety modules

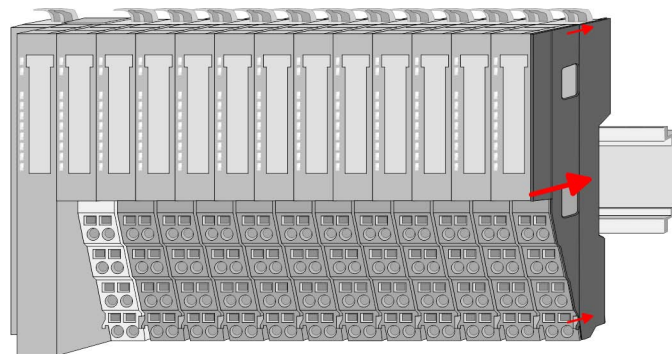
- Please consider when planning with System SLIO safety modules that you may not install a System SLIO safety module before and or behind System SLIO clamp modules!



- Please consider when planning with System SLIO safety modules that you may not install a System SLIO safety module behind a slave extension module of the System SLIO line extension!

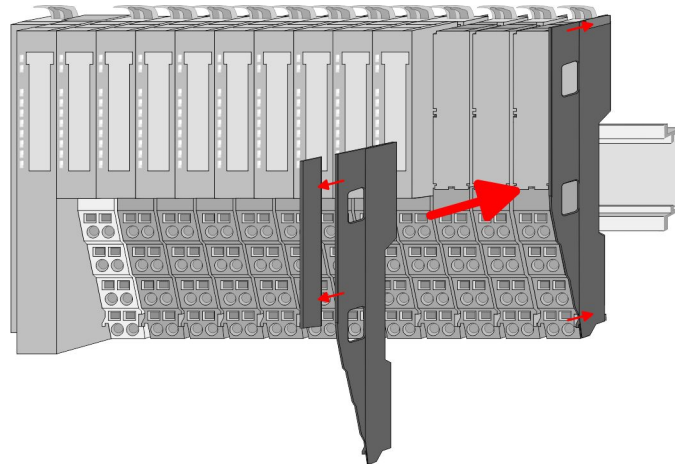


Mounting the bus cover at a peripheral module



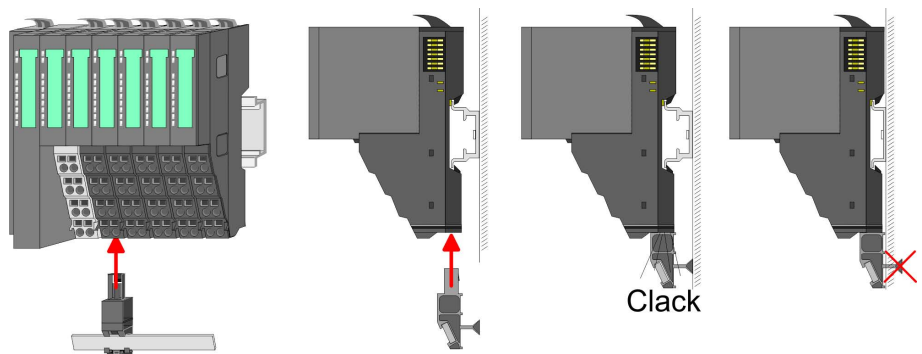
- After mounting the whole system, to protect the backplane bus connectors at the last module you have to mount the bus cover, now.

Mounting the bus cover at a clamp module



➔ If the last module is a clamp module, for adaptation the upper part of the bus cover is to be removed.

Mounting shield bus carrier



➔ The shield bus carrier (available as accessory) serves to carry the shield bus to connect cable shields. The shield bus carrier is mounted underneath the terminal of the terminal module. With a flat mounting rail for adaptation to a flat mounting rail you may remove the spacer of the shield bus carrier.

3.5 Demounting and module exchange

A defective module must be replaced immediately.



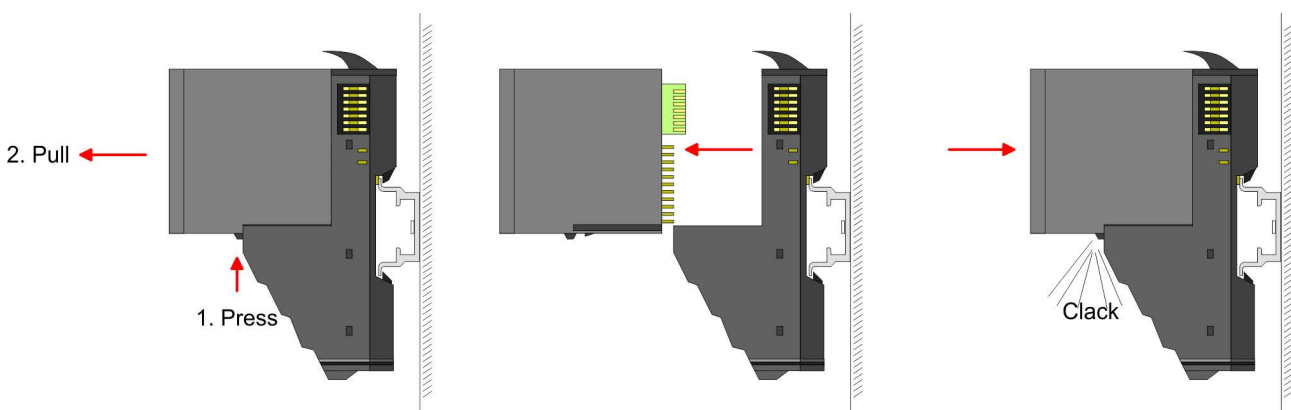
CAUTION!

- Demounting respectively module exchange may be performed only by authorized and qualified personnel.
- A defective system SLIO safety module may only be replaced by a System SLIO safety module with the same order number respectively by a module of the compatibility list, which is under construction.
- After the module exchange a complete function test inclusive verification and validation for the system must be accomplished. This should accordingly be documented.
- Proceed with the function test accordingly carefully, since you may reckon that after the module exchange there is an incorrect behavior of the machine respectively plant.
- Defective modules must be labelled as defective and should be sent back to VIPA. A re-use is absolutely prevented by measures within the quality management with the user.

3.5.1 Proceeding

With demounting and exchange of a module, head module (e.g. bus coupler) or a group of modules for mounting reasons you have always to remove the electronic module of the just mounted right module. After the mounting it may be plugged again.

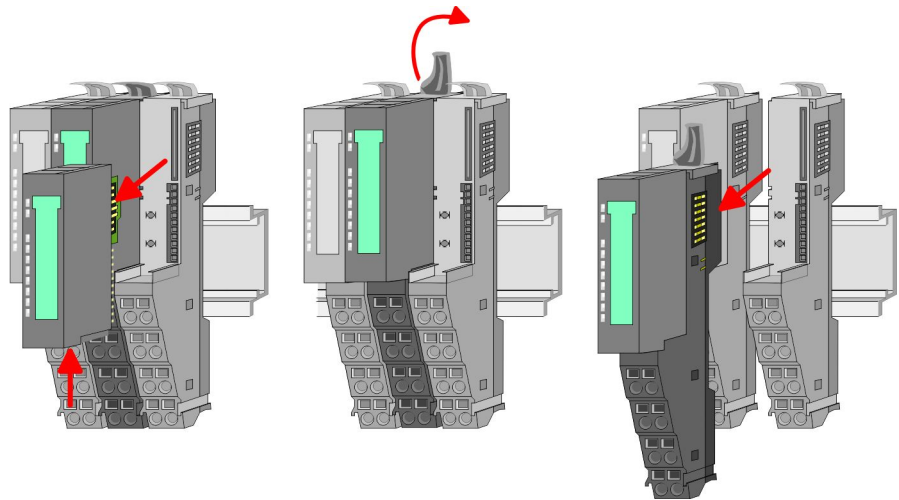
Exchange of an electronic module



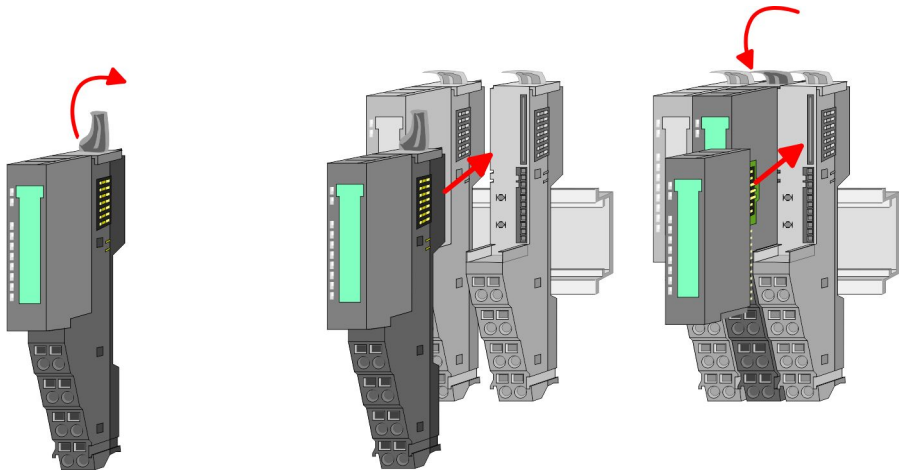
- 1.** ▶ For the exchange of an electronic module, the electronic module may be pulled forward after pressing the unlocking lever at the lower side of the module.
- 2.** ▶ To exchange a System SLIO safety module read the F-address of the address switch of the module to be changed and take these settings for the replacement module.
- 3.** ▶ For installation plug the electronic module guided by the strips at the lower side until this engages audible to the terminal module.

Exchange of a module

1. ▶ Remove if exists the wiring at the module ↪ *Chapter 3.6 'Wiring' on page 88.*



2. ▶ Press the unlocking lever at the lower side of the just mounted right module and pull it forward.
3. ▶ Turn the locking lever of the module to be exchanged upwards.
4. ▶ Pull the module forward.



5. ▶ For mounting turn the locking lever of the module to be mounted upwards.
6. ▶ To mount the module put it to the gap between the both modules and push it, guided by the stripes at both sides, to the mounting rail.
7. ▶ Turn the locking lever downward again.
8. ▶ Plug again the electronic module, which you have removed before.

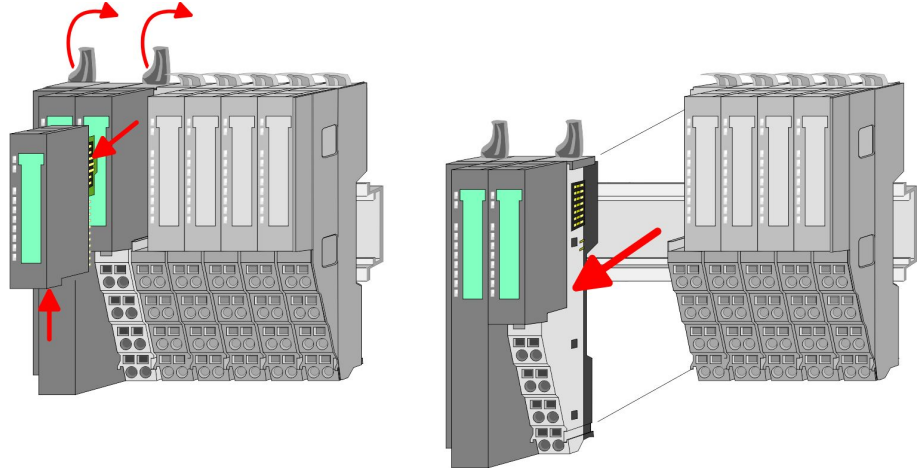
Exchange of a head module (e.g. bus coupler)



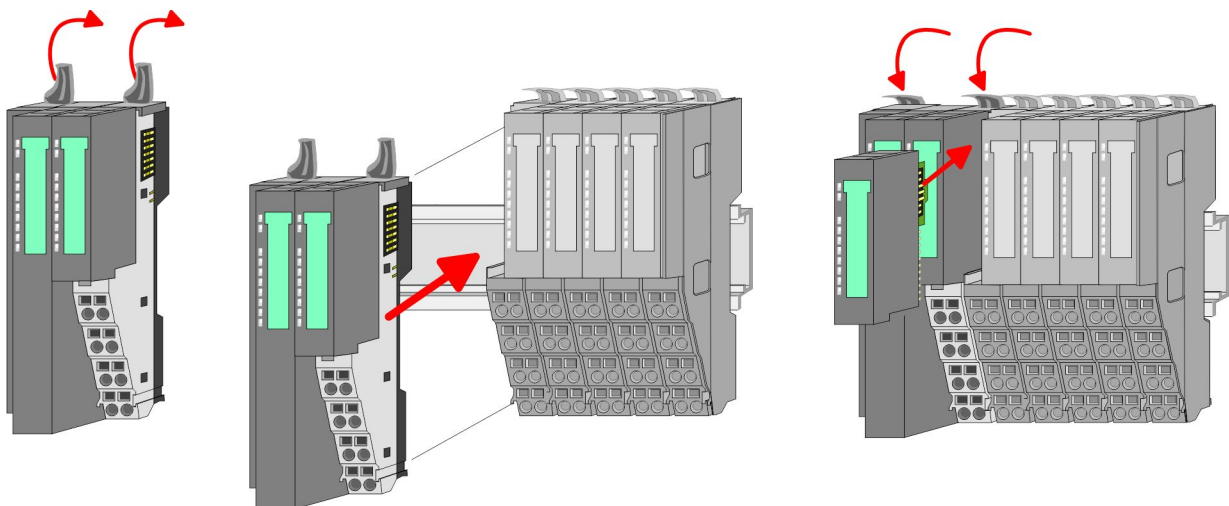
CAUTION!

Bus interface and power module of a head module may not be separated! Here you may only exchange the electronic module!

1. Remove if exists the wiring of the head module. ↪ *Chapter 3.6 'Wiring' on page 88.*



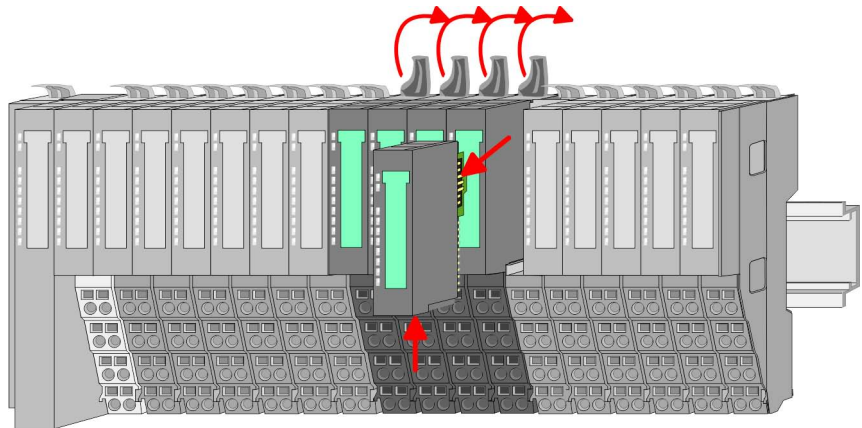
2. Press the unlocking lever at the lower side of the just mounted right module and pull it forward.
3. Turn all the locking lever of the head module to be exchanged upwards.
4. Pull the head module forward.



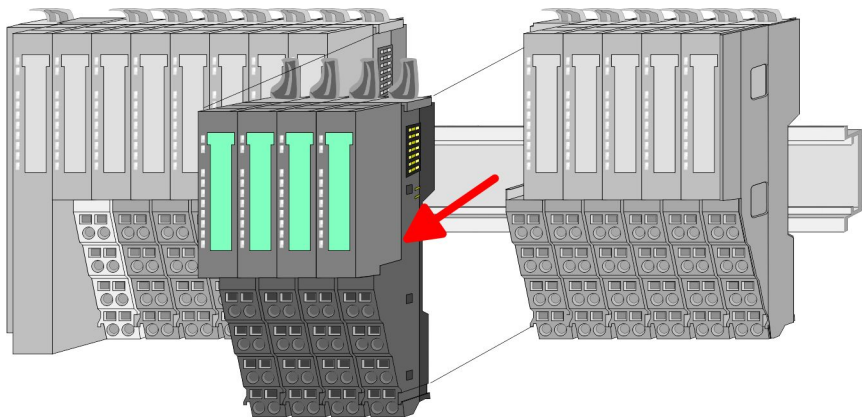
5. For mounting turn all the locking lever of the head module to be mounted upwards.
6. To mount the head module put it to the left module and push it, guided by the stripes, to the mounting rail.
7. Turn all the locking lever downward again.
8. Plug again the electronic module, which you have removed before.

Exchange of a module group

1. ▶ Remove if exists the wiring of the module group. ↪ *Chapter 3.6 'Wiring' on page 88.*

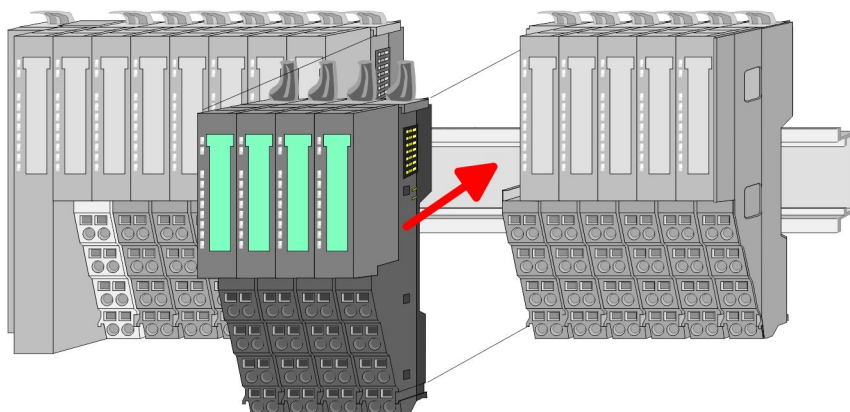
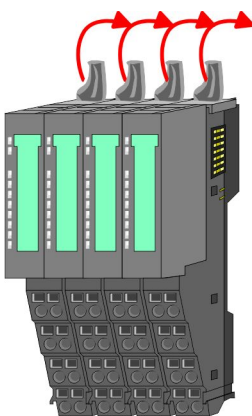


2. ▶ Press the unlocking lever at the lower side of the just mounted right module of the module group and pull it forward.



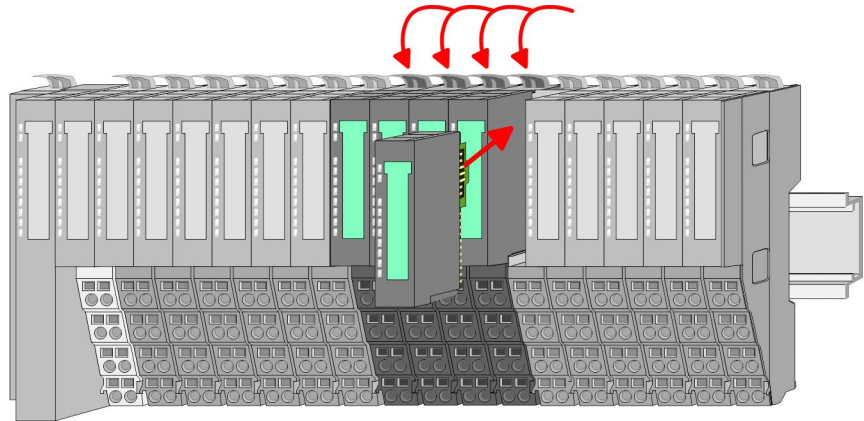
3. ▶ Turn all the locking lever of the module group to be exchanged upwards.

4. ▶ Pull the module group forward.



5. ▶ For mounting turn all the locking lever of the module group to be mounted upwards.

6. ▶ To mount the module group put it to the gap between the both modules and push it, guided by the stripes at both sides, to the mounting rail.



7. ▶ Turn all the locking lever downward again.
8. ▶ Plug again the electronic module, which you have removed before.

3.6 Wiring

Requirements on the electrical connection

To be able to fulfil the standard EN 60 204-1 (electrical equipment of machines), you have to use the cables, which are suggested there. The connectors may not drop away, otherwise the risk of short-cuts, external voltages etc. exists.

Pay attention to a EMC-compatible installation of the cables.



CAUTION!

Danger by electrical current!

The module can be destroyed/damaged, if you do not ensure the requirements for the electrical connection of the module.

- Make sure that the connected loads specified in the technical data are kept and that the connections are made in accordance with the specifications.
- Prevent a short-circuit between inputs and outputs. In the case of a short-circuit between inputs and outputs the electronic module can be destroyed.



CAUTION!

Please regard in particular that electromechanical sensors (safety switchgears) are supplied with suitable clock pulses for short circuit detection.

Electromechanical switches must correspond to the requirements in accordance with IEC 60947-5-1.

Requirement to the power supply

For the adherence to the NAMUR recommendation NE 21 IEC 61131-2 and EN 298 you have to use power supply units (AC 230V / DC 24V) with a mains buffering of at least 20ms.



WARNING!

Risk of injury by electric current!

There may only devices be connected to the controller, which have a safe separation of the 230V power.

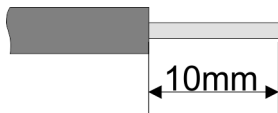
The power supply to generate 24V power must correspond to the requirements for PELV according to EN 60204-1.

Terminals

Terminals with spring clamp technology are used for wiring. The spring clamp technology allows quick and easy connection of your signal and supply lines.

In contrast to screw terminal connections this type of connection is vibration proof.

Requirements for the connecting cable



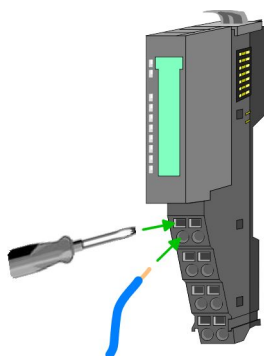
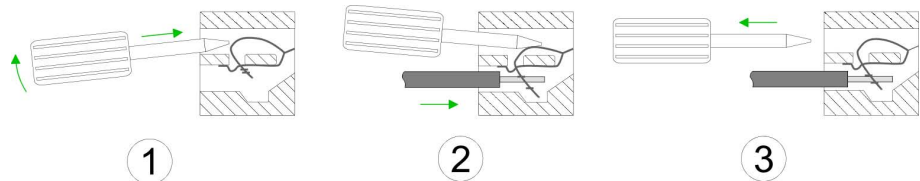
U_{max} : 240V AC / 30V DC

I_{max} : 10A

Cross section: 0.08 ... 1.5mm² (AWG 28 ... 16)

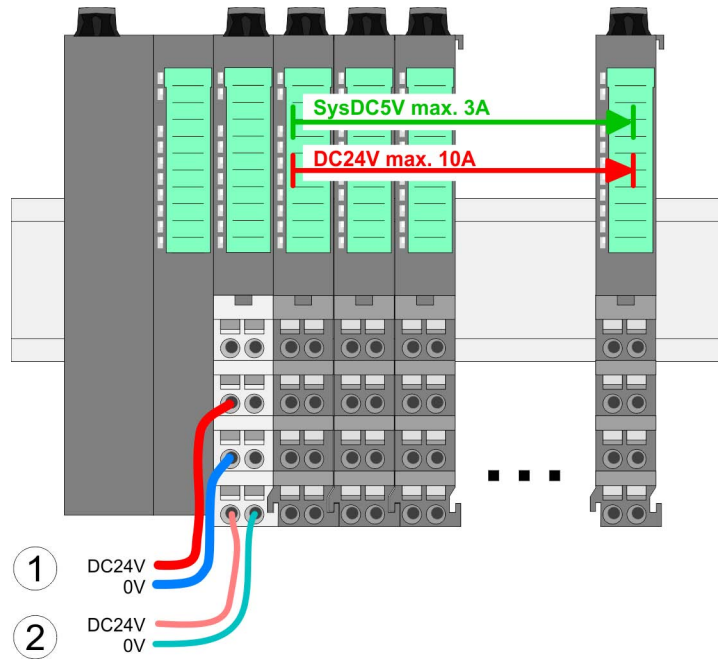
Stripping length: 10mm

Wiring procedure



1. Insert a suited screwdriver at an angle into the square opening as shown. Press and hold the screwdriver in the opposite direction to open the contact spring.
2. Insert the stripped end of wire into the round opening. You can use wires with a cross section of 0.08mm² up to 1.5mm².
3. By removing the screwdriver, the wire is securely fixed via the spring contact to the terminal.

Wiring power supply



- (1) DC 24V for power section supply I/O area (max. 10A)
- (2) DC 24V for electronic power supply bus coupler and I/O area



NOTICE!

Since the power section supply is not internally protected, it is to be externally protected with a fuse, which corresponds to the maximum current. This means max. 10A is to be protected by a 10A fuse (fast) respectively by a line circuit breaker 10A characteristics Z!



The electronic power section supply is internally protected against higher voltage by fuse.

The fuse is within the power module. If the fuse releases, its electronic module must be exchanged!

Fusing

- The power section supply is to be externally protected with a fuse, which corresponds to the maximum current. This means max. 10A is to be protected with a 10A fuse (fast) respectively by a line circuit breaker 10A characteristics Z!
- It is recommended to externally protect the electronic power supply for bus coupler and I/O area with a 2A fuse (fast) respectively by a line circuit breaker 2A characteristics Z.
- The electronic power supply for the I/O area of the power module 007-1AB10 should also be externally protected with a 1A fuse (fast) respectively by a line circuit breaker 1A characteristics Z.

State of the electronic power supply via LEDs

After PowerON of the System SLIO the LEDs RUN respectively MF get on so far as the sum current does not exceed 3A. With a sum current greater than 3A the LEDs may not be activated. Here the power module with the order number 007-1AB10 is to be placed between the peripheral modules. ↪ *'Power module 007-1AB10' on page 91*

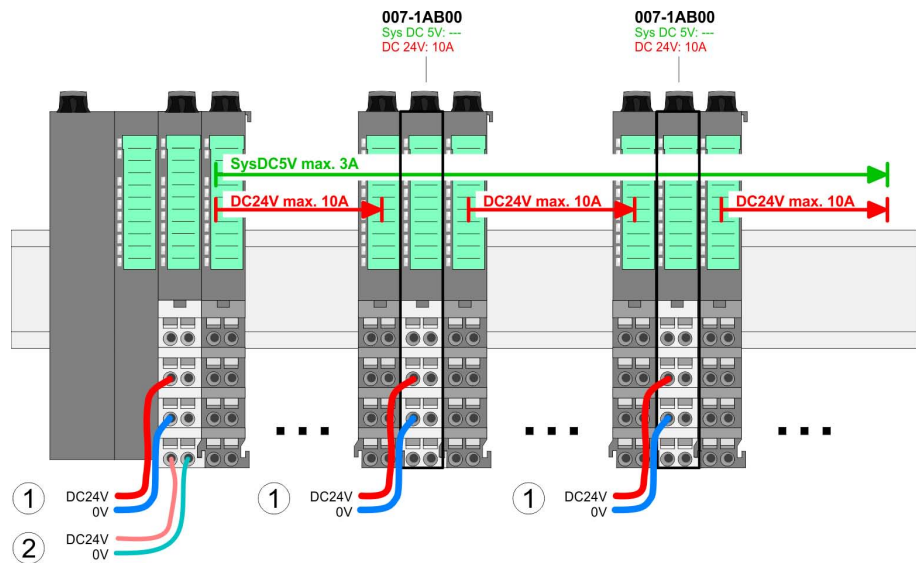
Deployment of the power modules

If the 10A for the power section supply is no longer sufficient, you may use the power module from VIPA with the order number 007-1AB00. So you have also the possibility to define isolated groups.

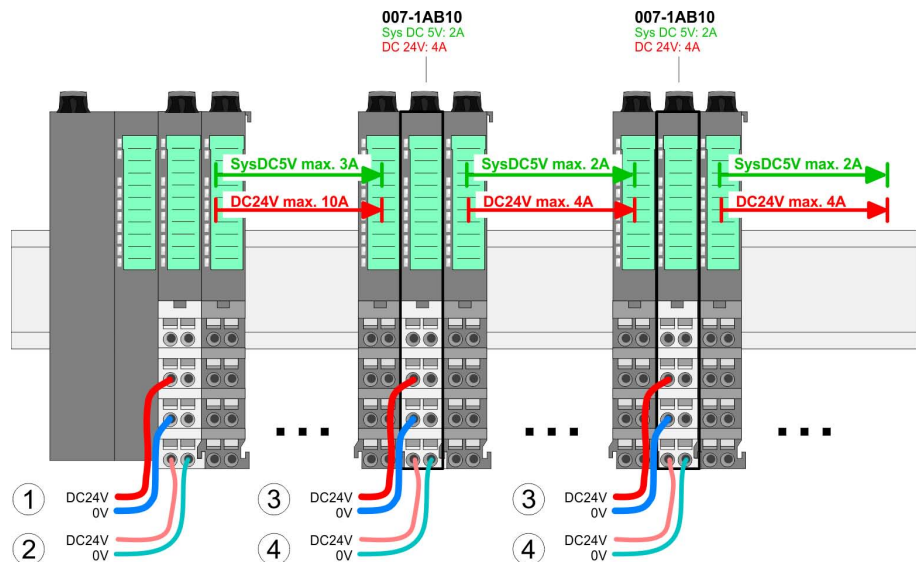
The power module with the order number 007-1AB10 is to be used if the 3A for the electronic power supply at the backplane bus is no longer sufficient. Additionally you get an isolated group for the DC 24V power section supply with max. 4A.

By placing the power module 007-1AB10 at the following backplane bus modules may be placed with a sum current of max. 2A. Afterwards the power module 007-1AB10 is to be placed again. To secure the power supply, the power modules may be mixed used.

Power module 007-1AB00



Power module 007-1AB10



- (1) DC 24V for power section supply I/O area (max. 10A)
- (2) DC 24V for electronic power supply bus coupler and I/O area
- (3) DC 24V for power section supply I/O area (max. 4A)
- (4) DC 24V for electronic power supply I/O area

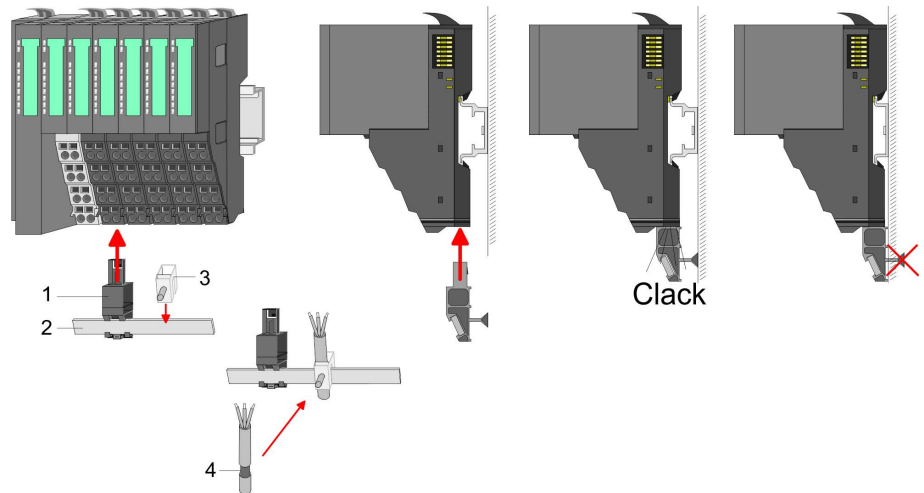
Shield attachment

To attach the shield the mounting of shield bus carriers are necessary.

The shield bus carrier (available as accessory) serves to carry the shield bus to connect cable shields.

The shield bus carrier is mounted underneath the terminal of the terminal module. With a flat mounting rail for adaptation to a flat mounting rail you may remove the spacer of the shield bus carrier.

After mounting the shield bus carrier with the shield bus, the cables with the accordingly stripped cable screen may be attached and fixed by the shield clamp.



- 1 Shield bus carrier
- 2 Shield bus (10mm x 3mm)
- 3 Shield clamp
- 4 Cable shield

3.6.1 Requirements to the sensor and actuators

Note the following warning in terms of safety-oriented operation of sensors and actuators:



CAUTION!

A safety system always consists of sensors, logic and actuators. The usage of the sensors and actuators lies outside of our sphere of influence. We equipped our electronics safety-relevant in such a way that we can offer you for the sensors and actuators 85% of the maximally permissible probability of dangerous errors (corresponds to the recommended dispatch between sensors, actuators and the electronic circuits for input, processing and output in expenditure in safety technology).

Instrumentation using sensors and actuators poses considerable safety responsibility. Not safety-rated sensors may not be offhand used!

Note that sensors and actuators generally do not allow a proof-test interval of 10 years to IEC 61508 standard.

A safety function must comply in terms of the probability and rate of hazardous faults with limits determined by the safety integrity level (SIL). The achieved values may be found in the technical data at "Safety relevant parameters". ↪ *Chapter 1.17 'Functional safety - safety relevant parameters' on page 19*

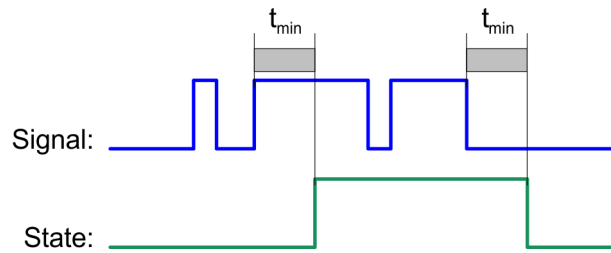
In order to achieve the desired security level, suitably qualified sensors and actuators are necessary.

Requirements to the sensors

The System SLIO safety DI module can be used with cable length up to 330m (capacity up to 100nF, ohmic resistance up to 22.4Ω). General rule: A single-channel sensor is sufficient to achieve SIL2/Cat. 3/PLd; to achieve SIL3/Cat.4/PLe, sensors must be connected via two channels.

Duration of the sensor signals

Note the following requirements on the sensor signals:



CAUTION!

In order to guarantee accurate detection of sensor signals by the safety DI module, you must ensure that the sensor signals have a defined *minimum duration*.

The *minimum duration* is a minimum switch-on and switch-off duration, which is necessary to detect a signal in the worst case. The time interval between two signal transitions must be greater than the PROFIsafe monitoring time to allow reliable detection of the pulses. ↪ *Chapter 2.5.2 'Overview PROFIsafe F parameters' on page 42*

Reliable detection by the safety DI module

| Parameter short-circuit test | Parametrized input delay | | |
|------------------------------|--------------------------|------|------|
| | 1ms | 3ms | 15ms |
| de-activated | 7ms | 9ms | 23ms |
| activated | 8ms | 12ms | 37ms |

In the table exemplary the minimum duration of the sensor signals of the safety DI module is shown. It depends on the configuration of the short-circuit test and the input delay in STEP®7 from Siemens.

Requirements to the actuators

The safety-related output modules perform a cyclic test of the outputs. The F module briefly disables the activate outputs. This test pulse lengths can be parametrized to match the load current and the cable capacitance / length.

In the table below you will find orientation values for the *test pulse length*:

| Load current | Cable length (capacity, resistor) | Test pulse length to be configured |
|--------------|-----------------------------------|------------------------------------|
| 2 mA | 100 m (30 nF, up to 6.7 Ohm) | 2500 µs |
| 2 mA | 333 m (100 nF, up to 22.4 Ohm) | 3500 µs |
| 2 mA | 1000 m (300 nF, up to 67 Ohm) | 6000 µs |
| 5 mA | 100 m (30 nF, up to 6.7 Ohm) | 2000 µs |
| 5 mA | 333 m (100 nF, up to 22.4 Ohm) | 2500 µs |
| 5 mA | 1000 m (300 nF, up to 67 Ohm) | 4000 µs |
| > 25 mA | 100 m (30 nF, up to 6.7 Ohm) | 1000 µs |
| > 25 mA | 333 m (100 nF, up to 22.4 Ohm) | 1000 µs |
| > 25 mA | 1000 m (300 nF, up to 67 Ohm) | 1500 µs |

High-speed actuators may briefly drop out or be activated during this test. If your process does not tolerate this action you must use actuators with a sufficient lag (> 1 ms).



CAUTION!

The outputs of a fail-safe output module must be electrically isolated to EN 50178 from components which carry higher voltages if the actuators are operated at voltages higher than 24 V DC, for example, at 230 V DC, or are being used to switch higher voltages. ↪ *Chapter 3.1 'Planning of a safety-related control system' on page 70*

Relays and contactors usually comply with this rule, is to be proved separately. This aspect is of particular importance when using semiconductor switchgear.

These components must be considered in the security calculation like the SLIO safety modules.

3.7 Connection examples

**WARNING!****Warning against personal and property damage!**

The use of the connection examples described in this section alone is not enough to execute the safety function according to the SIL, Cat./PL determined from the risk analysis. In connection with safe devices, sensors and actuators, additional measures may be necessary to ensure the safety function. This includes, for example, the appropriate wiring and parameterization of digital inputs and outputs, as well as measures to exclude unforeseeable errors.

More information is available in the user manuals of the safe devices used.

General

The section generally describes possible applications, in which the functions of the System SLIO safety module for implementation of a safety function are used. You can only use the depicted connection examples in a tangible safety application after a performed risk analysis.

**CAUTION!****Please consider at single-channel operation**

At single-channel operation the demand rate of the safety functions is max. 1/100 of the test rate!

- System SLIO safety input
 - The test rate for the System SLIO safety input module at single-channel operation is 1x per 150ms. This means the max. demand rate is 1x per 15s.
 - You have to evaluate the external components, which are used in single-channel operation, regarding the demand rate (e.g.: manual check of a single-channel protection door switch).
- System SLIO safety output
 - In single-channel operation each output-channel of the System SLIO safety output module internally exists twice (serial redundant). Therefore, the requirement with regard to the demand rate is not applicable.
 - But you have to evaluate the external components, regarding the demand rate, which are used in single-channel operation.

3.7.1 Connection examples for digital inputs

You can operate e.g. the following sensors on the digital inputs:

- Potential-free, contact emergency off buttons
- Protective door switches
- Light array (general contactless protection system) with the following characteristics:
 - the outputs are source-mode outputs
 - the outputs must be compatible to IEC 61131-2



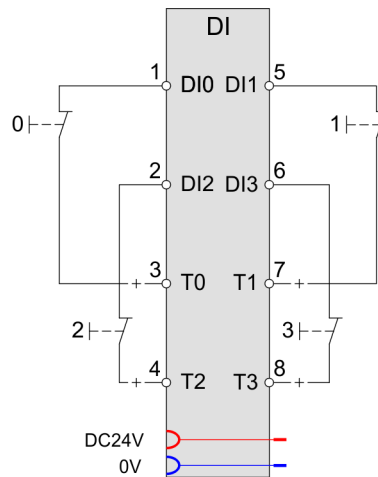
WARNING!

Achievable SIL, Cat./PL for single-channel use of the digital inputs!

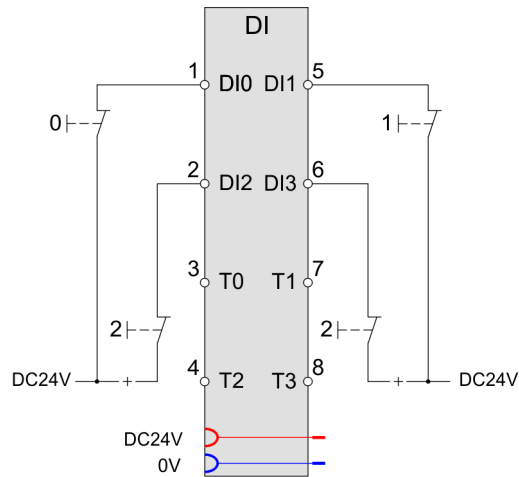
The achievable SIL, Cat./PL depends on the quality of the safe sensors. This must be certified according to EN 60947-5-1 /-5.

3.7.1.1 Emergency Off connection, single-channel

Connection 4 x emergency off, single-channel, *Test pulse activation active*



Connection 4 x emergency off, single-channel, *Test pulse activation* not active

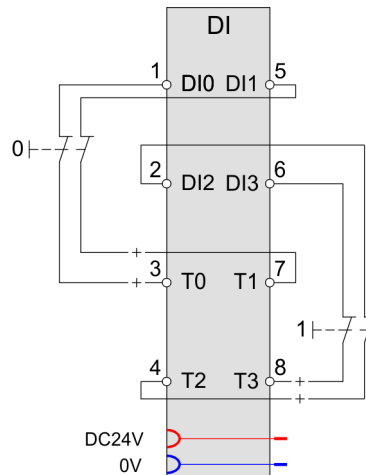


- You can connect the digital input via a switching element (e.g., an emergency off switch) either to the associated clock output or to the field supply voltage U_v directly. Alternatively, you can connect the semiconductor output of a sensor to the digital input directly. For the single-channel use of a digital input, you must set the parameter *Evaluation of the inputs* to "1-channel".
- If you do not connect the digital input via a switching element to the associated clock output (e.g., semiconductor output), set the *Test pulse activation* to "deactivated". Otherwise, the safety module detects a short circuit on the input and reports the "Short circuit" diagnostic message.
- If you connect the digital input via the switching element to the associated clock output and the safety module should monitor the signal line for short circuits, you have to set the parameter *Test pulse activation* to "activated".



Please consider the instructions for single-channel operation with regard to the demand rate. ↪ 'General' on page 96

Connection 2 x emergency-off switch, dual channel, equivalent evaluation



WARNING!

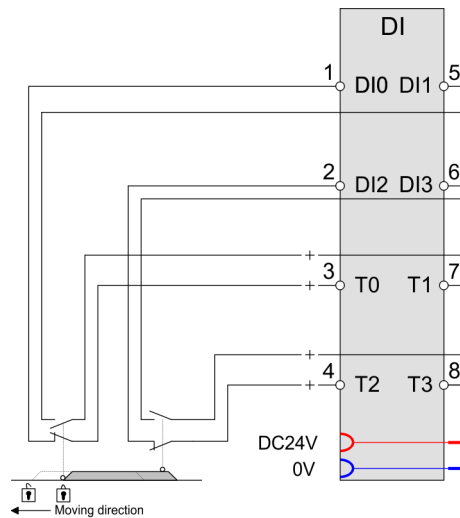
Pay attention to the protected installation of signal lines during *Test pulse activation* is "deactivated"!

If you have set the parameter *Test pulse activation* to "deactivated", as condition of fault exclusion, the signal lines must be installed protected among each other and between the sensors and inputs according to EN 60204-1 or EN ISO 13849-2 (e.g., as separate sheathed lines or in separate cable ducts).

- For emergency off applications that require single fault security, you can connect two digital inputs via two switching elements (two-channel emergency off switches with two break contacts) to the safety module.
- Use the hardware configuration together with the VIPA Safety CRC-Tool to set the parameters. ↪ *Chapter 3.9 'Deployment with PROFIBUS'* on page 110, ↪ *Chapter 3.10 'Deployment with PROFINET'* on page 115
- Set the parameter *Evaluation of the inputs* to "2-channel" and *Signal polarity* to "equivalent". In addition, set the *Discrepancy timeout* parameter to the discrepancy time required for the two switching elements. In addition, set the *Discrepancy timeout* parameter to the discrepancy time required for the two switching elements.
- You can set the *Test pulse activation* of both inputs used to "activated" or "not active". Please note that the *Test pulse activation* parameter must be set the same for both digital inputs. If you connect the digital inputs via the switching elements directly to the field voltage of DC +24 V or to two semiconductor outputs of a sensor, then you have to set the *Test pulse activation* parameter to "deactivated" because otherwise the safety module wrongly detects a short circuit and reports the "Short circuit" diagnostic message.
- The safe sensors used must be certified according to EN 60947-5-1 /-5.
- When using electronic sensors with semiconductor outputs you can achieve SIL3/Cat.4/PLe.

3.7.1.2 Connection interlock monitoring

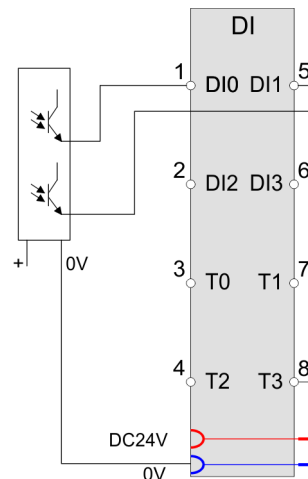
Connection 1 x interlock monitoring, dual channel, antivalent evaluation



- To monitor protective devices, you can connect the normally open contact of a protective door switch to four digital inputs of the safety module.
- Use the hardware configuration together with the VIPA Safety CRC-Tool to set the parameters. ↪ *Chapter 3.9 'Deployment with PROFIBUS' on page 110*, ↪ *Chapter 3.10 'Deployment with PROFINET' on page 115*
- Set the parameter *Evaluation of the inputs* to "2-channel".
- So that the signal lines of the digital inputs of the safety module are monitored for short circuits, for every input set the *Test pulse activation* to "activated".
- You must set the parameter *Signal polarity* to "antivalent". In addition, set the *Discrepancy timeout* parameter to the discrepancy time required for the normally open contact of the protective door switch.
- You can achieve SIL3/Cat.4/PLe with this circuit.

3.7.1.3 Connection light array

Connecting a light array



- For light array applications which require single fault security, you can connect two digital safety inputs to the according light array outputs.
- Here set the parameter *Evaluation of the inputs* of the digital safety inputs to "2-channel".
- For this the *Input smoothing time* of the according safety input must always be greater than the *Test pulse length* of the light array output (manufacturer data).
- Set the parameter *Test pulse activation* to "deactivated". Otherwise, the safety module wrongly detects a short circuit on the input and reports the "Short circuit" diagnostic message.

3.7.2 Connection examples for digital safety outputs

The following loads can be operated on the digital safety outputs:

- resistive loads
- inductive load after DC13 according EN 60947-5-1



Wire break detection at the digital safety output

To detect a wire break between the safety outputs DO 0 ... 3 and 0V to the connected load, for each safety output the parameter *wire break detection* may separately be set. The error wire break is reported if the output current is less than 10 ... 30mA. This error stops the module.

3.7.2.1 Switching inductive loads

You can operate inductive loads on the digital safety outputs of the SLIO safety module by using the internal recovery circuit. Consider the maximum switching frequency of 0.1Hz.



WARNING!

Defect by thermal overheating if the switching frequency is too high!

If the inductivity and load current you have selected is too high for the selected switching frequency, it can lead to thermal destruction of the digital safety output.

Destruction of the digital safety output can cause the safety function to fail.

Selecting an external diode recovery circuit

If you use a suitable external diode recovery circuit, then the magnetic energy when shutting down the inductive load is not converted in the SLIO safety module, but on the external diode recovery circuit.



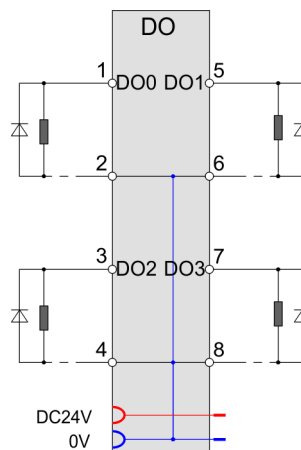
NOTICE!

The external diode recovery circuit must be designed for the resulting heat loss.

Connection with diode recovery circuit

When shutting down an inductive load, the magnetic energy stored in the inductive load must be dissipated. This magnetic energy converted by a diode recovery circuit into heat. You can convert the magnetic energy into heat with the SLIO safety module or with a suitable external diode recovery circuit.

These components must be considered in the security calculation like the System SLIO safety modules.



Please consider the instructions for single-channel operation with regard to the demand rate. ↪ 'General' on page 96

3.7.2.2 Switching electronic loads

You can switch electronic loads (e.g., electronically controlled door locking device) using the System SLIO safety module.

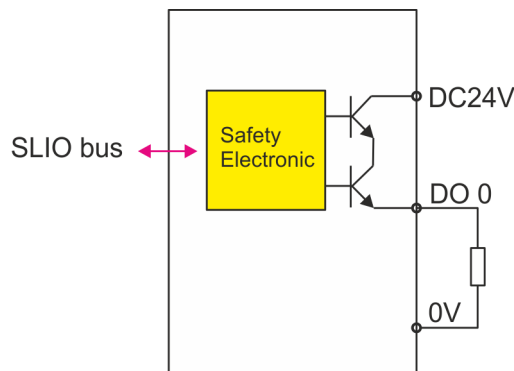


Switching electronic loads

When switching electronic loads, increased inrush currents that significantly exceed the rated current can be caused by internal capacities in the electronic loads. This can lead to passivation of the System SLIO safety module with the "Overload" diagnostic message. You can remedy this by limiting the inrush current, e.g., by placing an additional series resistor between the digital safety output and the electronic load.

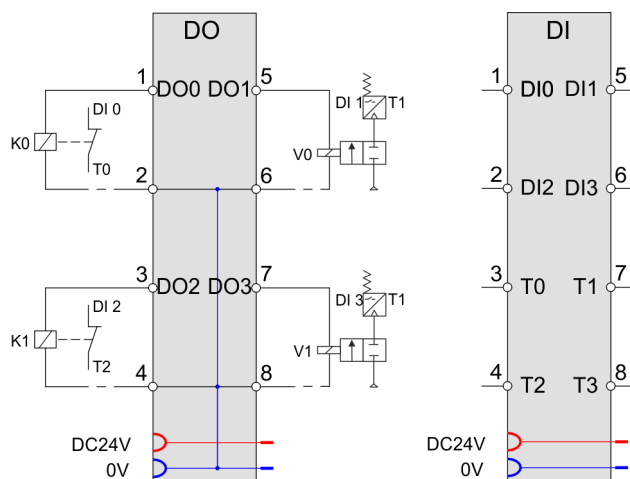
Schematic diagram

The following schematic diagram shows the internal two channel system of the System SLIO safety module.



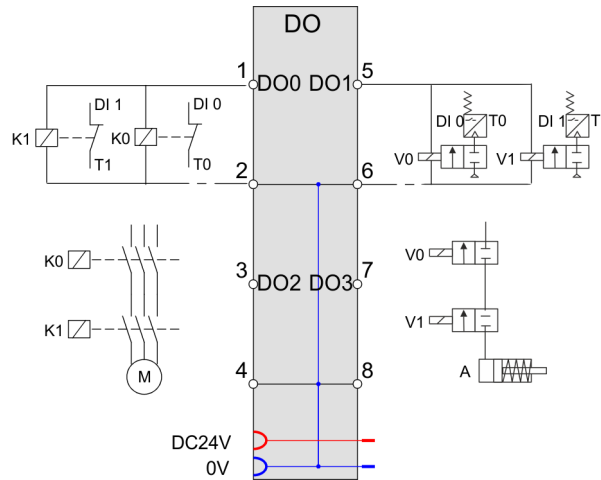
Connection a load to a safety output

In the following the connection of a load (relay respectively pneumatic valve) to an output with optional feedback (switch respectively pneumatic pressure switch) to a System SLIO safety input module is shown.



Connection 2 parallel connected loads to a safety output

With this connection, you can achieve SIL3/Cat.4/PLe by re-reading the relay states on the condition that in the external wiring a cross-circuit to the power supply can be excluded.

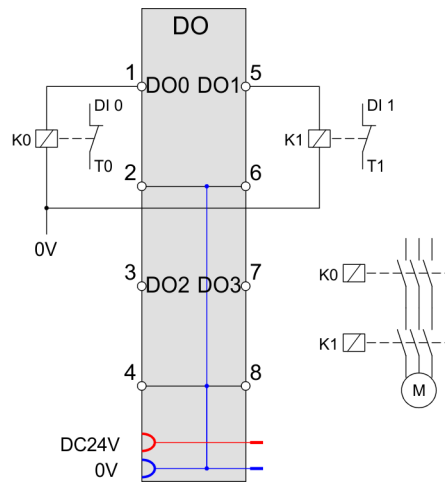


WARNING!
Pay attention to the protected installation of signal lines!
 To prevent a short circuit between the connecting cables of the safe sensors and the safety module, the signal lines must be installed protected between the safe sensor and the safety module according to EN 60204-1 or EN ISO 13849-2 (e.g. as separated sheathed lines or in sep. cable ducts).

i *Set the parameter Activation mode of the according safety output to 1-channel.*

Connection load to safety output and ground 0V

With this connection, you can achieve SIL3/Cat.4/PLe by re-reading the relay states.



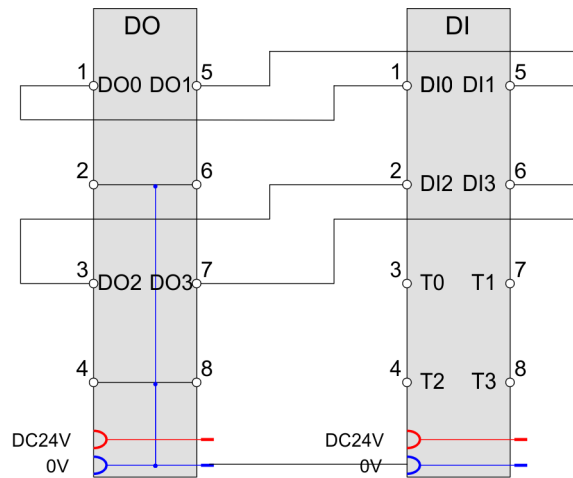
You can connect a load (e.g., a relay) between a digital safety output DO 0 ... 3 and the ground connection 0V of the field power supply. It is not necessary to lead back the ground connection to the according connection of the System SLIO safety module.

Please observe the following conditions:

- Ensure for the fact that the relay and the System SLIO safety module have the same reference potential.
- For single fault security, you need at least 2 relays and the cross-circuit fault on the supply voltage must be excluded by a protected wiring
- You must connect the normally open contacts (K0 and K1) of 2 relays in series to the load to be switched.

Connection digital safety outputs to digital safety inputs

In the following it is shown how to connect the safety outputs DO 0 ... 3 to the safety inputs of a System SLIO safety input module.



- For the according safety input you have to set the parameter *Test pulse activation* to "deactivated". Otherwise, the safety module detects a short circuit on the input and reports the "Short circuit" diagnostic message.
- For this the *Input smoothing time* of the according safety input must always be greater than the *Test pulse length* of the safety output.



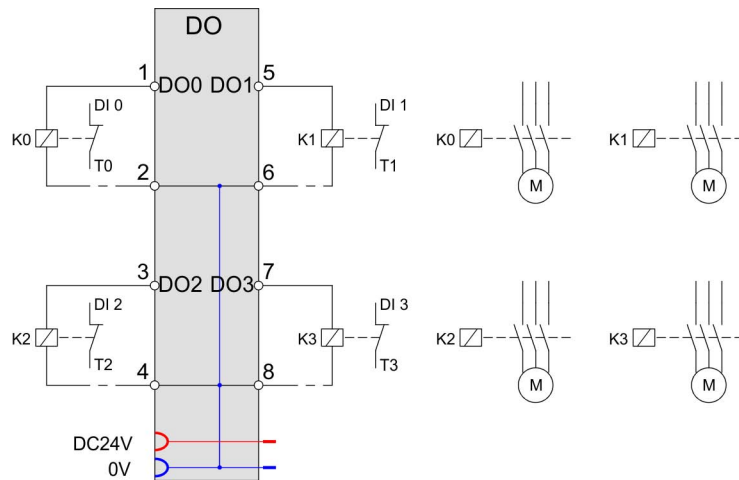
In this case wire break detection is not possible!

Connection 4 motors, external single-channel with feedback (1 contactor per motor)

You can connect a contactor to a digital safety output and connect a motor single-channel using normally open contacts of the contactor. Connection is possible to each of the four digital safety outputs. You must observe the warning messages for single-channel use. With this connection, you can achieve SIL2/Cat.2/PLd by re-reading the relay states.



Please consider the instructions for single-channel operation with regard to the demand rate. ↪ 'General' on page 96



WARNING!

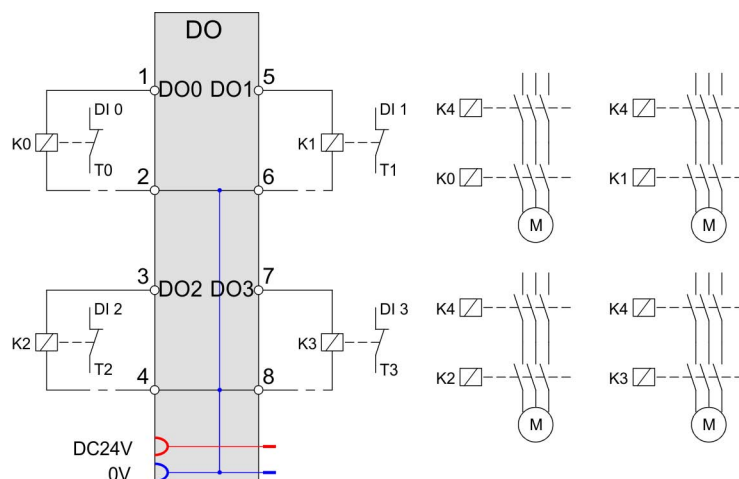
Important note to single fault security!

Never use a single digital safety output alone for the safety function if single fault security is required!

If single fault security is required, you have to integrate a second disconnection facility (e.g., a line contactor K4) in the safety application by e.g. analysing the relay states read back.

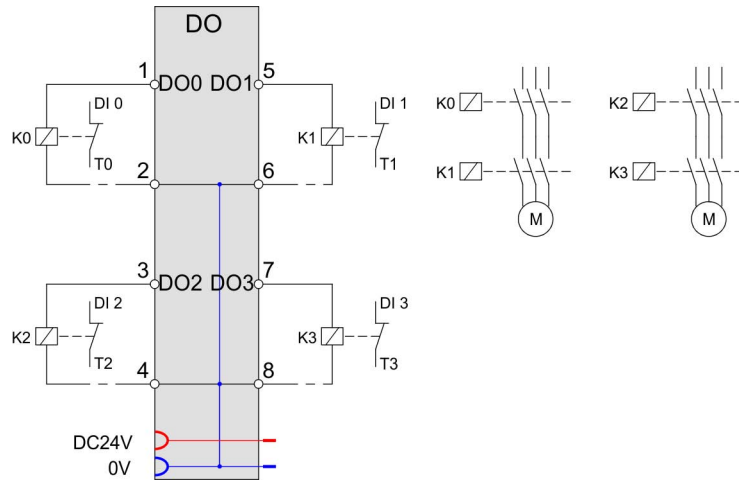
Connection 4 motors, 2-channel with feedback (2 contactor per motor)

With this connection, you can achieve SIL3/Cat.4/PLe by re-reading the relay states.



Connection 2 motors, 2-channel with feedback (2 contactor per motor)

With this connection, you can achieve SIL3/Cat.4/PLe by re-reading the relay states.



- To achieve signal fault security, we recommend the use of two positively driven normally open contacts of a contactor in series to the motor to be connected. These can originate from one contactor or from two different contactors.
- Connect the contactors between the digital safety outputs.

3.8 Notes for commissioning

General

The Commissioning guarantees that the System SLIO safety module functions correctly. Guarantee before commissioning that the following conditions are fulfilled:

- The digital module is correctly installed.
- The digital module is connected to safety components (Emergency stop device, safety light array etc.).
- The safety devices are activated.



For the operation the ambient data, which are specified in the technical data must be adhered to! Commissioning is only permitted after the acclimation of the System SLIO safety modules! ↪ Chapter 2.6 'SDI 4xDC 24V - Technical data' on page 45, ↪ Chapter 2.10 'SDO 4xDC 24V 0.5A - Technical data' on page 62



WARNING!

Risk of injury by electric current!

In the phase commissioning the check list "Check list commissioning and validation" in the appendix must be used.
 ↪ Appendix 'Checklist commissioning, parameterization and validation' on page 149

- Make sure that the system is exclusively commissioned by qualified personnel.
- Make sure during the commissioning that there is no person in the danger zone. You always may reckon that the machine, plant or safety device do not behave in such a way, as it is intended.
- If there are changes or extensions on the system during commissioning, influences to the system behaviour must be checked. Here the check lists for planning and installation must be handled again.



DANGER!

Risk of injury from moving parts!

During the commissioning machine parts / components or the entire machine / plant can move.

- Keep a sufficient distance from any moving parts of machinery / equipment or parts from the moving machine / plant.
- Note that via attached further modules the parts of machinery / equipment or parts from the moving machine / plant can set to motion.
- Activate in each case their safety devices.

Requirements to the operating personnel

The work for commissioning must be performed by professionally trained personnel, who in particular understands and acts on the safety regulations and notes.

**DANGER!****Risk by mechanical influence!**

During the commissioning of the module the machine / plant or parts of the machine / plant may be moved by a completely available application program.

- Keep a sufficient distance from any moving parts of machinery / equipment or parts from the moving machine / plant.

Change of the safe parametrization

With each change of the safe parametrization you get the message from the Siemens SIMATIC Manager, that safety-relevant changes were accomplished. So that these changes become effective, you have to generate the safety program again as indicated. For this you have to start the function "Generate" at "Calculate the safety program" in the Siemens SIMATIC Manager.

**Behaviour on changes of the safe parametrization**

If the safety program was not again generated and transferred to the F PLC after changing the safety parametrization, the System SLIO safety module does not report any error. Then the F PLC passivates the module and the inputs and outputs remain at 0.

3.9 Deployment with PROFIBUS**General**

- During the project engineering the SLIO I/O modules are assigned to the PROFIBUS DP master via the System SLIO DP salve.
- The project engineering happens in the Siemens SIMATIC Manager as hardware configuration for a Siemens F CPU.
- A direct assignment takes place via the PROFIBUS address that you set at the DP slave and in the master project at slave properties.
- By installing the corresponding GSD file the IM 053-1DP00 is listed at the hardware catalog as "VIPA 053-1DP00".



Due to the restrictions of PROFIBUS in the parameter telegram you can operate maximally 5 System SLIO safety modules at the backplane bus of the PROFIBUS DP slave.

More information about the project engineering and the parameters of the PROFIBUS DP slave IM 053-1DP00 may be found in the manual HB300_IM_053-1DP00.

GSD file

For every PROFIBUS slave from VIPA there is a GSD file available. This file may either be found on the supplied storage media or at the download area of www.vipa.com. Please always use for the System SLIO safety modules the DP-V1 variant. Install the file VI010C19.gsd in the Siemens SIMATIC Manager. Details on the installation of the GSD and/or type files are available from the manual respectively in the online help of Siemens. After the installation of the GSD file you will find the DP-V1 slave in the hardware catalog from Siemens at:

PROFIBUS DP > Additional Field devices > I/O > VIPA_SLIO > VIPA 053-1DP00 (DPV1)

The assignment of the GSD file to your slave is shown in the following table:

| Variant | GSD file |
|------------------------|--------------|
| VIPA 053-1DP00 (DP-V1) | VI010C19.gsd |

Project engineering

1. ▶ Mount your PROFIBUS system.
2. ▶ Set on your System SLIO safety module a F-address.
3. ▶ Start your project engineering tool with a new project.
4. ▶ Configure a master system with a F CPU from Siemens and create a new PROFIBUS subnet.
5. ▶ For the project engineering of the IM 053-1DP00 take the "VIPA 053-1DP00 (DPV1)" from the hardware catalog and drag it to the DP master subnet.
6. ▶ Parametrize the DP slave. Here enter among others a PROFIBUS address between 1 and 125 and set the same address at the address switch.
7. ▶ Place the System SLIO modules on the DP slave in the plugged sequence starting with slot 1, by dragging them from the hardware catalog.
8. ▶ Place in this way your System SLIO Safety I/O modules.
9. ▶ For each System SLIO safety module a parametrization is necessary. In addition you must validate the parameters by means of the VIPA Safety CRC-Tool and take the resulting checksum to the parametrization. ↪ *Chapter 3.9.1 'Parametrization System SLIO safety module' on page 111*
10. ▶ Save and transfer your project to the PLC.

3.9.1 Parametrization System SLIO safety module

The parameters of a System SLIO safety module can only be assumed, if the set parameters are validated by the VIPA Safety CRC-Tool and the resulting checksum is taken to the parameter F_iParCRC. In this way it is ensured that the transmitted parameters are always consistent.

Installation of the VIPA Safety CRC-Tool

From VIPA you get the software "VIPA Safety CRC-Tool" at a data carrier. This software serves for the validation of the set module parameters.


1. ▶ Close the Siemens SIMATIC Manager before installing the VIPA Safety CRC-Tool.
2. ▶ For installation start setup.exe from the data carrier.
3. ▶ Select the language for installation and click at [OK]. The Install-Shield-Wizard is started.
4. ▶ Accept the terms of license and click on [Next].
5. ▶ Enter your user information and click on [Next].
6. ▶ Select a destination folder and click on [Next].
7. ▶ Start the installation with [Install].
 - ⇒ After the installation the VIPA Safety CRC-Tool is available in the hardware configurator via the context menu.

Parameter setting

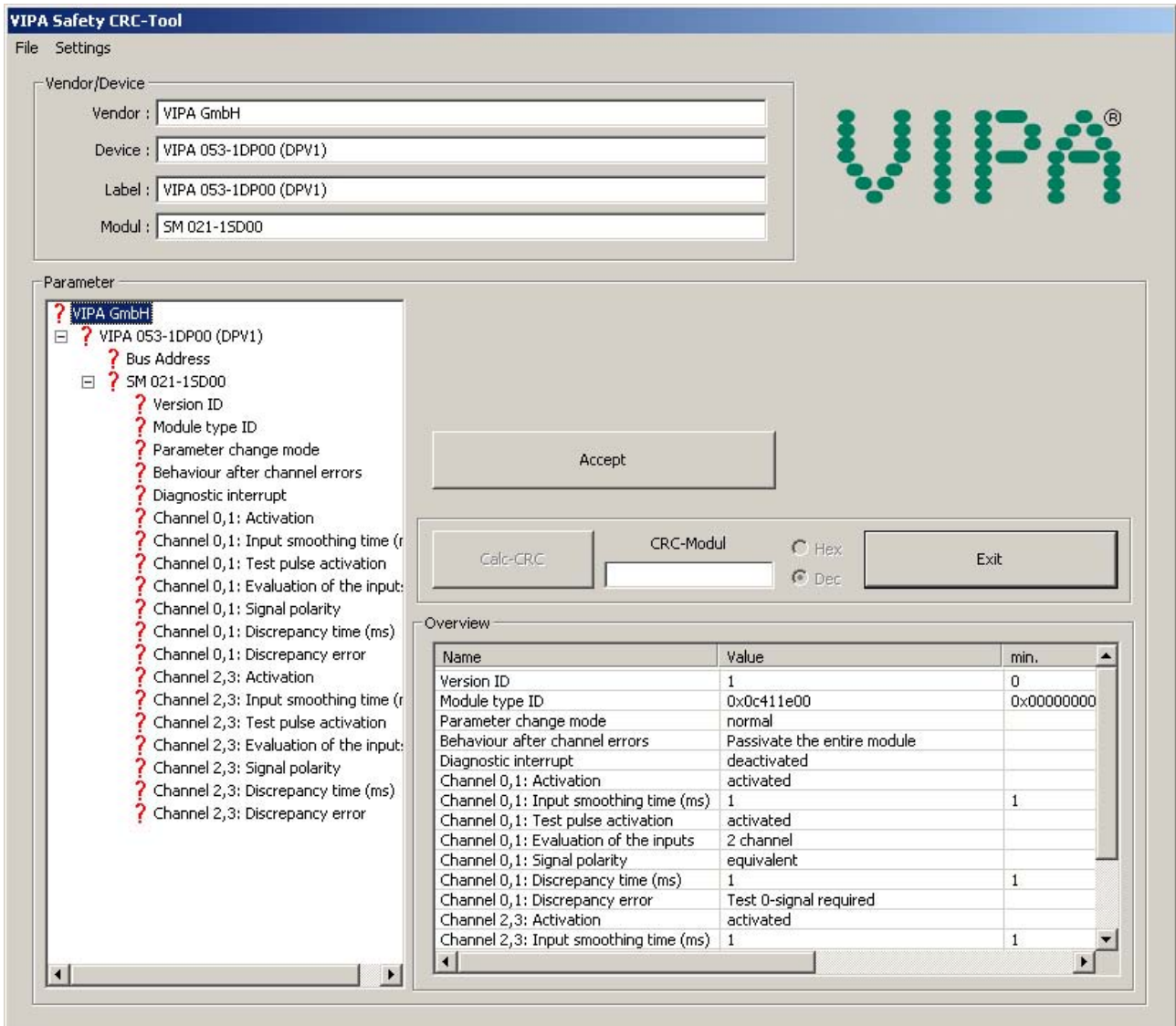
1. ▶ Open in the Siemens hardware configurator by a double-click to the properties dialog of your System SLIO safety module.
2. ▶ Enter the according parameters. Information about the parameters may be found in the chapter "Product description".
 - ↳ Chapter 2.5 'SDI 4xDC 24V - Parameter record set' on page 37, ↳ Chapter 2.9 'SDO 4xDC 24V 0.5A - Parameter record set' on page 55
3. ▶ Close the properties dialog.

Parameter validation

With this step the safety-related test of the parameters is examined.

 **DANGER!**
By incorrect configuration there is a hazard for man and machine!

1. ▶ For the validation of the parameters, click at the System SLIO safety module and choose 'context menu → Start device tool' "VIPA Safety CRC-Tool".



VIPA Safety CRC-Tool

File Settings

Vendor/Device

Vendor : VIPA GmbH

Device : VIPA 053-1DP00 (DPV1)

Label : VIPA 053-1DP00 (DPV1)

Modul : SM 021-1SD00

Parameter

- ? VIPA GmbH
 - ? VIPA 053-1DP00 (DPV1)
 - ? Bus Address
 - ? SM 021-1SD00
 - ? Version ID
 - ? Module type ID
 - ? Parameter change mode
 - ? Behaviour after channel errors
 - ? Diagnostic interrupt
 - ? Channel 0,1: Activation
 - ? Channel 0,1: Input smoothing time (ms)
 - ? Channel 0,1: Test pulse activation
 - ? Channel 0,1: Evaluation of the inputs
 - ? Channel 0,1: Signal polarity
 - ? Channel 0,1: Discrepancy time (ms)
 - ? Channel 0,1: Discrepancy error
 - ? Channel 2,3: Activation
 - ? Channel 2,3: Input smoothing time (ms)
 - ? Channel 2,3: Test pulse activation
 - ? Channel 2,3: Evaluation of the inputs
 - ? Channel 2,3: Signal polarity
 - ? Channel 2,3: Discrepancy time (ms)
 - ? Channel 2,3: Discrepancy error

Accept

Calc-CRC

CRC-Modul

Hex

Dec

Exit

Overview

| Name | Value | min. |
|--|-----------------------------|------------|
| Version ID | 1 | 0 |
| Module type ID | 0x0c411e00 | 0x00000000 |
| Parameter change mode | normal | |
| Behaviour after channel errors | Passivate the entire module | |
| Diagnostic interrupt | deactivated | |
| Channel 0,1: Activation | activated | |
| Channel 0,1: Input smoothing time (ms) | 1 | 1 |
| Channel 0,1: Test pulse activation | activated | |
| Channel 0,1: Evaluation of the inputs | 2 channel | |
| Channel 0,1: Signal polarity | equivalent | |
| Channel 0,1: Discrepancy time (ms) | 1 | 1 |
| Channel 0,1: Discrepancy error | Test 0-signal required | |
| Channel 2,3: Activation | activated | |
| Channel 2,3: Input smoothing time (ms) | 1 | 1 |

2. ▶ In this tool among others every module parameter is listed. Here you must validate each parameter, but you cannot change a parameter. Please check and validate each parameter with [Accept]. Per default the tool starts in English. With settings an other language may be selected.

- For information about the currently being validated module, at 'Vendor/Device' you will find information about the module such as vendor, bus coupler to which the System SLIO safety module is connected and the order number of the module.
- In 'Overview' all the module parameters are listed.

3. ▶ Start the validation of each parameter by clicking in *'Parameter'* at the entries, checking and accepting each entry with [Accept].
 - In the 1. position in *'Parameter'* there is the vendor VIPA GmbH, followed by the bus coupler with PROFIBUS address, to which the System SLIO safety module is connected. Please check here again the PROFIBUS address.
 - The parameter *'Version ID'* is only be found in the VIPA Safety CRC-Tool. This is the version ID of the safety parameter in the GSD file. The current *Version ID* is 1.
 - The *Module type ID* shows the type ID of the System SLIO safety module. Also this parameter is exclusively be found in the VIPA Safety CRC-Tool.
There are the following type IDs:
 - SM 021-1SD00 - Type ID: 0x0C411E00
 - SM 022-1SD00 - Type ID: 0x0C812E00
 - Starting with *'Parameter change mode'* the parameters are listed, which you have entered in the hardware configuration.
4. ▶ After you have accepted each parameter the button [Calc-CRC] is activated. Depending on the specifications of the hardware configuration there is the possibility to calculate the CRC as hexadecimal or as decimal value.
5. ▶ Copy the calculated CRC value to clipboard and close the VIPA Safety CRC-Tool with [Exit]. Since the VIPA Safety CRC-Tool does not store any entry, there is a confirmation request before exiting the tool. Confirm this.

Enter CRC in HW configuration

1. ▶ Return to the hardware configurator and open the properties dialog of the System SLIO safety module.
2. ▶ Open the register *'PROFIsafe'* and select the parameter *'F_iPar_CRC'*.
3. ▶ Click on [Change value] and insert from the clipboard the CRC value. With [OK] the value is accepted.

3.9.2 Generate safety program

Proceeding

1. ▶ Save and translate the hardware configuration and return to your project in the Siemens SIMATIC Manager.
2. ▶ To confirm the new safety hardware configuration you have to start *'Calculate the safety program → Generate'*.



*As soon as you change a parameter of a System SLIO safety module in the hardware configuration, you must validate this with the VIPA Safety CRC-Tool and you have to enter the calculated CRC value to *'F_iPar_CRC'* of the module. Afterwards the safety program in the Siemens SIMATIC Manager must be generated again.*

3.10 Deployment with PROFINET

General

- During the project engineering the SLIO I/O modules are assigned to the PROFINET IO controller via the System SLIO IO device.
- The project engineering happens in the Siemens SIMATIC Manager as hardware configuration for a Siemens F CPU.
- A direct assignment takes place via the PROFINET address that you set at the IO device and in IO controller project at IO device properties.
- By installing the corresponding GSDML file the IM 053-1PN00 is listed at the hardware catalog as "VIPA 053-1PN00".



With PROFINET, you can operate, taking into account the maximum current on the backplane bus, System SLIO safety modules up to the maximum expansion.

More information about the maximum expansion, the project engineering and the parameters of the PROFINET IO device IM 053-1PN00 may be found in the manual HB300_IM_053-1PN00.

GSDML file

From VIPA there is a GSDML files for the IO device available. This file may either be found on the supplied storage media or at the download area of www.vipa.com. Please install the GSDML file in your Siemens SIMATIC Manager. Details on the installation of the GSDML file may be found in the manual of Siemens SIMATIC Manager. For configuration in your configuration tool every SLIO module may be found in the GSDML file as XML data. After the installation of the GSDML file you will find the System SLIO IO device in the hardware catalog from Siemens at:

PROFINET IO >Additional field devices > I/O > VIPA SLIO System > VIPA 053-PN00

Project engineering

1. ▶ Execute an initialization of the PROFINET IO device. More may be found in the additional manual HB300_IM_053-1PN00.
2. ▶ Mount your PROFINET system.
3. ▶ Set at the System SLIO Safety module a F address.
4. ▶ Start your project engineering tool with a new project.
5. ▶ Configure a master system with a Siemens F-CPU and create a new PROFINET subnet.
6. ▶ For the project engineering of the IM 053-1PN00 take the "VIPA 053-1PN00" from the hardware catalog and drag it to the PROFINET subnet.
7. ▶ Open via double click to the inserted symbol the properties dialog of the PROFINET device and enter at "General" the device name, which was preset by the address switch during the initialization. Confirm with [OK].
8. ▶ For parameterization of the PROFINET device the VIPA specific properties dialog may be opened in the slot overview.
9. ▶ Insert the peripheral modules from the hardware catalog and parameterize them if necessary.
10. ▶ Save and transfer your project to the PLC.

3.10.1 Parameterization System SLIO safety module

The parameters of a System SLIO safety module can only be assumed, if the set parameters are validated by the VIPA Safety CRC-Tool and the resulting checksum is taken to the parameter F_iParCRC. In this way it is ensured that the transmitted parameters are always consistent.

Installation of the VIPA Safety CRC-Tool

From VIPA you get the software "VIPA Safety CRC-Tool" at a data carrier. This software serves for the validation of the set module parameters.

1. ▶ Close the Siemens SIMATIC Manager before installing the VIPA Safety CRC-Tool.
2. ▶ For installation start setup.exe from the data carrier.
3. ▶ Select the language for installation and click at [OK]. The Install-Shield-Wizard is started.
4. ▶ Accept the terms of license and click on [Next].
5. ▶ Enter your user information and click on [Next].
6. ▶ Select a destination folder and click on [Next].
7. ▶ Start the installation with [Install].
 - ⇒ After the installation the VIPA Safety CRC-Tool is available in the hardware configurator via the context menu.


Parameter setting

1. ▶ Open in the Siemens hardware configurator the properties dialog of your System SLIO safety module by double-click.
2. ▶ Enter the according parameters. ↗ *Chapter 2.5 'SDI 4xDC 24V - Parameter record set' on page 37*, ↗ *Chapter 2.9 'SDO 4xDC 24V 0.5A - Parameter record set' on page 55*
3. ▶ Close the properties dialog.

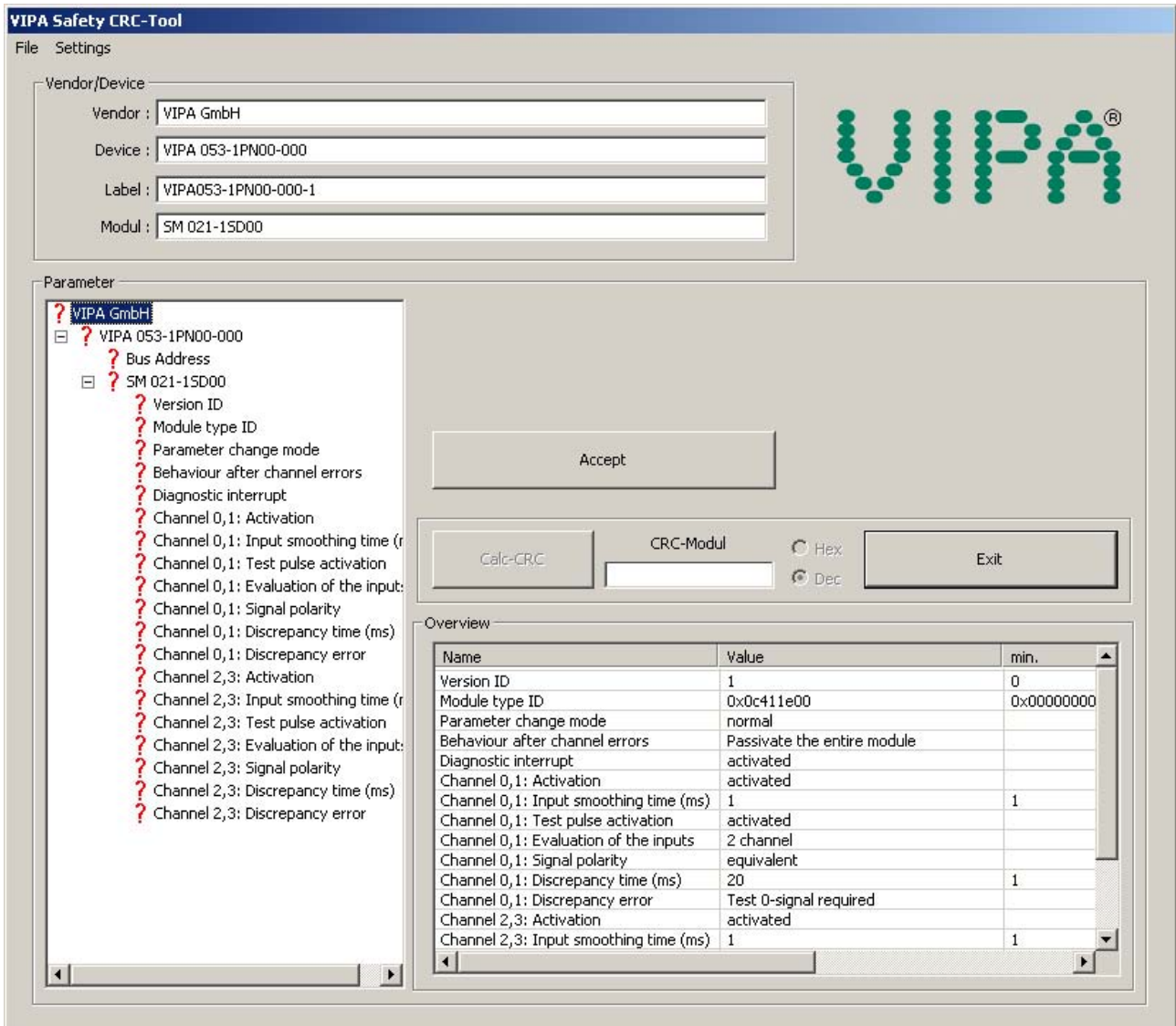
Parameter validation



With this step the safety-related test of the parameters is examined.

 **DANGER!**
By incorrect configuration there is a hazard for man and machine!

1. ▶ For the validation of the parameters, click at the System SLIO safety module and choose 'context menu → Start device tool' "VIPA Safety CRC-Tool".



2. ▶ In this tool among others every module parameter is listed. Here you must validate each parameter, but you cannot change a parameter. Please check and validate each parameter with [Accept]. Per default the tool starts in English. With 'settings' an other language may be selected.

- For information about the currently being validated module, at 'Vendor/Device' you will find information about the module such as vendor, bus coupler to which the System SLIO safety module is connected and the order number of the module.
- In 'Overview' all the module parameter are listed.

3. ▶ Start the validation of each parameter by clicking in *'Parameter'* at the entries, checking and accepting each entry with [Accept].
 - In the 1. position in *'Parameter'* there is the vendor VIPA GmbH, followed by the bus coupler with PROFINET address, to which the System SLIO safety module is connected. Please check here again the PROFINET address.
 - The parameter *'Version ID'* is only be found in the VIPA Safety CRC-Tool. This is the version ID of the safety parameter in the GSD file. The current version ID is 1.
 - The *'Module type ID'* shows the type ID of the System SLIO safety module. Also this parameter is exclusively be found in the VIPA Safety CRC-Tool.
There are the following type IDs:
 - SM 021-1SD00 - Module type ID: 0x0C411E00
 - SM 022-1SD00 - Module type ID: 0x0C812E00
 - Starting with *'Parameter change mode'* the parameters are listed, which you have entered in the hardware configuration.
4. ▶ After you have accepted each parameter the button [Calc-CRC] is activated. Depending on the specifications of the hardware configuration there is the possibility to calculate the CRC as hexadecimal or as decimal value.
5. ▶ Copy the calculated CRC value to clipboard and close the VIPA Safety CRC-Tool with [Exit]. Since the VIPA Safety CRC-Tool does not store any entry, there is a confirmation request before exiting the tool. Confirm this.

Enter CRC in HW configuration

1. ▶ Return to the hardware configurator and open the properties dialog of the system SLIO safety module.
2. ▶ Open the register *'PROFIsafe'* and select the parameter *'F_iPar_CRC'*.
3. ▶ Click on [Change value] and insert from the clipboard the CRC value. With [OK] the value is accepted.

3.10.2 Generate safety program

Procedure

1. ▶ Save and translate the hardware configuration and return to your project in the SIMATIC Manager.
2. ▶ To confirm the new safety hardware configuration you have to start the function *'Calculate the safety program → Generate'*.



*As soon as you change a parameter of a System SLIO safety module in the hardware configuration, you must validate this with the VIPA Safety CRC-Tool and you have to enter the calculated CRC value to *'F_iPar_CRC'* of the module. Afterwards the safety program in the Siemens SIMATIC Manager must be generated again.*

3.11 Validation of the system

General

With the first commissioning all the safety functions and the proper functionality of the programmed and installed system must be checked. And the check of the system must be documented.



WARNING!

Danger with commissioning!

The control system may be operated only after successful testing by a competent person.

- Perform a complete functional test and check the correct assignment of the connected safety components.
- In the Appendix there is a checklist "Commissioning and validation" for commissioning and validation of the system. Perform the system validation in accordance to this checklist and document this accordingly.
↳ *Appendix 'Checklist commissioning, parameterization and validation' on page 149*
- Make sure that the service personnel is trained in the handling of the control system.

Function test

The function test is the main part of the validation of the entire system. The perfect allocation of the safety components of the network and the programmed logic of the system can be determined by the function test. Depending on the complexity of the combinational logic of the according project it is recommended to execute graded function tests. The following proceeding for function tests is recommended:

- Connect the actuators and drives with the safe output terminals only if while checking the wiring no errors were found.
- Examine a fully IO test. This means in order to bring all the sensors in each switch positions, each (normally on, off respectively actuated, not actuated).
 - Please check whether the specified and expected signal state is also the real state.
 - Please also check whether the state of the corresponding variables also accordingly changes in the safety control (a detailed description of this test can be found in the manual of your safety control).
 - You have to check the actuators as well when you want to control them with your safety output modules. You have to check each process state, which is specified in the safety application, as well.
 - If the safety control does not provide a suited test mode, you have to release the corresponding safety functions in your application and you have to check the reaction of the respective outputs.
- Examine a fully function test with the entire sensors (initiators), switches, actuators and drives.
- Document the result of the function test.
- To examine the function test you have to release all safety functions successively and you have to document the reaction of the system. Check whether the reaction corresponds to the expected behavior.

3.12 Operation

**DANGER!**

During operation of the safety control system, no changes to the system configuration are allowed.

Therefore:

Before extending the system, removing individual system components and changing the wiring, the PLC system is basically be set into a safe state dependent on the application by professional personnel.



For the operation the ambient data, which are specified in the technical data must be adhered to! Commissioning is only permitted after the acclimation of the System SLIO safety modules!

Instructions for operation

Instructions for the operation of system SLIO standard system components like power supply, bus coupler, IO modules can be found in the according manual.

3.13 Maintenance

**CAUTION!**

Make sure by organizational measures that the interval for the repeat inspection of all system components is kept.

↳ *Chapter 1.17 'Functional safety - safety relevant parameters' on page 19*

- With the System SLIO safety module there is no repeat test possible for the user.
- If you keep the prescribed environmental conditions (see technical data) the corresponding safety module is maintenance-free.
- If you determine or assume a defect on a safety module, please contact the VIPA GmbH.

3.14 Repair

**CAUTION!**

Defective safety modules may only be repaired by the manufacturer.

A defective safety module cannot be repaired. Please contact VIPA GmbH for spare.

3.15 Diagnostics

Requirements to the operating personnel

The personnel, who works with the safety signal module, must be instructed in the safety regulations and the operation of the module to correctly operate it. In particular the reaction to error messages and states requires special knowledge which the operator must have. In the following you will find information about disturbances and the resulting error messages.

Fail safe principle

The module bases on the fail-safe principle. This means that each error automatically leads to a safety state (safety switched off outputs, every input reports off-circuit state).



CAUTION!

Do not switch a safety-related incorrect system to operating state again, as long as you do not know the cause of the error or an error has been corrected.

Detecting errors in the periphery

The electro-mechanical error detection is ensured by the input circuit. Electronic sensors must have an own error detection relating to a short-circuit on the output.

3.15.1 Error response

Safe state

The safety concept is based on the existence of a safe state at all process variables. For digital safety modules, this safe state is the value "0". This applies to sensors and actuators.

In safe condition the safety signal module safely switches off the outputs. Thus a control of the attached actuators is safely interrupted.

Response to error and start-up of the safety-related system

The safety function requires the use of substitute values (safe state) instead of process values for a safety-related signal module (passivation of safety-related signal module) in the following cases:

- during the start-up of the safety-related system
- when errors in safety-oriented communication between the F-CPU and safety module are detected by means of the PROFIsafe safety protocol (communication error)
- when peripheral or channel errors are detected (e.g. wire break, discrepancy error)

If possible errors are logged to the diagnostic buffer of the safety-related CPU and reported to the safety program of the safety-related CPU. Safety modules cannot store errors non volatile. After PowerOFF - PowerON during start-up a further existing error is again detected. You can make error storage however in your standard program.



CAUTION!

Channel errors do not trigger any diagnostic reactions or error handling for channels that have been set to "deactivated", even when this channel is affected indirectly by a channel group error ("Channel activated/ deactivated" parameter).

Remedying faults in a safety-related system

To remedy errors in your fail-safe system, proceed as described in EN 61508-1 Section 7.15.2.4 and EN 61508-2 Section 7.6.2.1 e. For remedy the following steps must be performed in a safety-related system:

1. ► Diagnosis and repair of the fault
2. ► Revalidation of the safety function
3. ► Recording in the service report

Substitute value output for safety modules

- If channels are passivated with safety DI modules, the safety-related system provides substitute values for the safety program instead of the process values applied to the safety-related inputs:
 - For safety DI modules, this is always the substitute value (0).
- In the case of safety DO modules, if passivation occurs the safety-related system transfers substitute values (0) to the safety-related outputs instead of the output values provided by the safety program. The output channels are de-energized. This also applies when the safety-related CPU goes into STOP mode. You cannot program substitute values.

Reintegration of a safety module

The system changes from substitute to process values (reintegration of a safety module) either automatically or only after user acknowledgement in the safety program. After reintegration:

- for a safety DI module the process values pending at the safety-related inputs are provided for the safety program.
- for safety DO module the output values provided in the safety program are again transferred to the safety-related outputs.

🔗 *'Error acknowledgement' on page 144*

Reaction of the inputs to communication errors

The safety modules with inputs respond differently to communication errors compared to other errors.

- If a communication error is detected, the current process values remain set at the inputs of the safety module and the channels are not passivated.
- The current process values are sent to the safety-related CPU and are passivated in the safety-related CPU.

Reaction of the safety modules on module failure

On a serious internal error in the safety module, which leads to a fault of the safety module:

- the connection to the backplane bus is interrupted and the safety-related I/Os are passivated.
- Diagnostics are not transmitted from the safety module and the default diagnostic message "Module Fault" is reported.
- the SF LED of the corresponding safety module is on.

3.15.2 Fault diagnostics

Diagnostics are used to determine whether error-free signal acquisition is taking place at the safety module. Diagnostics information is assigned either to a single channel or to the entire safety module. None of the diagnostic functions (displays and messages) are safety critical and therefore not designed to be safety-related functions. Consequently, they are not tested internally. The following diagnostic options are available for fail-safe modules:

- LED display on the module front
- Diagnostic functions of the safety modules (slave diagnostics in accordance with IEC 61784-1:2003).



Behaviour on changes of the safe parametrization

If the safety program was not again generated and transferred to the F PLC after changing the safety parametrization, the System SLIO safety module does not report any error. Then the F PLC passivates the module and the inputs and outputs remain at 0.

ERR LED status in case of error

On error the ERR LED shows an error by a corresponding blink behavior. ↪ 'ERR LED' on page 33



Thus diagnostic messages that persist only for a short time, also can be handled, you have to adapt the error handling in the corresponding error OB of your user program for example the diagnostic messages are stored in a data block.

SDI 4xDC 24V

| Error | Behavior of the diagnostic messages | Error recovery |
|---|--|---|
| Short circuit <ul style="list-style-type: none"> ■ The test pulses are no longer detected on the input. ■ e.g. cross circuit to DV 24V | Error is permanently reported. | Correct the wiring, sensor or configuration errors. Acknowledge the error and perform a power cycle. |
| Cross circuit <ul style="list-style-type: none"> ■ At an input the wrong test pulses are detected. ■ e.g. wiring error. | Error is permanently reported. | Correct the wiring error. Acknowledge the error and perform a power cycle. |
| Discrepancy error <ul style="list-style-type: none"> ■ The signal state of the dual-channel input does not match. | The error is only a short time reported. | Correct the wiring, sensor or configuration error. Acknowledge the error and perform a power cycle. |
| The address switch for F-address was changed <ul style="list-style-type: none"> ■ The address switch and the configuration was changed. ■ e.g. module replacement | Error is permanently reported. | Change the F-address ↪ Chapter 3.3.1.1 'Changing an existing F-address at the module' on page 76. Perform a power cycle. |
| Other errors <ul style="list-style-type: none"> ■ Error in configuration | Error is permanently reported. | Correct the configuration data such as a wrong F-address. Perform a power cycle. |
| Other errors <ul style="list-style-type: none"> ■ "Light" internal errors | Error is permanently reported. | Perform a power cycle. |
| Other errors <ul style="list-style-type: none"> ■ "Heavy" internal errors | An error can not be reported. The System SLIO Safety module switches into safe mode and then becomes inactive. | Perform a power cycle. |

SDO 4xDC 24V 0.5A

| Error | Behavior of the diagnostic messages | Error recovery |
|--|---|--|
| <p>Short circuit</p> <ul style="list-style-type: none"> ■ The test pulses are no longer detected on the output. ■ e.g. the set test pulse length is too small | <p>The error is only a short time reported since with disabling the output no more testing is possible.</p> | <p>Correct the wiring or configuration error. Acknowledge the error and perform a power cycle.</p> |
| <p>Cross circuit</p> <ul style="list-style-type: none"> ■ At an output the wrong test pulses are detected. ■ e.g. wiring error | <p>The error is only a short time reported since with disabling the output no more testing is possible.</p> | <p>Correct the wiring error. Acknowledge the error and perform a power cycle.</p> |
| <p>Wire break error</p> <ul style="list-style-type: none"> ■ With enabled output, no current > 30mA could be determined. | <p>The error is only a short time reported since with disabling the output no more testing is possible.</p> | <p>Correct the wiring or configuration error. Acknowledge the error and perform a power cycle.</p> |
| <p>Read back error of the output part</p> <ul style="list-style-type: none"> ■ The target state does not match its current state. ■ Either external power supply DC 24V and output should be 0 or external short circuit to ground and output should be 1. | <p>Error at external power supply is permanently reported. A short circuit or defect of the module is only a short time reported.</p> | <p>Correct the wiring error. Acknowledge the error and perform a power cycle.</p> |
| <p>The address switch for F-address was changed</p> <ul style="list-style-type: none"> ■ The address switch and the configuration was changed. ■ e.g. module replacement | <p>Error is permanently reported.</p> | <p>Change the F-address ↪ <i>Chapter 3.3.1.1 'Changing an existing F-address at the module' on page 76.</i> Perform a power cycle.</p> |
| <p>Other errors</p> <ul style="list-style-type: none"> ■ Error in configuration | <p>Error is permanently reported.</p> | <p>Correct the configuration data such as a wrong F-address. Perform a power cycle.</p> |
| <p>Other errors</p> <ul style="list-style-type: none"> ■ "Light" internal errors | <p>Error is permanently reported.</p> | <p>Perform a power cycle.</p> |
| <p>Other errors</p> <ul style="list-style-type: none"> ■ "Heavy" internal errors | <p>An error can not be reported. The System SLIO Safety module switches into safe mode and then becomes inactive.</p> | <p>Perform a power cycle.</p> |

Configurable diagnostics functions

Via the parametrization you may activate a diagnostic interrupt for the module. With a diagnostics interrupt the module serves for diagnostics data for diagnostic interrupt_{incoming}. As soon as the reason for releasing a diagnostic interrupt is no longer present, the diagnostic interrupt_{going} automatically takes place. Within this time window (1. diagnostic interrupt_{incoming} until last diagnostic interrupt_{going}) the MF-LED of the module is on.

For the following events the triggering of a diagnostic message depends on the parametrization of the System SLIO safety module
 ↪ *Chapter 2.5 'SDI 4xDC 24V - Parameter record set' on page 37* respectively
 ↪ *Chapter 2.9 'SDO 4xDC 24V 0.5A - Parameter record set' on page 55*:

- for safety DI module short- and cross-circuit monitoring
- for safety DO module wire-break detection



CAUTION!

Diagnostic functions should be activated or deactivated in accordance with the application.

3.15.2.1 Diagnostic data

With PROFIBUS and PROFINET the access happens by record set DS 01h. Additionally the first 4 bytes may be accessed by record set DS 00h.

| Name | Bytes | Function | Default |
|---------|-------|-------------------------------------|---------|
| ERR_A | 1 | Diagnostic | 00h |
| MODTYP | 1 | Module information | 18h |
| ERR_B | 1 | reserved | 00h |
| ERR_C | 1 | Module internal error | 00h |
| CHTYP | 1 | Channel type | 30h/31h |
| NUMBIT | 1 | Number diagnostics bits per channel | 08h |
| NUMCH | 1 | Number channels of the module | 04h |
| CHERR | 1 | Channel error | 00h |
| CH0ERR | 1 | Channel-specific error channel 0 | 00h |
| CH1ERR | 1 | Channel-specific error channel 1 | 00h |
| CH2ERR | 1 | Channel-specific error channel 2 | 00h |
| CH3ERR | 1 | Channel-specific error channel 3 | 00h |
| ERR_D | 1 | Module-specific error | 00h |
| ERR_E | 1 | reserved | 00h |
| ERR_F | 2 | PROFISafe error code | 00h |
| DIAG_US | 4 | µs ticker | 00h |

ERR_A - Diagnostic

| Byte | Bit 7 ... 0 |
|------|---|
| 0 | <ul style="list-style-type: none"> ■ Bit 0: set at module failure ■ Bit 1: reserved ■ Bit 2: set at external error ■ Bit 3: set at channel error ■ Bit 4: set at external auxiliary supply missing ■ Bit 6 ... 5: reserved ■ Bit 7: set at error in parameterization |

MODTYP - Module information

| Byte | Bit 7 ... 0 |
|------|--|
| 0 | <ul style="list-style-type: none"> ■ Bit 3 ... 0: Module class <ul style="list-style-type: none"> – 1000b safety-related digital module ■ Bit 4: set at channel information present ■ Bit 7 ... 5: reserved |

CHTYP - Channel type

| Byte | Bit 7 ... 0 |
|------|--|
| 0 | <ul style="list-style-type: none"> ■ Bit 6 ... 0: Channel type <ul style="list-style-type: none"> – 30h: safety-related DI module – 31h: safety-related DO module ■ Bit 7: reserved |

NUMBIT - Diagnostic bits

| Byte | Bit 7 ... 0 |
|------|--|
| 0 | Number of diagnostic bits per channel (here 08h) |

NUMCH - Channels

| Byte | Bit 7 ... 0 |
|------|---|
| 0 | Number of channels of a module (here 04h) |

CHERR - Channel error

| Byte | Bit 7 ... 0 |
|------|---|
| 0 | <ul style="list-style-type: none"> ■ Bit 0: set at error in channel 0 ■ Bit 1: set at error in channel 1 ■ Bit 2: set at error in channel 2 ■ Bit 3: set at error in channel 3 ■ Bit 7 ... 4: reserved |

CH0ERR ... CH3ERR - Channel-specific

| Byte | Bit 7 ... 0 |
|------|--|
| 0 | Channel-specific error: Channel x: <ul style="list-style-type: none"> ■ Bit 0: set at short circuit to DC 24V ■ Bit 1: set at short circuit to ground ■ Bit 2: set at wire-break ■ Bit 3: set at cross-circuit ■ Bit 4: set at discrepancy error ■ Bit 7 ... 5: reserved |

ERR_C - Module-internal

| Byte | Bit 7 ... 0 |
|------|---|
| 0 | Module-internal error: <ul style="list-style-type: none"> ■ Bit 3 ... 0: reserved ■ Bit 4: set at a communication error on the System SLIO safety module ■ Bit 7 ... 5: reserved |

ERR_D - Module-specific

| Byte | Bit 7 ... 0 |
|------|---|
| 0 | Module-specific error <ul style="list-style-type: none"> ■ Bit 3 ... 0: reserved ■ Bit 4: set at error in I parameter ■ Bit 5: set at error in F parameter ■ Bit 6: set if the F-address set by the F-address switch, does not fit to the F-address stored in the EEPROM. ■ Bit 7: set if the F-address in the EEPROM was reset. |



If the change process of the F-address is initiated by the configured record set, then bit 7 of ERR_D is set.

If the re-parameterization happens by means of the F-address switch setting 0...0, the reset function of the bus device during start-up can possibly prevent that this bit is reported.

ERR_F - Diag byte

| Byte | Bit 7 ... 0 |
|------|---|
| 0, 1 | PROFIsafe diagnostic code ↗ 'PROFIsafe diagnostic code' on page 129 |

DIAG_US - μ s ticker

| Byte | Bit 7 ... 0 |
|---------|---|
| 0 ... 3 | Value of the System SLIO μ s ticker at the moment of the diagnostic |

 μ s ticker

In the SLIO module there is a timer (μ s ticker). With PowerON the timer starts counting with 0. After $2^{32}-1\mu$ s the timer starts with 0 again.

ERR_B, E - reserved

| Byte | Bit 7 ... 0 |
|------|-------------|
| 0 | reserved |

PROFIsafe diagnostic code

| Code | Description |
|--------|---|
| 0x0000 | no error |
| 0x0040 | <i>Mismatch of safety destination address (F_Dest_Add)</i> The F-address set by the DIP switch and the F-address configured by F parameter configuration (HW configuration) do not agree. |
| 0x0041 | <i>Safety destination address not valid (F_Dest_Add)</i> The F-address, which was set by the F parameter configuration is not valid (e.g. = 0). |
| 0x0042 | <i>Safety source address not valid (F_Source_Add)</i> The F source address, which was set by the F parameter configuration is not valid (e.g. = 0). |
| 0x0043 | <i>Safety watchdog time value is 0 ms (F_WD_Time)</i> The monitoring time, which was set by the F parameter configuration is not valid (e.g. = 0). |
| 0x0044 | <i>Parameter "F_SIL" exceeds SIL from specific device application</i> The safety integrity class, which was set by the F parameter configuration is greater than the maximum possible F-SIL value for the System SLIO safety module. |
| 0x0045 | <i>Parameter "F_CRC_Length" does not match the generated values</i> The length of the CRC2 key, which was set by the F parameter configuration does not agree with the generated values. |
| 0x0046 | <i>F_Par_Version of F-Parameter set incorrect</i> The version of the F parameters, which was set by the F parameter configuration is not understood by the safety module. |
| 0x0047 | <i>CRC1-Fault</i> The calculated CRC1 checksum is incorrect. |
| 0x004B | <i>Inconsistent iParameters (iPar-CRC error)</i> The checksum of the iParameters is incorrect. |

3.16 Packing and transport

Packing

Each device was packaged before in a way, that makes becoming damaged while on transport very unlikely.

Transport

The units are packed at the factory in accordance with the order.

- Avoid heavy shaking while on transport and severe bumping.
- Avoid electrostatic discharge on the electronic components of the modules.
- Take the module until immediately before installation out of the protective packaging.
- If you have to transport the module later, please consider the following:
 - use the original packaging or
 - use a appropriate packaging for ESD sensitive components.
- Make sure that the transportation conditions "Approvals, directives, standards" during the entire transport are met. ↪ *Chapter 1.18 'Approvals, directives, standards' on page 22*

Unpacking

After delivery of the still packaged item check if there are visible transportation damages. If yes report this to your deliverer. Request a written confirmation of your reclamation and make immediate contact with you local VIPA GmbH representation.

**DANGER!****Risk by electrostatic discharge**

If you expose the module, particularly its electronic components to electrostatic discharge by touching with the hand, the module can be damaged or destroyed completely.

- Consider in handling the module the regulations and references to handling electrostatic sensitive components.
- If you recognize a transport damage or the delivery is not complete, you have to complain at the appropriate VIPA representative.

If there is no transport damage visible:

- Open the packaging of the device.
- Check the scope of delivery by means of the delivery note.

Scope of delivery

- System SLIO signal module
- Manual incl. conformity / manufacturer declaration

Disposal of packaging

The packaging consists of cardboard and / or plastic. Please observe the local disposal regulations, if you discard the packaging.

3.17 Storage and disposal**Storage conditions**

Store the safety module in an appropriate packaging and to the storage conditions, mentioned in "Approvals, directives, standards".
↪ *Chapter 1.18 'Approvals, directives, standards' on page 22*

Shipping

For shipping always use the original packaging.

Disposal

In principle the disposal takes place via the VIPA GmbH. Send defective and/or to be disposed System SLIO safety modules to VIPA GmbH.

Demands on the personnel

The personnel which you instruct to demount devices must have the knowledge and training to carry out these jobs properly.

Choose the personnel in a way that it is secured that safety information are understood and observed.

3.18 Sample application

Precondition

This instruction describes the usage of the System SLIO safety modules with both PROFIBUS and PROFINET. Decide whether you want to build the sample application with PROFIBUS or PROFINET. The sample application requires the following hardware and software:

Module

| CC/Coupler | Module | Designation / Order number |
|---------------------|---------------------------|--|
| Central controller | Safety PLC | Siemens IM151-8F PN/DP CPU (6ES7151-8FB00-0AB0, product version 3, FW 2.7.1) Siemens DP master for CPU (6ES7138-4HA00-0AB0) |
| | Power supply safety | Siemens power module PM-E DC24V (6ES7138-4CA01-0AA0) Terminal module TM-P15S23-A0 (6ES7193-4CD20-0AA0) |
| | Safety I/O module | Siemens 4F-DI73F-DO DC24V/2A (6ES7138-4FC01-0AB0) Terminal module TM-E30S44-01 (6ES7193-4CG20-0AA0) |
| | Power supply standard I/O | Siemens power module PM-E DC24V (6ES7138-4CA01-.0AA0) Terminal module TM-P15S23-A1 (6ES7193-4CC30-0AA0) |
| | I/O module Input | Siemens 8 DI DC24V (6ES7131-4BF00-0AA0) Terminal module TM-E15S24-01 (6ES7193-4CB20-0AA0) |
| | I/O module Output | Siemens 8 DO DC24V/0.5A (6ES7132-4BF00-0AA0) Terminal module TM-E15S24-01 (6ES7193-4CB20-0AA0) |
| | Bus termination | Siemens 6ES7 193-4JA00-0AA0 |
| | Coupler | VIPA SLIO bus coupler |
| VIPA SLIO AO | | VIPA SM 032 AO 4x12Bit (VIPA 032-1BD40) |
| VIPA SLIO AI | | VIPA SM 031 AI 4x12Bit (VIPA 031-1BD40) |
| VIPA SLIO Safety DI | | VIPA SM 021 (VIPA 021-1SD00) |

| CC/Coupler | Module | Designation / Order number |
|------------|---------------------|------------------------------|
| | VIPA SLIO Safety DO | VIPA SM 022 (VIPA 022-1SD00) |
| | VIPA SLIO DI | VIPA SM 021 (VIPA 021-1BD10) |
| | VIPA SLIO DO | VIPA SM 022 (VIPA 022-1BD00) |

Switch/Relay/Software

- Switch/Relay
 - DC 24V Relay with two two-way switches (e.g. Finder Type 40.52 with base 95.95.3)
 - Switch (normally open contact)
- Software
 - Siemens SIMATIC Manager
 - SIMATIC Distributed Safety Programming
 - VIPA Safety CRC-Tool
 - VIPA SLIO gsd/gsdml file

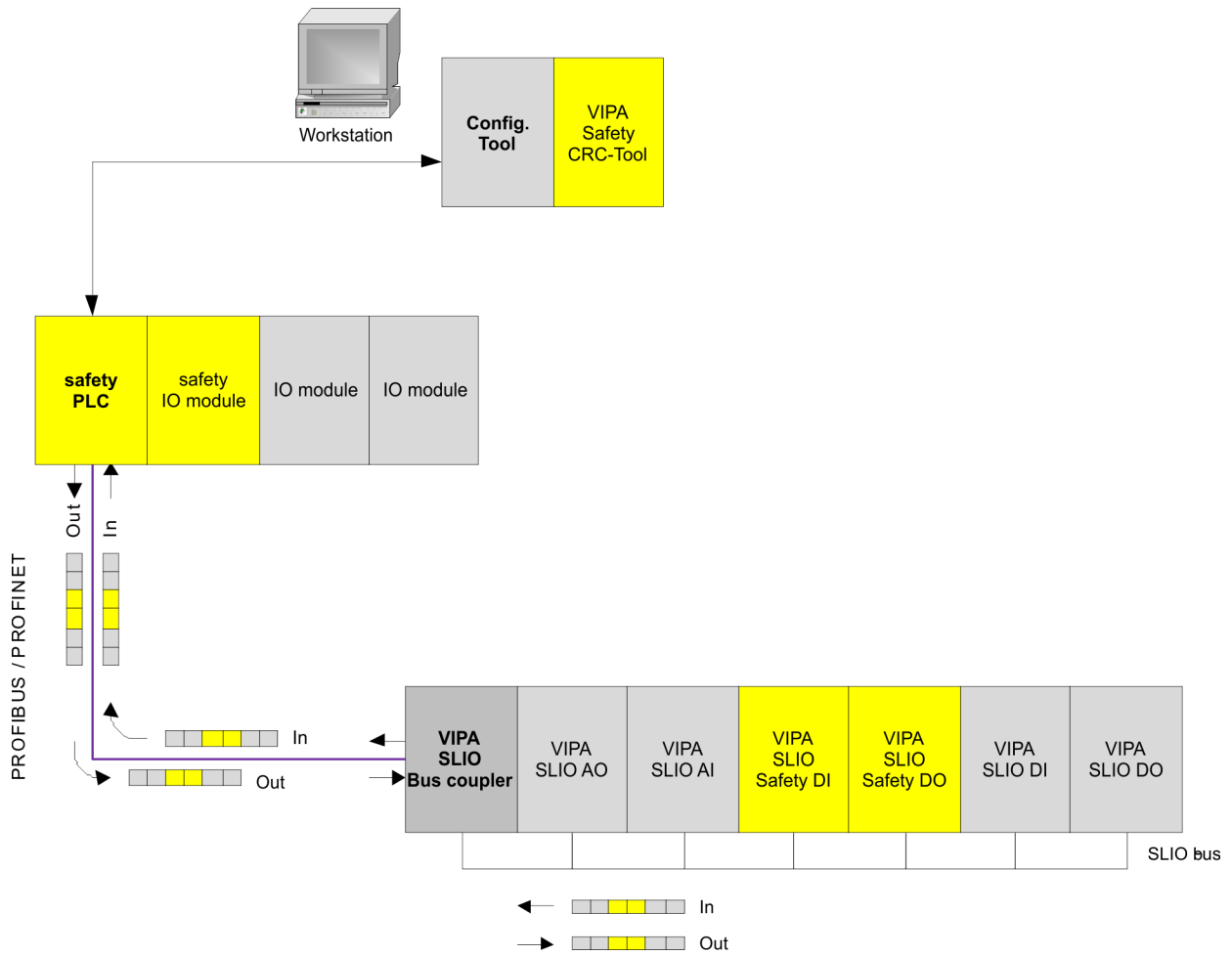
Setting the F-address

Please preset the F-address of the following modules via the F-address switch, before they are installed:

| Module | F-address decimal | Switch positions |
|--------------------------------|-------------------|------------------|
| Siemens 4 F-DI/3 F-DO DC24V/2A | 200 | 0000 1100 1000 |
| System SLIO 021-1SD00 | 199 | 0000 1100 0111 |
| System SLIO 022-1SD00 | 198 | 0000 1100 0110 |

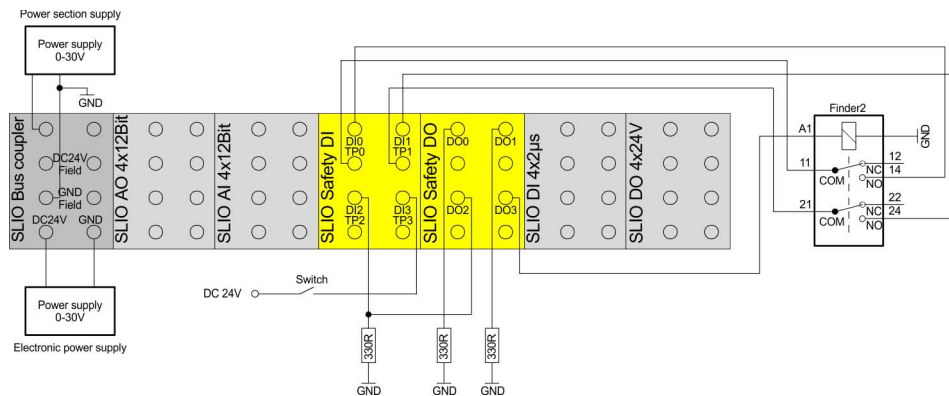
Hardware structure

Build the sample application according to the following figure:



Wiring

Wire the sample application as shown in the following figure:



3.18.1 Configuration in the Siemens SIMATIC Manager

Procedure

1. ➤ Configure in your Siemens SIMATIC-Manager a new project with a SIMATIC 300 station.
2. ➤ Open the hardware configuration for this station and configure the hardware structure according to the hardware structure above.
3. ➤ Decide whether you will realize your example with PROFIBUS or PROFINET.

← → (0) IM151-8F PN/DP CPU

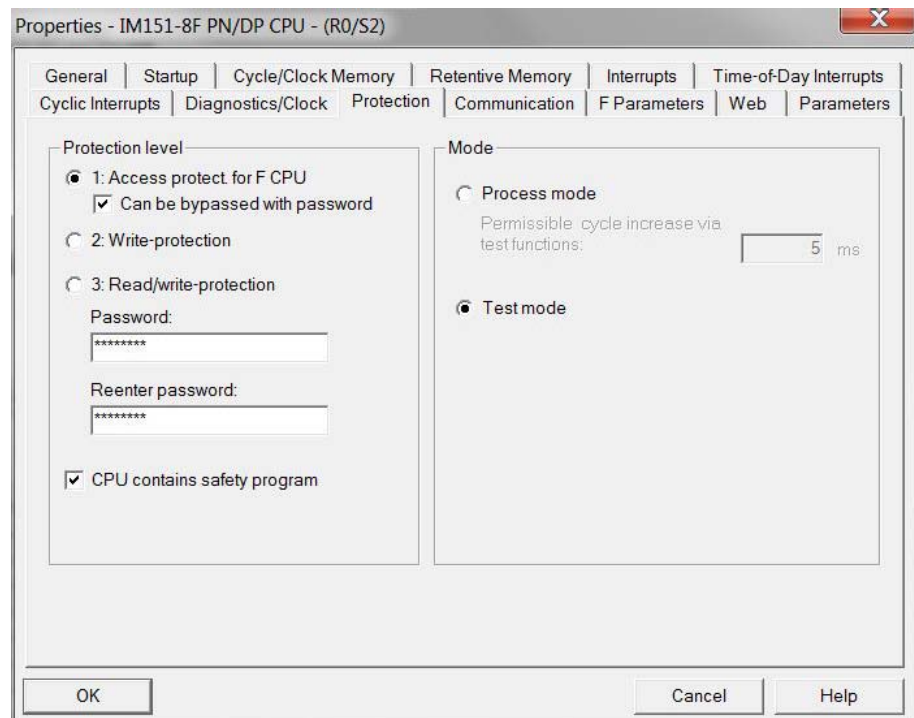
| Slot | Module | Order number | Firmware | MPI address | I address | Q address | Diagn... | Comment |
|------|------------------------|---------------------|----------|-------------|-----------|-----------|----------|---------|
| 1 | | | | | | | | |
| 2 | IM151-8F PN/DP CPU | 6ES7 151-8FB00-0AB0 | V2.7 | | | | | |
| X1 | PN-IO | | | | 2047* | | | |
| X1 A | Port 1 | | | | 2046* | | 2046* | |
| X1 A | Port 2 | | | | 2045* | | 2045* | |
| X1 A | Port 3 | | | | 2044* | | 2044* | |
| X2 | DP | 6ES7 138-4HA00-0AB0 | | | 2042* | | | |
| 3 | | | | | | | | |
| 4 | PM-E DC24V | 6ES7 138-4CA01-0AA0 | | | | | 2041* | |
| 5 | 4 F-DI/3 F-DO DC24V/2A | 6ES7 138-4FC01-0AB0 | | | 0...6 | 0...4 | | |
| 6 | PM-E DC24V | 6ES7 138-4CA01-0AA0 | | | | | 2040* | |
| 7 | 8 DI DC24V | 6ES7 131-4BF00-0AA0 | | | 7.0...7.7 | | | |
| 8 | 8 DO DC24V/0.5A | 6ES7 132-4BF00-0AA0 | | | | 5.0...5.7 | | |
| 9 | | | | | | | | |
| 10 | | | | | | | | |

← → (1) VIPA053-1PN00-000

| Slot | Module | Order number | I address | Q address | Diagnostic address: | Comment |
|------|--------------------------|--------------|-----------|-----------|---------------------|---------|
| 0 | VIPA053-1PN00-000 | 053-1PN00 | | | 2039* | |
| IF | 053-1PN00 Profinet Devi | | | | 2038* | |
| IF P | IF Port 1 | | | | 2037* | |
| IF P | IF Port 2 | | | | 2036* | |
| 1 | 032-1BD40 AO4x12Bit I | 032-1BD40 | | 256...263 | | |
| 2 | 031-1BD40 AI4x12Bit I | 031-1BD40 | 256...263 | | | |
| 3 | 021-1SD00 DI4xDC24V Saf | 021-1SD00 | 8...12 | 8...12 | | |
| 4 | 022-1SD00 DO4xDC24V 0.5 | 022-1SD00 | 13...17 | 13...17 | | |
| 5 | 021-1BD10 DI4xDC24V 2µs | 021-1BD10 | 18 | | | |
| 6 | 022-1BD00 DO4xDC24V 0.5A | 022-1BD00 | | 6 | | |
| 7 | | | | | | |
| 8 | | | | | | |

Parameterization of the CPU

1. ▶ When you add a CPU, a dialog box opens to adjust the properties of the new PROFINET subnet. Click "NEW" and create a new subnet. Similarly, a dialog box opens when you add the DP master for setting the PROFIBUS properties. Here act in the same way. After the installation of the GSD/GSDML files, the VIPA components can be found in the hardware catalog at: PROFINET IO > Additional Field devices > I/O respectively PROFIBUS-DP > Additional Field devices > I/O
2. ▶ To open the properties dialog double click at the CPU and select the tab 'Protection'.
3. ▶ Activate below the option '1: Access protect for F CPU' the option 'Can be bypassed with password'.
4. ▶ Enter the password for the F-CPU with at least 8 characters below the option '3: Read/write protection'. Repeat the password at 'Reenter password'.
5. ▶ Activate the option 'CPU contains safety program'.



6. ▶ The settings in the tabs "F Parameters" and "Cyclic Interrupts" are let on default values.
7. ▶ Open the properties dialog of the Siemens module 4 F-DI/3 F-DO DC24V/2A and enter in the tab 'Parameter' for 'F_target_address' the value "200".
8. ▶ Close the properties dialog with [OK].

Parameterization of System SLIO analog modules

➔ Parameterize the system SLIO analog modules according to the following figures. This point shows how configurable "non-safety" System SLIO modules can be configured with System SLIO safety modules.

The image displays two screenshots of the Siemens SIMATIC Manager parameterization interface for analog modules.

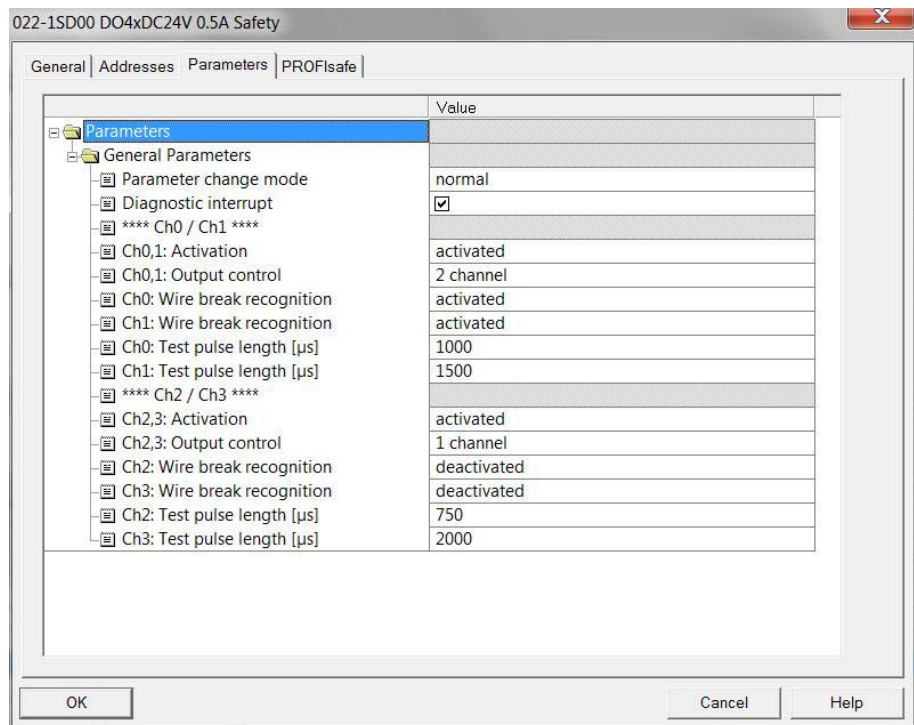
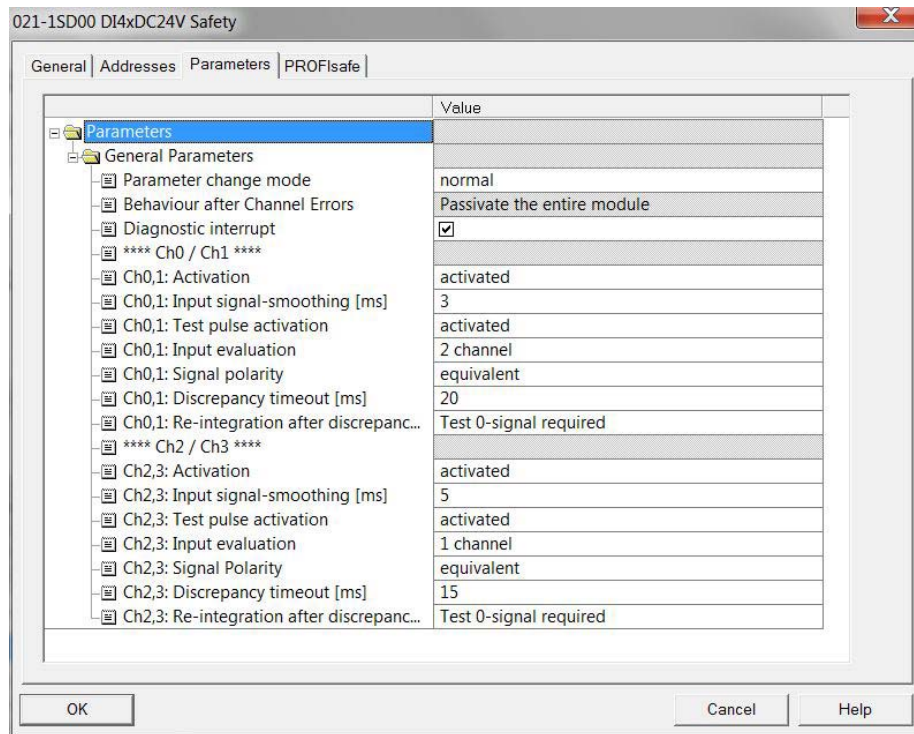
031-1BD40 AI4x12Bit I

| Parameter | Value |
|--------------------|--------------------------|
| General Parameters | |
| **** Ch0 **** | |
| Function | S7 Current 0..20mA (31h) |
| **** Ch1 **** | |
| Function | S7 Current 0..20mA (31h) |
| **** Ch2 **** | |
| Function | S7 Current 0..20mA (31h) |
| **** Ch3 **** | |
| Function | S7 Current 0..20mA (31h) |

032-1BD40 AO4x12Bit I

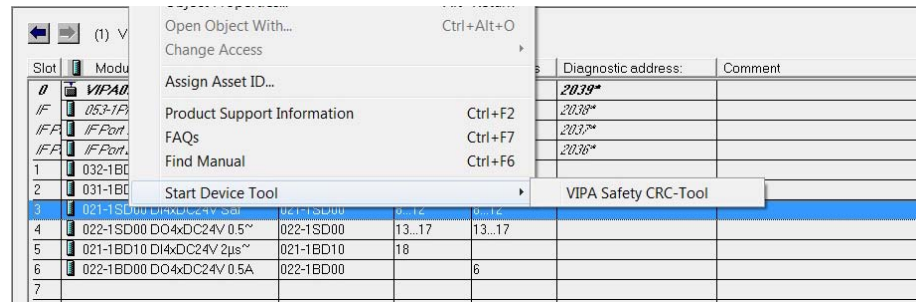
| Parameter | Value |
|------------------------|-------------------------------------|
| General Parameters | |
| **** Ch0 **** | |
| Wire break recognition | <input checked="" type="checkbox"/> |
| Function | S7 Current 0..20mA (31h) |
| **** Ch1 **** | |
| Wire break recognition | <input checked="" type="checkbox"/> |
| Function | S7 Current 0..20mA (31h) |
| **** Ch2 **** | |
| Wire break recognition | <input checked="" type="checkbox"/> |
| Function | S7 Current 0..20mA (31h) |
| **** Ch3 **** | |
| Wire break recognition | <input checked="" type="checkbox"/> |
| Function | S7 Current 0..20mA (31h) |

- ➔ For 021-1SD00 and 022-1SD00 open the properties dialog with a double click, each and set the parameters at 'Parameter' according to the following figures:



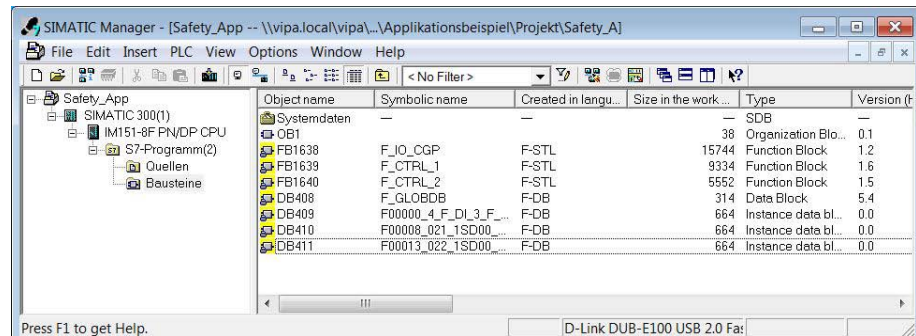
Validation with the VIPA Safety CRC-Tool

1. Start the validation tool from the module 021-1SD00 with 'context menu → Start Device Tool → VIPA Safety CRC-Tool'.




2. Validate each parameter in the CRC-Tool according to the description "Validation of the system" with the [Accepted] button and then calculate the checksum with [Calc-CRC]. The [Calc-CRC] button is only enabled when all the parameters were "accepted". ↪ Chapter 3.11 'Validation of the system' on page 119
3. Copy the CRC to the clipboard and then close the "VIPA Safety CRC Tool".
4. Re-open the properties dialog and select the tab 'PROFIsafe'. Here open the dialog 'Change value' of the parameter 'F_iPar_CRC' and paste the copied CRC. Set the value of 'F_Dest_Add' to "199". Confirm with [OK].
5. Repeat these steps for the module 022-1SD00 and set the parameter 'F_Dest_Add' to the value "198".
6. 'Safe and translate' your project and close the hardware configuration.

⇒ The following automatically generated blocks should now be shown in the Siemens SIMATIC Manager:



Create F-FC - FC1

1. ► Configure in the Siemens SIMATIC Manager a F-FC. First configure a FC1.
⇒ The properties window of the FC1 opens. Select as configure language "F-FBD".
2. ► Create symbolic names and comments for the used safety inputs and outputs in the symbol editor.



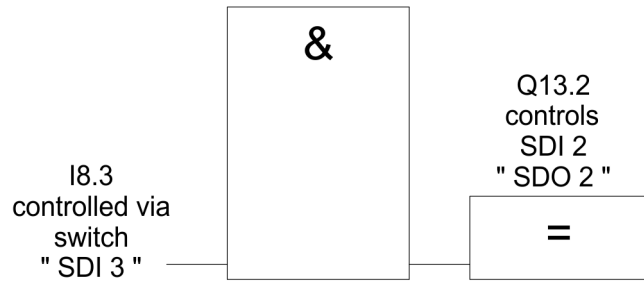
| | Statu | Symbol / | Address | Data type | Comment |
|---|-------|----------|---------|-----------|--------------------------------|
| 1 | | SDI 0 | I 8.0 | BOOL | 2-channel; controlled by relay |
| 2 | | SDI 1 | I 8.1 | BOOL | 2-channel; controlled by relay |
| 3 | | SDI 2 | I 8.2 | BOOL | controlled by SDO 2 |
| 4 | | SDI 3 | I 8.3 | BOOL | controlled via switch |
| 5 | | SDO 0 | Q 13.0 | BOOL | 2-channel, only LED |
| 6 | | SDO 1 | Q 13.1 | BOOL | 2-channel, only LED |
| 7 | | SDO 2 | Q 13.2 | BOOL | controlles SDI 2 |
| 8 | | SDO 3 | Q 13.3 | BOOL | controlles relay |
| 9 | | | | | |

Press F1 to get Help.

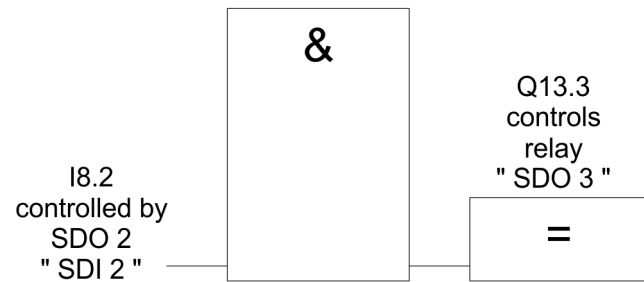
3. ► Double-click at the FC1 in the Siemens SIMATIC Manager. The dialog field to assign the password for the safety program opens. Enter (2x) for the safety program a maximum 8-character password and confirm with [OK].
⇒ The LAD/STL/FBD editor opens.
4. ► Program the FC1. Save this and close the editor.

FC1

Network: 1 Controlling SDO 2

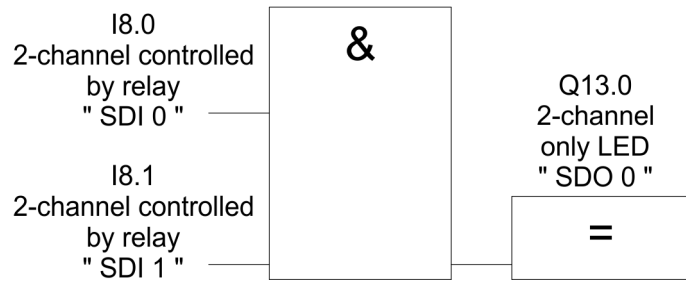


Network: 2 Controlling SDO 3 (Relay)



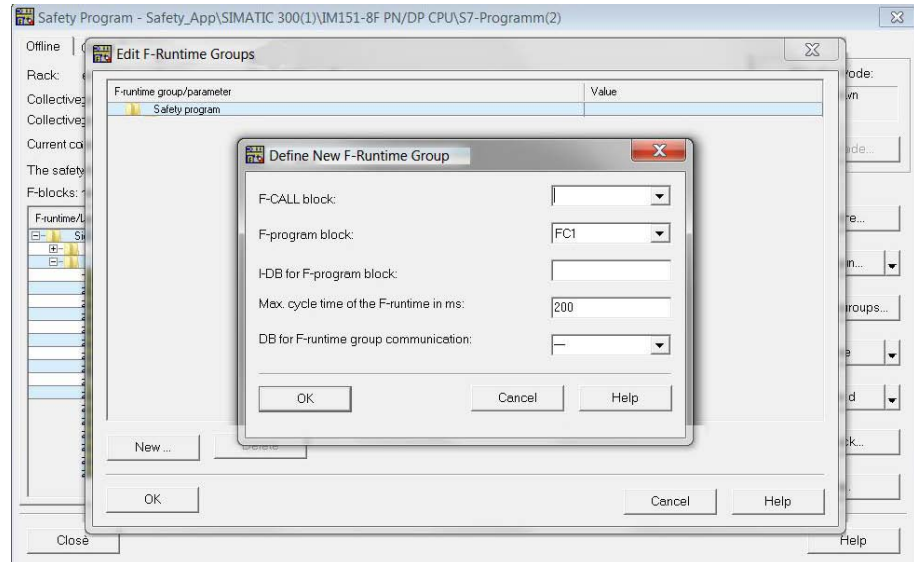
Network: 3 Controlling SDO 0

Since the channels SDO 0/1 are configured as 2-channel, both channels are switched to "1" with controlling Q13.0.



Edit safety program

1. ▶ Open in the Siemens SIMATIC Manager the dialog via *'Options' → 'Edit safety program'*.
⇒ The dialog "Safety program" opens.
2. ▶ Open the dialog *'Edit F-Runtime groups'* via the button [F-Run-time groups].
3. ▶ Because a F-Runtime group does not exist, select with [New] the dialog *'Define New F-Runtime Group'*.



4. ▶ Enter "FC2" at "F_CALL block". This FC is automatically generated, as soon as you have left the dialog *'Edit F-Runtime groups'* with [OK]. Due to the usage of a FC as F-program block, there is no instance DB (I-DB) required for the F-program block. The max. cycle time of the F-runtime group should be 200ms. A DB for the F-runtime group communication is not required.
5. ▶ Close the dialog with [OK].
6. ▶ Close the dialog *'Edit F-Runtime Groups'* with [OK].
⇒ A message window opens. Here you are asked whether the missing blocks (in the example only FC2) should be automatically generated. Answer with [Yes].
7. ▶ Now you are returned in the dialog *'Safety program'*. Click at [Generate]. During the generation a consistency check of the relevant F blocks is established. Then a run able safety program is generated.

Create cyclic interrupt OB35

1. ▶ Create in the Siemens SIMATIC Manager an OB35. Call the F-CALL (FC2 in the example) in the cyclic interrupt OB35 and save the OB35.

OB35: "Cyclic Interrupt"

Network: 1

```
CALL FC 2
```

2. ▶ Open the dialog window *'Safety program'* and click at [Load].
 - ⇒ A message window is shown about the possibility to load the default blocks together with the safety program. Answer with [Yes].
3. ▶ To activate the safety operation, perform a STOP/RUN transition.
 - ⇒ Now you have created a run able safety program.

Changing the F-address

1. ▶ Switch off DC 24V power supply of your System SLIO station and demount the System SLIO safety module 022-1SD00. Switch all the DIP switches of the F-address switch to 0 position.
2. ▶ Mount the System SLIO safety module and switch on the DC 24V power supply. Please wait for about 5s and switch the DC 24V power supply for the System SLIO module off again. Hereby the internal F-address memory of the System SLIO safety module is cleared.
3. ▶ Demount the System SLIO safety module again and switch the F-address switch to the address "201" (switch setting 0000 1100 1001).
4. ▶ Mount the System SLIO safety module and switch on the DC 24V power supply.
5. ▶ Open the hardware configuration for the application sample.
6. ▶ Open the properties dialog of the System SLIO Safety module 022-1SD00 and select the tab *'PROFIsafe'*. Change the parameter *'F_Dest_Add'* to the value "201".
7. ▶ Close the properties dialog with [OK]. *'Save and translate'* your hardware project and transfer it into the CPU. Then you can close the hardware configurator.
8. ▶ Open in the Siemens SIMATIC Manager the dialog *'Edit safety program'*. *'Generate'* your safety program and *'upload'* it into your CPU.
 - ⇒ The program is now executable with the new F-address.

Modification (changing parameters)

1. ▶ Open the hardware configuration of the application sample and select the VIPA053-1PN00-000 station.
2. ▶ Open the properties dialog of the module 021-1SD00 via double click and select the tab *'Parameter'*.
3. ▶ Change the parameter *'Channel 2,3: Input signal-smoothing [ms]'* from "5" to "6" and confirm your changes with [OK].
⇒ The properties window is closed.
4. ▶ Start the validation tool from the module 021-1SD00 with *'context menu → Start Device Tool → VIPA Safety CRC-Tool'*. Accept in the "VIPA Safety CRC-Tool" every parameter, calculate the CRC and copy the CRC to the clipboard. Then close the "VIPA Safety CRC-Tool".
5. ▶ Re-open the properties dialog and select the *'PROFIsafe'* tab. You will now be prompted to enter your password. Enter the password and confirm with [OK].
6. ▶ In the *'PROFIsafe'* tab open the dialog *'Change value'* of the parameter *'F_iPar_CRC'* and paste the copied CRC.
7. ▶ Close the properties dialog with [OK]. *'Save and translate'* your hardware project and transfer it into the CPU. Then you can close the hardware configurator.
8. ▶ Open in the Siemens SIMATIC Manager the dialog *'Edit safety program'*. *'Generate'* your safety program and *'upload'* it into your CPU.
⇒ The program is now executable with the new F-address.

Error acknowledgement

Acknowledgeable errors are implicitly acknowledged with a restart of the PROFIBUS or PROFINET communication e.g. by a STOP→START transition of the super-ordinated safety controller. Also, in the Siemens F-CPU it is possible to trigger an explicit error acknowledgement by generating an edge 0-1 at bit "ACK_REI" (0.2) in the automatically generated instance data block (F-DB) of the affected System SLIO safety module. In the example for the System SLIO Safety input module at I/O address 8 it is DB 410 with the symbolic name *'F00008_021_1SD00_DI4xDC2'*. With this data block error acknowledgement is possible with an edge 0-1 at DB 410.DBX0.2.



Please consider in terms of the error acknowledgment the according description of the safety controller.

Appendix

Content

- A Checklist planning**
- B Checklist installation**
- C Checklist commissioning, parameterization and validation**
- D Checklist modification and retrofitting**

A Checklist planning

Checklist

| Run. No. | Requirement | fulfilled | | Notes |
|----------|--|-----------|----|-------|
| | | yes | no | |
| 1 | Planning | | | |
| 1.1 | Was a risk evaluation established and were the required SIL and performance level according to DIN EN ISO 13849-1 or IEC 62061 determined? | | | |
| 1.2 | Are exclusively power supplies used according to PELV specification? | | | |
| 1.3 | Does the wiring take place after valid standards and guidelines? | | | |
| 1.4 | Is the power supply for the local I/O modules and field bus components correctly dimensioned? | | | |
| 1.5 | Do all the safety-related system components fulfill the requirements of the determined SIL (IEC 61508), performance level (DIN EN ISO 13849-1) and safety category (DIN EN 954-1)? | | | |
| 1.6 | Does the wiring of the safety components correspond to the requirements of the safety classification specified before? | | | |
| 1.7 | Do the components fulfill the environmental conditions of the application? | | | |
| 1.8 | Does the system fulfill the necessary degree of protection? | | | |
| 1.9 | Is degree of pollution 2 kept? | | | |
| 1.10 | Was the maximally permissible response time of the safety functions determined by a hazard analysis? | | | |
| 1.11 | Is the maximally permissible response time reached? Was the proof established by means of a calculation? | | | |
| 1.12 | Is the system protected against mechanical overloading? | | | |
| 1.13 | Is the system protected against aggressive media? | | | |
| 1.14 | Are the specified electrical values of the output terminals kept? | | | |
| 1.15 | Are all the electromechanical sensors supplied with clock pulses for the recognition of short-circuits? | | | |
| 1.16 | Was a list created, which contains all the parameters of the devices and its settings? | | | |

Date:.....Name:Sign:

B Checklist installation

Checklist

| Run. No. | Requirement | fulfilled | | Notes |
|----------|--|-----------|----|-------|
| | | yes | no | |
| 2 | Installation | | | |
| 2.1 | Is it guaranteed that the safety switch devices are not short-circuited due to a wiring fault? | | | |
| 2.2 | Is it guaranteed that the safety switch devices are not short-circuited due to a wiring fault? | | | |
| 3.3 | Was the wiring checked by means of the installation plan? | | | |
| 2.4 | Are all the plugs labelled according to their allocation? | | | |
| 2.5 | Are the connecting terminals with screws applied with the specified breakaway torque? | | | |
| 2.6 | Is guaranteed that the isolation of the lines does not lead to a faulty contact? | | | |
| 2.7 | Was the reliability of all the clamp connections controlled by a mechanical tensile load? | | | |
| 2.8 | Was a visual inspection of the installed components accomplished? | | | |
| 2.9 | Were necessary installation distances kept to other components? | | | |
| 2.10 | Do the components fulfill the environmental conditions of the application? | | | |
| 2.11 | Does the system fulfill the necessary degree of protection? | | | |
| 2.12 | Is degree of pollution 2 kept? | | | |
| 2.13 | Is the system protected against aggressive media? | | | |

Date:.....Name:Sign:

C Checklist commissioning, parameterization and validation

Checklist

| Run. No. | Requirement | fulfilled | | Notes |
|----------|--|-----------|----|-------|
| | | yes | no | |
| 3 | Commissioning | | | |
| 3.1 | Is guaranteed that all safe communication participants of a system have a clear safe device address (F-address)? This is valid also for participants, which belong to different safety controllers, if the controllers are connected by gateways (e.g. Ethernet). | | | |
| 3.2 | Is the station number of the safety controller correctly adjusted? | | | |
| 3.3 | Were the device parameters of the System SLIO safety modules validated? | | | |
| 3.4 | Was the safety cycle time determined and adjusted in the safety controller? | | | |
| 3.5 | Was the maximum response time with the adjusted cycle time proofed by calculation? | | | |
| 3.6 | Were the project data copied on a memory card? | | | |
| 3.7 | Was a complete functional test accomplished and documented? | | | |
| 3.8 | Was the service personnel instructed into the handling of the control system? | | | |

Date:.....Name:Sign:

D Checklist modification and retrofitting

Checklist

| Run. No. | Requirement | fulfilled | | Notes |
|----------|--|-----------|----|-------|
| | | yes | no | |
| 4 | Modification and retrofitting | | | |
| 4.1 | Is the modification/retrofitting compatible? Are the requirements of the checklists of planning, installation, commissioning and validation further fulfilled? | | | |
| 4.2 | Are the calculated reaction times further kept after modification/retrofitting? Proof necessary! | | | |
| 4.3 | Were the project data copied on a memory card? | | | |
| 4.4 | Was a complete functional test accomplished and documented? | | | |

Date:.....Name:Sign: